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FRUIT-GROWING IN ARID REGIONS

PADDOCK AND WHIPPLE

FRUIT-GROWING IN ARID REGIONS

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FRUIT-GROWING

IN

ARID REGIONS

AN ACCOUNT OF APPROVED FRUIT-GROWING PRACTICES IN THE INTER-MOUNTAIN COUNTRY OF THE WESTERN UNITED STATES, COMPRISING THE STATES OF COLORADO, MONTANA, IDAHO, UTAH, NEVADA, AND IN NORTHERN ARIZONA AND NEW MEXICO, WITH APPLICATIONS TO ADJACENT REGIONS

BY

22346

WENDELL PADDOCK

PROFESSOR OF HORTICULTURE IN THE COLORADO AGRICULTURAL COLLEGE AND EXPERIMENT STATION

AND

ORVILLE B. WHIPPLE

FIELD HORTICULTURIST IN THE COLORADO AGRICULTURAL COLLEGE AND EXPERIMENT STATION

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PREFACE

This volume is the outgrowth of over eight years' experience in inter-mountain horticulture. From the nature of our work, much time has been spent in orchards in the various districts, and Mr. Whipple, in the capacity of Field Agent in Horticulture, has been stationed for the past three years at Grand Junction, Colorado, the center of one of the most famous fruit sections in the Union. During this time the writers have become acquainted with the many problems that are of interest to the experienced orchardist and most perplexing to the novice, through personal contact with fruit-growers and at horticultural short-courses as well as through correspondence. Arid horticulture is very different in many respects from that of the humid states, and a fruit-grower from the East has much to learn. But the majority of our fruit-growers had no experience in horticulture before coming West, and many of them had little or no knowledge of country life. Such persons have everything to learn, and it is to them that this volume is especially addressed. Horticulture has only begun to be developed in the semi-arid West; consequently new settlers will continue to come to us for many years, and instruction in the elements of the art of horticulture will continue to be in demand.

The observing traveler is at once impressed with the intelligence of the people who are engaging in fruit-growing in the inter-mountain country. We find here people from all walks of life, attracted by the advantages of climate or the possibilities of money-making in a pleasant and healthful occupation. One may meet in a day's ride among the orchards, former doctors, lawyers, teachers, preachers, merchants, farmers, and young men recently graduated from an eastern university or college. It is such persons that create a demand for horticultural information, and their letters to officers of the Experiment Stations, while direct and intelligent, often would require one to write a book in order to supply the information. We have endeavored to meet this demand in the following pages.

The inter-mountain states include a vast territory, where a great number of different conditions exists, and inexperienced men are planting orchards in all parts of this region at the rate of many hundred acres a year. It is impossible to include everything of interest to the orchardist in a volume of this size; however, we hope to supply working information that will apply to the entire region; and in a general way this book should be of value wherever fruit is grown under irrigation.

Several of the chapters have formed the basis of experiment station bulletins, and the substance of most of them has been given many times at horticultural short-courses. The articles on Insects and Insecticides have been adapted from the numerous writings of Professor C. P. Gillette, Entomologist of the Colorado Experiment Station. The discussion on Live-stock on the Fruit-farm was prepared by Professor H. M. Cottrell, Superintendent of Farmers' Institutes in Colorado.

We are also indebted to other members of the College Faculty, for without their help and advice this work could scarcely have been completed.

WENDELL PADDOCK.
O. B. WHIPPLE.

AGRICULTURAL COLLEGE,
FORT COLLINS, COLORADO.
June 15, 1909.

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FRUIT-GROWING IN ARID REGIONS

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CHAPTER I

HISTORY AND DEVELOPMENT OF THE FRUIT INDUSTRY IN THE ARID AND SEMIARID WEST

Twenty years ago the idea that the inter-mountain states would ever become important in fruit-growing was scarcely thought of. The romance of mining and of cattle grazing was then at its height and but little thought was given to developing the agricultural resources. Fruit-growing is one of the highest types of intensified farming, so it is but natural that it is the last of the great resources of a new region to be developed. The same has been true of all new countries.

The idea prevailed in the early days that the semiarid part of the United States was destined to remain an unfertile and an undeveloped tract; and public sentiment is no small factor in the development of a country. Daniel Webster's speech in 1838, in which he characterized the entire region, beginning with the great plains and extending westward to the Pacific Ocean, as a "vast worthless area" could not be soon forgotten. Forty years later the horticultural side of the question was still being debated. W. G. M. Stone of Denver, writing in 1892, discusses this incident in the following apt words: —

"It was in 1838. A measure was before Congress to establish a post-route from Independence, Mo., to the mouth of the Columbia River. During the discussion, Daniel Webster, on the floor of the Senate, opposed it and closed his speech as follows: 'What do we want with this vast worthless area? this region of savages and wild beasts, of deserts, shifting sands and whirlwinds of dust, of cactus and prairie dogs? To what use could we ever hope to put these great deserts, or those endless mountain ranges, impregnable, and covered to their very base with eternal snow? What can we ever hope to do with the western coast, a coast of 3000 miles, rockbound, cheerless, uninviting, and not a harbor on it? What use have we for such a country? Mr. President, I will never vote one cent from the public treasury to place the Pacific Coast one inch nearer to Boston than it now is!' To stand here in this city of 150,000 people, to see these grand structures for business, these palatial homes, and think of the countless interests of trade and far-reaching enterprises; when we survey the state at large with its cities and towns, its growth and energy; and we take a still broader view and think of five great railways crossing the continent to this same rockbound coast, 'cheerless and uninviting,' and when we see these 'impregnable' mountains traversed with railways and yielding their ready millions of gold and silver, and find them also stored with coal and iron and marble, we wonder how Daniel Webster could have uttered such words as the above. Ten years later there was a change — the treaty of Hidalgo; and ten years after that the discovery of gold in the 'shifting sands' of this 'worthless' region. Had all possessed the same wisdom of foresight as Webster, this country had never reached 'Beyond the Mississippi,' and the Indian, the buffalo, the cactus and prairie dog would be in full and undisputed possession of it, and the Hudson Bay Company would be buying skins at Vancouver. Had every one been Websterian in his range of adventure, 'Pike's Peak,' the Union

Pacific, with all these Rocky Mountain railways, these cities, including San Francisco and the entire Pacific Coast, would to-day be with the unawakened atoms still floating in the primordial abyss of being. While Webster, with his giant strength, was holding this worthless region away from Boston, the Carsons, and Fremonts, and Gregories, and Greeleys, and their thousands of assistants were breaking his hold; and while at that time these mountains were sixty to seventy days from Boston, they are now within about as many hours, and becoming nearer and nearer with the opening of each succeeding decade. Humanity is stronger than any one man; enterprise more powerful than conservatism; exploration and discovery more potent than apathy and inanition.

"Daniel Webster sleeps at Marshfield; his words linger as curios. The energy and genius of his fellows and their posterity are converting these 'deserts' into gardens, and causing these mountains to pour their long-hidden treasures into the lap of the world. Strong cords of interest and fellowship now bind us to the Atlantic and the Atlantic to us, and Denver stands to-day in the midst of those cheerless realms of fancy pictured by the great statesman to attest the wondrous change on this half of our continent within a lifetime, and the memory of thousands.

"For fifty years the new states have one by one passed through a peculiar period of 'We can't raise fruit.' Illinois had it; and Wisconsin, Iowa, and Minnesota. It is like measles and chicken pox, 'must go round.' Colorado caught it when a mere infant and had it very hard. 'We can't raise fruit' was impressed on almost every mind from the very first. 'Too high!' 'too dry!' 'too cool o' nights!' too this! and too that! so that Fruit Culture was not admitted for many years, and when a few men less conservative than rash asked to enter apples at the annual exhibits, as Colorado Grown, they were subjects of legitimate suspicion as lunatics or knaves, — just as though they had 'salted' their gardens from a barrel of Ben Davis or Greenings from beyond the Mississippi. The stranger just arrived and full of the dreariness of the plains may smile at the mere suggestion of fruit in Colorado, and may ask, in the slang of the day, 'What are you giving us?' We shall offer neither bananas nor oranges, pomegranates nor figs, but shall beg to place before the mind's eye every kind of fruit grown in the belt north of Mason and Dixon's line."

The prevailing opinion that fruit could not be grown in the arid regions was fostered locally by the disastrous failures that resulted from many of the early attempts at tree-growing. But it is a difficult task for a man who may have been a successful farmer in the East to work out, unaided, the principles of irrigation. Failure often stimulates desire. So with the pioneers, they seem not to have been disheartened, and the repeated attempts finally proved to the world that fruit and forest trees can be grown. It surely took a man of courage in the face of almost universal opposition and no small amount of ridicule, to make the round trip from the Rocky Mountains by wagon to Iowa for a load of nursery stock. The general trend of public opinion was that this region was to be devoted forever to mining, and to some extent, to grazing. Anything like the present development in general agriculture was not dreamed of; and that it should ever become noted for the production of fine fruit is not yet realized by a majority of the people.

The Mormons were the first to grow fruit in the arid section. The history of their immigration to Utah, the hardships and privations they endured, are so well known that it would be out of place to recount them here, even if space would permit. In regard to their early efforts in fruit-growing, Mr. Anthon H. Lund, Historian of the Latter Day Saints, communicates the following:—

"In a General Epistle of the Church, dated 1847, to the Saints throughout the earth and signed by Prest. Brigham Young, the following paragraph appears: 'To all Saints, we would say, come immediately and prepare to go West, bringing with you all kinds of choice seeds, of grain, vegetables, fruits, shrubbery, trees, and vines, — everything that will please the eye, gladden the heart, or cheer the soul of man, that grows upon the face of the whole earth; also, the best stock of beast, bird, and fowl of every kind that shall tend to promote the comfort, health, happiness, or prosperity of any people.'

"On the 23d of July, 1847, the advanced company of the Pioneers camped on what was subsequently known as the 8th Ward Square of Salt Lake City. Apostle Orson Pratt called the camp together, dedicated the land to the Lord, invoked his blessings on the seeds about to be planted. 'What,' in the language of Apostle Woodruff, 'was to hinder the house of God from being established in the mountains, and exalted above the hills, and these valleys from being converted into orchards, vineyards, and fruitful fields.' The first successful plowing was done by Wm. Carter, and a company commenced the work of getting out water for irrigation.

"'By August the 26th,' the historian records, 'the colonists had laid off a fort, built 27 log houses, plowed and planted 84 acres with corn, potatoes, beans, buckwheat, turnips, etc.' Among the 'seeds' blessed by Elder Pratt and afterwards planted were peach, apple, pear, plum and other fruits. In due course of time these bore fruits, to the great joy of the people. Nor were shade trees lost sight of, for quarts of locust seeds were also put into the ground by the pioneers, and at this writing many of the pioneer shade trees can be seen in different parts of the city.

"During the year 1856 the Desert Agricultural and Manufacturing Society was organized for promoting the introduction, improvement, and multiplication of everything needful in land culture, stock-raising, manufactures, etc., suited to our varied conditions. Fruit-raising formed one of its principal considerations and industries.

"It has always been our custom to plant fruit and shade trees in the formation of new settlements at the seasonable time of the year. Our cities and towns and homes all over the inter-mountain region, including the neighboring states, Canada and Mexico, are embowered in and surrounded with fruit and shade trees, flowers, etc.

"Bancroft, the historian, states that in 1875 Southern Utah produced 544 acres of grapes, the total yield being about 1700 tons; and that the value of Utah's orchard products in 1883, including apples, — of which there were at least 90 varieties, — pears, plums, quinces, cherries, peaches, currants, and berries of many descriptions, was estimated at $157,000. The yield of apples was about 90 bushels to the acre, of pears 75, of peaches 120, of plums 165, and cherries 75." (Fig. 1.)

Colorado was probably the next to undertake fruit-growing, although it was not until fifteen years after the settlement at Salt Lake that the first attempt was made. The experience of the Mormons seems not to have reached the world at large, as we find that the first attempts at tree-planting near Denver were generally regarded as being impracticable. Fortunately, Colorado's early horticultural history has been recorded. Mr. Stanger, the author, is a pioneer, and as editor of the *Colorado Farmer* had much to do in finally impressing the people with the fact that fruit can be grown in the state. The following extract from Mr. Stanger is taken from the Report of the Colorado State Board of Horticulture for 1903:—

"In the early spring of 1862, Henry Lee, of Denver, sent from Iowa City to his brother, William Lee, then, as now, living on his farm in Jefferson County, four miles

Fig. 1.—An Elberta Peach Orchard, near Ogden, Utah.

east of Golden, 125 apple, peach, pear and plum stock; they came to Denver by express, and cost Mr. Lee $30. This nursery stock was planted on a little island in the Clear Creek bottoms, the spring they were sent. March 24, 1864, William Lee arrived in Denver with a mule team, bringing 6000 one- and two-year-old apple stocks, also 500 stocks each of peach, pear, plum and cherry, which he planted in a nursery on his island farm; then no one thought of planting anything on the uplands.

"May 27, 1864, a great flood in Clear Creek destroyed this nursery, and also all that was left of the 125 trees saved from a fire set by a careless hand to destroy weeds. Only about 150 of the 6000 trees were rescued from the débris left from the flood, and in 1866 these were set out in an orchard on Mr. Lee's upland farm. Many of these trees are living yet, and yearly yield crops of golden fruit, and look as if they will continue to do so for many years to come.

"In the spring of 1863, Hirman C. Wolf, of Denver, received by express a box packed with different kinds of fruit stock, principally berries and some apple, pear, and plum, for which package he paid $62. Owing to poor condition and lack of knowledge to handle the stock, they failed to grow.

"September 24, 1863, Mr. Wolf left Denver with a four-horse team and drove to Des Moines, Iowa, about nine hundred miles, for the purpose of bringing to this territory a full load of apple, pear, plum, cherry, and berry stock. Loading there, he, on the 3d day of November, started for Denver and arrived here on the 16th day of December, 1863. The stock he bought was buried, and in the spring of 1864 was set out in orchard, principally in the Clear Creek bottoms, but some on the uplands of Mr. Wolf's farm one mile south of Arvada, in Jefferson County.

"The great flood in Clear Creek in 1864 destroyed nearly all of the orchard planted in the bottom, and the lack of irrigation caused that planted on the uplands to perish. None of the trees of this costly experiment of Mr. Wolf's lives to-day, and it is only a reminiscence.

"In 1870, Mr. J. W. Cook, of Ralston Creek, Jefferson County, brought from Illinois a lot of orchard, berry, and grape stock, and set them out on his farm in that valley. Mr. Cook was a practical nurseryman in Illinois, but failed to succeed in Colorado with Illinois methods of tree culture. He was an enthusiast and somewhat erratic, but he did make a success of his orchard and vineyard, and taught us many a profitable lesson. He has been dead many years, but neither he nor his enthusiastic endeavors to impress all with whom he came in contact as to the possibilities of Colorado for fruit-raising are forgotten.

"Henry Lee, in 1870, brought from Iowa fifteen thousand nursery stock and sold these from his place of business in Denver to many customers, most notable of whom are David Brothers, Mart L. Everett, Joseph Morris, Wilson Perrin, and others, principally located on Wheat Ridge, a suburb of this city. Many of these trees are living to-day and yearly produce crops of apples.

"As nearly correct as can at this time be positively determined, the late Wilson Perrin started in 1869 or 1870 the first nursery in the territory of Colorado on his farm on Wheat Ridge, four miles west of Denver. His example was soon followed by others, notably H. G. Wolfe, of Denver, and G. W. Webster, of Longmont, Boulder County, Colorado, and J. W. Cook, and also, about the same time, nursery stock was set out in the Union colony at Greeley, Weld County. And here permit me to digress and read to you part of a private and characteristic letter from the Hon. J. Max Clark, in reply to an inquiry of mine for facts on fruit-raising in the Union colony.

"Mr. Daniel Stanley, a settler in Boulder County, in 1865, brought by mule team from Iowa a lot of orchard stock and sold them to his neighbors, notably of whom were G. W. Webster and J. W. Goss, of Hygiene, Colorado. I here incorporate into this address an extract from a letter of a late date from the latter gentleman. He says, writing of Stanley's venture: 'I bought six out of this lot and set them out in 1866. I paid for six trees, $30. Four of those six trees are alive to-day, and have been bearing since about the fourth year after setting out. Two of them are yellow sweets (I do not know the name), one is Red Astrachan, and the other is a winter variety, something like the Ben Davis, but better in flavor.'

"In 1870 Mr. G. W. Webster planted a considerable orchard, the trees being brought from California, and for years was an ardent and persistent advocate of the possibilities of Colorado for fruit-growing, and was one of the first, with William Lee and J. W. Cook, to exhibit home-grown orchard-fruits at the yearly fairs of the agricultural association of Colorado. Others there were in northern Colorado who planted about this time orchard-fruits, but who, from modesty or other reasons, kept their light under a bushel, and I have not been able to bring them to the light of history.

"In 1864 or 1865 Mr. Jesse Frazier, of Florence, Fremont County, Colorado, brought from Missouri, by team, a quantity of different varieties of orchard-fruit stock, and set them out on his farm at that place. In the files of the *Colorado Farmer* is a letter to me, giving a full history of this venture of Mr. Frazier's; but these files are not now accessible. This nursery and orchard was the nucleus from which has sprung the grand achievements of the orchardists of the Arkansas Valley. His example was followed by Mr. Helm and others. I have been disappointed in obtaining more definite information of Mr. Frazier's orchard, but the honor is to him for being the pioneer orchardist of this grand fruit-growing section of our state.

"So far as I have been able to definitely ascertain, the above-mentioned efforts were the beginning of planting of orchards and nurseries in Colorado. In 1874, 1875, and 1876 strenuous endeavors were made through the columns of the *Colorado Farmer* to arouse an interest in this branch of agricultural industry, and the results were favorable. Rarely were there heard any wails from the disapproving Jeremiahs. These prophets no longer had any honor in the land; pessimists there were, but many more optimists could be found. The chief kick was, it would not pay. Nurseries were planted, and they prospered — some more, some less."

The history of fruit-growing in the various other parts of the West from the early sixties is much the same. In most cases it has meant hardship and the expenditure of much time and money. Gradually, orchards became established in a few localities, and as travel increased, the fact that fruit could be grown in the mountain regions became common knowledge.

Commercial fruit-growing in the arid region is of very recent date; in fact, the first important shipments of fruit to points outside were made by the Fruit Growers' Association of Grand Junction, Colorado, in 1897. Since this time development has been rapid. There are now many thousands of acres planted to orchards, and the available territory is being constantly increased by the construction of new irrigation projects. In response to the unprecedented demand for land, not only are the new lands being developed, but the large ranches are being divided. Thus history repeats itself, as it is well known that irrigated countries are the most densely populated and that they average the smallest farms in the world. This is due largely, if not entirely, to the fact that the water supply being under control, each acre may be made to produce a maximum crop. It has been estimated that one acre of good irrigated land, intelligently cultivated, will produce a far better living for a man and his family than can be purchased by 60 per cent of the average wage earning of the American factory hand.

Irrigation divides and subdivides lands into small home tracts. The best examples of communities of small farms in the United States are to be seen in various parts of California. Here may be found collections of farms of a few acres in extent, and each self-supporting and in many instances yielding the owner a good income. These communities often extend over hundreds of acres, and yet the homes are so close together as to suggest to the traveler that he is passing through the suburbs of a large city.

This centralizing movement has already begun in the Rocky Mountain region, as one may see by visiting the more prosperous communities in any one of the several states, such as the Grand Valley in Colorado, the Cache Valley in Utah, the Willammette Valley in Oregon, the Yakima Valley in Washington the Payette Valley in Idaho, Bitter Root Valley in Montana, the Mesilla Valley in New Mexico, and many others. We may confidently expect to see this movement increase very rapidly in the near future, and the basis of this intensive farming will be the various horticultural products.

CHAPTER II

LOCATION, EXPOSURE, SOILS, AND WINDBREAKS

THE stranger who is about to locate in the inter-mountain states is often at a loss to know why all localities at the same altitude are not equally well adapted to fruit-growing. In a few favored localities peaches are successfully grown at an altitude above 6000 feet. But on the eastern slope of the mountains no peaches are grown commercially without winter protection where the altitude is only 5000 feet. Occasionally crops of peaches are produced in the lower Arkansas Valley, and in some favored localities on the plains where the elevation is much less. But in general, it may be said that, as a rule, fruit cannot be grown to any extent at an altitude much above 5000 feet, and at this height much depends on the protection afforded by the mountains.

Generally speaking, the fruit belt on the eastern slope of the Rocky Mountains, with the exception noted above, consists of an irregular area along the foothills not over ten miles in width. Beyond this distance the limits of the profitable production of tree-fruits at present are soon reached. Success is due to the protection afforded by the mountain range from drying winds and hailstorms, from cold in winter, and from late spring frosts. Small-fruits, which may be given winter protection, are grown in any situation where the common grains will mature.

The narrow valleys in the foothills are especially well adapted to fruit-growing, and some of these, where irrigation is possible, support very prosperous communities. Such locations are especially favorable for growing fruit, not only because of the protection afforded by the hills, but because a breeze invariably blows down the cañons at night and prevents many frosts.

All orchards that are located away from the hills, even a short distance, should be protected on the west at least, and preferably also on the north as well, by a windbreak.

The question of air drainage is always important, but cold air is not nearly so likely to become "pocketed" here as in the states farther to the east. However, low lands that are not affected by a night breeze should be looked upon with suspicion until they have been tried.

In the inter-mountain region proper, the fruit lands are more confined to comparatively narrow valleys that are protected by high mountains on all sides and that are also likely to be favored by an evening breeze. This protection, producing warmer and milder and more stable winter weather, as well as less liability to late spring frosts, together with good soil and an abundant water supply, makes an ideal fruit region. But even in the famous peach-growing districts, frosty places are likely to occur. We have in mind two examples that illustrate this point. One famous locality, which has never had an entire failure of the peach crop, and where vinifera grapes are also grown, is located at the mouth of a cañon. The night breeze down the cañon is almost a complete insurance against late spring frosts, for a distance of one to four miles down the valley. Beyond this rather indefinite line, frosts occasionally occur. In another near-by equally favored neighborhood, two narrow valleys come together and form a broader valley. Below this point for several miles, and in the narrow valleys as well, the night breeze is almost certain insurance against damaging frosts in the late spring. But at the intersection of the two valleys there is an abrupt mountain, and at its base there is a small area where the night breeze is not so noticeable. The orchards that are located here have been damaged by frost, while those both above and below have escaped. A dozen miles below this point, where the valley is much wider, a part of it has the reputation of being "frosty," while the adjacent mesas are much more favorable for fruit-growing.

Soils

The average soil of the arid region will grow good apples, but preference should always be given to the deep loams that have good natural drainage. These loams may be either clayey or sandy. Those that have a predominance of clay are perhaps the stronger and more lasting, but the red sandstone soils are much more easy to work and to keep in good tilth. Heavy adobe soils should be avoided, as they are difficult to till, and are also difficult to irrigate properly. Shallow soil should also be avoided, particularly for apple-growing, as the fertility is soon exhausted; but what is more important, the roots of the trees spread out near the surface, where they are exposed to the influence of sun, frost, wind, and drought. While it is true that many fairly good apple orchards are growing on this kind of land, it is difficult to keep them in good condition.

The one thing that all semiarid soils is liable to be lacking in is organic matter. The climatic conditions are such that this important soil constituent is rapidly exhausted, and many orchards, particularly in the newer sections, are planted on desert land that was given no preparation except clearing and plowing a few furrows for the tree rows; the space between the rows was plowed as time permitted. These soils contained almost no vegetable matter when planted, and as clean cultivation is nearly the universal practice, but little has since been added.

One of the more important actions of decaying vegetable matter is that it tends to prevent clayey soils from becoming hard or puddled. It is a noticeable fact that toward the middle or latter part of the season, soil that appeared to be in good tilth in the spring gradually becomes more and more compact, until finally, in the worst types, it becomes almost impervious to water. Measurements taken in such an orchard in August will illustrate this point. Water had been running in the furrows twenty-four hours. Two furrows between each two rows of trees were supposed to be sufficient to irrigate the orchard, allowing the water to run twenty-four hours. Measurements taken just after the water had been turned off showed that the moisture had penetrated to a depth of only eighteen inches, and twenty-eight inches laterally. It is obvious that trees should never be planted in such soil.

There are a great many acres of such land planted to orchards, and it is safe to say that the most of it will sooner or later be given over to the growing of alfalfa, grain, and similar crops. In its native state such land usually develops a rank growth of grease-wood (*Sarcobatus vermiculatus*), and is commonly known as grease-wood land. In some regions there is a strong prejudice against using grease-wood land of any description for orchard purposes. However, this is certainly carrying a prejudice too far, as many of our most valuable orchards are located on land which must come under this general description. Some of this land is sandy, and therefore is easy to work at all times.

Sage-brush land, on the other hand, is usually good orchard land. It derives its name from the fact that in the wild state the characteristic vegetation is the so-called sage-brush (species of *Artemisia*). This shrub often grows over extensive areas, to the exclusion of all other woody plants, and on the higher mesas there is often a mixed growth of sage and cedar or piñon trees. This type of soil contains more sand and gravel, is not inclined to bake, irrigates easily, and consequently is one of the best types for orchard purposes.

So-called volcanic ash soils are common in Idaho and other parts of the Northwest. The origin and composition of such soils are imperfectly understood, but that they are well adapted to the growing of fruit has been clearly demonstrated. A. L. Knisely, formerly chemist of the Oregon Agricultural College, has the following to say in regard to them: "There are certain regions, especially in eastern Oregon and adjacent states, in which part of the soil is known as volcanic ash soil. Soils which have this name are usually very uniform and are exceedingly fine; some of them are of considerable depth. The supposition is that their origin was from some volcano, probably in our region from Mt. Hood, which is almost an extinct volcano, though not quite, since at the present time considerable fumes of sulfur and steam are given out from the old crater. I might also add that this soil is exceedingly rich in mineral plant-food, especially in potash and phosphoric acid, and seems to be almost inexhaustible when the supply of humus and nitrogen is kept up in it.

"I believe some think that some of this soil was thrown out as a dust from the volcano, others that it is disintegrated lava. This may give you some idea as to what we term volcanic ash soil."

Such soils, in common with others of the region, are deficient in vegetable matter, and consequently the nitrogen content is low. This feature may be corrected by the judicious use of shade-crops in the orchards and by growing alfalfa before the land is planted to trees.

Some instances occur where it is difficult to grow trees successfully because of excessive drainage. The soil is so loose in its make-up that water rapidly sinks and is soon lost. This character might be corrected, to some extent at least, by the addition of organic matter, which may be best supplied by plowing under green-manure.

The Subsoil

The subsoil is as important as the surface soil; this is a feature that is often overlooked and on which the uninitiated are often deceived. Mesa lands are often shallow, being underlaid with a layer of marl, gypsum, or shale.

Gypsum rarely occurs, while marl is common, but the casual observer is not able to distinguish between the two. They are usually light-colored, chalky materials, and may occur in compact layers or mixed with earth. If the layer is compact and near the surface, naturally the soil is shallow, and so the plant-food is soon exhausted. While it is true that tree roots may penetrate these layers, the majority of them do not do so, but rather spread out laterally, thus producing a shallow-rooted system. Here the roots are exposed to sun and frost, and as the soil is easily dried out, constant care is necessary to keep the trees in good condition. It is on such soils that the so-called tuft blight, or rosette, of apple trees occurs, and where stunted trees with yellow foliage are often seen. Much of the fruit grown under these conditions is undersized, and thus but comparatively small amounts can be marketed as first-class.

With proper attention to watering, cultivation, and fertilizing, much can be done to ameliorate such subsoil. In fact, a few growers are meeting with good success with orchards on this kind of land. A system of green-manuring, as set forth under the head of Shade-crops (Chapter XII), would be of special benefit under these conditions. It has also been found by experience that certain varieties of apples are much better adapted than others to such soils.

The base of both gypsum and marl is lime; and it is thought by some investigators that the lime in the marl is very harmful to fruit trees. Whether this is true in the case of marly soils of this region remains to be determined.

Very rarely what are known locally as cement soils are found. For some reason, which is not known to the writers, such soils cannot be made to take enough water, by ordinary methods, to support trees and keep them in a vigorous condition. In a few instances orchards planted on this kind of soil have been relieved by digging several holes around each tree. A post-hole digger was used for the purpose, and the holes were filled with coarse manure. Water was then turned on, and the results indicate that the ground became well moistened.

Sinking Land

Land that settles when water is applied is known as sinking land. Some of the highest-priced peach orchards are located on such areas. To all outward appearances this land does not differ from that found in many other places. No hint as to this peculiar characteristic is gained from the general looks of it; but when irrigation is attempted, irregular patches, here and there, settle four or more feet, and in some cases cracks occur that may extend into the ground to a depth of fifteen feet. Such an occurrence is surely alarming, to say the least, to the uninitiated.

In one locality, where there is a small tract of such land, the owner attempted to establish an orchard, and planted the trees before the land had been irrigated. At the first application of water, spots of land here and there began to sink, and deep cracks were formed. Of course it was impossible to save the trees with the land in such condition, and the owner was obliged to give up. This type of land may usually be "settled" in one season if water is persistently applied. It often requires more time, however, and as the "settling" is very uneven, much leveling is required in order to fit the land for cultivation. The tendency to settle appears to be due to the porous condition of the subsoil.

Seepage

The presence of an underlying stratum of shale within six feet of the surface should always be looked on with suspicion, and as a rule, such land should be avoided for orchard purposes. Wet or "seeped" places are bound to occur as irrigation increases, for the reason that the water cannot escape except by evaporation. Consequently, the level of the water in the soil gradually rises until it comes to the surface. This may occur only in small spots which do no great amount of harm, but usually these areas gradually spread until from a few to many acres are involved. Large tracts of valuable orchards have been ruined in this way.

An impervious layer of clay is also sometimes found which has the same effect as shale. There are other peculiar formations which tend to hold water. One which is more or less common occurs in soils that are rather deep and porous but not stratified. Water moves easily among the particles of such soils, but not to any extent laterally, as is the case where strata occur. Such soils are very likely to become seepy, especially when they occur at the lower levels, and when irrigation is practiced on the higher lands adjacent.

According to surveys made by the Bureau of Soils of the United States Department of Agriculture, however, by far the greatest amount of damage by seepage in the fruit regions is due to the gradual rise of the level of water in the ground, and which is caused by excessive irrigation. Under these conditions any soil that is at all retentive of moisture may become wet. This is especially true of the low-lying land where the adjacent higher lands are irrigated.

A rational use of water in irrigation will, of course, lessen the damage by seepage, and by conservative and intelligent drainage, practically all seeped lands should be reclaimed. Moreover, in the case of fruit regions, the high price which such land brings will usually make drainage profitable.

Alkali

In brief, alkali land is always seeped land, or at least the efflorescence of alkali upon the surface of the ground can occur only where the evaporation of water takes place. It is rare indeed that soil in the virgin state contains enough of these salts to be harmful to the ordinary orchard and farm crops.

The name alkali is comprehensive, and includes the salts of sodium, potassium, magnesium, and calcium. The so-called black alkali, sodium carbonate, occurs but rarely in the inter-mountain fruit regions. These substances are all more or less soluble, and may occur in any soil formation. Originally they were constituents of certain rocks, particularly feldspars, from which they are dissolved. They are taken into solution and carried to the fields during irrigation, where they may be deposited by evaporation. But such deposits rarely occur in sufficient amounts to be harmful; therefore it may be safely assumed that alkali never collects in excessive quantities in cultivated land where there is a free downward movement of water, and that the reclamation of alkali land, where black alkali is not present, is largely, if not entirely, a question of drainage.

But little can be said here on the practice of drainage where irrigation is practiced, for the reason that an engineer should usually be consulted. The problems are quite different from those that are involved in the humid states.

It has long been the notion that many crops cannot be successfully grown in soil strongly impregnated with these salts. This would be true with black alkali, but after many years' study of Colorado soils and a great many analyses of soils from all parts of the state, Dr. Headden has never been able to find more than a trace of this substance. Moreover, he finds that all of our common vegetables, orchard and farm crops, thrive in soils that contain as high as 4.69 per cent, or 160,000 pounds per acre, of soluble white alkalies in the first foot of soil.

We may therefore safely conclude that alkali is responsible for little or no damage in this region. But where it collects in excess, we may be sure of the presence of free water. Alkali, then, is a question of seepage, and the death of trees and crops on such land is due, in a large measure at least, to water.

Soil Surveys

It should be mentioned here that the Bureau of Soils of the Department of Agriculture is doing a valuable work in making surveys of soils, although these surveys are yet confined to relatively few regions. This work comprises mechanical analyses of soils, the determining of the nature of subsoils, the cause of seepage, as well as other features of a similar nature. The questions of climate, physiography, and geology are also considered. A fairly accurate map accompanies the descriptions, in which is given the location of the different types of soil and other important features.

Such work requires a great deal of time; consequently, but a comparatively small amount of the total area of the United States has as yet been surveyed. But fortunately a few regions in the Rocky Mountain states have been surveyed, and any one who is interested in fruit-growing or in farming in general will profit by reading these reports. By making a study of such a survey one can readily determine, within limits, to be sure, the kind of land that is best adapted to different crops, and where it is located.

Windbreaks

The fruit districts of the Rocky Mountain region are not subject to severe winds, and in the best fruit sections a windbreak would be a nuisance. But in some of the lesser fruit regions conditions are such that a protection from wind will usually be a great help. The winters are commonly dry, and no provision has yet been made for winter irrigation. Consequently, when winds occur, even though they are not severe, their effects are severely felt. Scarcely a winter passes but that many young trees perish under such conditions simply by becoming dry, — the common cause of most of the so-called "freezing dry." Windbreaks will certainly be a great aid in preventing this loss, at the same time being beneficial in many other respects. If fruit is to be grown at any considerable distance from the foothills, protection from north and west winds will be essential in most localities.

Every farmer owes it to his family to see that an abundance of fruit is provided for their use. But in the strictly agricultural districts, even the kitchen-garden is often wanting. The lack of a garden is due to neglect in many instances, but the sentiment seems to prevail that fruit-growing is impossible, even for home consumption. But a few people in almost every locality, where there is any possibility of fruit trees growing at all, are proving that, with suitable protection, much may be accomplished.

Windbreaks, as the term implies, are plantations of trees or similar plants intended to check the force of the wind. They may be used to lessen the drying effects of winds both in winter and in summer, to prevent injury or loss to fruit in autumn, and to check or deflect the cold winds of winter from yards and buildings. Windbreaks for the last purpose are usually called shelter-belts, and are often several rods in width.

The location of the windbreak will depend, of course, on the direction of the prevailing winds. For general purposes, the north and west sides of the area are the ones along which the breaks are planted in most parts of the West. Shelter-belts should be planted far enough from buildings so that drifting snows on the inner side will not be an inconvenience.

The simplest kind of windbreak is formed by planting some one species of tree in a single, close row. If a tall-growing tree is used alone in this way, there is a tendency for the trees to spindle up, and in time the trunks lose their lower branches. Such an arrangement may do very well for a time, or where only partial checking of the wind's force is desired. But where more complete shelter is desired, it is usually necessary to plant several rows of different species, so arranged that the low, dense-growing kinds will fill in the places between the taller ones.

For the taller-growing tree in this region the common cottonwood may be used, setting the trees about eight feet apart for the outer or north and west rows. A second row of some denser-growing kind should be planted about eight feet from the first and as close as four feet in the row. For this purpose box-elder is a suitable tree, except in dry situations, in which case the green ash is recommended. The trees in the third row may be planted as in the second row, using a more compact-growing kind. The Russian golden willow is recommended for this purpose as a rapid grower. The Russian olive (*Elæagnus*) is a more compact tree of lower growth and is particularly desirable. White or American elm is also a suitable tree for the inner rows in many places, particularly where a fair amount of moisture can be depended on.

In cases where the wind is exceptionally strong, it may be necessary to plant a belt four or five rods wide, in order to secure complete protection. The outer two rows may consist of Russian olive, the third and fourth rows of black locust, the fifth and sixth of box-elder or ash, the seventh and eighth of American elm, and the inner two or three rows of cottonwood or Carolina poplar, the rows being about eight feet apart. The Russian golden willow may be used in place of the elm, and honey locust may take the place of the black locust.

CHAPTER III

PREPARATION OF LAND FOR PLANTING

A STUDY of the preceding chapter has at least suggested to the reader that there is variation in types of soil found in our Western mountainous regions; and in presenting a chapter on the preparation of the land for planting it must be realized that it is impossible to lay down a set of rules that will fit all cases. That the formation of the soil varies is not so surprising as that it varies in unexpectedly small areas, a condition of affairs that is not so commonly met on the plains. The foregoing chapter has suggested important points to be observed in choosing land for orchard purposes; if in this chapter we mention methods of handling types of soil that are there classed as undesirable for orchard purposes, it is not because we are divided in our opinions; but we realize that in the eagerness to plant orchards, some of the warnings of the previous chapter will be disregarded, and suggestions on handling all types of land will be timely.

The type of soil will, in a way, dictate the course to be pursued in preparing it for the young orchard; but there is one maxim that will hold good in all cases, and that is, "what is worth doing at all is worth doing well." Too often the orchard is marked for life by being planted on land improperly prepared; as improperly leveled or plowed, or, as sometimes occurs, plowed only where the tree rows are to be placed. While the majority of our young orchards have been planted on raw land, it is no doubt true that best success is attained by planting on land that has been previously cultivated and irrigated. Men who are in a position to make comparisons have intimated that fruit trees of the arid region are shallow-rooted, and if this is true, it can no doubt be attributed to setting on new land; the subsoil is dry, and the roots of the young tree seek the moisture supplied by the first irrigations. It requires several years to get some soils moistened to the depth that tree roots normally go.

Orchards on raw land are more difficult to irrigate the first season, and as a rule poorer stands are secured. From the observations of several seasons it would seem that, in the long run, it would pay to crop the land at least one season before planting the orchard. The texture of some of our heavier soils and the water-holding capacity of some of our lighter mesa lands would be greatly improved by plowing under a good green-crop of some kind. Cropping the proposed orchard site for one season with a grain crop not only puts it in better physical condition and insures a better growth and stand of trees, but largely does away with the annoyance of releveling among young trees, a condition that must be contended with in planting young orchards on some types of raw land. Young orchards on alfalfa land, properly prepared, make even a better showing than those on areas previously cropped with grain.

Settling and Leveling

In the arid regions there are types of land (as indicated in Chapter II) that settle from one to three feet when irrigation water is applied; such areas should be thoroughly watered before an attempt is made to level them. As a rule the higher knolls settle most, and leveling before settling often moves soil that must be moved back after the process of settling is completed.

One of the first steps in preparing such land for planting is to plow furrows and run water as high as possible on these high places. As a rule they will sink to a level with the surrounding land; in fact, the presence of these knolls is often considered an indication that the land will settle. The settling cannot be completed in a few days, but the bad spots will go down, and future settling is gradual, and seldom seriously affects the general lay of the land. While the settling may continue for three or four years, land that has been properly watered the first season seldom settles so much but that it may be easily releveled without disturbing the trees. The soils that settle most are those built up by a decomposition of shale and sandstone, and while they generally lay comparatively level, the surface is more or less undulating.

Orchard land should be well leveled before an attempt is made to plant it; leveling after the trees are planted is very unsatisfactory, to say nothing of the difficulty experienced in watering the young orchard on land improperly leveled. It need not be a uniform grade all over the area, but the grower should have it in such shape that he can form a definite plan for irrigating it. Few fruit-growers go to the trouble of going over the land with a surveyor's level, although it would pay in many cases. We have seen fields broken by having a head ditch run across one corner when the level would have shown that the ditch could have followed the border just as well. Men who are used to it, however, can grade well by eye, and find little use for the level. Several forms of grading tools are on the market, most of them much more convenient than the common scraper.

With soils that wash easily and where there is no danger

Fig. 2. — Leveling with Water.

of seeping lower lands, high knolls may be easily moved to lower levels by washing with irrigation water. It is surprising how quickly a hill may be moved with a small stream of water. The water is carried by gravity, or with a pump, to the highest point of the hill, and when released over the side, carries the soil to the low places, where it is caught by a dike. (Fig. 2.)

In grading, the important point is to see that water can be run on all the land, and that no low places are left without outlets for waste water. A little care in leveling will save one much labor and inconvenience in watering; in one case the water will only require setting, and in the other constant attention. The expense attached to starting the young orchard is heavy, and there is a temptation to set the trees and do the leveling at leisure times afterward; but such a course cannot be commended, and often means disappointment. The man who makes a success of growing the young orchard is the one who has too much pride to allow himself to slight the work in any way at the outset.

Plowing

Fall-plowing is in many ways desirable for the proposed orchard site. The soil is exposed to the action of the weather, which not only improves its texture but liberates plant-food. Fall-plowed land settles well before spring, and waters easily, while spring-plowed land is often irrigated the first time with difficulty. The water spreads too rapidly in the spring-plowed land, and this is especially objectionable with the heavier soils, as it tends to run the particles together, resulting in puddling and subsequent baking. When it is proposed to plant crops between the trees, fall-plowing provides a much better seed bed than spring-plowing.

Fall-plowing is objectionable, however, in sections frequented by heavy spring winds, as the finely pulverized surface soil blows easily. Yet this difficulty can be largely overcome by an early spring discing.

Land that has been plowed in late winter or early spring should be well worked down with the disc and harrow before planting, and if this is thoroughly done, less difficulty will be experienced in the first watering. In cold, backward springs, young orchards have been seriously injured by a flooding of the surface in an attempt to water newly plowed land without first working it down. While young orchards may be started well on spring-plowed land, most men of experience will agree that the earlier the plowing can be done the better.

The land selected for the new orchard, whether raw, or that which has been in cultivation, should be plowed to a good depth. The fact that land has been previously plowed and cultivated is often an argument in favor of more thorough preparation rather than a suggestion that the work may be slighted. There is no doubt but that careless handling has put some of our heavier soils in worse condition than they were in their native state. Alfalfa land should be well plowed if it is to be planted to young orchard. Turning the sod with a good sharp plow with an extra long share will save much labor in killing out the alfalfa the first season, for when once an alfalfa plant is cut off below the crown, it does not sprout from below; but a portion of a crown attached to a taproot is a trouble maker. When the crown is severed from the taproot and buried, it may throw up sprouts, but a little deep cultivation soon discourages them.

Some persons recommend the use of the subsoil plow in breaking up subsoils that are inclined to be hard. It may be that this tool could be used successfully to break up the marly subsoils of our thin mesa land and loosen some of the heavy soils that refuse to take water. In most cases it would hardly pay to subsoil the whole area, but subsoiling a few furrows near where the tree row is to stand could hardly be a mistake. It would aid the water in reaching the dry subsoil and encourage deeper rooting of the young trees.

In extreme cases giant powder has been used to break up hard subsoils, and has apparently given good results. There are only a few instances in which such a course can be recommended, but it is possible that with some of our mesa soils, which are underlaid with marl, it will prove to be worthy of trial. While one could hardly advise the planting of an orchard on a large body of land requiring such preparation, it is true that small spots that might be benefited or overcome by such treatment are often found in large bodies of good orchard land, and rather than have a break in the orchard plot it may be well to attempt to correct the fault by breaking up the subsoil. To apply this treatment, a bar is driven down where the tree is to stand, and a charge of dynamite, heavy enough to lift all the soil above it, is placed three feet below the surface.

CHAPTER IV

PLANNING AND PLANTING THE ORCHARD

One of the first problems in projecting the orchard is to decide what kind of fruit to grow. In planting the commercial orchard, the grower must escape from his old idea of the home orchard, where everything was supposed to grow, and be content with a few varieties of possibly one kind of fruit. We hear on every hand that this is a day of specialists, and the fruit-growing industry is no exception. The scientific as well as the practical farmer advises diversified farming, the rotation of crops being conceded to be the simplest and most economical method of maintaining the fertility of the soil; but in fruit-growing, where the ordinary rotation of crops is out of the question, the orchardist has learned that it is more profitable to do one thing and to do it well. General farming and fruit-growing do not go well together, and the promiscuous growing of fruit harmonizes little better. However, the man who is capable and in position to handle an apple, peach, and pear plantation probably reaps a more uniform annual return than the one who stakes all on one of the three. That few men are capable of handling large orchards is a fact worth remembering, and large orchard enterprises must be promoted cautiously. The men who are making the most money in our best fruit regions are those handling ten- and twenty-acre orchards.

The chapter on "Location, Exposure, Soils, and Windbreaks" has been introduced not alone with the idea of helping the fruit-grower to choose orchard localities, but to provide help in solving the problem as to what kind of fruit to grow. The chapter has suggested that certain types of soil are best adapted to growing particular kinds of fruit, and it has mentioned sites and locations suitable for growing fruits that frequently suffer from untimely frosts.

In a way, the size of the orchard will determine what shall be planted. It is easier to handle — at least to harvest and market — ten acres of peaches and ten acres of apples than to harvest and market twenty acres of peaches; and, as far as it is practicable, the orchard should be planned with the idea of handling the maximum amount of fruit with the minimum force of help. Unless the locality seldom suffers from late frosts, the fruit-grower cannot afford to plant peaches alone; and where the peach crop is uncertain, there is surely more money in growing apples and pears.

What fruit one shall grow is often determined by the distance from a shipping point. Peaches cannot be hauled by wagon over any great distance, and this one factor may make an apple-growing district of a natural peach region. The questions of help and transportation must also be considered, for these are more serious problems in peach-growing than in apple-growing; peaches must be handled promptly, and delay generally means loss.

Varieties

The man who must sell his fruit through coöperative associations or commission houses, has learned that he must confine himself to a few recognized commercial varieties, for, to sell to the best advantage, he must have quantity as well as quality. All things considered, the orchard with a few varieties is more easily cared for and the crop more easily handled. The grower who lives near a large city where he can sell his fruit directly to the consumer or the marketmen, may adhere to the old type of orchard with a varied assortment of fruits and a succession of varieties; but the grower more distant from his market cannot hope to make a financial success of the ten-acre orchard planted with the idea of furnishing him employment the year around and a continuous picking season. The length of the season, the soil, and the demands of the market, all have a part in determining what varieties should be planted, and they will receive further attention in the discussion on varieties (Chapter XV).

Selection of Trees

The choice of trees is a matter of primary importance, and it should receive very early consideration in planning an orchard. It is very often true that the man who plants an orchard has only a vague idea of what constitutes a first-class tree, but the man is to be pitied more who knows a good tree, and then plants a second-class one because it is cheaper. Cheap trees are seldom, if ever, a bargain; the grower should insist on having first-class trees and should be willing to pay for them. The question of where the trees are grown does not seem to be so important as some persons are inclined to think. Provided the trees reach the grower in good condition, it probably matters little where they are grown. As a rule, the southern-grown trees have given as good satisfaction in the West as those grown in the northern nurseries.

Provided the trees are equally strong and clean, it seems to matter little whether they are budded or grafted, or how they are grafted. Yet we often find growers who are prejudiced toward one or the other, and nurserymen who are ready to contend that, on account of their peculiar method of propagation, their stock is superior to all other.

As a rule, the budded stock shows less crown gall than the grafted stock. The average yearling bud is larger than the average yearling graft, has a better root system, and with equal chances, makes a better growth in the orchard the first season. As yearlings, both the budded and the grafted tree are mere whips, and may be headed to suit the grower. The two-year-old budded tree is generally too large to plant, and, like the two-year-old graft, stands a chance of having been spoiled by improper training in the nursery. First-class yearling root-grafts are very satisfactory trees to plant, although they will not make as good growth the first season as most yearling buds or two-year-old grafts; the root system is not well developed. Good "stands" are generally secured with the yearling grafts, however, and if the purchaser insists on getting first-class stock, — trees that are three feet in height, and caliper better than three eighths of an inch, — he will not be disappointed in the results. When it is possible to get a two-year-old graft properly headed, it is a very satisfactory tree to plant. With equal chances, it makes as good if not better growth than the yearling bud during the first season in the orchard, and gives equally as good "stands." Unless the purchaser is quite sure, however, that the two-year-olds are well headed, he should buy the yearlings instead. First-class one-year-old budded trees probably give as good satisfaction as any.

In the arid states, at least, the age of the tree at the time of setting seems to have little to do with the age at which the orchard comes into bearing, so that one really gains nothing in setting trees too large to start well.

June-budded peach trees from southern nurseries have been extensively planted in some parts of the inter-mountain states, and have generally given good satisfaction. The tree is rather immature and, unless carefully packed for shipment, the tops dry out and the buds refuse to start except from near the base. In buying such stock, the grower should order trees of good size, and insist on their reaching him in good condition. After he receives them, it is to his interest to see that they are well handled. Should they arrive early, and it be necessary to heel them in until the land is prepared, or until the weather is favorable for planting, the greater part of the top as well as the roots should be well covered with moist earth.

The grower has a right to insist that his trees be free from insect pests and injurious diseases. If he orders first-class trees, he has a right to expect them to be such, and if he orders second-class trees, he generally takes what comes. Do not expect, however, every first-class tree to be absolutely straight, or those of all varieties to be of equal size; varieties vary in their habits of growth. Do business with the agent who works your territory annually rather than with the itinerant tree-peddler or with distant nurseries advertising cheap stock. The business of the nurseryman is not always lucrative, and you can generally rely upon his business ability to give you no more than you pay for. Do not expect the inspector to interfere with the agent who attempts to deliver trees that are not up to grade, or stock that is in bad condition from causes other than the attacks of insects or of plant diseases, for that is not his business. The buyer must settle those differences with the agent himself.

Care of Nursery Stock

Trees are often delivered by the nurseryman before the grower is ready to plant, and in such cases the recipient should know how to handle them. To keep the trees from drying out and, if planting must be delayed, to keep them in a dormant condition, are the ends to be attained in caring for nursery stock.

The stock should be unpacked as soon as it is delivered, for if stored in large bundles it may heat and the buds may start. If the stock is to be heeled-in out of doors, a spot should be chosen where the trees will be in the shade most of the day. Here a trench is dug, and, after cutting the bundles open, the roots are placed in the trench and covered with well-broken soil, which should be thoroughly shaken in among the roots. The layer of trees should not be thick, and they should be placed at right angles to the trench in preference to being inclined with the trench with the tops overlapping. If space will not permit of spreading the trees out in this way, the tops may be overlapped, if the roots of each succeeding layer are well separated from the last by plenty of earth. Unless the soil is very moist and can be well shaken in among the roots, it should be settled with water and re-covered with fresh soil to prevent baking and drying out. The trees may be kept dormant longer by burying them root and top. Trees may be stored in a cool cellar, with the roots packed in moist straw or moss. They should be frequently sprinkled, and the cellar kept as cool as possible by ventilating at night and closing in the daytime.

It occasionally happens that trees become dry in transit, and the grower is faced with the question of accepting them or going without trees. It is hard to say just how dry the tree may get before it is actually injured to the extent that it will not revive, but no agent can force the delivery of trees that have dried to the extent that the bark is shriveled, without, at least, a provision to replace those that are lost. Trees that are received in a shriveled condition should be buried, root and top, in a well moistened soil and kept there until they regain their original plumpness. The chances are that trees set in a shriveled condition will die, but we have seen good stands secured after freshening the trees as advised. The freshening may be hastened somewhat by immersing the trees in water. This question is not discussed in defense of the nurseryman who willfully delivers his stock in a careless condition, but such cases will arise, and knowing how to lessen the seriousness of the injury may save both the nurseryman and the grower much inconvenience and loss.

Plans, and Distances for Planting

The plan of laying out the orchard and the distances for planting are points on which growers do not all agree, for questions are involved that may be considered personal and not necessarily essential.

All things considered, the square or rectangular method of planting seems to be the most satisfactory. It allows of cultivation two ways, and where our fields are mostly squares or rectangles, it is practically the simplest plan of laying out.

Another plan is that known as the hexagonal system. With the trees the same distance apart, about 15 per cent more trees can be planted to the acre than with the rectangular system. The trees alternate in the adjacent rows, and the rows are crowded together so that all adjacent trees are equally distant from each other. The plan is well illustrated in Figure 3. Set on the square 30×30 feet, 48 trees may be planted to the acre; with the hexagonal system, 55 trees may be planted to the acre, with no spaces between adjacent trees less than thirty feet. While the hexagonal plan allows of planting more trees to the acre, it leaves no wide middles. It is not only a question of having the trees far enough apart to prevent their interlocking, but the middles must be wide enough to accommodate orchard machinery. The figure shows that while the trees are 30 feet apart, the widest middles are only 26 feet. If the grower insists upon planting 55 trees to the acre, leaving the rows 30 feet apart, and crowding the trees to 26 feet in the row would probably be more satisfactory in the long run.

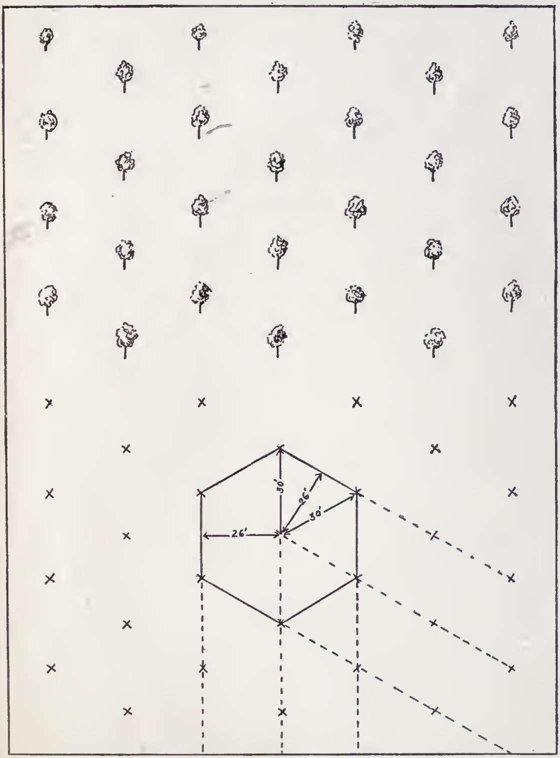


FIG. 3. — Hexagonal Plan of Planting.

Before any definite plan of planting is decided on, one should get the dimensions of the plot to be set, and figure out which way it may be planted to the best advantage.

Distances for planting will vary for different fruit trees, with varieties, and with soils; and all of these points should be carefully considered in laying out the orchard. It is safe to say that growers more often make the mistake of planting too close than too far apart. No doubt it has been demonstrated to the satisfaction of most fruit-growers that, on usual soils, few varieties of apples should be planted closer than 30 feet. On some of our lighter soils they may be planted a little closer without crowding, but a better plan would be to improve such soils and set at the greater distances. Such varieties as the Wagener, Rome (Beauty), Missouri (Pippin), Wealthy, and Oldenburgh may be planted as close as 25×25 feet to good advantage. Planting 30×30 feet may seem close to some persons, but there are probably only a few instances in the arid regions in which more space could be recommended or utilized. Fruit-trees in the inter-mountain country are more inclined to overbear than to overgrow, and to keep them well pruned and within bounds is not only beneficial to the tree but it is an advantage to the grower, as most orchard operations are facilitated thereby.

To allow of proper pruning and the full development of the tree, most varieties of peaches should be planted not closer than 20×20 feet; and when we consider that a ten-year-old peach tree that has been properly pruned should have a spread of sixteen feet, it will be seen that the distance is not too great. As many peach trees are spoiled because the pruner is not given the room to train them properly as are spoiled by incompetent pruners. It is true that peach trees can be grown when set 16×16 feet, but they cannot be developed properly, unless it be on some of the lighter mesa soils.

Cherries should have about the same amount of room as the peach. Some of the sour cherries of the Morello type are poor growers, and could be planted closer; and if some of the upright-growing sweet varieties are to be allowed to take their natural form, they may be grown closer, but a better plan would be to give them plenty of room and spread the top by proper pruning.

