Massachusetts Agriculture Series, No. 2 December, 1920

The Commonwealth of Massachusetts

DEPARTMENT OF AGRICULTURE

Dr. ARTHUR W. GILBERT, Commissioner

136 STATE HOUSE, BOSTON

ORCHARDING

REVISED FROM THE FIFTH EDITION OF THE BULLETIN ON APPLE GROWING

BOSTON
WRIGHT & POTTER PRINTING COMPANY, STATE PRINTERS
32 DERNE STREET
1921

A promising young Massachusetts apple orchard.

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PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

CONTENTS.

INTRODUCTION.

Increasing interest in apple growing in Massachusetts and the many requests for information applying to Massachusetts conditions have made necessary a new edition of the bulletin on "Apple Growing." Since the new book includes a chapter on peach growing, and it is planned to have a chapter on pear culture in the next edition, the title has been changed to "Orcharding."

In preparing this book the text of the last (fifth) edition of "Apple Growing" has been carefully revised and brought up to date. The three articles, "Varieties of Apples for Massachusetts Orchards," "The Planting of a Commercial Orchard in Massachusetts" and "The New Orchard," all by Professor F. C. Sears, have been combined into one new article, which appears as Chapter I. The material presented in the article entitled "Three Common Scale Insects" and "Plant Lice or Aphids," both by H. T. Fernald, have been included in the chapter on "Apple Insects," and the "Spray Calendar for Apples" by Erwin H. Forbush has been revised and included in the chapter on "Insecticides and Fungicides."

Orcharding is undoubtedly one of the most important branches of Massachusetts farming. Apple growing particularly is a well-established part of our agriculture, because Massachusetts produces good fruit and has the advantage of being at the door of large markets, which will take all she produces as soon as it is properly graded and packed. The soil and climate are among the most advantageous known for the production of apples of the finest quality, and with the adoption of organized marketing methods by the growers there

is every reason to believe that the business will be more profitable and will continue to increase in volume.

The Apple Grading Law, which is fully explained in Chapter XI, has proved to be one of the best adopted by any State, and has given good service in establishing a high standard for grading and packing in closed containers.

Every effort has been made in this book to present practical information for the guidance of orchardists, and to deal with all the principal points adequately and concisely.

Boston, November 26, 1920.

Chapter I.

ESTABLISHING AN APPLE ORCHARD.

F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE.

In any country which grows as fine apples as Massachusetts, and in a section where orcharding is as important a branch of farming as it is in this Commonwealth, there is a constant demand for information as to the setting of orchards. The following brief suggestions are offered in the hope that they may, in part, supply the desired information.

Future of the Orchard Industry.

Naturally, any man who contemplates setting an orchard is anxious to know the answer to the above question, and while it cannot, of course, be answered conclusively, it would certainly seem to the writer that with the conditions which obtain here in Massachusetts it is as reasonable to expect success in the orchard business as in any other branch of farming. We are close to the best markets in the country; our land values are reasonably low; our transportation facilities are excellent; and our conditions as to labor, fertilizers and other factors which go to influence the result of an orchard enterprise are certainly no worse than in other sections. The writer would therefore be inclined to believe that the future of the orchard business in Massachusetts is as good as it is in any other part of the United States.

Selecting the Orchard Site.

If one is buying a farm with a view of using it as an orchard proposition and wishes to ascertain how much of the land is useful for that purpose, or if one already owns a farm

and wishes to judge of the availability of certain blocks of land on that farm for orchard purposes, the following score card may prove useful: —

Score Card for Orchard Site.

1. Soil,		30
(*a*) Surface,	15	
(*b*) Subsoil,	15	
2. Water drainage,		30
(*a*) Surface,	10	
(*b*) Subdrainage,	20	
3. Atmospheric drainage,		15
4. Aspect,		15
(*a*) With reference to the sun,	5	
(*b*) With reference to winds,	10	
5. Windbreaks,		10

The attempt has been made here to give a list of the important considerations which ought to govern the selection of a site and to attach to each factor a numerical value. Doubtless these numerical values are not in all cases correct, but at least they are suggestive.

Under each particular factor many different things might be considered, but the following are at least some of the important ones: —

1. *Soil.*

(1) In the consideration of the surface soil one ought to take into account first of all the fertility of the land, whether it is rich enough to give a satisfactory growth of tree, which is of course desirable; and, on the other hand, whether by liberal use of barn manure it may by any possibility be too fertile for the best type of growth of the young tree. While the latter is much less likely to occur than the former, there are cases where land is too fertile to give the most satisfactory results.

(2) The second question under surface soil would be adaptation of the particular block to the special type of fruit one wishes to grow. This is probably the most important single item in judging an orchard site. We recognize that, as a class, peaches ought to grow on rather light soil, pears on

rather heavy soil, while apples do well on various types of soil, running from fairly light to rather heavy. As a matter of fact, in the case of apples, the work of Mr. H. J. Wilder and others has shown fairly definitely the soil preferences of certain varieties of apples, and we recognize that a Hubbardston or a Wealthy does well on light soil, while a McIntosh or a Baldwin requires a medium type of soil, and a Rhode Island Greening a rather heavy type of soil.

(3) A third item to be considered in the surface soil is the ease with which it can be worked. Very stony land or heavy clay land would be scored down under the head of difficulty in working it, though it might be good enough in other respects to more than offset this.

(4) A fourth item would be the question of whether the soil is sour or not. While it has not yet been definitely shown that apple trees prefer an alkaline soil, we do know that limestone districts are particularly noted for their fine fruit, and that the cover crops which we wish to grow in the orchard will not thrive, at least most of them will not, on an acid soil. This means that in case the soil in our block is sour, it will be necessary to apply lime to correct that condition.

(5) A fifth item would be the humus content of the soil. It will be found that young trees will start off much better on soil which is fairly well supplied with humus, and while this deficiency may be made up through the agency of barn manure or cover crops, it will be found that the soils which need humus most are the last ones to grow satisfactory cover crops. One will therefore find it a slow proposition to correct this deficiency.

Turning now to the subsoil, we have the question of the fertility of this subsoil, whether it is a pure sand and carries relatively small quantities of plant food, or a gravelly clay which may be decidedly fertile. This point is more important than is usually recognized, since the great bulk of the root system of our trees is down in the subsoil and not in the surface soil. One ought also to consider the ease with which the roots can penetrate this subsoil. Ledges and stiff clay hardpan would both be objectionable from this standpoint.

2. *Water Drainage.*

The second general item in the above score card is water drainage, which is certainly extremely important. It is desirable to have sufficient surface drainage to carry off the surface water, since it is a well-recognized fact that trees will not do well in a wet soil. On the other hand, if the slope is too abrupt we may get washing of the soil, especially in the spring, and loss of water during summer rains when there may be a scarcity of water in the soil. For this reason very abrupt slopes are less desirable, at least in this respect. Under subdrainage would be considered the question of whether there was sufficient drainage or whether the water was held in the soil; and, on the other hand, whether there was too much drainage making the subsoil too dry.

3. *Atmospheric Drainage.*

The third question to be considered is the matter of atmospheric drainage, and the importance of this varies a good deal with different fruits in different sections. In those sections where frosts are likely to occur in the spring after the trees are in bloom, and with early blossoming classes or varieties of fruits, the question of atmospheric drainage may be very important. If one is considering this question there are several points which ought to be looked into. First, is there sufficient slope to carry off the cold air? This does not require much slope, and one which will move the water over the surface will be ample to carry off the cold air also.

One ought also to consider whether there is any obstruction at the bottom of the orchard against which the cold air will bank up and so cause a frost to occur in the orchard. This obstruction might be a very thick block of timber or a rise in the land.

4. *Aspect or Slope.*

The fourth item is the aspect or slope of the land, whether to the north, south, east or west, and the score card considers this first with reference to the sun, second with reference to the wind. In the former point, slope with reference to the sun, we have the advantage of southern aspect in the

ripening of the fruit which makes it desirable, if this can be secured without subjecting the plantation to danger from frost. As a matter of fact, with apples in this State there is usually little danger of the blossoms being hit by late frosts.

Another item which ought to be considered in this question of the aspect with reference to the sun is the danger of sun scald, which is considerably greater on a southwestern slope than on any other. But this is ordinarily not a serious matter in Massachusetts.

The other side of the question of slopes, that is, slopes with reference to wind, is much more important, and it is very desirable to secure, if possible, a slope which is away from the prevailing winds of the section. In most sections of the State the northwest wind is the most dangerous, since we are likely to get gales from that quarter in the autumn before the fruit is picked, and this may cause serious damage from windfall fruit.

5. *Windbreaks.*

The last item in the score card is the matter of windbreaks, which, in conjunction with the slope, help to protect the plantation from the effect of wind, and which are, in the opinion of the writer, very important. It is often possible to do such labor as spraying, pruning or harvesting in the orchard with entire comfort when it is protected by a good windbreak, while it might not be possible to work at all if exposed to the wind. This is peculiarly true of spraying, where one has to consider not only the discomfort of the wind, but also the difficulty of getting the spray where it is wanted.

In this matter of windbreaks several items ought to be considered. First, and most important, is the kind of trees. As a general proposition it may be said that no tree should be set which harbors a fungus or an insect which is likely to be troublesome on the orchard. This would eliminate cedars, oaks and cherries. All things considered, perhaps the best trees for windbreaks are the pines and spruces among evergreens, and the hard maples among deciduous trees.

The second item which ought to be considered in this matter of windbreaks is the question of how far away they ought to be. This depends somewhat on whether the orchard is set

down by the side of a windbreak already established or whether the windbreak is planted with the orchard. But in any case it is better to have them too far away than too near. Probably 50 or 60 feet would be the minimum, and 100 to 150 would be more desirable. The land between could be used for grass or utilized in some other way. Where the trees are set too near the orchard there is always a good deal of damage and the fruit is much poorer on that side of the orchard.

It is also desirable, if it can be arranged, to have both near-by and distant windbreaks; and where the windbreak is at the bottom of the slope (if the orchard is located in a section which is likely to be troubled by frost), care should be taken to keep it open at the bottom so that the cold air may drain through.

It may be worth while to close this discussion of windbreaks by a mere catalogue of the advantages to be secured from them. Some of the important ones would be as follows: —

(1) To protect plantations from cold in winter. This depends somewhat on the type of winter, but it was shown very definitely in the winter of 1913–14 that those plantations that were out exposed to severe winds were damaged much more severely than similar plantations which were protected.

(2) The windbreak reduces the number of windfalls. This needs no discussion, but is often a serious matter. The writer recalls one orchard man whose crop was around 3,000 barrels, and who one season picked up 700 barrels after a severe wind storm.

(3) It prevents the breaking of trees when laden with fruit or covered with ice.

(4) It reduces the evaporation of moisture from the soil. This might be extremely important during severely dry spells.

(5) It facilitates labor. This has already been discussed.

(6) It helps to retain snow and leaves in the orchard. This is important in those sections where deep freezing of soil is likely to occur and result in root injury.

(7) It prevents injury to the blossoms where severe winds occur during the blossoming period.

The California orchard plow.

This is a fairly impressive list of benefits and ought to convince any one that the windbreak is a useful thing to have in connection with the orchard if it is possible to get it.

Choice of Varieties.

We may next attack the question of the choice of varieties for the plantation, and in the writer's opinion this is the most critical question which can come up for decision so far as its bearing on the success of the orchard is concerned. One is more likely to succeed if he chooses the right varieties and puts them on the wrong soil than if he chooses the wrong varieties and has them on satisfactory soil.

It is impossible in a paper of this type to discuss a long list of varieties, and those which have been selected are, in the opinion of the writer, the most useful for our State.

Let us begin by considering the advantages of a fairly long list of varieties for the orchard, say the advantages of five or six varieties in the orchard as against one or two. These advantages stated briefly would be as follows: —

First, it provides better for cross-pollination. This has been shown to be frequently a very important factor in the success of the orchard; and while most of our varieties are reasonably self-fertile, yet nearly all of them are benefited by cross-pollination with other varieties, — the yields being steadied and made more certain.

