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THE MINNESOTA ORCHARD[1]

By K. A. Kirkpatrick, Division of Agricultural Extension

There is no part of Minnesota where enough of the tree fruits may not be grown to supply the home and the local market needs provided: (1) That the grower will give careful attention to the choice and preparation of the site where the trees are to be planted. (2) That only adapted hardy varieties, the stock of which has been propagated in an approved manner, are used. (3) That the trees have the proper care and attention in the formative period. (4) That the grower will give them reasonable maintenance care, taking into consideration at all times that Minnesota is a big state with varying soil and climatic conditions that must be recognized.

Failures in fruit growing in Minnesota result from one or more of the following causes: (1) Winter injury by low temperatures and drying winds. This trouble is always worse in open winters. (2) Snow drifting into the trees and breaking them down. (3) Rabbits and mice gnawing the trees. (4) A poor site. (5) Careless or insufficient preparation of the soil before planting the trees. (6) Getting trees that are untrue to name or that are not adapted to local conditions. (7) Getting trees that have not been rightly propagated. (8) Laying out the orchard improperly; either overcrowding or setting the rows to run in the wrong direction. (9) Neglecting to prune the trees during the formative period as well as later. (10) Lack of knowledge of the life histories of the principal insects and plant diseases, and consequent failure to spray properly for their successful control. (11) A feeling on the part of many persons that "it can't be done," or "an orchard is too much trouble."

Home-grown fruits are desirable for several reasons. Fruit from other sources is sometimes of poor quality and must often be picked green in order to ship well. Not only is the family table better supplied with fruits conducive to the best of health by using home-grown fruits, but the family funds are largely conserved.

By planting an assortment of kinds and varieties known to be adapted to local conditions, a continuous supply for the table throughout the year may be assured if the surplus is canned or dried.

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[1] This bulletin supplants Farmers' Library bulletin 22, Establishing the Orchard. The scope of the bulletin has been enlarged to include a few pertinent suggestions on the maintenance of the orchard and the disposal of the fruit crop.

The writer hereby acknowledges suggestions and valuable assistance from W. G. Brierley, R. S. Mackintosh, A. G. Ruggles, and A. G. Tolaas, of University Farm.

A well-kept orchard is the crowning distinction of a good farmer and the best farm home.

Those interested in the growing of small fruits should send to the Office of Publications, University Farm, St. Paul, for Farmers' Library bulletin 16, Strawberries and Bush Fruits for the Farm, by LeRoy Cady and K. A. Kirkpatrick.

COMMERCIAL ORCHARDING

In some parts of Minnesota, notably the Minnetonka district and several favored locations along the Mississippi River in the southeastern part of the state, commercial orcharding has attained pronounced success. Such an industry will be successful in a limited way in Minnesota. The elements for success are: Nearness to market; good transportation facilities; and abundant labor, available on short notice at a reasonable wage, for spraying, picking, packing, and general care. The present tendency undoubtedly is to get away from commercial orcharding as compared with fifteen years ago, and more emphasis is being placed on the home orchard, composed of a few well-selected trees properly cared for.

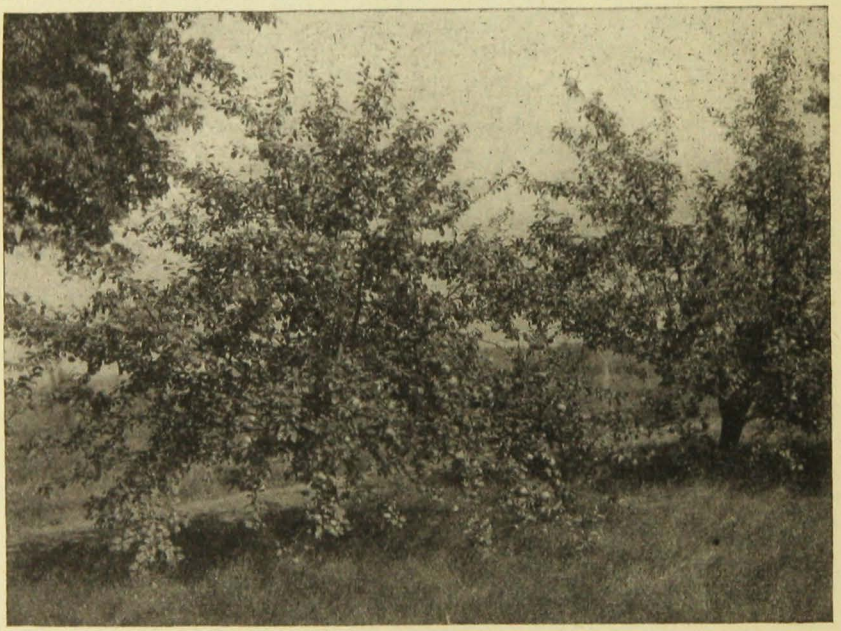


Fig. 1. Minnesota Fruit Trees

These trees are in a corner of the Edward Ellingson orchard, Bloomington Township, Hennepin County. Mr. Ellingson was induced to spray by the county agricultural agent, with remarkable results.

ESTABLISHING AN ORCHARD

Size

The use of from half an acre to an acre, including the small fruits or in addition to the space given to them, will provide sufficient fruit for the ordinary farm family. Figure 2 is a suggested plan for a fruit plantation.