If properly trained, pear trees will utilize all the space when planted twenty feet apart. Some kinds may be planted closer and be allowed to grow in their natural form, but is it doubtful whether it is advisable.

Both peaches and pears may be crowded to sixteen feet in the row, leaving the one wide middle, but, with the peaches, especially, it hardly permits cross-cultivation after the trees reach any size.

When planted on the square, 20×20 feet, 108 trees may be planted to the acre; set 16×20, the number will be increased to 135. After forming a general idea of the plan and distances for planting, it may be necessary to modify them to suit the particular piece of land to be planted. Suppose, for example, that we are planting a square ten-acre plot, and that we decide to set the trees 30×30 feet; the rows will contain 22 trees each way, and give a 15-foot border. But with a fence around the orchard this border is hardly wide enough, and by reducing the distance between trees 6 inches each way, 5 feet could be added to the border, and we should hardly notice that the trees were any closer together.

A simple method of determining the number of trees required to plant an acre, when planted by the square or rectangular plan, is to multiply together the two distances, in feet, at which the trees stand, and divide 43,560 (the number of square feet in an acre) by the product. To find the number required for the hexagonal system, add 15 per cent to the number required to set at the same distance with the rectangular system.

Fillers

The advisibility of planting "fillers" (or temporary trees between the others, to be removed as the others mature) in the apple orchard has been argued pro and con, and it probably always will be a debatable question, for much depends on the man who grows the orchard. The only objection the writers have to planting fillers is that they too often become fixtures. The average man lacks the courage to pull out a tree when it gives promise of producing another crop, and, as a consequence, the shape of the permanent tree is ruined before the filler is removed. If we were planting an orchard, we would probably plant fillers, but at the same time we could not advise every one to follow our example.

If properly selected and removed in time, fillers are profitable. Peach trees as fillers are probably as profitable as any in a section where a peach crop can be relied on, and, if properly handled, they should produce a box of fruit the third season with an increase of two to three boxes per season for the next three years, or until it becomes necessary to remove them. Varieties of apple that bear young may be used as fillers, and such varieties as the Missouri (Pippin), Wagener, and possibly Rome (Beauty) may be made to yield good returns.

Fillers give best results in the orchard laid out on the rectangular plan; in fact, it is difficult to place fillers to advantage when the permanent trees are set by the hexagonal system. With the permanent trees set on the rectangular plan, the best place for the filler is in the center of each rectangle, or in the "diamond," as it is sometimes termed. This doubles the number of trees per acre, and gives all the trees the maximum amount of available space. Some object to this system, however, and prefer to plant the fillers in the row, leaving one wide middle.

With the permanent trees 30 feet apart, apple or peach fillers may stand in the row from 6 to 7 years, and if they are planted in the diamond, it is safe to say that they could stand 2 years longer. If fillers are to be employed, they should be given the maximum amount of available room, and pruned sparingly to encourage early fruitfulness. The average man, however, will have better success in growing crops in the young orchard instead of trying to secure an early income from fillers.

Interplanting of Varieties

The interplanting or mixing of varieties to secure cross-fertilization has been widely recommended, especially in the East; and while it is doubtful whether any one is willing to say that it is necessary or even beneficial in the arid fruit regions of the West, it is probably wise, at least, to avoid planting large blocks to a single variety.

It is a fact that some varieties are poor pollen producers, and, while we have not seen a case in which lack of proper pollination could be proved to be responsible for a poor set of fruit, we are inclined to favor the interplanting of varieties.

It is often inconvenient and, no doubt, unnecessary, to alternate the rows, as some do, but it is just as convenient to have, say, four rows of one variety and then four of another variety. This arrangement is sufficient to insure perfect cross-pollination. It is necessary, however, to plant together varieties with coinciding seasons of bloom. Practically all of our commercial varieties of pears bloom near enough together to insure perfect cross-pollination, and with the exception of the Rome (Beauty) and Ralls (Geneton), the blooming periods of our common commercial varieties of apple overlap enough in normal seasons that they may pollinate each other.

When to Plant

In many fruit regions the grower has his choice of planting either in the spring or in the fall, but in the arid fruit sections of the West, spring planting is really the only practice that can be recommended. Trees planted in the fall do not become well established, and in the dry winters the roots are unable to supply moisture as rapidly as it is being transpired from the top. As a consequence, the tree often dries out to the extent that it lacks the vitality to make a good start in the spring.

March and April are the favorable months for tree-planting in the Middle Western states. As a rule the trees may be planted as soon as the ground is in condition to work in the spring; we may almost say, the earlier the planting the better. The tree makes its start from stored-up plant-food, and any growth the tree makes before it is planted weakens it that much. If it is necessary to delay the planting, every effort should be made to hold the trees in dormant condition; and, if they are kept in this condition, good "stands" may be secured by planting, even after the orchards are practically in full leaf. But the chances are against the young orchard planted late, and planting with the opening of spring is recommended.

Methods of Planting

Too much care cannot be given to laying out the young orchard in a neat and attractive way, and there is much in knowing how. If the proposed orchard site is a square or a rectangular plot, and the trees are to be set on the rectangular plan, one of the simplest methods of laying out is to establish the boundary lines and lay off on two opposite sides the distances between rows, and on the other two sides the distances between trees. These points are marked with stakes that can be easily seen across the field, and with these points established, a few more rows of stakes should be sighted-in through the middle. Unless the field is very large or rough, two rows of stakes through the middle will be sufficient and, we may say, desirable, as with four established points any stake knocked down in marking may be reset without the aid of a second man to do the sighting.

If the field is irregular, the best plan is to establish the boundary lines of the largest rectangular plot it contains, and proceed as before. Irregular corners can then be plotted by sighting to stakes in the larger area.

In plotting the field for hexagonal planting, the only difference is that double the number of points would have to be established on the sides to give the position of the trees in the alternate rows.

Fig. 4. — Method of Marking Land for Planting.

Some practice marking both ways with a light furrowing shovel attached to a convenient orchard cultivator, and then throw out the rows with a plow; others simply plow out the rows, and then a man cross-marks the field by walking to the stakes and dragging a chain or some other convenient marker behind him. Marking the field both ways gives all the points for trees, and, with the stakes reset to facilitate sighting-in the trees, the orchard may be well lined up. In sighting-in the trees, the setter should always look ahead and line the trees with the stakes rather than with the trees set behind. The final test for determining the accuracy of the position of the tree is to see that it lines up with the diagonal rows. Other methods of laying out, as with a line, could be given, but most of them are tedious if not impracticable.

The system that requires the most work does not always give the most satisfactory results. Figure 4 shows a large field laid out by the stake method and marked both ways. Here fourteen men are shown, actually engaged in planting; two are distributing trees from the wagon, six are digging the holes and filling in about the trees, and the other six are trimming and placing the trees. These fourteen men set twenty acres per day without difficulty, and set them well.

Trees should be handled carefully in planting, and the roots should be exposed to the air no longer than necessary. If the force of men is large, the plan of hauling the trees in a wagon, with men to distribute them, is a good one. With the furrow method of planting, the man with the shovel may dig the hole, while the other prunes the roots, and, if he is to be trusted, the top.

A very convenient method of handling the trees when setting with four men or less is to carry the bundles of trees, with the roots well protected, on a sled. A barrel one quarter full of water is placed on one end of the sled, and as soon as a bunch is cut it is dropped in the barrel. With the sled between the two rows, the two men sighting-in the trees can take them from the barrel. Root-pruning consists in cutting off the broken ends, cutting them all back to six or eight inches in length, and possibly thinning them out a little. The hole should be large enough to let the tree stand two or three inches deeper than it stood in the nursery. In localities where strong winds affect the growth of the tree, the heavier part of the root system is turned in the direction of the prevailing winds. Where the wind is not a factor, the heavier part of the root system is turned toward the southwest. The top may be leaned to overcome the influence of prevailing winds, or to the southwest to protect the body from the sun. In our hot climate the trees show an inclination to grow heavier in the northeast side, and leaning the tree to the southwest or placing the heavier part of the root system or of the top in this direction helps to overcome this tendency.

With the tree in position, the fine top soil is pushed back in the hole and worked in about the roots by a slight churning motion of the tree. In this process the tree will work upward somewhat, and the planter must allow for this in placing the tree. With the roots well covered and the top soil slightly tramped, the water is turned in the furrow to complete the settling. After a thorough watering, fresh soil is thrown about the crown of the tree, and the furrow is left open for a second watering ten days or two weeks later. After the second watering, it is advisable to fill this furrow and to water from the side.

CHAPTER V

THE ORCHARD PLANT

Few persons who attempt to plant and grow trees realize what delicate organisms they are, and still fewer persons have a correct conception of how plants take their food from soil and air, how the crude food materials are made over in the leaves, and of the other numerous life processes. Considering the delicate nature and intricate structure of plants and the lack of information on the subject, it is surprising to note the degree of success to which the business of orcharding has attained. We may well take the time, then, to make a somewhat hasty sketch of the make-up of the orchard plant.

For our purpose a tree may be divided into three parts, — roots, stems, and leaves.

The Roots

Roots serve the two principal purposes of anchoring the tree, and thus holding it in place, and of taking plant-food from the soil.

The roots of trees have a greater spread than is commonly realized; ordinarily it is safe to assume that the spread of the roots is greater than that of the branches. The length of roots depends on the nature of the soil and the amount of water and of raw food materials. Ordinarily roots should penetrate deeply in mountain soils for the reason that orchard land is, or should be, deep and with no hard subsoil. But if the soil is shallow, or the moisture and supply of food materials are largely near the surface, the roots soon occupy the space in spite of the fact that it is their nature at first to grow downward. Those instances in which roots, when very young, grow upward, are very likely due to poor cultivation and the consequent location of the food materials and moisture supply near the surface. Eventually, however, the upper layers of soil are largely occupied with a mass of small roots.

Roots may grow to great lengths in poor soil, but in a fertile soil they tend to make shorter growths and to occupy all of the ground. A root of a cottonwood tree recently brought to the writer was forty-eight feet in length and only one and one-half inches in diameter at the larger end. This tree grew in the mountains in a rocky situation near a river bank. The root pushed out laterally just beneath the surface, evidently in search of water, till finally a change in the river bed caused it to be washed out.

All of the elements of plant-food, with the single exception of carbon, are taken into the plant from the soil in solution. The larger roots are not concerned to any great extent in this process of absorption, but near the end of the smallest growing points are the regions where this process takes place. Just back of the growing tip is a short zone where minute and often invisible growths, known as root-hairs, push out from the outer cells. These root-hairs are exceedingly delicate and are of short duration. As the root increases in length, new ones are formed and the older ones die, so that they are continually dying and new ones are being formed throughout the growing season. (See Fig. 5.) Great numbers of these organs are formed in good soil which is in proper tilth, and thus provide the tree with an immense absorptive surface. These tiny growths penetrate in between and often grow around the soil particles in order to absorb more readily the film of water which surrounds the particles.

Fig. 5.—A Root-hair. (After Stevens.)

Such delicate structures as root-hairs are easily destroyed, so it is not to be wondered at that nursery trees, as they are received by the orchardist, have lost all of these organs. When such trees start into growth, they do so at the expense of the food that has been stored in the tissues, and this drain must continue until new root-hairs can be formed. Untoward conditions of any kind, such as extremes of moisture or drought, heat or cold, may cause the death of these important organs. Hard, compact soils exclude the air to such an extent that but few root-hairs develop. Yellow foliage and a stunted growth are common symptoms resulting from these conditions.

The soil water, of course, contains small amounts of plant-food materials in solution; usually not more than .01 to .03 per cent of solid matter dissolved in it.[1] When the soil solutions contain as much as 2 per cent of dissolved

[1] Percival, "Agricultural Botany," p. 203.

substances, injury to the plant may result. The presence of free water for any great length of time deprives the roots of the normal supply of air and results in death. Soil is said to contain free water when the spaces between the soil particles are filled.

Soil water is taken up by the root-hairs by a process known as osmosis. This process may be explained briefly as follows: When two liquids, one concentrated and the other dilute, are separated from each other by a thin membrane, there will be a movement of the dilute solution through the membrane into the more concentrated. This is the only way that water can enter roots. The cell contents of the root-hairs being more concentrated than the soil solutions, the passage is into the plant. Should the soil solutions by any means have the greater concentration, the movement would be from the root-hairs into the soil, and injury or death would result. This is what is supposed to happen in those rather rare instances when plants are injured by alkali. The soil water dissolves these salts, and thus becomes more highly concentrated than the cell contents of the root-hairs.

From the root-hairs the moisture moves to the central part of the root and on up to the stem.

The Stem

Did the reader ever stop to think of what use stems are to plants, or why they have stems or trunks at all? We know there are various forms of stems, ranging in size from the smallest plant to the tallest tree. Some are thick, others thin, and some, as the vines, require support. Why all these various forms, and what, indeed, is the need for stems at all? The only purpose they serve is to lift the leaves up to those situations where they will receive the maximum amount of sunshine and of air. In its natural state the grapevine could best do this with the support of other plants. It can now easily reach the tops of tall trees, and is thus enabled to flourish in situations where it would otherwise perish. On the other hand, the dandelion has so successfully adapted itself to conditions that it has become a most persistent weed, and yet it is nearly stemless.

But the crude food materials taken in by the roots must pass through the stems or trunk to the leaves, and a portion of elaborated food must be returned, even to the smallest root, to build up the parts. The trunk must therefore be kept in a healthy, vigorous condition, and a knowledge of its make-up will help one to a more thorough understanding of some of the important horticultural operations.

A good idea of the make-up of such a stem as is found among orchard trees may be had by consulting the diagram shown in Figure 6. This represents a plant or a stem at the close of the first season's growth. Older trunks or branches would present much the same appearance, with the exception that there would be as many layers of wood as there were years of growth, and the parts would be more compact.

The central portion of the stem at 1 is composed of pith. This was originally formative tissue, and out of it the other special cells are formed. The pith may serve as a storage for plant-food, but as the plant becomes older, these cells gradually lose their function.

The large tubes shown at 2 form a part of the new or sapwood. It is through these vessels that the water taken in by the roots passes upward to the leaves, and they form a continuous passage, interrupted only at rather long in-

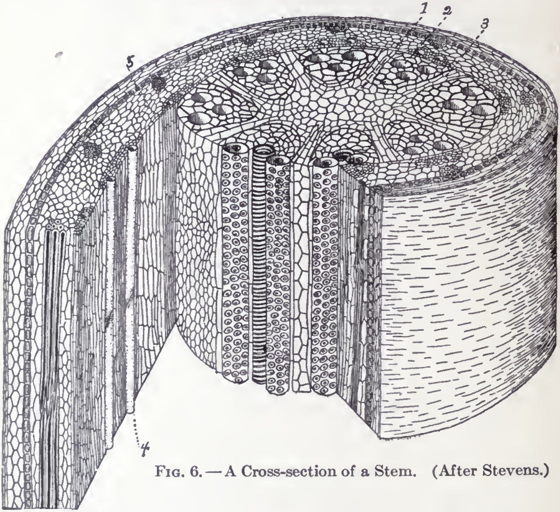


Fig. 6. — A Cross-section of a Stem. (After Stevens.)

tervals by thin cross-partitions. As the plant grows older, these tubes become thickened or woody, and new ones are produced, until a more or less solid layer of wood is formed. After a few years what is now sapwood becomes heart-wood, and its activities then cease.

The peculiar markings on these vessels are thin places in the walls, and they allow water to escape. They may also allow some of the stored food in the stem to enter these water passages in the spring of the year, as at this time the buds are swelling, and an extra food supply is needed at once in these parts.

Transformed formative tissue extends outward between the bundles of water-carrying vessels, as shown at 3. As the bundles increase in thickness and in numbers, they so crowd these cells that they are contracted into very small space. A cross-section of any limb or trunk shows these flattened cells as fine white lines that radiate outward from the center. These are called medullary rays, and their function is to allow a movement of both food and water to and from the inner, living tissues.

Other sets of vessels or tubes are shown at 4 on the inner side of the bark. These are not so large as the water vessels, neither are they so nearly continuous in their connection. These are known as sieve tubes, and their function is to carry food that has been elaborated in the leaves, in either direction, wherever the demands of growth require.

The cambium or growing layer is shown at 5. This is composed of a narrow zone of small cells, out of which the water vessels and eventually wood are formed on the inner side and sieve-tubes and the several layers that compose the bark on the outer side. This is the only region in the entire stem or trunk in which growth is possible in orchard plants.

The bark does not ordinarily increase in thickness to any great extent. The outer layers serve as a protection to the delicate tissues within. As a new layer is formed each season from the outer cambium layer, the outer layers of bark, when dead, are split by pressure from within, and gradually drop off.

We can now understand how the trunks of all tree fruits with which our orchardists have to deal increase in size by the growth of a ring of wood each year just beneath the bark. By counting the rings, one may determine the age of a tree with a fair degree of accuracy. As the tree grows older, the inner wood becomes inactive, and so takes but little part in the life processes. This accounts for the fact that a hollow tree — a mere shell of a trunk — may live as long as though it were perfectly sound, if the tree does not break down.

It is a common notion that the split made in limbs in grafting will grow together, but we can now see that this is impossible and, moreover, that the region where a union of the stock and cion can take place is very small. This necessitates careful handling of the parts to prevent injury, as well as to see that the cambium layers of cion and stock come into intimate contact.

The movement of sap up the stem and the channels may be illustrated by inserting a freshly cut succulent stem in red ink. After a time it will be found that the ink has ascended the stem for some distance, and the water vessels above described are the only parts which are colored.

This function of the vessels of sapwood is also proved by the action of girdled trees. If a ring of bark only is removed without injuring the wood, a tree may live through an entire season; but if a ring of sapwood is removed at the same time, the tree will soon die.

Girdling or ringing a tree will also illustrate where the tissue that conveys the elaborated food is located. If the ring of bark is taken from the trunk below all leaves or leaf-bearing limbs, the tree usually will die. This must be for the reason that no food can reach the roots from the leaves, consequently starvation of those parts results. On the other hand, if a ring of bark is removed from the trunk above several limbs, the wound will usually heal, provided, of course, that it is not so large that the sapwood is seriously injured by drying out. A noticeable swelling of the bark occurs on the upper side of the girdle, caused by an excess of food, its movement downward having been arrested at that point. Advantage is sometimes taken of plants in horticultural practice in arresting the downward movement of plant-food from the leaves by removing a ring of bark. The upward flow of crude material from the roots is not interfered with, but the food that has been made over in the leaves cannot get past the girdle, consequently those parts above this point receive an excess of food. This practice is common in vineyards in some sections, and some varieties of grapes may be made to ripen twenty days earlier than on unringed vines, and the berries grow from one-third to one-half larger. Earliness in ripening and increased size is usually at the expense of quality; consequently this practice cannot be recommended as being worthy of general adoption.

The Leaves

The biblical saying that "all flesh is grass" is true to the last degree, for there are no living organisms other than green plants that do not, in the final analysis, owe their existence to the leaves of plants or rather to the products of leaves. We have seen that plants may be practically stemless, but none of the higher plants can exist without leaves, or organs that take their place. Many of the cacti are leafless, but their stems have been so modified that they perform the work of leaves.

It is in the leaves and young green parts that plant-food is manufactured; the one element of plant-food that is taken into plants in a gaseous state (carbon, in carbon dioxid gas) enters through the leaves and to some extent through other green portions; the excesses of moisture and of gases are given off by the leaves. It will be seen, then, that the leaves are the most important organs in the economy of a plant, and as such are worthy of study. This may be done best by referring to a diagram.

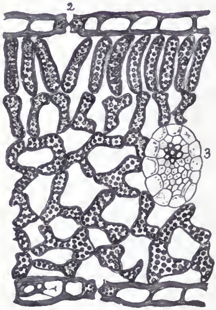


FIG. 7. — Cross-section of a Leaf. (After Stevens.)

A cross-section of a leaf is shown in Figure 7, the upper side being at the top of the figure. The first layer of cells, at 1, constitutes the epidermis. The one feature of special importance in the epidermis is the opening or stoma shown at 2. It is through such minute openings that carbon dioxid, with air, enters, and through them the excess of water and of gases is given off.

Since the water solutions of the soil contain the elements of plant-food in such minute quantities, a much greater amount of water must be taken into the plant than can be used in building tissue. This excess must pass off through the stomata. It has been estimated that from 15 to 25 pounds of water must pass through a plant in order to produce one ounce of dry material; or to make it more expressive, in the formation of 1000 pounds of dry matter, 240,000 to 400,000 pounds of water are used.

A German investigator calculated the amount of water evaporated by an oak tree which was about 20 feet high and which grew in an isolated situation. His experiments, the results of which are given in the following table, extended through the growing season:—

Table I. Amount of Water evaporated from an Oak Tree during the Growing Season

May (14 days)	1,944 pounds.
June	57,250 pounds.
July	63,265 pounds.
August	47,839 pounds.
September	38,882 pounds.
October	37,450 pounds.
Total	236,630 pounds.

This is equivalent approximately to 29,578 gallons. This investigator also "found that water evaporated during the season, when considered with reference to the area of ground covered by the tree top, was equal to a layer 212 inches high; observation had shown the annual rainfall to be 25.6 inches; so that the water evaporated from the tree was eight times the amount which fell upon the earth under it."[1]

The passage of air and gases in and out of leaves is an equally important function of stomata. About one-half of the dry weight of a tree is composed of carbon, or the

[1] Adapted from Bessey, "Botany," p. 172.

charcoal that is left when wood is so burned as to produce this product. The air contains only three to four parts of carbon dioxid in 10,000, so in order to make 1000 pounds of dry wood, 38,864,193 cubic feet of air must have been taken into the plant.[1]

Stomata are found in green stems as well as in leaves, but are usually more abundant on the under surface of leaves. In order to do the enormous amount of work that leaves are called on to perform, there must be great numbers of these openings. The apple leaf, for example, contains about 24,000 to the square inch.[2]

The next thing one notices in the diagram is that the leaf is made up of a mass of irregularly shaped cells with air spaces between them. These cells are largely occupied by small, round, green bodies. This coloring matter, called chlorophyll, is what gives the characteristic color to leaves. It is in these minute bodies that the transformation of food materials is performed. The green coloring matter absorbs energy from the sunlight, and the water from the soil is combined with the carbon of the air to form sugar and starch, and later, other combinations. The starch does not remain here long, but is soon dissolved, transformed, or combined, and passes through the sieve-tubes to parts where food is needed or is stored in less active tissue when an excess is made.

At 3 is shown a leaf vein. Veins are largely made up of a continuation of water vessels and of sieve-tubes. It will be remembered that it is through the former that the soil water passes up to the leaves, and the sieve-tubes

[1] Adapted from Strasburger, Noll, Schenck and Karsten, p. 215.
[2] Bergen and Davis, "Principles of Botany," p. 104.

transport the food after it has been transformed into products which plants may use.

Starch is formed only during the daytime, and it is reasonable to suppose that the greater amount of sunshine common to the arid regions must result in a larger production of starch. This must be one important reason why plants are more fruitful in the higher altitudes. Other and more complex materials are produced at night by the combination of the starch with the materials brought in from the soil. The uniformly cool nights may hinder this part of plant-food manufacture, and thus tend to retard growth, resulting in early bearing and fruitfulness.

CHAPTER VI

BUDS

Most of the fruit-trees with which our orchardists have to do normally make a determinate or definite growth during a season; the apricots and many of the plums are exceptions. If we examine the winter condition of the last growth made by an apple tree, we shall find that it is terminated by a bud, and that there are a number of side buds that occur at fairly regular intervals. Any of these buds, either lateral or terminal, may be fruit-buds, as will be shown later.

If we select one of the branch-buds and pick it to pieces, we shall find that it is composed of a mass of tiny leaves, those on the inside being much crumpled and compacted, while the outer ones are of regular formation. The latter are known as bud-scales, and they drop off soon after the bud starts into growth. The interior ones will form the leaves of next season's growth; and usually all of the leaves which the new growth of the season will produce are present in miniature in the bud, the exact number being determined the season before.

One can easily distinguish between the growth of different years when the branch is not too old, or when second growth has not taken place, by the slight bulge that is encircled by several rows of tiny scars. This enlargement marks the position of the bud from which growth proceeded during that season, and the scars mark the point of attachment of bud scales.

Since the growth of an apple limb from year to year is generally straight, it follows that shoots proceed from terminal buds. But terminal buds may also produce blossoms, or the shoot may be broken or cut back in pruning. In such cases the new growth develops from one of the side or lateral buds.

All will remember that leaves occur singly on new growths. By a further examination of these leafless shoots, we find that at the base of each bud is a scar that marks the point where a leaf was attached. Buds and leaves, then, always go together, and under normal conditions a bud forms in the axil of each leaf. In some plants, as the asparagus, this is the only way one can decide which are the true leaves, as in this case they are mere scales, while leaflike branches perform the function of leaves.

The question of what becomes of the lateral buds may be decided best by examining two-year-old wood. We notice here that short branches have taken the place of some of the buds, others produce flower clusters, while a few remain dormant. These lateral branches are of varying lengths, some of them being so short as to be mistaken for buds.

More than one leaf came from the original bud in the spring, and now there is formed at the end of each that did not produce flowers, no matter how short, a terminal bud for a continuation of the branch the next year. The more vigorous lateral branches are usually well out toward the end, while many of those lower down have had a struggle to make any growth at all.

By examining still older wood, we shall find that many of these

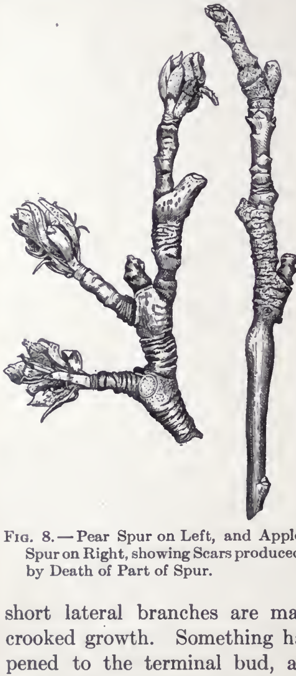


Fig. 8. — Pear Spur on Left, and Apple Spur on Right, showing Scars produced by Death of Part of Spur.

Fig. 9. — Once a Fruit-spur.

short lateral branches are making a crooked growth. Something has happened to the terminal bud, and the scars at the end show that a cluster of blossoms formed. This would termi-

Fig. 10. — Opening Flower-buds on One-year-old Apple Spurs.

Fig. 11. — Missouri (Pippin) showing Axillary Flower-buds.

Fig. 12. — Mature Jonathan Apples from Axillary Buds.

nate the growth of the branch but for the development of buds lower down. These lateral buds develop branches that may grow one or more years in a straight line, when they in turn are stopped by the formation of a flower-bud. The continued repetition of flower-bud formation and the consequent development of lateral buds, together with slow growth, gives the peculiar crooked appearance to the fruit-spurs of apple and of pear trees.

Fig. 13. — Axillary Flower Clusters of Duchess Pear.

It has often been said that the large scars on fruit-spurs mark the place where a fruit was borne. One can only be sure that this is true when several smaller scars surround the larger one, thus showing that a blossom-cluster actually existed at the point. Short branches which have borne flowers very often die back to the main spur, thus producing a scar which is evidently often mistaken for those which are produced where fruits were attached. This is well shown in the case of both the apple and the pear in Figure 8, which is from a photograph.

All of the branch-buds are alike in the beginning, but because of less advantageous position as regards light and food-supply some of them make little growth. Some of these restricted branches become fruit-spurs, and consequently we must conclude that slow growth is conducive to fruitfulness. Once a branch has become a fruit-spur, it usually retains this character, and some of them may be many years old and yet be only a few inches long. Nevertheless, the bearing habit of a tree may be easily changed, much to the owner's disadvantage, by severe pruning. If trees are heavily pruned, and particularly if a small crop of fruit is borne the following season, many of the fruit-spurs may be forced into strong-growing twigs. Figure 9, from a photograph, shows such an instance. There are no fruit-buds now present and probably they will be produced only after two or more years, when growth becomes less vigorous.

Fruit-buds of the apple and of the pear are usually terminal, but not always so. Neither must the fruit-spur be two or more years old before it may bear fruit. In fact, many varieties produce much of their fruit on one-year-old spurs and on the tip ends of twigs of the last season's growth. (See Fig. 10.) Many varieties also produce flower-buds in the axils of leaves on the growth of the current season, the same as the peach. (See Figs. 11, 12, 13.) These facts seem not to have been noticed by horticultural writers and no doubt this manner of fruit production is uncommon in the East. But under semi-arid conditions, where the conditions under which the trees grow are most artificial, such fruit formation is of common occurrence. The following tables show some of the varieties that bear fruit-buds in the axils of leaves and on one-year-old spurs; also the relation of such characteristics to annual bearing.

Table II, showing varieties of apples that produce blossom-buds, on one-year-old spurs, on the ends of one-year-old spurs, terminal growths other than spurs, from the axils of leaves on the previous season's growth, and whether they are annual bearers: —

Variety of Apple	Bloom on One-year-old Spurs	Bloom on End of Last Year's Terminal Growths not Spurs	Bloom in Axillary Buds on Last Year's Growth	Annual Bearer
Arkansas	No	No	No	No
Astrachan	Yes	No	No	No
Bellflower	Few	No	Few	No
Ben Davis	Yes	No	Few, weak	No
Grimes	Yes	Yes	No	Yes
Hyslop	Yes	Yes	Yes	No
Jonathan	Yes	No	Few	No
Mann	Few	No	Yes	No
McIntosh	Yes	No	No	Yes
Missouri (Pippin)	Yes	No	Yes	No
Newton	Yes	No	No	No
Northern Spy	Yes	—	No	No
Ralls	Yes	No	No	No
Rome (Beauty)	Yes	No	No	No
Strawberry	Yes	No	Yes	No
Striped Lawyer	Few	—	Yes	No
Transcendent	Yes	Yes	Yes	—
W. Pearmain	Few	No	Few, weak	No
Willow Twig	Yes	Yes	No	Yes
Winesap	Yes	No	Yes	Yes
Yellow Transparent	Yes	Yes	No	Yes

Table III, showing varieties of pears that produce blossom-buds, on one-year-old spurs, on the ends of one-year-old spurs, terminal growths other than spurs, from the axils of leaves on the previous season's growth, and whether they are annual bearers:—

Variety of Pear	Bloom on One-year-old Spurs	Bloom on End of Last Year's Growths	Bloom in Axillary Buds on Last Year's Growth	Annual Bearer
Anjou	—	—	Yes	Yes
Bartlett	—	Yes	Yes	Yes
Duchess	—	—	Yes	Yes
Kieffer	Yes	—	Yes	No
Sheldon	No	—	No	Yes

The foregoing lists are very incomplete, but they serve to show that these methods of fruit-bearing are not uncommon with the apple, and that the pear may also produce fruit-buds in the axils of leaves on the current season's growth. Further observations will no doubt change some of these determinations, and will certainly add much to the list. It is well known that varieties vary in their characteristics in different localities, a few miles often being sufficient to show marked changes. These notes were made in Grand Junction, Colorado, so that observers in other localities need not be surprised if their observations do not agree with these in all respects.

While the capacity of a variety to produce annual crops is undoubtedly influenced by several factors, the table is of interest in indicating that the characteristic of fruit-bearing on one-year-old spurs is conducive to the production of annual crops. This is as might be expected; and by examining older fruit-spurs we find that, when a fruit-bud has been produced, growth is stopped, and a lateral bud has developed into a branch and continued the growth of the spur. This lateral is not ordinarily terminated by a fruit-bud that year, for the supposed reason that the energies of the spur have been depleted in the production of flowers, and perhaps fruit as well, on the older part. We learn from this that fruit-spurs, as a rule, may bear fruit only every other year, but in reality such regularity is far from being common.

Bud-bearing on Stone-fruits

When we undertook to write on the subject of buds, it was found that our observations did not agree in many respects with what has been published, and one of us (Mr. Whipple) made a study of the subject. These observations on bud characters and bearing habits of the stone-fruits are given below.

The branch-buds of the peach, apricot, plum, and cherry differ little from those of the apple and pear. With the apricots and many of the plums, true terminal buds are rarely developed, while the lateral branch-buds of at least the first three may share their position in the axils of the leaves with one or more fruit-buds. In the peach, however, such a group of buds is generally developed in the axils of a cluster of three leaves. When the terminal bud is absent and the last lateral bud is a branch-bud, it continues the growth of the branch the following season, and, while the line of demarcation of each succeeding year's growth (as shown by the scars of the bud-scales) is not as pronounced as in twigs with terminal branch-buds, the continuation of the growth in a straight line is just as perfect. Quite often this last lateral bud is a fruit-bud, and later such twigs generally die back to a lateral branch developed from the last branch-bud.

The fruit-buds of the peach, apricot, plum, and cherry differ from those of the apple and pear in that they are simple buds (each contains in miniature a modified branch which carries only flowers, no leaves, or at most only rudiments of leaves), while the apple and pear have mixed fruit-buds. As the fruit-buds of the cherry and plum open, they often show one or two small leaves which rarely persist during the full season of fruit formation. The fruit-bud of the peach and apricot normally carries a single flower, sometimes two; that of the cherry from one to five, two the prevailing type; and that of the plum from one to five, two and three being the most common numbers. With few exceptions, the fruit-buds of these four stone-fruits are developed laterally and in the axils of leaves; occasionally a terminal fruit-bud may be found in the cherry. In the stone-fruits, then, the fruit-buds are developed in the axils of leaves of the current year's growth and the fruit is borne on one-year-old wood.

An examination of the fruiting wood of the peach will show that the fruit-buds are borne singly with a branch-bud, or in pairs with a branch-bud. (See Fig. 14.) With trees making a satisfactory growth, the latter is the more common. Their position upon the twig is determined more or less by the general growth of the tree; the stronger the growth the nearer the tips will they be found. With trees making a moderate growth, the majority of the fruit-buds will be found along the central portion of the season's growth and in pairs, one on either side of a branch-bud. On twigs making a weak growth they more often appear singly and along the entire length of

Fig. 14. — Flower-buds of Peach.

the season's growth, while with young trees making a rank growth they will be found only scattering near the tips of the twigs. Thus, like the apple, the formation of fruit-buds in the peach is apparently incited by slow growth; they are developed during a period when there is least increase in length of the twig.

In its fruiting habit, the apricot is very much like the peach. Fewer fruit-buds are found on the stronger-growing new wood, however, and a larger proportion on short, spurlike, new growths. Often these spurs on the apricot are so short and bear buds so close together that we are liable to think of them as being different from other fruiting wood, but they do not differ materially. They are simply short, new growths bearing axillary fruit-buds generally borne singly, rather than in groups, as is the case on the stronger-growing new twigs. The last lateral bud is a branch-bud in most cases, and continues the growth of the spur the following season. Unlike the peach, the groups of buds are developed in the axil of a single leaf. (See Fig. 15.)

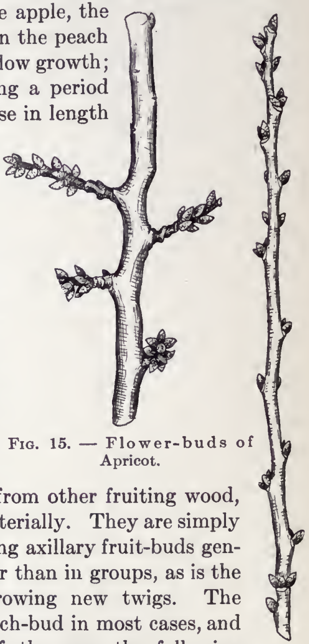


FIG. 15. — Flower-buds of Apricot.

The different cherries are quite uniform in their fruit-bearing habits. Few fruit-buds are found on the stronger-growing new wood, the short spurs being the fruit-bearing part of the tree. Like the apricot, these spurs are new growths bearing axillary fruit-buds, and with a few exceptions a terminal branch-bud. Figure 16 shows the type of fruiting wood of the sweet cherry. Below each side bud on spurs or stronger new wood will be found a leaf-scar, and as each spur is almost invariably supplied with a terminal branch-bud, observe the absence of crooks noted in the spurs of the apple and the pear. The figure also shows some strong new growth, with rounded fruit-buds near the base and the more pointed branch-buds near the tip; these branch-buds will later develop into fruit-spurs like those on the older wood below. The fruiting wood of the sour cherry differs little from that of the sweet. Some varieties, however, produce many axillary fruit-buds on the long, new growth. These develop into flowers the following spring, and as these spurs are annual in duration, they are shed at the close of the season. No lateral branch-buds being developed, this results in long, naked branches, the only leaf or fruit-bearing wood being

FIG. 16. — Flower-buds of Sweet Cherry.

on the new growth at the end. (See Fig. 17.) With the peach and the apricot the fruit-bud is quite readily distinguishable from the branch-bud, but with the cherry the fruit-bud can hardly be identified from external appearances. After the buds begin to swell in the spring, the fruit-buds have a more rounded or blunt appearance; compare the fruit-buds near the base of the new growth in the figure with the branch-buds nearer the tip.

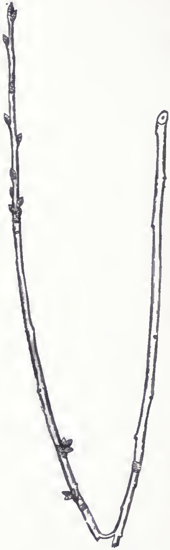


Fig. 17. — Flower-buds of Sour Cherry.

The plums vary somewhat in their manner of fruit-bearing, but all are alike in that the fruit-buds are axillary. With some, the development of fruit-buds on the stronger-growing new wood is quite common, while with others it is rare.

Fig. 18. — Flower-buds of Domestica Plum.

Figure 18 shows the fruiting wood of the Silver Prune, and is a fair illustration of the fruiting habit of the Domestica plums (commonly called prunes). An examination of the tip will show that the terminal bud is not a true terminal bud, but an axillary bud. The fourth spur from the top bears a single bud, which might be taken for a terminal fruit-bud, but it, too, is an axillary bud, as is shown by the leaf-scar below it. The Japanese plums, locally represented by such varieties as the Burbank, Abundance, Satsuma (Blood), and the Red June, resemble the apricot more in their manner of bearing fruit. The fruit-buds are still axillary, and like the apricot are found on both spurs and stronger-growing new wood, commonly appearing in the latter case, one on either side of a branch-bud. With some of the plums it is quite impossible to distinguish the dormant fruit-bud from the branch-bud, while with others they are easily identified. As with the other fruits, rampant growth seems to be adverse to the development of fruit-buds.

CHAPTER VII

PRUNING YOUNG TREES

THE writers have been impressed, when visiting the various fruit districts, by the lack of knowledge on the part of many growers of the requirements of young trees. No doubt a large majority of our fruit-growers have had no experience in the business, and so have everything to learn, and surely no part of orchard management is more important than to start the young trees just right. On this depends not only the future usefulness of the orchard, but in many instances large numbers of young trees fail to live through the first season for the simple reason that they are not properly started. In several instances the writers have been asked to investigate the cause of the dying of newly planted trees, and on visiting the orchard it was found that the trees were planted just as they had been received from the nursery. No doubt some of them had been injured somewhat by exposure and improper care, but with the best of treatment it is difficult for the mutilated root system of a transplanted tree to establish itself and at the same time support a vigorous or overgrown top.

It is not generally realized that when a tree is taken from the nursery row, a large part of the root system is left in the ground. The balance between the roots and the top is thus destroyed, and obviously a part of the top should be removed. Practically all of the elements that nourish and build up a tree, except carbon, are taken from the soil by the roots in liquid form. This material is carried in the cell sap, mostly through the outer sapwood, to the leaves (Chapter V). Here the crude food materials are changed by the influence of the sunlight and the green substance of the leaves to a form that can be readily assimilated by the plant. This will illustrate, briefly, how important the roots are to the plant.

Much of the elaborated food may be stored in the cells, especially in the fall, to be drawn upon at any time that the roots fail to supply the requisite amount. In transplanting, the nursery tree is often deprived of one-half or more of its roots, and not only must it become established in the soil, but it must produce a large number of new roots before much new food can be supplied. In the meantime, the leaves begin to push out, and the reserve food and moisture may all be used before the root system is in a condition to supply more. This will explain how newly planted trees may start into growth with apparent vigor, only to die later, when the reserve food and moisture is exhausted. By cutting back the tops, and thus reducing the number of buds, this supply is conserved, and thus the tree is tided over the critical time until root-hairs are formed.

Is it any wonder, then, that the failure to cut back the tops of newly planted trees results in the death of many of them? This is especially true in the arid region, as the dry air and intense sunshine cause the young trees to dry out rapidly.

It is also true that many nurserymen, as well as fruit-growers, are careless in handling trees before they are planted. Not infrequently the roots are exposed for hours to the drying action of wind and sun. One must take the chances of such treatment from the nurserymen, but after the trees have been received by the grower, there is no excuse for neglect in this respect. The trees should be heeled-in deeply at once in damp soil, and when planting, the work should be so arranged that the roots of each tree shall be exposed to the air the shortest possible time.

All bruised and torn roots should be carefully removed and cut back to healthy tissue, leaving smoothly cut ends that will readily heal; if this is not done, decay is likely to set in, which may seriously injure the tree. Long, straggling roots may well be shortened, and any tangled mass of fine roots should be shortened and thinned.

It would seem to be almost superfluous to insist on the importance of having all nursery stock inspected by the county inspectors, yet there are persons who try each year to evade the law in this respect. There are several insect pests and plant diseases which are very common on young trees, all of which may be easily overlooked by any one who is not thoroughly familiar with them. It is quite useless to spend much effort in pruning and caring for diseased trees.

The woolly aphis is such an insect, and it is doing a great amount of damage in all sections. This insect lives on the roots, and is introduced into orchards almost wholly by infected nursery stock. When once established, it spreads rapidly and is almost impossible to eradicate.

Crown-gall is a common disease in many nurseries, and it attacks all kinds of fruit trees. It is the worst kind of folly to plant a tree that has a trace of this disease, for not only is the tree almost sure to die before it comes into full bearing, but the infection may be spread by the cultivator or in the irrigation water to all parts of the orchard.

A statement previously published by the writers, on the subject of inspection, will bear repetition here: "All possible assistance should be given the county inspectors in their inspection of nursery stock. In counties where many trees are being planted, sufficient assistance should be provided, so that there will be no possibility of any shipments being overlooked. And finally, some means should be devised whereby the importance of inspection can be impressed on the growers, since, in some instances, they antagonize the inspectors and hinder their work. It is no doubt true that the inspection of nursery stock alone, if well done, pays many times over for all the expense incurred, even in those counties which expend the most money in orchard inspection."

But in those localities where several hundred thousand trees are planted each spring, the inspectors are so rushed with their work that the most careful men are liable to overlook an occasional infected tree; therefore no grower can afford to be unfamiliar with these common pests. Each tree should be reinspected as it is planted, and to make the work thorough the roots should be dipped in water so as to remove any dirt that might conceal small galls or a few aphids.

In this discussion it is presumed that the planting is done in the spring, as this is nearly the universal practice in the arid region.

It should also be stated here that the requirements of apple trees have been foremost in mind in the following pages. The same principles will apply, however, to all other kinds of fruit, with the possible exception of the peach.

High and Low Heads; Sun-scald

The proper formation of the top is by no means the least important reason for cutting back the branches of newly planted trees. In the first place, the importance of low-headed trees for this climate cannot be too strongly emphasized. Hundreds of trees are dying in all parts of the West because of the exposure of the long trunks to the afternoon sun, either directly or by reflection, from hot dry soil in summer or from snow in winter. Young trees are especially liable to injury, which results in early death or a weak, sickly growth, from which they never recover. There is less injury from sun-scald in the humid states, but in those districts many authorities are advocating lower-headed trees.

In addition to forming low heads, there can be no question but that it pays still further to protect the trunks of newly planted trees from injury by sun-scald. Various devices are used, such as wrapping the trunks with burlap, paper, straw, wood veneer, or by shading the trunk on the southwest side with a thin piece of board set upright in the ground. Whitewashing the young trunks to serve the same purpose has come to be extensively used in some sections. Whatever method is adopted, it should be employed soon after the trees are planted and continued in good condition through the second winter, or until the shade of the trees becomes ample.

The advantages of low-headed trees may be stated to be greater ease in picking, thinning, pruning, and spraying, and less damage to trees and fruit from winds. Some

Fig. 19. — Low-headed Trees, with Ascending Branches. Paonia, Colorado.

growers object to low-headed trees on account of the greater difficulty of cultivating around them, but with proper training low-headed trees develop ascending branches, as shown in Figure 19. There is not the slightest difficulty in working around the trees in this orchard, whereas the branches on high-headed trees commonly droop after they have borne a full crop of fruit, and so interfere with all orchard management.

The following extract is taken from Bailey's "Pruning-Book": "The relative merits of high or low heads for fruit trees are always in dispute. This controversy is partly the result of confusion of ideas and partly of differing mental ideals and of varying climates. Two factors are chiefly concerned in these disputes — the question of ease of cultivation, and the question of injury to the trunk by sun-scald. It is the commonest notion that short trunks necessarily make low heads, and yet any one who can see a tree should know better. The number of the trunks which a tree has does not determine the direction of the leaf-bearing limbs. This tree [referring to illustration] can be worked around as easily as it could be if it only had one long trunk. In fact, branches which start high from a trunk are very apt to become horizontal and droop. There must be a certain number of scaffold limbs to form the head. If these limbs are taken out comparatively low, they may be trained in an upright direction and hold their weight and position. If they are started out very high, they will not take such an upright direction, because the tree will not grow beyond its normal stature. High-trained trees are often practically lowest-headed."

Form of Tree

The business of Western orcharding is not old enough to have developed systems of pruning that may be said to be characteristic of the region. The conditions existing in the fruit districts have been so favorable for the production of fine fruit that the growers have not felt the need of the finest development of the art. We have grown fine fruit whether we would or no. But now that competition is more severe, and insects and diseases are multiplying, more attention must be given to methods and systems of culture.

In training trees, one of two ideals must be adopted, known as the pyramidal and vase forms. The former preserves the leader, which is made to form a central shaft to the tree. This style has the advantage of more bearing surface, as the leader grows and in time forms a "two-storied" tree. The objections to tall trees are apparent, and need not be discussed here. But it should be mentioned that under our conditions some difficulty is experienced in securing a good distribution of bearing wood. Some varieties, as the Gano and Ben Davis, are inclined to produce too many branches, and because of their position they make a weak growth and produce inferior fruit. Eventually the best fruit is produced at the top of the tree.

The leader is done away with in the vase form, and a few limbs, usually not more than five, are chosen to form the top. A more or less open-centered tree is thus formed, but by skillful pruning this space is occupied by branches of bearing wood. Very tall trees are thus avoided, but what is more important, such trees are not so likely to be destroyed by blight, as recently pointed out by M. B. Waite. Death to trees results when the blight germs gain entrance to the trunks and larger limbs. Such attacks are usually brought about by the presence of small limbs, water-sprouts, or fruit-spurs, which become diseased, and which the germs follow till the main trunk or branch is reached. Should the leader of a pyramidal tree be attacked seriously enough to necessitate its removal, the tree would be ruined, but by having several main branches or trunks, one of them might be spared without seriously crippling the tree. But the protection may be carried still further by keeping the main branches of the vase-shaped tree free of all small limbs and fruit-spurs which are so susceptible to attacks of blight. In any event, one important essential with the vase-form training consists in keeping the center of the tree well supplied with good bearing wood.

Shaping the Newly Planted Tree

The term "low-headed" is a relative one, but a top may be considered low when the first branch is 30 inches from the ground. Some of our successful growers prefer higher heads than this, while others start them lower. Our own preference is for a trunk about 20 inches in height. But whatever height is determined on, the tree must be cut back, preferably just after it has been planted.

Should the tree be supplied with suitable limbs at the point where the head is desired, three to five of them, properly spaced, should be chosen to form the framework of the tree. The others are removed. The selected branches should then be shortened-in to a sound bud within 12 or 14 inches of the main stem. But ordinarily the lower branches are pruned off in the nursery, so that we seldom secure a tree from which suitable branches may be chosen. In this case the entire top should be removed without regard to branches, making the cut a foot to 18 inches above the point where the lowest limb is wanted. In doing this, it is expected that branches will push out below in sufficient numbers so that suitable selections may be made. For this reason, strong yearling trees are always preferable to older ones. Should suitable branches fail to grow, one of the lower branches that nearly always form must be developed to form a new head.

The trees should be gone over several times during the first summer to remove surplus shoots, and especially those that push out far below the point where the lowest branch is wanted. Occasionally some of the upper branches develop a vigorous growth at the expense of the others. These should be headed-back so as to give all a chance to develop, otherwise some of the important scaffold limbs may be found to be very weak at the close of the season.

When a branch is headed-back, great pains should be taken to make a slanting cut just above a sound bud. A sharp knife is better for this purpose than the pruning shears, for the reason that on small limbs a cleaner, sharper cut can be made. The cut should be started a little below the bud, and with one movement the blade is brought out just above the bud. This will leave a small surface exposed to the possibilities of drying out, and the wound is not close enough to the bud to injure it. If the cut is made too far above, the stub will die back at least as far as the bud, and often farther. If made too close, the bud may be so injured that a stub is formed that will die back at least to the next sound bud.

The position of the buds on the branches is of considerable importance in pruning. For example, one would not expect a bud situated on the lower side of a nearly horizontal limb to develop an upright growth comparable to one on the upper side. In general, then, one should cut off the branches just above a bud that points in the general direction it is hoped the branch will take. One cannot hope to overcome varietal growth entirely, but it may be modified. By cutting to outside buds, the upright-growing kinds may be spread somewhat, and similarly the spreading varieties may be contracted by cutting to inside buds.

As soon as the trees are planted, the top should be cut back as described above. With yearling trees a profusion of branches will be pushed out, the lowest of which should be removed or cut back to one or two buds. By the time these branches begin to grow, the roots are established, and new ones formed, so that an adequate supply of food materials is provided. It will be remembered, however, that the plant cannot use these materials until they have been made over into food in the leaves. It is for this reason that a large leaf surface is necessary; and this surface is also desirable to afford shade protection from the sun.

The kind of top which the tree is to assume is developed with the first season's pruning, which should be begun in most sections not earlier than the first of March. If performed earlier, a longer time must elapse before the wounds can heal, and necessarily the cut surfaces are exposed that much longer to the drying action of the sun, wind, and frost. It is commonly understood among orchardmen that trees must not be pruned when the wood is frozen. Pruning when the trees are in this condition often results in bad wounds and the dying back of branches, but this result is probably due to the agencies just mentioned rather than to the fact that the wood was frozen. In any case the rule is a good one to follow. Then, too, there is always more or less danger from winterkilling after the time when early pruning is done, so that the trees would need to be gone over a second time.

From three to five limbs are now chosen to form the framework of the tree, which should be cut back about twelve inches from the trunk. The remainder are removed. If the lowest branch has been taken out at twenty inches from the ground, the highest branch should be at least a foot above it; two feet would be better. A common mistake is to cut trees back too far, thus crowding the branches, as shown in Figure 19. Neither were these branches thinned-out nor headed-in during the first season, but were all allowed to develop into leaders. This latter mistake often results in long, willowy branches that droop with a load of fruit; and this is the main reason for condemning low-headed trees.

Many growers carry their pruning up to this point successfully, but fail to head-in the first season's growth, and so miss one of the critical points in the proper formation of the top. (Fig. 20.)

It is a common notion that the branches gradually get higher from the ground as the trees continue to grow. The apparent gain in height is due solely to the increase in diameter of the limbs, which soon begin to crowd if sufficient space has not been left between them. The centers of the limbs will always remain the same distance apart, so in forming the head one should have in mind what the appearance of the limbs will be when they have attained a diameter of six or more inches.

Second year. — It may be regarded as a rule, that when a limb is cut back, unless the cut is made just above a strong lateral, two or more branches will start near the cut end, and some of the buds lower down will develop into shoots. The usual practice is to allow two of these to grow on each of the previous year's limbs to form additional framework for the tree. The two chosen should be some distance apart, one at the end and one farther back, and so placed that the formation of crotches will be impossible. They are now cut back from a half to two-thirds of their growth, and the laterals are shortened to one or two buds, so that they may later develop fruit-spurs and also shade the branches with their clusters of leaves. If too many have formed, some of them should, of course, be removed. On the other hand, if we are to develop Waite's idea of making the tree more resistant to blight, these laterals should all be removed and so carry the fruit-bearing wood farther away from the trunk and main branches.

FIG. 20.—Yearling Whip, properly Headed-back when planted, but improperly trained and Annual Pruning neglected.

Some growers object to heading-in trees at all, for the reason that all of the buds are likely to develop into branches and so the formation of fruit-spurs is retarded and the surplus branches must be cut out. But it is highly desirable that all of the buds should develop, and then by heading them back to spurs, as just mentioned, the formation of fruit-spurs is largely under control of the pruner.

Any tendency toward one-sidedness may be corrected to some extent, and open spaces filled in by choosing branches that are already growing in the general direction of the vacancy. Then, by cutting to a bud that is on the side toward the opening, such faults may be gradually overcome.

Third year. — The framework of the tree should now be well formed, so that it will require less attention from this time on. Surplus branches and those that rub or are inclined to form crotches should be removed. Very vigorous growths should also be headed-in.

Application to pyramidal trees. — Thus far our discussion has been confined to the shaping of open or vase-formed trees. If a leader is desired, the treatment is practically the same, except that the upper shoot is allowed to grow with little heading-in. Branches are allowed to develop on this leader at proper intervals, using the same care as to location, pruning, and development as in the former case.

A Study of Examples

A discussion of some photographs of actual experience in pruning young trees will help to review and fix the points of the different stages. These were second-grade trees, and were evidently three years old when planted. The lower laterals had all been pruned away in the nursery, so that the tops were much too high for this climate. There was also difficulty in getting branches to form at

21 21 *a* 21 *b* 21 *c*

Fig. 21. — Shaping the Top.

suitable places from which to make the selections for the head. However, the results are much better than if the tops had been left as received from the nursery, as is so often done.

The trees in Figures 21, 22, and 23 were all headed-back to about 24 inches in April, 1904. This left them mere stubs. Had there been any laterals below this point, they would have been pruned back to single buds, so that clusters of leaves might have formed, and thus provided shade for the trunks. These pictures show how the trees looked in April, 1905, at the time of the first pruning.

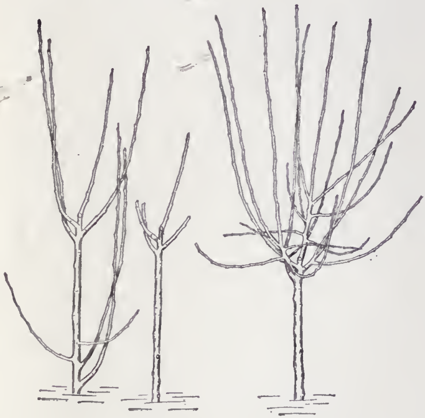
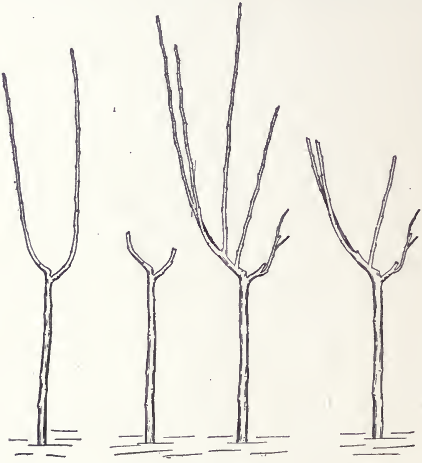


FIG. 22. — Shaping the Top.