Second, a longer list of varieties lengthens the season for picking and handling the fruit. In the writer's opinion this is the strongest argument for a fairly long list of varieties. Let us compare the orchards of two men, both of whom we will say are harvesting 3,000 barrels of apples in the season. One man has Baldwins alone, and if we allow a 15-day picking season (which would probably be a generous estimate counting from the time the fruit was in proper condition to pick up to the time when it would begin to drop badly), this would mean that the owner must pick 200 barrels per day during this picking season.

On the other hand, suppose the adjoining owner has five varieties beginning with Oldenburg, which is ripe around the

middle of August, following this with Wealthy, then McIntosh, then Baldwins, then Wagener. The latter need not be picked before the middle of October or even later. This would give the second man two months in which to do his picking, or an average of around 60 barrels per day. Any one who has ever attempted to manage a picking crew will easily see the great advantage to the second owner.

Third, a longer list of varieties insures some fruit each year. If the McIntosh are not bearing the Baldwins will be; if the Baldwins are off the Wageners will be bearing.

Fourth, it increases the chances of pleasing customers. This is not an extremely important item but still it is worth considering, since one customer prefers one kind of apple while another prefers some other kind.

Fifth, it may utilize the types of soil better. One variety, as already suggested, does well on a light soil, another on a medium soil, and another on a rather heavy soil.

Sixth, it enables the owner to hold his markets better. If he has a continuous supply of apples available from the beginning of the season until the end, he can dispose of them much better than if he has one early and one late and loses the market in between.

Seventh, it lengthens the period of income. This ought not to be an important matter, but as most men are constituted it is.

Looking at the other side of the question, the disadvantages from the increase in the number of varieties, we have, first, that it decreases the chances of selling the entire crop to one buyer. This would be an important consideration in those sections where the practice is to sell the crop, either on the trees or in the packing house, to a buyer who takes the entire crop at one sale; and in certain sections the advantages enumerated above might be more than offset by this single disadvantage.

Second, it may lower the efficiency of the orchard because it includes less efficient varieties. For example, Wealthy and McIntosh are both extremely efficient varieties, growing large crops of good apples. If one plants some Oldenburgs or some Spies or some Gravensteins, he is likely to reduce the efficiency

of the orchard because these latter varieties are not as generally efficient as the former.

Third, the soils may not be suitable for the particular varieties one wishes to set. This might or might not be an important consideration.

Turning now to a few specific varieties which seem to be well adapted to most of our orchard sections in Massachusetts, we may suggest the following list: —

Oldenburg.

This is a Russian variety imported into this country about 1835 and probably more generally grown, take the United States as a whole, than any other variety with the possible exception of the Ben Davis. The tree is very hardy, very productive; comes into bearing early, often yielding fruit the third or fourth year; is a vigorous grower while young, but soon steadies down to a rather scant growth and therefore never makes a large tree. It is a reliable cropper, often yielding annual crops, but likely to be biennial, and is exceptionally healthy in the matter of foliage.

The fruit of the Oldenburg is of good and uniform size, a fine light yellow in color, striped more or less with red, but is only fair in quality. Its season is the latter part of August and early September, and it is usually a profitable variety on account of its many other good characteristics and in spite of the fact that it is not high in quality.

Wealthy.

This variety was originated by Peter Gideon at Excelsior, Minnesota, and is another variety that is very generally successful. The tree is very hardy; a good grower while young, but slowing down fairly rapidly and never making a large tree. It comes into bearing early, frequently by four or five years, and is extremely prolific. The fruit has a fine color, being well covered with a handsome red, its quality is excellent, and the fruit is very even in size and shape. It drops badly, which necessitates picking over the trees at least twice if the best results are to be secured. The fruit is of good size when the trees are young, but is apt to run small as the

trees get older, necessitating heavy pruning, good fertilizing and thinning of the fruit. The season is September and October. At the present time it is doubtful if any other variety is more profitable than the Wealthy for Massachusetts orchards.

McIntosh.

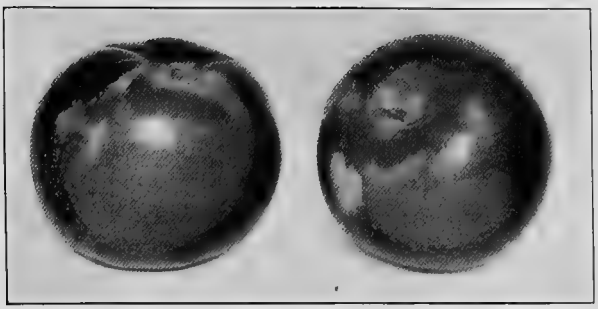
This variety originated in Ontario, but has rapidly come to the front in Massachusetts of late years, and probably no other variety is more popular or more profitable at the present time. The tree is a strong grower, very hardy, healthy except for a tendency to be attacked by scab; comes into bearing fairly early, say five or six years, and bears regularly and annually thereafter. Some trees in the agricultural college orchard have borne twelve successive crops. It makes an excellent tree in shape, being one of the best in that respect.

The fruit of the McIntosh is wonderfully fine in color, with beautiful white flesh, juicy and tender, and of the very highest quality. It is in season in ordinary storage from October to December, but under refrigeration much longer, and in any case keeps extremely well for an apple of its season. The fruit drops badly, necessitating several pickings if the best results are to be secured. Doubts are sometimes expressed as to whether the McIntosh is not being overplanted in this section, but it would seem that with an apple of this quality put on the market at a reasonable figure, there would be a chance to dispose of almost unlimited quantities.

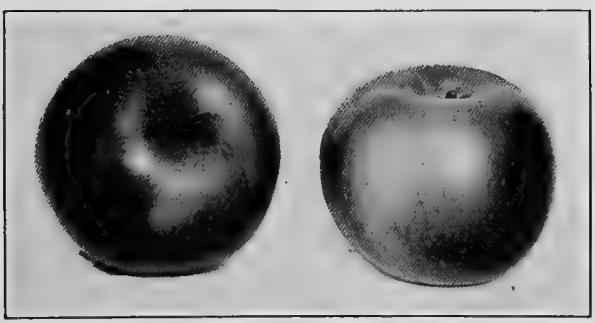
Baldwin.

This is a Massachusetts variety, having originated at Wilmington, near Lowell, and is the most generally grown of any variety, and next to the McIntosh is probably the most popular for this State. The tree is a strong grower, long-lived, and bears abundantly in alternate years. It is not especially hardy, though it succeeds well in most parts of this State. It comes into bearing in seven or eight years, and usually bears very abundant crops biennially from that time forward. The fruit is excellent in quality when well grown, of fine color, of good size, and keeps well. In ordinary storage its

Baldwin.



McIntosh.



Palmer Greening.

THREE POPULAR VARIETIES.

season is from November to February or March, and it is at present and always will be a leader in Massachusetts orchards.

Wagener.

This apple originated in New York and is not widely grown in Massachusetts, but in some respects is a most promising variety. The tree is of medium size, a good grower while it is young, but slow as it gets older. It is remarkably early in coming into bearing, sometimes producing apples at the third or fourth year, and bears abundantly, at least biennially, after that. The fruit is of good size, fine color and excellent quality, though somewhat inclined to produce culls where there are few apples on the trees. The season is November to February. The special value of Wagener to orchardists is the fact that it is a late-keeping apple and yet a small tree, and is therefore adapted to use as a filler where that system of growing is adopted.

Gravenstein.

This variety, originated in Germany, was introduced into the United States about 1825 and has been a very popular variety in many sections. The tree is very vigorous, almost too much so, making a large tree and tending to overgrow and winter-kill as a result of late growth, unless soil conditions and soil management are just right. It is rather slow in coming into bearing, requiring about seven or eight years, and is an uncertain cropper. In some sections it bears very abundantly indeed and is extremely popular, and in others it is a shy and uncertain bearer. The fruit is of high quality, handsome in color, very popular in the market, and in sections where the Gravenstein succeeds it stands close to the head of the market varieties. Its season is September to November, and barring the fact that the trees are apt to go bad through winter-killing and other troubles, it would stand second or third in many sections. This difficulty could doubtless be overcome to some extent by setting other hardy varieties and topworking Gravenstein on these.

Delicious.

This is one of the newer apples, but is one of promise and is being fairly largely set in some sections. It promises to be a good variety of high quality to follow the McIntosh as a dessert apple. It originated in Iowa, but seems to be taking decidedly to New England conditions, and some excellent fruit of this variety is being grown in various parts of the State. The tree is a good grower, comes into bearing fairly early, and is said to bear annually. Conclusive evidence on this last point is lacking as yet for this State. The fruit is handsome in color, of good quality, though apt to lose its quality fairly quickly and become mealy. Its name and advertising make it popular in the market. It is probably not to be recommended for general planting as yet, but certainly is a variety of promise.

Yellow Transparent, Red Astrachan and Williams Early.

The two former varieties are Russian in origin, while the Williams is a Massachusetts production. All three of these are grown as early apples more or less freely in many sections of the State, the Yellow Transparent, coming in the last of July or the first of August, followed by Red Astrachan and then by Williams. For early varieties there are at present no others which can compete with them, though all of them have their shortcomings, — the Yellow Transparent being yellow in color, easily bruised and making rather a poor tree; the Red Astrachan being slow in coming into bearing and not producing freely; and the Williams being a poor, sprawling tree and not prolific.

In the writer's opinion the foregoing list of varieties comprises the best sorts for Massachusetts orchards. Other varieties which are fairly popular, but of which space will not permit a detailed description, are Rhode Island Greening, Northern Spy, Hubbardston, Palmer Greening, Winter Banana and Opalescent.

To sum up the writer's opinion on the variety question for Massachusetts orchards it would be that for a commercial orchard nothing but a red apple should be set. The five

leaders for most sections are, in the order of their ripening, Oldenburg, Wealthy, McIntosh, Baldwin and Wagener, with Gravenstein standing near the head for some sections and Delicious a promising candidate.

Buying of Nursery Stock.

This question brings up many minor details which have to be settled before a satisfactory purchase can be made. A few of these questions would be —

First, shall we buy northern or southern grown stock? This probably makes no difference provided the stock can be landed at the orchard in good condition.

Second, the advantages of locally grown stock. These are certainly considerable and personally the writer would never go far from his orchard for nursery stock. Locally grown trees arrive at the farm in fresher condition, the transportation charges are less, and any disagreement with the nurseryman can be more easily adjusted.

Third, shall one set dwarfs or standards? For most commercial propositions probably the standard is to be recommended. There have been cases where dwarf trees have done remarkably well, but, on the whole, the standard is more satisfactory.

Fourth, the best age of trees to buy. This question is largely on one-year versus two-year trees, and in the writer's opinion the one-year tree is likely to be more satisfactory where soil conditions are ideal, but the two-year trees are to be preferred where soil conditions are not of the best.

It is unquestionably wise to buy direct from some reputable nurseryman instead of from an agent, and to get in your order as early as possible. If it can be done in November or December, one is sure to get the varieties he wants and to avoid many other difficulties.

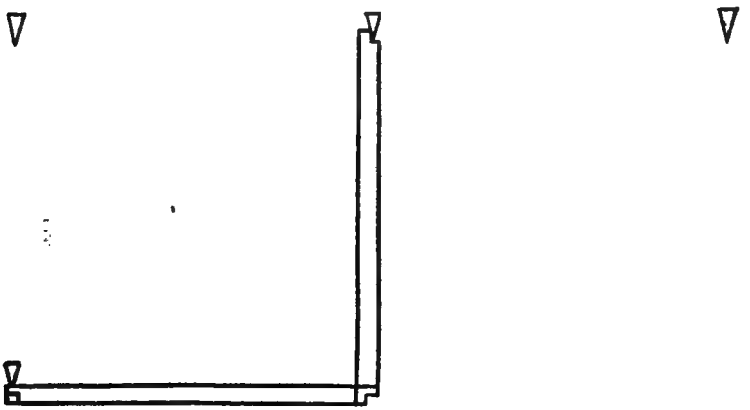
Preparation of Soil.