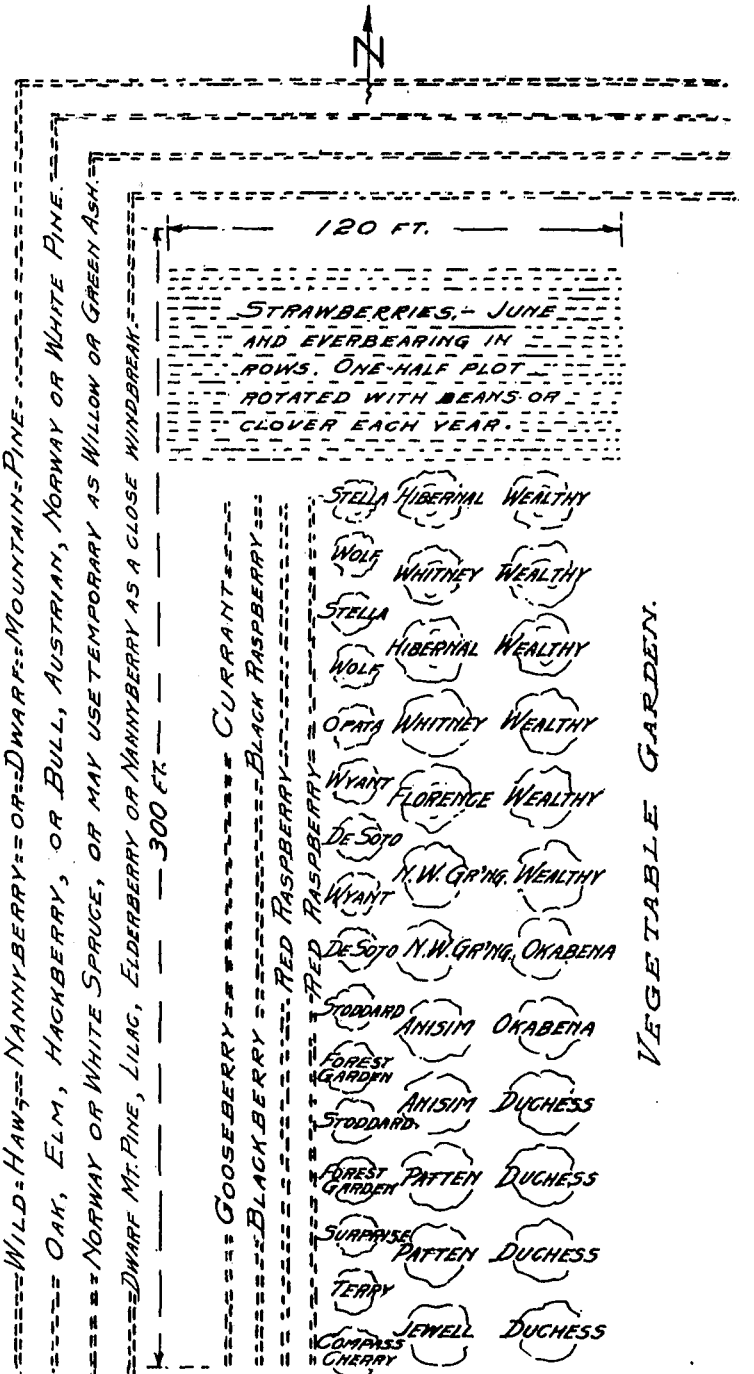


Fig. 2. Suggested Plan for a Minnesota Home Orchard of Approximately One Acre
The windbreak, which is not included in the one acre, is planned with shrubs on the inner and outer margins in order to stop the snow more effectively.

Location

It is always desirable to have the orchard near the house. However, if the part of the farm devoted to the farmstead is not suited to orchard growing, the orchard should be given the best location even tho not near the house. Some of the chief distinctions of a good fruit-growing site are:

Elevation.—Land that is elevated somewhat above the surrounding country is likely to escape unseasonable frosts. Sites in or near low-lying flat or peat areas are almost sure to be affected by frost. Trees on high land are less susceptible to plant diseases.

Exposure and slope.—A slope is desirable because it is conducive to a constant shifting of air strata, preventing "air pockets" and "frost pockets" and securing good air drainage. A northern exposure provides a slower soil with more moisture. On winter afternoons the sun's rays strike the trunks and larger branches more obliquely. This results in less warming of the bark and consequent sunscald. The strong southerly winds of summer, which are usually damaging to an orchard, are warded off by the higher ground above it.

Proximity of water.—A broad river or lake adjoining the site is worth much as a tempering influence against unseasonable weather changes. If the body of water is north of the orchard, it will best serve this purpose.

Soil.—Orchard soil should have abundant moisture but free water should not be near the surface. Extreme hills and ridges should be avoided unless known to be composed of good loam with a clay subsoil. At any rate they are likely to wash badly when given the proper cultivation. Tracts underlaid with sand or gravel beds, if these are at all near the surface, give extremely poor results. Soil underlaid with still clay or hardpan will require thoro subsoiling in preparation or, in extreme cases, dynamiting the holes for the trees.

Drainage.—If parts of the orchard tract are boggy or seepy at certain seasons of the year, thoro tile drainage must be provided. In some localities where orchards are to occupy steep slopes, the lines of trees should be laid out on the contour lines in order to forestall washing. If the trees must be put on very flat areas, the plot may be back furrowed until the rows of trees stand in the center of backlands from 12 to 18 inches high and the width of the space between the rows. Tile drains should be laid under the dead furrows, or central low points, midway between the rows of trees. On sandy areas the reverse of this plan properly adapted has been used with good results. The ridging in this case collects the snow and rain and turns them to the roots of the trees, insuring a larger supply of moisture.

Preparation

It is a mistake to plant trees with the idea of working up the soil afterward or with the idea that a fruit tree can fight its own way just as a forest tree would. Wild or sod land should be cultivated for at least one year before setting the trees. Any field or truck crop that will leave the soil in good tilth may be planted.

Selecting Nursery Stock

Good stock is essential to success. Many orchards in the state have failed because the trees were not propagated right or were not of the variety ordered. If possible, trees should be bought from a home nursery in order that they may be taken directly from the ground in which they are growing to the new location and because the stock is more likely to be true to name. The more the stock changes hands, the greater the possibility that labels will be lost or misplaced.

Stock should be propagated in the manner approved as best for Minnesota conditions. A long cion and a comparatively short mother-root for the root grafts is urged in propagating young trees. This puts the union of the cion and the root, the hardiness of which is not known, far below the surface of the ground and in case the mother-root is killed by a severe winter, a large part of the root system has developed on the hardy cion and will be able to maintain the tree. Figure 3 shows two methods of propagation.