No. 21 had formed five vigorous branches, No. 22 produced four, and No. 23 but two.

The five branches on No. 21 were saved to form a framework for the tree and were cut back to about one foot in length. These are well distributed about the trunk, but have the fault of being too close together. The lowest limb might well be double the distance from the top that it now is. No. 21 *a* shows No. 21 after it was pruned, with the idea of making an open-centered tree.

The objection also applies to No. 22 that the limbs are



23 23 *a* 23 *b* 23 *c*

Fig. 23. — Failure.

too close. All of these were saved to form the framework of a tree with a leader, as is shown in No. 22 *a*. The only difference between this and No. 21 *a* is that the topmost branch was left longer than the others. The pruner of this tree is open to severe criticism because he allowed three vigorous limbs to grow from near the surface of the ground.

These limbs could serve no useful purpose, and so only rob the other limbs of plant-food. Such growths are best prevented by pinching off the buds early in the season.

Tree No. 23 failed to throw out enough branches to form a suitable top. The two branches are nearly opposite, so that a bad crotch would soon result. Both branches were cut back to the second bud, as shown in 23 *a* in the hope of inducing dormant buds to push out lower down.

Tree No. 24 shows one of this lot of trees that was left unpruned. Notice the weak, spindling growth and short laterals, as compared with the others. There is small chance of making a satisfactory tree from such a specimen, even though it should live. Such illustrations as this, which may be seen on every hand, should prove to any one that all trees should be headed-back when planted, if for no other purpose than to induce a vigorous growth.

Fig. 24. — Neglected.

At the close of the season of 1905 the pruned trees had made the growths shown in 21 *b*, 22 *b*, and 23 *b*.

Pruning should, of course, be done in late winter or early spring, but these trees were pruned for the purpose of illustration, and the results are shown in 21 *c*, 22 *c*, and 23 *c*. Tree No. 21 has now taken the form shown in 21 *c*. One of the scaffold limbs seemed to be superfluous, so it was removed, and the new growth, shown in Figure 21 *b*, was cut back about one-half. The few side shoots were cut back to a single bud, with the idea of developing fruit-spurs. In the season of 1906, numerous branches should develop on all of these scaffold limbs. As a rule, two of the best placed of these secondary limbs will be chosen on each of the main scaffold limbs to form additional framework. The remainder may be removed or cut back to develop fruit-spurs, as may seem best.

The form of the tree, then, should be developed at the beginning of the season of 1907, and subsequent pruning should be directed toward retaining this shape, cutting back excessive growths and thinning and renewing the bearing wood.

The pruning of tree No. 22 is much the same, except that a leader is being developed. Fig. 22 *c* shows that, although the top was cut back the same as tree No. 21, the topmost branch is developing into a vigorous central shaft. The first set of scaffold limbs has been formed, and a second set is to be developed at a suitable distance above. The new growth is to be cut back, as has been described.

The tree shown in the series 23–23 *c* is, so far, practically a failure. The severe heading-in it received in the spring of 1905 failed to make branches start lower down. It would have been a better plan to have inserted two or three buds at suitable points around the main stem in June, 1905. This can probably be done next June, but the chance for success is not so great. Limbs can be developed by this means just where they are wanted, but the average person will succeed better with trees that do not require such manipulation.

Subsequent Pruning

The form of the young tree should be well established after the third season. From this time on the question of pruning is merely to retain, so far as possible, the form we have started, to prevent the formation of crotches and cross branches, to thin out an excess of branches so that sunlight may be admitted and the amount of bearing wood reduced and renewed.

One of the peculiar effects of high altitude, with the accompanying sunshine on plants, is that it induces fruitfulness and early bearing. Many varieties of apples produce paying crops when the trees are six years old, and the tendency of young trees to overbear annually is pronounced. We therefore are rarely obliged to prune to induce fruitfulness. Should such an occasion arise, the following should be borne in mind: Prune in summer to induce fruitfulness, and in winter to promote wood growth. This is true for the reason that summer pruning checks the growth of the tree by removing a part of the leaf surface. An injury of any kind will have the same effect; likewise a weak-growing or sickly tree should be severely headed-in while still dormant in order to induce a vigorous top growth.

Thin out the top every year. No general rule can be given, as each tree presents a different problem. A thick growth of branches results in weak-bearing shoots and spurs. And finally, when cutting back limbs on bearing trees, the cut should be made just above a strong lateral wherever possible. The tendency of the sap will be to flow into the lateral, and thus prevent the formation of numerous branches, which nearly always results when a so-called stub cut is made.

A number of our best varieties of apples are likely to develop long, slender branches that may bend and rest on the ground; and, indeed, it is not uncommon for such branches to break under a load of fruit. Some of these kinds, as the Winesap, are very liable to overbear periodically as they get older, often to such an extent that the branches are broken with a load of undersized fruit. Such trees may require two seasons in which to recover from the effect of overbearing, but the third year the process may be repeated. A severe heading-in and thinning-out of the branches would largely correct these faults, and make it possible for the trees to bear annual crops of fine fruit.

The orchard man should become well acquainted with the habit of growth of different varieties, as a few kinds grow slowly and will not bear heavy pruning. Others are erect growers and some are spreading.

One cannot expect entirely to overcome such tendencies, but they may be corrected to a marked degree. The upright varieties may be spread somewhat by pruning to the outside laterals, and the spreading kinds may be contracted by cutting to those that have an inward direction; and by cutting back the vigorous growths each season, those two feet and more in length, the limbs are made stocky, thus in great measure doing away with drooping branches. However, we think that, under our conditions, it is advantageous in many ways to keep trees from becoming very tall. This can be done only by intelligent annual pruning. In Figure 25 is shown a photograph of a

Fig. 25. — Young Apple Trees well Headed-in.

successful young Colorado orchard that has been severely headed-in.

Thus far our discussion has had to do entirely with apple trees. The same principles apply to most of the other fruits, with the exception of those, like the peach, that bear fruit on last season's wood. The pear is pruned much the same as the apple, as are also the blue or domestica plums. The latter should be headed lower, and they require much less attention after the character of the top has been formed. The sour cherry and red or cultivated varieties of American plums, require almost no pruning, except that the tops should be kept very low.

Pruning Young Peach Trees

The response of the young peach tree to proper pruning is even more marked than that of the apple; it seems to have a greater range of possibilities. In habit of fruit-bearing, the peach differs from the apple in the fact that its fruit-buds are axillary and not terminal. The fruit is borne on one-year-old wood (Chapter VI). As compared with the apple, the development of its fruit-buds is less easily influenced by overgrowth; that the tree will stand more vigorous pruning than the apple is suggested by its habit of fruit-bearing and proved by experience. The grower should take advantage of this as a means of keeping his trees well within bounds. The excuse so often offered for heading the tree high no longer applies, for experience has shown that, if properly trained, the low-headed tree is no more difficult to work about than the high-headed tree (Figs. 19 and 26).

The first important step in growing a young peach orchard is a proper choice in nursery stock. Either a one-year-old bud or a June-bud is a very satisfactory tree to plant. The yearling bud is the type of tree grown in the northern nursery, and the top represents one season's growth from a bud set in August or September. It

Fig. 26. — Low-headed Peach Trees, Mesilla Park, New Mexico. Photo by Garcia.

possibly has the advantage of being a little stronger and better-matured than the June-bud, but it occasionally has the disadvantage of being overgrown, with head formed too high and the buds rubbed off below.

The June-bud is a product of a climate with a long growing season, and is the type of tree grown in the southern nursery. The top of the tree represents the growth of the remainder of the season from a bud set in June. It generally has the advantage of being headed lower, but occasionally, when received by the western grower, the upper part of the tree shows lack of vitality. This may be a matter of long shipment, and is probably due to conditions under which the tree is delivered rather than to any inherent characters.

The peach tree nearly always comes from the nursery with the head already formed, that is, with lateral branches developed. The common practice is first to set the tree and then head-in the main stem to within 18 inches of the ground and the laterals to one or two buds. In the yearling tree, heading to 18 inches may mean the removal of all laterals formed, but buds will generally start from below to form a well-balanced head. Leaving stubs of all the laterals insures a large leaf surface for the first season, provides for the protection of the body from the sun's rays, and supplies a goodly number of strong limbs from which to choose those to form the head of the tree.

Fig. 27. — Poor Head on Young Peach. The Result of Pruning for Fruit.

The first spring after setting, the pruning will consist in thinning out the new wood to not over 5 arms well spaced around the entire trunk, and cutting these back to 12 or even less inches in length. Should some of the arms be inclined to crowd toward the center, cutting to a good strong outside branch may be of service in spreading the tree. When pruned for its second year's growth, the peach tree should not be over 3 feet in height (more often 2), and the tree will consist of a main trunk with 3 to 5 limbs from 8 to 12 inches in length. This is severe pruning for a peach tree that has made a good growth, but it will pay in the end.

FIG. 28.—The Same as Fig. 27 after One Season's Growth.

The second spring after planting, the head will need some thinning-out and cutting-back. Pruning the two-year-old orchard for fruit is a common mistake; it is impossible to prune such a tree properly and leave fruit-buds on it. The more rapid the growth of new wood the nearer the tips will the fruit-buds be found; practically all the fruit-buds on a two-year-old tree that has been properly pruned as a yearling will be in the top of the tree. Figure 27 shows the style of pruning that must be adopted to leave even a few of these buds. With such pruning it is impossible to grow a well-shaped peach tree. The result of such practice is well illustrated in Figure 28, which shows the same tree after one year's growth. Note the tall, "leggy" tree with very little spread. While the tree may not have been an ideal two-year-old, there is no excuse for growing it into such an ill-shaped three-year-old. Figure 29 shows a two-year-old tree pruned for shape rather than fruit, while Figure 30 shows the same tree before pruning, and Figure 31 after one season's growth. Before pruning, this two-year-old stood 5 feet high, after pruning 30 inches, and at the end of the third season it stands 6 feet in height. Compare this broad, well-formed top with the one pruned for fruit. Had it not been for severe injury from attacks of twig borers, this tree would have made a much better top; the figure shows many dead stubs, and a close examination will show that the upper arm, as shown in the center and to the back of Figure 29,

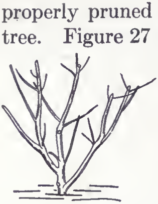


Fig. 29. — Two-year-old Peach Tree well Pruned.

Fig. 30. — Same as 29 before Pruning.

was lost entirely on account of the borers checking the young growths as they started. This is a loss of practically one third of the top, and well illustrates the advantage of leaving the fourth arm which appears in the foreground, and which must now be developed to take the place of the stronger one which came to the untimely end.

FIG. 31. — Same Tree as Fig. 29 but One Year later.

In Figure 31 is shown a tree after three years' growth in the orchard with sufficient fruiting-wood to produce a box of fruit the fourth season, and with this wood so placed that it may be left without interfering with proper formative pruning. The center of the tree presents a brushy appearance, which is largely due to a secondary growth forced by the borers checking the terminals early in summer. On account of this abnormal growth, the tree carries an unusually small number of fruit-buds low down. While the spraying of the young orchard is often neglected, this tree should sound a warning to the proud possessor of a promising young peach orchard.

To secure the top well spread and the fruiting-wood near the ground, it is necessary to prune severely and possibly to outside buds or branches. As a rule the two-year-old tree should not stand higher than four feet after pruning. A tree pruned in this way and kept growing thriftily will produce very few fruit-buds for the following year's crop. With moderate growth produced by judicious watering, the young tree may carry a few specimens in its third season and produce a good supply of fruit-buds for the following season. The young tree will do well to produce a box of fruit the fourth season, with an increase of 2 boxes per year for the next 7 years. The peach orchard will rarely more than hold its own after the twelfth year, but individual trees well formed and well pruned may occasionally yield as high as 20 boxes of fancy fruit per year.

In pruning the peach trees set as fillers in the apple orchard, a more moderate system might well be adopted. The second and third spring prunings should be light, hardly more than a little thinning-out. The extra amount of wood left will tend to check the rampant growth of the tree and encourage the formation of flower-buds. While it means a sacrifice as regards the shape and profitable bearing life of the tree, early bearing is, in this instance, more to be desired than long life. Peach trees set as fillers should never reach maturity. Heavy watering, however, may counteract light pruning, and the grower may easily defeat the purpose of the pruner by forcing the growth.

By the end of the third season the form of the peach tree should be well established, and from now on the pruning will be less severe. Many growers, however, still remove most of the fruiting-wood the following spring. The top should be cut back quite severely, but possibly more small wood left in the body of the tree than has ever been left before. In this and all subsequent prunings the pruner should encourage the growth of fruiting-wood well down in the head of the tree. While the head should be kept fairly open, this does not mean that fruit cannot be grown in the center of the tree. Some go to the extreme in growing a head with no central limbs; such a practice is simply a waste of space, necessitating an increase in the height of tree to secure the required bearing area.

The fourth spring the peach tree will need considerable thinning-out and some cutting-back. The idea should be to thin the fruit by cutting out the fruiting wood, with such other pruning as will encourage the spreading of the tree and keep the fruiting area near the ground. The tree is coming to a point now where it is impossible to lay down any definite rules for pruning, and the grower will have to depend largely on his own judgment; and judgment comes only from experience and close observation. With four years' growth in the orchard, the tree is practically mature, and subsequent pruning will be discussed in general in Chapter VIII.

The story of the two trees, as told by the drawings taken from actual photographs (Figs. 27 to 31 inclusive), should serve to guide the pruner in pruning his young peach orchard. The owner of the first will soon be picking from the top of a 12-foot ladder, while the owner of the second would be ashamed to possess one over 6 feet in height. The spread of the second tree will always exceed its height, which means that the angle at the lower point of a circumscribed triangle will always exceed 60°, and should rarely exceed 90°.

CHAPTER VIII

PRUNING MATURE TREES

MANY and varied are the excuses offered by the man who owns an unpruned orchard; he is ashamed of the neglected trees, and tries to justify himself by advancing what he considers, or more likely what he tries to persuade himself, is a good reason. One holds that pruning is little short of sacrilege, contrary to the laws of nature; another tells of h s fond recollections of childhood, and what excellent fruit he picked from the old apple tree, pruned alone by nature; another says it does not pay, and in his particular case it does not, for the chances are that the orchard is neglected otherwise. The only excuse that has any semblance of justification is that of ignorance, and that does not excuse the man who makes no attempt.

Nature's object is the production of seed, with provision for its distribution, and she is satisfied when a cherry is produced with enough flesh to attract some fruit-loving bird that may, perchance, drop the seed far from the parent tree. Man grows the fruit for its fleshy parts, and tries to improve these parts, as much by placing the plant in a more favorable environment as by plant-breeding and selection. The man who has the fond recollections of childhood would no doubt find them only childish fancies, as did the man who returned to his childhood home to renew his boyhood coasting and found no place steep enough on which to slide. The man who cannot afford to prune cannot afford to grow fruit, and the man who does not know how to prune, must learn; the principles are not complicated.

Physiology of Pruning

To be an intelligent pruner one must know something of plant physiology. He should know the effects produced by pruning at different seasons of the year, how to make a cut that will heal most readily, and the influence of pruning on the fruit-bearing habit of the tree.

It may be said that in the inter-mountain states the fruit-grower prunes at his leisure, but luckily this conforms rather closely to the proper season, when looked at from a physiological point of view. It is generally conceded that pruning in the dormant season incites wood growth, while pruning in the growing season promotes fruitfulness; and, since our trees tend to overbear, it is logical for us to prune largely during the dormant season.

Although it is said that pruning in the summer season may encourage the formation of fruit-buds on tardily bearing varieties, it may have the opposite effect, unless performed at the proper time, and may cause late growth and unfruitfulness. To give the desired results, one must summer-prune shortly before the season of growth ends; earlier pruning starts new growth, while late pruning gives no results. The benefit derived from summer pruning seems to depend on the ability of the orchardman to prune at a time to bring about early maturity. In an irrigated section where soil conditions are easily controlled, the same end may be more easily attained, no doubt, by proper manipulation of the irrigation water.

Both the season at which the wound is made and the character of the cut has an influence on the healing process. The pruner should remember that all food material capable of healing a wound is taking a downward course through the inner bark, and that to heal well, a wound must be in position to intercept the downward flow of sap from the foliage. When a limb is to be removed entirely, the cut should be at the union with and parallel to the surface from which the limb arises. When limbs are to be headed-back, they should be cut to a side limb and not to a bare stub. Wounds naturally heal best when made at a season when growth is most active, but, with the possible exception of wounds made in early winter, and subjected to a long season of drying, the season at which the wound is made practically has no important bearing upon the healing process. The grower, who has a small orchard that will permit of such a practice, should delay the pruning until as near the opening of the growing season as possible.

The influence of pruning on the fruit-bearing habit of the tree has been briefly mentioned, but the following pages will show how a fruit-bearing habit may, to a certain extent, dictate a course in pruning. The fruits with which this discussion has to deal have two general types of fruit-bearing: from terminal fruit-buds and from axillary fruit-buds (Chapter VI). The first type of fruit-bud is well represented in the apple and pear and the latter in the stone-fruits. Trees that produce axillary fruit-buds are naturally more prolific and require severe pruning as a means of thinning the fruit. In fact, a system of pruning under which the tree with axillary fruit-buds would thrive would cause the apple tree to overgrow to such an extent that it would be rendered almost barren. The point may be more fully illustrated by comparing the peach and the cherry. Although both develop axillary fruit-buds, they differ in their fruiting habits; the fruit-buds of the cherry are seldom found on the stronger-growing new wood, and severe pruning, as practiced on the peach, would throw much of the strength of the tree into the production of strong new wood that would carry very few fruit-buds. We have said that in the apple the type of fruit-bearing is from terminal buds, yet many varieties develop axillary fruit-buds. Varieties that develop axillary fruit-buds and bear terminal fruit-buds on young spurs all tend to overbear, and require severe pruning. To a certain extent, therefore, one can decide for himself how much to prune by observing how the tree bears its fruit.

Treatment of Wounds

The argument advanced in favor of dressing wounds is that it prevents decay and checks evaporation, both of which might interfere with the healing process. While in our arid climate the first is hardly applicable, the second should probably be doubly important. Yet the matter of dressing wounds is not so important but that work improperly done is worse than no treatment. A good lead paint is one of the most satisfactory dressings yet found. Rather a thick paint should be used, and careless daubing of the surrounding bark should be avoided. Grafting-wax is a good dressing, but is rather expensive, and difficult to apply. Other materials have been used, some successfully and some disastrously, and the grower is to be cautioned about experimenting; better adhere to materials known to be safe and efficient. Growers often overdo the matter and waste time in treating small wounds. Surely a wound less than one and one-half inches in diameter is not worth bothering with, if the wound is properly made.

These suggestions apply to wounds made by the careless cultivator as well as those made by the pruner. Unsightly wounds and permanent injury may often be avoided by proper treatment of trunk wounds. When the body of the tree is injured, the ragged edges of the bark should be pared off to sound tissue and the whole injury covered with paint or grafting-wax. If promptly done, this prevents drying out of the tissues, and new bark will readily form, except on parts where the outer wood cells are actually destroyed, and in time this will grow over. Wrapping the part with cloth, or, if it is near the ground, mounding earth up over it, will often answer the same purpose.

Pruning Tools

Every pruner shou d be furnished with good tools; they encourage him to do good work. This does not necessarily mean that he must have every tool on the market, for many of them are useless; it does mean, however, that the ax and a dull saw have no place in the catalogue of pruning tools. The pruner needs a good sharp saw, a good

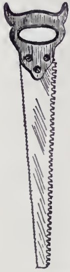


Fig. 32. — Pruning Saw.

pair of light shears, a pair of heavy shears, possibly a good heavy knife, and of course a good ladder.

The two common types of saws found on the market are those shown in Figures 32 and 33. That shown in Figure 32 is a good cheap saw, and will answer the purpose in many cases. A handier saw is shown in Figure 33. The blade is stretched between swivels and can be turned to any angle. It is well adapted to close work in the crotches of the tree. This type of saw, of various makes, can generally be bought for three dollars. The blades are not as frail as they look, and seldom break if properly handled; they can be replaced at a cost of fifty cents. It is really the best type of pruning saw, and should be used more generally.

Fig. 33. — Pruning Saw.

A good type of hand shears is that shown in Figure 34. It is indispensable for light work. Various makes are on the market. Buy the one that appeals to you. A pair of heavy shears like those illustrated in Figure 35 is almost a necessity. They take the place of the saw in many cases, and will do the work in less time. They are used in heading-in limbs where the saw can hardly be used. The peach pruner finds good use for them. They work well on limbs up to one and one-half inches in diameter. The

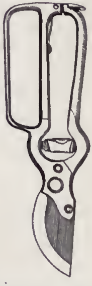


Fig. 34. — Pruning Shears.

only objection the writers have to this tool is that the pruner sometimes gets careless and leaves stubs. There is a type of heavy shears on the market that has two cutting edges instead of one, but it seems to do no better work. The pruner finds very little use for a knife in pruning mature trees, and seldom carries a special pruning knife. Several types of the long-handled tree pruners are on the market, but they are of little value in the commercial orchard. The pruner should be close to his work, and with a good ladder and short-handled tools he will do better work.

Fig. 35. — Heavy Pruning Shears.

Pruning the Apple

With the young orchard well grown (see Chapter VII), the pruner has probably solved the most difficult problem in the pruning of the apple tree. The principles involved in the pruning of the old orchard are not complicated. Nearly all our standard commercial varieties of apple tend to overbear in the Far West, and one of the first objects of the pruner should be to overcome this tendency; the more prolific the variety, the heavier the pruning.

To be an intelligent pruner, one must also acquaint himself with the habits of growth of the different varieties as well as habits of fruit-bearing. Upright growers will require pruning to spread them, and straggling growers such heading-in as will make them grow more upright. The head should be kept reasonably open and well supplied with fruiting-wood throughout. The idea of the open head, however, can be overdone. (See Fig. 36.)

Limbs that interfere or are liable to form bad crotches should be removed and the main branches headed-in, as

Fig. 36. — Exaggerated Type of Open-centered Tree.

the tree indicates the need by overbearing or by weak growth. Moderate annual prunings are always to be preferred to heavy pruning at irregular intervals; these heavy prunings tend to upset a regular bearing habit, and may bring on an "off-year." However, if it should become necessary to employ drastic measures in pruning the neglected orchard, do not be afraid to use them, but do not make the mistake of selecting an "off-year" in which to do this heavy cutting.

Fig. 37. — Jonathan well Headed-in.

A discussion of the amount of pruning required by different varieties could almost as well be introduced here as that on the pruning of different kinds of fruit.

Yet the growth of the tree, and necessarily the pruning, depend much more on soil conditions; and while it might

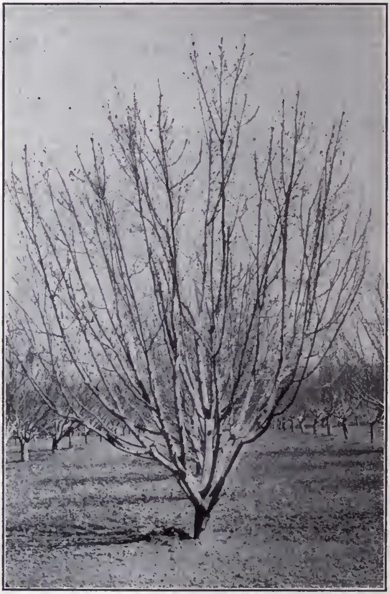


Fig. 38. — Jonathan, growing Long, Weak Branches, due to Lack of proper Pruning.

be possible, it would hardly be safe to lay down definite rules for the pruning of any particular variety. Both the Winesap and Missouri (Pippin) may be classed as prolific varieties that require severe pruning. The Jona-

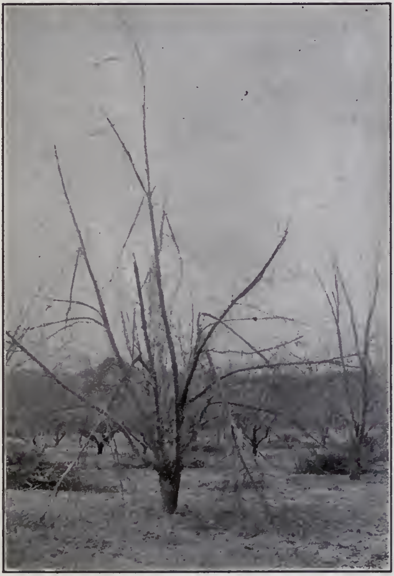


FIG. 39. — Ben Davis Fifteen Years Old and ruined. Such Loss may be avoided by proper Pruning.

than at the age of 11 or 12 years almost invariably begins to grow spindling in the top, and requires frequent cutting back to keep that tree in a thrifty condition. Figure 37 shows a Jonathan tree well headed-in, with stocky growth, while Figure 38 is of a neglected tree of the same variety and of the same age. These willowy limbs bear small

Fig. 40. — White Pearmain showing Type of Growth.

leaves and an abundance of apples that rarely come up to size, and the liability of such neglected trees breaking down under a load of fruit is well shown in Figure 39. Figure 37 shows how sprouts are largely avoided by cutting to side limbs. Varieties that bloom heavily but set very few fruits should be treated as varieties that overbear, and be pruned heavily during the dormant season. Varieties that refuse to develop fruit-buds should not be pruned excessively, at least not in the dormant season.

An idea of the difference in growth and fruiting-habit of two varieties may be had by comparing Figures 37 and 40, Jonathan and White Pearmain. The White Pearmain is rather a strong grower and a variety that does not bear heavily on young spurs. The fruiting-spurs are distributed along the larger limbs. Such a variety does not need a great deal of pruning.

Summer pruning is supposed to incite fruitfulness, but does not always give uniform and satisfactory results. Unfruitful varieties may be forced to bear fruit more easily by withholding water in late summer, or, better still, if the fault is known, plant them on a light soil; poor bearers are nearly always strong growers, and very often a shy bearer on heavy soils is prolific on a gravelly hillside. The Yellow Newtown is a striking example of a variety of this type. The growth and fruiting-habit of the tree determine largely what treatment it shall receive at the hand of the pruner. While pruning may not take the place of thinning entirely, it may be employed as a means of correcting the faults of alternate bearing and of overbearing.

Pruning the Apricot

In the general growth and fruiting-habit of the tree, the apricot occupies a position between the cherry and the peach. The fruit-buds are developed in the axils of leaves on both shortened, spur-like twigs and on the stronger-growing branches, both of the current season's growth. These fruiting-spurs of the apricot differ from those of the cherry in the fact that they develop no true terminal buds. The apparent terminal of the new growth is a lateral bud and may be either a fruit-bud or a branch-bud. It is generally a branch-bud, but it is not uncommon to find weak spurs bearing only fruit-buds, and such spurs, with no branch-buds to continue their growth, must perish at the close of the fruiting season.

The general plan of pruning the apricot resembles that followed in pruning the peach, although, as a rule, the cutting should be hardly as severe. The young tree is a strong grower, and must be put through about the same course of training as the young peach. This strengthens or stiffens the framework and develops a broad, low-headed tree. Normally the tree does not grow as much new wood as the peach, and it is often possible to do the greater part of the pruning by simply heading-in the strong growth. The pruning should be sufficient to keep the fruiting-wood growing thriftily and the tree well within bounds.

While to a certain extent pruning reduces the labor of hand thinning, it will not take its place entirely. If properly thinned, the apricot will stand much neglect as regards pruning, but proper pruning is a matter of economy. As the tree grows older it will need more severe pruning to force new fruiting-wood in the center. The absence of fruiting-wood in the center of the carelessly pruned apricot tree is even more pronounced than in the neglected peach tree. The top should be well spread and the fruiting area of the head maintained near the ground.

While the season for pruning the apricot generally extends through February and March, summer pruning is rather extensively practiced on the Pacific coast, where the trees are headed-in as soon as the crop is harvested. This starts the smaller laterals into stronger growth, and they develop an abundance of fruit-buds. Limited observations of the same system employed in the inter-mountain climate suggest that it may not be without merit here. While this late growth is inclined to be immature and may suffer from severe winter freezing, it is more desirable from the standpoint of late blooming. Fruit-buds on this immature wood open four to five days later than those on mature wood. This may frequently be an advantage in localities where late spring frosts are not uncommon. The advisability of such a practice has not been fully demonstrated, and is given only as a suggestion.

Pruning the Cherry

The man who objects to pruning, vowing homage to nature, should grow cherries, for there is no fruit-tree of which it may be said that nature is a more efficient pruner. In fact, it is a common impression among fruit-growers that the mature cherry tree needs no pruning. This condition, however, is more largely due to indifference on the part of the markets than to an inability to secure results from pruning. When competition becomes more keen, fancy grades of cherries will gain in popularity and, as in the growing of other fancy fruits, pruning will be found to be expedient.

In the cherry the fruit is borne on one-year-old wood and mostly on short growths or spurs. An examination of the spurs will show that they differ from those of the apple in carrying both terminal and axillary buds, the terminal, with few exceptions, being a branch-bud, and those developed in the axils of the leaves mostly fruit-buds. Fruit-buds are also found as axillary buds near the base of the stronger-growing new wood. The cherry, then, has a fruiting-habit which would indicate that the tree will stand only moderate pruning. Trees overpruned produce an excess of strong new wood with few fruit-buds. In neglected trees the spurs become weak and spindling from constant bearing, the flowers are borne singly in the buds when they should be in pairs or triplets, and the tree produces a large number of medium-sized fruits.

The method of pruning will depend somewhat on the variety, but the general plan should be to keep the fruiting area of the tree as near the ground as possible; to shade the trunk to prevent sun-scald; and to encourage the growth of fruiting-wood throughout the entire top.

The sweet and semi-sweet varieties are upright growers, and will need some heading-in to keep them within bounds. The rapid growth forced by pruning must be checked by careful watering. Unless this precaution is heeded, immature growth will result, and young trees may be killed outright in severe winters. Like the Anjou pear, some of the cherries produce an excess of weak fruit-buds that fail to set fruit. When this is found to be the case, it is a good sign that the tree is not being pruned as severely as it should be. Heavy pruning in the dormant season will often correct this fault. On the contrary, lack of bloom is generally due to excessive pruning or overwatering. Occasionally we find a variety in which this fault is characteristic, but it may usually be overcome by proper handling.

Pruning the Peach

There is probably no fruit-tree that gives the careful, observing pruner as much pleasure in the pruning as does the peach. Results soon indicate whether the pruning is right or wrong, for no fruit-tree will suffer more from neglect, and none responds more promptly to careful treatment. This prompt response, so plainly indicated, lends not a little inspiration to the proper training and care of the peach orchard, and it is safe to say that, largely on this account, no fruit-tree is better pruned in our recognized peach sections. The practice is simple, and lack of courage is more often responsible for failure than complicated principles. As already mentioned, the peach develops its fruit-buds in the axils of the leaves, and the fruit is borne on one-year-old wood, being a system of fruit-bearing that makes severe pruning a prerequisite to successful peach-growing.

In pruning the peach, the object of the pruner should be to cut out enough wood to force good, strong new growth each year, to remove superfluous fruiting-wood, and to give the tree the desired shape. The mature peach tree should make an annual growth of at least 18 inches. With such new growth, much of the new wood will have to be removed entirely, while that remaining may be cut back to remove a part of the fruit-buds it carries. While some persons object to shortening-in the fruiting-wood, contending that it injures the fruit, the years of experience of our most careful growers recommend rather than condemn such a system of thinning. While it does not take the place of hand thinning entirely, it saves a great deal of tedious hand work.

It is hard to say just how much of the new wood is to be removed, or how much the remainder should be shortened-in.

Fig. 41. — Well-trained Peach Tree, Seven Years Old. Palisade, Colorado.

Probably four-fifths is removed entirely, the amount removed from what remains depending more on the location of the fruit-buds. With the older tree it may be half or even more, while in the young tree it may be necessary to leave the laterals unpruned on account of the fruit-buds being nearer the tips.

It is a common practice to do the heavier pruning early in the spring, leaving the clipping-back and thinning until later, some waiting until all danger of frost is past.

The pruner should constantly keep before him an ideal form for the peach tree; the well-grown young orchard at the mercy of a careless pruner may become ungainly and

Fig. 42.—Peach Tree, Nine Years Old, well Trained. Note how nearly it conforms to a Right Angle.

unproductive at the age of 10 years. Effort should be made to keep the fruit as near the ground as possible, as most of the fruit on a seven-year-old tree should be reached from the ground, and in no peach orchard should the picker need a ladder longer than six feet. (See Fig. 41.) The depth of the fruiting area of the peach tree will seldom exceed six or seven feet, and an attempt to increase this depth will only result in a smothering out of the wood below.

A better plan is to increase the productiveness of the tree by increasing its spread rather than its height. The ideal peach tree is one in which the top just comes within a right angle, or in other words, the spread should be almost double the height. Figure 42 illustrates the point very well. Notice how the head is well filled with fruiting-wood, and compare with Figure 43, a tree of the same age. With such a system of training, the first tree will be productive at the age of 15 years, while the latter, now 9 years old, must be rejuvenated by severe heading-in or be discarded as unprofitable.

There is no more frequent fault of the old peach tree than that of the absence of fruiting-wood in its lower parts. Such wood can be maintained below only by vigorous pruning in the top. The center should also be well filled with fruiting-wood, as space may be unnecessarily wasted by training the top too open; the open center is not a necessity in the arid sections, where sunshine is abundant. The fruiting-wood in the center of the tree will hardly appear as strong as that nearer the tips, but, nevertheless, some of our best fruit comes from short and apparently weak spurs along the larger limbs. Some have tried summer pruning (thinning out the new wood in the center of the tree), hoping to strengthen the remaining wood, but it has not given satisfactory results; too often it starts new growth that is immature and unfruitful.

It is seldom that we read a paper on the subject of pruning the peach orchard without finding some reference to the treatment of winter-injured trees. With the exception of young trees grown too late, or orchards in higher

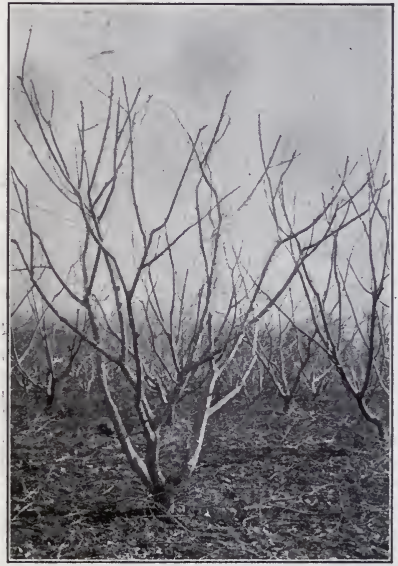


Fig. 43.—Peach Tree of Same Age as Fig. 42. Note the Long Limbs with Fruiting-wood only in the Top.

altitudes or northern latitudes, such injury is not often experienced in the inter-mountain country. It is well for the grower to remember, however, that the winter-injured peach tree makes the best recovery when it has received a moderately severe pruning.

Fig. 44. — Peach Tree rejuvenated by Cutting-back or "Dehorning" the Large Limbs.

A subject more worthy of mention is that of the rejuvenation of the old peach orchard. The occasional loss of a peach crop by a late frost offers an excellent opportunity to grow a new top on the old peach tree. Figure 44 shows a peach tree 11 years old, two years after the grower had taken advantage of such an opportunity. The cutting-back should be performed as soon as possible after the loss of the crop can be ascertained. Severe pruning as late as the first of June forces rank new growth that develops very few fruit-buds. Rather large limbs may be cut if the bottom of the tree has some smaller growth, but cutting to bare stubs over two or three inches in diameter is hardly advisable.

Pruning the Pear

The mature pear tree does not require much pruning, nor does it allow lack of pruning to interfere seriously with its proper behavior so far as fruit-bearing is concerned. However, when the market demands that the fancy pear be from 2¼ to 3¼ inches in diameter, the owner of the old pear orchard is often reminded that the trees need pruning. In general, the manner of fruit-bearing of the pear is practically identical with that of the apple. The spurs are a little shorter and give the tree rather a more barren appearance, and, although some varieties develop axillary fruit-buds quite freely, the majority of the fruit-buds are terminal on these short spurs. The different varieties vary somewhat in their fruiting-habits, and a study of this character will indicate, to a certain extent, how much pruning each will require.

Apparently the grower accepts the upright-growing habit of the pear as inevitable, with hardly so much as an effort to train it otherwise. With proper training there is no reason why the pear tree may not be grown with a moderately broad and low head. Pears that grow in the tops of high trees are too often scarred if not whipped off by wind

Fig. 45. — Improper Pruning of Neglected Pear Tree.

before they are mature, and, besides, it is too expensive to pick them. The shaping of the tree is determined mostly by the treatment that the young tree receives; but a little judicious heading-in of the old tree, taking care to cut to outside buds or branches, will improve an undesirable form. Too often the tree is allowed to grow at will until it is out of reach, and then in a fit of desperation the grower resorts to such a system of heading-in as is shown in Figure 45. This system may be correct for the lawn hedge, but it is not well adapted to the pear, as is shown by Figure 46, the same tree one year later. By the time the pruner gets through with this tree he will have decided that it is poor policy to head-in pear trees. Had the pear tree been properly headed-in, the result would have been different. It is only reasonable to suppose that leaving stubs of large limbs which bear numerous fruit-spurs will result in rank new growth from these spurs, especially in an off-year, when the spurs carry a large proportion of branch-buds. When it becomes necessary to head in the large pear trees, always cut to side limbs, and do not make the mistake of choosing an off-year to do this severe pruning; a heavy crop tends to check rampant growth encouraged by vigorous pruning.

While some growers really believe that the pear tree will not stand pruning, we know of no variety to which moderate pruning is detrimental. On the other hand, there are varieties that require severe pruning. In spite of the fact that the Anjou pear is a favorite on the market, many a grower will not consider the planting of this variety. Yet a few of its more forbearing admirers have demonstrated that its one bad fault (tardy bearing) may be overcome by proper pruning. The young tree blooms freely and apparently sets very well, but before the fruits reach any size, the crop thins itself to almost nothing; even the old tree carries a very small proportion of its bloom to maturity. Heavy pruning in the dormant season will stop this

FIG. 46. — Same as Fig. 45 after One Season's Growth.

shedding and insure a good crop of fruit. The practice of the most successful growers is to cut the tree back each year and cut out some of the new wood that may have been forced by the last pruning. When once the tree begins to bear good crops, there is less trouble about its shedding.

Some other varieties are more tardy about blooming, and heavy pruning in the dormant season would only augment this objectionable character. Such varieties often respond to June pruning; and, if they do not, girdling in June will often prove beneficial. In girdling, a strip of bark one quarter of an inch in width and extending entirely around the trunk may be removed; but perhaps a safer plan is to remove vertical strips of bark one and one-half inches in width, leaving other strips of about the same width intact. If the wood is uninjured, these wounds soon heal and do not permanently injure the tree.

It is difficult to say just how much the pear should be pruned. The grower must decide for himself. The main object of pruning the mature tree should be to thin the fruit and thus improve the quality as well as to encourage more regular bearing. However, the grower must not feel that pruning will take the place of thinning entirely; to secure best results the two must go together.

The subject of pruning the pear could hardly be complete without some reference to the control of pear-blight. While it is true that when once the pear tree is inoculated with blight we must lay aside many of our ideas about pruning and cut to remove the affected parts, it is also true that, in a way, the tree may be trained to reduce to a minimum the loss from attacks of this disease. After the tree begins to bear, heavy pruning that may induce very heavy growth should be avoided if possible, as it is generally conceded that blight is more destructive to trees making rank growth. The majority of inoculations takes place through the blossoms, and one of the most serious types of injury is that occasioned by the entrance of blight into larger limbs through short spurs. Through these short spurs the germs gain entrance to the larger parts, and often girdle them before discoloration indicates their presence. It is the nature of the pear tree to develop these short spurs in abundance, and it will be necessary to remove them from the base of the larger limbs. Strong new wood may be allowed to take their places, and this may later be developed into fruiting-branches. Then, should blight enter these blossoms, they are far enough removed from the main limbs that the disease may be detected and intercepted before it reaches the most vital parts.

Pruning the Quince

While the importance of the quince industry in the West might not seem to warrant the insertion of this paragraph, the almost criminal neglect from which the quince tree suffers as regards pruning would move one to write a book. Among the fruit-trees herein considered, the quince has a fruit-bearing habit peculiar to itself. With the advance of spring the dormant buds on the one-year-old wood push out leafy shoots from three to four inches in length, and these are terminated by a single flower. While both axillary and terminal buds produce these flower-bearing shoots, the stronger flowers come from the axillary buds on the last half of the annual growth; terminal buds more frequently give rise to branches, or at most weak flower-bearing shoots. Considering its fruiting-habit, then, the quince should receive about the same pruning as the peach. While with some varieties the plant very readily assumes a tree form, others are, at their best, only a bush. A course of severe pruning for the young tree, however, will aid the grower in securing a desirably shaped tree.

When the tree has reached a bearing age, it should be pruned annually by thinning out the new wood and clipping-back that remaining to about two-thirds of its length. With proper pruning, the quince should produce annual growths from 12 to 24 inches in length. Too rank growth is not desirable on account of the stronger fruit-buds being nearer the tips, and in cutting-back such rank growth the pruning must not be too severe. The plant should be made to assume as near a tree form as possible, and then in addition it should be pruned with the idea of growing a goodly supply of new wood each season.

Pruning the Plum

Under this head is grouped a large number of species and varieties of fruit differing widely in their habits of growth and of fruit-bearing. Were it not for the fact that common practice seems to discourage the pruning of many varieties to any considerable extent, this would be a difficult subject to handle; no well-defined system of pruning would suit all. In their habits of fruit-bearing the majority of the plums resemble the apricot very much. Still, many of them, like the cherry, show more of an inclination to bear only branch-buds on the thriftier new wood. Like the apricot, the plums, with possibly a few exceptions, develop no true terminal buds. Except on weak spurs, the last axillary bud is generally a branch-bud that continues the growth of the branch or spur the following season. The fruit-buds are developed in the axils of the leaves on both spurs and on the ranker-growing new wood, the different varieties showing considerable variation in this respect.

The body of the plum tree is subject to injury from sunscald, and it goes without saying that the tree should be headed low. The young trees of most varieties will need cutting-back, and the tops thinned out, to develop them into desirably shaped trees. Some varieties will require pruning to spread them, and others, of a more straggling habit, will need cutting-back to inside buds or branches to make them grow more upright.

As mentioned before, the bearing plum tree, according to local custom, receives at most only moderate pruning. As a rule, the Domestica plums, locally represented by the various prunes, are pruned very little after they reach the bearing age. There are certain varieties that tend to overbear, however, and a certain amount of thinning-out of the fruiting-wood would greatly facilitate hand thinning, promote more regular bearing, and improve the quality of the fruit.

The pruning of the native plums is left largely to nature, although there is no reason why moderate pruning might not improve the quality of the fruit and lessen the difficulty of picking.

There is little doubt but that such varieties as the Burbank, Abundance, Satsuma, Red June, and others of the Japanese group, respond satisfactorily to rather severe pruning. In fact, they are more like the apricot in their fruiting-habit, and thrive under the same system of pruning. When neglected, they tend to overbear in alternate years. They should receive an annual heading-in and thinning-out to force strong new growth which makes very desirable fruiting-wood. While pruning as a means of thinning the fruit is not without merit in the case of the plums, it does not seem to give results comparable with those secured in the peach. The grower of fancy plums must supplement moderate pruning with hand-thinning.

Thinning the Fruit

In fancy-fruit growing, the necessity for thinning will become more apparent as competition becomes more keen. While the wisdom of thinning peaches is no longer doubted, growers are not so willing to take up systematic work in thinning apples and pears. But the time is coming when the fruit-grower will be forced to conclude that it no longer pays to grow poor fruit. Even now, the years that the grower makes a profit in shipping choice fruit are the exception rather than the rule. There are but few localities in which choice fruit cannot be grown, and wherever shipped, such fruit must generally compete with the home-grown product. On the other hand, localities in which strictly fancy fruit can be grown are limited, and competition in this class is more impartial. The competition is between localities which are probably equally distant from the market, and the one producing the best fruit is the successful competitor.

To a certain extent, pruning is a method of thinning, but it will not take the place of hand-thinning entirely. The production of a fancier grade of fruit is not the only benefit derived from thinning: it encourages more regular bearing; lessens the loss from the breaking of limbs; and gives the grower an opportunity to destroy insect-infested fruit, and thus check the spread of insects early in the season. The tree that has been properly thinned should produce a good crop of fruit buds each year, and if it has been both properly trained and thinned it will never need a prop.

While many persons have observed that apple and pear trees are inclined to bear alternate years, probably few understand the cause. Fruit-spurs with terminal fruit-buds, as those of apple and the pear, generally bear in alternate years only, and if the spurs are all full of fruit one year, the next must be an "off-year." Not only do the spurs fail to bear annually, but if the tree is overloaded, spurs that produce bloom, even though they fail to set fruit, may not be sufficiently nourished to produce fruit-buds for the following season. If the tree bears only a moderate crop of fruit, spurs that produce bloom but no fruit often develop fruit-buds the same season. If the tree is bearing a light load, spurs may mature fruit and develop fruit-buds the same season. Varieties differ, and while some are regular bearers under almost any treatment, others show a stubborn inclination to bear only alternate years. After the old tree has fallen into the habit of bearing alternate years, it is no doubt more difficult to get it back to a regular bearing habit. Off-years are not uncommon with some of the fruit trees bearing from axillary fruit-buds, but it is not so pronounced as with the apple and pear.

Thinning the Apple. — Fixed rules to be followed in thinning are hard to give. Much depends on the general thrift of the tree, and, as in pruning, the grower must learn much by experience. If we thin to encourage annual bearing, it will be seen that all the fruit must be removed from some of the spurs, and, at the same time, the number of fruits remaining must be reduced to such an extent that the tree is not overburdened. Some persons thin to leave the apples at given distances apart, but a rule fixing a certain space between the fruits will not hold good in all cases. If we were always sure the tree had been properly pruned, we might be able to give a satisfactory rule to be followed, leaving the fruits at so many inches apart.

A plan the writers have tried and found to be very satisfactory is so to thin as to leave a certain number of boxes of fruit on the tree. Suppose you decide that the tree should produce ten boxes of fancy fruit. A fairly uniform grade of apples ranging from $2\frac{1}{2}$ to 3 inches in diameter will pack about 150 to the box, and by thinning two or three trees and leaving the 1500 apples, actually counting them or estimating them as closely as possible, one learns what a tree properly thinned should look like. With these trees as a model, it is surprising how close one can come to leaving just the right number. We think it is possible, by careful work, to come within a box of the ideal. But knowing how much the tree should produce is where the experience counts.

Not many varieties of apple will require much thinning before they are 10 years old, and at this age the average tree should produce about eight boxes of fancy fruit; some will produce more and some less. After the tenth year a gain of a box per year would be a conservative estimate. Of course the yield will vary under different conditions; and, while this is not a rule that may be implicitly followed, it is surely more accurate than thinning to a certain distance.

The thinner first removes defective or wormy specimens, and he should be supplied with a bag to carry the wormy fruits from the orchard to be destroyed; then those from the tips of the limbs may as well be removed, for they seldom make fancy fruit; and, if possible to do it and leave the required amount, thin to one fruit on the spur. June and early July is the proper season for thinning apples and pears.

Experiments have shown that it pays to thin apples. The fruit is improved in both size and color, the tree bears more regularly, and those that might break under heavy loads are saved. Some persons say it is expensive to thin; but, if one stops to calculate, he will find that it really costs no more to pick fruit in June than it does in October. A man can thin from ten to fifteen twelve-year-old trees per day, and the actual cost of thinning should not exceed two cents per box. It is true that the results the first season are often disappointing, for an unthinned tree may produce sixteen boxes of fruit that will grade 50 per cent fancy, while the thinned tree of the same age produces only ten boxes that will grade 95 per cent fancy. This hardly seems profitable; but the next year will tell, and it is safe to say that two years running the thinned tree will produce as much fancy fruit as the unthinned tree will produce of both fancy and choice.

Thinning Pears. — Methods of thinning pears differ little from those of thinning apples; the principles are the same. As a rule, the pear tree will produce about as many boxes of fruit as will the apple tree of the same age. The fruit is generally picked by installments, and it is possible to mature a large crop of fancy fruit; fruit that is small may be left until it reaches the desired size.

Pears running from 135 to 150 to the box are considered to be ideal size, and fruit for such a pack must measure from $2\frac{1}{4}$ to $2\frac{3}{4}$ inches in diameter. Pears larger than three inches are really not as desirable for the fancy fruit trade as those of smaller size. The fruit stands like a pear that can be sold two for five cents at a profit, and there is no profit to be made in selling the larger ones for that price, and they are not large enough to sell for five cents each.

Thinning Peaches. — In growing peaches, much of the thinning is done with the shears in the pruning season, but additional hand thinning is absolutely necessary. A good grade of peaches should run less than 90 to the box, and we may say it seldom pays to ship smaller fruit. A size that will pack less than 80 to the box is desirable. The young peach orchard that has been properly pruned will do well to average a box of fruit to the tree the fourth season in the orchard, and the yield should increase at the rate of about two boxes per tree per year. Unless the trees have been exceptionally well pruned and cared for, they will rarely more than hold their own after the eleventh or twelfth year.

The one object of thinning, as practiced with the stone-fruits, is to produce better fruit. The thinning should be performed before the foliage gets too heavy and the pits begin to harden. By carefully thinning a few trees and estimating the number of fruits remaining, one can soon form an ideal to work by. The pruning shears may be used as a help in thinning, and such fruiting-wood as is not necessarily needed may be removed entirely.

CHAPTER IX

TOP-WORKING FRUIT TREES

It is becoming more and more apparent of late years that certain localities and soils are peculiarly adapted to growing particular kinds and even varieties of fruit. Commercial fruit-growing localities are making their reputation by being able to grow a few varieties well. So each new fruit country must go through an experimental stage, when a host of varieties is being tested to determine those best adapted to its peculiar conditions. Then in the development of each new fruit country there comes a time when the grower will be obliged to solve the problem as to what to do with the undesirable varieties. Shall he destroy the trees or graft them over to better varieties?

Modes of grafting over old trees have long been practiced, and experience has proved that, if properly done, top-working brings quicker returns than the replanting of young trees. It is not uncommon to see a fairly good crop on the three-year-old top of a top-worked tree. Trees properly worked over give tops as desirable and sometimes more desirable than trees of the same variety grown from first-class nursery stock.

Top-working as a means of establishing a weak-growing variety on a stronger root system than its own is now coming into favor. The Rome (Beauty), when on its own roots, is an indifferent grower on the best soil; but when worked on some strong-growing stump, it makes a very satisfactory tree. Some varieties of apple, susceptible to attacks of root rots, could no doubt be successfully grown on roots of varieties that are apparently resistant. The Northern Spy seems to be a striking example of an apple-tree root free from the attacks of woolly aphis, and it is sometimes planted and later worked over to other varieties.

Broken and diseased limbs may be saved by grafting, and progressive fruit-growers, who desire to test new varieties, can best do it by grafting a few cions into bearing trees.

Some years ago the fruit-grower looked on the practice of grafting as a mysterious art and on the man who went about doing the work as a sort of wizard. As a matter of fact, it is so simple that any careful orchardist can and should do it himself.

All of our common fruit trees can be easily grafted or budded. The apple and pear may be intergrafted upon each other, and the same may be said of the peach, plum, apricot, and almond. But in practice, we do not undertake such wholesale mixing. It may be said that the apple and pear never make good unions; while such combinations may unite, the union may not be perfect enough to make a good top. We would not expect the top-working of apple to pear, or vice versa, to be a success. The writers have seen peach grafts start very vigorously upon apricot, and plums upon peach trees. We have observed plum trees top-worked to peach with perfect unions and the ten-year old tops bearing excellent crops of fruit. In this case the combination seemed to result in a dwarfing of the peach top, although the growth is by no means stunted. So, in practice, we adhere largely to the intergrafting of different varieties of the same kind of fruit.

To understand the principles underlying graftage, the orchardist should know how the stems of our fruit trees grow. He should understand that growth in diameter takes place only in a very small region between the bark and sapwood. This part of the stem is called the cambium. In this thin layer of tissue the cells are still active and capable of division, while the activity of each succeeding layer, on either side, grows less and less.

Fig. 47. — Longitudinal Section through a Graft, showing that Union takes Place only around Outer Edge.

When the limb is split to insert a cion, the cleft does not grow together along its entire length, as some may think. The cells in the cambium may produce a growth that may, to a certain extent, fill up the cleft and cover over the stub, but the tissues of the stock and cion make a true union only where the cells of the cambiums of the two come in contact. Figure 47 is a pen drawing of a section through a stub, grafted two years before. The stub was kerf-grafted, and shows that no union has taken place between the woody tissues of the stock and cion. The important point in grafting is to see that the cambium layers of the stock and cion are matched at some point.

When growth is most active, we say that the bark "peels." Budding is done during this period because separation of bark and wood is possible; it not only simplifies the work of inserting the bud, but, as growth is more active, the tissues of the bud and the stock are more likely to unite.

TOP-WORKING OLD TREES

In the working over of old trees, it is well to bear in mind that trees which show a poor growth in the orchard are seldom worth the time it takes to graft them. This is very often true of some varieties of apple. For example, we have never yet seen a Yellow Transparent stock grow a top worth the space it occupied. The same is almost invariably true of tops on Wagener, Duchess, Missouri (Pippin), Wealthy, and Hyslop crab. In fact, it seldom pays to top-work any crab. Figures 48, 49, and 50 are from a series of photographs of a Transcendent crab-apple, the first showing Winesap grafts one year old and some just set; the second figure, the same tree one year later (quite a promising tree); and the third figure the result at the end of the third season, almost the entire top being blown off by a heavy wind. The grafts were Winesap and were set in a kerf, not a cleft.

As a rule, the weaker-growing varieties are very unsatisfactory stocks upon which to work other kinds. Then the wisdom of top-working stone-fruits would almost seem questionable. While good tops may be grown on either peach, plum, apricot, or almond, it is doubtful whether these tops will bear much quicker returns than young trees set in the place of the old ones. Still, we would not care to discourage a practice most successfully followed by some growers, but will say that only strong-growing young trees under the most favorable conditions are worthy of such an attempt at renewal.

Fig. 48. — Transcendent Crab Grafted to Winesap.

Various modes of graftage may be employed in changing over the top of the old trees. Some method of cion-grafting is generally used, although it is not uncommon, in stone-fruits especially, to bud into new growths. Of the methods of cion-grafting two are commonly used in the West: cleft-grafting and kerf-grafting. Those who have

Fig. 49. — The Same as 48, One Year later.

Fig. 50. — The Same as 48 Two Years later. Grafts mostly Blown out.

practiced grafting in the East as well as in the West contend that the wood of western fruit trees is much more brittle, and that on account of excessive splitting, cleft-grafting is more difficult. This has led to the introduction of a new method locally known as kerf-grafting.

Cleft-grafting. — The operation of cleft-grafting is very simple. The limb to be grafted is sawed off squarely, leaving a smooth, solid stump. The stub is split down about two inches with a grafting-chisel or knife. The chisel is removed and the cleft is wedged open with the wedge on the back of the knife, or a wedge provided for the purpose. The cion should be cut to contain three buds and should be of strong, well-matured wood of the previous season's growth. The lower end is then trimmed to a wedge, leaving the first bud a little below the top of the wedge, and cutting the edge of the wedge opposite the bud a little thinner than the other. The cion is then set firmly into place with the lower bud to the outside and a little below the top of the cleft, being sure to bring the inner bark on the outer edge of the wedge in contact with the inner bark on the stub. This is the important step in grafting, as it is between these parts that the union takes place. Sometimes the inexperienced grafter makes the mistake of setting the cion flush with the outer edge of the stock. On large stubs with thick bark it would almost be impossible to set a cion more illy matched than in this way. Some persons advocate setting the cion on a slant, the point of the wedge toward the center of the stub. This insures a contact of the cambium layers where they cross and is a good suggestion, since a point of contact is sufficient for a good union.