If the land is not too sloping, it is desirable to plow the field the autumn before it is to be set, but on land which slopes much, it is best to wait until early in the spring. After

plowing, the land should be fitted in the best possible manner, using the disc harrow first and following this with any other harrows that may be available, ending with a planker or clod-crusher, which should leave the land in first-class condition to be laid off.

Laying off the Orchard.

This is a matter which deserves much more care than it usually receives. The operation should be begun by setting a stake in one corner of the orchard block at the point where the corner tree is to grow. This ought to be not less than 25 feet and preferably 50 feet from either edge, and if there



are trees growing along either margin of the field, 75 to 100 feet is better. Next a range stake is set at the opposite end of the field and stakes are then driven every so often, being such a distance apart as it is desired to have the trees stand.

The light-draught orchard harrow.

Just what this distance ought to be is a much-discussed question. In the writer's opinion it ought seldom to be less than 40 feet for the standard trees, which would make the fillers, if these are used, 20 feet apart. Next a row of stakes is set at right angles to the first row, usually about the middle of the field, these being all the stakes that are set by the sighting method, the balance being best set with what are called measuring boards. These are two boards of a length equal to the distance between the trees. These boards have notches at the ends, and are laid down the end of one against a stake in one row and the end of the other against a stake in the second row of stakes as shown in the accompanying diagram, and the new stake is driven in the notch where the two boards meet. All this may sound like a good deal of work, but it would surprise any one who has not tried it to see how quickly the stakes may be set.

Locating the Trees.

For locating the trees a planting board should be used. This is a device which is by no means new but which deserves much wider use than it gets. There are several types of them, but the one shown in the accompanying diagram is

perhaps as good as any. The board should be 4 or 5 feet long by 8 inches wide, with a notch at each end and one in the middle. The middle notch is placed against the stake set for the tree and a short piece of lath is then driven down at each end in the notches, the planting board taken away, and the hole dug for the tree where the center stake stood. Then when it comes time to set the tree, whether it is that afternoon, or the next day, or the next week, the planting board is put in place again with the two small stakes in the end notches and the tree is slipped into the middle notch and planted out, and of course stands exactly where the original stake stood. This is another operation which may sound bungling but which in actual practice works out very satisfactorily.

Setting the Tree.

Where soil conditions are just right, that is, land well prepared and well drained, and where the nursery stock can be bought near by so that it is certain to be on hand when wanted, and yet will not have been dug while too immature, autumn setting will succeed. But it is usually best, in our climate, to set orchards in the spring, and the earlier in the spring they can be set the better.

The field operations of digging the holes and setting the trees will vary greatly according to the number to be set, and various other factors, but in general would be somewhat as follows. The holes should be dug about 18 inches to 2 feet wide and perhaps 15 inches deep. The top 8 or 10 inches of soil should be put in one pile and the subsoil in another. The tree is prepared for setting by cutting off all large roots that are broken, and shortening in any long, straggling roots. The actual setting can best be done by two men, one holding the tree and the other shoveling in the soil. The tree is slipped into the notch in the planting board mentioned above, and is held at the proper height by the man setting it while the other man shovels the soil into the bottom of the hole. If the hole is considerably deeper than necessary for the depth of the tree, some soil may be shoveled in before the tree is put into the hole. The tree ought to be set at about the same depth at which it grew in the nursery; an inch or two deeper is probably all right, but it should not vary greatly from its original depth. The soil should be packed in carefully under the crown of the tree and the roots brought out into approximately their original position. When the soil has been filled in so that all roots are covered, the man setting the tree should tramp the soil down firmly about the roots so that there will be a good contact between them, and the tree can start off properly. The surface soil should be used first, and subsoil filled in at the top of the hole.

Where operations are being conducted on a fairly large scale, it is well to mount a barrel on a stone-boat, fill it half full of water and then put the trees into this barrel to be transported around the orchard. This insures their arriving at the holes in first-class condition.

Pruning the Tree after Setting.

If one-year trees have been set they will usually consist of a straight whip, and the only question with regard to pruning is the height at which this whip should be cut off. Opinions vary on this, but probably most growers would say around 30 inches. Eighteen inches would be considered a very low head, and 40 inches a fairly high one, though many growers head even higher than this. If the tree is a two-year tree, the question of pruning it is considerably more complicated. But, to begin with, all branches ought to be removed except those which are wanted for scaffold branches, and these should not be over five, and preferably three or four. These scaffold branches should be well distributed around the central trunk of the tree so as to give a well-balanced head, and a good deal of time and thought ought to be given to this first problem. When the superfluous branches have been removed, then those remaining ought to be cut back from a third to half their length.

Cultivating the Orchard.

As soon as possible after the trees are set, cultivation ought to be begun in the orchard and kept up from that time until about the first week in July. For this cultivation one of the V-shaped cultivators is perhaps as good as anything, and the land should be worked with it every week or ten days in order to keep up a good dust mulch and to keep down all weeds. Everything possible should be done to protect the trunks of the trees from damage through this cultivation. This means a steady horse, a careful man, and padding the ends of the whiffletree with an old bag in order to prevent the trees from being barked if the whiffletree accidentally touches them.

In addition to the cultivating some hoeing may be necessary provided weeds are abundant. But, on the other hand, with good cultivation, upon land not too much infested by weeds, the cultivator may do all the work that is necessary.

Fertilizing the Trees.

The type and quantity of fertilizers used in the orchard will vary a good deal according to soil conditions and according to the cultivation that is maintained. With a reasonably fertile soil and with good cultivation, it may not be necessary to use any fertilizers whatever; while, when the soil is poor and the cultivation not of the best, a considerable quantity of fertilizer may be necessary. For this fertilizing nothing is better than good barn manure, and where this is available it may be the only fertilizer needed. Two or three forkfuls around a tree will bring along a more satisfactory type of growth than can be got in almost any other way. While this may be all that is necessary it frequently is desirable to put on a little nitrate of soda at the start to bring the trees along quickly.

Where barn manure is not available some nitrate of soda, say 2 or 3 ounces per tree, and some tankage, say a half pound per tree, will usually result in a very satisfactory growth of the trees.

The question of the application of any other types of fertilizers to trees the first year is still a matter of debate, but probably in most cases it is not worth while to apply potash; and while the case of phosphoric acid is less certain and a half pound of acid phosphate per tree might be worth using, still, if the soil is handled properly in other respects, the trees will probably make a very satisfactory growth without any other types of fertilizers than some form of nitrogen.

Cropping the Orchard.

It is a much debated question whether it will pay to grow other crops among the young trees during the first few years of the orchard, and the answer to this question depends very largely on the type of land and the type of market available. In most cases it is probably wise to attempt to grow some sort of crops in the orchard. If the right crop is selected it will usually help towards carrying the expense of bringing the orchard along, and the cultivation is apt to be more thorough and systematic where there is a crop involved than where there is nothing but the orchard on the land.

Barley as a cover crop in a young orchard. This is one of the best cover crops for Massachusetts orchards.

The choice of this crop will be largely a personal matter and is frequently a rather difficult question to settle, but it ought to be a cultivated crop without any question, and usually an annual crop. Some of the most generally successful companion crops for young orchards are late potatoes, beans, late cabbage, corn (preferably sweet corn or small-growing flint corn) and squash.

Cover Crops for the Orchard.

Whether the orchard is cropped or not the land along the tree rows should be sowed down about the first week in July to some type of cover crop. If the land is not cropped then the entire orchard should be seeded down. This cover crop is a very important part in the proper management of the orchard. Some of the things which it does to the orchard are to check the growth of the tree toward the latter end of the season, thus insuring that it goes into the winter in a well-ripening condition; to prevent the washing of the soil during winter and spring rains, which of course is extremely important where the land has any great slope; to add humus to the soil, which has already been discussed and which is very important; and if a leguminous crop is used, to add nitrogen to the soil. In sections where the soil is likely to freeze deeply the cover crop also assists in preventing extreme depths of freezing and still more important in preventing alternate freezing and thawing of the soil.

Various crops are used for this purpose. One of the best plans is to use a mixture of two crops; and it will be found that a half bushel of barley with either 6 or 8 pounds of crimson clover added, or with a peck of winter vetch added, makes an excellent combination. Another good plan is to substitute buckwheat for barley, using a half bushel of buckwheat with 6 or 8 pounds of crimson clover or with the peck of winter vetch. These mixtures insure that nearly all of the functions mentioned above will be satisfactorily performed in the orchard.

Protecting the Trunks of Trees.

The last thing which ought to be done to the orchard in the autumn is to adopt some plan of protecting the trees from damage by mice. If mice are not plentiful in the section and are seldom known to do any damage of this type, then merely clearing away the trash and cover crop from around the trees may be all that is necessary. But if there is any great probability of damage, then it is better to use some sort of protectors; and a strip of good waterproof building paper about 18 inches wide, placed around the tree at its base and tied in one or two places to hold it snugly, will usually insure the tree coming through without damage. Do not use tar paper!

Chapter II.

RENOVATING OLD ORCHARDS.

F. C. SEARS, PROFESSOR OF POMOLOGY, MASSACHUSETTS AGRICULTURAL COLLEGE.

There are undoubtedly thousands of old apple trees in Massachusetts, some in orchards and others scattered about fields, which would pay good returns if they could be thoroughly "renovated" and thereafter be given proper treatment. On the other hand, there are just as many, and probably far more, which would be more profitable on the woodpile than anywhere else. The first question, then, for one to decide, if he owns such trees or orchards, is "Will it pay to make the attempt to get them into a thrifty condition again?" In the writer's opinion this depends on three conditions: (1) the age and vigor of the trees; (2) the stand of trees in the orchard; and (3) the varieties. To discuss each of these briefly: —

1. *The Age and Vigor of the Trees.* — If the trees are vigorous, with good trunks and main branches, unaffected with canker or other injuries to the bark, it has been my experience that they can be brought into a profitable condition even though the tops are full of dead branches and they have been systematically neglected for years. This is supposing, of course, that the other factors mentioned above are favorable. It is truly surprising what can be done with an old orchard when it is taken in hand and given modern, up-to-date treatment. On the other hand, if the trunks or main branches are damaged by canker, or have been injured by cold so that the bark has fallen away in patches of any size, as very often happens, or if the trunk and main branches are badly rotted out in the center, then it is very doubtful if the orchard will pay for renovating. It must be remembered that the trunk is the

highway by which the results of our improved care are transported back and forth from the roots to the top, and if this highway is in a demoralized condition we are not going to get the best results.

2. *The Stand of Trees.* — This is supposing, of course, that the trees to be treated are in an orchard, and it will be easily seen that if half of the trees are out it is not going to pay to cultivate and fertilize the whole of the land for trees which could be put on half of it. And it is seldom satisfactory to attempt to grow anything else in such vacant spaces in an old orchard, or to plant young trees in the vacancies. If the trees are along fences or odd corners, so that cultivation of the soil will not be attempted, then the question of stand is less important, and may, perhaps, be ignored altogether. But in an orchard there ought to be a three-quarters stand at least to make it worth while to take the matter up, except under the most favorable circumstances.

3. *The Varieties in the Orchard.* — This is of less importance than the two points already mentioned, yet it is a factor that is decidedly worth considering and that has an important bearing on the cost of the renovating process. It is possible, of course, to graft over the trees, but this is both an expensive and a lengthy operation, and I should condemn to the brush heap an orchard which needed to be grafted far more quickly than one which already had the right varieties in it. Of course the question of varieties is very largely personal, and need not be discussed here, but I should mean by "right" such varieties as suited the grower and the markets for which he was producing, preferably standard sorts, like Baldwin, Rhode Island Greening and Roxbury Russet.

The above, as I have said, are the main factors in deciding for or against the renovation of an old orchard, yet perhaps I have omitted the chief factor after all, and that is the man himself. If he has just come into possession of the orchard, and is making an attempt to clean up all along the line, I should have far more faith in the ultimate good results of the matter than if he were author and finisher of the neglect from which the orchard has suffered, even though he might

FIG. 1. — A promising type of tree for renovating. When dead branches have been removed and top thinned it will make an excellent tree.

have firmly determined to "do the right thing by the orchard" henceforth.