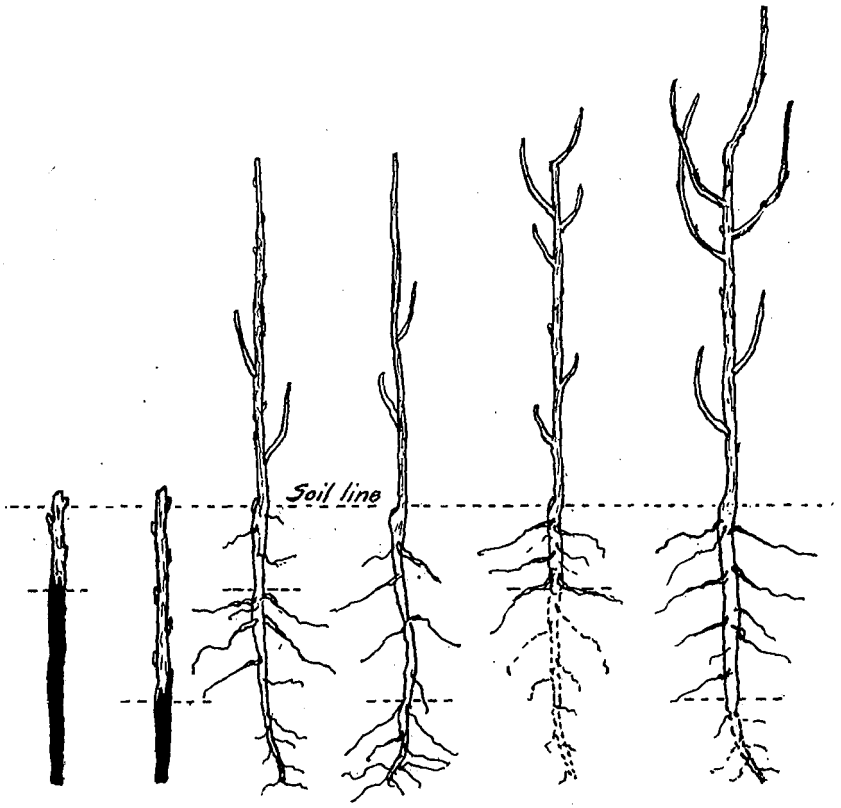


Fig. 3. Possible Results from the Two Kinds of Whip Grafts

The relation of the long-root, short-cion method to the soil line is shown at a, b, and c; the long-cion, short-root, at A, B, and C. If the roots are seedlings and from tender parentage, a severe winter will injure a large part of the root system under the first method, as shown by the dotted line in c.

Probably the best tree for orchard planting carries a good thrifty two- or three-year-old top. If the orchard is to have very good care, some prefer to use one-year-old tops, or so-called whips. The claim is made that this practice allows the branches to be formed to suit the ideas of the planter. In the other case the branching has already been started by the nurseryman. As he grows trees in quantity and makes his profits on a great many trees at a few cents each, he is seldom greatly concerned about the particular style of branching of the individual trees. As a result many nursery trees two and three years old show great crotchiness and extremely poor branching systems.

Size of trees.—All trees should be of good size for their age. There should be strong indications of health, thrift, and vigor. Sometimes trees that are not vigorous are held over and four- or five-year-old trees are sold for thriftier stock. These will undoubtedly give very indifferent results because there is usually some constitutional reason for the lack of thrift.

Time to order.—Trees should be selected before planting time. Some growers make a practice of selecting from the catalogs or by a trip to the nursery six months or a year before they are ready to plant. If the stock should arrive a week or more before the planting season, the trees may be heeled in until they can be planted. Heeling in consists in making a trench on the north side of a building or in a shady location, opening the bundles, and spreading the trees out at an angle of 45 degrees with their roots in the trench. The trench may run east and west, the tops of the trees point south. Earth is then thrown from directly in front of the line of trees up over the roots and trunks and if necessary another layer of trees may be put in the trench which has just been formed and covered in the same way. The soil may reach well up into the branches, or practically cover the tops of the trees. The soil should not be tramped down but left loose in order that the trees may not receive enough moisture to start growth while the air incorporated in the loose soil acts as a blanket to keep them from drying out. They may be kept ten days or two weeks in this way without injury. Care should be taken that the labels are fastened on the trees in such a way that there will be no confusion of varieties in taking them out for planting.

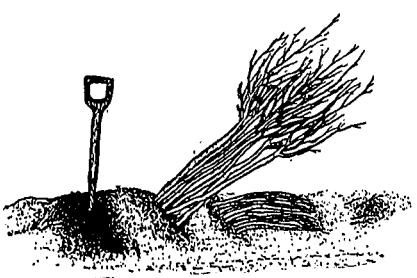


Fig. 4. Heeling In
The tops need not be covered unless they are to be left for some time.

Prices of nursery stock.—Prices of nursery stock are as variable as prices of clothing. Good reliable trees properly propagated can scarcely be expected at less than from 50 cents to $1 each. At less than this price, the trees often have not been well propagated or are from a mixed lot that will give a large percentage of untrue varieties. One can well afford to pay the home nurseryman a good price for rightly propagated home-grown trees of the variety desired.

Varieties to use.—Only hardy stock should be used. The planter will do well to make his selection from the varieties recommended by the State Horticultural Society. The list of tree fruits recommended in 1919 is given herewith. New lists may be had each year by addressing the Secretary, A .W. Latham, 207 Kasota Block, Minneapolis.

Apples

First degree of hardiness: Oldenberg (Duchess) Hibernal, Patten Greening.

Second degree of hardiness: Okabena, Wealthy, Malinda, Anisim, Iowa Beauty, Lowland Raspberry, Jewell's Winter, Milwaukee, Superb.

Valuable in some locations: Wolf River, Yellow Transparent, Longfield, Northwestern Greening, Tetofsky, Peerless, Salome.

Most profitable varieties for commercial planting in Minnesota: Wealthy, Oldenberg (Duchess), Okabena, Anisim, Patten Greening.

Recommended for top-working on hardy stocks: Wealthy, Malinda, Northwestern Greening, Grimes Golden, Milwaukee, McIntosh, Salome, Yahnke, Windsor Chief.

Varieties for trial: Eastman, Red Wing, Red Warrior, Dominion Winter, Dudley.

Crabs and Hybrids

For general cultivation: Florence, Whitney, Early Strawberry, Sweet Russet, Transcendent, Virginia.

Varieties for trial: Faribault, Dartt, Success.

Plums and Hybrid Plums

For general cultivation: De Soto, Forest Garden, Wolf (freestone), Wyant, Stoddard, Terry, Surprise.

Most promising for trial: Compass Cherry, Hanska, Opata, Sapa, Stella, Minn. No. 8, Minn. No. 21, Emerald.

Laying Out and Planting

Twenty-five trees of undoubted hardiness and of varieties adapted to the district, if they are well cared for, will supply plenty of fruit for the average family.

The advantages of laying out the orchard to a well-formulated plan are: saving of space, adapting the varieties to the space available, putting the orchard into the farmstead plan, and making the cultivation and care easier.

A great majority of the orchards planted twenty-five years ago were planted so closely that to-day, where there is an orchard standing, fruit is borne only on the tips of the branches. In many cases crowding has killed the trees before they attained their full usefulness. There should be plenty of room for each tree to develop its full individuality.

For the best development of the trees and that each may have full sunlight, it is desirable to have the rows run north and south if possible. The distance between the rows may be greater than that between the trees in the rows. Less damage is done by crowding in the north and south direction than in the east and west direction. Contour planting is advisable in hilly or broken locations, but more room is required for each tree than in the method just described. Contour lines follow lateral levels around a slope. If the slope is steep, it is often desirable to use a plow or a grader and throw out the soil so as to produce contour terraces on which the rows are planted. Some of the most successful orchards in the Mississippi River district have been planted in this way.