With a cion properly set in each edge of the cleft — provided the stub is large enough — the wedge is removed. This allows the cleft to tighten on the cions, the greater thickness of the outer edge of the wedge-shaped portion of the cions insuring greater pressure at this point. With the removal of the wedge, the cleft should hold the cions firmly in place. Wax should now be applied to all cut surfaces, even to the tips of the cions. Special pains should be taken to see that the stub is well covered between the cions as well as the cleft as far as it extends down on the sides of the stub. This prevents drying out; and it is important that it be thoroughly done.

Kerf-grafting.— This system of grafting differs little from inlaying. The stub is prepared as for cleft-grafting, but, instead of splitting, saw cuts are made on opposite edges of the stub and trimmed to thin, V-shaped grooves with a saddler's knife. The cion is then trimmed to fit, driven firmly into place, and waxed as in cleft-grafting. With a little practice, the cions may be set as firmly as in cleft-grafting. It is contended that this method has the advantage in speed and that the cions are not as easily blown out in early summer. Cions are lost by both methods, and if properly performed, one is probably as good as the other. The kerf has the advantage that more cions may be set in large stubs and thus hasten the process of healing. The same care must be used in setting the cion to insure a union. The latter system seems to be especially adapted to working with stone-fruits, in which splitting is even more noticeable than in the apple and pear.

Sharp tools that give a smooth-cut surface are essential in all grafting work.

Bark-grafting. — Some orchardmen advocate a method known as bark-grafting. In this case, the stub is cut as before, the cion is prepared with a long slope on one side and slipped between the bark and sapwood. It is generally necessary to slit the bark at the point of insertion, and very often the bark is removed from the base of the cion up to the top of the sloping cut. The stub is bound with waxed string, or other material, to hold the cions firmly, and it is then waxed, as is the cleft-grafted stub. The method really has no advantages over the others, unless when compared with cleft-grafting in large stubs.

Terminal-grafting. — Another style sometimes employed is that known as terminal-grafting. This work is generally performed in the latter part of June or as soon as new growth has matured enough to allow a terminal bud to be secured. On old trees, such wood may be found in June. A twig that has completed its growth may be picked out by the presence of a well-formed bud at the tip and full grown, or practically full grown, terminal leaves. The cions are cut three or four inches long and the leaves practically all trimmed off.

There are different ways of inserting the cion. The most common method is to cut a vertical slit in the bark of the stock, trim the lower end of the cion with a long sloping cut on one side, and then slip it under the bark at an angle about 45° with the slit. The cut surface of the cion should rest upon the wood of the stock. It is not necessary to wrap or even wax the wound.

The cions start into growth the same season, but the top of the stock is left until the following spring. The method seems to work well. It may prove to be a practical way of supplying lower limbs on young trees headed too high. When one neglects to remove the top when such grafting is performed in the lower part of old trees, these cions readily form fruiting-wood, generally bearing the third season. It is suggested that it may be the proper course to take as a means of securing specimens of new varieties in the shortest length of time.

Choosing the stubs. — There is much to be gained by the proper selection of stubs into which cions are to be set. A too common practice is to remove the whole top the first year and graft all the stubs. It is surprising that some good results come from such a practice. More often, however, this proves too much for the tree and it fails even after the grafts have made a good start. It may linger two or three years and then die from no other cause than the severe cutting-back, although the growers are prone to attribute it to some other affliction. The cutting away of the greater part of the top may be advisable in top-working stone-fruits. The pear will withstand much more abuse in this respect than the apple.

A far better plan in all cases is to cut away only enough limbs to carry cions for a good top. This will generally be about half of the tree, as in most cases six stubs will provide for a good top. The working of more stubs results in a too dense top or necessitates their removal later. The remaining limbs may be shortened, but the foliage is needed to protect the stubs and trunk from sun-scald as well as to supply nourishment. If the stubs are well chosen, the remaining limbs will do much to protect the young grafts from wind and especially from being brushed out by passing teams and orchard machinery. It is well to choose inside limbs for grafting as they are best protected, but care must be taken not to contract the head of the tree too much. It should be borne in mind that top-worked trees tend to grow upright; but it is a difficulty that may be largely overcome by judicious pruning.

After the cions have made one year's growth, much of the remaining top may be removed, but it should seldom all be removed from old trees before the second year. If some stubs have met with accidents or have failed to start the cions, or if the shape of the tree or a scarcity of scaffold limbs has prevented a full top being placed the first spring, it may be completed the second.

While we sometimes see grafts doing well in stubs six inches in diameter, it is very doubtful whether such grafts will make a strong union or a long-lived tree. The wisdom of working limbs over three inches in diameter is to be doubted. In the choosing of stubs, the grafter should remember that large wounds, properly made, heal more readily than large stubs. Choose the smaller limbs for grafting even though the later removal of the top may necessitate the cutting of larger limbs lower down. It is better to raise the head of the tree than to work large stubs. Figure 51, showing a two-year-old top on a pear tree, illustrates this point; notice the large wounds below the grafted stubs.

Season for Grafting. — The ideal time for grafting is just as the buds are beginning to swell. While cions may be set earlier than this, there is danger of their drying out before a union is established. Should one care to prolong the season, it is better to run late than to begin early. The opening of the season will vary from the first of March to the first of April or even later in some parts of the West, and may be extended until the first leaves are practically full grown. Good results cannot be expected from cions set later than this. Some persons

Fig. 51.—Showing Pear Tree Grafted in Small Limbs. The Large Lower Limbs were Removed later.

go through the orchard in winter and remove the tops of the stubs that are to be grafted, cutting them at least a foot above where the cions are to be placed. This saves some time, and by hauling the brush out before the grafts are set, it saves some of them from being knocked out by careless men in removing it later. When ready to graft, the stub is recut from a foot to eight inches lower.

Protecting the Body. — Since the removal of any considerable part of the top often exposes the body of the tree to the direct rays of the sun, it is well in the arid regions to whitewash the trunk and main branches. The whitewash reflects the rays of the sun, and by such an application many cases of sun-scald may be avoided. (See Formula, p. 390.) The wash can best be applied with a spray pump. A good coating can only be secured with two applications, the second to follow as soon as the first is dry.

Cion Wood. — In this connection, it is well to say a word about the selection of cion wood for grafting. The man who is interested in his bearing orchard has early learned that the individual trees in the plantation show a great variation, especially in productiveness, and very often in the size, color, and quality of the fruit. Some of this variation may be accounted for in various ways, but, after all, we are coming to believe that, environmental conditions being equal, no two trees are constitutionally alike in bearing habits. It is a natural variation. There are trees that never bear well, and cions from such trees will, no doubt, produce trees very much like them. Mark your favorite trees and select cion wood from them.

The cion wood should be one year old, strong and well matured, but not overgrown. The terminal shoots from trees that have made a growth of 12 to 18 inches make excellent cions. The question is often asked as to the use of watersprouts. The term "watersprout" may mean different things to different persons. By watersprouts we generally mean rank growth from adventitious buds; and such growths with immature tips, weak buds far apart, and pithy centers make very poor cion wood. Otherwise, any new wood with well-developed buds comparatively close together may be used for cions. The statement sometimes made that watersprouts never produce fruit is erroneous. Figure 52 shows the difference between good and poor cion wood.

Fig. 52. — Good and Poor Cion Wood. Good on the Right.

Cion wood should be gathered in the fall, preferably as soon as the leaves have fallen, and stored until spring. The object is not to avoid winter injury, as some think, but to keep the cions in a dormant condition. Few realize that buds complete the resting period early in the winter and under favorable conditions may begin to swell before the first of January. While the unobserving man may say that there is no difference in the buds of the young growth in early December and in February, there may be a marked difference in some climates. The open winters in the Middle West are especially likely to start early growth. The object of keeping the cions dormant is to allow time for a partial union before the buds are started into growth by the warm days of the grafting season. Cions with buds well swollen often throw leaf surface before a sufficiently strong union has been made. The result is the exhaustion of the stored-up food supply and moisture of the cion to a point that may cause its death.

The cions may be stored in sand in a cool corner of the cellar or buried out-of-doors. The main object is to keep them cool and moist and away from fluctuating temperatures. An excellent plan is to bury them on the north side of a building or in some spot that is shaded most of the day. They need not be buried deep, from twelve to eighteen inches being sufficient in a well-shaded spot.

Growing the Top. — It would hardly seem wise to leave the subject of top-working old trees without some comment on future treatment of the grafts. The setting of the cions is only the first step in working over the tree. Should we stop here, a most miserable failure or, at least a poor top, might be the result. Many a good "catch" is ruined by neglecting the pruning the first two seasons.

In the first season the grafts should make a very rank growth and they will require some pinching-back to save them from becoming top-heavy and consequently easily blown out. The common practice is to head-in the rapidly growing shoots when they have attained a length of eighteen inches to two feet. This forces branches from below; and if growth becomes too heavy, these secondary branches may need cutting back before the season is over. This pruning insures stockiness of the new growth and throws much of the energies of the top into a good union.

The growth of suckers or watersprouts from the stock should not be allowed to any great extent. Should the stubs be exposed to the direct rays of the sun it is well to leave some of this growth, pinching it back to cause it to form a dense shade. Unless needed for protection, it is well to rub the sprouts off as fast as they appear.

The following spring the system of pruning should resemble very much that of pruning young trees. The grafts should usually be cut back to not over eighteen inches in length. They may be cut even shorter if the growth has not been satisfactory. If all three buds have started from a cion, it is well to remove all but one to avoid crowding. As a rule, the growth from the lowest bud will be the strongest and should be retained. Should the formation of the top allow it, a second growth may be left. If the grafts have been set close in near the head of the tree, they will require some pruning for the purpose of spreading the top. The general tendency is for the top-worked tree to grow too compact. Cut the grafts back to one of the strong outside branches started by the first pinching-back and it will give them a start in the right direction.

When two cions start in the same stub and the stub is less than three inches in diameter, one should be removed. Keep the stronger, or if there should be little difference, the one best situated to help make a good top. Cut the other off close, even to removing a small corner of the stub on that side, as the wound will heal better. Should the stub be over three inches in diameter, there is some reason for leaving the extra graft another year. It will help to callous over the stub, and it may

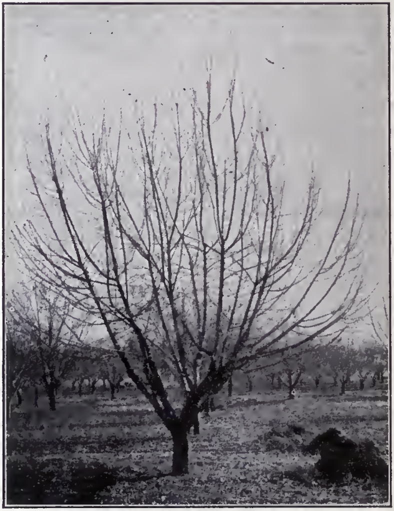


Fig. 53. — A Well-formed Grafted Tree.

be removed the following spring, leaving a comparatively small wound. If left longer, or until the two grow together, the result is a bad crotch and sometimes a pressure that may actually split the stub.

Subsequent pruning will consist in such cutting-back as will help form a stocky and well-shaped top. They will demand the same attention as young trees. Spread the top by pruning to outside buds or branches and do not pay too much attention to the small wood. Some of the small branches may require cutting-out or clipping-back, but remember that in this we have the start for early fruiting-wood. In Figure 53 is shown a well-formed top-grafted tree. Small limbs were chosen for grafting and enough of the original top was left to afford protection and to provide nourishment. Fewer grafts would probably have answered the purpose just as well.

TOP-WORKING YOUNG TREES

There is a growing conviction among fruit-growers that better results may come from planting vigorous young trees of some strong-growing kind to be later worked over to the desired variety. In the opening remarks on this subject, mention was made of the desirability of working weak-growing kinds on stronger root-systems, as well as top-working, as a means of lessening loss from attacks of root troubles and woolly aphis. The embarrassment of growing the orchard to a bearing age only to find some of the trees not true to name may be avoided by this plan of starting the young orchard. The fruit-grower has observed also that few trees of the same variety are alike in bearing habit and character of fruit, as we have said. No doubt, many growers have some particular tree in their bearing orchard that is better and nearer their ideal than all others. By choosing grafting wood from this tree, a young orchard may be grown as near like it as is possible.

In top-working young trees, it is a common practice to set the trees where they are to grow, and after the scaffold limbs are well formed, to graft or bud into these the future top. Some eastern men have advocated purchasing two-year-old trees in the fall (trees in which the head is already formed) to be grafted-over indoors in December. In the West, and especially on a large scale, this system would hardly seem to be practicable. The method in this case is whip-grafting.

Grafting Young Trees. — In grafting young trees in the field, it is probably well to perform the operation as early in the life of a tree as possible. As soon as a good strong framework can be secured, the tree is ready for top-working. The small size of the stubs makes cleft-grafting difficult and kerf-grafting almost out of the question. Some growers, however, report good success in cleft-grafting young trees after two years' growth from a yearling whip. In this case, the stubs must be bound with waxed cloth or other material to hold the cion firmly, and then waxed as in cleft-grafting larger stubs.

Another mode, known as whip-grafting, is well adapted to working these small stubs of young trees. The process is well illustrated in Figure 54. With this style of grafting, it may be possible to set the cions after one year's growth in the field, but it is doubtful whether much time will be gained by such practice. The cion should be as near the size of the stub as possible, if anything a little smaller. The cambium of the stock and cion is matched only on one side, paying no attention to the other. The joint should be well wrapped with waxed cloth, and, to be doubly sure that all air is excluded, it may be painted over with warm wax.

In grafting young trees, it is a common practice to remove all of the top, placing cions in those arms that one wishes to keep. It is always well to work a few extra stubs, as accidents may befall some of the cions.

Fig. 54. — The Operation of Whip-grafting.

The season for top-grafting the young trees is the same as for old trees. While top-working the old trees tends to hasten the bearing of the cions, it is doubtful whether top-working young trees induces earlier fruitfulness.

Budding the Young Trees. — Budding is, no doubt, the simpler method of putting a new top on young trees. While the process of budding is a little more delicate than that of grafting, with a little practice the average man can get very satisfactory results. Buds should be placed as soon as the top is well formed, setting one or two in each scaffold limb that is to be retained. The buds are generally set from six to twelve inches from the main stem, depending on the formation of the head. Trees two years old when set may generally be budded the following fall, and should yearling whips make a strong growth, the arms may be large enough to receive buds in September. Any stem as large as a lead pencil may be budded easily. Arms in which buds fail to start may be grafted the following spring or budded in June. Should arms fail to appear in the proper place, it is possible to supply them by setting buds directly into the body of the young tree.

When the buds begin to push into new growth, they will require about the same care as young grafts. They will need some pinching-back to strengthen the stem and to overcome the tendency to become top-heavy. With the possible exception of young trees budded in late June, all growth from the original stock should be removed as it appears.

Buds may be set in June, or in August and September. For June-budding the bud-sticks are cut as soon as good firm new wood can be secured. New wood with buds mature enough for budding may generally be cut from old trees the latter part of June. As soon as the buds unite with the stock, the bandage is cut and the part of the stock above the bud is removed. In June-budding it is well to leave some of the new growth that springs from the arms below the bud. This takes the surplus sap and helps nourish the roots until the buds are well started. Wood from buds set in June may not mature well in our climate, and so is susceptible to winter injury during severe winters. By careful watering, such growth may mature very well.

When practicable, fall budding should be given the preference. In the case of peach trees, June-budding is preferred where, in early spring, attacks of twig borers often destroy buds set the previous fall. In the apple and pear it is more convenient to bud in the fall. Arms that are large enough to bud in early spring were large enough the previous September, so that one really gains rather than loses time by budding in the fall. Most budding is done in the fall.

In fall budding, the buds are taken from the current year's growth. Buds may be inserted in wood of one, two, or three years' growth. The stiffness of the bark of the older wood makes budding difficult. The heavy bark not only makes the insertion of the bud difficult, but in drying out it curls away from the bud and exposes it to the air. The position for the bud is chosen with reference to the prevailing wind, protection from the sun's rays, or best to form the top of the tree. It is well to place the bud on the shady side of the stock, if possible. Should the locality be subject to strong prevailing winds, the bud will withstand more wind if placed on the side of the stock toward the wind.

The simplest form of budding is that known as shield-budding or T-budding. A T-shaped incision is made in the bark and the corners of the bark below the transverse cut raised to facilitate starting the bud into the opening. The bud is then cut from the bud-stick by starting the knife half an inch below the bud, cutting under and to about the same distance above the bud. This gives a long bud, which is especially desirable in our dry climate. In cutting under the bud, the knife should be run deep enough to leave a small shield of wood. Figure 55 shows the various steps in the process of shield-budding (which is the usual mode).

A simpler method of lifting the bud, at least for the beginner, is to start the knife as before, and cut sharply into the wood to about one-third the diameter of the stick and then upward under the bud, making a tongue about an inch long. The knife is then run across the tongue half an inch above the bud, cutting through and lifting the bark at this point. The bud is then grasped between the thumb and first finger and lifted, leaving the wood on the stick, as shown at *b*. While the removal of the wood from under the bud is no particular advantage, the method is simple and gives the inexperienced budder a larger percentage of good buds. The writers have lifted thousands of buds in this way with the best of success. It is difficult to cut buds in this way from some varieties of cherry and plum with thin bark, but it works well on the apple, pear, peach, apricot, and the heavy-barked plum. Of course, it would be impossible to lift dormant buds in this way for spring budding.

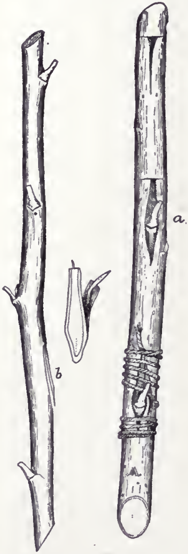


Fig. 55.—The Operation of Budding.

The bud is slipped into place, as shown at *a*, and well wrapped with raffia or soft wrapping twine. About four wraps below and three above, so spaced as to close the whole opening, is sufficient. In wrapping, the common practice is to start below, and by crossing over the first end and running the last end under the bud is wrapped without a knot. The tying material is usually cut in the desired lengths beforehand, and if raffia is used, it should be kept moist, as it ties better.

On healthy young wood, the buds will unite within ten days to two weeks. Then the wrapping should be cut by drawing a knife across it on the side of the stock opposite the bud. Should the stock be making a slow growth, there need be no hurry about cutting the tie. The only thing to be guarded against is that the wrap does not cut into the bark, for this pressure interferes with the flow of sap, and tends to throw the bud into premature growth; this often means a loss of the September bud.

The bud set in August and September should remain dormant over winter. The following spring, as soon as the buds on the top of the stock begin to push out, the stock is cut away. Should the stock be cut off too early in the spring, or too close, there is danger of the stub drying out to the injury of the bud. Some persons recommend leaving a longer stub to which the young growing shoot from the bud may be tied until it is well established. This saves some buds from being blown out, but necessitates a second cutting in midsummer to allow the stub to heal over.

We have said that buds for fall budding should be taken from the current year's growth. The common practice is to cut the terminal growth from bearing trees. The leaves are trimmed off at once, leaving a small part of the leafstalk with which to handle the bud. Budsticks trimmed in this way may be stored in a cool, damp place and kept for some time without injury. The leafstalks, however, will loosen and drop off in many cases if stored over ten days; this does no harm, but some budders miss the little handle in inserting the bud. The first few buds at the base of the stick are generally poorly developed and should be discarded, while those near the tip are too immature to be used. As a rule, not over half of the new growth cut in early September will carry buds suitable for budding. The sticks should be carried in a damp cloth to avoid drying out.

CHAPTER X

THE PROPAGATION OF ORCHARD TREES

PLANTS are propagated by seeds, separating and dividing, layers, cuttings, and by budding and grafting. The grower of orchard-fruits is interested more particularly in the propagation of trees, so that only this phase of the subject will be considered.

Propagation of the Apple

In the case of the apple, the stocks are grown from seed. Many seedlings are imported from Europe, particularly from France, but many seedlings are also grown in various parts of the United States. French crab stock is often spoken of as being exceptionally vigorous. Such seedlings are grown merely from the seed of wild seedling apple trees of that country. They are of the same species as our common apple. This stock probably does have the merit of being less variable than that produced from more highly developed varieties that do not come true to seed.

In this country, the seeds are commonly washed from pomace from cider mills. They are sown at once, or at least before they become dried out, in narrow drills in well-prepared land. At the end of the first season, the little trees are dug and the largest may be root-grafted during the winter or planted in nursery rows to be budded the following summer. The smaller sizes must be grown another season before they are suitable for working.

Dwarf apple trees are secured by top-working our common varieties on stocks of small-stature forms of apple. There are two dwarf races or varieties used for this purpose, known as the Paradise and the Doucin, both of which are forms of the common apple. The Paradise is mostly used, as it gives the smaller trees, they being mere shrubs. The cions, being of much stronger growing varieties, are not sufficiently nourished to enable them to make a vigorous growth; consequently, the trees always remain small, but most of them will require severe pruning to prevent them from making a more vigorous growth than is desired.

No small amount of interest has been taken in recent years in the possibility of combating woolly aphis by propagation trees on Northern Spy roots, as this variety is practically immune from attacks by this insect. Seed from Northern Spy apples will not reproduce the variety; consequently other means must be resorted to. One of the common methods is to graft a long Northern Spy cion on a short piece-root. If planted deep, the cion will send out roots; then the trees may be transplanted at the end of the season, when the nurse-root is removed. The foster-mother style of root-grafting may be used to advantage for this purpose. The top of this tree may be worked over to the desired variety, and the largest lateral roots may be used for further propagation.

Root-grafts are made by inserting a cion on a root or piece of a root, usually of a seedling tree. When the entire root of the seedling is used, a whole root-graft is the result. More commonly, however, sections of roots, about three inches long, are used. There has been much controversy over the superiority of the whole-root over the piece-root, or *vice versa,* but the consensus of opinion now seems to be that there is very little difference between the two when both are well grown and equally vigorous. However, a small weak piece-root will usually result in an inferior tree.

Propagation by budding has rapidly grown in favor, until at the present time a large percentage of the nursery stock is propagated in this way. This is particularly true in the large nursery centers of the East.

The seedlings to be budded are usually transplanted to nursery rows in the spring after they have made one season's growth (from the seed). The succeeding August the majority of them should be large enough to bud. The stocks are prepared for the budder by removing the leaves and branches from around their bases. The budders follow and insert the buds in the stocks as close to the ground as will admit of ease in working, and preferably on the north side of the tree. Boys are usually employed to tie the buds. A skilled workman will set 3000 or more buds in a day, but 2000 is considered to be a good day's work.

In about two weeks after the buds are set, the parts should be united. The bandages must now be cut, for if left too long, constriction of the stems and interference with nutrition will result.

The buds remain dormant until the following spring, when they start into growth with the rest of the tree. The stocks are now cut off just above the buds, and the strength of the strong root forces the bud into vigorous growth, and new tops are soon formed, often growing to a height of six feet the first season. It is in this way that strong yearling whips are produced, a growth difficult to secure in root-grafted trees.

As has been noted elsewhere, we prefer yearling trees and, generally speaking, well-grown yearlings can be secured only by budding. We also think that in the majority of cases better-rooted trees are secured by this method.

Propagation of the Pear

Pear trees are propagated in the same way as apple trees, although in practice they are seldom root-grafted, as the trees produced by this method are usually unsatisfactory.

Pear trees are dwarfed by working pear cions on quince stocks. The stocks are usually budded. The buds are set as close to the ground as possible, for the reason that it is desirable to have the point of union below ground when the trees are planted in the orchard.

Some varieties of pear do not take well on quince stock; consequently a system known as double-working must be resorted to if such kinds are to be dwarfed. This consists in working the quince to a variety of pear that is known to make a good union and, after this top has attained sufficient size, to bud or graft it to the desired variety.

Propagation of the Peach

Peach trees are almost universally budded. The pits from which stocks are grown should be collected as soon as possible after the fruit is ripe, so that they may not dry out. They may be planted in the nursery row at once, or they may be kept in bulk in any place where they will not become dry and where they will be exposed to the action of frost. This treatment will result in cracking most of the pits; those that are not cracked at the opening of spring must be cracked by hand if prompt germination is desired; otherwise some of them may lie dormant until the following spring.

If the seedlings do well, most of them will be large enough for budding the August succeeding sowing, when they are handled the same as apple trees. The seedlings that are too small for budding the first season may be cut back to the ground the following spring, and thus a vigorous growth may be secured.

June-budded peach trees are usually produced in the South, where seedlings of a size to admit of budding are secured by June of the year in which the seed germinates. As soon as the buds have "taken," a part of the top is removed, and after they have made a vigorous start, the top is entirely removed. Salable trees are produced by this method in one season. When well grown, there is no objection to a June bud, but unless the season is very long, there is always the danger of the tops being immature when cold weather comes on.

Peaches may be worked on plum seedlings, but this is unusual. In those cases in which numerous sprouts occur in the peach orchard, it is probable that plum seedlings were used for stocks.

Propagation of the Apricot, Plum, and Cherry

The apricot may be propagated on either apricot, peach, or plum stocks, but the peach is most used. The methods of propagation are the same as for the peach.

Plum trees are worked on a variety of plum stocks, as there is a number of different species. Special advantages are asserted for some of them. Peach seedlings are also sometimes used. Probably the best stocks come from seeds of inferior forms of the common domestica plum. These usually come true to seed, and thus give more uniform seedlings. Budding is the usual method employed in propagating plums, although root-grafts are sometimes made.

Cherries are also commonly budded. The seeds of several wild or spontaneous species are used in growing stocks, the Mazzard and the Mahaleb being most in favor.

CHAPTER XI

THE TILLAGE OF ORCHARDS

Clean tillage has been practiced by the majority of arid-country orchardists from the time the first trees were planted. It would be difficult to explain just why this plan has been followed, but it is probable that it was copied from California. While a certain amount of tillage is necessary, we wish to state emphatically that we do not believe in any system by which the soil is exposed to the action of arid sunshine during the heat of summer. In fact, we hold that this practice has been very much overdone and that the older orchards are in some cases beginning to show the effects. We may well profit by the experience of fruit-growers in other states, and in this connection the following quotation should be instructive:—

"For a quarter of a century great areas of vineyards yielded thousands of tons of grapes. All these years, under the stimulus of success, these same areas of land received clean, annual, and (may we not truthfully add) *merciless* cultivation. The natural fertility of the soil was gradually reduced by enormous crops of fruit and its physical condition lowered year by year, without the restoration of any considerable amount of plant-food or vegetable matter. After the lapse of many years, from various troubles and diseases, the vigor and fruitfulness of the vineyards waned, and the industry began to languish. Hundreds of acres of vines were pulled out and the land immediately and without improvement set to peach trees which, for another long term of years, and under the usual relentless culture without the addition of humus in any form, thrived and produced numerous, heavy crops of fruit. Again, as the remaining store of fertility became further depleted by the searching root systems of adult peach trees, enemies began to appear and make their presence felt. San José scale and leaf curl fell upon the island as a scourge and came near writing the final chapter in the history of successful peach culture there. With the destruction of great areas of orchards by the scale and the injury of thousands upon thousands of trees, upon which the scale was not quite successfully combated, it is only natural that great discouragement and depression should overtake the orchardists, so long accustomed to bountiful rewards for labor performed under such favorable conditions."

Has not Professor Green[1] truthfully portrayed what we have a right to expect will happen to the Rocky Mountain fruit-growers if our system of orchard management is not changed? No sane man should hope to continue to take large crops of first-class fruit from an orchard for very many years without doing something to restore the lost fertility. True, we do not expect to have many of the Eastern orchard insects and diseases to contend with, but they are possibilities. We have, however, been faithful in giving clean cultivation, and when one comes to think of it, do not the expressions "merciless cultivation" and "relentless culture" aptly describe this system?

[1] Green, W. J., and Ballou, F. H., Ohio Expt. Sta. Bul. 157, p. 118.

If we were to follow our own inclination, we would close this chapter at this point and refer all who are interested to the subject of fertilizers and shade-crops. But an understanding of the subject will help us to correct mistakes, and for this reason, at least, a discussion will be desirable.

Bailey [1] has summarized the benefits of tillage as follows: —

1. Tillage improves the physical condition of the land —
   - (*a*) By fining the soil, and thereby presenting greater feeding surface to the roots;
   - (*b*) By increasing the depth of the soil, and thereby giving a greater foraging and roothold area to the plant;
   - (*c*) By warming and drying the soil in spring;
   - (*d*) By reducing the extremes of temperature and moisture.
2. Tillage may save moisture —
   - (*e*) By increasing the water-holding capacity of the soil;
   - (*f*) By checking evaporation.
3. Tillage may augment chemical activities —
   - (*g*) By aiding in setting free plant-food;
   - (*h*) By promoting nitrification;
   - (*i*) By hastening the decomposition of organic matter;
   - (*j*) By extending these agencies (*g, h, i*) to greater depths of the soil.

A composite of the practices of a number of the most successful fruit-growers results as follows: Use the

[1] Bailey, L. H., "The Principles of Fruit-growing," p. 139.

turning plow in the spring, each year or often enough to prevent the ground from becoming hard. Follow the plow with a harrow or disc if lumpy, and this with the smoothing harrow. Some use a float instead of the harrow. The subsequent tillage or cultivation consists in going over the ground often enough to prevent a crust from forming and to keep the weeds down. This necessitates tilling after each irrigation and after rains. The Planet Jr. cultivator and the smoothing harrow are used for this purpose. Tillage is continued until the branches are bent down by the fruit, which will average about the first of August.

Winter tillage is practiced when the condition of the ground will permit. Two tillings in the winter is considered to be about correct. The Planet Jr. cultivator or a disk harrow is used for this purpose.

Turning now to the classification of the benefits of tillage as given on page 181, it would seem at first thought that the system followed by our best orchardists meets all requirements. We find first that tillage improves the physical condition of the land. By the physical condition is meant its tilth and general make up, whether it is compact and hard, or whether it is loose and loamy. But any one who has traveled among the orchards knows that in the majority of cases the soil is far from being loose and loamy. On the contrary, it soon is compact, lacks fiber, and it becomes puddled after irrigation or rains. We have even seen orchard soils so hard two inches below the surface that an opening could be made into them only with the aid of a pick. And yet thorough cultivation had been given the land for years. Evidently something is wrong, so we follow on down the classification and find under (*i*) that tillage may hasten the decomposition of organic matter. Here we believe is the cause of our difficulties. Cultivation, bare soils, and intense sunshine do hasten decomposition and in fact the burning up of such material. The classification is correct, but we have failed to adapt our system of cultivation to the climatic condition. The best advice has insisted that tillage and green-manuring (or cover-cropping) are complementary practices of equal importance; in the arid regions, we have emphasized only the tillage.

We are absolutely dependent on decaying organic matter to keep the soil in proper physical condition, that is, loamy and friable. But upon examination we find that this material is largely absent, having been sacrificed as a burnt offering to the gods of clean cultivation.

A certain amount of cultivation or clean tillage is necessary, but one need not wear out his soil in an effort to supply it. As will be seen in the next chapter, we advocate growing a shade-crop in the orchard in hot weather. If this system is adopted, the land should be plowed at least every second season, depending on the soil. By so doing a sufficient amount of tillage will be given, and at the same time organic matter will be supplied.

In the case of young orchards, unless the ground is very poor, some hoed crop will probably be advisable. Such crops shade the ground, and their growth need not interfere with the proper development of the trees. Among the crops used are cantaloupes, potatoes, squashes, and corn.

CHAPTER XII

FERTILIZERS AND SHADE-CROPS

We often hear it said that western soils[1] are inexhaustible; and indeed it is true that they are fairly rich in many of the elements of fertility. But we now know from experience that land cropped year after year to wheat becomes unprofitable, that even the second crop of potatoes is rarely satisfactory, and that all fruit association men and local dealers know that small apples and pie peaches are becoming more and more common.

[1] Some of our readers have no doubt seen the papers on various phases of soil fertility published in recent years by the Bureau of Soils of the United States Department of Agriculture. Their investigations seem to show that there is no such thing as soil exhaustion, as generally understood, but rather that there is an inexhaustible supply of all of the mineral elements of plant-food in ordinary soils. They contend that the decreased yields of the various crops is due to poisonous substances excreted by the roots of plants. Thus, according to this view, any crop may soon poison the land to such an extent that proper development of the plants is hindered, and decreased yields result. The remedy, according to this theory, is naturally a proper rotation of crops and methods of soil sanitation. The idea that the roots excrete poisonous materials is an old one, and new evidence lends support to it; but that this is accountable for all of the many cases of unsatisfactory yields is difficult to believe. At any rate the writers prefer for the present to adhere to the well-established theories, believing that the available supply of plant-food may be depleted. The presence of decaying vegetable matter in the soil improves its physical condition, helps to set plant-food free, and, in a measure, takes the place of crop rotation in the orchard. This may best be supplied and conserved under arid conditions by the use of shade-crops.

In several western regions the land was planted continuously to wheat in the early days, and, as any one would now expect, the soil became depleted and in some instances the farmers faced bankruptcy. This same land is now producing immense crops of wheat, oats, sugar-beets, potatoes, and alfalfa. What has brought about the change? Alfalfa was introduced about the year 1860. It was adapted to our conditions from the first, and large areas of this land were soon growing luxuriant crops of this unexcelled forage plant. The feeding of animals was then in its infancy, and alfalfa soon became a drug on the market. It was then found that alfalfa sod could be successfully broken, and, much to the surprise of all, when planted to wheat, the yield per acre was far greater than when the land was first subdued.

What had alfalfa done to the soil? It had added some nitrogen, which it is able to gather from the soil-air by the aid of the nitrogen-fixing bacteria. It also brought up from the lower depths, ten or more feet below the surface, potassium and phosphorus. These two important elements of plant-food were deposited in the surface soil in the shattered leaves and stems as crop after crop was removed, and when the sod was broken, the decaying roots and stubble added their quota. But more important than all these, decaying vegetable matter and its products had been added to the soil. Without decaying vegetable matter the physical condition of the soil is almost ruined for agricultural purposes, and the hosts of bacteria that perform many essential activities are prevented from developing.

Our orchards have been planted, for the most part, on desert land, and in most cases the land was cleared of the native growth and planted directly to trees. Thus there was little or no vegetable matter in the ground; and since our growers have been very insistent on clean cultivation and stable manure is scarce, little has been added. Does it not stand to reason that continued cropping to apples or to peaches will bring the same disastrous results that befell the wheat-growers?

The following information compiled by Roberts[1] is valuable in this connection. Table IV shows the amounts of plant-food that are removed in the grain and straw in twenty years of continuous cropping to wheat. It is assumed that an average of 15 bushels of grain and 35 pounds of straw are removed from an acre each year:

TABLE IV. AMOUNTS OF PLANT-FOOD REMOVED FROM AN ACRE IN TWENTY YEARS' CONTINUOUS CROPPING TO WHEAT

	NITROGEN	PHOS. ACID	POTASH	VALUE
	lb.	lb.	lb.	
Grain . . .	424.80	160.20	109.80	$79.86
Straw . . .	234.78	50.40	214.20	48.37

In contrast with this, the same author gives similar figures of the plant-food that may be expected to be carried away in 20 years in fruit and leaves from an acre of bearing apple orchard. The figures represent 20 years of the productive life of a New York apple orchard between the ages of 13 and 33 years, and does not include the materials stored in the wood of the tree.

[1] Roberts, I. P., Cornell Exp. Sta. Bul. 103.

Table V. Amounts of Plant-food removed from an Acre of Apple Orchard in Twenty Years

	Nitrogen	Phos. Acid	Potash	Value
	lb.	lb.	lb.	
Apples . . .	498.60	38.25	728.55	$110.26
Leaves . . .	456.75	126.00	441.00	97.17

Total value in wheat, grain, and straw for 20 years, $128.23.
Total value in apple, fruit, and leaves for 20 years, $207.45.

These figures show that an apple crop takes more fertility from the land than wheat; and most farmers know from experience that continuous cropping to most farm-crops leads to disaster. The day of reckoning does not come quite so soon, perhaps, with mismanaged orchards, but it is none the less certain. The fact that trees grow to great size and live for many years in forests does not apply to growing apples unless, perchance, they are grown for cider. The quicker the fruit-grower realizes that each crop of fruit makes large inroads on the available supply of plant-food, the quicker will he waken to the fact that scrupulously clean cultivation is not all there is in the handling of orchard land.

There are thirty-eight elements that may enter into the make up of a plant; ten of this number are considered to be essential to its proper growth. These essential elements are as follows: carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, potassium, calcium, magnesium, and iron. Normal development of a plant is impossible if a single one of these elements is absent. Only three of this number are considered, ordinarily, in the fertilizing of soil, namely, nitrogen, potassium, and phosphorus, because the others are normally present in most soils or in the air in sufficient amount.

Nitrogen is essential to vigorous growth, and an oversupply in the soil often promotes a rank growth of twigs and foliage at the expense of fruit-production.

Potassium or potash is especially important in fruit-growing, since it aids in developing color and is the base in combination with fruit acids. It also forms more than 50 per cent of the ash of fruits and constitutes a large proportion of the ash of the wood of fruit trees.

Phosphorus is probably not so important in fruit-growing as in grain production, as it enters largely into the composition of seeds. But it is an essential constituent of tree and fruit, and aids particularly in the proper ripening of the latter.

These three substances are supplied in various forms in commercial fertilizers, and it would seem to be a simple matter to provide any one or all of them as the individual orchard seemed to demand. Such manures are used very extensively by orchardists in the eastern states, but so far as we know, commercial fertilizers have not been tried in the orchards of the inter-mountain states, and we hope that their use will not become necessary for many years to come. In any event, freight rates are so high as to make their use almost prohibitive. Then, the benefit to be derived from their use under our conditions is problematical, as the following experience would indicate.

Potato-growers feel that they should grow two crops in succession after turning under alfalfa sod. The second crop, however, is rarely as good as the first and is very often produced at a loss. To one who is familiar with farming methods as practiced in the East, it would seem to be a simple matter to bring up the yield of the second crop by an application of commercial fertilizers. Accordingly, a series of acre plots was laid off in a potato field to which commercial fertilizers were applied. High-grade nitrate of soda, sulfate of potash, and phosphoric acid in the form of dissolved bone meal were applied separately and in various combinations. These experiments were carried through four years, and at the end of that time it could not be shown that the fertilizers had in any case produced an increased yield over the unfertilized plots.

How, then, are we to maintain the fertility of our orchard lands? We have already seen what are the benefits to wheat and potatoes of plowing under alfalfa, so why not adopt a system of green-manuring for the orchard? The potato-growers do not think of growing more than two crops of potatoes after alfalfa has been turned under. If they can afford to grow alfalfa for the purpose of producing better potatoes and in the meantime secure but two crops in five years, surely the orchardist can adopt similar methods. There will be no rotation with the orchard crop, but an actual saving in labor may be made, since there is little or no cultivation while the green-manure is occupying the ground. The potato-grower secures some returns, to be sure, from the alfalfa hay and from the grain with which it is seeded, but the potato crop is the money-maker.

We have already noticed both in this and in the preceding chapter what are some of the effects of plowing under green-crops. But the importance of the subject will warrant a repetition. The following summary has been adapted in part from Bailey's writings on cover-crops: —

1. Green-manures improve the physical condition of the land: —

(*a*) Shade the surface soil from intense sun in summer, thereby protecting the trunk and limbs from the reflection of the sun from the soil;
(*b*) Prevent the very rapid burning of organic matter in the soil;
(*c*) Conserve some of the surface moisture, and prevent crusts from forming;
(*d*) Prevent soils from cementing and puddling;
(*e*) Prevent the rapid drainage of water from loose, porous soils;
(*f*) Prevent one form of freezing dry.

2. Green-manures modify or influence chemical activities: —

(*g*) They catch and hold some of the leaching nitrates;
(*h*) Render plant-food material available;
(*i*) Appropriate nitrogen, if leguminous crops are grown.

Shade-crops

Cover-crops have become very popular in the East in orchard management. The name is derived from the fact that the seed is sown in the fall or late summer and sufficient growth results so that the ground is covered and protected during the winter. The crop is intended primarily for a green-manure, but under eastern conditions it cannot occupy the land during the growing season. The trees usually need all of the available moisture during that period, and clean cultivation is practiced to conserve it. As soon as the trees have made their growth for the season, the cover-crop is planted, and its growth uses the surplus moisture, and thus the trees are aided in maturing before cold weather comes on. Our conditions are quite different, from the fact that the water is largely under man's control. We think that our conditions demand a cover for the soil far more in the summer than in the winter. And, moreover, nearly as much protection is afforded in the winter if the crop is plowed under late in fall, as if the plants are allowed to stand. We therefore propose the name "shade-crops," for a system which we hope may come into general use in the semiarid region.

Many orchardists have seen young trees killed by running water close to them during a hot day, the reflection of the sun from the water causing sun-scald. It is thought that reflection from a hot, baked soil may cause similar injuries.

As has been noted, arid soils are very deficient in decaying vegetable matter, and this material is very rapidly dissipated when it is supplied. A summer cover will perform one of its most important functions in preventing at least a part of this loss.

Examine a moderately heavy soil in an orchard where a manurial crop is growing. The surface soil under the plants will be found to be cool, moist, and friable, while adjacent, unprotected land will be found to be hot, dry, and compact. This difference is due not alone to the shade afforded by the plants, but to the transpiration of immense quantities of water as well. It has been found, for example, that a grass plant will give off its own weight of water every twenty-four hours in hot, dry summer weather. To be sure, it requires more water to irrigate an orchard when any crop other than the trees is grown, but when sufficient water can be had, this feature need not be considered.

It is well known that our heavier soils, particularly if they are strongly alkaline, become so compact that it is almost impossible to till them after the first irrigation in the spring. It is also true that continued clean tillage, particularly if plowing is omitted, will make almost any of our soils compact. It is this condition that prevents the proper development of absorbing roots and the setting free of the native fertility of the soil. A few of our fruit-growers have shown that green-manures in combination with the necessary plowing will work wonders with such soils as well as with the appearance of the trees growing on them.

Earthworms do damage in some orchards for the reason that they puddle the soil, and much of the irrigation water seems to disappear through the channels that they make deep in the ground. A supply of decaying organic matter should do much to overcome these defects.

Soils are occasionally found which are so porous that water leaches through them much as if through a sieve. If fiber can be incorporated in such land by plowing under green-crops, this tendency to leach will be overcome, to a certain extent at least.

Many young trees are lost each year in the colder districts as a result of "freezing dry." This term is used to denote a condition that may be induced in different ways. The usual cause is merely a lack of water in the soil in the winter. Trees give off water in cold weather from twigs and limbs, and if the supply is not replenished, death results. A similar effect is produced when a damp soil is frozen to such a depth that root action is suspended. The tops of such trees usually die after a feeble attempt at putting forth leaves, while the roots are usually in perfect condition.

The lack of water may be avoided by winter or late fall irrigation. The deep freezing presents more of a problem, but we think that it may be prevented to a considerable extent by the use of shade-crops. True, the system we propose contemplates plowing in the fall, but eastern experience proves that as much protection from frost is secured when a crop is plowed into the land in the fall as when it is left standing throughout the winter.

The winter of 1903 to 1904 was very severe in the East, and in some sections hundreds of orchard trees, particularly peach trees, were destroyed. Green[1] made a survey of the injured orchards the following summer, and found that injury occurred only on improverished and bare soils. A cover-crop, sod, good growth of weeds, or stable manure afforded almost complete protection from the cold. And, moreover, and what is more important for our purpose, he found that when such materials had been recently plowed under, the protection was just as effective.

[1] Green, W. J., Ohio Agri. Exp. Sta. Bul. 157, 1904.

Humus: What it is and what it Does

Popular writers on horticultural topics have woefully confused humus with decaying organic matter, and have implied that all organic material is humus as soon as it is mixed with the earth and decay has set in. The fact is, humus is the final product of organic decay, and as such has entirely different effects on soils than have organic materials that are undergoing the processes of decomposition.

When green-manure is plowed into the soil, various low forms of plant life, including fungi, yeasts, and bacteria, attack it, thus inducing decay. Fraenkel[1] "found in the cultivated soil of Liebefeld 5,750,000, in meadow land 9,400,000, in a manure pile 44,500,000, bacteria per cubic centimeter. These figures seem high for so small a quantity of material, but taking the average size of a bacterium, a cubic centimeter might readily contain six hundred millions."

Other forms of bacteria begin to multiply as soon as fermentation sets in. Different organisms have different and important functions in promoting chemical activities in the soil; plant-food elements are set free, changed and combined into substances that plants can use. No less than five different acids are generated by the processes of decay, carbonic acid being among the most important.

Sackett[2] found that clover taken in full bloom in June, when ground and mixed with soil at the rate of 10 tons per acre, gave off at the end of three days carbon

[1] Hilgard, "Soils," p. 143.
[2] Sackett, W. G., unpublished notes.

dioxid[1] corresponding to 3812 pounds per acre foot. This action continued through a period of three weeks, gradually diminishing, however, until at the end of that period very little of the gas was evolved. One hundred tons per acre of red-clover treated in the same way gave off after twelve days five tons of carbon dioxid per acre foot. This investigator also tested the solvent action of pure carbon dioxid on various materials. Pure ground bone meal was placed in a flask, and carbon dioxid was allowed to pass through it. At the end of one hour 2.11 per cent of the insoluble phosphoric acid had been made soluble. At the end of two hours 5.21 per cent was made soluble. Ground phosphate rock treated in the same way gave the following results: after one hour .16 per cent of the insoluble phosphoric acid had been made soluble; in two hours .28 per cent. Magnesium phosphate similarly treated yielded 16.33 per cent in one hour and 22.35 per cent in two hours of soluble phosphoric acid.

Carbonic acid is, then, an important agent in dissolving rock particles, and with its aid latent fertility is brought into a condition to be used by plants.

Organic matter is often almost entirely consumed under arid conditions very quickly after it is incorporated with the soil. The heat of the sun in conjunction with insufficient moisture produces conditions which oxidize the material, or, in other words, burn it much as though it had been consumed by fire; hence the "burning out of soil," an expression common among farmers. This

[1] Carbon dioxid and carbonic acid gas are synonymous; when combined with water, carbonic acid is formed.

change in organic matter is no doubt begun by soil organisms, while the later stages are probably of a chemical nature.

The decay that results in humus takes place at moderate temperatures. Organisms do not develop in a low temperature, and at a high temperature oxidation or burning results. An apparent contradiction to this statement is found in the difficulty with which unrotted stable manure decays when plowed into land, if moisture is not abundant. The lack of moisture probably prevents the development of bacteria in sufficient numbers to begin decay, consequently the chemical changes that result in burning do not occur. The presence of such material is a detriment to growing plants as it keeps the soil so open that an undue amount of moisture is permitted to escape. This effect is so noticeable that many of the so-called dry farmers make no use of stable manure. This wanton waste might easily be prevented by composting, as there is sufficient moisture in the rain and snow thoroughly to rot manure treated in this way.

The compound resulting after organic decay is completed is humus. Such decay results in a dark-colored material, without organic structure, soluble in alkalies after the lime has been removed. Humus gives a dark "rich" color to otherwise light-colored soils. It is complex in composition. It is especially important as being a reservoir of nitrogen. Much of the nitrogen that is brought to the soil by leguminous plants, as well as that which is stored in the plant in the processes of growth, is not available to growing plants until the humus stage is reached.

Humus usually exists only in small quantities in arid soils, and often is entirely absent when clean cultivation without manuring has been practiced. It may also be present in small quantities along with partially decayed organic matter. Much of this valuable material is lost by constant clean cultivation and the consequent burning of the organic materials, before it reaches the stage in which humifaction may take place. A large part of the loss of nitrogen could be prevented, and many of the benefits conserved, by shading the soil.

While it is no doubt true that humus aids in improving the physical condition of the soil, it is probable that much of the beneficial effect, such as giving fiber and improving tilth, as well as increasing the water-holding capacity, is due in a much larger degree to the partially decayed organic matter.

The Leguminous Green-crops

Several leguminous crops are known to be of great importance in orchard management, but their value needs to be still further emphasized. By leguminous plants is meant the members of the family that includes the beans, peas, cowpeas, clovers, alfalfa, and vetches. These are the only plants of agricultural importance, so far as now known, that have the power of taking nitrogen from the air and converting it into combinations that other plants can use. Thus they actually add plant-food to the soil; and nitrogen is the most expensive element to supply in commercial form as well as the most difficult to keep, since it is readily dissipated in gaseous form. A certain species of bacterium lives on the roots of vigorous legumes where the swollen regions or tubercles are formed. This low form of plant life is able to take the free nitrogen from the soil-air and change it into forms that plants can use. Consequently, legumes can be grown on land from which nitrogen has been exhausted.

It is also found that leguminous plants do not thrive in soil where the accompanying bacteria are absent if the nitrogen content of the soil is low. This led to the making of pure cultures of the bacteria which are now supplied in commercial form. These cultures, after being diluted and after sufficient multiplication of bacteria has taken place, are sprinkled over the land; or better still, seeds are soaked in the culture material just before planting. Such cultures have not been as successful as was anticipated, and in the meantime a mass of overdrawn articles on the subject has been printed in magazines and papers. The result is that many farmers have been led to think that by simply applying the cultures to their land wonderful benefit will result to any and all crops. The truth is, these cultures have no direct effect on any plants other than the legumes. And, moreover, should one wish to secure such material, he must designate the particular crop he intends to grow. Cultures from clover bacteria would not be expected to have any effect on beans or alfalfa. It would be idle to apply these cultures to land that is already producing good crops of any of these plants; and, moreover, the whole subject is yet in an experimental stage.

How to use Shade-crops

What crops shall be grown for shade-crops and how they shall be handled, is a difficult question to answer, as the practice is new. The system of cover-crops as advocated in the East will not apply to the arid regions, for various reasons. We cannot plant in the fall and expect to get much growth to plow under in the spring because of the short seasons. Then it might not be advisable to irrigate at the particular time the seed should be sown, as would probably need to be done to insure germination. We have also found that fall-plowing is better suited to our conditions than spring-plowing, particularly if a crop or manure is to be turned under. If a mass of vegetable matter is plowed under in the spring, the ground is likely to remain so porous that difficulty is experienced in irrigating. The ground at the upper end of the row soon becomes saturated, but still a large head of water must be used to force it through to the lower end. Naturally the trees at the upper end are injured. Finally, we think that both land and trees will be benefited by keeping the surface of the soil shaded in the heat of the summer.

In the light of our present knowledge it will probably be the best plan to prepare the land fairly early in the spring and sow the seed at that time. Or, if experience shows that we need a certain amount of spring tillage in order to aërate the soil and to promote soil activities, the planting may be delayed until June.

Whether, in the case of perennial shade-crops, it will be best to let them occupy the land for two seasons, plowing them under the second fall or not, must be determined by experience and individual conditions. It now seems best to plow the land at least every second season. All of the land may be occupied by the crop in old orchards, but with younger trees space must be left for irrigation as well as to prevent the possibility of the crop appropriating food and moisture to the detriment of the trees. There would also be more danger of injury from small vermin and grasshoppers; the latter pest would probably have to be reckoned with in the young orchard in any event.

One must take pains to see that the irrigating furrows are kept open, not allowing them to become choked with vegetation. Provision must be made that water may be as judiciously distributed as though the land were bare. The trees should always receive first consideration; do not allow the prospects of a few jags of hay to warp judgment when it comes to a question of the health of the trees.

Whether or not it will be advisable to remove any of the crop for hay must be determined for each orchard. When the land has been badly impoverished, or is in poor physical condition, all of the growth should be returned to the land.

If it is found that the continued use of legumes is furnishing too much nitrogen, as will be indicated by a rank growth, then a change should be made; rye or buckwheat may be used instead. The kind of plant that will be best adapted for use as a shade-crop is yet to be determined, and it is likely that different soils and different localities will demand different things.

Red clover is at present most in favor in the arid regions among the few who have tried any crop at all. A number of orchards have recently been planted to clover, and the results are very satisfactory. It has made an excellent growth, even close to the trunks of the largest trees (Fig. 56).

Winter vetch has been used to some extent, and it

Fig. 56. — Shade-crop of Clover.

makes a good growth in any of the orchard districts of this region. A few orchardists are experimenting with Canada field peas. They have the advantage that they make good feed if one wishes to combine hog-feeding with orcharding. The pods will not fill nearly so well, however, as they do in the higher altitudes where the climate is much cooler. Pea seed should, therefore, be planted as early in the season as possible. Cowpeas have been tried to a limited extent, but the season in many parts of the arid region seems to be rather short for them, and the young plants are easily injured by overwatering. In one orchard where we were experimenting with this crop the plants made almost no growth, possibly because the proper bacteria were not present.

Alfalfa has been tried by some persons, but at the mere mention of the word most orchardists will raise strong objection. If it were not so difficult to plow, it would certainly be an ideal crop for the purpose. We do not wish to give the impression of advocating the use of alfalfa, but it is not impossible that a method of handling may be devised that will make its use feasible, except in stony land. Why not plant it in rows? — then tillage could be given throughout the season if desired. Then if the tops are mown off before the seed has set, there ought not to be much trouble with its spreading. If the turning plow is used when the plants are not over two years old, it is not such a difficult matter to cut the roots, and the ground will usually need to be plowed that often at least. But if one wishes to continue to grow alfalfa in the orchard, it would be an advantage not to kill it out, but to have it continue to come up year after year.

CHAPTER XIII

IRRIGATION IN ORCHARDS

As with many of the other orchard operations, no definite rules can be laid down for the proper application of irrigation water. At best we can give only a few of the more important points in the practical application of water, and with these suggestions in mind the grower must work out his own system of irrigation.

The methods of applying water and the quantity necessary are largely determined by soil conditions, subsequent cultivation, the kind of fruit, and the age of the orchard. The orchardist must first thoroughly understand the physiological principles discussed in the chapter on "The Orchard Plant" if he expects to be an intelligent irrigator. He should know in what ways water serves the plant, what constitutes ideal soil conditions for the plant, and how to judge the needs of the plant by its behavior.

There are times when the orchard should not be irrigated. It is a common opinion among growers that fruit trees should not be irrigated when in bloom, and while we have no proof that judicious irrigation during the blooming period really interferes with the setting of the fruit or the normal growth of the tree, it is as well to avoid irrigating at this time. The orchard that goes into winter in the proper condition does not need so early an irrigation.

Excessive irrigation in midsummer and later may retard or even prevent the development of fruit-buds for the ensuing year. The formation of fruit-buds evidently goes forward more rapidly in periods of slow growth. In other words, rapid growth apparently depletes the supply of elaborated plant-food to such an extent that it interferes with the development of fruit-buds, just as a heavy crop of fruit may prevent fruit-bud formation. The bearing fruit tree should make very little growth after the middle of July, and if the orchardist wishes to promote fruitfulness, he should not over-irrigate. Of course the present crop of fruit cannot be sacrificed in order to insure a crop of fruit-buds for the following year, but rampant growth is not essential to the proper development of the fruit. In withholding water with the idea of promoting fruitfulness, one must avoid letting the ground dry to the extent that it will hasten the ripening of the fruit. Fruit checked in its growth by dearth of water seldom responds to later irrigation.

Excessive late irrigation may also retard coloring. Color naturally comes with maturity, and the injudicious use of water may prolong the growing season until the fruit has no time in which to color. Every effort should be made to get the fruit up to size early in the growing season, and then promote coloring by withholding water.