Having finally decided that the orchard is worth while, the work of renovating will fall naturally under the following heads: first, cultivation; second, pruning; third, spraying; fourth, fertilizing; fifth, cover crops; sixth, grafting, — arranged somewhat in the order of their importance, though, of course, this will vary greatly with different orchards, and all with the possible exception of grafting will be needed to secure the best results.

I have placed cultivation first because though trees will often do well in sod, if otherwise well cared for, and though it may sometimes be necessary, even in attempting to revive an old orchard, to let the trees stand in sod, yet, as a rule, to get them into satisfactory condition cultivation is the prime requisite, and will do more than any other one thing to start the orchard on the right road. It is usually difficult in an old orchard, such as we are considering, to do anything like a thorough job of plowing. If one can secure an ox team they will do the work better than a team of horses, as they will be able to get under the trees better, and the slow, steady gait of the oxen is better than that of most horses. Do not be alarmed over cutting some tree roots with the plow, even some large roots. A little root pruning will not hurt the trees, and the fresh, new feeding-roots, sent out from the broken and cut ends of the old roots, will very soon equal in absorbing ability the parts of the old roots which are cut away. Another point in plowing is the question of throwing the furrow towards or away from the trees. One frequently finds an old orchard in which the plowing has been for years always in the direction of the trees, until each row stands along a ridge, with deep hollows between. Such an orchard should be plowed away from the trees, until the land gets back reasonably level again. After that it is well to plow the orchard alternately towards and away from the trees, — one year north and south and the next east and west. In this way the land can be kept in the best condition for the trees.

Occasionally it is impossible to do even a makeshift job of plowing, and then one can sometimes begin operations by running a heavy disc harrow through the orchard, to cut up the sod and start things in the right direction, and perhaps plow it the following year.

After the plowing has been done it is always advisable to use the disc harrow and follow it with the spring tooth harrow, going both ways with each of them, and going over the land several times, so as to get the land in good tilth. After this, through the balance of the season, it is best to cultivate the land once every week or ten days, up to perhaps the first week in July. And let this weekly cultivation be thorough! If the two harrows suggested, disc and spring tooth, are available, it is well to run the disc over the long way of the orchard first, and then finish with the spring tooth the opposite way. This insures all the land being worked over, and leaves it more level than if one finishes with the disc, which of course is desirable on account of reducing evaporation. It is difficult to overdo cultivation at this season of the year, and with an old, neglected orchard I should feel inclined to let this be the principal feature of the program, so far as the soil is concerned.

Now for our second point in the program, pruning. This is apt to vary more in the extent to which it is needed and in the character which is best to apply than any one of the other factors. If the trees are very high, with little or no bearing wood near the center, as is apt to be the case, then they should be given drastic pruning, so as to grow an entirely new top, a good many feet nearer the ground than the old one. If there are water sprouts in the center of the tree, as is frequently the case, then the tree may be dehorned, as it is called, that is, all the old top can be cut away, leaving stubs perhaps 3 or 4 feet long at the base of each main branch. If there are no water sprouts, or very few, then the top should be pruned severely but not dehorned, in the hope that it will send out water sprouts and thus allow of dehorning later on. This seems like heroic treatment, and it is, but in the great majority of cases, if the trees are otherwise healthy, they will send out a bushy top which, with

FIG. 2. — A poor type of tree for renovating. Trunk is too long and main branches have no bearing wood except at tops. If renovation is attempted this tree should be severely cut back to renew the top.

judicious thinning, will make practically a new tree out of the old one. And one great reason why such old trees as we are now considering (tall, overgrown ones) are *not* profitable is that they are so tall that every operation — pruning, spraying, picking, etc. — is four or five times as costly as with lower trees. So it is absolutely essential to get them down nearer the ground if they are ever to be made profitable.

On the other hand, if the trees are reasonably low, the pruning may consist largely in thinning the top throughout, beginning, of course, with the dead branches, and then taking enough live ones to leave the head fairly open to light and air, and to the sprayer when that comes on the scene. Even in this class of trees (those which are *not* unreasonably tall) it is often possible to reduce their height to advantage, without materially altering their form, by simply cutting back each of the main, upright branches to one of its strong, main offshoots. At the start the effect may not be just what we should like, and the top may be thrown somewhat out of balance, but with a year's growth it will largely recover its symmetry, and even if it should not altogether the advantages of the lower top will offset any disadvantages.

Another point in this latter type of pruning, and one often neglected, is not to remove too large branches in the thinning. Of course it is much easier to remove what one considers the required amount of wood by taking out a few large branches, but the results are much better if one will take comparatively small branches (not above an inch, and preferably much smaller, in diameter) and take more of them. This thins the top uniformly, letting in light, air and spraying materials to all parts equally; while the removal of a few large branches leaves the top too open in some places and as thick as ever in others. Still another point which one should bear in mind in his pruning is to keep a sharp watch for diseased branches, and take these out in preference to healthy ones. The European and some other cankers are, in particular, liable to be found in such an orchard, and may be largely held in check by such pruning. And lastly, after the pruning has been done, and the wounds made have had time to dry up and "check" somewhat, all wounds of an inch and a half or over

should be thoroughly painted with thick lead paint, to keep out moisture and prevent decay. White lead and boiled linseed oil make the best kind of covering for such wounds, but it is well to add a little brown color, merely to take off the glaring whiteness of the painted wounds. One frequently sees the advice to take the paint pot into the tree when pruning, and attend to the painting at once, when the limb is removed, but in the writer's experience the pruning tools are all that one wants to be bothered with at one time, and the paint will certainly adhere better to the cut surface when this has dried somewhat.

Our "thirdly" is the spraying problem. This will vary somewhat, according to the insect and fungous diseases which may be present in the orchard or locality. If the San José scale is there a thorough spraying with oil in the autumn, after the leaves have fallen, and with lime-sulfur just as the buds are swelling in the spring, will be found to be the most efficacious treatment. Where one does not have too bad an infestation of scale, in the writer's observation the best thing to use is the lime-sulfur, and one has the satisfaction of knowing that while he is driving this pest out of his plantation he is also most effectively reducing the vigor of a number of fungous diseases which might have caused trouble later in the season. In this connection (fighting insects and fungi) one is frequently asked as to the desirability of scraping the trees to remove the rough, scaly bark. While this ought not to be necessary as a regular practice in orchards which are cared for, and especially in those which are sprayed, yet in the beginning I believe it is an excellent treatment for such orchards as we are considering. Certainly it will add materially to the effectiveness of any spraying which may be done in the orchard.

It will not usually be found necessary to use oil after the orchard is once cleaned up, and the following spraying schedule will generally be satisfactory for future years.

First Spraying. — Early spring, just as the buds are breaking. Commercial lime-sulfur, about 6 gallons, and arsenate of lead paste 4 pounds, or powder 2 pounds, 40 per cent nicotine sulphate, three-eighths of a pint, to 50 gallons of water. This

FIG. 3. — Type of tree which should be cut back severely in renovating; 10 or 12 feet at least could be removed to advantage. Except for poor trunk (see Fig. 2), this tree could be very successfully remodeled.

is for scale, aphis, bud moth, and also for certain fungous diseases. Unless buds are well broken and tips of leaves showing when this spray is made, omit arsenate of lead.

Second Spraying. — Just before the blossoms open. Lime-sulfur 1 gallon, 40 per cent nicotine sulfate, three-eighths of a pint, arsenate of lead paste 3 to 5 pounds, or powder $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds, water, 50 gallons. There is some experimental evidence to show that 5 to 10 pounds of lime, slaked and added to each 50-gallon cask of spray containing lime-sulfur and arsenate of lead, will prevent the burning of foliage which sometimes follows the use of this combination. It is at least worth trying. This spraying is for bud moth, tent caterpillar, browntail moth, curculio, aphis, red bug and scab.

Third Spraying. — Within a week after the petals fall. Warm weather shortens and cool weather lengthens this period. Same as second spraying. This spraying is especially for codling moth, curculio, apple scab, red bug, gypsy moth and aphis.

Fourth Spraying. — About four weeks later. Same materials as the third, omitting nicotine. Especially important for codling moth, lesser apple worm, scab, gypsy moth, sooty fungus of apples, etc.

The relative importance of these different sprayings will vary with different orchards. Some may be omitted altogether in certain sections. There are few localities, however, where the second and third will not give excellent returns on the cost of applying.

In some sections of the State injury to the foliage has resulted from spraying with the combination of lime-sulfur and arsenate of lead. In similar climates this difficulty has been avoided by substituting Bordeaux mixture for commercial lime-sulfur in the second spray in the above program, and self-boiled lime-sulfur for the commercial in any later applications. This has worked out well in New Jersey, Nova Scotia and elsewhere, and is certainly worthy of trial here.

Of course one may be confronted by special problems, like an acute attack of canker worms or a scourge of apple aphis, in which case a specialist should be consulted. But for all

ordinary cases the foregoing program ought to be entirely adequate, and it would certainly surprise most old orchards to receive half of this attention.

The fourth factor in our operations is the fertilizer question, which is naturally very closely related to our cultivation problems and sometimes has to be varied to suit the cultural methods adopted. At the beginning I do not believe it is desirable in most cases to apply any nitrogenous fertilizers, or if they are applied it should be in very limited quantities, and early in the season. A moment's reflection will show the philosophy of this. Trees which have been allowed to grow in sod, as the old orchards which we are considering will undoubtedly have been, and in soil which has been impoverished by constant removal of the grass as hay, and of the fruit, without any return of fertilizer, will have long, straggling roots sent out to forage at a distance for all the plant food possible. And these long roots will have comparatively few branches or small feeding roots, as it is a well-known fact that roots branch freely in a fertile soil and sparsely in a poor soil. Now when the land in the orchard is plowed and cultivated, and fertilizers are applied, the conditions become very much more favorable in the soil, and the roots begin to branch freely in response to these improved conditions. If the fertilizer has been applied in the form of barn manure, as is often the case, this requires some time to decay and get into soluble condition so that the roots can take it up, but when this has taken place it furnishes a large amount of highly nitrogenous food which tends to stimulate a very strong wood growth late in the season. The trees having the root systems such as we have described, long and spreading, and having sent out an abundance of feeding roots all along these original main roots in response to improved conditions, are sure to take up an unusual amount of this plant food, much more than trees which have had regular care from the beginning, and which therefore have more compact root systems. The result is that the growth is continued very late in the season, that the new layer of tissue between the old bark and wood does not ripen up in the autumn as it should, and that when cold weather comes on it is no better fitted to

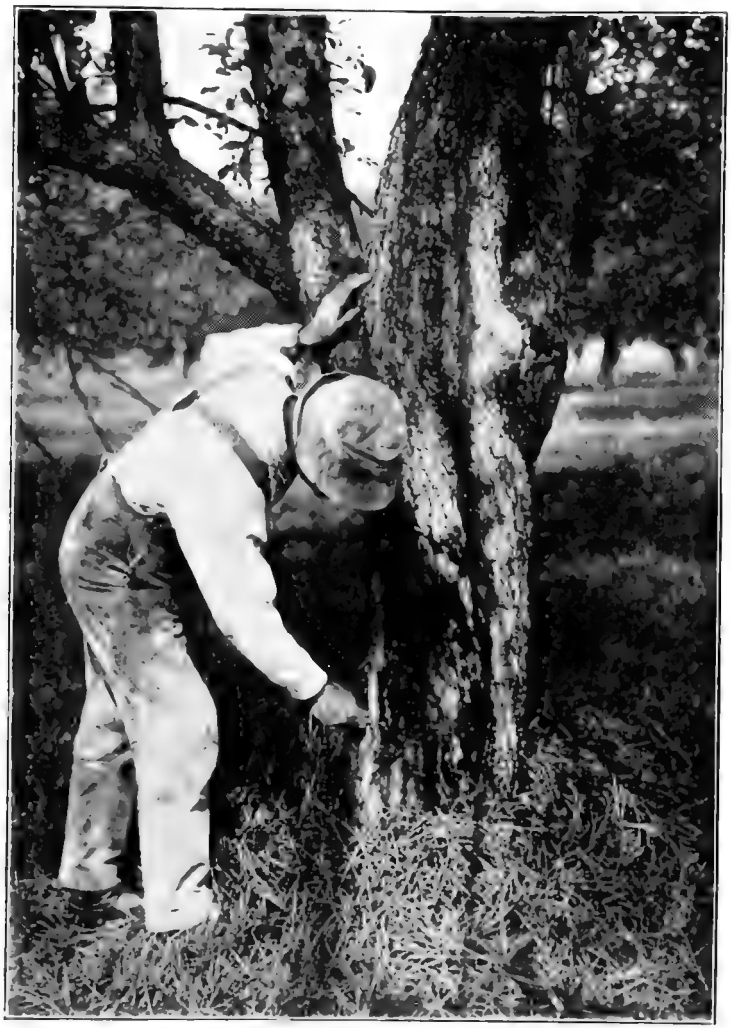


FIG. 4. — Trunk injured by cold. Such trees are usually not worth renovating.

withstand freezing than a potato or a cabbage, and is destroyed during the winter. Soon after this the bark separates from the wood, and the tree dies if the bark has been killed all round, or is seriously weakened if only part way. For these reasons, as I said in the beginning, I should advise withholding nitrogenous fertilizers almost entirely the first season in the case of most orchards. If the soil has any fertility to it at all the cultivation and consequent improved physical condition will liberate all the nitrogen that the trees need to make an entirely satisfactory growth.