Time to plant.—Only spring planting of nursery stock is desirable in Minnesota and the Northwest, as the trees have too great an opportunity to dry out during the winter if planted in the fall.

Staking.—The positions for the trees should be marked by stakes before the actual planting is begun. This may be done by the use of a wire the length of the orchard. On the wire, strips of cloth may be tightly knotted at regular intervals to mark the points where the trees are to stand. After the wire is stretched across the tract, stakes should be driven at the marker points. The trees should generally be spaced from 20 to 30 feet apart north and south and

from 30 to 40 feet east and west. For upright growers like the Whitney crab and most of the plums, the distance may be shortened to from 16 to 20 feet north and south and from 16 to 25 feet east and west. Too much space is better than too little. The land may be inter-cropped for several years so it will not be wasted.

The planting board.—A planting board made as shown in Figure 5, is a great help in getting the trees in the right place. A six- or eight-inch board one inch thick and ten feet long may be used. In this bore a hole at each end and one in the middle about two inches from the edge, with a 2-inch auger.

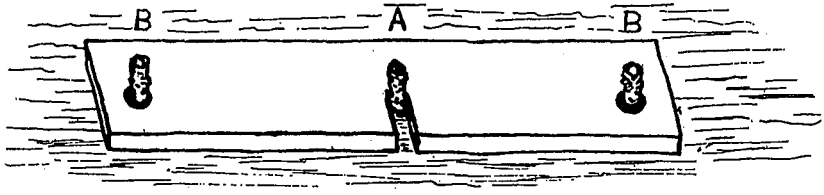


Fig. 5. Planting Board

Accuracy in planting is assured by using a planting board made from a seven-eighths inch board six inches wide and ten feet long.

The middle one may be opened up with a saw, as shown in the diagram. In using the planting board, the center opening should be dropped over the stake where the tree is to stand, with the back of the opening against the stake. Small stakes should then be put through the holes in the ends of the board. The board may now be removed to dig out the center stake, making a hole large enough to hold the roots of the tree. The board is then replaced on the end stakes and the tree fitted in the center opening in the board. This will hold it exactly in place while the soil is filled in around the roots.

Digging the hole.—Holes for planting should be large and roomy. Trees are someimes planted by the "post-hole" method. This consists in digging a very small hole, wadding in the roots of the tree, and putting a few spadefuls of earth on them. This is not good practice. The holes should allow all roots to take their normal position.

Where the subsoil is gravelly or rocky, it is often desirable to dig it out for a space of several feet and replace it with good top soil before setting in a tree. Very stiff clay subsoil should be dynamited or spaded out deeply and replaced, or the subsoil plow should be used. Such practice insures marked improvement in the growth of the trees.

Two persons are needed to plant a tree properly. One person may hold the tree, at first jarring it vertically to work the soil about the roots and then tamping the soil thoroly. The other person shovels the soil on the roots. Some people have the idea that tamping the soil about the roots of a tree will make it too soggy or hard. This is contrary to practical experience, if the soil is in good working condition. Tamping gets the soil particles in intimate contact with every part of the root system and thoroly establishes capillary action with the lower layers of soil, so that the moisture comes up to the roots at once. It is a very essential part of the process. About one inch of loose, well-pulverized soil should be left on top to act as a blanket.

Position of the tree.—The heavier branches of the tree being planted should be turned to the southwest. It is also advisable to give the top a slant of about ten degrees toward the southwest. This reinforces the tree against

the strong winds of summer. By these practices the shadows from the branches are made to fall more surely upon the trunk and scaffold on the afternoons of late winter, thus warding off sunscald injury.

Use of water.—No water is necessary when planting. It is really a detriment unless the soil is very dry. The process described above will accomplish results equal to those obtained by any watering method. It is sometimes desirable to put the trees in a barrel of water to prevent them from drying out and in order to have the roots freshly wet when they go into the soil. If many trees are to be set out, they should be made into small bundles according to variety and heeled in temporarily in the rows where they are to be planted. One or more trees can be taken out at a time without exposing the roots of the rest to the air for any length of time.

Training

The best training is that which begins when the tree is one year old. The one-year-old strong whip should be cut back to from 18 to 30 inches. Two- or three-year-old trees may sometimes be cut the same way, because most nursery trees are not grown with the final form in mind.

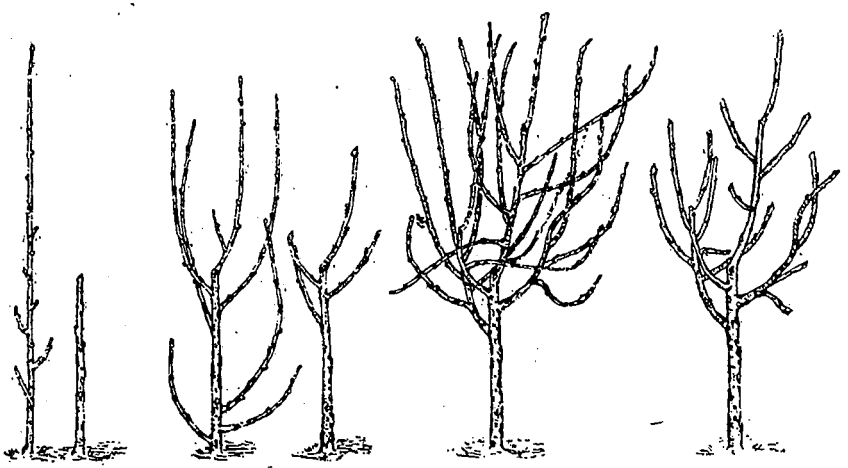


Fig. 6. Training the Young Tree
The sketch suggests the steps during the first three years, the critical time in orchard pruning.

The preliminary pruning should form a scaffold for the future top. The tree that has been cut back as suggested will throw out a great many branches, often ten or twelve, the strongest being the one that comes from the last bud left at the tip of the straight whip or stalk. The ideal scaffold should constitute a whorl whose base embraces 10 or 12 inches vertically and constitutes a complete circle horizontally. Five branches are best, as two or three are likely to form a crotchy whorl, while six or seven may give a scaffold that is too crowded. The semi-vase form of top is probably best for Minnesota conditions.

Beginning the second season the branches that are to form the scaffold should be selected and all others cut out. If the top is to be semi-vase form, a strong upright shoot or branch should be selected as the leader. In the ideal, this leader should be the center or hub of the circle and the five branches

should divide the circle into equal parts. The leader will afterward be cut out from two to three feet above the base of the scaffold, so that its after-growth is thrown outward to bisect the largest segment.