Growth forced by late irrigation is immature and is subject to winterkilling. The growth of young orchards, especially, must be checked by withholding water. The date of the last irrigation will vary with different soils, but it is safe to say that few young peach orchards should be watered after the first of August, and young apple or pear trees seldom later than the middle of August. On some heavy soils summer irrigation must be discontinued much earlier. All new wood should be well matured before frost, and the grower need not be alarmed if the ground becomes so dry that some of the foliage turns yellow and begins to drop before this time, for the trees will not suffer.

How Water is held in the Soil

Water may be found in the soil in three forms: hydroscopic, capillary, or free. The first two forms of water are held as a film about the soil particles, and are sometimes referred to as "film moisture." The hydroscopic water is the part of the film nearest the soil particle, and it probably serves the plant very little. It is even present in road dust, and can be driven off only when the temperature is raised to the boiling point.

The outer part of the film on the soil grain represents the capillary water, and this is the direct water-supply for the plant. It does not flow under the influence of gravity, but passes from particle to particle, and thus tends to keep the soil uniformly moist. Soil is in ideal condition for plant growth when it is well supplied with capillary water. Such a soil is moist enough to stick together when pressed in the hand, and yet will crumble when broken apart.

Free water is that which fills the spaces between the soil particles. It flows under the influence of gravity, and is that part of the soil water carried off by drains. When it occupies the part of the soil where roots normally grow, it is actually detrimental to the growth of most plants. When well below the surface, it serves as a reservoir from which water may be drawn by capillary action. Soils that contain free water stick together when pressed in the hand, but will not crumble apart again as do the soils with only film moisture.

Orchardists have relied far too much on the appearance of the surface soil as a guide in irrigation, and as a result an excess of water has been applied. So long as the free water sought a level far below the surface, no disastrous results followed, but now with the water-table raised by excessive irrigation, over-watering is a more serious matter. Many of the seeped areas in our best fruit sections are the result of this persistent over-irrigation.

The orchard should not be irrigated until a careful examination of the soil — not only at the surface but to a depth of three or four feet — shows that there is need of water. One of the most convenient means of making this examination is to dig a few holes in different parts of the orchard with a post-hole auger or a shovel. If the water-table is too near the surface, the orchardist must cultivate more and irrigate less, or give frequent light irrigations. Orchards will apparently thrive on land in which the free water comes within five feet of the surface. Fruit trees really grow well on land when the water-table is nearer the surface, if the water was there when the trees were planted; roots will not penetrate a saturated soil. But if the water-table rises after the trees have rooted deeply, it is a different matter, as the lower roots which come in contact with the water will be smothered, and the death of the tree will result in a short time.

Nature of the Soil modifies the Practice

The nature of the soil may determine both the way in which the water is applied and the amount that is required.

The system of irrigation well adapted to a sandy soil may be a failure with a heavy soil, and the amount of water necessary for the orchard on well drained mesa land might prove injurious to the orchard on poorly drained bottom ground.

Heavy soils are difficult to irrigate and to keep in good physical condition. The general tendency is for the water to run the soil particles together, thus causing the soil to bake. The heavier soils, composed largely of decomposed shale, sometimes become almost impervious to water. This difficulty may be overcome, to a certain extent, by using deep furrows and placing them far apart. In this way one avoids wetting the surface soil, and it is possible to till before the bottoms of the furrows bake. The ditches may be placed about eight feet apart and should be thrown out with a heavy stirring plow. The head of water should be small and, in some cases, must be run for a considerable length of time. It is doubtful, however, whether it ever pays to run water over seventy-two hours in the same furrows. We have seen water run thirty days, but after the first three days the bottoms and sides of the furrows were so well coated with sediment that very little of the water escaped from them With the heavy soils the water may be run almost any distance. If the rows are extra long, they should be started with a large head of water, and when it has reached the other end of the orchard, the head should be cut down just enough to carry it through. The surface of the heavy soils must not be wet, unless shaded with some crop, and this is the purpose of the deep ditch and the small head of water. Heavy soils that have been plowed must be well settled before an attempt

Fig. 57. — Heavy Land well Furrowed.

is made to water them. Fall-plowed land generally settles well during the winter, but land plowed later should be

Fig. 58. — Sandy Soil well Furrowed. Grand Junction, Colorado.

well worked down with the disc and harrow. One should avoid letting these heavy soils get dry, as they take water very slowly when once dry and filled with air. A good, heavy, fall irrigation is one of the best ways of wetting such land. Figure 57 shows an apple orchard on heavy soil well furrowed for irrigation.

Sandy soils take water freely, and the furrows should be closer together and the rows not so long as in the heavier soils. In the heavy soils the water moves more freely laterally, and in lighter soils the movement is downward. The longer the rows, the larger should be the head of water. The upper end of the orchard is sometimes over-watered by trying to run a small head of water through long rows in sandy soils. It is better to water a few rows well than to try to spread the water over the whole orchard the same day. The length of time the water is allowed to run will depend entirely on the soil. The orchardist must learn to understand his soil and know how long it will take to wet it. Provided the free water does not come too near the surface, heavy waterings at greater intervals are always to be preferred to light and frequent irrigations. Figure 58 shows a pear orchard on sandy soil well furrowed out for watering. Figure 25 shows a common mistake of furrowing near the trees only. With the sandy soil it is not so important that the water be kept off the surface, but flooding should be avoided if possible, especially if the ground is bare.

Frequency of Irrigation

Soil conditions and the treatment the orchard receives between times will determine how often it must be irrigated. Sandy soils, as a rule, require more frequent irrigations, especially where they have good drainage. Orchards that are sparingly tilled require more frequent irrigation. As a rule, from two to four summer irrigations and one late fall irrigation will be sufficient for the old orchard. Apple trees may be watered more freely than peach trees, and pear trees will stand more water than apple trees.

The orchard that is receiving clean tillage should be tilled after each irrigation. Unless the ditches are cultivated in, the bottoms and sides crack and allow the ground to dry out quickly.

Young orchards really do not require a great deal of water, especially if they are set on land that has been previously irrigated. The second season is the critical time in the growth of the young orchard, and unless sparingly irrigated and properly matured, it may be seriously injured in severe winters.

Orchards that have been dried out in late summer to mature the fruit or the new wood must be irrigated in the fall. This is especially important in localities where there is a light winter snowfall. This irrigation may be given at any time after frost has touched the foliage.

CHAPTER XIV

OTHER PHASES OF ORCHARD MANAGEMENT

Fruit-growing is not always a separate business. It is often only one part or phase of one's farming, and as such is most likely to be associated with various forms of live-stock raising. This live-stock may also be essential to the orcharding itself, to supply the necessary manure. We may therefore discuss some phases of stock-raising in connection with fruit-growing before we pass to the question of varieties and the discussions of marketing.

The person who engages in fruit-growing without capital is likely to ask what he may do for a living while his orchards are coming into bearing. To suggest an answer is still further to discuss some phases of orchard management; and this question we may here consider.

LIVE-STOCK ON FRUIT-FARMS

There was a full crop of apples in 1906 in one of the large orchards in Western Colorado. Part of the trees had been bearing for fifteen years, and part had just begun to bear heavily. In the young orchard 95 per cent of the crop graded "extras" and "firsts." Half the apples on the older trees were below these grades, being undersized and "off color." Another old orchard bearing a low-grade fruit was heavily manured with rich barnyard manure, well worked in, and the following year the fruit was as good as when the trees first came into bearing.

Comparatively few fruit-growers in irrigated sections are located where manure can be bought, and if their trees need this kind of food, animals must be kept to produce it. The kind of stock to raise or to feed will depend on the cost of feed and the area of land not in trees that adjoins the orchards.

Horses

On some fruit-farms it is practicable to use brood mares to do all work requiring horse-power. Then colts may be raised. Heavy draft-horses are easiest to raise and the most profitable when the grower keeps only a few and does not make a business of horse-raising. Every extra pound above 1600 pounds weight is worth fifty cents, and every pound above 1800 pounds weight is worth one dollar in a well-built, sound horse, having good action.

The fruit-grower should select mares of good draft type weighing 1200 to 1800 pounds each, according to the work he has to do, choosing the breed he prefers. Regular hard work, if slow and steady, is beneficial to mares in foal. Care should be taken to use wide shafts and single-trees, and the pregnant mare should not be driven fast nor turned quickly. At least half the hay should be alfalfa in order to develop the unborn colt. Native hay may comprise the remainder, or oat straw or corn-fodder. Oats is the best grain, but when working hard, the mare may be fed corn or rolled barley.

The colt should be halter-broken when a week old, and should not be allowed to follow the dam when she is at work. It is best to let the colt suckle at the middle of each half day as well as at regular mealtimes. If the mare is warm, she should be allowed to become thoroughly cool before the colt suckles.

The colt should be encouraged to eat grain early, and after he eats well, should be fed all the oats and alfalfa hay he will consume clean. It is well to feed some native hay, oat, straw, or corn-fodder. Carrots are good for both mare and colt. The colt should have ample exercise and good shelter, and should be pushed to make a gain every day until he reaches full mature weight. A well-fed and well-managed colt at one year will weigh one-half as much as when fully matured. Well-bred draft-colts have been fed on alfalfa and oats to a weight of 900 pounds each the day they were one year old. The most serious loss usually occurs by letting the gain stop the second winter.

"Baby Beef" (Calves)

Feeding for "baby beef" is profitable in fruit-growing sections where alfalfa is cheap. With feed close to the feed yards, one man can take care of 200 calves. There is a good profit in the feeding, and a large supply of manure for the orchard. The work is done when labor is lightest in the orchard.

There are two methods: one to market the calves fat at the end of the first winter, and the other to "finish" them at some time during the second winter. The latter plan is most profitable where cheap summer pasture is available. With both methods the calves should be weaned while in prime condition and still gaining every day, and the feeding should begin as soon as the calves are taken from their dams. Before being weaned the calves should be vaccinated to protect against blackleg.

The foundation of baby beef production is in feeding all the alfalfa hay and roots the calves can be induced to eat, and very little grain. The alfalfa should be cut when the first few blooms appear and cured, to save the leaves, as for this kind of feeding a pound of leaves is worth more than four pounds of stems. The roots may be sugar-beets, stock-beets, mangels, or ruta-bagas, and should be sliced for feeding. Give the calves access to good straw, as a little will overcome the too laxative effect of the early cut alfalfa. Oat, wheat, and barley hays and corn-fodder are good to feed for variety. The calves should have good shelter and free access to pure water. The more they can be induced to lie down, the greater will be the gains; and a dry place on which to lie should always be ready. Every time that a calf stands up after eating because there is snow or mud in the yard, he loses money for the feeder.

If the calves are to be marketed at 14 months, they should be fed grain from the time of weaning, starting with one pound per head a day and slowly increasing to four to six pounds per head daily, feeding only sufficient grain to keep up a daily gain of two pounds per calf. The grain may be either corn, oats, or barley, or a mixture of any two or all three of these feeds, and it should be crushed. Grain should never be fed alone. Either mix it with an equal weight of fine, leafy alfalfa, or else sprinkle it on the sliced roots. With this system well-bred beef calves will weigh 700 to 800 pounds at 14 months of age. Heifers fatten better than steers.

If the calves are to be marketed the second winter, they should be handled as above through the first winter except that no grain should be fed. They should be pushed as fast as can be done with hay, fodder, and roots. The second summer they should be kept on good pasture and put in the feed lots in the fall while in prime condition. The first 30 to 60 days feed hay and roots, then begin with a light feed of grain, slowly increasing until February first, when they will be eating 6 to 8 pounds per head daily. At this time, if well bred and properly managed, they will be ready for the market, and should average 1200 pounds each.

Dairying

Dairying is especially adapted to high-priced land as, if necessary, dairy cows can be kept profitably on a limited area and not pastured at all. Manure is valuable in proportion to the character of the feed, and as cows giving milk need good feeding throughout the year, their manure is rich.

An acre of good alfalfa cut and fed green to cows confined in a yard will supply ample feed for five good animals throughout the summer. A ton of alfalfa hay, cut when the first few blooms appear and cured to save all the leaves, is equal for milk production to a ton of bran and usually costs about one-third as much.

Fruit-growers deal with high-priced land and high-priced labor, and they must be careful to select cows of extreme dairy type. They cannot afford to feed and milk cows that use part or most of their feed to put on flesh. Under prevailing conditions in irrigated fruit sections, the yearly income from the dairy cow varies from $25 to $120, depending largely on the type of cow selected. The lower return does not pay expenses, but the higher amount gives a large net profit.

The breed is a matter of indifference, but the nearer each individual approaches the extreme dairy type, the greater will be the profits from judicious feeding and management. In most fruit-growing sections selling milk or cream is more profitable than marketing butter.

Alfalfa should be the basis for milk production. In the summer it may be cut daily and fed slightly wilted. Alfalfa for hay for dairy cows should be cut when the first few blooms appear, cured with as little exposure as possible in order to save the leaves, and should have a bright green color. A cow of the right type can be fed profitably all of this hay she will eat. Early cut alfalfa hay is usually too laxative, and this trouble may be overcome by allowing the cow to eat all the good clean straw she wants. A cow will usually eat 2 or 3 pounds of straw daily.

Fed all the alfalfa she will eat, a cow needs some grain rich in starch. Corn, barley, or oats, or a mixture of these, is the most profitable, depending on the price. The amount of grain to feed varies with the cow. Some cows will return a profit on 4 pounds daily; others can profitably be fed 8 to 10 pounds daily.

Sugar-beets, stock-beets, carrots, mangels, and cull apples may be fed up to 25 pounds per cow daily. With most cows, a larger quantity is detrimental. The trimmings from market-garden products, such as celery and cabbage leaves, are relished and save hay. All feed should be given after, and not either before or during, milking. There is then no danger of tainting the milk. The dairy cow needs good shelter and plenty of water and salt both summer and winter. Petting and kindness will increase both the yield and richness of the milk.

Hogs

Hogs are profitable consumers of cull fruit. They are often fattened on peaches alone. Apples can be used to save at least half the grain. On several farms in irrigated fruit sections, hogs have been fitted for market on squash and alfalfa pasture or hay. The squash puts the animals in good condition, but gives the flesh an objectionable yellow color. A ton of sugar-beets fed with grain to fattening hogs takes the place of 200 pounds of grain.

Hogs selected for breeding-stock should belong to prolific strains, with sows that regularly have six to ten pigs at a litter. Any dark-haired breed is satisfactory. The intense sunshine in irrigated fruit sections blisters white hogs, and they usually do not thrive. Well-built hogs, having well-arched backs, well developed in shoulder, heart, loin, and ham, and well up on their feet should be chosen.

The hogs should have alfalfa every day in the year — pasture in summer, leaves from alfalfa hay in winter. It does not pay to grind or cut alfalfa hay for hogs, as the woody stems are detrimental. The hogs should have dry, warm shelter every night in the year, well ventilated, but without drafts.

Corn, barley, wheat, and field peas are the grains available for fattening. Barley makes a better-flavored pork than corn. It should be either rolled or soaked before feeding. Good gains are secured from feeding wheat, but the meat is tough, and both meat and fat have a dark color. Where wheat is the cheapest feed, the hogs should be fed the last four to six weeks on corn or barley. This will whiten and harden the flesh and give it a better flavor. Wheat should be either ground or soaked. Field peas make a specially fine-flavored pork. It is customary to fatten pigs by letting them pasture the unharvested ripe crop; sometimes the ripe peas and vines are cut and stacked like hay, and the entire dried product, peas and hay, fed to the hogs. An acre of good peas will make 400 pounds of gain on hogs when pastured, and from 600 to 800 pounds of gain on hogs when harvested and fed to them in small pens.

While suckling the pigs, the sow should be fed liberally with milk-producing feeds, such as grain, alfalfa, and roots. A limited supply of cull fruit is good, but if given all the fruit she will eat, the tendency is seriously to reduce the milk flow. A few days before the pigs are to be weaned, the sow's feed should be reduced to water and alfalfa, and she will become dry without injury to her udder.

The pigs should not be weaned earlier than eight weeks of age, and ten weeks is better. It is best to feed them three to five times daily when first weaned. In two weeks feeding twice daily is sufficient. When the pig reaches a weight between 50 and 75 pounds, feed from one-half to one pound of grain daily at night, and let him spend the day eating alfalfa, cull fruit, and other available cheap roughness. When finishing time arrives, feed twice daily all the grain, fruit, roots, and hay he will eat. To produce pork profitably, at least half the total weight of the finished hog must have been made from rough feed.

Poultry

One hundred laying hens can be kept on each acre of a full-grown orchard without interfering with the regular operations. Four hundred laying hens can be kept on each acre of a newly set orchard. An experienced poultry-grower can make from one to two dollars net per year per hen.

The hens should be kept in small numbers in cheap, portable houses. With the run of the orchard a house 8×10 feet will shelter thirty-five hens and can be built for $15 to $25. It can be easily moved by four men or by one man and a team. No floor is needed, and it is preferable to use muslin in the place of glass for windows. The house should be tight on the north, east, and west ends.

The hens should be forced to their full laying capacity, and in February and March at least two hundred chicks should be hatched for each one hundred hens. All the cockerels and half the pullets should be marketed for broilers at a weight of 1¼ to 1½ pounds. Sell all the old hens except the best ones in May and early June, when the price is highest. The young pullets will begin laying in August.

Many successful poultry-men make wheat half the ration for laying hens, and for the other half feed a variety of grains, such as corn, oats, kafir, and barley. A self-feeding hopper is kept before the hens filled with dry-meat meal. If hens have not been fed the meal, they are likely to gorge themselves at first. This can be prevented by using for a short time a mixture of half-meat meal and half-bran. Alfalfa should be fed every day in the year.

MAKING A LIVING WHILE THE TREES ARE COMING INTO BEARING

This is a subject that need not worry any able-bodied and willing man, as work is always plentiful in a fruit country. Moreover, there are many things that may be grown between the rows of young trees which will bring good returns. As a rule, the double-cropping of orchards should be discouraged for the reason that the trees are likely to be neglected or misused and the soil ruined. But if due care is exercised, particularly not to over-irrigate, crops of various kinds may be grown between the rows for several years. When this is done, a strip at least five feet wide should be left on either side of the tree row for cultivation and irrigation. It should always be remembered that the young trees are of first importance, and upon their present health and vigor depends the future usefulness of the orchard. It would be better to lose an entire season's work rather than to stunt the trees by an injudicious irrigation.

Potatoes may be mentioned as a crop well adapted to growing in young orchards. It is a staple commodity and is often shipped across the continent. But in order to do this a community must produce a sufficient quantity to ship in car-load lots. Potatoes thrive best in the lighter mesa soils as a rule, but occasionally bottom lands are found that are adapted to the crop. Potato land should not become hard and puddled, and it should have good natural under drainage. In order to be successful under

Fig. 59.—Cantaloupes Growing in Young Orchard.

arid conditions, potatoes must be grown in high ridges and be given very deep cultivation.

The cantaloupe is another crop that in some sections is grown in young orchards. (See Fig. 59.)

Most any of the vegetables may be grown, but with all such crops the question of markets should be carefully considered before any large area is planted. In any section there is always something in the way of vegetables that may be grown at a profit. Many of the towns in the fruit districts now have canning factories, and in the past it has been difficult for them to secure a sufficient supply of such things as tomatoes, corn, and beans. Many of these vegetables are very easy to grow and with good care enormous yields are secured.

The canning industry is bound to grow, and it provides a means of using much fruit that does not ship well. But in order to round out the season to advantage as well as to supply demands, many vegetables are required. It has been difficult to find enough people in the various districts to grow sufficient vegetables to supply the factories.

We do not like to recommend the growing of small-fruits in the orchard for the reason that the trees are so often injured by overwatering. A much better plan is to set aside an acre or two that may be used exclusively for this purpose. There has always been a ready sale for small-fruits.

There are always great possibilities with poultry; and a few hogs and a cow or two should find a place on the fruit-farm.

Taking the situation as a whole, it would seem that the opportunities for a small-fruit farmer, not only to make a living, but something of an income as well, while his trees are maturing, are encouraging. In fact, one does not need to ride far through the fruit districts in order to find a number of men who are accomplishing this.

If one is endowed with sufficient strength to warrant his attempting farm work at all, he need have no fear of being able to make a comfortable living, at least, while his trees are coming to the bearing age.

CHAPTER XV

VARIETIES

The question of choice of varieties is, fortunately, quickly answered. When orchards were first being planted, those kinds that were favorites in the eastern homes were given preference. When it was found that fruit could be grown at all, many of the early orchardists, wishing to show what could be done, planted many varieties. Thus it happened that the older orchards often contained many varieties, most of which have not proved to be well adapted to arid conditions.

So long as there were local markets, the kind of fruit mattered little. But when it became necessary to compete in the markets of the world, conditions were changed. Home markets were then out of the question except in a limited way; and because of the great distance, carload lots were the units of shipment. Buyers could not afford to pay freight on anything but the best, and in order to be successful in the markets, they must have large quantities of a certain kind. They want to know, for instance, how many cars of fancy Jonathan a certain association or dealer can furnish. Such information gives a basis upon which a stable business may be conducted. The buyers soon found that a few varieties were in greatest demand, and naturally calls came to the growers for an increasing supply.

Thus it is that the consumers in distant states have

Fig 60.—Gathering Newtown Pippins. Medford, Oregon.

largely determined what varieties we shall grow. For these reasons the number of varieties of leading commercial apples has been reduced to five or six, and of peaches to three or four.

When the question of varieties for planting arises, it is always best to consult with the men who have charge of the marketing, as they are in position to know the kinds that are in most demand.

The pleasure of testing new fruits would best be indulged in an amateur way. New kinds are at a disadvantage on the market as they cannot ordinarily be furnished in quantity. It is best for a locality to develop a reputation on a few varieties and adhere closely to them. Eastern people are now fairly familiar with the Western Jonathan and Winesap, and the Esopus (Spitzenburg) and Newtown Pippins of the Northwest.

Will it pay to plant other kinds on soils that will grow the foregoing varieties to perfection and trust to the uncertain public taste to create a demand? We think it is a better plan to grow the very best Jonathans or Winesaps and then learn to pack them in the very best way; or, if these varieties are not adapted to the soil, the grower may specialize on one or two of the other well-known varieties that will be certain to succeed.

In considering the list of apples that are grown in the mountain region, we find that the varieties that do best in Missouri, Kansas, and other states in the same latitude have been most grown here in spite of the higher altitude. These include such varieties as Winesap, Jonathan, Grimes, White Pearmain, Rome (Beauty), Willow Twig, Ralls, and the Ben Davis family. All of these varieties reach their highest development in the arid country if the soil is adaptable; otherwise they are likely to be shy bearers, the fruit undersized, or lacking in color. The Esopus (Spitzenburg) and Newtown Pippin are apparent exceptions to this rule, but as yet they are successfully grown only in the vicinity of the Cascade Mountains in the states of Oregon and Washington.

Ben Davis should be left for the ordinary orchardist, although it must be said that this much-maligned apple has probably made more money for our growers than any other one variety. But with the increasing cost of box material and of labor it is doubtful whether we can now afford to plant it, for it is a cheap apple.

Adaptation of Varieties to Soils

The adaptation of varieties to soils is a question of much importance and one to which very little attention has been given. Most varieties will grow and bear some fruit on nearly all soils, but when we study the results, we find that there is a marked difference in behavior of a certain variety in the same locality. The effect of soil on a product is best illustrated with the potato. This crop is a failure in many parts of the inter-mountain country, but paying crops may be grown in any locality, if what we know as potato soil can be found in which to grow them. The experienced farmer does not attempt to grow potatoes commercially unless he knows that he has "potato land."

A study of the adaptation of varieties to soils indicates that it is largely a question of the character of growth of the variety. In the case of apples most varieties may be classed, for this purpose, under the two general heads of vigorous-growing and weak-growing kinds. Most varieties will grow more vigorously, as a rule, in the heavy soils than in the lighter ones. The strong-growing kinds are likely to be shy bearers of poorly colored fruit when planted on heavy soil, as the energies of the tree are largely used in growth. On the other hand, varieties that are inclined to overbear on the light soils will make more growth on heavy soils, and consequently they will produce less fruit, but of a better size.

The proper coloring of the fruit is an important factor, not to be overlooked. Not all of the slow-growing kinds will bear highly colored fruit when grown on heavy land. These varieties that are late in ripening are specially liable to be poorly colored. High color usually indicates high quality for the variety, no matter where the fruit is grown. There are, no doubt, exceptions to this statement, but ordinarily it may be adopted as a rule, notwithstanding the strenuous objections to the contrary made by our eastern contemporaries.

Adaptation of the Standard Varieties of Apples

The following discussion of the behavior of varieties, drawn from the experience of growers and from personal observation, will illustrate the relation of varieties of apples to soil.

The Jonathan does best on a rich mesa soil; that is, bears fruit of good size, color, and quality. More highly colored apples, but of smaller size, are produced on the lighter soils. It succeeds nearly as well on the sandy bottom lands, but does not color as well on heavy land.

The Grimes and White Pearmain are comparable in their behavior. The Grimes should almost be classed with the heavy growers, but neither it nor the White Pearmain bears well or produces fruit of the best color on the heavier soils. Probably the main reason why the latter variety is ever reported from eastern markets as being "off in flavor" is because many of them are grown on poor, heavy soils and are not properly matured.

The Winesap is not a vigorous grower and is inclined to overbear, as well as to produce fruit of undersize when the trees reach maturity. It develops its best color, however, on rich, well-drained soils. The tendency to overproduction and weak growth so noticeable on light soils may be counteracted to some extent by systematic pruning and thinning.

The Missouri (Pippin) is in the same class with the Winesap, being, perhaps, the best example we have of a slow-growing, overproductive, and consequently a short-lived tree. It does best on the heavier soils.

Rome (Beauty) attains more nearly to perfection on a medium soil, that is, land neither too light nor too heavy. The land should be well drained and fertile. The fruit colors poorly on heavy soils, and the tree makes but little better growth. The fruit is liable to be "off color," anyway, unless the fall weather is suitable for ripening. Therefore, if Rome is to remain a standard variety, it should be planted only on suitable soil. The tree makes an indifferent, upright growth, with an ill-shapen trunk, particularly when young. It is more satisfactory when top-worked on a vigorous, spreading variety, as the Northern Spy.

The Newtown Pippins, both Green and Yellow, are very susceptible to soil properties, and the areas in which they are at all satisfactory are very limited. For this reason they are not much grown outside of favored localities in

Fig. 61. — A Newtown Pippin Orchard. North Yakima, Washington.

Washington and Oregon (Figs. 60, 61), yet they have been known to grow and bear well on a rocky hillside and almost refuse to bear on heavy or medium heavy lands.

The Ben Davis group, which includes Gano and Black Ben Davis, is cosmopolitan in its adaptation, as it succeeds fairly well on all sorts of soils where apple trees will grow at all. All the kinds bear well on heavy soils and make satisfactory growth on the lighter lands. The trees need more pruning in the latter case to produce more growth, thus preventing the production of an over-

Fig. 62. — An Esopus (Spitzenburg) Orchard, Hood River, Oregon.

load of small apples. Higher-colored fruit may usually be expected, however, on the lighter soils.

The Arkansas, commonly and improperly known as Mammoth Black Twig, usually overgrows and is non-productive on heavy soils, though it is of the Winesap type. It does well on light mesa soils, where the trees are usually of good size and productive. The fruit is also of good size, uniform, and of good color.

Arkansas Black has not been very satisfactory as a rule. It does best on light mesa soils. It is also of the Winesap type of fruit and a vigorous grower.

The Spitzenburg does well on medium soils, but is very susceptible to blight; consequently it is but little grown except in the Cascade Mountains, where it finds a congenial home (Fig. 62).

Winter Banana is a weak grower ordinarily on heavy soils, but makes a good growth on rich lands if the drainage is good. Where the conditions are adaptable, the fruit is beautiful and of high quality. These characters are not well brought out when grown on heavy land. This variety is also very susceptible to blight.

Ralls makes good growth on rich mesa soils, and the fruit colors well. The fruit is borne in clusters, and therefore the trees are very likely to overbear. It makes a strong growth on heavy lands, and the fruit is often poorly colored. This variety often produces fruit when others fail, on account of the lateness of the blossoming period.

McIntosh is rather a medium to strong grower, has a fruiting-habit something like White Winter Pearmain, long and strong limbs with short spurs. It is somewhat inclined to bear in clusters, and on alternate years, if not thinned, often so bunchy that part of the fruits are pushed off before the picking season. The fruit is inclined to drop if not picked on time. It would be called a prolific variety adapted to medium to strong soil. It is particularly adapted to Montana conditions, where it becomes one of the finest winter apples (Fig. 63).

Fig. 63. — A McIntosh Orchard, Montana.

Choice of Varieties

In summing up this list of varieties we find that there are seven that do best on rich, medium mesa soils or their equivalent. These are: Ben Davis, Gano, Grimes, Jonathan, Rome, White Pearmain, Winesap, and Winter Banana. The Missouri is distinctly a variety for heavy land, and the Arkansas as distinctly a variety for light land, while Ben Davis and Gano may be fairly successful on any orchard land.

What, then, is the grower to plant who is not the possessor of rich loamy soil? He should, first of all, put his land in the best possible condition by plowing under green-manures, and then strive to maintain it by judicious use of tillage and shade-crops. Personally we would select, for the commercial orchard, from the following varieties, according to the character of soil: Gano, Grimes, Jonathan, Rome, and Winesap. Oregon and Washington growers will of course include Newtown Pippin and Esopus (Spitzenburg), and Montana growers the McIntosh.

Local markets and express shipments are important factors in apple marketing in the lesser fruit districts. Early apples are therefore profitable and much grown. The commoner early kinds are the (Duchess of) Oldenburg, Haas, Plumb Cider, Utter, and Wealthy.

For the many localities in the higher altitudes, where apples are grown only for home uses, the following varieties have proved the most hardy: (Duchess of) Oldenburg, Northwestern Greening, Wealthy, Whitney No. 20, Crab, and Yellow Transparent.

Description of Varieties of Apples

Arkansas. — Commonly but erroneously called Mammoth Black Twig. This variety very closely resembles the Paragon, but it is known to have had a separate origin. Tree rather large, vigorous, somewhat spreading; fruit large, uniform, roundish, inclined to conic, somewhat ribbed, uniform in shape; skin becoming deep yellow, largely overspread with deep dull red, obscurely striped with darker red; flesh tinged with yellow, very firm, moderately juicy, subacid, crisp, good. Season December to May.

Arkansas Black. — Tree moderately vigorous, somewhat spreading. Fruit medium to large in size, nearly round; skin yellow, but usually pretty much covered with a lively red which becomes almost black on the exposed side; flesh yellow, firm, juicy, subacid, good to very good. December to April. This variety has not been productive, as a rule.

Ben Davis. — Too well known to need a description. The fruit in the inter-mountain region is beautiful when well grown, of good size and a better quality than when grown in many other regions. The Gano is largely replacing the Ben Davis, as it has all its characteristics, with better size and color, and perhaps better quality. The tree has been one of the first to be affected by arsenical poisoning. The buds are very susceptible to late spring frost, and the fruit is easily rusted by spray mixtures.

Esopus (*Spitzenburg*). —Tree moderately vigorous, somewhat spreading. Fruit should average large, uniform, roundish conic, somewhat ribbed; skin tough, waxy, deep yellow, usually covered with bright dark red; flesh tinged with yellow, firm, crisp, tender, juicy, aromatic, very good to best. Season November to March or later in cold storage. The red apple *par excellence* of Washington and Oregon. Has not come into prominence outside of those states.

Gano. — An improved Ben Davis, and is largely replacing that variety. Tree moderately vigorous, upright, spreading, somewhat inclined to droop. Fruit large, form roundish, conic, uniform in size and shape; flesh whitish, tinged with yellow, firm, juicy, mild subacid, nearly good in quality. Season extending from December to May.

Grimes. — Tree moderately vigorous, upright, spreading, inclined to droop. Fruit medium to large; form roundish oblong, flattened at the ends; skin tough, clear, deep yellow; flesh yellow, very firm, tender, crisp, juicy, subacid, rich aromatic, very good to best. Season November to February. This variety has been rated as the type of excellence in apples. It is one of the handsomest yellow apples, and is proving to be a reliable market variety.

Haas. — Tree large, very vigorous, becoming spreading or roundish with age. Fruit large; form oblate, somewhat ribbed; skin thin, yellow, washed and nearly covered with deep bright red with splashes of carmine; flesh white, often stained with red, firm, juicy, subacid, fair in quality. Season October to early winter.

Jonathan. — Tree medium in size, moderately vigorous, roundish, somewhat spreading and drooping with age. Fruit medium to large (should average large with good culture), roundish conic, uniform in shape; skin thin, tough, bright yellow, usually overlaid with lively dark red which usually deepens to purplish on the sunny side; flesh whitish to yellow sometimes tinged with red, firm, crisp, juicy, aromatic, sprightly, subacid, very good to best. Season November to January. This is one of the best commercial apples. Tree usually does best when top-worked on a more vigorous growing kind. This variety is also very susceptible to arsenical poisoning.

McIntosh. — Tree vigorous, roundish, somewhat spreading. Fruit large, roundish oblate, slightly ribbed; skin thin, tender, light yellow, mostly covered with bright red and striped with carmine; flesh white, sometimes veined with red, firm, crisp, tender, very juicy, sprightly subacid, aromatic, very good to best, especially for dessert. Season October to December, or later in storage. Succeeds especially well in the valleys of Montana. Many specimens become dark red in this climate; thin lilac bloom.

Missouri (Pippin). — Tree only moderately vigorous, with long, slender, drooping branches. Fruit medium in size, roundish; skin thick, tough, glossy, pale greenish overspread with bright red and striped with purplish red; flesh tinged with yellow, firm, not very juicy, subacid, fair to good in quality. Season October to January or later. Highly colored specimens are nearly solid red.

Oldenburg (*Duchess of Oldenburg*). — Tree medium in size, roundish. Fruit large, uniform, roundish oblate; skin thick, tender, greenish yellow, almost covered with regular splashes and stripes of bright red mottled and shaded with crimson; flesh tinged with yellow, rather firm, crisp, tender, juicy, sprightly subacid, aromatic, very good for culinary purposes. Season late August and September.

Plumb Cider. — Tree fairly vigorous, medium, upright. Fruit medium to large, roundish, slightly conic; skin yellowish, shaded with pale red and striped with brighter red; flesh yellow, firm, fine, juicy, subacid, good. Season October to January.

Rome (*Beauty*). — Tree fairly vigorous, but makes poor growth when young, upright. Fruit large to very large, uniform in shape, roundish, oblate, somewhat conic, cylindrical; skin thick, tough, yellowish or greenish, and in well-colored specimens should be almost solid red on the exposed side; flesh nearly white, firm, crisp, juicy, mild subacid, quality good. Season November to April or May. Should be top-worked on a vigorous-growing kind for best results. Blooms late, and so often escapes frost.

Utter. — Tree vigorous, roundish to upright, healthy, hardy. Fruit medium to large, roundish oblate; skin orange-red and streaked with bright carmine; flesh whitish, tinged with yellow, somewhat coarse, crisp, tender, juicy, mild subacid, good. Season October to December. Some fruits show little or no red, but on highly colored specimens the prevailing color is red.

Wealthy. — Tree of medium size, moderately vigorous, with curving branches, spreading and somewhat open. Fruit medium to large, roundish conic, slightly flattened at the base; skin thin, tough, pale yellow, blushed and marked with narrow stripes and splashes of red deepening in highly colored specimens to nearly solid red; flesh whitish, sometimes stained with red, crisp, tender, very juicy, subacid, sprightly, good to very good. Season October to January.

White Pearmain. — Tree vigorous, spreading. Fruit medium to large, roundish ovate to conic, somewhat ribbed; skin tough, slightly waxy, pale yellow with a decided blush if well grown; flesh slightly tinged with yellow, firm, fine-grained, crisp, tender, juicy, mild subacid, aromatic, very good to best. Season December to March. It does not attain such quality on the heavier or poorer soils.

Winesap. — Tree medium in size, spreading, straggling, and inclined to droop. Fruit medium in size, regular, roundish, slightly conic; skin tough, glossy, bright deep red over a distinctly yellow ground color; flesh tinged with yellow, veins sometimes red, firm, crisp, very juicy, slightly subacid, good to very good. Season December to May. Usually does best when top-worked on a stronger growing kind.

Winter Banana. — Tree medium in size, spreading, somewhat inclined to droop. Fruit large, form roundish conic, somewhat ribbed; skin smooth, tough, waxy, bright pale yellow, thin, and when at its best has a dark pinkish red blush; flesh tinged with yellow, moderately firm, crisp, tender, juicy, mild subacid, aromatic, good to very good. Season November to February. This variety was introduced in 1890, and its place as a market fruit has not yet been determined. However, its susceptibility to blight will probably prevent its being planted extensively.

Yellow Newtown (Pippin). — Tree vigorous, roundish upright. Fruit large, roundish oblate, somewhat ribbed; skin rather tough, bright yellow, with a distinct blush; flesh yellowish, firm, crisp, tender, juicy, sprightly subacid, aromatic; quality best. Season February to May or later in cold storage. This variety is very susceptible to soil conditions, and thus far it has found congenial surroundings only in the Cascade regions in the states of Oregon and Washington. The Green Newtown differs from the Yellow principally in color.

Apricots

The apricots are not quite so adaptable to soils as are the peaches. They do best on rich red land. Just why so excellent a fruit and ripening so early in the season should not have a greater demand is difficult to explain. However, there is a growing demand, and plantings are being increased.

Early Montgamet. — Tree vigorous, spreading, and needs severe pruning, hardy and very productive. Fruit large; skin orange-yellow, reddened on sunny side; flesh pale salmon color; quality fair; freestone. Season just after New Castle.

Moorpark. — Tree large and vigorous. Fruit large, uniform, nearly round; skin orange color with a deep orange-red cheek; flesh bright yellowish orange color, firm, juicy, with a rich, high flavor; quality good; freestone. Season August 1 at Palisade, Colorado: the same at Nampa, Idaho. Has proved to be a shy bearer and to ripen unevenly in some localities.

New Castle. — Tree upright, vigorous. Fruit medium size, roundish; skin rich golden yellow, with bright red cheek; freestone; quality good. Season the last week in June at Palisade, Colorado. Early July at Brigham City, Utah.

Royal. — Tree upright, moderately vigorous. Fruit of large size, roundish, somewhat compressed; skin dull yellow, with orange cheek and a faint blush; flesh light orange color, firm but juicy, vinous flavor; quality good; freestone. Season of Alexander peach, about August 20. One of the leading varieties for canning and drying.

Cherries

As has been mentioned, the Esopus (Spitzenburg) and the Newtown apples find congenial conditions in the Cascade Mountains. The same is true of cherries. In fact, we know of no place where this fruit reaches the degree of perfection that it does in the valleys of Oregon and Washington (Fig. 78). It does not appear at present that any locality in the inter-mountain country can hope to produce cherries equaling those that are grown in these two states where the atmosphere is uniformly much more humid.

However, this does not mean that cherries cannot be produced at a profit outside of those localities. The fact is that this crop is growing in importance in most localities, and plantings are being rapidly extended.

Of all fruits the cherry must have a dry soil. It thrives best in rich loamy land. When irrigating the cherry orchard, the rule should be to give it only enough water to keep the trees in good condition, and no more. The sweet cherries are nearly as susceptible to cold as the peach, while the sour kinds are about as hardy as the red plums, and the intending planter should select his varieties accordingly.

The large sweet varieties, as the Lewelling and the Napoleon, have done best in the higher altitudes. This is probably due to the greater annual precipitation and the porous, well-drained soil commonly occurring in such localities.

The sweet cherries have the reputation of being difficult to transplant, and many persons have experienced difficulty in securing a good stand. Two factors enter into this difficulty, the more important one being that if the buds have started before the trees are planted, it is almost impossible to make the trees live. Since our nursery stock is mostly shipped in from other states, it is not to be wondered at that the buds swell to a certain extent before the trees can be planted. The second point to be considered in planting cherry trees is that they do not require, and will not withstand, as much water as many other fruits. We think that these two factors will account for many of the failures in securing a good stand of cherry trees.

Cherries are divided into two distinct groups, the tall, upright-growing kinds, bearing sweet and more or less heart-shaped fruit; and the smaller round-headed trees, bearing round, sour cherries.

The sweet cherries were formerly divided into four groups as follows: Mazzards, inferior seedlings, very large trees; Hearts, the soft sweet cherries, either light- or dark-colored; Bigarreaus, the firm-fleshed, sweet cherries; Dukes, light-colored, somewhat acid flesh, although borne on the upright class of trees. These groups have now become so thoroughly mixed by crossing that there is little use of trying to separate the varieties into the various classes.

The sour cherries were also separated into two classes, the Amarelles and the Morellos.

We have selected only a few of the many varieties for description, — those that at present are the more profitable market kinds; and the descriptions follow.

Lewelling (*Black Republican*). — Tree moderately vigorous for the class. Fruit large, shining black; flesh solid and firm; quality good. One of the best, for long-distance shipments. Season late.

Napoleon (*Royal Ann*). — Tree vigorous. Fruit large, heart-shaped, pale yellow with bright red cheek; flesh very firm, juicy, sweet. One of the best market varieties when well grown, as well as the leading sweet cherry, for canning. Season June 20 at Grand Junction, Colorado, also at Brigham City, Utah; July 1 at Nampa, Idaho.

Royal Duke. — Tree upright, vigorous. Fruit very large, roundish; skin dark red; flesh reddish, tender, juicy; quality good. Season medium early.

Windsor. — Tree vigorous, hardy, and prolific; fruit of good size, but not as large as Lewelling, heart-shaped; skin very dark red; flesh very firm and of good quality. Season about the same as Napoleon. Will withstand frost and neglect better than most cherries.

Sixteen to One. — A hardy sweet cherry, and peculiar because it ripens its fruit over a long period. It is being planted to some extent as a market variety, but we think that it will prove to be an amateur fruit only. Originated on the farm of E. J. Mathews at Paonia, Colorado, as a chance seedling.

Bing and *Lambert* are two of the newer dark red, sweet cherries that are being extensively planted in the Northwest. Both varieties are very large, and excellent for market as grown in the coast states. Both varieties are being planted in the intermountain country proper, but it will be several years before we will know whether they will be adapted to our conditions.

Montmorency Ordinaire is perhaps the best sour cherry. The tree is vigorous, hardy, and productive. Fruit of good size, firm; skin and flesh light red, with light-colored juice, less tart than most sour kinds and makes a good appearance when canned; quality good. Distinctly a canner's cherry and an excellent market variety. Season late June and early July on the western slope of Colorado, the Cache Valley, Utah, and at Nampa, Idaho; July 10 to 15 in the colder districts where sweet cherries do not succeed.

English Morello. — This variety has been more extensively planted than any other sour cherry, but we think that the Montmorency will largely take its place in the future. Tree smaller than Montmorency, productive. Fruit of good size, very dark red and very acid. Season, middle of July to August 1 on the western slope of Colorado; somewhat earlier at Brigham City, Utah; July 15 to 20 at Nampa, Idaho; August 1 in the colder districts.

Peaches

Peaches are nearly as indifferent to soil conditions as is the Ben Davis apple. To be sure, they respond to good land, but the productiveness and the quality of the fruit seem to be about the same in any soil where the trees are in a vigorous, healthy condition. This is assuming, of course, that the relative susceptibility to late spring frosts of different locations is not taken into account.

As with other fruits, but few varieties should be grown for market. The one variety for this purpose, above all others, in this section, is the Elberta. The reasons for the Elberta's supremacy as a market peach are: that it endures long shipments well; it is of large size and handsome in appearance; and its season is when there is the least competition from other states.

A comparatively few early and a few late varieties are grown to extend the season, and there is also sale at high prices for a limited amount of the very early and for the very late kinds. The planter, however, should be sure of the season of his locality before planting the later kinds.

Champion. — Tree vigorous, spreading. Fruit medium to large, roundish; skin white, with a deep red blush; flesh white, firm, juicy; quality good; freestone. Season just before Elberta.

Elberta. — Tree strong, vigorous grower, tree inclined to thin the fruit itself; foliage dark green. Fruit large, roundish oval, with a well-marked suture; skin lemon-yellow, with a blush on the sunny side; flesh pale yellow, tender, juicy; quality good. A good shipper and can be gathered before it is fully ripe. Season medium late; September 25 at Palisade, Colorado; September 5 at Brigham City, Utah; last of August at Nampa, Idaho.

Globe. — Tree vigorous and symmetrical. Fruit very large, globular; skin lemon-yellow, with a mottled red cheek; flesh yellow, deep red at the pit; quality good, rich, and juicy; freestone. Season ten days later than Elberta or about October 5 at Palisade, Colorado, somewhat earlier at Brigham City, Utah.

Orange Cling. — Tree vigorous, tall, somewhat spreading. Fruit large, nearly round; skin orange-yellow, with red cheek; flesh yellow, firm, juicy, rich; quality very good; clingstone. Season about with Globe or a few days later.

Triumph. — Tree strong grower, medium spreading, buds hardy during severe winter. Fruit large, round; skin yellow, well overlaid with red where exposed; flesh deep yellow, juicy, good, semi-cling. Season August 10 at Palisade, Colorado; August 5 at Brigham City, Utah; the same at Nampa, Idaho. The best early, yellow-fleshed variety for this section.

Pears

The pear is the one tree-fruit of the inter-mountain country of which it is depressing to write, because of the devastations of the fire-blight. Ten years ago the planting of pears was being extended rapidly, but about that time blight appeared, and a large number of acres of pear trees were destroyed in the succeeding four years. In some localities where there were formerly hundreds of acres of fine orchards, almost none are standing to-day. Only one locality remains, in Colorado, — the country tributary to Grand Junction, — where pear-growing is still profitable. And even here blight is doing great damage every year, so it would seem to be only a question of time when these famous orchards will be things of the past. This experience has been common to most of the older fruit-growing sections of the inter-mountain states.

In the light of such experience the writers cannot encourage the planting of pear orchards. And when we consider the menace that even one blighted pear tree is to large areas of apple orchards, we cannot but think that the interest of a very large percentage of our fruit-growers would be best served if no pear trees were grown.

Aside from the question of blight the pear is one of the easiest fruits to grow. It thrives in a great variety of soils, if fertility is not lacking, but perhaps does best in a moderately heavy soil.

Anjou. — Tree vigorous, upright, productive. Fruit large, obtuse pyriform; stem short, fleshy, set in a russeted cavity; skin greenish yellow, sprinkled with russet, dull red blush; flesh whitish, buttery, juicy with a rich vinous flavor; quality good. Season about September 15 at Grand Junction, Colorado; the same at Brigham City, Utah, and at Nampa, Idaho. Will often keep until the holidays. Liable to be a shy bearer unless severely pruned.

Bartlett. — Tree vigorous, erect. Fruit large, obtuse pyriform; stem long, stout, cavity shallow; skin clear, yellow, often with reddish blush; flesh whitish, fine-grained, tender, and buttery; fine flavor; quality good. Season about August 25 at Grand Junction, Colorado. A few days earlier at Brigham City, Utah; September 1 at Nampa, Idaho. One of the best market pears, but very susceptible to blight.

Lawrence. — Tree moderate grower, upright. Fruit medium size, pyriform; stalk short, set in shallow basin; skin light yellow, with many small dots; flesh whitish, buttery, aromatic; quality good. Season about September 15 at Grand Junction, Colorado, at Brigham City, Utah, and at Nampa, Idaho; will keep until December.

Mount Vernon. — Tree upright and vigorous. Fruit medium in size, obovate, irregular; stalk short, but slightly sunken; skin dull russet, with a red cheek; flesh greenish white, a little coarse, rich, vinous; quality good. Season, October 4 at Grand Junction, Colorado; the latter part of September at Brigham City, Utah; October 25 at Nampa, Idaho.

Seckel. — Tree rather a slow grower, but vigorous, upright. Fruit small, obovate; stalk short, cavity small; skin brownish green, turning to yellowish brown, with russet-red cheek; flesh whitish, fine-grained, melting, rich, sweet; quality very good. Resists blight better than most varieties and sells fairly well in half boxes. Season September 1 at Grand Junction, Colorado; latter part of August at Brigham City, Utah, and at Nampa, Idaho.

Winter Nelis. — Tree rather straggling, with slender branches. Fruit medium size; stalk moderately long, usually bent; cavity narrow; skin yellowish green, much russeted; flesh yellowish, fine-grained, buttery, sweet; quality good. It is picked just before frost and will keep until December.

Fig. 64.—An Idaho Prune Orchard. Boise, Idaho.

Plums

Plums do well on a variety of soils, but thrive best when planted on land of good tilth and of a fair degree of fertility. For the sake of convenience we may make two classes of plums; those adapted to conditions in which peaches thrive, and those that must withstand a more rigorous climate. Of the former class numbers of varieties may be grown successfully, but a few varieties grown in quantity are always better than many, so that only a few of the best ones will be considered.

Plums have not been very profitable for long-distance shipments, and the making of prunes has not become an important industry throughout the inter-mountain region. Localities in Western Idaho have been producing prunes for a number of years, and large orchards have been planted (Fig. 64). Oregon and Washington also produce many prunes, but these states are hardly to be considered within our range. Prunes of excellent quality can be produced in any locality in the region where peaches mature, but it is generally held that other lines of orcharding pay better, and there is certainly less danger of overproduction.

Abundance. — Tree upright, vigorous, a prolific bearer. Fruit large, oblong, tapering to a point; stem rather short, suture shallow; skin yellow, but mostly overlaid with bright red; quality good. Season early. A Japanese variety; blossoms early in common with its class, and is therefore especially liable to injury by late spring frosts.

Bradshaw. — Tree vigorous and attains large size. Fruit large, obovate, cavity shallow, usually with a ring about the stem; stem about an inch long; suture shallow; color dark purplish red, with blue bloom; flesh greenish yellow; stone rather small, nearly free; sweet, quality good. Season September 1 at Delta, Colorado; August 20 at Brigham City, Utah; September 10 at Nampa, Idaho.

Italian Prune (*Fellenberg*). — Tree moderately vigorous, spreading. Fruit of decided prune-shape, medium to large in size; color dark blue with blue bloom; flesh greenish yellow; freestone; quality very good, sweet. Season about with Elberta peach.

Tragedy Prune. — Tree moderately vigorous, upright. Fruit medium size, prune-shaped, suture deep; stem short; skin dark purple with blue bloom; flesh firm, yellow; stone large, cling; quality good. Season early. This variety is being planted, to some extent, on account of its early ripening, its season at Grand Junction being the latter part of June.

Satsuma. — Tree upright. Fruit large; round conical, cavity deep and abrupt; stem short and stout; suture nearly obsolete; color dark, bright red, with light bloom; flesh dark red, firm; cling; flavor rather acid, good. Season medium to late. Must be planted with other varieties which blossom at the same time in order to insure uniform crops of fruit. Not as hardy as some other Japanese kinds.

The second class is composed almost wholly of the cultivated varieties of the native red plums, with a very few of the hardier Domesticas. The red plums have been profitable in the colder districts, where they usually find ready sale in near-by markets. When consumers are able to overcome their prejudices and become accustomed to these fruits, they find that the better red plums are superior in flavor, and that they are especially adapted to the making of preserves, jellies, and marmalades.

American Eagle. — Tree a good grower for the class, productive. Fruit large, oval; suture a faint line; stem medium; cavity abrupt; color yellow, mostly overlaid with dark crimson, with thick blue bloom; flesh firm, yellow; stone large, cling; quality good. Season medium.

De Soto. — Tree not very vigorous and inclined to overbear. Fruit medium in size, oval; suture a line; stem rather long; color orange, mostly overlaid with crimson; bloom blue; flesh yellow, firm; stone oval, cling; quality very good. Season medium.

Forest Garden. — Tree a good grower for the class, productive.

Fruit large, nearly round, suture obscure; cavity shallow; color orange, mostly overlaid with dark red; bloom thin, blue; flesh yellow, sometimes red around the stone; stone roundish, cling; quality very good. Season medium.

Wolf. — Tree vigorous, productive. Fruit oval, medium to large, suture a faint line, color orange overlaid with crimson; bloom bluish; skin tough; flesh yellow; freestone; quality good. Season medium early.

Arctic (*Moor*). — Tree vigorous, somewhat spreading. Fruit medium or below in size, roundish, suture indistinct; stem short, slender; color nearly black, with a thin blue bloom; flesh tender, firm, nearly sweet, yellowish; freestone. Season medium. One of the hardiest of the blue plums, but is distinctly inferior in quality to the American plums just described.

CHAPTER XVI

PICKING THE FRUIT

The subject of picking and packing fruit is one of vital importance to the western fruit-grower, who depends to a large extent on the demands of the eastern market. The inter-mountain states, which embrace some of the best fancy fruit-growing sections of the world, do not, by any means, contain the most desirable markets. The western markets are new, and the consumer has not been educated to pay fancy prices for fancy fruit. Not only this, but the western markets are no longer able to consume the western-grown fruit. The grower must study the demands of the distant markets, and, so long as the requirements can be met with justice to the profit side of his ledger, he will do well to cater to their demands. Even the experienced fruit-grower, thus isolated from his markets, to say nothing of the large class of inexperienced growers, might profit by the writers' efforts in this chapter on the picking and the packing of fruit. It is hoped that a general discussion of these subjects will help the grower to market his fruit more intelligently, and, to a certain extent, aid him to grasp the meaning of the stock phrases of the wholesaler so often accompanying unsatisfactory returns.

The terms "pack poor," "poor grade," and "fruit in poor condition," so often used by the buyer, often mean little to the grower after the fruit is out of his sight. He knows that the fruit was not satisfactory to the buyer, but he is often at a loss to know how to improve his methods of marketing. While the fruit-grower need not be alarmed over our present methods, we feel sure that improvements in methods of picking, packing, and marketing will have to keep pace with the rapidly increasing acreage of bearing orchards. Otherwise the net returns will gradually diminish until large profits, which are now the great stimulus to fruit-growing, will no longer recommend it to the man in search of a vocation. When asked whether there is any danger of overproduction of fancy fruit, we feel safe in answering in the negative, but always qualify the statement by suggesting that we may be obliged to grow better fruit. There will always be a market for the best fruit, and there will always be a best way to pick and to pack it.

Picking the Fruit

Possibly the grower of fancy fruit in the arid fruit sections does not fully realize that much of his fruit is held in cold-storage during the early part of the season, and that the high price which he receives, as compared with prices paid for fruit in other sections, is due partly to its superiority as a cold-storage product. It is to the grower's advantage, then, to see that the fruit goes into storage in the best possible condition. This means that the fruit must be picked in the proper condition, handled carefully, and stored promptly.

The fruit-grower must realize that the fruit is a living organism that reaches the end of its life and dies of old age. The life processes are proceeding continually, but more slowly in cool temperatures than at higher ones. It is the purpose of the cold-storage house to check the ripening processes in the minimum temperatures that will not injure the fruit, and in this way prolong its life. The cooler temperature also checks the spread of fungi, that may kill the fruit prematurely. The ripening processes may then be considered little more than decay, and the fruit should be handled in a way to delay this decomposition as long as possible.

The fruit must not be allowed to become overripe upon the tree. It should be picked just as it reaches the height of its life development and before it begins to decline. Pears allowed to hang on the trees too long soften at the core and soon rot in storage. The Jonathan apple occasionally rots at the core in storage, and it is generally conceded that allowing the fruit to hang on the tree too long is the cause of the trouble. The Jonathan and some other varieties crack at the calyx end when picking is delayed, and this also gives entrance for molds in storage. Under normal conditions the ripening processes proceed much faster after the fruit is picked from the tree, and every effort should be made to check it by storing the fruit in a cool place or promptly delivering it to the buyer.