In a few orchards, where the soil is very poor, it may be necessary to apply some nitrogen, and if this is done it should be in the form of nitrate of soda. An application of perhaps 200 pounds of this material, made early in the spring as soon as growth starts, will usually be all that is necessary even in the worst of cases.

Other fertilizers may or may not be needed. It is very difficult to make a general recommendation. On light, sandy land some potash is often desirable, and 200 pounds of sulfate of potash may well be applied. For supplying phosphoric acid the most common material used is acid phosphate, and a good application of this is 200 to 300 pounds per acre.

Nearly all of our old orchard soils are benefited by lime, and an application of 2 tons of ground limestone per acre may well be made. Just how much this will affect the trees themselves is still a matter of doubt, though there is some evidence to support the belief that it is an advantage to them. But there is no question that it will benefit the cover crops grown in the orchard, especially the leguminous ones, and this is sufficient justification for its use.

We come now to the question of cover crops for the orchard, by which is meant some crop grown in the orchard, usually late in the season, and exclusively, or at least mainly, with the object of improving the soil of the orchard. That it can be made to play a very important part in the upbuilding of an old orchard has been shown time and again. Some of the best ones for Massachusetts orchards are buckwheat, barley, soy beans, turnips, dwarf Essex rape and the vetches. The chief advantages derived from their use would be that

they take plant food away from the trees in the autumn and thus help to ripen them up; that they catch and hold nitrates in the soil after the growth of the trees has stopped, and when these substances might otherwise be washed out of the soil; that they help to pulverize and rot down the sod, which is especially important at the beginning; that when they are plowed under the following season they furnish humus, which in turn furnishes plant food to the trees; and that, in the case of soy beans and the vetches, they help to keep up the store of nitrogen in the soil by what they take up from the air and store in their roots. This is by no means all that these cover crops do, but it covers the main points, and serves to show how important they are. The general plan of their use would be this: that the orchard would be plowed as early in the spring as the soil would permit and thoroughly fitted as outlined earlier. Then thorough cultivation would continue up to the first week in July, when the cover crop would be sown. The only important deviation from this course would be in the case of some of the leguminous cover crops mentioned, particularly soy beans, which often give better results if sown in drills earlier in the season (the middle of June), and cultivated several times before the orchard is laid by. Of course the objection to this is that the cultivation by this method is much more costly, since it must be done with a one-horse cultivator, a row at a time, instead of with a disc or spring-tooth harrow, covering three or four times the space. But even this objection is often, if not usually, overbalanced by the much better growth of the cover crop.

After cultivation ceases and the cover crop is sown, nothing further is done to the soil until the following spring, when the cover crop is plowed under, and the program begins again. Where a good growth of one of the nitrogenous cover crops can be secured it is often possible to obtain all the nitrogen needed for the orchard in this way.

I should feel inclined to begin with buckwheat as a cover crop in starting an old orchard because it is peculiarly effective in rotting down sod and putting the soil in fine physical condition. This might be followed in a year or two by either soy beans or a mixture of one half bushel of buckwheat, and one peck of summer or winter vetch.

FIG. 5. — A dehorned tree after one year's growth, showing how well these trees recover. Note also the fine crop of buckwheat used as a cover crop.

As to amounts of seed per acre of the different crops suggested the following will be found right for ordinary conditions: —

Buckwheat,	1 bushel.
Barley,	1½ bushels.
Soy beans,	1½ bushels broadcast; ½ bushel in drills.
Summer vetch,	1½ bushels broadcast; 1 bushel in drills.
Winter vetch,	1 bushel broadcast; ½ bushel in drills.

The principal objection to the vetches is the cost of seed, and they are probably best used in the mixtures above suggested.

Lastly there is the question of top-grafting the trees. I have already said that I should consider the necessity of this a strong factor against the orchard, for it requires considerable time, two to four years, and not a little expense, to work over the trees into other varieties. But it frequently happens that odd trees in an orchard are of unsatisfactory varieties, and it is sometimes worth while to graft over an entire orchard where the trees are relatively young and otherwise in good condition. Where this is to be done I believe it is generally advisable to employ an expert grafter if one can be found in the neighborhood; or, if the orchard is of sufficient size to warrant it, a professional grafter can be secured from a distance. In either case it is better business, and more satisfactory generally, to pay by the stub, and to have the grafter guarantee the scions to live. Of course in such a case one must have confidence enough in the man to insure that he will not put in grafts needlessly, but after all it is better to have too many grafts than not enough, and with a little knowledge and supervision on the part of the owner there is usually little difficulty on this score. If the owner is situated so that he can do so I should strongly advise his furnishing the scions himself, and too great care cannot be exercised in selecting them. They ought to be taken from bearing trees, and they should be thoroughly well matured and not too long-jointed. Let them be selected while the trees are still dormant, and stored in moist soil or sawdust in the coolest possible place; if an ice house is available so much the better.

A great many problems will undoubtedly come up in renovating an old orchard besides those which have been discussed, and modifications will have to be made to suit special fruits, such as peaches and plums, but if a campaign along the general lines indicated could be made among the old, and at present profitless, orchards of the State, either cleaning them up or cutting them down, it would certainly do a great deal toward putting Massachusetts fruit on a better footing with both dealers and consumers, and it would make an addition to the income of the farmers of the State by no means to be despised.

Chapter III.

THE ESTABLISHMENT AND MAINTENANCE OF PEACH ORCHARDS IN MASSACHUSETTS.

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Massachusetts is on the northern frontier of peach growing. While there is limited production in southern New Hampshire and still more limited production in southern Maine and Vermont, the commercial crop in these three States is almost negligible. It follows that the peach industry in Massachusetts is beset with many difficulties and calls for wide and thorough knowledge and a high degree of skill on the part of the grower if he is to attain a commercial success in the business.

During the past few years peach growing in the northern and central portions of the United States has been passing through a period of depression. There have been several years of partial or complete crop failure, while apple growing has been more profitable, causing many growers to turn from peaches to apples as a more profitable crop. Peach growing has always had its ups and downs, and it is reasonable to suppose that in the near future there may be a revival of interest in the business.

Limiting Factors.

1. *Winter-killing of Fruit Buds.*

The most frequent cause of crop failure in Massachusetts is winter-killing of the fruit buds. Buds that are perfectly dormant may survive a temperature of 20 degrees below zero, but higher temperatures are often fatal especially when, as frequently happens, the buds are started into slight growth by warm periods in midwinter. Buds are sometimes practically all

killed by a temperature of 10 degrees below zero, but it is probable that in such cases they have been caused to swell by warm winter days. Just what temperatures will bring this about is uncertain, but a maximum of 45 degrees or higher for two or three days will often have an appreciable effect. During November or December high temperatures will have no effect, as may be learned if one will bring peach twigs into a warm room and put them in a jar of water. In early winter the buds will not respond, while in midwinter, or later, they will in a few days come into full bloom. The date of completing this resting period depends on many things. It is desirable to have it continue as long as possible and to this end we may encourage the trees to grow reasonably late in the fall. Varieties differ greatly in bud hardiness, and Greensboro seems hardiest of the common varieties. Carmen and Champion are hardier than the average, while Elberta is very tender in bud.

Air temperature varies greatly with the local elevation, and it follows that peach trees should be planted only on elevated sites. If possible one should choose a site 200 or 300 feet above the stream level of the locality, with free outlet for the downward flow of cold air, and without broad slopes above which may cool the air so that it will flow down over the orchard. At the same time it is important to avoid sites exposed to sweeping winds. In Massachusetts one should be careful about planting peaches more than 1,200 feet above sea level.

Open expanses of water serve to modify extreme winter cold, and therefore locations near the open ocean should be less subject to harmful winter temperatures though they may be somewhat objectionable for other reasons. Still the writer believes that the region about Buzzards Bay and portions of Cape Cod ought to be favorable for peach growing.

Direct means for preventing the winter-killing of peach buds are of rather small practical value. Keeping the trees thoroughly whitened during December and January by spraying with whitewash has been recommended and it is often quite effective. The writer hesitates to express an opinion of its practical value in Massachusetts, but it is worth experimenting with. Small trees may be covered with corn stalks

FIG. 1. — At left, twigs with fruit buds somewhat swollen during winter. Center, twig in full bloom. Right, shucks beginning to fall, nearly time to spray for the curculio.

or similar material. Some growers have laid down the trees in the fall with success, but the labor involved and the check to the trees from cutting the root system on two sides in order to bend the trees over will interfere with a general adoption of this scheme. In general one must rely on selecting hardy varieties and on a wise choice of site, and the latter is a point that cannot be overemphasized.

Certain soil conditions are believed to favor bud hardiness. Among these are a warm, dry, gravelly soil, yet retentive enough of moisture to promote good growth and prevent excessive drying out of the tree in winter; moderate fertilization, giving vigorous growth completed so that the tree may go into winter with well-ripened wood; and the growth of a good cover crop as a winter protection of the soil. Low-headed trees are thought to be more hardy than high-headed ones.

It ought to be possible to make progress in solving this most important problem of peach growing by breeding bud hardy varieties, and this is now being attempted at the State Experiment Station.

2. *Winter-killing of the Wood.*

The fruit buds are considerably more tender than the wood, yet in severe winters there is often considerable killing of the branches and sometimes of the whole tree. The remarks concerning bud injury will apply fairly well to wood injury, and it is to be prevented as far as may be by much the same methods. Varietal hardiness of wood and bud do not always go together, as Elberta, which is tender in bud, is about as hardy in wood as any variety.

Peach trees will recover from winter injury if not too severe, when proper steps are taken. These are a severe pruning of the tree, cutting back into three or four year old wood, and removing half or two-thirds of the top. Extremely heavy pruning, spoken of as dehorning, is not to be resorted to. Then the tree should be encouraged to make a strong growth by thorough cultivation and fertilization with material rich in nitrogen.

3. *Diseases.*

Peach diseases often limit the crop in Massachusetts, yet by proper measures they may be controlled so that losses are not serious.

Brown rot is the most destructive, especially in years when warm, humid weather persists just before and during the harvesting period. When the disease is present in the orchard it does a great deal of damage to the fruit after it is sent to market. Sound fruit, but carrying spores of the disease and exposed to warm, moist air, often rots to an alarming degree while on the way to the consumer.

Not only does the disease cause characteristic decay of the ripening fruit, but it may destroy the bloom, small twigs and even larger branches by causing cankers thereon.

The disease carries over winter chiefly in dried fruits hanging to the tree or fallen to the ground and known as "mummies." It follows that these should be destroyed by plowing under or in some other way, but the main reliance is on proper spraying, which will be discussed later.