Beginning the third season, the lateral shoots on the original scaffold branches that are filling in the tree top should be cut out. The direction of the scaffold branches should be continued by thinning out and "cutting to a bud." In general, about one-third of the growth should be cut back each season besides cutting out most of the lateral shoots and all that lead toward the center of the circle that has been formed by the scaffold.

Cutting to a bud consists in using the principle that the terminal healthy bud left on the shoot or branch determines the direction that the new growth will take. If the last bud is left on the lower side of the branch, the new growth that comes from it will at first take a downward direction. If the bud is left on the upper or inner side, the resulting growth will be upward and inward. The strongest shoot thrown from a branch that has been cut back comes from the last thrifty and uninjured bud below the cut.

Cultivation

The objects in cultivating the orchard are: (1) To encourage a thrifty growth by conserving moisture and keeping the soil in the best possible condition so that the trees may obtain a liberal supply of plant food; (2) to keep down weeds; (3) to provide returns from the land until the orchard begins to bear; (4) to avoid winter injury through excessive drying of the soil; (5) to prevent attacks of fire blight; (6) to avoid insect injury and to overcome the effects of such injury.

Several methods of cultivation are in common use in Minnesota: (1) Clean cultivation either with or without an annual crop such as vegetables or corn; (2) clean cultivation in the early part of the season followed by a late cover crop such as rape, oats, buckwheat, or millet; (3) cultivation with or without an intercrop for the first two or three years, followed by clover or mixed grasses that are cut for hay; (4) the use of a permanent grass mulch which is usually pastured off; (5) piling about each tree the grass that is cut from between the trees, or mulching the trees with straw, cornstalks, manure, or wild swale hay; (6) in some of the hill sections, spading a space around each tree extending as far out as the spread of the branches.

Ideal orchard cultivation should be such as to encourage a thrifty early growth, enabling each tree to set a full crop of fruit buds and to ripen its fruit. A continuous and plentiful supply of moisture and plant food is needed during late spring and early summer. At the beginning of winter the new wood should be thoroly ripened and mature. Unless the orchard is perfectly level, a tough sod or grass mulch is likely to turn the water away from the trees. If there is a pronounced slope away from the trees or if they stand on a general slope they may suffer severely.

If the new shoots are too tender they are liable to injury from blight or other plant diseases and insects. Plant lice and attacks of blight usually go together.

When a mulch of straw, grass, or manure is used, the feeding rootlets are inclined to grow out of the soil into the mulching material. This is obviously true in an extremely dry period. If the mulch is removed and the soil underneath is cultivated once in two or three years and the mulch then replaced there is no objection to this method.

The soil can not be expected to furnish continuously all the plant food needed for fruit crops. Manure or legumes are as necessary to the fruit crop as to wheat and corn.

Tools.—The ordinary cultivating tools used on the farm, the disk harrow, spring-toothed drag harrow, stirring plow, and cultivator, may be used in the orchard, but a steady team and a careful driver must go with them. A high-spirited team or a careless driver may cause the utmost injury. Projecting parts of the harness should be wrapped with cloth or burlap so that the trees will not be easily injured if rubbed by them; better yet, high hames and similar projections should be dispensed with. For large orchards special tools are needed, an extension disk harrow, extension spring-toothed harrow or extension cultivator, and a special orchard harness, in order that good work may be done around low-headed trees.

MAINTAINING AN ORCHARD

Orchard maintenance includes all the operations such as pruning, spraying, thinning the fruit, and tillage after the trees reach the bearing stage. It is distinguished from the work of the formative stage, which includes the period from planning and planting to bearing time.

Pruning

If the tree has had the right formative training, the practice of cutting to a bud should be studiously followed so as to keep the tree lowheaded and inclined to the flattened cone formation. This means that trees with a naturally upright habit of growth must be cut to the outer bud continually; those with a spreading or drooping tendency may be cut to the outer bud until the proper width is reached, then the plan must be reversed. The semi-vase form must be kept in mind and the trees pruned annually. The growth should be cut back just enough that all fruit will receive direct sunshine for a short time each day.

The heads of the trees must not be kept so open that there may be long-continued periods of direct sunshine on the trunks or the scaffold branches during either summer or winter. This would invite sunscald, blistering of the bark, and other troubles.

A good test for the proper degree of opening in the head of a tree is to note whether fruit buds are being formed and fruit is coloring in the central part of the tree as well as at the extreme top and at the tips of the branches. If not, there is a strong probability that the head is too crowded.

Pruning for fruit thinning purposes may be undertaken probably with good results when the tree has been allowed to grow too much brush, when the formative pruning has been neglected, when there is an unusually heavy set of fruit, or when the crop is so large that the tree is not going to be able to mature and color all of it properly.

The impression is prevalent that annual summer pruning, including thinning by pruning, makes for moderate annual fruit crops rather than biennial extra heavy crops. Recent work in the orchards at University Farm does not bear out this impression. Biennial fruiting seems to be a weakness of certain varieties which cannot be overcome in every instance by any system of pruning yet tried. Those varieties which have been found not to respond to pruning for this trouble have in some cases reacted favorably to judicious fruit thinning.

Annual pruning.—Annual maintenance pruning assists nature. It is necessary in order to get the best crop of nicely colored fruit. The idea that pruning will kill a tree is exploded by tests made over several years' time at this and other experiment stations. Protection of pruning wounds with paint or wax is not necessary, but is probably advisable when the wounds are more than two inches in diameter. It has been found that wounds in general do not heal any faster or give any better results than when not so protected. The only precaution to be observed is to avoid blight and canker infection from one wound to another. It is wise to have a can of disinfectant, such as a strong formalin solution or a non-corrosive coal tar or lysol wash, at hand when pruning. The pruning tools should be dipped in this from time to time. Some of the wash may be applied to the wounds to disinfect the surfaces. As far as possible extremely large wounds should be avoided. They will not be necessary if the proper formative pruning has been done.

Necessary tools.—The proper and necessary pruning tools are: A substantial hand pruning shear, which should cost about $1.50; a swivel-blade pruning saw, about $1.75; a strong pruning knife, about 50 cents; a pole shear from 8 to 12 feet long, about $2.50. These are all the tools actually needed, but a good draw-cut lopping shear at about $2 may be added. A good step-ladder should be included in the outfit, and will cost from $12 to $15, altho a home-made tripod-style ladder will do as well. A garden trowel for cleaning the trunks of the trees and examining the crowns will cost 25 cents, and a whitewash brush for spreading the trunk wash will cost about 75 cents.