The following statements from a recent bulletin of the United States Department of Agriculture emphasize the importance of storing promptly: —

"Rhode Island (Greening), Tompkins King, and Sutton apples picked September 15, 1902, and stored within three days, were firm till the following March, with no rot or scald, but fruit from the same trees not stored till two weeks after picking was badly scalded or decayed by the first of January. None of the immediately stored fruit was scalded or decayed by the first of February, but the delayed Sutton and Rhode Island (Greening) apples were soft and mealy, and one-third were scalded at that time, while nearly 40 per cent of the delayed Tompkins King were soft and worthless. The commercial value of these varieties was injured from 40 to 70 per cent by the delay in storage.

"Apples of these varieties picked from the same trees on October 5, 1902, and stored immediately, and also some stored two weeks later were less injured by the delay, as the temperature and humidity were not sufficiently high to cause rapid ripening or the development of the fruit rots."

To keep satisfactorily in cold-storage, fruit should be well colored; in other words, it should be well matured. Poorly colored fruit shows a tendency to scald in storage, and this explains why the buyer insists upon having well-colored fruit. The color may be improved by proper pruning, thinning, irrigation, and tillage and by planting varieties that ripen within the season. It is possible to secure a more uniformly matured and uniformly colored grade of apples by picking over the trees several times instead of taking all the fruit at the first gathering. As yet, many growers have not reached this stage in the growing of fancy fruit, but it will no doubt come

While in many of our fruit-sections we have not begun to wrap the fancy apples, it has been fully demonstrated that wrapping prolongs the life of the fruit in storage. It largely prevents the spread of rot fungi from one fruit to another, checks transpiration, and saves the fruit from many bruises in rough handling.

Picking Equipment

The grower with a large orchard knows that it pays to have good picking equipment, and he is generally ready to adopt new devices supposed to facilitate his work. The inventor has taken advantage of this readiness, and has introduced many appliances supposed to reduce the

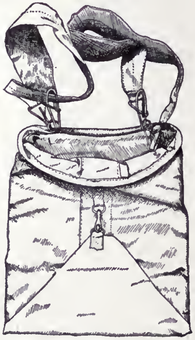


Fig. 65.—The Bowman Picking Bag.

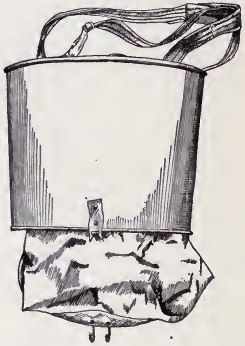


Fig. 66.—The Excelsior Picking Receptacle.

labor of picking to a minimum. In the East we find that many kinds of fruit-pickers have been devised, and most of them discarded. The agent with the patent fruit-pickers has not invaded the western fruit countries. The only three essentials in picking fruit are: a careful man, a good picking receptacle, and a good ladder. Other appliances may be indulged as a luxury, but are generally discarded as impracticable in commercial operations.

Unfortunately, good pickers are not always to be had, and here the grower with the large orchard is at a disadvantage. With a force of pickers of any size it will pay the grower to spend his time overseeing the work. More often, however, he considers the packing house a point of more vital importance to him and hires a competent man to look after the pickers. With tree-fruits it is better to pay the pickers by the day or hour in preference to paying so much per box. The man who is mean enough to take advantage of his employer under this system would injure him more if allowed to pick by the box. If one is paying a picker by the day, he can insist upon careful work being done.

Fig. 67.—A Good Type of Ladder.

Several forms of picking receptacles are used. Some persons prefer a rather broad three-gallon tin pail; some use half-bushel baskets; and others use a special picking bag. The bucket is very good for picking soft fruit that is easily bruised, if the picker is careful in transferring the fruit to boxes for carrying it to the packing house. Too often, however, the picker is tempted to pour the fruit.

Half-bushel baskets are rather awkward to handle, and unless made of sheet metal, are not very durable. The bails of the buckets and baskets may be supplied with a heavy wire hook, so that the receptacles may be hung on a limb, thus giving the picker two free hands.

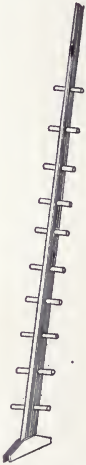


Fig. 68. — The Pole Ladder.

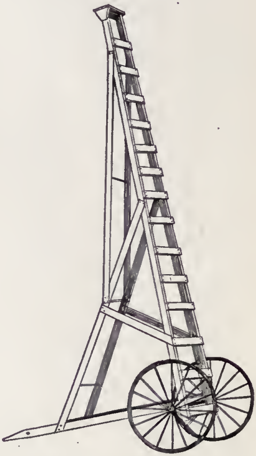


Fig. 69. — A Wheel Ladder.

The most convenient form of a picking receptacle is one of the picking bags, which is supplied with straps to run over the shoulders and thus support the bag in front of the body. Two types are commonly used, one a metal contrivance with a drop-bottom and a canvas extension to facilitate emptying without bruising the fruit; the other a canvas bag open at the bottom, with a snap to close this opening and a heavy wire ring to keep the top distended. The two types are shown in Figures 65 and 66.

Several types of picking ladders are now in use. One of the most convenient forms is a common step-ladder with a broad base, as that shown in Figure 67. The broad base allows the picker to lean to one side without danger of tipping the ladder. It is better to have two lengths in ladder instead of making all the pickers carry long ones. Another ladder, rather handy for work on the inside of the tree, is that shown in Figure 68. With the top placed securely in a fork it is a very steady ladder to work on. Different types of wheel ladders have been introduced. Figure 69 is a common home-made form. This ladder is rather heavy and cumbersome to handle, and except for high cherry or pear trees it is not to be commended. Fortunately, our fruit-trees do not grow large, and we are learning to train them in convenient forms.

Picking Apples

Many rules have been laid down to guide the fruit-grower in picking apples. All are more or less correct, and probably all fail to be universally applicable. Taken as a whole, however, it should be possible to give a set of rules that is fairly reliable.

One of the most common rules is to pick when the seeds begin to turn brown about the edges. In many cases this is a good rule to follow, but in others it is far from reliable. The writers have observed cases in which the seeds were practically brown thirty days before the fruit was really ready to pick. This is not a varietal characteristic, either, for we have seen the standard winter varieties with the seeds brown the first of September, and many are not picked until the middle of October. Allowing the ground to become dry in midsummer seems to color the seeds prematurely, yet the fruit will improve in color and size when the needed moisture is supplied. Other conditions may also have their influence on the coloring of the seed. Many of the early varieties are picked before the seeds show any color. But in most cases the color of the seed, in connection with other characters indicating maturity, is worthy of consideration.

About as much reliance can be placed on the color of the fruit as any other one character. Well-colored fruit is desired by the market, a factor which must be catered to, and, within the bounds of reason, picking should be delayed until the required color is attained. Yet we find cases in which it is out of the question so to delay the picking; and, again, as the average grower understands color, some varieties show no colors that would indicate to him that the fruit is ready to be picked. In waiting for color one may run the risk of serious loss from wind or early freezes. Fruit matures better on some soils than on others, so that color cannot be considered a uniform character.

The ease with which the fruit separates from the spur is one factor that often determines the season of picking. One cannot afford to wait for color in seeds or fruit after the stem loses its firm grip on the spur. The writers have known cases in which 75 per cent of a crop of fancy fruit has been sold as wind-falls, and merely because the grower was waiting for color, regardless of the condition of the stem. With such varieties as the Fameuse (Snow) and McIntosh, which have a habit of dropping more or less, we feel justified in running some risk in waiting for the fruit to color, even though the dropping indicates that the fruit should be picked. With such varieties as the Ralls (Geneton) and the Winesap it would be folly to wait for the stem to loosen, after the fruit has attained size and color.

Flavor is a character worth considering in picking apples, as the fruit should begin to have some flavor before it is harvested. However, the flavor of the apple improves after picking, and allowing the apple to become eating ripe on the tree shortens its life in storage. The red colors improve little if any after picking, but the yellows improve in storage. As an exception to this statement it may be said that some summer varieties color after picking. These four indicators of maturity must be considered together, and we cannot say that any one constitutes a safe rule to follow.

Apples are generally picked in canvas picking bags, but buckets, baskets, and metal picking bags are used to some extent. The fruit should be picked with the stems on. The picker soon learns that by a certain tilting motion the stem may be separated from the spur with no damage to either. In some varieties the spurs are easily broken, so that careless pickers will bear watching. As a rule, the full crop is gathered at one picking, but there are cases when it pays to make more than one picking. When the fruit is ready to harvest, it is generally gathered regardless of size, as apples gain little in size after they are really ready to be picked. The fruit should be handled carefully, as bruises detract much from its beauty and are often the starting points for decay. The fruit should be stored in a cool place as soon as possible after picking, and kept cool until delivered for shipment.

Picking Apricots

Rules that apply to picking peaches will apply equally well to the apricot. The fruit is tender and must be handled carefully. It is even more perishable than the peach, and it must be handled promptly. Its color improves in transit and storage, and fruit picked when the color is rather green often appears on the market an attractive yellow.

Picking Cherries

Cherries are picked before they are fully ripe. The best test for fitness is the taste. Color should also be a guide, as the fruit should have all the color possible before picking. The fruit should also be well flavored before it is picked, for it improves little afterwards. By testing a few fruits one may soon train the eye to pick by color.

The fruit is picked with the stems on. It may either be cut with shears or pulled by hand. If pulled by hand one should grasp the stems and not the fruit; the latter method loosens the fruit from the stem and the package is stained with juice and becomes unsightly before it reaches the market. Cherries are generally picked in buckets or baskets. The fruit should not be allowed to stand in the sun after picking and it should be marketed promptly.

Picking Peaches

Picking peaches for the distant market and for the home market are two different considerations. In growing peaches in a commercial way, it is necessary to pick much of the fruit before it is ripe, and we must sacrifice flavor if we expect to reach the distant market. It does not improve much in flavor after picking. When one knows where the fruit is to be marketed, he may pick accordingly. More often, however, the grower has little idea where the fruit is to go, and must deliver it to the shipping point in condition to reach the most distant market.

To a certain extent, color may be considered an indication of ripeness in peaches, at least, it first draws the picker's attention. The fruit may or may not show a blush of red, but the green begins to lighten and traces of yellow appear on shaded parts. But the peach that is well colored is not always ready to be picked, and lack of color is not always a sign of greenness.

The peach picker learns to go more by touch. Freestones should be picked as soon as the fruit begins to feel elastic. One need not bruise the fruit to determine this, but simply clasp the fruit in the hand and test it with a gentle pressure, using the broad face of the thumb. Picked in this way there will always be enough soft fruit to supply the near-by markets. The clingstones need not be picked so promptly after the flesh becomes elastic to the touch, as they stand up much better in transit than the freestones and do not soften so quickly. They should be left until they attain very good flavor. In taking hold of the fruit one should be sure to test the suture side (the flesh near the fold or crease running from the stem toward the apex). While we have largely eliminated varieties that show a decided tendency to soften first at this point, we still find some specimens that do it. Specimens with split pits generally soften at the suture side first.

Peaches must be handled carefully, as fruit bruised in picking or packing will not carry any great distance. Most peach-growers favor a rigid picking receptacle, as a bucket or a sheet metal picking bag. The metal picking receptacle shown in Figure 66 is a very good form. It is furnished with a drop-bottom and fruit may be easily transferred to a box without being bruised. Peaches carried in canvas picking bags are more or less bruised by striking against limbs or the ladder, or by being pressed between the picker and the limbs or the ladder. The fruit should be transported from the orchard to the packing shed in shallow boxes. A very good box for such work is that shown at the base of the tree in the foreground in Figure 70. Most growers use a sled for short hauls and a wagon with springs for a longer haul.

Picking Pears

Most pears are picked rather green and ripened in storage, so that it is difficult to give rules that will guide the inexperienced grower. If pears are allowed to ripen on the tree, or if they are even allowed to advance far enough to show any pronounced indications of ripening, the fruit softens at the core and soon rots in transit or in storage; and, unlike most other fruits, the pear ripened in storage is of better flavor than when allowed to mature on the tree. Nearly every one not accustomed to hand-

Fig. 70.—A Packing Scene.

ling pears, makes the mistake of delaying picking too long.

It is a common saying, that Bartlett pears are ready to pick as soon as they are large enough, or when over $2\frac{1}{4}$ inches in diameter. This, however, is not always

FIG. 71.—Pear on Right Ready to pick; the Other too Green.

a safe rule to follow, for pears on young trees or trees carrying a light crop may reach the desired size and yet be too green to ripen well. Pears picked too green wilt in storage and refuse to ripen. When ready to pick, the Bartlett and many other varieties have a characteristic mottled appearance as shown in Figure 71. The pear on the right is a Bartlett ready to pick and the one on the left is too green. This mottled or spotted appearance is brought about by a lightening of the dead green color over most of the surface, leaving the dark green base of the dots standing out in contrast with the lighter green. The first trace of yellow appears about the base of the stem, and fruit picked as soon as the green begins to fade at this point will ripen in storage. This first change of color at the tip of the neck is considered to be a reliable indication of the maturity of the fruit. With some varieties these changes of color are not so pronounced and other tests must be applied.

The ease with which the fruit separates from the spur is considered a reliable test for maturity and, with most varieties, a pear that comes from the spur when taken in the hand and tipped up is ripe enough to pick. It is generally conceded that the crop is ready to pick when the wormy specimens show the first indications of ripening, or when they begin to turn yellow and are well flavored. Experts also learn to pick by the grain of the flesh, as the coarseness disappears at picking time.

It is the general practice to make two or three pickings, each time picking only those that are large enough to make a desirable pack. A light watering after each picking will help to bring the smaller fruit up to size. The picker may be given a $2\frac{1}{4}$ inch ring and instructed to pick all that will not pass through it. A quicker way is to learn to measure with the hand. Clasp a $2\frac{1}{4}$ inch pear in the hand and attempt to encircle it with the thumb and second finger, and in this way learn how near they should come to meeting on the smallest size allowed in a good pack.

Pears should be carefully picked and handled to avoid bruising. Bruises do not show early, but after the fruit is ripe, decay starts quickly in the injured spots. The fruit should be picked with perfect stems and without destroying spurs. It should not be allowed to stand in the sun or warm storage, as this shortens its life in cold-storage; and, although it may be mature enough to ripen well in cold-storage, fruit may wilt if handled carelessly. It is best for the grower to harvest and market the pear crop as promptly as possible and let the buyer take the responsibility of ripening it.

Picking Plums

Plums are picked before they are really considered eating-ripe. Many of the red plums of the American and Japanese types will ripen well when picked green and will color well off the tree. As a rule, however, it is well to leave the fruit on the tree as long as possible, especially the fancier plums supplied to the fruit-stand trade. The varieties commonly known as prunes carry very well after they are really ripe.

Like a peach, a plum picked after the flesh feels elastic to the touch will ripen well in storage or in transit. Plums picked for jelly are best taken rather green.

CHAPTER XVII

PACKING AND GRADING THE FRUIT

THE idea of packing tree-fruits in what we may term fancy packages is not an old one, and there is no reason to suppose that we have reached perfection. Yet there is little doubt that the western fruit-grower now leads in putting his fruit on the market in attractive packages. He prides himself on this point. Whether an indication of cleverness or an outgrowth of necessity, it has been demonstrated that it pays to market fruit in neat and attractive packages.

It seems to us that the western fruit-packages have four points of merit: they are neat and attractive; they are of convenient size, that is, they suit the buyer of fancy fruit better than a larger sized package; they are of convenient form for shipping in car-load lots; and they carry the fruit in excellent condition.

Probably the western grower may claim the credit for demonstrating that the first two points are worthy of consideration in choosing the fancy fruit-package. There is little doubt, however, but that the distance from market has had a marked influence on the evolution of the fruit-package in the West. Western growers have largely adopted the ideas worked out in California. Considering our distance from the large markets, it would be absurd for the western grower to try to market his peaches in bushel baskets; and almost as ridiculous to attempt to market apples and pears in barrels. The form of the package, and possibly its size, have been determined largely by conditions under which the western grower markets his product. The peach box, for example, is designed to reduce the loss from bruising to a minimum. The same is true of other packages; they are designed to carry fruit long distances. The western package is generally small as compared with other packages, and it is a favorite with consumers who do not care to take the risk of buying in larger quantities. A neat package is without question an advertisement for the fruit.

Granting that our growers are satisfied with the package in which they market their fruit, the question of grading and packing is well worthy of consideration. The co-operative fruit-growers' association has done much to establish a uniform system of grading and packing fruit. Yet the writers are of the opinion that at the present time the management of some of our associations need arousing, that they may keep abreast of the times. Our growers are now allowing the fancy fruit-growing sections in the Northwest to take the lead, especially in grading and packing apples. So far we seem to be at the front in grading and packing pears and peaches; but even here competition will no doubt force us to improve on present methods. While many growers now contend that the present method of grading places the standard for fancy fruit too high, the writers expect soon to see the requirements raised for the different grades; and they will be raised at the request of progressive growers. When we say that the management of the association needs to be roused, we do not necessarily mean the man who stands at the head of the organization, for he often foresees changes that must come long before he dares to suggest them; it is the influential growers within the association who need to be made to realize that methods must be improved.

The early idea of many associations was to pack the fruit at a central packing-house. By employing a competent man to look after the packers, they hoped to secure a uniform pack on which they could establish a reputation. The plan is still followed by some associations, in spite of its drawbacks. With a large volume of business, however, it is impossible for the management to handle the fruit under such a system. It is impossible for one foreman to see that a hundred packers, or even half that number, pack a uniform grade. Again, it is not always possible to secure help, and the equipment generally proves inadequate at the critical time. To say the least, the difficulties experienced in securing a uniform grade and in handling a large crop, are burdensome to the management.

The oldest association, and the one now doing the largest business in this group of states, has long since given up this plan and has adopted a system of platform inspection. Each grower is responsible for packing his fruit and delivering it to the platform. Here the inspector opens as many of the boxes as he chooses and inspects the contents. If the grade and pack is satisfactory, the grower is given credit for so many boxes of such a grade; if the pack is not up to grade, he has his choice of having it "marked-down" or taking it back home and regrading and repacking it. This association gives the growers instruction in packing and it furnishes printed rules for grading.

After seeing the two systems in practice, the writers are inclined to consider the latter the best. The grower is made responsible for packing his own fruit, and he generally secures the help, or he works overtime doing it himself; and with a good inspector we think that the association markets a better grade of fruit. Repacking about one load of fruit will make such a lasting impression on the packer that he will never forget what constitutes a good grade.

We realize that in arriving at this conclusion our ideas are contrary to those of some other writers on the subject. In a recent bulletin from the Idaho Experiment Station, Judson writes as follows in regard to the management of packers: "Few men are fit to pack their own apples, as it is too hard for them to see worm-holes. No fruit union can afford to allow members to do their own packing, and even unorganized communities would benefit greatly by employing the same body of trained packers successively at the various orchards. Even the isolated growers should endeavor, if their orchards are large, to train a group of expert packers and employ the same ones as far as possible year after year. This is the way to build up a reputation that has a cash value."

Judson seems to arrive at this conclusion after studying the system employed by the Hood River Apple Growers' Union. This association handles its own packers, sending them out in groups of four, each group with a competent foreman. We realize that this is different from one man handling a hundred packers, and with this system Hood River has developed a remarkable reputation for its fancy apples. An idea of the precautions taken by this association in handling its packers, and the care with which they are chosen, is best conveyed by quoting their printed instructions to packers: —

INSTRUCTIONS TO PACKERS

1. A crew will consist of four packers and one foreman extra.

2. Each packer, before he is permitted to pack for the Apple Growers' Union, must have his name registered at the office of the Union and receive a rubber stamp free. He shall be required to stamp each box at the lower left hand corner when packed with his official stamp.

3. Each packer shall be required to put up a first-class pack. If upon any inspection any packer be found guilty of putting up a poor pack, or putting in apples not suitable for the pack being made, he shall bear the expense of repacking such box or boxes for the first two offenses. Upon further neglect he shall be dropped from the list of the Apple Growers' Union packers.

4. Each packer, when a box is packed, shall write with pencil upon the end of the box, in the center near the top, the number of apples the box contains.

5. Each box of apples shall be packed with about a ¾-inch to 1-inch swell in the middle of the top and bottom combined, but no box must be packed so high that it will be necessary to cleat the box before nailing on the lid.

6. Each packer shall receive his pay from the grower in cash, or on a written order on the Apple Growers' Union, which will be cashed by the manager on presentation.

7. The charges fixed by the Union and agreed to by the packers for packing, will be 5 cents per box for all boxes containing 128 apples or less, and 5 cents per box for all boxes packing 4½ tier. All 5-tier apples will be packed at 6 cents. This price shall cover any and all packs ordered by the manager.

8. Each packer will be furnished meals by the grower where he is packing, without charge, but must make necessary arrangements for his bedding.

9. Packers are only required to pack fruit properly wiped and assorted from culls fairly well by the grower before being placed upon the packing table, but the packer will be required to make the final culling, which shall not exceed 8 per cent, or 8 boxes in 100. Such boxes as the packer may throw out he will be required to handle with as much care as first-class fruit.

10. Each packer must be supplied with suitable and necessary room at the packing table, which must be properly and substantially made.

11. Each packer shall require the grower to supply him with empty boxes and have the paper in a convenient place.

12. Each packer must set off his box when packed.

13. If the grower is not properly prepared for the packers, the packers will be at liberty to move on, or may charge the grower at the rate of 20 cents per hour for extra time spent in culling and wiping properly. It shall be the duty of each packer to notify the grower of such conditions, when existing, in advance, and should the grower make a protest, the packer will be at liberty to move on and report the matter to the manager, who will endeavor conscientiously to adjust the matter satisfactorily.

14. Packers must be sure to have the exact number of apples in the box as numbered. Foremen are cautioned to watch this. Avoid criticism by following this instruction. We are on the lookout for this sleight-of-hand trick.

15. Please assist the packer. He is also a grower and your friend; and remember he is following the instructions given by the Board of Directors, who are acting as directors with your interest at heart, giving one day each week of their time without pay.

We must give these Oregon growers the credit of putting their apples on the market in what is probably the finest commercial pack ever put up. (Fig. 97.) The time is probably not far distant when other fancy fruit-growing localities will be following their example. Their apples are packed as carefully as most growers pack their peaches or pears, or as carefully as California growers pack their oranges, and the returns justify them for the extra labor and expense. The association schools its packers and holds them responsible for faults in their own packing. While the printed instructions state that the packers are paid by the piece, this plan has been abandoned and the packers are now paid by the day. Provided such a system can be worked on a large scale, this is no doubt the best method of handling packers that has yet been devised.

Packing Appliances

It is hardly necessary to mention the desirability of having convenient packing equipment on the fruit-farm. Most growers are provided with packing houses, but many of these buildings are poorly lighted. In planning the packing house, this point should be given special attention as the packers must have good light properly to grade the fruit.

Packing out of doors is often hard on the packers and hard on the fruit, especially in the warm days of early fall. Figure 70 shows a force of packers moved outside because the well-equipped packing house proved too small for the force of packers necessary to handle a large crop from a 200-acre orchard.

Owners of large orchards sometimes supply themselves with a large tent in which to do the packing. It is surprising how cool a tent will keep the fruit, and the light is almost perfect. The grower should at least provide some place where the fruit may be stored in the shade as soon as picked and kept as cool as possible until it can be delivered to the shipping point.

Packing tables are generally home-made. The table shown in Figure 70 is a very good type. Each of these tables accommodates four packers, has stands for two boxes in front of each packer, and a stand for the cull-box on either side near the center. This table has a canvas bottom and fruit may be packed from it with very little danger of bruising. It could be improved by placing the stands for the boxes a little higher and constructing them so that they hold the boxes in an inclined position, the end near the packer being slightly lower.

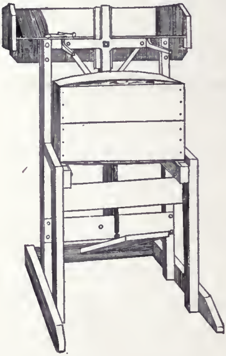


FIG. 72. — Box Press.

Most tables are made to accommodate two packers. It is a good plan to have the top of the table on an incline, the packers working on the lower side. The table is filled from the back and the fruit gradually slides down to the front as the packer works that nearest him off the table. Tables with board bottoms should be well padded and all sharp corners should be covered. The best tables have either canvas or burlap bottoms.

There are many styles of box-presses to be had, both factory-made and home-made. A good press is indispensable in packing apples and pears. Figure 72 shows a very good type of press that may be used for either apples or pears. There are other presses, however, that are just as good and some that are not nearly so cumbersome.

Box material, or "box shook" as it is called, is bought knocked-down and is made up by the grower. The common price paid for making apple and pear boxes is 90 cents per hundred. A box-maker who knows his business will set up fifty boxes per hour. Peach boxes are made by the piece for 40 cents per hundred. The following is the price list on box material as furnished the growers by the Grand Junction Fruit-growers' association during the season of 1908:—

BOXES

	Per 100	Less than 50
3¾- and 3-inch Peach	$ 8.00	$ 8.50
4-inch Peach	8.50	9.00
4½-inch Peach	9.00	9.50
5-inch Peach	9.50	10.00
4½-inch Grape Crates (no baskets)	11.00	11.50
4½-inch Grape Crates, complete	15.00	15.50
Pear Boxes	14.00	14.50
Apple Boxes	16.00	16.50
Standard Cantaloupe Crates	16.00	16.50
Pony Cantaloupe Crates	16.00	16.50
Tin Top Baskets	1.00	1.00
Climax Baskets	5.00	5.00

PARTS OF BOXES

Apples	Per 100 boxes	Per bundle
Ends	$6.75	$ .90
Sides	5.40	1.35
Top and Bottoms	5.40	1.35
Cleats	.50	.50

	Per 100 boxes	Per bundle
Pear		
Sides	$4.40	$1.10
Ends	6.00	.75
Peach		
Ends	3.00	.75
Sides	2.20	1.10
Grape Crates		
Ends	4.00	1.00
Sides	2.20	1.10
Bottoms	2.20	1.10
Tops	3.00	1.50
Cleats	.80	.80

PAPER

	Bundle	Broken bundle
Peach, Pear, and Apple, paper, per 100	$5.50	$6.00

NAILS

	Keg	Pound
Barbed Box Nails, 4d, 5d, 6d	$4.50	$ .05
Cement Coated Nails, 3d, 4d, 5d, 6d	4.50	.07
Cement Coated Nails, 2d	5.00	.10

A keg of cement nails contains only about seventy pounds, but contains the same number of nails as a keg of wire nails.

BERRY BOXES

Hallock Folding Quart Boxes, square, per M	$ 3.50
Hallock Folding Pint Boxes, square, per M	3.00
Hallock Folding Pint or Quart Boxes, square, per 100	.40
Hallock Crates, Quart Spruce, per 100	10.00
Hallock Crates, Pint Spruce, per 100	9.00

Packing Apples

In the several inter-mountain states there are various systems of apple-packing. Possibly the bulk of the apple crop is packed in what is known as the "jumble pack," and in two grades known as "fancy" and "choice." Some associations put out a particular pack known as

FIG. 73.—A Typical Box Label for Extra Fancy Fruit; also illustrates the 2-2 Pack.

"extra fancy," and label it with some special label as that shown in Figure 73. This grade is extra-selected for size and color, but is otherwise no better than the fancy grade. It is a question whether with this system of packing it is better to pack in three grades or in two.

Fancy fruit must be of good size, free from worm-holes or worm-stings or other defects, of good color, and good shape. The standard of size generally given for the different varieties are those found in the grading list of the Grand Junction Fruit-growers Association, as printed below. The choice grade is made up of fruit larger than $2\frac{1}{4}$ inches in diameter, reasonably free from worms or other blemishes. It is true that buyers seem to find little fault with this method, but competition will probably necessitate a more uniform method of grading and a better system of packing.

Boxes of different dimensions are used in the various fruit sections. They are made of light pine, the ends of $\frac{3}{4}$-inch, and the sides, tops, and bottoms of $\frac{1}{4}$-inch material. Material $\frac{3}{8}$ of an inch in thickness is sometimes recommended for the sides, as it prevents bulging. Boxes are generally stacked and hauled on the side, and if the sides are bulged there is a tendency to bruise the fruit. The sides of the box are each a single piece, while the tops and bottoms are generally made of two pieces. In making up the box, the top is put on instead of the bottom and is held with $\frac{3}{8} \times \frac{3}{4}$ inch cleats. These cleats mark the face of the box; and the package is naturally opened on this side, as the cleats facilitate opening. If the box were faced on both sides, it might be well to cleat both top and bottom. As a rule, where the jumble pack is used, the box has inside dimensions of $11\frac{1}{2} \times 11\frac{1}{2} \times 18$ inches and should hold fifty pounds when packed.

For the fancy grade the box is lined with paper. The paper is usually cut 18 × 24 inches, two pieces being sufficient to line the bottom, sides, and top of the box.

Fig. 74. — The 2–3 Pack.

A one-inch plait is folded across the paper about six inches from one end. In placing the paper in the box, this fold is laid in the angle between the side and bottom, thus furnishing enough slack so that the paper will not tear when the top and bottom of the box bulge. Some persons use paper in the end of the box, but this is not necessary. Boxes for choice fruit are seldom lined.

FIG. 75. — The 3-3 Pack.

The box is placed before the packer with the end from the packer slightly raised. The apples in the first layer are placed with the stems down and they are neatly arranged, for this is to be the face of the box. Whether the face is to be the 2–3 or the 3–3 pack will depend on the size of the fruit. Large fruit is sometimes packed the 2–2 pack. Figure 74 is a box of Gano faced with the 2–3 pack. The box shown in Figure 75 is faced with the same apples except that a few of the larger ones had to be replaced with smaller ones in order to make it come out right with the 3–3 pack. According to the size of the fruit, the face should be packed to present the neatest appearance, and the face showing the fewer large openings is generally considered the neater. The straight pack as shown in Figure 76 is sometimes used, but it is too hard on the fruit, one apple lying directly on top of the one in the tier below. The second tier is faced stem down as the first, and, with the "diagonal" or "offset" pack, is placed to cover the openings in the first tier as is shown by Figure 75. The remainder of the apples are put in with the jumble pack, paying little attention to placing them; they find their places. The box should be so filled that when the bottom is pressed down and nailed on, the box will appear as shown in Figure 77. So long as the jumble pack is used, this bulge should be $\frac{3}{4}$ inch to an inch on both top and bottom.

Fig. 76. — Straight Pack.

When the fruit is packed in tiers all the way through, a box of different dimensions has come into use. The box known as the "standard" in the Northwest has inside dimensions of $10\frac{1}{2} \times 11\frac{1}{2} \times 18$ and the "special" $10 \times 11 \times 20$. It has been found necessary to use these sizes in putting up the fancy tier packs. They accommodate all sizes of apples. The apples are packed in regular tiers and are graded very uniformly as to size. They are wrapped in paper, and a piece of heavy cardboard is placed between

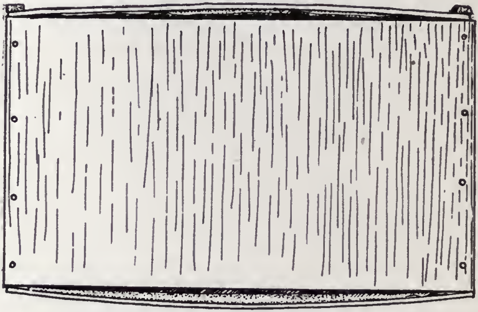


FIG. 77.—Box of Apples Ready for Shipment, showing Proper Bulge of Top and Bottom.

each two tiers. The number of apples packed in each box is stamped on the end. This is no doubt the best pack of apples put on the market to-day. Wrapped and packed in this way, the box of apples appeals to the buyer as a strictly fancy package. The fruit carries with fewer bruises, and such a pack is especially desirable for export trade. The time is probably not far distant when all fancy apples will be marketed in this way. Wrapping prolongs the life of the fruit in storage. When packed in regular tiers, it is best to place the apples in the top and bottom tier stems outward.

Packing Apricots

Apricots are packed for shipment in the common four-basket carrier, which is used for grapes and plums. The inside measurement of this crate is $16 \times 16 \times 4\frac{1}{2}$ inches, and it carries four wood-veneer boxes, each 8 inches square and 4 inches deep. The way in which the fruit is packed depends on its size. The fruit must be large enough to fill the basket and stand high enough to touch the lid when packed three-tier. This requires a fruit with one diameter of at least $1\frac{1}{2}$ inches, and to pack apricots of this size, it is necessary to stand them on end and place one directly over the other. Fruit of this size does not make a satisfactory pack, and a size large enough to work with the diamond pack is desirable; this bruises the fruit less.

The empty baskets are placed in the crate and packed with paper between each two layers of fruit. This paper is a continuous strip, first running across the bottom and then over each layer of fruit by being worked back and forth across the basket. With the third tier in place the end should be long enough to cover the face of the basket. The fruit is placed in any position to pack to the best advantage. When the four baskets are full, the face of the crate should have the appearance of that of a solid box of fruit. The fruit should be snugly packed in each tier, and the last tier must stand high enough to give a slight bulge to the cover. Both the bottom and the top of the crate are cleated to relieve the bulge of any pressure in stacking the crates.

Packing Cherries

Growers outside of Oregon and Washington are raising simply canning cherries. While the inter-mountain orchardmen are beginning to grow some of the fancy varieties, they are really not growing a fancy grade or shipping them in a fancy package.

At present the bulk of the cherry crop of most sections is sold in strawberry crates. Different styles of crates are used, the common crate holding twenty-four quart boxes, the square or oblong form being used more often than any other. Of the two, the square box is possibly a little easier packed and faced. Regardless of the box, the packing is the same. The first requirement is that each box shall contain a pound of fruit, and the twenty-four-basket crate should weigh about thirty pounds gross. The boxes should be faced with no stems showing, if the package is to make an attractive appearance, and most shipping associations require the grower to face the package in this way. The fruit should be well colored for the variety and of good size; it should also be sound and must not have stems loosened or pulled off.

Fancy cherries are largely shipped in ten-pound boxes. The inside dimension of this box is $18\frac{1}{2} \times 9 \times 2\frac{1}{4}$ inches. It is divided in the middle and gives two cells $9 \times 9 \times 2\frac{1}{4}$. The cherries are packed in layers, the face of the package showing no stems.

Figure 78 shows the different-sized packages that are used in shipping cherries. They hold thirty, ten, and eight pounds respectively, while the individual cartons shown at the top contain but one pound. When first

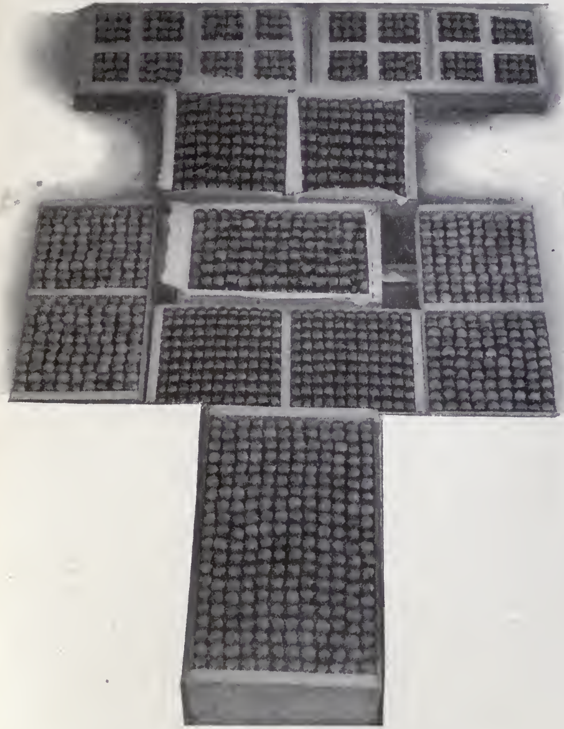


Fig. 78. — Cherry Packages. (Courtesy of "Better Fruit.")

opened, the larger packages present a very pleasing appearance, but as soon as the face of the package is disturbed, they are often far from pleasing. The pound cartons are not open to this objection, and for this reason are much more satisfactory to the retailer, as the last pound makes as good an appearance as a full crate.

Packing Peaches

The peach has probably been marketed in as great a variety of packages as any other fruit, from the bushel basket to the common grape basket and the four- and six-basket carriers. But the California peach box, in which all Colorado-grown peaches are now shipped, seems to come nearest perfection of any package ever used for shipping peaches long distances. It is a convenient shape for loading in cars, carries the fruit in excellent condition, and may be termed a fancy-sized package. It is a light pine box 18 inches in length and $11\frac{1}{2}$ inches in width, and is made in three depths, 4, $4\frac{1}{2}$, and 5 inches (all meas-

Fig. 79. — Peaches, 6–6 Straight Pack.

urements inside dimensions). The ends are of $\frac{11}{16}$-inch, and the tops, sides, and bottoms of $\frac{1}{4}$-inch material. As the box carries only two layers, the lower one is not bruised by the weight of the fruit above, and the contents cool quickly in the car or in storage. The box is made up in a way to provide ample ventilation.

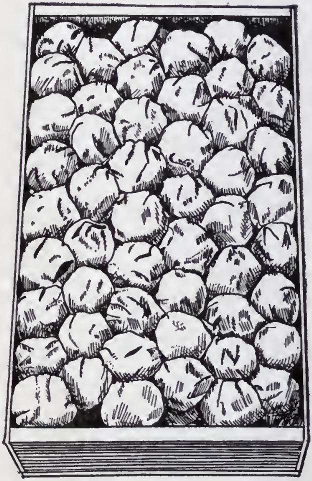


Fig. 80. — Peaches, 3–3 Pack.

Peaches are commonly packed in three grades, and although they may go by different names, they are practically uniform. The common terms used to designate these grades are "extra," "90's," and "108's"; or "extra fancy," "fancy," and "choice." While many of our Eastern friends persist in calling for "choice" fruit when they mean "fancy," the western grower has a dislike of the term "choice"; and some persons object to calling the "108's" "choice," when in the true sense of the word they are not. The first set of terms is to be preferred. A box of "extra" peaches should run less than 80 to the box, a box of "90's" from 81 to 94, and "108's" from 95 to 108.

These three grades are packed in the 4-, $4\frac{1}{2}$-, and 5-inch boxes respectively. Occasionally a smaller grade, known as "pies," is packed unwrapped and shipped to near-by markets, but as a rule it will not pay to ship such fruit. The years when the grower really gets profitable returns from 108's are the exception rather than the rule. Extras sometimes run as low as 40 to the box, but such fruit is too large to be widely popular; probably the most popular size is the extra running from 70 to 80 to the box.

Fig. 81. — Peaches, 4–5 Pack.

Most peaches are graded by hand, and there seems to be little promise of finding a more satisfactory system. The packers grade the fruit as they pack. They have the three boxes for the three marketable grades before them and a cull box at one side for the remainder. Experienced packers are able to grade by eye, and inexperienced packers are furnished gauges to go by until they learn. Peaches that grade extra must not run less than $2\frac{1}{2}$ inches in diameter, fancy from $2\frac{1}{4}$ to $2\frac{1}{2}$, and choice from 2 to $2\frac{1}{4}$.

So far only one fruit association (The Peach Growers' Association, Palisade, Colorado) has installed machinery for grading. This plant has been in operation only one season, and it cannot be said that it has been fully tested. The writers have watched the plant in operation, and while it gives an absolutely uniform grade of fruit, it seems that some fruit cannot escape being bruised. The fruit is first lifted to the grading belts from the floor level by an elevator, and is then lowered from the hoppers to the distributing belts through a canvas tube. The fruit of each grade is weighed automatically, and the grower is given credit by these weights. The managers of the business seem to be pleased with the system. If the associations insist on packing peaches at a central packing house, some such system of grading must be installed. Previous to the installing of the grader, this association graded with one of the common foot-power graders.

Peaches should be packed from well-padded or canvas-bottom packing tables, and should be handled as carefully as possible. The table should be so arranged that the packer has a place for three boxes and a stand for the wrapping paper. One end of the box is slightly raised, and each layer is packed from the lower end up. The packer generally stands with the right hand to the table, takes the fruit in the right hand, places it in the center of the paper in the left hand, crumples the paper about it, and then places it in the box. The paper is a rather heavy tissue, 7×7 or 7×8 inches. The experienced packer learns many little tricks in wrapping and packing. More is gained than one would think in having the paper in just the right place, and a rubber stall on the thumb of the left hand is a great help in picking up the paper.

There are many styles of packs. Men who are in a position to know seem to prefer the 3–3 or the 2–3 pack for all grades, and the time will come when these will be the only packs allowed. Any of the straight packs are objectionable, as one fruit lies directly on top of the one below. Figure 79 illustrates what is called a 6–6 straight pack. It is objectionable because it allows the packer to pack too small a grade of fruit. As the peaches of the top tier lie directly on top of those below, many bruises result. Figure 80 illustrates the 3–3 pack of 108's.

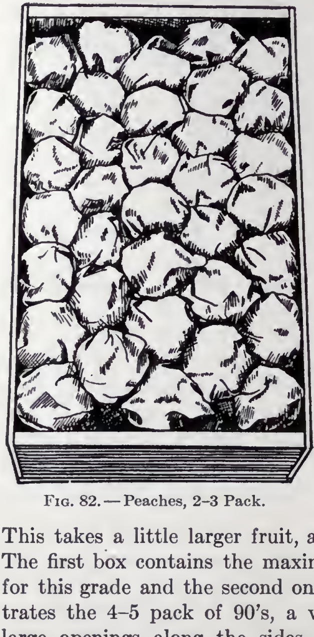


Fig. 82. — Peaches, 2–3 Pack.

This takes a little larger fruit, and it is more desirable. The first box contains the maximum number of peaches for this grade and the second only 102. Figure 81 illustrates the 4–5 pack of 90's, a very neat pack, but the large openings along the sides are objectionable. For the sake of uniformity it would have been better to have used the 3–3 pack; in fact, such a pack is not allowable. Figure 82 is the 2–3 diamond pack used for the extra grade. This box contains 70 peaches and may be considered an excellent grade. This style will accommodate peaches of any size, from 40 to 80 to the box. Associations should insist on a 3–3 pack for 108's and 90's and a 2–3 pack for extras, and many do so. These styles have proved to be the best, and uniformity in packing is a great aid in marketing.

In placing the fruit in the box it should be pressed together tightly enough to give a slight bulge to the sides of the box; and by working the larger fruit nearer the center it gives a slight bulge to the top and bottom. With the top on the box every fruit should be held firmly in position. Both the top and the bottom are cleated to save the fruit from any pressure after the boxes are stacked.

Overripe fruit is culled out by the packer and is either packed in boxes and marked "Ripe," for local shipment, thrown in the cull box, or put in boxes to be delivered to the canning factory.

Some growers are beginning to wrap a part of the fruit with wrappers printed in attractive colors with a design and the owner's name and address; others are wrapping in two colors of paper. It may be said that both add to the attractiveness of the package, and the first surely shows that the grower is not ashamed of his grade and pack.

Most of the packing is done by girls. A good worker will pack 200 to 250 boxes per day. The common price paid for packing peaches is two cents per box. The grower delivers the fruit to the table and furnishes a man to take away the packed boxes and cover them. The man who does this work is generally hired by the day; on large jobs, as at a central packing house, they are sometimes paid by the piece.

Packing Plums

All the larger plums and prunes are packed in the same way as apricots, in the four-basket crate. The fruit must be big enough to fill the basket and touch the cover of the crate when packed four-tier. It will be seen by the grading list of the Grand Junction Fruit-growers' Association that the packed crate must have a gross weight of twenty-eight pounds or more.

Small plums of the American type, Damson and the like, are shipped in $2\frac{1}{2}$-inch plum boxes. The box must be well filled and neatly faced. The inside dimensions of this box are $18 \times 11\frac{1}{2} \times 2\frac{1}{2}$ inches.

Packing Pears

Western pears are shipped in a box commonly known as the California pear box. This is made of light material, as spruce or pine; the ends of $\frac{3}{4}$-inch, and the tops, sides, and bottoms $\frac{1}{4}$-inch material. The inside dimensions of this box are $18 \times 11\frac{1}{2} \times 8\frac{1}{2}$. It is supposed to hold a bushel and should have a gross weight of at least fifty-three pounds when packed.

Pears are packed in two grades, "fancy" and "choice," and each grade in three sizes, four-tier, five-tier, and six-tier. "Fancy" pears must be free from worms or worm stings, abrasion marks, scale pits, and other defects, and must be smooth and of good shape. Excepting where characteristic of the variety, heavy russeting, which is sometimes the result of a light frost in the spring, is objectionable on fancy fruit; it detracts from the beauty of the fruit when it is ripened. The "choice" fruit must be reasonably free from worms, may include fruit with abrasion marks (limb rubs, etc.), russet, or a few scale pits, and fruit slightly "off" in shape. However, the term

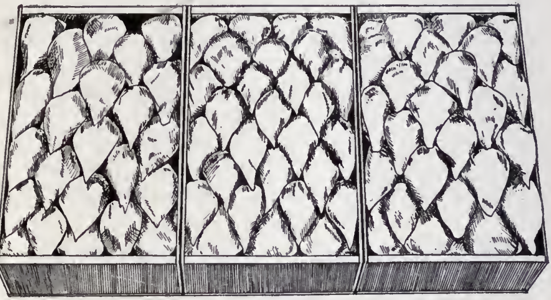


FIG. 83.—Pears: *a*, 2–3 Pack; *b*, 3–3 Pack; *c*, 3–4 Pack.

"choice" must not be misconstrued to mean everything that grows on pear trees.

The terms "four-tier," "five-tier," and "six-tier" refer to the number of layers of fruit required to fill the box. A six-tier pack contains fruit under $2\frac{1}{4}$ inches in diameter, and in one sense may be considered choice. Some varieties, however, seldom run larger than this. The five-tier pack seems to be the favorite as far as the markets are concerned; it should contain pears $2\frac{1}{4}$ to $2\frac{3}{4}$ inches in diameter. Larger pears make up the four-tier pack, which finds a rather brisk demand at good prices, but it is not so good a seller as the five-tier and seldom demands a better price. The neatest pack of pears put on the market is the five-tier pack, running 135 pears to the box, requiring fruit all running close to $2\frac{3}{4}$ inches in diameter.

For sake of uniformity the four-tier pear should be packed with the 2–3 pack as shown in Figure 83 *a*, and the five-tier and six-tier with the 3–3 pack, shown in Figure 83 *b*. The terms, "2–3," "3–3," "5–6," etc., refer to the number of fruits in adjacent rows, either across the box or from end to end. Packed in this way, the face and sides show very few openings. The buyer often opens the package on the side, and he gets a bad impression if he sees as many holes as pears. As a matter of fact, if the four-tier pears shown in Figure 83 *a* were packed the 3–3 pack, the box would contain more pears in spite of the large openings that would appear if the side of the box was removed. The smallest five-tier pack allowed, but one that is not encouraged, contains 180 pears, packed 3–3 across the box and 6–6 long; the next pack contains 165 pears, packed 5–6, long; the next 150 pears, the rows 5–5 long; and the largest, 135 pears, packed 4–5 long. Occasionally we find such a five-tier pack as that shown in Figure 84. This is packed five-tier, as is shown by a side view of the box in Figure 85, but there are too many pears

Fig. 84. — Pears, Five-tier Pack of Six-tier Grade.

in the rows; in other words, the fruit is too small for a five-tier pack, and this package would be marked down to six-tier by the inspector. Most of the pears in this box are $2\frac{1}{4}$ inches in diameter, but the pears of this variety are short, and the box contains 210 pears. This fruit could have been packed six-tier, 5–6 long, to good advantage. A 3–4 pack is sometimes allowed on a six-tier pear, but it gives the packer an opportunity to work in fruit that is really too small. From the 135 five-tier pack we drop to the four-tier packed 2–3 across the box and 5–6 long, the box containing 110 pears; then to 5–5 long with 100 pears; 4–5 with 90 pears; and the largest size, 4–4 long with 80 pears. Larger pears are generally packed some other style. Occasionally we see a 6–6 four-tier, the box containing 120 pears. While such a pack is often passed by the inspector, it is better to work such fruit into a good five-tier pack.

Fig. 85. — Side View of 84.

Possibly in a few cases it may be necessary to vary from the styles of packs here given, in order to make a neat-appearing package with odd-shaped fruit. The main point is to see that the face and side do not show large openings. If pears are carefully packed with either the 2–3 or the 3–3 pack, one has no trouble to secure the required weight. Growers often complain that the boxes will not hold fifty pounds of fruit without bursting the top or bottom, but if they will drop the 3–4 and the 4–4 packs, they will have no difficulty.

There is evidently a difference of opinion as to the meaning of the terms "four-tier," "five-tier," and so on, in different fruit-growing sections. As we understand the word "tier" as applied to a pear pack, it means a layer of fruit in the box, and so long as we take Webster's definition, we will probably have to hold to the idea that a four-tier pack of pears is one with four layers of fruit and a five-tier pack one with five layers of fruit. It is unfortunate that growers cannot agree on the use of such simple terms as these.

Possibly the only way our pear pack could be improved would be to grade the fruit a little more uniformly, that is, avoid mixing $2\frac{1}{4}$- and $2\frac{3}{4}$-inch pears in a miscellaneous five-tier pack. If pears are properly packed, there is no trouble determining how many pears the box contains, and surely the buyer would appreciate having the exact number stamped on the end of the box. The fruit vender would then know how many pears he is buying, how much he can afford to pay, and how he must sell them to make a profit. Oranges and lemons, and fancy apples from some sections, are now packed in this way, and there is no reason to suppose that it will not pay to pack and mark pears with the same care.

Pears are wrapped in the common grade of paper used for wrapping fruit, cut in sizes 8×9 and 9×10, the smaller size for the five- and six-tier fruit. Even after one has learned how, it requires practice to become a good pear packer. Different packers wrap in different ways. One of the simplest methods of wrapping, and also one of the neatest, is to hold the paper in the left hand, rough side up, lay the pear on the paper, then fold the lower left-hand corner over the neck of the pear with the left thumb, catch it with the first finger of the right hand, with the other fingers of this hand clasping the base of the pear give it a twist to the right, wrapping the paper about the neck in a neat cone-shape, and complete the process by gathering the loose corners of the paper in the right hand and folding them under the pear. Wrapped in this way, the pear will appear as shown in Figure 86. Others wrap more quickly possibly by placing the pear diagonally across the paper near the center, gathering the corners together about the base, and with a twist to the right, wrap the other loose corners about the neck. This makes a very neat wrap when one learns how to make it. Short stubby pears are difficult to wrap, but one can generally find some neat way. Be sure to have paper large enough. Packers always wrap with the rough side of the paper to the pear.

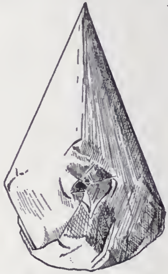


Fig. 86. — Wrapping Pears First, place Pear in One Corner of Paper; a Twist to the Right and a Cone-shaped Package results.

In packing the box is placed in front of the packer with the farther end slightly raised. The first pear is placed in one of the lower corners of the box, and the other two pears in this first row are placed according to the pack. If it is to be a four-tier, one is placed in each corner and one in the center; if a five-tier, the other two are evenly spaced between the first pear and the opposite edge of the box, leaving as much space between the last pear and the side of the box as between pears. With the first row of the tier in place with the butts to the lower end of the box, the position of all other pears in the tier is reversed, the stem toward the packer or the lower end of the box. In the four-tier pack the second row will contain only two pears, and they will be placed one on either side of the center pear of the first row. The third row contains three, the fourth two, and so on until the opposite end of the box is reached. Here the last rows butt against the other end of the box. Starting again at the lower end of the box, two pears are placed in the first row of the second tier, one on either side of the center pear of the first row of the first tier, and the tier is completed as the first. The third and fourth tier start with three and two pears respectively. In this way the pears of each succeeding layer fit down between the pears in the tier below. In the five-tier pack the only difference is that each row across the box contains three pears, the adjacent rows of each tier starting on opposite sides of the box, and the first row of succeeding tiers start on opposite sides of the box. To make the latter point plain, suppose the first pear of the first tier is in the lower left-hand corner, then the first pear of the second tier will be in the right-hand corner. The larger pears are worked toward the center of the box to give it the desired bulge, or if they run quite uniform in size, the same result may be accomplished by crowding the pears a little closer together in the center. While we still find some five-tier pears packed 3–4, this pack should be avoided whenever possible. Six-tier pears are sometimes packed 3–4, and it is not objectionable if the total number of pears does not run too high.

Seckel pears are usually shipped, without wrapping, in five-inch peach boxes lined with the heavy paper commonly used in lining apple boxes. Small fruit of other varieties is sometimes shipped in this way and labeled "pickling pears." The time may not be far distant when our fanciest fruit will be shipped in one of the peach boxes or in half-bushel boxes. Some of our early Bartletts are now shipped in this way.

Pears are generally packed by the piece, five cents per box being the common wage paid. Most of the packing is done by girls, who pack from fifty to seventy-five boxes per day. Men who are expert at the business have packed one hundred boxes in an eight-hour day; some possibly do better.

GRADING-LIST OF THE GRAND JUNCTION FRUIT-GROWERS' ASSOCIATION, GRAND JUNCTION, COLORADO

Peaches

Boxes containing 80 peaches or less	extra
Boxes containing 81 peaches to 94	90's
Boxes containing 95 peaches to 108	108's

All grades must be free from worms, all other defects and a tight pack.

Apples

Fancy. — Winesap, Grimes Golden, Missouri Pippin, Red Romanite, Geniton, and kindred varieties must be two and one-fourth (2¼) inches in diameter and up. Boxes of Missouri Pippins and Winesap must not contain to exceed 15 per cent of 2¼-inch apples. Eighty-five per cent must be larger. Jonathans, Arkansas Black, Ben Davis, Gano, Willow Twig, Shackelford, Pearmain, Mammoth Black Twig, Rome Beauty, White Winter Pippin, Mann, Tallman Sweet, Dominie, McIntosh, Wealthy, Steele's Red, Lawver, Baldwin, Huntsman, Spy, Minkler, Stark, Smith Cider, Walbridge, Pewaukee, Imperial, etc., two and one-half inches (2½) in diameter and up. Absolutely free from worms and other defects. Bright and normal color. Shapely in form.

Choice. — Should not be less than two and one-fourth (2¼) inches in diameter, and reasonably free from worms. In other words, only stock a little below fancy. Throw away your trash, it won't pay freight. We also advise using the diamond pack.

Summer apples. — Pack only one grade of summer apples, "Orchard Run," but in making this pack keep out all very small and wormy apples. Do not put grade mark on the box, only your number and variety.

Pears

Fancy. — Must be free from worms, smooth and of good shape, gross weight fifty-three pounds or more. The number of tiers must be stamped on the box. Four tiers should measure from two and three-fourths (2¾) inches up. Five tiers should measure from two and one-fourth (2¼) to two and three-fourths (2¾). Six tiers should measure from two and one-fourth (2¼) down, but not so small but what they will make a good heavy six-tier pack.

A five-tier pear is 3–3 pack and not over 6 long, which would make not over 180 pears. Some growers pack 3–3 pack, but 7 long, which makes 210 pears. This pack will be marked and considered six-tier.

Choice. — This grade should consist of pears which are slightly scarred, otherwise defective and reasonably free from worms, not culls. In fact, stock that is only a little below the fancy grade.

Plums — Prunes

The large fancy Hungarian, Italian, Botan, Green Gage, Egg, etc., are put in four-basket crates, well filled, gross weight twenty-eight pounds or more. Small varieties, Wild Goose, Mariana, Damson, and the smaller plums of all varieties in two and one half (2½) inch boxes, well filled, gross weight eighteen pounds or more.