Yellows occasionally causes great havoc by destroying the trees. The first symptom is likely to be premature ripening of the fruit on a part or all of the diseased tree. Often the fruit shows reddish spots and reddish streaks through the flesh. The same season or the next tufts of weak, yellowish shoots appear through the tree, and in a very few years the tree perishes. The disease is contagious, passing from one tree to another commonly through budding in the nursery. It follows that great care should be taken to plant stock free from the disease, and any tree in the orchard showing possible symptoms should be watched, and the moment it seems probable that it is suffering from yellows it should be dug and destroyed. A new tree may be planted at once in its place if desired. Spraying is of no avail with this disease.

Leaf curl sometimes causes extensive defoliation and consequent weakening to the tree, but does not directly affect the wood or fruit. The swollen, distorted leaves, often yellowish or reddish in color, are very characteristic. Once seen the disease is readily recognized. It is easily controlled by

spraying, but the application must be made early before the buds start into growth in the spring.

Scab affects some varieties more than others, Greensboro being especially susceptible. It is readily recognized through the appearance of black spots over the surface of the fruit. The usual spraying program will ordinarily prevent the disease.

There are other diseases that sometimes cause damage, but these are the most common and serious in Massachusetts. Their prevention by spraying will be discussed later.

4. *Insects.*

The toll taken by insects is serious, but by care and watchfulness their ravages may be held in check. While there are a great many insects feeding on the peach, only three are deemed important enough to find mention in this brief discussion.

Borers work just beneath the bark on the tree trunk, below and a little above the ground. Their presence is indicated by the appearance of masses of a brownish jelly-like material, commonly at the surface of the ground. The only satisfactory remedy is to dig them out. Go over the trees in the fall, and, if the insects are abundant, again in the spring. Dig away the soil 5 or 6 inches deep and go over the bark carefully. Dig out the "worms" and kill them. Put back the soil and do it all over the next year.

Various protective and repellant materials have been tried for borers, but while they may decrease the number of borers, nothing has been devised yet that will remove the necessity of digging them out. Heaping up a mound of earth 6 or 8 inches about the trunk of the tree in late June, forcing the insects to locate where they are more accessible, is as helpful as anything. Liberal fertilization with nitrate of soda to promote vigorous growth will help the trees to overcome borer injury.

The *San José scale* is found on peach as well as other fruit trees. Formerly it was very destructive, but now it does serious damage only in neglected orchards. Nevertheless, one should watch for the ashy-gray scurfy appearance on the

twigs caused by this pest and take energetic control measures if necessary.

Curculio causes serious damage in three ways: (1) by causing heavy drop of the young fruit during the few weeks following fruit setting; (2) by blemishes on the fruit from the egg punctures; and (3) by furnishing an opportunity for infection by brown rot through the egg punctures, the last being more serious than often realized. The adult insect passes the winter in rubbish along fence rows, in neglected fields and near-by woods. Care should be taken to locate the orchard away from the immediate vicinity of such places or to clear them up as the case may be. The chief prevention, however, is spraying as discussed later.

5. *Marketing Conditions.*

After one has overcome the limiting conditions of production, the efforts of the commercial grower go for nothing unless a satisfactory market is at hand. Fortunately for the Massachusetts grower he has a first-class market at his doorstep. The only difficulty that arises is that he is likely to have a crop only in years when peaches are abundant and the price consequently low. Great profits in growing such perishable fruits as peaches are secured only when a combination of good prices and a good crop occurs. It should therefore be the effort of the grower to get, so far as possible, a crop in years when other growers fail. Means of attaining this rather difficult aim, in part at least, will now be considered.

Establishing the Peach Orchard.

From the foregoing discussion it follows that one should direct all efforts towards overcoming these limiting factors and especially the most important and difficult one of winter-killing of fruit buds. Several factors not previously mentioned may be considered in establishing the orchard.

Soil.

The importance of local elevation, slope and protection from sweeping winds has been mentioned. Peach trees succeed on a wide range of soils, but it is in all cases imperative that the

FIG. 2. — Newly set peach tree pruned to short spurs at setting. It should have been cut off at the arrow.

FIG. 3. — At left, peach twig killed by winter cold. At right, twig alive but fruit buds killed.

soil be well drained. The subsoil should be open, preferably with a layer of gravel 2 or 3 feet down, underlaid with a more compact soil that will retain moisture. If these conditions prevail, the character of the surface soil is of less importance. It may be of medium clay to decidedly sandy. Peaches prefer a more fertile soil than apples, but may do well on soils too poor for first-class production of field or garden crops.

Slope.

Peaches do well on lands sloping in any direction, but it would seem that northerly slopes ought to be a little better in Massachusetts as there will be less tendency for the buds to start during winter thaws. A gentle slope falling off sharply below the orchard and without great expanse of sloping land above ought to be ideal.

Trees.

One-year-old trees are the rule and the medium sizes are generally to be preferred, but the planting and care of the trees is of more importance than any small differences in the stock. One should not plant trees if the bark is shriveled or if they are badly infested with San José scale or crown gall. Large well-branched root systems are important.

Varieties.

The number of varieties of peaches is legion, yet those that have found favor with any considerable number of commercial growers in the State are few. The following are discussed in approximately the order of ripening: —

Greensboro is the hardiest in bud of the common varieties, and is adapted to as wide a range of soil conditions as any. The quality is not especially good, yet coming among the first it is acceptable. In the market it competes with later varieties from the south and is sometimes less profitable on that account. It is susceptible to scab which is easily controlled by spraying.

Carmen is in higher favor than Greensboro, being ten days to two weeks later and of better quality. While less hardy in bud than Greensboro, it is hardier than most of the yellow-

fleshed sorts. It is one of the very best for Massachusetts orchards.

Champion follows Carmen at a week or ten-day interval, and is reputed to be about the best in quality of any. It is apt to crack in wet seasons and is much subject to brown rot.

Belle would be in higher favor if it did not compete in season with the yellow-fleshed Elberta; it is hardier in bud and equal or a little better for eating fresh, but does not hold its shape so well in canning.

Hale (J. H.) has been brought forward as a substitute for Elberta. It is a trifle earlier, somewhat larger and handsomer, but does not seem to have the adaptability to all sorts of conditions that Elberta has. It is a fine peach, but will hardly replace its well-established competitor.

Elberta is the standard peach all over the country. Probably more are grown than of all other varieties put together. It has two serious faults: it is not of the highest quality for eating fresh, and it is tender in bud. Often an orchard will have good crops of Greensboro and Carmen when Elberta is totally killed.

Other varieties worth trying to fill out the season are, in approximate order of ripening, Mayflower, Arp, Waddell, Edgemont, Mountain Rose, Hiley, Rochester, Stump and Fox Seedling.

Planting.

Before planting, the soil should be put into good tilth by deep plowing and harrowing. The trees should be set 18 or 20 feet apart. The hole should be large and the soil well packed over the roots. If trees can be secured from near-by nurseries, they may be set in the fall, but generally spring planting is best. Immediately after planting they should be severely pruned, cutting the tree back to 24 inches or lower, and cutting off all weak branches and shortening in the strong ones two-thirds or more. The branches to form the head should come out from 6 to 24 inches from the ground.

Soil Management.

A successful peach orchard cannot be grown in sod. It is imperative that continuous cultivation be kept up from early

spring till midsummer or later. For this reason peach orchards on steep slopes are generally undesirable on account of the soil washing that is apt to occur. In July or early August a cover crop should be sown. It is impossible to say what crop is best further than that it should furnish the largest possible amount of organic matter to plow under in the spring. The trees should grow fairly late in the fall so they may not complete the resting period too soon, yet it is important that the leaves fall and the wood ripen up before the cold days of November come. It is probable that a good cover crop on the soil as the trees go into the winter is helpful in securing the bud hardiness that is so important in Massachusetts.

Peach orchards require more fertilization than apple orchards. Barnyard manure in moderate quantity is good, but it is often unobtainable. Of the chemical fertilizers, nitrogen-carrying materials are most often of benefit and nitrate of soda has given good results. The amount to use will depend on the soil. Generally 4 pounds per mature tree will be profitable. Nitrogen, especially in liberal amounts, will delay ripening of the fruit, which may or may not be desirable. It will cause the tree to grow late in the season, which, if not overdone, will favor hardiness to cold.

Phosphoric acid has not generally proved of benefit to peach trees, but it is often helpful to the cover crop and its use may be justified on that account.

Potash alone is sometimes profitable, but has generally given better results when used with nitrogen and possibly phosphoric acid.

The leading shoots of a bearing peach tree ought to make a growth of 12 to 20 inches each season, and if they are not doing this an application of 2 to 4 pounds per tree of nitrate of soda is likely to prove profitable. The peach owner is advised in such cases to try it with and without potash and phosphoric acid and judge if the use of the last two is profitable. The amount of acid phosphate should be 2 to 4 pounds per tree, and muriate or sulphate of potash 1 to 2 pounds per tree. It is best to use rather small amounts until one is satisfied that that particular element is needed; then it may be increased to the limit of profit.

Pruning.

Few Massachusetts peach orchards are intelligently and systematically pruned. More attention to pruning should pay large dividends in increased crops and longer life of the trees. The peach bears by lateral buds on the new annual growth and on lateral or terminal buds on short, straight spurs. Most fruit buds are of the former kind, and as a result of this habit the bearing wood gets farther away from the center of the tree each year. This tendency is to be checked by heading back. Sometimes the fruit buds are near the base of this new growth, sometimes near the tip, and sometimes evenly distributed the entire length. These facts should be observed before pruning so that intelligent limiting of the crop may follow pruning. Heavy heading back should follow a loss of crop from winter cold, but one should make sure that the buds are destroyed before cutting, lest he destroy a crop. Dead buds will show a brown center within forty-eight hours after killing, but 90 or 95 per cent of the buds may be killed and the remainder make a fair crop. This is why the peach crop is sometimes destroyed in April and yet floods the market in September. If the buds are really all killed, cut the branches back into three or four year old wood and cut to a side branch; also cut back the side branches and remove all weak shoots.

If a crop is promised, less severe pruning should be practiced. The new growth should be shortened one-third or more and weak side shoots removed. Cut to a side branch whenever possible. Every effort should be made to keep the tree from going high in the air by cutting back severely the upright growth in the center of the tree.

Spraying.

The summer spraying program in the peach orchard will differ considerably from that for apples largely because lime-sulfur and lead arsenate will burn the foliage severely and cause partial defoliation. Thoroughness of application is of vital importance as with all spraying work; every leaf, twig and fruit should be completely covered with the spraying material.

FIG. 4. — Peach tree cut back into three or four year old wood, after severe winterkilling, making a good recovery.

FIG. 5. — Cover crop of buckwheat.

Self-boiled lime-sulfur is the best material for summer spraying. It is made by putting 8 pounds of lime in a wooden or iron container and slaking in the usual manner. When it starts to boil, sift in 8 pounds of finely ground sulfur and continue boiling with constant stirring for a few minutes. At the first appearance of a very slight reddish tinge, add cold water to make up to 50 gallons and apply at once. Only the best of lime should be used. If it does not start slaking readily use hot water, but do not use any artificial heat to cook the mixture. Better results follow if twice or four times the amounts given are prepared in a single batch.

For small operations a proprietary material known as atomic sulfur is sometimes used with good results.

No fixed spraying program will be the best under all conditions and in all seasons, but the following will give generally satisfactory results: —

First Spraying. — Before the buds start to swell, commercial lime-sulfur, 1 gallon to 9 gallons water, for San José scale and leaf curl. Not needed if these pests do not occur.

Second Spraying. — For the curculio, arsenate of lead, 3 pounds paste, or $1\frac{1}{2}$ pounds powder, to 50 gallons of water, just as the shucks are falling, — a week or ten days after blossoming. It is a safe thing to add 2 or 3 pounds freshly slaked lime to prevent possible injury to the foliage.

Third Spraying. — For curculio, brown rot and scab, self-boiled lime-sulfur and arsenate of lead two weeks after second spraying. Atomic sulfur may be used in place of the self-boiled lime-sulfur, in which case it is best to add milk of lime as in second spraying.

Fourth Spraying. — For brown rot, self-boiled lime-sulfur four or five weeks before the fruit ripens. To be omitted with Greensboro and other early varieties. Atomic sulfur may be used as a substitute.