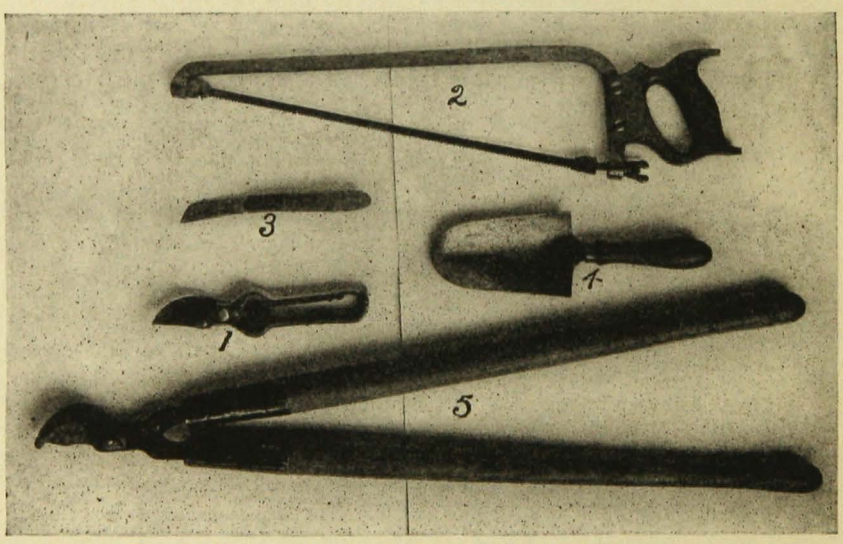


Fig. 7. Necessary Pruning Tools in Order of Their Importance

1. Hand shear
2. Swivel blade saw
3. Fixed blade pruning knife
4. Trowel (for scraping scaly bark, and examining for borers)
5. Lopping shear

A pole shear may be desirable, but is not shown.

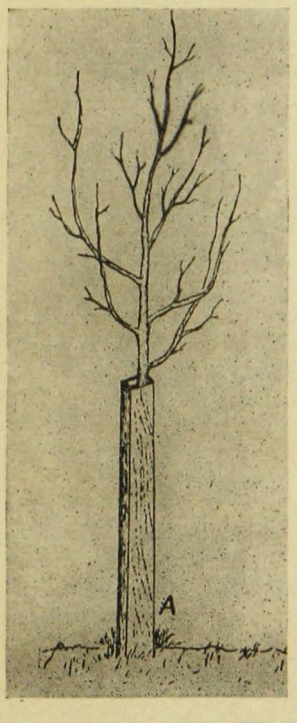
Top-Working

Top-working orchard trees is sometimes desirable when the trees are seedlings or are undesirable varieties. Top-working is also desirable in the central and northern parts of the state in order to increase the hardiness of the trees.

Hardy stock, as the Virginia or Hibernal, can be planted and after the third or fourth year top-worked to Wealthy or some of the more tender sorts.

Maintenance Tillage

It should always be borne in mind that the orchard exists for the fruit it will produce, and not for the livestock that can be pastured in it or for the hay. Hilly land will often require sod tillage, but it may be modified by cultivating about the trees with a spading fork to a distance equal to the spread of the branches. At first, comparatively deep cultivation should be given in order to force the root growth away from the surface. When the trees are older, the cultivation should be shallow, such as can be given with the disk or spring-toothed harrow. Clean cultivation until the middle of July followed by a heavy seeding of buckwheat or oats allowed to grow up and stand over winter, then cultivated into the soil in the spring is suggested for tracts where the slope is not too abrupt. The growth will catch the snow and prevent the soil from being swept by drying winds.



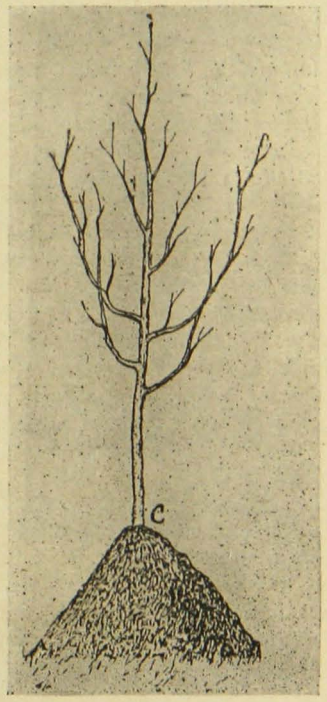


Fig. 8. Protecting Young Trees

a. Wood veneer wrapper

c. Mounding (this is often done in connection with a wrapper by slipping the wrapper up on the trunk until the mound of soil is in place.

Winter Protection

For the prairie regions the use of snow-breaks is advocated to prevent drifts from breaking the trees. In some cases a hedge of lilac, Siberian pea, or Russian artemisia has been planted at a distance of about a hundred feet

from the orchard on the north, west, and south sides. In very exposed locations it is advisable to have this windbreak one hundred feet back of an actual shelter belt of trees that stands close to the orchard.

Protecting from injury by animals.—To protect the trees against injury from rabbits, mice, and ground hogs, grass, weeds, and rubbish should not be allowed to accumulate about the orchard. If the orchard is surrounded by brush, wild meadows, or other areas that harbor these pests, avoid mulching with straw, manure, or hay. Wood veneer and wire wrappers, with or without mounding as shown in Figure 8, are used in many orchards, but when snow drifts in or if the trees are low-headed, this type of protection will do little good.

Even with the best care it is often necessary to resort to killing the animals by the use of box traps, guns, or dogs. Poison is sometimes used with good results. A poison bait made of corn or grain soaked in strychnine is put on wooden trays and left in the orchard from late in the evening until early the next morning. The trays are then gathered up and stored during the day. The animals die a short distance from the bait and can be picked up and disposed of.

In case of injury from rabbits or mice, a tree may often be saved by painting over the gnawed surface with melted grafting wax or with a preparation made by melting sealing wax and adding linseed oil to make a sirupy liquid. If the injury is not too high, the trunk of the tree should be banked up with soil for one or two seasons. If it extends a considerable distance, a small box may be built around the trunk and filled with soil as high as the injury extends. If any of the cambium, or growth layer, is left, this preserves it and allows it to recover. Many trees have been saved in this way that would otherwise have been lost.