Grapes

Concords in eight pound climax baskets and should be well filled. Muscat, Rose Peru, Tokay, Purple Damascus, Black Hamburg, in four-basket crates, same as California, and must weigh twenty-eight pounds or more gross. See rule for packing grapes.

Cantaloupes

Standard crates must be packed three rows each side and five melons lengthwise, which will make 45 melons to the crate.

Pony, same as standard, except six melons long which will make 54 melons to the crate. Cantaloupes must be carefully picked at least once a day.

PUT YOUR NUMBER, VARIETY, AND GRADE ON THE UPPER LEFT-HAND CORNER OF THE BLANK END OF THE BOX.

Any one who does not know when to pick fruit or how to pack it, should consult with our inspectors or their neighbors.

TO DEALERS: In ordering peaches by wire or letter, the different grades will be known as extra, fancy, and choice. We guarantee our pack to grade as above, and in case they do not, please advise us, giving stencil number.

CHAPTER XVIII

MARKETING FRUIT

MOST people will no doubt be surprised to learn that the first successful coöperative fruit-growers' marketing association in the West was established in Colorado. The California Fruit-growers' Exchange has eclipsed all other similar organizations because of the immense volume of business transacted, but the first real attempt at organization in that state was in 1893[1] and the present organization was perfected in 1905. The Grand Junction Fruit-growers' Association of Grand Junction, Colorado, had its beginning in 1891, when a few growers agreed to ship their crops together and appointed one of their number manager of the association for the season. This arrangement continued with varying success up to 1897, when it became apparent that the increased business, if no other cause, would necessitate employing a manager by the year, who would devote his entire time to the association. Accordingly this was done, and the output has increased gradually, until now a million dollars' worth of business is done a year.

The association idea has become thoroughly established throughout the entire West, and at the present time there are very few communities where much fruit is shipped

[1] Bailey, "Cyclopedia of Agriculture."

that do not support thriving associations. That three-fourths of all the fruit grown in the western states is marketed through associations would be a conservative estimate; perhaps four-fifths would be more nearly correct. Unfortunately, however, not all of these institutions are worthy of the name.

The number of fruit and produce associations in the various states may be summarized as follows: Colorado 32, Idaho 4, Montana 1, New Mexico 3, Oregon 12, Washington 18.

Advantages of Association

It is well known that farmers are slow to organize and that many of their attempts have met with failure. It will be instructive, therefore, to inquire into the reason for successful coöperation in the West, as well as to discuss the advantages to the grower.

Before the days of associations there was a time when all of the fruit was consumed by the home markets. Those were days of high prices and of prosperity. Increased production rapidly followed, and this necessitated that an outlet be found in the markets of the world. High freight rates, distance from markets, lack of business experience, lack of reputation, want of experience in packing, and eastern competition, were difficult problems to face and overcome. Only the few fruit-growers with exceptional business ability, who could produce or command car-load lots, could hope to succeed, and for the small grower there was little chance of success. Car-load lots must be the unit of shipments; and express shipments, even to-day, are out of question except to near-by points. All growers were alike at the mercy of commission men and traveling buyers. Under such conditions there could be no such thing as uniformity in grades, in packing, or in prices. Each grower was a law unto himself, and competition among neighbors was the rule. Such conditions are bad enough even in the vicinity of the large cities of the East, but when separated from the markets by hundreds of miles, they soon become intolerable.

The growing of fruit is a complex and exacting business in itself, particularly under irrigation, and it is all that the average grower should attempt. If he makes a success of orcharding, his time will usually be fully occupied. The association manager has many advantages in marketing over the grower, some of which may be mentioned.

The manager must have daily telegraphic reports on the condition of the markets. He often has a personal acquaintance with the buyers, and he finds it to his advantage to make occasional trips for the purpose, even to distant states. He may also have a system of diverting cars after they have been sent out of the state, and thus avoid a glutted market, or may send his fruit where it will sell to better advantage. The icing of cars can also be looked after properly. Associations are often the means of securing lower freight rates, because the hauling of several hundred cars is an item worth competing for. Such rates are, of course, open to all shippers. Buyers often want a number of car-loads of a certain variety and are willing to pay a premium if their wants can be supplied, and not infrequently such sales are the means of disposing of large quantities of the inferior varieties or grades. An individual is seldom in position to take advantage of such opportunities. Associations are successful in maintaining a uniform pack, and by this means they establish a reputation for their goods. Usually the best grades of fruit are sold as a certain brand. The brand, which should be copyrighted, is sufficient guarantee for the quality, or, at least, it must be if the association expects to gain and hold a reputation.

Supplies of various kinds, used on fruit-farms, may be bought at wholesale, often in car-load lots, which is an advantage, particularly on such items as spray and box materials. The prices to growers are only slightly in excess of actual cost. It is also advantageous to keep a certain amount of the better class of help from year to year and to furnish them with employment, so that a more or less extensive jobbing business may be conducted; not only is a large quantity of fruit-growers' supplies handled, but a wholesale business in other lines may be done, depending on the demands of the locality.

Finally, an association can be handled more economically than it is possible for most individuals to market their own fruit, unless they depend entirely on the traveling buyer, or resort to the doubtful expedient of consigning to commission men.

Given a capable manager and a wise board of directors, there can be small chance of failure under our conditions. But men who are capable of handling 500 to 1500 cars of fruit at a good profit are not common, and when one is found, every effort should be made to retain him.

When a capable manager is found, he should have a salary in proportion to the amount of business and the responsibility that must be carried. The latter item is certainly important when we consider that he may be responsible for a number of car-loads of a very perishable product, all on the road at once. Much supervision on the part of the board of directors, who usually have small knowledge of the business, only hampers the manager and restricts his personality. If he cannot make a success of the association in his own way, the advice or help of the directors will be of little value. A much better plan is to give the manager a fair chance to work out his own ideas, and then if he fails, try another. But here is the cause of most of the failures: too much supervision by the directors and unjust criticism and fault-finding on the part of the stockholders.

A common source of discontent is the rumor that a neighbor in another association has received a higher price for his produce, or that an outside buyer is offering attractive prices. Unscrupulous firms frequently adopt the latter method of getting consignments, only to swindle the grower. If there was not some decided advantage in buying direct from the growers, these firms would not go to the expense of maintaining an agent in the field when just as good or better fruit could be had from the association.

The association idea is no longer an experiment, and when each one does his share to maintain the reputation of the fruit, and the volume of business is sufficient to pay expenses, there is small chance of failure. The history of associations, the country over, shows that petty jealousies and distrust on the part of the members is a common cause of failure.

Growers who are not members may ship through the association on the same terms, but they are usually required to pay more for supplies. All of the larger concerns require both members and non-members, for whom they ship, to bring all their fruit to the association. Formerly stockholders were allowed to sell their own fruit by paying the association a small premium. Neither were objections made to members filling orders from near-by towns. But, as these means of disposing of fruit are manifestly unfair to a majority of the association members, they have come to be looked on with disfavor and in most instances are no longer allowed.

One of the strong points in the association idea is the possibility of securing a fairly uniform pack. This results in better prices, since buyers have the assurance that all associations strive to make their goods as nearly uniform as possible. Contrary to the idea often advanced that poor fruit brings as great a price as good, the most rigid grading must be practiced, and the intention is to place each fruit in its proper grade; thus the best grade commands the price that it deserves, and the grower of inferior fruit is fortunate to dispose of his crop at all.

Hood River Methods

A system of association packing has been worked out in the Northwest, notably at Hood River, Oregon, that is giving good satisfaction under their conditions. The association does all the packing, but sends crews of trained packers to the various orchards to do the work. An inspector is assigned to each crew of four packers, and as a further assurance that honest packing shall be done, horse-back inspectors are employed. These men drop in on the various crews unawares, and thus serve as a further check upon careless work. The management has gone on the idea that the very best fruit put up in the best way will sell itself (Fig. 97); and this has proved to be true. They even go so far as to hold a packing school where men and women are trained in the art.

All fancy apples are wrapped, and paper is placed between each two layers in the box. They find that apples packed on their sides are more satisfactory than when placed with stems up, as is commonly done. Perhaps no other apple-growing section is so well advertised, and no section receives a higher average price for fruit.

As early in the fall as estimates can be made, printed lists are made of the number of boxes and grades of the various varieties. These lists are sent to dealers in all parts of the United States and in Europe, and bids are invited. The fruit is struck off to the highest bidders, and if any remains unsold, lists are again sent out. Thus all of the fruit is sold f.o.b. Inasmuch as it sells itself, the manager's time is devoted largely to seeing that the fruit is properly picked and packed.

Whether this method of packing will work on a much larger scale remains to be determined. But the attention to the details of picking, grading, and packing may surely be studied with profit by all. The idea of building up and holding a reputation to the point where fruit sells itself is certainly a good one.

The Hood River Berry Association has found that by the same careful attention to details it can ship strawberries to Chicago at good profit.

The charge is often made that while these prominent associations in Washington and Oregon are successful in putting out an extremely fancy pack, this is true only of a comparatively small number of cars. These cars of fancy fruit are supposed to be used as advertising to promote land sales, and though sold at high prices, the growers actually lose money on such fruit. This, it is argued, must be true, as such strict grading results in many culls that can be marketed only at low prices. It is also said that the markets are flooded with the inferior grades, resulting in demoralized prices for all. The writers have investigated these charges and fail to find any evidence to sustain them, so far as the prominent associations are concerned. Statistics of fruit shipments from such associations as Hood River, Yakima, and Wenatchee do not indicate that these localities have been responsible for flooding markets with fruit either good or bad. It must be remembered that these regions are comparatively new, and that while a large acreage of orchard has been planted, the shipments are, as yet, comparatively small. It is safe to say that as soon as well-regulated fruit-growers' associations market the bulk of the crop, we will hear less about glutted markets and demoralizing effects of inferior grades of fruit.

Methods and Results in Association Work

There are several systems used by associations to insure the proper packing and grading of fruit. (1) With the older system the association does all the packing, usually at their packing houses, the growers delivering the fruit just as it is taken from the trees. Here the packers, under the direction of a superintendent, sort the fruit into grades, and at the same time pack it into boxes or crates. Should there be any culls, they are returned to the grower and are at his disposal. Each grower is given a number, which is used to designate his fruit throughout the season. As each box is packed, it is marked with his number and the grade. When the boxes are loaded into the cars, the number of boxes, the varieties, and the various grades that belong to any grower are kept account of and duly recorded. In this way the price for each box in any car is easily determined.

(2) But when there is a large quantity of fruit to be shipped, it is impossible to pack at central points. This difficulty is commonly met by allowing the growers to assume the work. With this arrangement the association employs an inspector, whose duty it is to inspect each load as it is delivered. This he does by opening the boxes on the side, in the case of apples, when a good estimate of the contents may be made. If the pack is satisfactory, not more than two boxes may be opened. If unsatisfactory, several may be examined, and if all run under the inspector's standard, the entire load must either be placed in a lower grade or be repacked. It will be seen that a great deal depends on the inspector, and that it is a difficult position to fill. On him rests the reputation of the association, so that he must be entirely free to do the work as he sees fit. Each man's fruit is kept track of by numbers, as in the former case.

All associations charge commission on all sales, usually 5 per cent, to defray expenses. In case the packing is performed by the association, an additional charge is made to cover the cost of the box and packing. Any surplus is, of course, distributed as premiums or used in building up the association. Any fruit-grower may become a member of the association so long as there is stock for sale, and the owner of one share is entitled to all of its privileges. The number of shares one individual may own is limited.

The growers are generally asked and, in many instances, required to furnish an estimate of their crop. In the smaller associations the manager sometimes secures this information by visiting the orchards in person. This estimate is made early in the fall, or not until damage by worms and other causes is practically over, and the crop is secure. With this knowledge in hand the manager can enter into contracts for delivering certain amounts of various varieties or grades.

The system of selling has been radically changed within the past few years. Formerly, practically all the fruit was consigned to commission men, who, as a class, are inclined to do the best they can by their constituents. But too often the experience has been unsatisfactory. Not infrequently has it happened that shipments consigned to a distant city have been reported as not being up to grade, or not in good condition, so that the market price could not be realized. In such cases although the manager may be certain that his fruit is as he represented, he is often unable to help himself, and must take what he can get. But of late years the plan of selling f.o.b. is being practiced more extensively, largely due to the organized efforts of the associations. Consignments are made only to well-known firms, and much of the fruit is sold at auction. The auction method is coming more and more into favor.

But even with these arrangements difficulties arise, so that in order to protect themselves, the larger associations have agents at the more important distributing points. It is the duty of these agents or brokers to inspect all cars that come into their territory, as near the destination as possible, and thus protect the association from dishonest buyers. The agent also is on hand to adjust differences that arise when the fruit actually reaches the buyer in poor condition.

Express shipments are made only to comparatively near-by points, and with such shipments the growers receive exactly what the fruit brings less the expressage and the association's commission. It is usually the early fruits that are expressed, but prohibitive rates prevent any very large amount of business being done in this way.

A well-managed association is always a benefit to the entire community, because it builds up reputation for fruit, and sustains prices, inasmuch as there is little tendency, even among non-members, to bid one against another in marketing. The greatest good that an association can do is not to protect the grower from the buyer, but to insist on improved methods of all phases of orcharding so that a perfect product may be secured. There is never any difficulty in selling fruit of the best quality; and this fruit can be produced only by the combined efforts of the growers, such as the modern association affords.

When fruit of poor quality is abundant, as it usually is, indifferent packing and haphazard consignments are clearly the principal causes of low prices. It is idle to assume that prominent associations are responsible for these conditions. They could not do business in this way and continue to give satisfaction to the growers.

John Moore, manager of the Grand Junction Fruit-growers' Association, in an address before the Utah Horticultural Society, sums up the causes of the difficulty in marketing the crop of 1908 in the following direct and, as we think, conclusive way. His ideas will apply to the general subject of marketing as well: —

"Never before in my twelve years' experience in the fruit business, have I been so impressed with the necessity of proper marketing and distributing methods for the protection of the man who grows the fruit. This protection would also include the jobber. We are in an age of revolution and evolution, and the unorganized and unsystematized mode of doing business of the past must give way to more modern methods.

"I am fully convinced that the numerous partially organized and unsystematized institutions which are attempting to assist the grower by agreeing to load their fruit and ship it somewhere are a great detriment to the business and the growers. Last season, in my efforts to secure reasonable prices, I was confronted on every hand by the statement from jobbers with whom I was attempting to deal, that they were being well supplied with fruit on a consignment basis, and as long as consignments could be secured they would not buy. We sold on either a f.o.b. or delivered basis, eliminating entirely consignments. Now, with a proper distribution of the fruits, there is no reason why each and every car cannot be sold at the market price, or put on the auction where it will receive a square deal and the grower paid all that his fruit is worth. Could the distribution be properly controlled and consignments eliminated, glutted markets would be rare. There are always, in nearly every market, dealers who will encourage consignments to their markets, when if they had to put up the money for the fruit, they would be very careful that an oversupply did not obtain. This condition can be controlled by the growers, and if every fruit-growing locality would create and properly conduct an association on a square and modern basis, I fully believe that returns could be very materially increased.

"This would require an outlay of some expense to the growers, but at the same time would really be an investment. If you knew that by purchasing a certain kind of machine for twenty-five dollars you could, by proper handling, decrease your orchard expenses one hundred dollars a year, would you hesitate to make the purchase? Well, as an association is a machine, each grower a part of that machine, and if kept in good running condition and handled by a man who knows how, it will produce results; therefore I claim that improper marketing was one of the greatest factors affecting the price of fruit in 1908.

"During the past year the larger fruit-producing sections were confronted with the proposition of marketing the largest crop ever produced. Georgia, that immense producer of peaches, was compelled to handle, with her crude and unsystematized methods, the largest crop in her history, with the result that out of the five thousand carloads, about two thousand were shipped to one market, and the results to the growers on account of poor distribution were disastrous. California produced nearly twice as many cars of fruit as were shipped in 1907, and many other fruit districts were ill prepared to properly handle the quantity produced.

"The deciduous fruit season which has just closed will go down in history as the heaviest ever known, yet it is my opinion that the quantity was not the prime cause of low prices, as I believe under normal conditions and proper distribution, with careful attention to high quality, an equal production could be placed in the hands of consumers at reasonably good prices and profit to the growers.

"With increased production more care must be given to the quality and packing. Every car of inferior fruit carelessly packed and placed on the market will tend to decrease the value of the fancy stock, and to such an extent that growers who are anxious to get something out of inferior fruit will be the losers considerably more than the profits realized from such sales."

District Organizations

Now that local associations have become established institutions, there yet remains to be organized a combination of associations, as has been accomplished by the California citrus fruit-growers. State associations would perhaps not meet the wants of the inter-mountain region so well as district organizations, since the fruit-growing localities are widely separated and their conditions are diverse. It is true that the managers now work together to some extent, but they all agree that a much closer union would be desirable.

Not only would our fruit become better known and better prices result by such union, but economy in many lines would be effected. If one man could have supervision of the sales of all associations, in a given section, the last trace of local competition would be eliminated. The railroads, as well as the large dealers, could be dealt with to much better advantage by one man representing a group of associations than by a number of men representing the divided interests of several. In the buying of supplies one man could not only do the work economically, but he would be able to secure much better rates. The same line of argument would hold for all phases of association management.

The time is not yet ripe, perhaps, for such an organization, but it is fast approaching. It is safe to say that the complete control of the market situation, to which the fruit-growers of the western states are entitled, will be realized only when such a combination is effected.

How to form an Association

The method of forming an association is simple. The success of an association depends more on the manager than on all else, and no pains should be spared to secure the right man. The mere fact that a man has been successful in selling shoes or some other staple commodity is not necessarily an indication that he would be equally successful in association management. Now that this method of selling fruit has become firmly established, there should be no difficulty in securing men who have had considerable experience. Above all the manager should be allowed to conduct the affairs of the association in his own way, for if he knows anything at all about such business, he will usually have the advantage of the majority of directors. The following constitution and by-laws may be used as a guide, and they will be found to contain all that is essential.

BY-LAWS OF THE GRAND JUNCTION FRUIT-GROWERS' ASSOCIATION

I

The name of the said Association shall be the Grand Junction Fruit-growers' Association.

II

The objects for which the said Association is created are to buy and sell fruit, vegetables, hogs, meat stock, and all the products of Mesa County, both fresh and manufactured; to erect, operate, and maintain canning and packing factories and commission houses; to manufacture any and all products of Mesa County; to lease, mortgage, and sell said business, and to borrow money for carrying on the same, and to pledge their property and franchise for such purpose. To acquire by purchase, or otherwise, and own real estate, buildings, machinery, and all the necessary power and power plants for carrying on said premises, and to lease, mortgage, and sell the same.

III

The term of existence of said Association shall be twenty years.

IV

The capital stock of the said Association shall be twenty-five thousand dollars, divided into five thousand shares of five dollars each.

V

The number of Directors of said Association shall be seven, and the names of those who shall manage the affairs of the Association for the first year of its existence are C. W. Steele, A. A. Miller, J. W. Rose, R. W. Shropshire, J. H. Smith, P. A. Rice, and A. B. Hoyt.

VI

The principal office of said Association shall be kept at Grand Junction in the said county, and the principal business of said Association shall be carried on in said county of Mesa.

VII

The stock of said Association shall be non-assessable.

VIII

The Directors shall have power to make such prudential By-Laws as they may deem proper for the management of the affairs of the Association not inconsistent with the laws of this State, for the purpose of carrying on all kinds of business within the objects and purposes of the Association.

BY-LAWS

Article I

Section 1. The Board of Directors provided for in the articles of incorporation of this Association shall be elected annually at the regular annual meeting of the stockholders, as hereinafter provided, and shall hold their office until their successors are elected and qualified.

Section 2. Said Directors shall be stockholders in said Association and shall be fruit-growers in Grand Valley and shall be residents of Mesa county, Colorado.

Section 3. Any vacancy occurring in the Board of Directors shall be filled by the remaining members of the Board.

Article II

Section 1. The Board of Directors shall, as soon as may be, after their election, elect a President and Vice-President from among their number, who shall hold their offices for one year, and at said meeting the said Board shall appoint a Secretary, Treasurer, and Manager, who shall be subject to removal at any time.

Section 2. The Secretary, Treasurer, and Manager shall each, when required by the Board, give bond in such sum and with such security as the Directors may require, conditioned on the faithful performance of their duties, and to turn over to their successors in office all books, papers, vouchers, money, funds, and property of whatsoever kind or nature belonging to the Association, upon the expiration of their respective terms of office, or upon their being removed therefrom, or with such other conditions as may be proper.

SECTION 3. The President shall preside at all meetings of the Directors or Stockholders. He shall sign as President all certificates of stock, and all other contracts and other instruments in writing, which may have been ordered by the Board of Directors.

SECTION 4. The Vice-President shall, in the absence of or disability of the President, perform his duties.

SECTION 5. The Manager shall have full charge of the commercial and shipping department of the Association. He shall receive all money arising from the sale of fruit and other commodities handled by the Association, and pay the same to the parties entitled thereto, and render a true account thereof; and he shall also be the Treasurer of this Association and safely keep all money belonging to the Association, and disburse the same under the direction of the Board of Directors, except as herein above set forth.

SECTION 6. The Secretary shall keep a record of the proceedings of the Board of Directors and also of the meetings of the Stockholders. He shall also keep a book of blank certificates of stock, fill up and countersign all certificates issued, and make the corresponding entries upon the marginal stub of each certificate issued. He shall keep a stock ledger in due form, showing the number of shares issued to and transferred by any stockholder and date of issuance and transfer. He shall have charge of the corporate seal and affix the same to all instruments requiring a seal. He shall keep in the manner prescribed by the Board of Directors all accounts of the Association with its stockholders, in books provided for such purpose. He shall discharge such other duties as pertain to his office, and as may be prescribed by the Board of Directors.

SECTION 7. These By-Laws may be amended by the Board of Directors at any special meeting thereof called for that purpose, a notice of such proposed amendment being given in the call for such special meeting.

Article III

Section 1. The regular meetings of the Board of Directors shall be held at the office of the Company, on the first (1st) day of each month, except when the first day comes on Sunday or legal holiday, then on the following day.

Special meetings of the Board of Directors may be called by the President when he may deem it expedient or necessary, or by the Secretary, upon the request of any three members of said Board.

Section 2. A majority of the Board of Directors shall constitute a quorum for the transaction of business, but a less number may adjourn from day to day upon giving notice to absent members of the said Board of such adjournment.

Section 3. The Board of Directors shall have power: —

First. To call special meetings of the stockholders whenever they deem it necessary, by publishing a notice of such meeting once a week for two weeks next preceding such meeting in some newspaper published in Grand Junction, Colorado.

Second. To appoint and remove at pleasure all employees and agents of the Association, prescribe their duties, where the same have not been prescribed by the By-Laws of the Association, fix their compensation, and when they deem it necessary, to require security for the faithful performance of their respective duties.

Third. To make such rules and regulations not inconsistent with the laws of the State of Colorado, and Articles of Incorporation, or the By-Laws of the Association, for the guidance of the officers and the management of the affairs of the Association.

Fourth. To incur such indebtedness as they may deem necessary for carrying out the objects and purposes of the Association and to authorize the President and Secretary to make the note of the Association, with which to raise money to pay such indebtedness.

Section 4. It shall be the duty of the Board of Directors: —

First. To be caused to be kept a complete record of all their meetings and acts, and also the proceedings of the stockholders, present full statements at the regular annual meetings of the stockholders, showing in detail the assets and liabilities of the Association, and the condition of its affairs in general.

Second. To supervise all acts of the officers and employees, require the Secretary, Treasurer, and Manager to keep full and accurate books of account of their respective business.

Article IV

Section 1. At the regular meeting in the month of January of each year the Directors shall declare such dividends upon the capital stock, to all the stockholders then appearing on record, as may be warranted by the net earnings of the Association for the preceding year.

Article V

Section 1. The Board of Directors may, whenever they shall deem it necessary, place on sale so much of the capital stock of the Association as may be necessary to raise funds for the purpose of carrying out the objects and purposes of the organization of the Association, such stock to be sold only upon the following conditions: —

First. That not more than three hundred (300) shares thereof be sold to any one person, firm, or association of persons.

Second. That such stock be sold only to fruit-growers in Grand Valley.

Third. That such stock be sold at not less than par value of Five Dollars ($5) per share.

Article VI

Section 1. The Annual meeting of the stockholders for the election of Directors shall be held on the third (3d) Saturday in January of each year, but if, for any reason, it should not be held on such day, it may then be held on any day subsequent thereto, as hereinafter provided.

Section 2. The Board of Directors shall be elected by the stockholders at the regular Annual meeting. Public notice of the time and place of holding such annual meeting and election shall be published not less than ten (10) days previous thereto, in some newspaper of general circulation printed in Grand Junction and the said election shall be made by such of the stockholders as shall attend for that purpose, either in person or by proxy, provided a majority of the outstanding stock is represented. If a majority of the outstanding stock shall not be represented, such meeting may be adjourned by the stockholders present for a period not exceeding sixty (60) days. All elections shall be by ballot, and each stockholder shall be entitled to as many votes as he or she owns shares of stock in said Association; provided, however, that no person who is not himself a stockholder shall be allowed to represent by proxy any stockholder in the said Association.

The persons receiving the greatest number of votes shall be the Directors for the ensuing year, and until their successors are elected and qualified.

Article VII

Section 1. Certificates of stock may be transferred at any time by the holders thereof, or by attorney in fact or legal representatives. Such transfer shall be made by indorsement on the certificate of stock and surrender of the same; provided, such transfer shall not be valid until the same shall have been noted in the proper form on the books of the Association. The surrendered certificates shall be canceled before a new certificate in lieu thereof shall be issued, and no transfer of any share of stock shall be valid or allowed upon the books of the Association upon which any deferred payments are due and unpaid, or which has not been sold and transferred in accordance with the provisions of the By-Laws of the Association.

Section 2. Any stockholder desiring to dispose of his stock in said Association shall deposit the same with the Secretary of the Association, and the same shall be sold by the said Secretary at not less than par for account of such stockholder, within sixty (60) days from date of such deposit, under the restriction of Section 1, Article V, of these By-Laws: provided, that if the Secretary shall not have sold such stock at the expiration of sixty days, then such stock may be returned to such stockholder, and be disposed of by him, without restriction or limitation by the Association.

Article VIII

Section 1. All members of this Association are required to market all their fruit through the Association and bear their proportionate share of the expenses of handling the same.

Section 2. Any member may have the privilege of selling his own fruit at the orchard, but no sales of fruit shall be made to a dealer in fruit, or to any person who buys to ship outside the county. In case of the sale of the entire crop of any particular fruit or fruits, by reporting the same to the Association, one-half ($\frac{1}{2}$) only of the regular commission will be charged.

Section 3. Any member having any grievance or cause of complaint as to treatment of his fruit by the Association can appeal to the Board of Directors, whose decision shall be final.

Section 4. All members must pack their fruit for shipping in a neat and workman-like manner, and pack the same in standard-sized packages, as adopted and in general use by the Association, having placed thereon their name or number.

Article IX

Section 1. A purchaser of stock in this, the Grand Junction Fruit-growers' Association, shall hereafter receive of the profits of the Association, in proportion to the money he has invested.

CHAPTER XIX

FROST INJURIES, SECONDARY BLOOM, AND FROST PROTECTION

THE value of knowing what can be expected of frosted bloom, or fruit just set, and second-crop bloom is realized only when one grasps the significance of the early spraying in a successful fight against the codlin-moth. Many times a crop of fruit that would have brought the owner profitable returns, if cared for, has been lost because the grower at first thought it would not be worth spraying. Omit the first spraying in an orchard bearing a partial crop, and it practically means the loss of the crop no matter how thorough the later applications of poison may be. The seasons of 1907 and 1908 in the inter-mountain West afforded excellent opportunities for the observing fruit-grower to educate himself on these points, but perhaps the opportunity has passed some persons unnoticed.

From the observations of these two seasons we may say that it is almost impossible to state at just what temperature injury takes place, for other factors besides temperature have a part in determining the extent of injury. While much time was given to the collection of data, as to minimum temperatures and amount of damage at particular times and in particular localities, the assembled information leads to no conclusions. Few fruit-growers have standard thermometers, and reports can hardly be comparable; the temperature varies in surprisingly small areas and fluctuates rapidly, and minimum readings often mean little so far as portraying true conditions is concerned.

In a general way, it may be said that little injury to fruit or blossoms occurs before the temperature falls below 28° and remains there for some length of time. Peach buds far enough advanced to show the pink in the tips have safely passed through nights when the mercury fell to 21°, and in other cases a higher temperature has injured apples in the same stage. It is probable that in the latter case the freeze was of longer duration. Peaches fertilized and large enough to fill the "husk," which surrounds them while young, have escaped uninjured, while the open bloom on apple trees not ten feet away was killed outright. One cannot read the thermometer and tell with assurance whether the crop is lost or not, but within twenty-four hours after the freeze one who knows how may easily estimate the extent of the injury.

The Kinds of Frost Injuries

Frost Russet. — The light frost often leaves marks that the fruit carries to maturity, an injury spoken of as "frost russet." On the mature fruit these marks of early injury take various fantastic forms. Often it appears as a band about the center of the fruit, as shown in Figure 87, or it may appear as a russet area at either the calyx or stem end. The position seems to differ with varieties. That shown in the figure is Chenango (Strawberry) apple. Unless severe, the markings do not necessarily injure the fruit, but marked fruit can hardly be graded strictly fancy. When the injury is confined to a light mark in the calyx end, the fruit is often allowed to go into the fancy pack. Evaporation seems to take place rapidly through this cork, russeted surface, and fruit like that shown in the figure has a decided tendency to wilt.

The russet is more evenly distributed over the entire surface of pears, a condition that is decidedly objectionable in such clear-skinned varieties as the Bartlett. It detracts greatly from their beauty when ripened.

Fig. 87. — Frost Russet of Apple.

Frost Blisters. — An injury to the foliage commonly called "frost blister" is shown in Figure 88. On close examination these crinkled leaves show separation of the upper and lower surfaces, with numerous cracks on the lower side. Their curled appearance or their yellowing up and falling off in midsummer often alarms the fruit-grower, who does not know the origin of the trouble. The figure shows that only the first leaves are affected, and while it may be a temporary check to the tree, the effect is not lasting.

Injury to Buds or Bloom. — Under this head it is proposed to discuss fatal and retrievable injury to buds or bloom, and try to explain what indicates fatality. It very often happens that a bud is killed before it opens, yet it will expand and will shed its petals as a normal bloom. Fatal injury to buds may be easily detected by splitting them with a sharp knife and examining the organs inside.

A discoloration of the central part of the bud indicates fatal injury. When the individual flower-buds are well swollen, — open enough to show the color of the petals, — the removal of the petals will disclose signs of fatal injury in the darkened pistils (the five central organs in the apple or pear flower and the central organ in the peach or plum bud). Such buds may open and appear to be normal to the casual observer, but they do not produce fruit. Internal injury to blossoms, especially after fertilization takes place, is not always fatal, nor is the percentage of fatality so easily ascertained; flowers injured to a certain extent after fertilization takes place may continue to develop and mature fruit.

Fig. 88. — Frost Blister of Apple Leaf.

What interests the grower is, how to determine how much he may depend on bloom so injured. Peach, plum, or cherry blossoms, frozen to the extent that discoloration appears in the basal part of the pistils, seldom if ever set fruit. In the apple the discoloration may show in the minute seed, and yet the fruit will develop to maturity, but no doubt only when the bloom has been previously fertilized. Blooms of the apple showing injury outside the seed cavities do not mature fruit; they may continue to develop for some time, but nearly always fall before the calyx closes. In this case, fatal injury is first indicated by a yellowing of the tissues about the stem end, the color appearing in time to indicate whether it will pay to spray.

Fig. 89. — Abnormal Pears, the Result of Injury by Frost.

When the injury appears only in the embryo seed, the fruit may mature without seed, and may generally be picked out at maturity on account of its smaller size.

Pear bloom may still mature fruit when showing more injury than the apple. The whole core cavity may be discolored without fatal results. The type of fruit from such a bloom is shown in Figure 89 (upper fruit attached to spur). While abnormal in shape, it has developed to maturity.

Injury to Young Fruit. — The various fruits differ in their ability to recover from severe freezing, and it is important that the grower know what to expect. When injury and discoloration are confined within the pit cavity, the peach, cherry, apricot, and plum may continue to develop until near the normal ripening period. The fruit may appear to be normal until the uninjured specimens begin to swell rapidly at the beginning of the ripening period, and then the injured fruit begins to fail, shows gummy exudations, and ripens abnormally, or drops before ripening. When the injury is more extensive, the fruit rarely shows any tendency to mature, usually dropping in a short time.

Apples frozen after the bloom has fallen show little more tendency to recovery than does the bloom itself. Injury that extends outside the seed cavities proves fatal, and while the fruit may continue to develop for some time, the yellow color of the flesh at the stem end soon indicates that the fruit is doomed. Some growers contend that discoloration of the flesh does not necessarily mean death, but they base their opinion on a hasty examination of the fruit at the time of the freeze, not realizing what a small percentage of uninjured fruit it takes to make a fair crop. They find later that they have a good crop, when they thought it all gone, and they conclude that it must have recovered; as a matter of fact, the crop undoubtedly represents the uninjured part. Death of the seeds does not necessarily mean death to the fruit. As compared with the normal specimens, the seedless specimens are a little smaller, and in some cases we observe a slightly shortened axis.

Fig. 90. — Longitudinal Section of Frozen Bartlett Pear.

The injured fruit of the pear, like the bloom, makes a remarkable recovery from frost injury. When the seeds alone are injured, the fruit matures and in most cases cannot be distinguished from the normal specimens. When the injury extends outside the seed cavity, the fruit may mature, but be abnormal in shape. Figure 90 shows a longitudinal section of a frozen Bartlett. Notice the black spot, the deadened core near the calyx; development has taken place in the part that should normally have been the neck. Fruit injured in this way may easily be distinguished by its square, thick form. Figure 91 shows a comparison of a normal and frozen Anjou pear, indicative that the form of the pear which normally has a short neck is the more abnormal when injured by frost. Such abnormal fruit cannot be considered fancy, but in most varieties is worth saving.

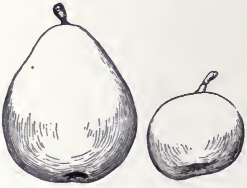


Fig. 91. — Anjou Pears. The Smaller injured by Frost when Young.

Discoloration of the tissues must extend well out toward the surface of the young pear before it can be pronounced dead, but when frozen to the extent that it results in blistering of the skin, it may be expected to perish.

Second-crop Bloom

The destruction of the first crop of bloom by frost is often followed, especially in the apple and pear, by the throwing out of a second crop of bloom; and the question is often asked what can be expected of this bloom. The grower is often at a loss to know whether the trees are worth spraying or not.

In the apple we have three types of second-crop bloom. One common abnormal type of bloom is that springing from the axil of a leaf on a normal spur after the early bloom has been killed by frost. This bloom will set and mature fruit, provided the ripening season of the variety is well within the season of the particular locality; fruit from such bloom is usually later and requires an extension of the season in which to develop. Figure 92 shows a mature Chenango (Strawberry) apple from such bloom, not over a week later in maturing than that from normal bloom. As the fruit generally develops within a week after that from the earlier bloom, in our lower altitudes most varieties will mature a crop from all late bloom.

Fig. 92. — Mature Chenango from Second-crop Bloom.

Small-fruits set from a second type of late bloom, shown in Figure 93, which is a fruit-spur forced from the larger limbs and even from the trunk. While such bloom often occurs in normal years, the amount is apparently multiplied by the destruction of the earlier bloom. This type of late bloom seems to terminate growth that should normally have been a watersprout; in fact, the growth shown in the figure as springing from the axil of a leaf below the fruit does often assume the proportions of a watersprout. Such bloom will set and mature fruit, and is well worth considering in connection with other late bloom.

A third type of late bloom terminates rather long growth of the previous season. On first starting, these buds

FIG. 93. — From Second-crop Bloom arising from Large Limbs or Tree Trunks.

would be taken for terminal leaf-buds. With the destruction of the earlier bloom they develop the normal number of flowers carried by a fruit-spur. This type of spur is not very common, nor is it easily distinguished from the normal fruit-spur, but its development seems to depend on the loss of the early bloom, and it should, no doubt, be classed as abnormal. In spite of the fact that some horticultural writings give the impression that apples do not bear from axillary fruit-buds, such is a common occurrence under our conditions. As these buds open a trifle later than terminal buds and, as the development of the flowers and fruit from them seems to be augmented by the destruction of the early bloom, they may be classed as second-crop bloom. Many of these buds produce fruit when all the bloom from normal terminal buds is killed. The production of fruit from axillary buds, however, is not limited to years when other bloom is killed. Many of our most productive varieties bear this way annually. Figure 12 shows a Jonathan twig of two seasons' growth bearing seven fancy apples on wood of the previous season's growth, or from axillary fruit-buds. This branch was taken from a twelve-year-old tree bearing approximately two boxes of fruit, all from either this type of bloom or from the type of secondary bloom as the fruit shown in Figure 92 has developed from.

In the pear there is one type of late bloom, that arising from the side of normal spurs. Figure 89 pictures a spur of the Bartlett pear bearing a fruit from a normal bloom and two from these late blooms (two fruits below). A close examination of the larger fruit will show a puckering about the calyx, an indication that the fruit has been injured by frost. The figure shows what can be expected from such bloom. Fruit from second-crop bloom will mature, but, while of normal flavor, such bloom cannot be depended on for fancy fruit. It is nearly always rough and irregular. As with the apples, some varieties of pear throw axillary bloom that is a few days later; but the development does not depend on the destruction of the earlier bloom. Other types of late bloom have not been observed in the pear. Unless plentiful late bloom in the pear produces fruit that is hardly worth the effort required to keep it free from worms.

Forecast of the Probable Crop

Whether to spray or not to spray for codlin-moth the grower must decide, after ascertaining all the facts. Trees should be carefully examined, both top and bottom, and a decision rendered with care; especially if it is likely to be negative. Remember that only a small percentage of a heavy crop of bloom will make a fair crop of fruit. Give the fruit the benefit of the doubt and spray before it is too late; omitting the first spraying has brought grief to many a box of fruit. With the apple especially a fair proportion of the late bloom may be depended on to mature fruit, and if it is to be saved, will necessitate an additional spraying to supply the calyxes with poison.

FROST PROTECTION

While the occasional loss of a fruit-crop from untimely frosts is considered in nearly every fruit section as one of the risks of the business, the loss or partial loss of two crops in succession arouses the fruit-grower to serious speculation of the possibilities of frost-fighting. With a method of frost prevention proved to be adequate and practicable, provision for the protection of the orchard should always be considered and the paraphernalia regarded as an indispensable adjunct to orchard equipment. The owner of a ten-acre orchard thinks nothing of investing four hundred dollars in a spraying machine. He might spend an equal amount for frost protection; it would be cheap insurance on a crop valued at an equal figure per acre; and without such insurance high prices for orchard land cannot prevail. It is true that serious injury by frost may not occur in many years, but it behooves the grower to be prepared.

Many devices and methods have been suggested and tried by the orchardist in an attempt to protect fruit from damaging late spring frosts. It is the purpose here to set forth the merits of the various systems, giving opinions based on previous publications, personal observations, and the experience of careful and observing growers.

Natural Protection

When the extent of the damage done by a recent frost is the subject of discussion, there is no commoner expression than that of surprise at the "spottedness" of the freeze or, in other words, the great variation in amount of damage done in different parts of some very limited area. Nothing arouses more contention among the growers than the question of the immunity of their respective localities from damaging frosts. Rivalry akin to malice is based on differences purely imaginary, for the escape of a particular locality can, in many cases, be attributed to conditions that are likely to be reversed another year. We have seen growers stand about the exhibition tables at the county fair and with satisfied pride point out their exhibits to a less fortunate neighbor and tell him how it happened that they had fruit when he had none. They talked knowingly of air-currents, and how the peculiar location of their orchard was such that it could never freeze out. And we have seen the same men one year later forced to listen to a similar exposition by the now more fortunate and equally visionary neighbor. Something went wrong; the air-currents failed to work.

The degree to which any locality suffers is, in many cases, a matter of chance. Mountainous sections are noted for their varieties of climate, and it is not uncommon to find localities differing very little in altitude and not over ten miles apart, showing a variation in season of blooming of almost as many days. So while one locality may be caught at a critical time one year and a neighboring locality escapes, it very often happens that the experiences are reversed the following spring. Yet we know that there is such a thing as natural protection; and there are localities that seldom suffer from untimely frosts.

One of the most reliable means of natural protection is that furnished by cañon breezes. Orchards in narrow valleys often escape injuries from frost, as the currents of air flowing down from higher altitudes keep the air moving, and thus prevent the settling of the colder air. Proximity to high bluffs that absorb a large amount of heat from the sun in the day and give it off gradually at night is also considered to be valuable protection. Orchards bordering on open areas, as desert land, are often only slightly injured, while those surrounded by other orchards suffer severely. The escape of the orchard on the border is apparently due to a better circulation of air. Low spots surrounded in the greater part by higher elevations are more often visited by untimely frosts, while ridges surrounded by lower levels are more exempt. These few factors account in part for the "spottedness" of frosts, but there are some variations that these factors will not account for. The grower who harvests a good crop one year while his neighbor has none may save himself no little embarrassment, should fortune turn another season, by not assuming a boastful altitude. And, furthermore, he must not be too sure that he can attribute success in saving a fruit-crop to some particular step in the cultural management of the orchard. While the only visible difference in the management of two orchards is that one grower waters in the fall and the other does not, a failure of one orchard does not necessarily mean that the system of watering is at fault.

Retarding the Blooming Period

Various plans of retarding the blooming period have been tried, but at most they only delay blooming a few days, while the fruit-crop may be in danger for as many weeks. Mulching the ground about the trees in late winter to retain the frost has had little if any effect as far as retarding the blooming of the tree is concerned. Experiments in whitewashing the trees from top to bottom and maintaining this coating throughout the winter and early spring have given varied results, but in no case has the practice retarded the blooming season enough to give promise of any great benefits. Some growers have omitted the late fall watering and have withheld water in the spring until after the blooming period, in fact until the trees actually suffered, yet in the past two seasons these orchards have suffered as much as those watered in the fall.

The Use of Water in fighting Frost

Water has been used in various ways in fighting frost, but in most cases it has either proved impracticable or inadequate. While spraying the plants would no doubt prove effective and practicable in the case of the flower-bed, it would not be practicable as a means of protecting the orchard. Various plans have been employed for evaporating water into the air with the idea of holding the dew-point above the freezing-point, but in the dry climates, where the dew-point is normally far below the freezing-point, such means of frost-fighting would avail little.

Irrigation, like smudging, is an effective method of frost-fighting when only a few degrees of frost may be expected, but it does not meet the requirements in most places. When the grower is not prepared in any other way to protect his orchard, it may be worth his while to turn on the irrigation water. In doing this, however, he runs the risk of forcing undue growth which may be more easily injured by later frosts; and when once the water is turned on, it generally puts a stop to all other means of frost-fighting. It is almost impossible to work where irrigation-water is running. The orchardist is to be warned that irrigation will not avert injury from heavy frosts. In the case of the strawberry-bed and garden crops, irrigation is often a simple and efficient means of protection.

Smudging

Fighting frost by means of smudges has long been in use, and while it has not always proved effective, it has many advocates. The philosophy of smudging is to prevent the radiation of heat from the ground by maintaining a blanket of smoke over the area to be protected. In other words, the idea is artificially to provide the protection of a cloudy night. This cloud of smoke is provided by burning various materials; as, stable manure, leaves, baled hay or straw, or in fact anything that will allow of the blaze being easily controlled to give rise to a dense smoke. Within certain limits such means of protection is successful, but when more than five or six degrees of frost occurs, the smoke and the small amount of heat given off by the burning of the smudges does not afford sufficient protection. Moreover, smudge material is difficult to secure in large quantity, and the supply too often gives out at the critical time.

The failure of smudging under conditions in which we would expect it to be successful can be attributed, no doubt, to half-hearted work, failure to begin before the danger point is reached, or lack of concerted action. Although the fruit districts of the inter-mountain states, isolated valleys as they are, seem to furnish ideal areas under which to demonstrate the value of smudging, it must be said that after thorough trial under existing conditions (isolated orchards, extremes of temperature, and the lack of suitable smudge material) it does not meet the requirements of frost-fighting. In lack of other protection, however, the grower should not give up, for faithful smudging is a failure only in the case of an extreme drop in temperature.

The fires should be started before the danger point is reached, and the cloud of smoke maintained until the sun is well up, or until the temperature rises above the freezing-point. The smoke screens the frozen plants from the sun's rays and prevents rapid thawing out, which is as detrimental as freezing.

Heating the Orchard

Undaunted by the failures of other methods, progressive fruit-growers have endeavored to demonstrate that it is possible and practicable to avert frost injury by actually raising the temperature of the air, by means of burning suitable fuel in small fires about the orchard, either in small piles upon the ground or in orchard heaters designed for the purpose. While many persons have been inclined to doubt the feasibility of heating "all-out-doors," it has been well demonstrated that fruit-crops may be saved by practical means of heating the orchard during the blooming period, even when the temperature falls as low as 20°.

This means of frost-fighting was probably first tried in a large way in California, in protecting the citrus fruit-crops from frost in the months of December, January, and February. In deciduous fruit-orchards it was probably first tried in Colorado in the spring of 1908. The results were so encouraging that great interest has been aroused in the designing and manufacturing of orchard heaters and in attempts to demonstrate the efficiency of the various patterns. Some of the most promising styles are shown in Figure 94. The writers have had many opportunities to study the behavior of these orchard heaters in actual tests, and much interesting information has been gathered, which may prove of practical value when assembled.

Fuels. — With the oil fields close at hand, it is natural that the California fruit-growers should favor the use of oil in heating the orchard. Possibly the only objection to its use in protecting the citrus fruit-crop in California

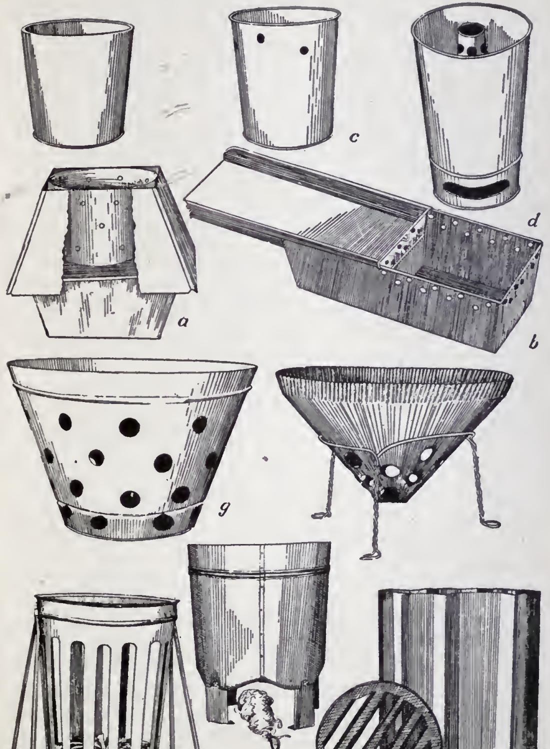


Fig. 94.

is the deposit of soot left on the almost mature fruit. This defect does not enter into the discussion in deciduous fruit-growing sections, where the fires are needed only during the blooming period or shortly after the fruit is set; practically all trace of the deposit disappears before the fruit is picked. Even in California this objectionable feature could be partially overcome by choosing an oil burner that would consume the fuel more perfectly than the one now commonly used in the citrus orchards. California growers have used crude petroleum, which can be purchased at the wells at a lower price than coal. In many fruit sections the conditions would be reversed.

Coal has been used in California, but with rather unsatisfactory results. California growers have given out the impression that it is possible to raise the temperature only four or five degrees with coal. The fact that California growers have tried to burn coal in an unsatisfactory burner is no doubt responsible for this false impression as to its heating value. This California coal burner is nothing more than an open wire basket, without draft, and it has been impossible to burn a sufficient quantity of coal. In other sections several types of coal heaters have been invented, and after one season's trial it is safe to say that with a satisfactory coal burner it is possible to raise the temperature as much as with an oil burner.

Local conditions will determine which will be the cheaper fuel. With gas oil or crude oil delivered at four and one-half cents per gallon, coal will probably be no more expensive at $4.50 per ton. One can count on about as much heat from a ton of coal as from 100 gallons of oil. With one year's actual experience in the use of these heaters it must be said that the oil burners are by far the most practical. The fuel is less bulky to handle, oil heaters can be handled with less help, and as the oil heaters may be extinguished at any time, the fuel may be used more economically. It will require one man to care for each two and one-half acres equipped with coal burners, while one man will tend five acres equipped with good oil burners. It is often almost impossible to secure the help required to take care of a large orchard equipped with coal burners. Five-acre orchards are easily protected with these coal burners. There are times when it may be necessary to maintain fires for only an hour, and it is a great waste of fuel to start a coal pot for such a short period of burning, for a coal burner once started may as well be allowed to burn out. Even though some coal may be saved by turning the pot over, it makes very poor fires after it is partially burned. There are also many cases in which the coal fires are started unnecessarily, for they are started before the danger point is really reached and known. A few minutes' waiting may have shown a change for the better, and the man who is burning oil can wait until the danger point is practically reached. The first cost of equipping the orchard with oil burners and storage tanks will probably be greater than the cost of coal equipment. While it is true that coal may be used for other purposes if not needed for protecting the orchard, the average grower cannot in one season dispose of the amount he must necessarily store for orchard-heating purposes. If oil is properly stored, there is probably less chance of loss by deterioration. Coal will slack if stored even from one year to another and will in time become undesirable for orchard-heating purposes. Coal containing over 20 per cent of slack is not desirable for burning in these heaters. In Colorado, crude oils have not been found to be the most satisfactory for burning in orchard heaters, on account of a tendency to boil over. A product known to the trade as "gas oil" is now being recommended by the oil companies. In fact, this is the only oil they will sell for orchard-heating. While this grade is not always uniform and will not always burn for the same length of time, it will burn as long on the average as crude oil and does not boil over.

Fuels may be made from various materials as coal slack, tar, crude oil, and shavings. These fuels are now found on some markets and are quite well adapted to orchard-heating purposes. As a rule they are pressed into cakes which may be burned in piles on the ground or in any of the coal burners. Like the coal, it is almost impossible to extinguish them when once lighted, and the fires require frequent stirring to keep them burning freely.

Cost of Equipment. — The cost of equipping the orchard with these oil heaters should not exceed $25 per acre, and the cost of a storage house for coal or a tank or cistern for oil should not exceed $7.50 per acre. A good 400-gallon tank for hauling and distributing oil, equipped with hose similar to the one shown in Figure 95, may be had for about $50. Local tinners will quote a price of about $30 on a 300-gallon galvanized iron tank furnished with an outlet and valve.

Storage of Fuel. — Most oil heaters will burn about a quart of oil per hour. Thirty hours should be about the maximum that it will be necessary to burn the heaters

FIG. 95. — Method of distributing Oil.

any one season, and for this period of burning it will necessitate the storing of about fifteen barrels of oil per acre. From four to five tons of coal per acre would furnish about the same protection as fifteen barrels of oil. Oil should be stored in fairly tight tanks or cisterns. Cement cisterns seem to be the cheapest storage reservoir. Apparently any cistern that will hold water will hold oil. A good 300-barrel cistern can be built on contract for about $150, and if the grower wishes to do the greater part of the work himself, the actual cash outlay need not be over a third of this. A 100-barrel galvanized iron tank may be built for about $75. Coal and the prepared fuels should be stored from the weather to avoid deterioration.

Heaters. — At first many of the designers and manufacturers of orchard heaters apparently had the idea that any receptacle that would hold coal or oil would make a satisfactory orchard heater. This idea did not last long, however, and many proposed orchard heaters were condemned, even before they had been tried in a practical way; and after one year's test in actually fighting frost, undesirable features have been emphasized in several of the manufactured heaters, and the number of really useful kinds has been still more reduced.

An oil heater should be so constructed and should hold so much oil as to burn for the maximum number of hours during any one night. They should burn at least seven hours without refilling. Refilling in the night is tedious and expensive, and requires a great deal of help. An oil burner that will burn for this period must be of the reservoir type. That is, it must be so constructed that only a part of the surface of the oil is exposed to the flames. The oil burner should also show very little variation in the rate of burning when full and when almost empty, and it should be so constructed that the gases are well mixed with air in the process of burning. This insures better combustion of the fuel, gives more heat, less smoke, and less soot.

A coal burner should have good draft and an open grate so that the ashes will fall out readily. If the grate is too close and the heater is not supplied with side draft, it will soon clog and refuse to burn. The coal burner must also have capacity. At best it seems that it has not been possible to construct a coal burner that will burn satisfactorily for over four hours without refilling, and the heater that will hold twenty-five pounds of coal and is so constructed that the fuel takes fire gradually, has a great advantage over the heater of small capacity in which all the fuel catches and burns at once.

It should be remembered that large fires are liable to create upward currents that will carry the warm air far above the tree-tops and allow the colder air to settle. It has been suggested that probably more benefit is derived from the slight currents of air produced by the burning of the small fires than from the heat that is actually given off in the combustion of the fuel. Fruit-growers have often given their experience in trying to protect a few favorite trees with large bonfires. One instance comes to mind in which the grower built large fires about some favorite cherry trees. The fires were placed as near as possible without danger of scorching the trees, yet the heat was carried up too high, and the cold air settled and froze the crop.

Management of Heaters. — At first thought the care of these heaters may seem to be a simple matter, but there is much to be gained in knowing just how to fire them. It would be a better plan for the grower to attempt at first to protect only a part of his orchard. And when once the particular make of heater is decided upon and bought, the grower should do a little experimenting on his own responsibility and learn how to fire them to the best advantage. This is especially true of coal burners.

In orchards at least 25 per cent more heaters should be placed around the borders than in the center of the block. This is especially desirable when low temperatures are accompanied by winds. As the heaters must remain in the apple and pear orchard during the spraying season, an effort should be made to place them where they will not interfere with the passage of the spraying machine. It is well to place the heaters at some distance from the trees. The flaring-up of oil fires from the pot boiling over may cause serious injury if the pots are placed too near the trees.

The number of heaters required per acre will depend on the heater and other factors. No doubt orchards with trees planted close together and large enough to meet across the middles, as those shown in Figure 96, are more easily protected than those with the trees far apart. It is doubtful whether any of the heaters now manufactured should be recommended as ample protection at a rate of less than sixty per acre. It is always best to have ample protection, holding a number of the heaters in reserve; and should winds accompany freezing temperatures, it is much more effective to light a goodly

FIG. 96. — Orchard Heaters in Position.

number of heaters on the windward side of the orchard than an equal number of scattering fires. It has been observed that on a still night the benefit derived from these heaters does not extend far outside the boundaries of the orchard, and many times with a temperature as low as 23° the crop has been a total failure within less than a hundred feet of the last row of heaters when a perfect crop was saved inside the heated area.

Oil heaters burning a quart of oil per hour and at the rate of 80 per acre should be ample protection in fighting a temperature of 20°, and coal heaters burning five pounds of coal per hour should afford the same protection with the same number per acre. Some of the larger heaters consuming more fuel have been recommended as sufficient protection when used as few as forty per acre, but it has been fairly well demonstrated that it is better both for the complacency of the men and sometimes for the orchard to have sixty. If one insists upon using oil burners that will not go through the night without refilling, it might be better to double the number of pots and burn them in two shifts. This would of course add to the expense of equipment, but would enable the grower to handle a large acreage with less help.