Dusting has recently been recommended as a substitute for liquid spraying and is fairly satisfactory for peaches. It is generally most desirable for large growers where haste is important or when water is difficult to obtain.

Harvesting and Marketing.

Peaches should be allowed to hang on the trees until as nearly ripe as possible. For near-by markets the time to pick is when they are well colored and at the first signs of softening on one cheek. Then they should be hurried into the consumer's hands as rapidly as possible. If several days must elapse on the way they must be picked a little sooner. Generally it will be necessary to go over the trees twice or three times to get all the fruit in the best condition. If hot weather prevails at ripening, they will often all come on at once. As with all fruit great care should be taken to avoid bruising and consequent decay.

The package most commonly used is the 14-quart Jersey basket. Except in years of a generally heavy crop marketing is a simple problem, and as previously pointed out the greatest success follows where one can get a good crop in years of scarcity. The American people spend too much money in carrying food products long distances. Let us produce more peaches at home and avoid this transportation cost.

Chapter IV.

PRUNING FRUIT TREES.

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The pruning of fruit trees is a subject which is as old as fruit growing itself. Definite and elaborate systems of pruning trees were in vogue centuries before such practices as thinning and spraying were heard of. Yet in spite of the antiquity of the practice it is only in recent years that well-conducted and thorough experiments have thrown light upon the underlying principles involved. At present the views of competent fruit growers are somewhat at variance as to how much pruning should be done, ranging all the way from none whatever to very heavy cutting, and also there is no universal agreement as to the best form into which a tree should be trained.

Pruning may be defined as the art or science of cutting away a portion of the plant in order to improve its shape, to increase its fruitfulness, or to repair damage. It should be recognized that training and pruning a tree are for different purposes. There are not many who would not attempt to train a tree for the first few years in order so to distribute the branches as to make the tree capable of carrying the maximum load of fruit when it becomes mature as well as to secure "the ideal" which the grower has in mind. Nevertheless, it is easily possible to overemphasize its importance, for the object of pruning a tree is certainly not to produce a beautiful or shapely object, but rather to make a tree well balanced and capable of carrying a heavy load and having the crop so distributed as to give it maximum size and color. It is not uncommon in some sections to have a ton and a

half of fruit hanging on a tree, and the tree's capacity to carry it must be a matter of foresight by the orchardist.

On the other hand, the matter of producing a fruitful tree is a complicated problem intimately associated with other practices and varying with different kinds of fruits and varieties of them.

Shape and Form of the Tree.

The general shape or form of a tree is largely a varietal character and is not easily changed. A tree which is quite upright in habit of growth, such as the Wealthy or Sutton, cannot be made to develop into a spreading type by any system of pruning. Likewise a tree of a spreading habit, such as the Rhode Island Greening, or one with a drooping habit, as the Wolf River, cannot be developed into an upright growing one by pruning or training. Yet much can be done to curb a wayward grower or improve the natural proclivities of a variety.

Types of Training the Apple Tree.

The grower should first decide upon the general type of tree which he wishes to develop and then begin with the newly set tree to follow out his plans.

There are several general forms into which the young tree can be trained, the three principal ones being the vase or open-headed tree, the semi-leader or modified leader, and the central or pyramidal type.[1] The vase-shaped tree is developed by selecting from three to six scaffold limbs which are to be somewhat equal in importance and all of which are lateral branches from the main trunk or stem, the central branch or leader being cut out at planting time. These scaffold branches are usually cut back to from 4 to 8 or 10 inches in length at time of planting, provided the tree is two years old, but if it is a one-year-old tree the top is cut back to from 20 to 30 inches in height and the scaffold branches are selected from the initial ones sent out during the ensuing summer or the following spring when they receive their first pruning. These

[1] In addition to these three general types of training we should perhaps include the natural type of unpruned tree, although this sort of neglect is not common in commercial orchards.

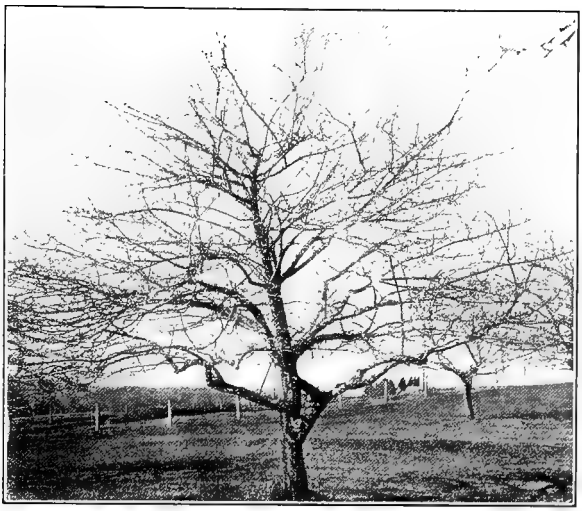

FIG. 1. — An apple tree in which the central leader has been allowed to develop. Such trees are inclined to grow too high. Compare with Fig. 2.

FIG. 2. — The open-center habit of growth. A well-balanced tree with plenty of room for the admission of light and air. Most orchardists favor this type of tree in preference to the type shown in Fig. 1.

branches are selected radially about the main stem.[1] The semi-leader type of tree is essentially different, in that the central leader is not removed at planting time but is allowed to remain and develop some 2 feet or more above the first set of scaffold branches, when the terminal is removed to prevent it continuing into a full leader tree. The result of this type of pruning is to secure what amounts to two sets of scaffold limbs, one some distance above the other, or else some branches distributed above the entire axis. The value of this type of tree is that the side or scaffold limbs are more strongly built and not so likely to be broken out by a heavy crop as in the case of the vase-shaped tree. This type of tree is gaining in favor in many sections of the East.

The leader or pyramidal type of tree has all its limbs developed from a central leader much as a pine tree. The limbs are strongly built and the loss of any individual limbs is of slight importance compared with the open tree, but it is not as desirable as the semi-leader. The branches are likely to crowd and the resulting fruit is adversely affected.

Heading Back versus Thinning Out.

In the actual pruning operation there are two different types of procedure to consider, namely, heading back and thinning out. The first refers to the cutting back of the shoot or branch, hence removing the terminal growing point and a certain number of the lateral buds or shoots nearest the terminus of the branch. The second, on the other hand, refers to the removal of surplus branches or shoots without any cutting back process. The effects of these two types of pruning are different and should be considered by the careful orchardist.

In general, the young tree must have some heading back for about three years in order to develop a strong, well-branched framework. After this only the long, rangy branches which are out of proportion should be headed in. The result of heading back mature trees, or those just passing through the transition stage from vegetative to reproductive growth,

[1] With no two opposite each other.

is to cause a bushy development of branches and retard the bearing. This result is due to the fact that the buds nearest the cut surface or wound make the greatest response the following season and fewer buds are left to develop into spurs than where the terminal is not cut. So that unless it is necessary to stimulate vegetative growth the heading back or "shearing" of mature trees should be confined to overgrowing branches.

The thinning-out process will remove cross limbs and others which cause the tree to be too dense. The result of this type of pruning is to maintain and develop the maximum number of fruit spurs and bring the tree into early bearing. Usually a combination of the two types of pruning is necessary at some periods in the life of a tree.

Cardinal Points in Pruning the Mature Tree.

In addition to the considerations above mentioned the following points should be borne in mind: —

1. *Remove Dead Branches.* — Remove all dead branches, also diseased or injured parts, in order to safeguard the remaining portions of the tree. Some exceptions to this may be noted in case such a disease as black rot canker (*Sphæropsis malorum*) is found abundantly through the tree. If it were all removed, little would remain of some trees, hence it is often retained until the limb shows evidence of decline.

2. *Open up the Tree.* — If the tree has become too thick and "bushy" it will be necessary to remove a portion of the limbs or a weakening of the fruit spurs results, and fruit inferior in size, color and quality will be produced. Rubbing limbs should be removed, and long, rangy limbs which are out of proportion should be headed back. The extent of this work will depend upon the experience and judgment of the operator.

3. *Avoid Removal of Fruit Spurs.* — This matter is paramount, and a thorough understanding of the way a tree bears its fruit must be one of the basic guides in the removal of branches. There are times when it is desirable to remove a portion of the spurs or portions of the individual spur.

4. *Stubs are to be avoided.* — In removing limbs or branches, no matter how small, they should be cut close to the trunk

or adjoining branch to which they are attached. This is not so important with the peach as with the apple, owing to the strong growth of the former which will more quickly envelop a small stub.

5. *Remove Suckers.* — As a rule it is desirable to remove the suckers or water sprouts which may arise throughout the tree. Strong sucker growth along the main limb of a long branch may be an evidence of decline in the branch, and the outer extremities may be robbed of vitality if these suckers are allowed to develop. On the other hand, it is often desirable to retain a portion of them for replacing limbs. In such a case it is usually desirable to head them back and treat in about the same manner as a young tree. A portion may also be retained throughout the tree for developing into fruit spurs by cutting back to a few inches long.

Summer Pruning.

It does not seem possible to harmonize the views held by different investigators on the value of summer pruning. It is an old practice and has commonly been credited with bringing about increased fruitfulness and as a means to bring tardy bearers into fruiting. There is very little experimental evidence on which to base this teaching, but it is well entrenched in the literature. The value of it seems to depend upon the variety, soil, climate, time and character of pruning, and, perhaps, upon some other undetermined conditions. For eastern conditions the consensus of opinion seems to be that it is not a desirable practice as the trees are enfeebled and the effects upon bearing are doubtful, often negative.

Dehorning Trees.

The dehorning of apple trees, or the cutting back of one-third, one-half or even more of the tops of old trees, leaving naked branches from which to grow a new top, has had its advocates. This procedure requires great caution, for it is not uncommon to find that trees which are subnormal in vitality may have their death hastened by such a procedure, although the first two or three years the operation seems suc-

cessful. It is usually better to cut back a portion of the tree at a time, and always cut to a side branch rather than trust to the outgrowth of suckers or water sprouts from a stub. Such trees should be stimulated in some way when this treatment is given. The peach, on the other hand, may be so treated with success.

Chapter V.

GRAFTING AND BUDDING.

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Grafting and budding are the practical means employed to reproduce established varieties of fruit trees. This is made necessary because the tree fruits do not come true to name from seeds. While the two operations have the same objectives, the method of manipulation and the season of doing the work vary so much that for purposes of clearness they will be discussed separately.

Grafting.

Grafting consists in placing a portion of a plant upon or into another plant or upon a different place of the same plant in such a way that the growing areas of the two are in contact and their permanent union results.

This actively growing area referred to above is found just beneath the bark and is technically known as the cambium layer. When growth begins in the spring, *i.e.*, when the leaves are unfolded, the cambium becomes so filled with food materials (sap) that the bark readily separates from the wood, or in common parlance the bark "slips." It must be noted that in every type of grafting and budding the success of the operation depends upon having the cambium, or growing areas of scion and stock, in intimate contact.

The part of the plant transferred is called the scion. It is the part of the graft which produces the tree or the branch, and will produce the same kind of fruit as the branch from which it was taken. The scions for grafting are best if cut from the terminal shoots of the past season's growth. These shoots or twigs should be well matured and the buds should be plump

and well matured. Scion wood may be cut any time from early winter until early spring. If cut several days or weeks before it is to be used, is should be stored in a cellar with at least 6 inches of the butt ends buried in moist sand in order to prevent drying out.

The part of the plant upon which the scion is inserted is the stock. It may be a root or even a piece of a root of a seedling or the stem or branch of an already established tree.

Equipment and Materials.

The equipment necessary to do the ordinary types of grafting consists of the following items: —

1. A strong pocket knife, very sharp, or a regular grafting knife.
2. A grafting chisel or a large, strong butcher knife.
3. A sharp saw with reasonably wide set.
4. A mallet of some sort for forcing the chisel or butcher knife into the stocks in top grafting work.
5. Grafting wax, for top grafting and for repairing girdled trees.
6. A supply of No. 20 cotton thread for use in root grafting, also in budding.
7. A supply of good scion wood.