Sunscald.—Sunscald results from the direct rays of the sun striking the trunk and the large branches on late-winter afternoons. The night comes on so quickly that the aroused cells are frozen and the tissue destroyed. It can be prevented by pruning so as to leave enough small branches to shade the trunk and scaffold branches, by shading the trunk with a board fastened on the south side, or by protecting the trunk with cornstalks. If the orchard is located on the north slope of a hill rather than the south slope, the danger will be less. Leaning the trees at planting as suggested earlier in this bulletin is also helpful.

DISEASES

Injuries caused by the attacks of definite organisms of fungous or bacterial origin are found on the fruit, the foliage, and the woody parts of trees. In many cases the disease organisms gain access through physical injuries or insect injuries. Occasionally the germs, after lodging on the various plant tissues, have the power to penetrate and destroy them.

Fire Blight

Fire blight is singled out for specific treatment because orchardists commonly fail to recognize it as a germ disease. The organism that is responsible for it lives over winter in injured twigs and branches of fruit trees. Early in the spring a sweetish milky liquid often oozes out of the bark at the point where the diseased and healthy portions join. This liquid, which is sipped by insects and bees, carries myriads of blight germs. Later the bees and insects introduce the germs into the blossoms and young shoots. With suitable weather and growth conditions and varietal susceptibility, the blight may become epidemic and the trees soon appear to have been struck by a hot blast.

To control this disease the affected branches should be cut out early in the spring and burned. The cut should be made on healthy wood, at least six inches below any apparent disease. The wood growth of the tree should be kept well balanced and not over succulent from excess moisture or plant food. Water sprouts, which may be caused by excessive spring pruning or abnormal weather conditions, should be cut out as soon as they appear. Coöperation of the neighbors is important in controlling fire blight.

Fruit Tree Cankers

Canker is treated specifically here because it is very intimately related to physical injury of the trees and is not usually ascribed to germ infection. Canker is the popular name for any one of several forms of infection of the woody parts of fruit trees. Even fire blight may produce a canker and be included in the group. The term is usually applied to the death of the bark, followed quite often by a callus around the edge of the dead area.

Canker treatment consists largely in prevention. The fungous and bacterial organisms should be destroyed and prevented from lodging in the crotches and on the branches and twigs by thoro and regular spraying. When in use, the pruning tools should be dipped frequently in a standard disinfecting solution. Cuts more than an inch in diameter and breaks in the bark should be washed with the same solution and then be coated with tree wax or a suitable waterproof paint. Paints containing naphthalene compounds or excessive amounts of drying spirits should be avoided, as they frequently break down the bark and encourage the very thing they should prevent. Pruning cuts should be smoothly made and no stubs should be left. Stubs provide an entrance for decay organisms. To prevent injury to crotches or bark, rubber-soled shoes or moccasins should be worn while stepping about the branches when pruning and when picking fruit. All cankers discovered should be neatly cut out of the bark at once, and disinfected. The uncovered area may then be coated with a good tree wax or waterproof paint. Fruit growers should write to the State Entomologist, University Farm, St. Paul, for Circular No. 51, "Fruit Tree Cankers," by E. C. Stakman and A. G. Tolaas.

Diseases of Foliage and Fruit

The foliage and fruit of fruit trees and plants in Minnesota are attacked by a host of organisms that may produce many diseases. These diseases tend to prevent or reduce the set of fruit, impair the efficiency of the foliage, reduce the size and the quality of the fruit, increase the number of windfalls, and, finally, to produce cankers on the woody parts. Thoro and regular spraying with fungicide preparations will control these diseases. A brief outline for spraying and the formulas for these preparations will be found on page 16.

INSECTS

The insects attacking fruit trees may be placed in two groups according to their feeding habits, chewing insects and sucking insects. Only one class, the borers, do their principal damage by attacking the wood. Because borers and plant lice are not successfully controlled by ordinary spraying methods, they are treated specifically in the following paragraphs. Chewing insects, those that eat the foliage or fruit, are controlled by a stomach poison which is usually some arsenical compound. Sucking insects are controlled by a contact poison that destroys by its caustic or irritating action. Formulas and a brief outline for their use will be found on page 16.

Borers

Borers cause considerable injury to young trees in many parts of the state. A tree is often seriously injured before the damage is noticed. The only method of meeting the injury consists in timely attention. Some persons have found it worth while to examine the trunks and crowns of trees at least once a year and preferably twice. In June the soil is removed from the crown of the tree with a garden trowel to a depth of three or four inches. Dark spots in the bark indicate a borer underneath. Often the chewed wood will be found thrown out through a small opening in the bark. When the borer is located it should be dug out with a sharp knife or should be killed by forcing a galvanized wire into the burrow. If this can not be done, bisulfide of carbon may be forced into the opening with a small oilcan.

The scaly bark should be removed from the tree by scraping with a trowel. A wash may then be applied which acts as a deterrent to the beetles that lay the eggs. A suitable wash is made by pouring a half pint of coaltar or crude carbolic acid over three pounds of unslaked lime. A quart of liquid soap, made by dissolving a pound bar of soap in a quart of boiling water, should be poured over the lime and coaltar, and just enough cold water added slowly to keep the mixture cooking violently while the lime is slaking. When slaking is finished, enough water may be added to make two and a half gallons of slimy whitewash. This should be applied to the trunks and branches of the trees and around the crown at the time the examination is made in June. The soil that was removed for the examination may then be replaced. If this is well done there is little need of a second examination in September, altho it is sometimes advisable in order to catch any injury that may have been overlooked in June.

Plant Lice

Plant lice are most intimately associated with outbreaks of fire blight. Observations made in many orchards lead the writer to believe that they frequently have a causal relation. They may be controlled by spraying just as the buds are bursting, with commercial lime-sulphur mixture, one gallon to eight gallons of water. This should be followed in a week, if lice are still present, with the "cluster-bud" spray, using the same mixture, one and one quarter gallons to fifty gallons of water into which should be stirred two fifths of a pint of nicotine sulphate.

Fruit growers should write to the Office of Publications, University Farm, St. Paul, for Agricultural Experiment Station bulletin 153, "Fruit and Vegetable Diseases and Their Control," by E. C. Stakman and A. G. Tolaas; and Special bulletin No. 29, "Garden and Small-Fruit Insects and Their Control," by A. G. Ruggles and S. A. Graham.

FORMULAS FOR SPRAYS

Bordeaux mixture.—Bordeaux mixture is a fungicide used to a large extent in orcharding and potato growing. One formula is: 4 pounds copper sulphate (blue vitrol), 4 pounds good stone lime, 50 gallons water. Dissolve each in 25 gallons of the water, then pour the two together into a 50-gallon barrel, stirring thoroly. Some leaves, like those of the plum, are very tender and only three pounds of the blue vitrol should be used in the formula. Dissolve the copper sulphate in a burlap sack suspended just beneath the surface of the water. The container must be of wood, never of iron.