Oil burners may be filled and placed in the orchard at any time after the fruit-buds have advanced far enough to be endangered by sudden drops in temperature. They must be kept well covered to exclude moisture, for this has a tendency to make the oil sputter and boil over. The burners are easily lighted with a torch, using a little waste for a wick. The waste may be thrown on the surface of the oil, but it will light more readily and will be surer if hung on a wire hook and only partially submerged in oil. Another plan for lighting without the wick is to carry a bottle of gasoline in one hand and pour a small quantity on the surface of the oil in the heater and touch it with the torch; this is rather dangerous, and it is no work for children, and it is really too hazardous to be recommended. When once the oil catches, it burns freely from the surface. The burning may be regulated by partially covering the heater with the lid. Most heaters are easily extinguished by sliding the lid entirely on.

By using the proper refilling receptacle and with a little care, the heaters may be refilled at any time while burning. It is best to use a regular oil bucket for this work. In refilling in the daytime a tank like that shown in Figure 95 is most convenient. Three men with a good pump to draw the oil from the cistern will refill the pots on twenty acres in a ten-hour day. The engine and the filling pump on the spray tank may be used for lifting the oil.

Coal burners may be placed in the orchard and filled at any time. Should damp weather precede a cold wave, they may be a little difficult to start, but the covers with which they are provided protect the contents very well. The heaters are usually charged with a handful of kindling, a little waste saturated with crude oil or gas oil, and from ten to twenty-five pounds of coal. Mixing a little kerosene with the heavier oil makes it possible to light more rapidly with the torch. Dry tree prunings make very good kindling when well chopped up. Large heaters with flaring sides are best started by putting the kindling near one side with only a small amount of coal directly over it; the fires break through more readily and the coal does not all fire at once. In refilling all coal heaters it is well to place the new coal on one side to avoid checking the heat any more than necessary. One of the most convenient methods of refilling at night is to draw the coal to the orchard in a wagon or sled, and as one man drives the team and fills the buckets, other men carry the coal to the heaters.

Thermometers. — The grower who intends to equip his orchard with the best means of frost protection will not overlook good thermometers. Electric frost-alarms, commonly called thermostats, are on the market. They may be placed in the orchard and connected with an electric bell in the house and set to ring the bell when the temperature reaches the danger point. In actual use these alarms have not been very satisfactory, and many persons who have tried them have reached the conclusion that they are not to be trusted. A good thermometer will serve the purpose, but though it necessitates having a watchman, this is the safer plan. A good crop is worthy of such vigilance; and by placing thermometers in different parts of the orchard more reliable readings are secured. The fruit-grower should not rely on cheap thermometers. Buy tested instruments, and, if possible, check them up with a good government thermometer.

The United States Weather Bureau offices often help the fruit-grower by predicting cold waves far enough in advance that the grower may be on his guard. Localities that are fortunate enough to have an office of the Bureau in the immediate vicinity come to rely on the official in charge, who with volunteer help watches the thermometer during the night and warn the growers when the temperature reaches the danger point. Localities not so fortunately situated should establish information headquarters. There is much to be gained by such organization. Headquarters may keep in touch with various growers over the guarded area, watch the temperature readings in different localities, watch the movements of the air-currents, and in many ways relieve the grower of much anxiety. Two or three good level-headed men at such headquarters, with telephone facilities and reliable thermometers in different localities, are often able to predict fluctuations in temperature, reassure men who are anxious to fire and would thus waste fuel, and generally warn them in time to be prepared for sudden drops in temperature.

Many fruit-growers are at à loss to know when the fires should be lighted. Hundreds of dollars' worth of fuel has been burned up needlessly when the fruit was in no danger, and hundreds of dollars' worth of fruit has been lost because the grower placed the danger point too low. It is doubtful whether a temperature of 30° will injure fruit or buds in any stage. A temperature of 28° if of long enough duration to freeze the tissues solid will kill peaches in bloom or after the fruit is set. After the little peaches have reached some size they often pass through periods of lower temperature of short duration. Peach trees well loaded with buds and far enough advanced to show a slight trace of pink have often escaped with a good crop with a minimum temperature of 22°. Fruit-buds of the apple and pear open far enough to show the tips of the flower-buds are seriously injured by temperatures lower than 20°. Apple or pear buds far enough advanced to show the color at the tips are usually only slightly injured by temperatures as low as 25°. Apples or pears in bloom and after the fruit is set will seldom withstand temperatures lower than 28°, if of long enough duration to freeze the tissues solid. Cherries, apricots, and most of the plums will require about the same protection as peaches. Native plums in bloom or with the fruit set will often endure a temperature of 25°.

Storing Heaters. — After the orchard heaters have been burned, they will probably rust badly if not well cared for. They should be placed in attics rather than in cellars and should be dipped in oil before storing. Smudging oil will do very well for dipping.

CHAPTER XX

ORCHARD PESTS AND THEIR CONTROL

THE fruit-grower in the semi-arid regions is fortunate in having but few of the many orchard diseases to contend with. The writers are of the opinion that this immunity to disease, so far as the great majority of common troubles is concerned, will be permanent. We are confirmed in this view for several reasons, among which may be mentioned this point: orchard pests are often spread from one locality to another on nursery stock, pear-blight and crown-gall having been brought to our orchards in this way. This being true, it stands to reason that many other things have found their way to our orchards, as trees and plants come to us from all sections of the United States. One can only conclude that the climatic conditions are such that many of these common pests of the humid states will not thrive. At any rate, they are not found here, and bordeaux mixture, the standard fungicide, is unknown to most of our growers. Four years ago a few leaves attacked by curl were found on each of six or eight young peach trees in an orchard at Paonia, Colorado. All affected leaves were picked from the trees for safety, but it is scarcely possible that all traces of the disease were removed. The trees have been examined each year since, but no further evidence of curl has been discovered.

Some of the diseases can be controlled only by cutting out the affected trees, as in peach-yellows. Pear-blight could be controlled if all of the diseased limbs were removed promptly, but this seems to be impossible for the majority of orchardists. Brown-rot of the stone-fruits has not as yet been successfully combated; and in wet seasons it is very difficult and often impossible to control such common diseases as apple-scab. This is due not only to the inability to spray at the proper time, or the material being washed off by the rains, though these are important features. Unfortunately, the copper in bordeaux mixture is made soluble under some conditions, and when this occurs, more damage results to fruit and foliage from the corrosive action of the copper than from the disease.

The apples that come to our markets from the humid states are more or less scabby and often discolored with the sooty blotch, and the peaches are commonly disfigured by scab or some surface-growing mold. Our growers have never been bothered by fungi that attacks leaves and fruit, consequently they have been saved the expense of spraying, and the fruit goes on the market without a blemish. These are distinct advantages which it is to be hoped will continue.

We have a few diseases, however, and at least one of them, pear-blight, is very destructive. These are described in the following pages, and the latest information in regard to their control is given.

As in plant diseases, the insect enemies with which our orchardists have to contend are comparatively few. Altitude and aridity certainly have something to do in rendering our orchards immune to a large array of pests that are common to orchards in lower altitudes both East and West. But the codlin-moth and the green and the woolly aphis are so abundant and persistent that they make up in a measure for the lack in number of species.

Only the more important insects are included in the following discussion. All of the information in regard to them has been abridged from the numerous publications of Professor C. P. Gillette, entomologist of the Colorado Agricultural Experiment Station.

It should be borne in mind that the term "plant-diseases" as discussed in these pages refers only to those orchard troubles that are caused by the attacks of small plants. While these plants are mostly microscopic and low in the scale of development, they are just as truly plants as are the trees upon which they live. If one can think of the bacteria and fungi as being microscopic weeds, it will help to an understanding of what might otherwise seem mysterious. It is difficult, for example, for the beginner to understand how the death of blighted pear trees is due to the growth of small plants within the tissues of the trees. Yet that such is the case has long been known.

All persons know that insect pests are live animals; but not all are familiar with the fact that insects have different modes of feeding. Any one can see that cabbage-worms chew their food and gradually devour large areas of cabbage leaves. But how about plant-lice, scale insects, mites, and a large number of similar insects? These pests are usually small, and their feeding-habits are not so easily observed. But it is plain that they do not devour leaves or bite holes into fruit. Some of them, in fact, remain stationary during the most of their lives. Close observation will show that in place of jaws this class of insects is provided with sucking mouth-parts. They must, therefore, pierce the bark, or epidermis, and suck the juices from the parts on which they feed. It is evident that it is impossible to poison such insects. In order to be a successful orchardist, one must make a careful study of orchard pests, as many of them require special treatment.

When it is possible to prevent the spread of plant diseases by spraying, bordeaux mixture has been almost universally used. Biting insects may be killed by poisoning their food; arsenate of lead has come to be the standard poison for this purpose. The sucking insects must be killed by some agent that suffocates or corrodes. Deadly gases are sometimes employed, but more commonly some mixture or solution is used that may be applied in the form of a spray, such as the lime-sulfur mixture or the tobacco decoctions. While good spraying is always necessary, it is specially important with sucking insects, as each individual must be hit by the spray.

The codlin-moth is sprayed for before the eggs are laid. The larvæ, or worms, do not hatch till several weeks later, but if the spraying is well done, the first mouthful results in the death of the insect. But as the sucking insects cannot be poisoned, it is no use to spray for them until they make their appearance, unless, indeed, the eggs are to be killed by a winter spray.

DISEASES AND INSECTS OF THE APPLE

Fungous Diseases

Blight (*Bacillus amylovorus*). See under *Pear*.

Crown-gall. — The subject of crown-gall is of vital importance in the semi-arid country, since under our conditions the organism that is responsible for this disease of fruit trees and plants finds congenial surroundings for growth and distribution.

The so-called galls are irregular outgrowth of tissue that commonly form around the crown of a tree just below the surface of the ground. They also occur frequently on the roots, but are very different in appearance from the swellings that are produced by the attacks of woolly aphis, which, unfortunately, are also very destructive.

There are two forms of galls, known as the soft and the hard. They are much alike in external appearance, but differ in structure. "Hairy-root" is possibly a distinct disease, but its effects are much the same. It receives its name from the quantity of fine roots which may or may not arise from a gall. All of these forms appear to be equally destructive.

The galls increase rapidly in size, when the conditions are favorable, and so interfere with the processes of nutrition that the vigor of the tree is greatly impaired. In many instances the death of the tree is but a matter of a few years. The point of attack being underground, the infected trees are commonly unnoticed until they begin to fail. This stage may be recognized by the weak growth and yellow appearance of the foliage.

This disease first began to attract the attention of experiment station workers in 1892, when the California station published a bulletin on the subject. This was followed by a number of articles from different stations, and in 1900 Toumey, then of the Arizona Experiment Station, published a bulletin in which he attempted to prove that crown-gall is induced by attacks of a slime mold. His results, however, have never been verified, and the exact cause of the disease is not yet definitely known.

In the spring of 1907 Smith and Townsend, of the Department of Agriculture, published a brief account of their work with galls on the Paris daisy. They proved that this particular gall is caused by the attacks of a bacterium, and, what is more important, they found that when pure cultures of this organism were inoculated into peach roots, galls were formed that resemble closely the common crown-gall.

So it appears that we are at last to have the cause of crown-gall explained. But in the meantime we know that under semi-arid conditions this disease is often fatal to all kinds of orchard trees. We also think that it is spread in the orchard from tree to tree, although this has not been proved. No remedy has yet been suggested which has any value in controlling the disease. The only thing that can be suggested is to insist on the most rigid inspection of nursery stock, and all trees should be rejected that show any traces of gall. All orchard trees found to be diseased should be destroyed, particularly apple trees, as they rarely live over ten years, and what fruit is borne is likely to be undersized.

Mildew (*Podosphæra species*). — A mildew similar to the disease that attacks the peach is found occasionally on apple twigs. This has not been serious as yet, but if at any time it should need attention, spraying with bordeaux mixture as outlined for peach mildew will be effective. The young, vigorous twigs, young trees, and grafts are most subject to attack.

Root-rots. — Orchardists and experiment station workers alike have been puzzled for several years over the cause of root-rot in apple and pear trees. The name conveys at once the condition in which the trees are found. In some cases no injury is to be seen above ground, but when the tree dies, it will be found to be girdled just below ground, and most of the roots are decayed. In other cases strips of dead bark extend up the trunks and often into the larger branches. In such cases the first indication of disease is the appearance on trunks and branches of dark brown spots caused by the exudation of sap. As the disease progresses, the bark dries down to the wood, all of the involved part taking on the dark color. Such trees usually ripen their foliage early in the fall, and the bark of the branches has a peculiar reddish cast. Many trees die in midseason, with fruit and foliage clinging, the second season after symptoms of trouble were noticed. The inner wood of the branches of some of the affected trees is dark-colored, or black-hearted, a condition which has popularly been supposed to result from injury by frost alone. Another symptom which seems to be associated with this trouble is the splitting of the bark on the trunks. Such wounds bleed profusely, and it may be that some of the excessive bleeding which sometimes takes place from wounds made in pruning may be due to the same cause. In all cases the starting point is either at or below the surface of the ground. Fungi may be responsible for some of the dead trees, but this has never been definitely determined. The common pear-blight may also work in the roots of apple and pear trees, but this is unusual.

The authors have spent much time over this all too common disease, but they were unable to arrive at any conclusions. Fortunately, our co-worker, Dr. W. P. Headden, became interested in the subject, and in a recent bulletin he gives the results of his investigations.[1] He found upon analysis that the inner bark and wood of affected trees, not dead trees, contained a large percentage of arsenic, as much as 12.77 parts in a million. All fruit-growers know that even a small amount of soluble arsenic in the soil is fatal to vegetation, but they have felt safe in using large quantities of the various arsenical sprays for the reason that these forms of arsenic were supposed to be insoluble. It has been the custom in some sections to spray from six to twelve times a season for the codlin-moth. The appliances were often crude in form, consequently much spray material was wasted and was deposited on the ground. Naturally, the greatest accumulation is around the base of the tree where the injury occurs. Analysis of soil taken from near the base of trees, to the depth of one foot, shows that arsenic has accumulated in varying amounts up to 61.3 parts of arsenic acid in a million of soil.

Even such large amounts of arsenic would be harmless if it remained insoluble, as had been supposed. Dr. Headden finds,

[1] Headden, W. P., "Arsenical Poisoning of Fruit Trees," Colorado Expt. Sta. Bul. 131, 1908.

however, that the alkali salt solutions, which are abundant in all arid soils, are solvents of arsenic and so are constantly bringing this extremely poisonous material into solution. This action is of course greater in some soils than in others, depending on the constituents present.

This condition is indeed serious. We have no poison other than the arsenic preparation with which the codlin-moth may be successfully combated, and if we are to grow apples and pears successfully, spraying cannot be dispensed with. In the bulletin mentioned above Dr. Headden sums up the situation as follows:

"I have no remedy to suggest for either condition. Preventive measures are, so far as I can see, our only recourse. Those which suggest themselves to me are: to remove the arsenic-laden soil from about the crown of the tree and replace it with fresh soil; to use standard brands of lead arsenate in preference to the arsenite of lime or white arsenic, sal soda, and lime; to use as little lead arsenate as possible. I have been told that good results have been obtained by using 2½ and even 2 pounds of pasty lead arsenate to 100 gallons of water, but the spraying must be done thoroughly. Spray no oftener than is absolutely necessary. If I am not mistaken, Professor Gillette has found that 95 per cent of the effect of the whole season's spraying was obtained by the first spraying when thoroughly well done. Some device should be used to prevent the spray material from running down the trunk and collecting at its base, or it would be still better to make provision for gathering the whole of the drip. Water rich in alkalies should not be allowed to flow close enough to the tree to permit of the deposition of the alkalies in the soil about the trunk of the tree. Concentrated lye, if used to kill woolly aphis, should not be applied to the soil at the crown of the tree or permitted to flow down and collect there."

Insect Enemies of Apple

Green Apple Aphis (*Aphis pomi*). — This is the common green louse that curls the leaves of the apple tree. While primarily a leaf-feeder, this louse also attacks the tender tips of growing shoots, especially grafts and watersprouts. This insect ranks close to the woolly aphis in extent of injuries to the apple tree. It also attacks the pear, the thorn, and the quince.

This louse remains on the apple, or closely allied trees, throughout the year and does not go on other trees or vegetables. The first lice in the spring hatch from eggs that were deposited the previous fall on the twigs. These first lice hatch a few days before the buds open and are ready to insert their sharp beaks into the first tender green tissue of the opening buds. They are all females, and become fully grown in about two or three weeks, when they begin giving birth to living young. From this time on the lice increase very rapidly if they are not kept down by their natural enemies or the insecticides of the orchardist.

At first all the lice are wingless, but by the 10th to the 15th of May in the warmer regions, and about two weeks later in the cooler orchard sections, the winged lice begin to appear and to fly from tree to tree and orchard to orchard with the prevailing winds. About the first week in September little brown wingless males and green wingless egg-laying females appear, and a little later the females begin laying green eggs that soon turn black upon the apple twigs. The freezing nights in November or early December kill all the lice, and the eggs live over to hatch the following spring.

Treatment for this insect may be for the destruction of the eggs and young lice before the buds open in the spring, or for the destruction of the lice on the leaves during the growing season. The early spring is the more important. There are two sprays that may be used with equally good results when the trees are dormant: —

Lime-sulfur mixture or Rex lime-sulfur, in dilutions down to one gallon in eight gallons of water, have given good results.

Black-leaf. — This preparation may be used in the proportion of one gallon in 25, or one gallon in 33 of water.

For the destruction of plant-lice on the leaves, spray very thoroughly and forcefully from all directions with Black Leaf, one part in 70 of water, or with tobacco decoction, or with whale-oil soap solution.

Woolly Apple Aphis (*Schizoneura lanigera*). — This is probably the most serious apple pest in this region. It is a bark feeder, and it attacks the roots, the trunk, and the limbs, but does not feed on the fruit or foliage to any extent. This louse is readily recognized on account of its being covered with a white, woolly secretion which has suggested its common name. Upon the trunk and the branches the lice attack either the tender bark about the scars or the bark of tender new shoots. Below ground the lice attack the bark of roots, particularly of the smaller roots, causing warty swellings upon them. If very abundant, the roots are often completely covered with these smooth wart-like growths, which sometimes cause the roots to die and rot off. When very abundant on the rapidly growing twigs, these lice often produce abrupt swellings due to the thickening of the inner bark. Sometimes these swollen parts crack open lengthwise, and the limbs may be sufficiently injured to cause them to die. Severest injury is done to the tops, where there is the tenderest and most rapid growth, as in grafts and watersprouts.

The life habits of this insect may be briefly stated as follows: Early in spring there will be a few living lice in protected places beneath the bark or under the dead bodies of the lice that were killed the previous fall. There will also be a large number of lice living over on the roots beneath the surface of the ground. The lice that live over on top are all very small. Those living over on the roots are of all sizes from the smallest to those that are fully grown. By the time the buds begin to open, the lice that live over on the top will locate on tender new bark and insert their beaks and begin to suck the sap of the tree and to grow in size. At the same time a greater or lesser number of small lice that live over winter about the crown of the trees, and perhaps some that came up from the roots, migrate to the top and begin to feed and grow. These lice start the round of development for the year on the tree-tops. They are usually first detected by the fruit-grower when the little lice have grown enough to secrete a white covering to their bodies which makes them appear like little moldy spots upon the bark. These lice increase very rapidly, so that by the middle of June or first of July the tree may be very badly infested, and the cottony secretion may be so heavy as to hang down and even fall from the bodies of the lice.

The lice are all wingless until about the first of September, when an occasional winged louse may usually be found upon the trees. They leave the trees where they develop and fly to others. Each of these winged lice gives birth to about four or five males and as many females. Before winter comes on, each female deposits a single egg and dies. No one seems to have followed this part of the life history of the woolly aphis in the orchard. It is supposed that these eggs hatch the following spring and start new colonies.

The woolly aphis lives on the roots in large numbers the year round, the only difference in the winter being that the lice reproduce very slowly, and so do not increase much in numbers. The cold weather seems never to be sufficient to kill them even in our coldest climates where the apple is grown.

Prevention is nearly always better than cure. Great care should be taken, therefore, when setting out a new orchard, to prevent the introduction of this louse. Orchards are usually infested by the lice that are on the roots of the nursery trees when they are set out. All nursery stock should be thoroughly disinfected either by fumigation with hydrocyanic acid gas, or by very thorough spraying of the trees, both roots and branches, before they are set, with one of the remedies mentioned below for spraying tops.

One method of preventing injuries from this louse is to have all apple trees on Northern Spy roots, as Northern Spy seems never to be seriously attacked.

If nursery stock is received with roots "puddled" (covered with mud), the purchaser should insist upon this mud being thoroughly washed off, and the roots treated for woolly aphis, as this is one of the methods that the nursery man has of covering up woolly aphis.

To prevent the spread of the woolly aphis from tree to tree and orchard to orchard, the lice should be well cleaned out of the orchard before the first week of September, as it is about this time when the winged lice begin to fly about to spread the species.

Wherever this louse can be reached by sprays, it may be destroyed like other plant-lice, but the spray must be applied with sufficient force to remove or penetrate the woolly covering. There are several spray materials that we have found to be entirely successful when thoroughly applied to this insect.

Black-leaf is, all things considered, by far the best spray for plant-lice that has yet been introduced. It gives no better results than kerosene emulsion when properly made, but the difficulty our growers experience in making a good emulsion with the universal alkaline water makes its use almost prohibitive. At any rate, very few growers attempt to make it. Black Leaf is a tobacco decoction which was originally manufactured as a sheep dip. It has been given a thorough test by many orchardists, and has given universal satisfaction. It is used in the proportion of one gallon to 65 or 70 gallons of water.

So far, the remedies mentioned have been for summer treatments, when the bodies of the lice are more or less covered with the waxy secretion. We think the best time to get results in the treatment of this louse is late in the winter, or early in spring before the buds open. This is not because the lice find protection from the opening buds, but because by the time the buds have opened, the lice have their bodies more or less covered by waxy secretions that protect them to some extent from the effects of the insecticides.

Many orchardists have found that when they used the lime-sulfur mixture for the destruction of the eggs of the green apple aphis, they largely freed the trees from woolly aphis at the same time.

The following formulæ have been found to be reliable: —

Lime 15 pounds, sulfur 15 pounds, water 30 gallons;
Lime 15 pounds, sulfur 15 pounds, water 45 gallons;
Rex lime-sulfur 1 gallon, water 7 gallons, lump lime 2 pounds.

We have no doubt that the kerosene emulsion, the tobacco sprays, and the whale-oil soaps could also be used successfully as early spring sprays for the destruction of the over-winter lice on the tree-tops, although we have not tested them in that way. As they are not as successful for the destruction of the eggs of the green apple aphis, and as the orchardist is likely to want to destroy both of these lice at the same time if possible, it is probable that the lime-sulfur sprays will become most popular for early spring applications.

To secure best results on the woolly aphis, the spring application should be made fully a week or ten days before the apple buds begin to open at all, and the trunk and crown of the tree should be thoroughly drenched. Then as a final act for best results, put Tanglefoot bands about the trunks of the trees so that the lice at the roots cannot migrate to the top.

In recent experiments large numbers of Tanglefoot bands have been used. This material is put out by the O. and W. Thum Co., Grand Rapids, Michigan, and is the sticky material of the Tanglefoot fly-paper. When at all abundant upon the trees, the newly born lice are much inclined to travel, and it is often astonishing to see the number of lice that will be captured in these bands. On the 7th of June, 1907, it was estimated that bands that had been on since the preceding fall had as many as 100,000 lice each in many cases. The bands remain fresh for several months and may be quickly freshened by rubbing a paddle over them, if they become filled with insects and dirt.

From observations recently made the indications are that Tanglefoot will seriously injure trees if applied directly to the trunks. A better way is to put a band of stout paper around the trunk and then put the material upon that. A light band of cheap cotton batting under the paper will prevent any lice from passing under.

The common notion that the woolly aphis may be killed by heavy irrigation in winter is an error. It would be impossible to keep a sufficient amount of water in the soil long enough to bring about this result without doing serious injury to the trees.

Brown Mite (*Bryobia species*). — The brown or clover mite is extremely small, and its presence is usually first detected by the faded, sickly appearance of the apple foliage. The trees have the appearance of suffering for water. The mites feed on the leaves, but deposit their red eggs on trunk and limbs. When very abundant, the eggs give a red color to the bark, an effect that is more often noticed during winter.

Mites are found on nearly all tree-fruits and on small-fruits as well. They are sometimes particularly destructive to the red raspberry.

This insect is best combated in the egg stage at any time in winter. For this purpose the lime-sulfur mixture or whale-oil soap, quadruple strength, may be used. If it becomes necessary to spray while the leaves are on the trees, use whale-oil soap or Black Leaf of ordinary strengths.

Codlin-moth (*Carpocapsa pomonella*). — Flesh-colored larvæ eating into the fruit and causing wormy apples. The first brood of larvæ (worms) begin eating into the fruit when early apples are about an inch in diameter. This brood is not very numerous, but it develops a second brood later in summer which is very much more numerous.

A good brand of arsenate of lead is the only poison that is worth considering, although other forms of arsenates may be used.

The methods of spraying for the codlin-moth have changed rapidly in recent years. Formerly the trees were often sprayed eight and ten times a season, but in spite of this a large percentage of wormy apples was the rule. Growers who followed this practice failed to appreciate the fact that about three-fourths of the first brood of worms enter the apples at the calyx. This is where the importance of filling each calyx-cup with poison comes in. If all of the first brood could be killed, there would be no second brood and consequently no worms late in the summer, when the greatest damage occurs. Many orchardists appreciate this fact, and so devote all their energies to applying the first spray at the proper time and in a thorough manner. This is a job that cannot be neglected. As soon as the petals have mostly fallen, spraying should be begun, and it must be persistently followed. The calyxes remain open for only about six or eight days, and after this the spraying is practically useless for the first brood of worms. If a second application is thought desirable, it should be given about thirty days later. Some of our progressive growers are now relying on the first spraying, performed at just the right time and applied in a thorough manner, and are meeting with good success.

Since we now know that trees may be poisoned by arsenic as a result of spraying, it is very important that all persons should spray as few times as possible and that the mixture should be as weak as will do effective work.

Advance has been made also in the amount of arsenic required. Formerly many growers thought that if a little was good, much more would be better, and many used as much as eight and ten pounds of poison to one hundred gallons of water. Melander has recently found that two pounds of poison to one hundred gallons is sufficient to do effective work under Washington conditions. Consequently we think that three pounds to each one hundred gallons is the most that should be recommended.

Traps in the form of cloth bands around the trunks for catching the larvæ are of considerable service if properly attended to. But when one has learned to spray most effectively, it is no longer worth while to use bands. Lights to trap the moths are valueless. The doors and windows of cellars and storage houses should be screened, as many moths develop from the worms in infested fruit.

Clean culture, and especially the stirring of the soil about the trunks of the trees, will prevent the worms from successfully undergoing their transformations under clods and about the crowns.

One should have outfits enough to complete the first spraying within eight days from the time it is begun; or if one has varieties that bloom at different times, arrange the work so that none of the trees will have to wait more than one week from the time the petals are off until they are sprayed.

A good power outfit for spraying will do to take care of twenty acres of apple orchard that is twelve or more years of age. It will be a mistake to expect it to do much more than this.

Large trees require from six to ten gallons of liquid each for a thorough first spray. If the average is eight gallons and there are eighty trees to the acre, it will require sixty-four tanks of two hundred gallons each to make the application.

If the weather is warm, some varieties will close their calyxes within six days from the time the petals are off, and the little apples that close their calyxes first are the ones most likely to set and make fruit.

When making the first spray, the grower must determine upon one thing, if he is to get anything like perfect fruit, and that is to *stay with each tree until every calyx has been filled with the spray.* He should stop occasionally and examine the blossoms to find out whether this is being done.

With large trees always have a tower or platform above the tank where two men may stand with long rods to spray downward while one or two men with short poles upon the ground spray upward through the trees.

A pressure of one hundred to one hundred fifty pounds is sufficient to do good work, if proper nozzles are used.

San José Scale. See under *Plum.*

DISEASES OF THE APRICOT

Blight (*Bacillus amylovorus*). —The germs of pear-blight occasionally attack apricot trees. The twigs and branches are killed, and the fruit rotted much the same as pear or apple trees are attacked.

The only remedy is to cut out and burn the infected parts. See *Pear.*

San José Scale. See under *Plum.*

INSECTS OF THE CHERRY

Pear-tree Slug (*Eriocampoides limacina*). — While the slug is primarily a pear-tree insect, it is more common on cherry trees. It is the larva of a fly, slimy in appearance, resembling a snail. It feeds on the upper surface of the leaves, rapidly skeletonizing them. It is common to see cherry trees denuded of foliage by these insects in midsummer. This results in serious damage to the trees ultimately, but there is no excuse for such injury as the slugs are easily controlled.

Fig. 97.—An almost Perfect Pack of Apples, by A. I. Mason, Hood River, Oregon.

The treatment consists in spraying with white hellebore or with arsenate of lead. Most of the insects may also be killed by simply dusting the trees thoroughly with air-slaked lime, wood ashes, or with road dust.

San José Scale. See under *Plum.*

DISEASES AND INSECTS OF THE PEACH

Fungous Diseases

Crown-gall. See under *Apple.*

Mildew (*Podosphæra oxyacanthæ.*) — This is the only disease for which our orchardists have found it necessary to spray, and that in only comparatively few instances. This is a surface-growing fungus, and in its early stages appears as white frost-like patches on leaves, twigs, or fruit. The leaves on new growths are most susceptible to attack and are often much crumpled and dwarfed, and later many of them fall. Thus the twigs are checked in their growth or killed outright, and the leaf surface reduced. It attacks the fruits when they are young, and the flesh under the spots becomes hard and the skin takes on a brown color. The hardening of the flesh arrests development at that point, and consequently the peaches are unmarketable. Entire crops have been ruined in this way.

Fortunately, mildew is easily controlled by spraying with bordeaux mixture, preferably in early spring before the leaves are out. If spraying is deferred until the leaves have started, only half of the amount of copper sulfate may be used. Bordeaux mixture of full strength is usually fatal to peach foliage.

Yellows. — The true peach-yellows has never been found in this region. In a number of localities, however, peach trees have developed yellow foliage, and some of the trees have died, and thus the suspicion has been aroused in some quarters that this dread disease has at last made its appearance in our orchards.

The first thing one notices in going into such localities is that not only are the peach trees affected, but that other trees present a similar appearance; even the cottonwood is not exempt. But there is in reality little similarity between this condition and true peach-yellows. There is no premature ripening of fruit, no clusters of small branches, and the trees may bear yellow foliage for a number of years and eventually recover, — something unheard of with peach-yellows, where death is swift and sure. Instead we find pale yellow or greenish yellow foliage, stunted growth, small fruit, bare branches with small clusters or rosettes of leaves at the end, and eventually dead branches and finally dead trees.

In all localities which have come under our observation, the affected trees occur on marly land, which is described on page 19. It is true that many orchards of vigorous trees may be found growing in this kind of soil, but it is also true that it is more difficult to keep the trees in good condition. In many of these orchards the culture has not been suited to the conditions, consequently the supply of available plant-food has been depleted, and the ground has become so compact that it is almost impossible for the absorbing roots to develop. When for any reason the soil conditions become uncongenial, it is impossible for many absorbing roots to form, consequently malnutrition results. The tree responds promptly, and the yellow foliage is the signal of distress. The importance of understanding the nature of plants as set forth under the heading of "The Orchard Plant" (page 53) should now be apparent to all. Had these growers fully understood the delicate nature of their trees, much of this loss and worry might have been avoided.

As to the remedy, it should be understood that marly land is not the best for orchards, but it has been made to grow profitable fruit plantations. As has been intimated, good culture must be practiced; when yellow foliage appears, the grower must change and improve his methods. We would recommend first that the ground be plowed late in the fall to a depth of at least six inches, and deeper if practical. In the spring plant some leguminous crop, as red clover. Do not cut any of the crop for hay, but return it all to the soil. Plow this material under in the fall, and repeat the process the following season. It may be advisable later on to allow the crop to stand for two seasons before plowing, but this must be determined by the conditions. In all cases the irrigation furrows must be kept open so that the water may be spread without overwatering the trees closest to the ditch. Well-rotted manure may be used in place of the green-manure, but in most orchard districts stable manure is not available, and for various reasons it is not so well adapted to the purpose as growing plants.

The writers have seen the plan as above outlined carried out in several orchards, and the results have been almost phenomenal.

Insect Enemies of Peach

Brown Mite. See under *Apple.*

Peach Twig-borer (*Anarsia lineatella*). — This is the worst insect enemy of the peach with which the mountain fruit-grower has to contend. As soon as the buds begin to open, a small, brownish larva with a black head eats into the buds and destroys them. When the new shoots start, the borer eats into them, causing them to wilt and die. Many of the second brood of this borer eat into the peaches, causing a gummy exudation and ruining them for market. The larvæ that appear in the spring spent the winter in little excavations which they made in the fall in the bark of the trees.

The treatment for the twig-borer consists in spraying the trees in the spring just before the buds open. The lime-sulfur mixture, or whale-oil soap in the proportion of one pound to two gallons of water, or arsenate of lead, one pound to 20 gallons of water, may be used.

We are not accustomed to think of peach trees as requiring systematic spraying, consequently young peach trees are sometimes neglected. If the borers get a start in the spring and are not checked, the second brood may be so numerous by midsummer as to seriously injure the growth. If it is found that these insects are numerous at any time during the growing season, a thorough spraying with arsenate of lead, of the strength recommended for codlin-moth, will be found to be both safe and effective.

Plant-lice. — The plant-lice that attack the foliage of the peach tree may be treated in the same way as the apple plant-louse. The black cherry-louse has not become thoroughly distributed as yet, and every effort should be made to exterminate it as soon as it is discovered.

San José Scale. See under *Plum*.

DISEASES AND INSECTS OF THE PEAR

Fungous Diseases

Blight (*Bacillus amylovorus*). — This disease is known under a variety of local names such as pear-blight, fire-blight, apple-blight, and sometimes, according to the parts attacked, as twig-blight, blossom-blight, body-blight, and root-blight. It is most destructive in its attacks on the pear, but is also very injurious to the apple and the quince. It also attacks the apricot and plum on occasion, but its injuries to these hosts have never been severe.

This, the most destructive of all orchard diseases, has been known in America for more than a century, and it is scarcely necessary to observe that during these many years of disastrous outbreaks, nearly every conceivable theory as to the cause of the disease has been advanced. These notions have been threshed over and over as new localities have been invaded year after year. A number of localities in this region are now having their first experience with blight, and a few are still exempt. Consequently, these many theories are being rediscovered and advocated by their adherents. One of the more recent causes to be advanced is a variation of the frozen-sap theory, which was first advocated by A. J. Downing in his "Fruits and Fruit Trees of America," which was published in 1845. The germ theory of the cause of the disease was first advanced by Burrill of the University of Illinois in 1878. In 1880 he made a more complete report of his work. He found that he could produce blight in healthy apple and pear trees by inoculating with diseased tissue or by simply pricking a healthy limb with a needle which had been dipped in juice from diseased bark. Although the micro-organisms were found in all cases, such experiments could not be accepted as positive proof. In other words, was it the germs or was it the "poisonous sap" which caused the disease?

The work of Arthur at the New York Agricultural Experiment Station, in 1884 and 1885, should settle this point forever. Dr. Arthur made cultures of blight germs in a liquid medium, which were taken from blighted trees. These were pure cultures and were carried through a number of generations. Blight was produced in trees by inoculating with the last culture. But to satisfy those who might still say that the injury was due to the liquid and not to the germs, inoculations were made with the liquid from which the germs had been removed. This was accomplished by filtering through earthenware cells. The filtered liquid was found to be entirely free from germs, and all inoculations with it failed entirely to produce results.

These experiments, which have been duplicated by many experimenters, prove beyond any possible doubt that this specific micro-organism is the cause of blight. The germs, which are a low form of vegetable life, feed on the cambium layer of the plant. They gain entrance only through wounds in the bark or through very tender tissue, such as is found in the nectaries of flowers and possibly through the small openings which are abundant in leaves and in the green bark of young twigs.

Where do these germs originate? is often asked. Because they are too small to be seen with the unaided eye this is difficult to understand. They should be regarded simply as microscopic weeds which live within trees instead of in the soil. We cannot always satisfactorily explain where weeds come from, yet they are always with us. Waite, of the Department of Agriculture, has demonstrated that the germs must be distributed by mechanical means, and that insects are very important agents in spreading the disease. He found the germs developing in the nectar in the blossoms and also found them adhering to the mouth parts of honey bees after they had visited infected flowers. Thus it will be seen that after one blossom has been infected, the disease is spread rapidly, as numerous insects of various kinds visit flower after flower. This accounts for the blighting of bearing trees, while those which for some reason failed to bloom may be entirely free.

But the more important point in the life history of these germs is their mode of living over winter. In the great majority of instances the organisms die as the tree takes on its dormant condition. In the eastern states there is but little evidence of the disease being in an active state of growth after the middle of the growing season, for the reason that the tissues become hardened. These germs thrive best in rapidly growing, succulent tissue. But under irrigation trees are often kept growing late in the season, much to their detriment, so that blight is sometimes found in an active state in October. A definite boundary between live and dead bark is an indication that the germs are dead, and this is the usual appearance of blighted limbs at the close of the season. But a few blighted areas may always be found where this separation is not distinct, and it is in these that the germs live over winter. The following spring the organisms start into growth with the activity of the tree, and a thick juice is exuded, which runs down the branch or trunk. This juice contains countless numbers of the germs of pear-blight, and it is from such cases of "hold-over blight" that many new infections ultimately arise. If there were no cases of hold-over blight, there would be no source of infection, and the disease would be a thing of the past.

It should be easy to understand, with these facts in mind, that no spray or wash that might be applied to a tree would have the slightest effect in controlling blight. But now that the life history of the disease is known some preventive measures may be taken which will lessen the amount of damage.

The removal of all hold-over blight in the fall should be mentioned as of first importance. The trees should be gone over carefully in the fall and again in spring, and all blighted limbs cut out. It does not seem to be possible in actual practice to detect them all, but much good may be accomplished in this way. Diseased branches should also be cut out during the summer to prevent further injury to the tree as well as to reduce sources of infection. Care should be taken, particularly in the summer, to make the cut ten or twelve inches below any sign of discolored bark or wood, so that no germs may be left. And as a further precaution the knife or saw should be disinfected after each limb is removed so as to kill any germs which might adhere and so prevent any possibility of spreading the disease in this way. A solution of alcohol, or of corrosive sublimate, one part to one thousand, or kerosene, may be used for this purpose. Waite reports that he has reduced blight to a minimum in large orchards by carefully following this plan.

We have already noticed that the most vigorous trees are the most subject to blight, and we have also seen that as soon as the tissues become hardened, the advance of the disease is checked. Here, then, is a hint to induce a slow, hard growth by lessening the food supply. Water is both a food and the conveyor of food, so by regulating the water supply we can in a measure control the food supply.

One of Waite's experiments proves this so completely that we will be pardoned for quoting him again. Two potted pear trees, both in active growth, were inoculated with pear-blight. After the disease had made good progress in both trees, water was withheld from one of them during a period of two weeks. It received just enough to keep the leaves from wilting, while the other was given the normal amount. "As a result, the blight stopped in the dried-out tree as soon as the water was withheld and progressed no farther, while in the watered tree it kept on until it killed the whole top."

No experiments have been reported which prove the practicability of withholding water, under orchard conditions, as a means of controlling blight. But the writer had an opportunity of studying an orchard in the summer of 1904 which had been without water for two and one-half years. The effect of this enforced drought on checking blight was very marked, and it also showed that pear trees can exist in this location for a considerable period without irrigation or cultivation. These results would probably be the same in all of the pear-growing sections where irrigation is practiced.

The orchard referred to was located on the side of a gradual slope. All other farms and orchards in the vicinity lay below, so there was no possibility of seepage water reaching these trees. The ditch which supplied the orchard with water broke in the fall of 1892, and as money was not available to make the necessary repairs, the orchards had been abandoned. At the time of my visit, June 25, 1904, many of the trees were still in good condition. This was especially true of the Winesap apple. The Jonathan trees were still in condition to be saved, but they were less vigorous than the Winesaps. Most of the Ben Davis trees were still alive, but the majority of them had put forth few or no leaves. About one-half of all of the apple trees of all varieties were dead, as well as most of the peach and plum trees.

But more remarkable was the appearance of a block of eight-year-old Bartlett pear trees. Most of the trees were still in a fairly vigorous condition, some of the twigs of the previous season's growth measuring 14 inches in length. The average of the current season's growth was about four inches, and quite a little fruit had set on some of the trees.

The inspector had visited the orchard each season, and he found that in 1892 blight was quite abundant in the pear trees, and some of them died from its attacks. The following year there was still a good deal of blight, though there was much less damage than before. At the time of my visit, June 25, 1904, there were but few twigs in which the disease had been active that season, and the germs were apparently dead. The dead bark of the blighted areas was surrounded by a definite boundary and had separated from the living bark.

These results show that the germs of blight do not thrive in slow-growing trees, and in fact that the disease may be eradicated by prolonged drought. They also show that pear trees will remain in good condition for some time without irrigation or cultivation. But just how far this could be carried in actual practice remains to be seen, but one cannot help but surmise that bearing pear orchards might be successfully handled with very little irrigation, depending upon cultivation or the lack of it to regulate the water supply.

The form of trees may be modified so as to lessen the injury by blight. For this reason an open-centered tree is preferable, as three or more main branches take the place of one. The blighting of the leader very often causes the death of the two-storied tree, whereas with three or more scaffold limbs, one may be removed without serious loss.

Blight usually gains entrance to the trunk and larger limbs through short fruit spurs and watersprouts. Such growths should not be allowed to form on the lower portions of the scaffold limbs. Longer fruiting-wood is allowable, but a departure from the rules of good pruning will make trees less liable to injury by body blight.

No doubt all growers have noticed that some varieties blight worse than others. The Bartlett pear is in this class, while the Kieffer is perhaps the most resistant. Sweet apples and the crabs are also very susceptible. Experienced growers soon recognized these differences and have selected their varieties for recent plantings accordingly.

Personally, we believe that the pear-growing industry in the West is doomed. Even in the few sections where a good many acres still remain the disease is gradually spreading, and from present appearances it would seem that in a comparatively short time these orchards will be worthless. This is a condition greatly to be deplored, as the pear is one of the finest fruits, and it has been a very profitable one to grow. But there is the consolation of knowing that with the passing of the pear trees a constant source of infection for apple trees is eliminated.

Insect Enemies of Pear

Codlin-moth. See under *Apple.*
Green Aphis. See under *Apple.*
Howard's Scale. See under *Plum.*
Pear-slug. See under *Cherry.*
San José Scale. See under *Plum.*

DISEASES AND INSECTS OF THE PLUM

Fungous Diseases

Crown-gall. See under *Apple.*

Insect Enemies of Plum

Brown Mite. See under *Apple.*

Howard's Scale (*Aspidiotus howardi*). — There are a number of forms of scale insects, none of the females of which have the power of locomotion in the adult stage. In the group to which Howard's scale belongs the insects are incased in hard shells, or scales, about one-sixteenth of an inch in diameter. They are light to dark gray in color except that the raised, central point is orange-red. They are inconspicuous, and trees are often badly infested before their presence is discovered. A mass of eggs is produced under the scales from which the young emerge throughout the summer. These tiny insects crawl about for a few days, then settle down and remain stationary during the rest of their lives. They injure trees by sucking the juices. They resemble closely the San José and the Putnam scales, and one is often mistaken for the other. Howard's scale is sometimes injurious, but is easily controlled by applications of the lime-sulfur mixture during winter or early spring. If it becomes necessary to spray for them when the leaves are on, whale-oil soap should be used.

Pear-tree Slug. See under *Cherry.*

Plant-lice. — Give the same treatment as for Green Apple Aphis.

San José Scale (*Aspidiotus perniciosus*). — This minute insect is perhaps the most dreaded pest that has yet appeared in the orchards of North America. So severe are its attacks that large trees may be killed in from one to three years after being infested.

This insect resembles closely the Howard scale, and for our purpose the description of one will answer for both, as only an expert can determine definitely the different species. It should be mentioned, however, that the San José scale is not nearly so particular in regard to its food plants, as it thrives almost equally well upon the various members of the rose family, to which most of our fruits, both large and small, belong. It may also infest some of the forest trees and shrubs.

Thus far, this insect has not been particularly troublesome in this region, and, in fact, it has never been found in some of the states. We hope that this immunity may be due to the inability of the scale to thrive in the higher altitudes.

The remedy for San José scale is the same as for the Howard scale.

SPRAY PUMPS AND SPRAYING

Pumps with metal valves should be used for the application of insecticides or fungicides in liquid form, as the materials harden or decompose leather valves so that they last but a short time. If bordeaux mixture is to be used, all parts of pumps and nozzles that come in contact with the mixture must be made of brass, as the chemicals very soon destroy iron. Wooden tanks must take the place of metal. If the pump is to be used with a tank or barrel, it is also important to have some kind of attachment that will keep the liquid agitated, so that the materials in suspension will not settle. A common error is to purchase a pump of too small capacity, because it is cheaper. A smaller, cheaper pump usually means less accomplished in a day with the same help and a poorer job, with a greater expenditure of labor. It is often important to complete the spraying in as short a time as possible after it is begun. To do this, a pump of large capacity with two or more leads of hose is necessary. The hose to which the nozzles are attached should be as light as possible and still have the requisite strength — a hose of good quality with heavy wall, but small caliber. Bucket pumps are sold by different dealers at prices ranging between about \$2 and \$8. They are suitable for use among garden vegetables, shrubbery, and all low plants, but should not be purchased for orchard work if one has more than a very few trees to treat.

FIG. 98.—Three-year-old Elberta Peach Trees, at Farmington, New Mexico.

If one has light spraying to do and is without help, the compressed-air sprayers are very convenient. Large compressed-air machines that derive their power from gearing attached to the wagon wheel are specially adapted to the treatment of low plants, but it is doubtful whether any spraying machines of this class on the market are well adapted to the spraying of large orchard trees where the wagon must stand still a large part of the time while the spraying is going on.

When large orchards are to be sprayed, it is a matter of necessity and economy to use tanks that will hold 200 and 300 gallons, and pumps of large capacity. In such orchards gasoline power sprayers are most useful and are becoming more and more common. Heavier engines are now being used, those of two and one-half and three horse power being preferred. They are more stable and give less trouble than lighter ones.

The first requisite for a good job of spraying is a pump that will give plenty of pressure in the hose. Then, if one has a good spraying nozzle and a liquid that is free from solid particles of a size to clog the sprayer, there will be no difficulty in securing a good spray.

Barrels and tanks should always be filled through a strainer to avoid loss of time and annoyance through the clogging of nozzles.

A very fine spray is most economical of material and for an even and thorough distribution is best, and is specially useful for the destruction of caterpillars, slugs, and other insects that devour the foliage of plants. In spraying the first time for the codlin-moth, however, it is recommended that the spray be a medium coarse one.

By this we do not mean that the spray should be composed mostly of large drops produced by the breaking up of a solid stream thrown forcibly into the air, or that it should not be a fine mist or fog. A rather coarse vermorel, or a good bordeaux nozzle with a pressure of 100 or 125 pounds, will furnish such a spray. When spraying is being done to destroy leaf-eating insects, care should be taken not to spray too long in one place, as this will result in the little drops that collect on the leaves uniting and running off, carrying the poison with them. Here, again, this rule does not apply to the first treatment for the codlin-moth. In that application there should be but one end in view, and that to fill every blossom-end or calyx-cup with the spray.

Two types of nozzles are used almost exclusively for the distribution of liquids. Perhaps the most popular are the bordeaux and the clipper nozzles, which throw a flat spray or a solid stream, and the vermorel nozzles which throw a cone-shaped spray which may be graded from medium coarse to extremely fine, depending upon the pressure and the tip that is used upon the nozzle. It is a big advantage in nozzles of this class to have them joined to the connecting end so they may be turned at any angle to the rod that is desired.

Any of these nozzles may be used singly or in batteries of two or more.

FORMULAS

Arsenate of Lead. — This compound contains only about 20 to 25 per cent of arsenious acid, but has some important advantages over the other arsenical compounds. It is so slightly soluble in water that it may be used in almost any strength without injuring foliage, and consequently is least likely to injure plants which are most sensitive to arsenical poisons. When suspended in water, this poison is so finely divided that it settles slowly, and consequently can be more evenly distributed than most arsenical mixtures. Its third point of superiority is in its adhesive qualities when applied to foliage. Applications made to foliage in the latter part of May at the Colorado Agricultural College could be seen upon the leaves the first of September. The disadvantage of the poison is its not being quite so quick to kill the insects that eat it as are the other arsenites, consequently it is necessary to use it in stronger mixtures.

The formula recommended is as follows:—

Arsenate of lead	2 to 4 pounds
Water	100 gallons

A stomach poison as are all preparations which contain arsenic.

White Hellebore. — Hellebore, as obtained from drug stores, is a light, yellowish brown powder. It is a vegetable stomach poison and is obtained by pulverizing the roots of an European plant, *Veratrum album.* It is not as poisonous as the arsenites, and consequently it is not as effective in the destruction of most insects, but it has its special uses. Slugs, which are the young of saw-flies, are particularly susceptible to its effects. The poisonous property is an alkaloid, and it loses its virtue after being exposed to the air for a few days. For this reason it cannot be used where it is likely to remain long before being eaten, and it must be kept in tight receptacles and must not be kept too long before using. It is often useful for the destruction of insects upon plants containing fruit which will soon be used for food.

Dry applications are easily made upon low plants by making a small cheesecloth sack, through which the dust may be sifted lightly over the foliage. The best time to apply is in the evening.

In the wet way use:—

White hellebore	1 ounce
Water	3 gallons

Apply as a spray in the evening.

Black-leaf Sheep Dip. — A proprietary decoction of tobacco which has recently come into prominence as a contact poison in combating sucking insects. It is used on dormant trees as strong as one gallon to 25 gallons of water. For use during the growing season one gallon of Black Leaf to 70 gallons of water is commonly used.

This preparation is being generally adopted as the best poison for combating the different forms of aphis.

Whale-oil or Tree Soap. — For ordinary plant lice one pound of the soap to eight or ten gallons of water is sufficient if the application is thorough. Double this strength will not injure most plants and is often required to destroy more resistant insects. For scale lice, like the San José scale, for example, it is used as strong as one pound, or even two pounds to a gallon of water. These strongest applications can only be used in the winter or early spring when the trees are dormant. The soap is more effectual if applied when quite hot. The soap solutions kill by contact only.

Lime-sulfur Wash. — This wash, when properly made, is one of the most effectual applications for the destruction of scale insects and eggs of the brown mite by contact, particularly in dry climates. It should be used only in the winter or spring, while the trees are dormant. The ingredients may be in the following proportions: —

Lump lime (good)	20 pounds
Sulfur	15 pounds
Water	50 gallons

Slake the lime, preferably with hot water, in an iron kettle or a barrel, and while slaking, slowly add the sulfur and stir it in. Then boil over a good fire or by means of a jet of steam in about one-half the required amount of water (25 gallons) for 45 minutes or until a dark red color is obtained.

The need of a fungicide to replace bordeaux mixture has led to experiments with various sulfur mixtures. A recent bulletin of the United States Department of Agriculture reports favorable results from the use of a self-boiled lime-sulfur mixture. It is made as follows: Place 15 pounds of fresh stone lime in a 50-gallon barrel, and pour two or three gallons of cold water over it. Immediately add the sulfur and another pail of water. Stir as necessary, to prevent burning and add more water if the mass gets too thick to stir; but as little water as possible should be used. When the boiling ceases, dilute with water to make 50 gallons, stir thoroughly, strain, and the mixture is ready for use.

The Rex preparation has given good results in our experiments in controlling grape mildew, so that there is no doubt but that the self-boiled mixture should give equally as good and perhaps better results.

Tobacco. — Tobacco has long been used in one way or another for the destruction of insects. Its chief use seems to be for the destruction of lice. When slowly burnt, the smoke may be utilized for the destruction of lice on plants in greenhouses or window gardens. In the form of a fine dust it is often effectual in ridding plants of flea-beetles, and in the form of dust or stems is one of the best remedies we have for woolly aphis on the roots of apple trees.

A decoction made by boiling tobacco dust or stems in water, in the proportion of a pound to three or four gallons, is destructive to plant lice and to lice upon cattle. Tobacco very finely powdered may also be used in the dry form against the same insects. It is best to first spray the insects with water.

Bordeaux Mixture.— Formula A.

Copper sulfate (blue stone or blue vitriol)	4 pounds
Quick lime	4 pounds
Water	45 gallons

Formula B.

Copper sulfate	2 pounds
Quick lime	4 pounds
Water	45 gallons

Only fresh unslaked lime should be used. It should be slaked in water in a separate vessel, diluted to a thin whitewash, and strained through a strainer with openings the size of a pinhead. This prevents the clogging of the nozzles with any of the coarse material left after slaking. The copper sulfate should be dissolved in warm water if wanted for immediate use. It may be dissolved in a considerable quantity of cold water by suspending it in a sack just beneath the surface. If to be used in large quantities, it is well to make up a stock solution by dissolving fifty pounds in twenty-five gallons of water. Keep well covered to prevent evaporation. Two gallons of this solution contain the four pounds of copper sulfate called for in Formula A, or one gallon contains the two pounds called for in Formula B. The required amount of this solution should be diluted to at least thirty gallons before the lime water is added. The lime may be slaked in large quantities, in which condition it will keep well all summer, and the amount of lime water or paste required may be determined by a chemical test.

For this test potassium ferrocyanide may be secured of any druggist and prepared for use by dissolving in ten times its bulk of water. A quantity of lime water is then added to the diluted copper solution, stirred well, and a drop of cyanide dropped upon the surface. If it gives a reddish brown color to the mixture, more lime must be added and the test repeated until no reaction occurs. This indicates that all harmful acids of the copper have been neutralized, and the mixture is ready for use. Red litmus paper may be used and lime added until the solution turns the paper to a blue color.

Bordeaux mixture is used in combating plant diseases. It has no effect on insects, except that it acts as a repellent. It has been used successfully in this way in ridding potatoes and other vegetables of flea-beetles.

Bordeaux mixture deteriorates rapidly and should be used as soon as prepared. While being sprayed it requires constant stirring. In the preparation of the mixture no metal vessels or tools other than copper or brass should be used. Apply to apple and to pear trees only on bright days, otherwise the mixture is likely to injure both fruit and foliage.

Whitewash. — Whitewash is much used in California to protect trees, both young and old, from injury by sun-scald. The stubs made in grafting are also protected in the same manner.

The California formula is as follows:—

Quicklime	30 pounds
Tallow	4 pounds
Salt	5 pounds
Water	enough to make mixture flow well

This makes a tenacious whitewash not easily washed off by rains or removed by other means.

Grafting-waxes. — Several formulas are given for the preparation of grafting-waxes. There are the waxes applied warm with a brush and those applied cold, the heat of the hands being sufficient to make them pliable. With the first it is necessary to have special equipment to keep the wax melted in the field, and this generally limits its use to a few professional grafters who are prepared to use it. The cold waxes are prepared for use by melting together the ingredients, pouring the melted material in cold water, and pulling it like taffy until it becomes a buff color. It can be kept from season to season by immersing it in water. The common formula given for the preparation of this wax is four pounds of resin, two pounds of beeswax, and one pound of tallow. Paraffin may be substituted for the beeswax in this formula; although it seems that the resulting wax is hardly as durable, it serves the purpose very well. By increasing the amount of resin in the above formula to six pounds, it makes a very good hard wax for warm application. Another good wax to be applied warm is prepared by melting together three pounds of resin, one pound of beeswax, and one pint of raw linseed oil.

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