Concentrated lime-sulphur mixture.—The concentrated lime-sulphur is both an insecticide and a fungicide. At the rate of one gallon to nine gallons of water, it is used only when the trees are dormant, at that time killing principally the scale insects. At the rate of one gallon to forty gallons of water, it is a fungicide and can be combined with arsenate of lead and sprayed when trees are in foliage. The following is the formula, altho it is usually much better to buy the commercial product on account of its constant chemical properties: 40 pounds fresh unslaked lime, 40 per cent pure; 80 pounds sulphur, thoroly and finely pulverized; water to make 50 gallons. After proper mixing, this must boil from forty-five to fifty minutes.

Grafting wax.—For coating torn bark and pruning-wounds, a wax made by melting together one pound tallow, two pounds beeswax, and four pounds resin, should always be kept on hand. It can be kept in a sheet-iron pan that will set in the top of an old milk-can. Having punched some holes for ventilation, set a lighted lamp in the bottom of the can and place the pan of wax in the top. The lamp should be turned just high enough to keep the wax melted. It must not be boiling when applied. Apply to the wounds with a cheap paint-brush or cloth swab kept in the pan for that purpose.

DISPOSING OF THE FRUIT CROP

Gathering the Fruit

Marketing is not important to the owner of only a few fruit trees. There is little need to be concerned about packing and selling. Yet it is well to remember that if the fruit is to be stored for either early or later use, it must be carefully picked and handled. Every physical injury, such as a little bruise or a break in the skin, even so small a thing as the scratch of a twig or a finger-nail makes the fruit susceptible to bacterial or fungous organisms that cause it to rot.

Various pickers have been devised in order to avoid climbing after the fruit, but practically none of them are satisfactory. They scratch or bruise the fruit. Canton flannel mittens should be worn when picking by hand and each fruit should be handled as carefully as if it were an egg.

A ladder made of poplar or willow poles is light to handle and is very efficient. Crosspieces may be nailed to two poles to form a ladder shaped like an inverted V. Two other poles may furnish the movable legs which will act independently, using one bolt to attach them at the top. This will allow the ladder to stand firmly on a slope or on uneven ground. Another ladder often used consists of a single pole of light wood about five inches in diameter, split and spread apart up to a height of about six feet. The spread of the split part should be about two feet. Crosspieces are then nailed on at the proper vertical distances. At the top of the pole an iron hook made from an old clevis or a piece of scrap iron is attached so that the upper end of the ladder may be steadied by hooking it over a branch of the tree.

For apples, the best picking vessel is a three-gallon heavy galvanized iron pail. A basket with a handle is good, but should be lined with canvas or burlap to prevent bruising the fruit. A sack over the shoulder is not desirable because there is a tendency to put in so many apples that they are bruised by the weight. It is very essential to avoid injuring the fruit spurs and the branches during the picking process. In some cases practically two thirds of the next year's fruit crop has been ruined by the carelessness of pickers.

Apples should be picked when the seeds are fully developed and have become brown. Some of the summer varieties may be picked when the seeds are green or are just turning brown. Fall and winter apples should be allowed to develop as much color as possible, but should not be left so long that they become over mature. Late apples should be picked before heavy frost. Light frost will not damage them materially.

Grading and Packing

In commercial orcharding the matter of sorting, grading to a definite size, and selecting for a desirable color are very essential. A grading board and table and a packing table are also essential for apples. Barrels and baskets are preferred for summer varieties, and for inferior fruit. (Generally it is best not to attempt to sell low-grade fruit.) With the Wealthy the use of boxes is desirable and becoming prevalent, especially for fancy and highly colored fruit.

Marketing

For a commercial orchard, a shipping market is probably the first essential. A grower at Howard Lake has never had any trouble in marketing all the Hibernal and other summer varieties he can produce because he has established a reputation for a good grade of fruit. The fruit is always packed in standard containers and brings fancy prices.

The buyers know that if they do not treat this grower well they will not get his graded fruit the following year, and consequently he has received splendid service from the Twin City buyers. Others who have had just as good fruit but have not made an acquaintance or a reputation among the buyers in the cities found it difficult to dispose of their fruit to advantage.

Many growers in the southeastern part of the state sell their crop on the trees and let the buyer pick and pack it. The only objection to this method is that pickers brought in by these men are often careless and seriously injure the trees. For home use, all those varieties that will keep should be stored. Duchess and Wealthy, of the summer and fall varieties, store very well for a few weeks, while Northwestern Greening, Malinda, and Jewell keep well into the winter.

Apples may be canned with or without sugar or may be dried. Dried fruit requires less space for storing than canned, and if well dried is just as good. Bulletins 839 and 984, published by the United States Department of Agriculture, Washington, D. C., are excellent guides in canning and drying fruits and vegetables.

SPRAYING OUTLINE FOR FRUITS

(Adapted from Special Bulletin No. 29)

Fruit	Apple	Plum	Raspberry	Currant Gooseberry	Strawberry
To control these insects and diseases	Coddling moth Curculio Scab Black rot Bitter rot Aphids, or plant lice Scale insects	Brown rot Curculio Plum pocket Scale insects	Anthracnose Fruit worms	Currant worm Leaf spot Currant leaf louse	Leaf spot Powdery mildew Leaf roller Weevil
Spray with	Arsenate of lead (3-5) plus concentrated lime-sulphur diluted (1 to 40), or bordeaux mixture (4-4-50) Nicotine sulphate or nicofume Lime-sulphur (1-9)	Arsenate of lead (3-50) plus concentrated lime-sulphur diluted (1 to 40) or bordeaux mixture (3-4-50) Copper sulphate Bordeaux mixture Same as for apple	Resin-bordeaux mixture Arsenate of lead (4-50)	Arsenate of lead or hellebore Bordeaux mixture Nicotine sulphate	Bordeaux mixture (4-4-50) Add lead arsenate (4-50)
First spray should be applied	As center bud in flower cluster begins to show pink. When insects appear Just when buds burst in spring	Just before flower buds break Copper sulphate before any growth starts in spring	Before leaves open When young shoots are six inches high	A few days after blossoming Just as leaf buds are breaking As buds are breaking	Before blossoms open
Second spraying	Just after petals fall	When plums are size of small peas Bordeaux mixture as soon as growth starts		As young leaves appear	After picking season is over
Third spraying	Three weeks later	When fruit begins to color			Weevils are controlled best by crop rotation —only one crop of berries on plat before plowing it up and growing some other crop