Grafting, as a rule, is practiced only when both stock and scion are in the dormant state. It is limited in its practical application to the apple, pear, quince, plum and grape. There are many methods in use, but those only of most practical value to the fruit grower will be discussed here.

Grafting Wax. — Grafting wax may be bought of dealers in hardware or of seedmen, or it may be made in the home by melting together over a slow fire 4 parts by weight of resin, 2 parts beeswax or paraffin, and 1 part linseed oil. When thoroughly melted, pour carefully into a pail of water. As soon as cool enough to handle, pull this wax the same as in making molasses candy. As the wax is pulled it takes on a lighter color and acquires greater elasticity. It should be soft enough to handle on ordinarily warm days, but not soft enough to run under influence of sun's heat.

In pulling the wax it may be kept from sticking to the hands by keeping them wet. When using the wax in the field have

a small quantity of linseed oil along. If the hands are oiled before attempting to apply the wax it will be found to facilitate the work and to preserve the good nature of the operator.

Top Grafting.

Top grafting is resorted to when for any reason one desires to change the variety of an already established tree or to remedy some defect or inherent weakness in the tree itself. If the tree is two or three years set it may be grafted in the stem or trunk, requiring only one operation to change the whole top. However, if the young tree has a well-shaped head it is more satisfactory to graft each of the scaffold branches, since a better shaped tree will be secured. If the tree has long been established the only method of changing it is to graft into the branches. Just how large a branch may be successfully grafted is an open question, but best results will follow if the branches selected for stock are not more than 3 inches in diameter. Branches 1 to 2 inches through make the most successful stocks.

In working over large trees it is advisable to graft first the lower or lateral branches and only a few of the more upright or central ones, leaving enough of the central branches to furnish some shade for the trunk and main branches. If the whole top is removed at one season sun scald is likely to occur, seriously injuring or even killing the tree.

If the scions set the first season make sufficient growth to supply the necessary shade, the remaining branches may be grafted the second season. Two or even three years are required to change completely the variety of a bearing tree. While young trees up to three or four years old may be completely grafted in the one season, even with young trees it is a good plan to leave one or two of the more central branches for at least the first season.

The best time to do top grafting is in late spring after severe freezing is not likely to occur and before growth begins. There are several distinct methods of uniting the stock and scions, but only two will be discussed.

Cleft Grafting. — In cleft grafting, the stock, which is either the stem or the branch of a tree, is cut off squarely with a

sharp saw. This stock is prepared to receive the scion by splitting it through the heart to a depth of 3 or 4 inches. This split or cleft, as it is called, may be made with a grafting chisel or a strong knife. The wedge on the grafting chisel or a wooden wedge is inserted to open the cleft to receive the scions (see Fig. 1, b).

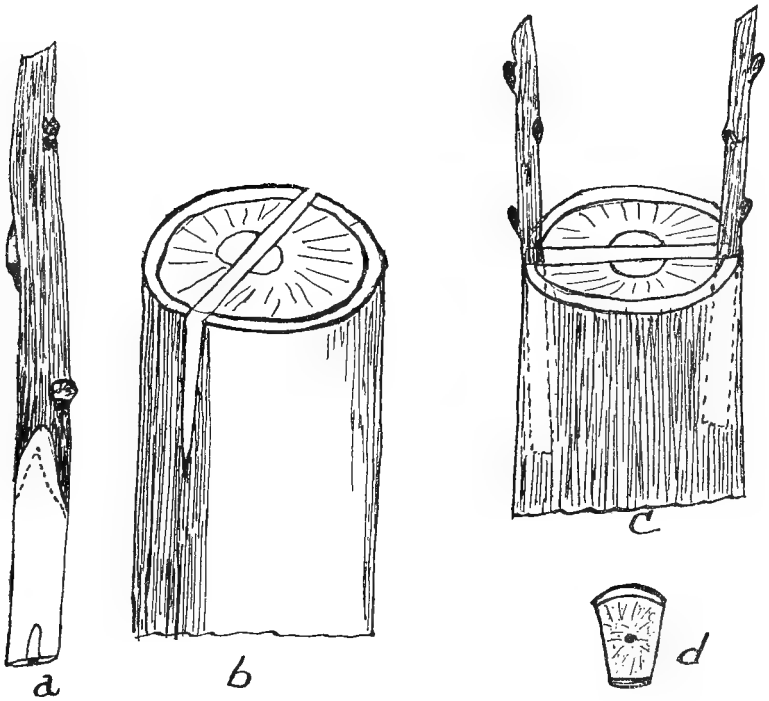

FIG. 1. — Cleft grafting: *a*, side view of scion; *b*, the stock ready to receive the scions; *c*, the scions in position; *d*, cross section through the wedge of the scion, showing one edge, the inner one, thinner than the other.

The scions are cut from shoots of the previous season's growth taken from a tree of the desired variety. On the lower end of a piece of scion wood cut a smooth wedge with a taper about $1\frac{1}{2}$ inches long, having one side a trifle thinner than the other (see Fig. 1, a and d); cut off the excess length, leaving two or three buds on the finished scion. The wedge of the scion is inserted into the cleft of the stock, the thinner edge inward, being sure that the inner bark lines, *i.e.*, the cambium layers, are in contact. To insure this, the scion may be slanted

just a trifle, having outer edges even at upper edge of stock (see Fig. 1, c). The scion must be cut so that it will fit firmly into the cleft. Another scion is prepared and inserted into the opposite side of the stock. Each stock should carry two scions. The weaker must be removed after one or two seasons' growth (see Fig. 1, c).

When the scions are firmly set in position the wedge is removed and the wound is carefully waxed. The wax must fit snugly around the scions at the top of the stock, and the cleft must be entirely closed with it. The wax should extend down the side an inch or two below any signs of cracks in the bark. If the wax has been properly made it will require no further attention after being applied. If too soft, it will run when warm days come and must be replaced with a harder wax. If the wax is not properly applied or is too soft, the air gains access to the wound, drying out the wood, and the scions will not grow.

The Notch, or Coburn Grafting. — This method is less commonly used than the preceding, but has some distinct advantages. Instead of splitting the stock a longitudinal cut is made, using a sharp saw with a fairly wide set. This gives a groove or notch the width of the saw cut about one-half inch deep at top of the stock, running down the side of the stock for 3 or 4 inches where it becomes a mere scratch on the bark at the lower end (see Fig. 2, a).

The scion is prepared in a slightly different manner from that in the cleft method. Instead of a wedge it is cut in such a way that the two sides of the tongue which is to fit into the saw cut have parallel sides (see Fig. 2, b and c). The edge that is to go toward the center of the stock should be a trifle thinner so that when inserted into the stock the greatest pressure comes on the outer edge. A few taps on the top of the scion will fix it firmly in place. If stock is more than 1½ inches in diameter, two scions may be inserted. The same care must be exercised as in cleft grafting to have the growing areas in contact. The wound must be thoroughly waxed as soon as scions are set.

In both types of top grafting only one scion should be permitted to make a permanent growth. After the first or second season the less desirable one should be removed. This is generally done by making a sloping cut down the stock, be-

ginning at the base of scion left and emerging at side of stock 3 or 4 inches below. If the cleft has not closed it should be rewaxed. No rewaxing will be necessary if the notch, or Coburn method, has been used.

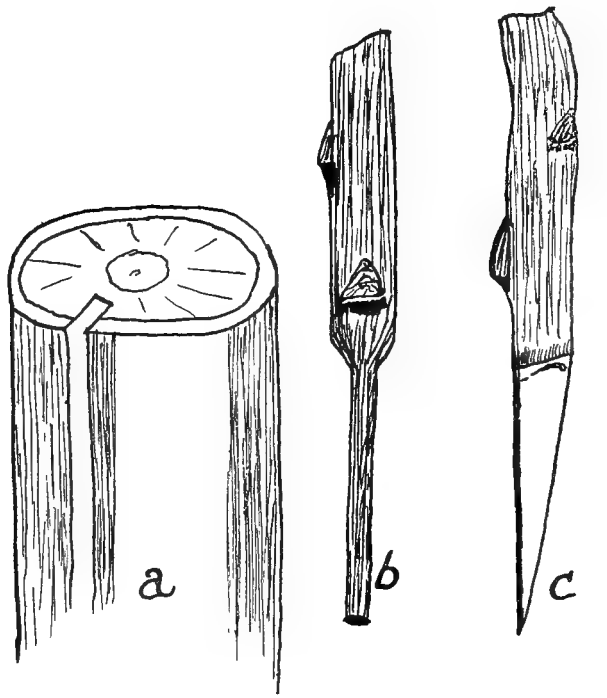

FIG. 2. — Coburn grafting: *a*, the prepared stock; *b-c*, prepared scion, showing method of cutting the tongue; *b*, viewed from side that goes outward in finished graft; *c*, viewed from side showing the sloping cut necessary to fit the sloping notch.

Root Grafting.

Root grafting is one of the common methods of propagating apple and pear trees. The stocks used for standard apple trees are one-year seedling trees, or, lacking these, the small roots, one-quarter inch in diameter, of young trees may be used. Pear seedlings are the stock used for propagating standard pear trees.

The stocks should be procured in the autumn and stored in moist sand in a frostproof cellar. The scions, also, may be cut in late autumn and early winter, tied in bundles and stored with the stocks, or they may be cut from the trees in early spring at the time the grafting is to be done.

The grafting should be done in late winter or early spring, about February and March, although expert grafters are successful if the work is not done until planting-out time. If the work is to be done in a warm room, only a small supply of materials should be brought in at a time or else some means must be employed to prevent drying out of both the materials and the finished grafts.

Preparation of the Stock. — In preparing the stock to receive the scion proceed as follows: Cut off the top from the seedling

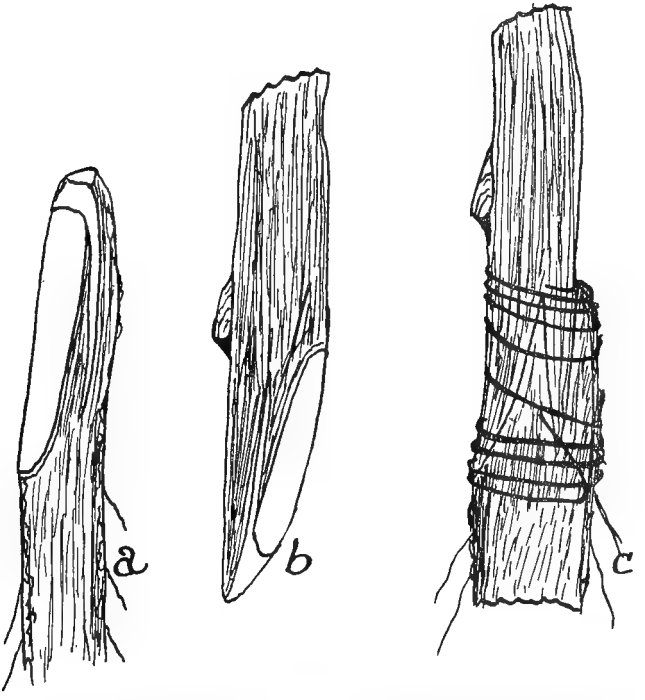

FIG. 3. — Tongue grafting: *a*, the stock prepared to receive the scion; *b*, the scion cut to fit the stock; *c*, the union of the finished graft, showing the interlocking of the tongues of stock and scion and the method of wrapping with string.

stock, use a sharp knife and begin the cut at the crown, *i.e.*, soil line. The cut should be an upward sloping one with a smooth, even surface about $1\frac{1}{2}$ inches long. Set the knife on the sloping surface about one-fourth inch from the upper end and cut the tongue. The tongue is made by cutting back toward the base of the sloping cut to a distance of about 1

inch, dividing the wood between the bark and face of sloping cut into two nearly equal parts (see Fig. 3, a). It will be seen that the tongue is cut, not split. Cut off the lower part of the seedling, leaving the stock about 3 or 4 inches in length. If the remainder of root is large enough, another stock may be made from it. Well-grown seedlings with a straight tap root 10 to 15 inches long will make two to three good stocks.

Preparing the Scion. — The uniting surface of the scion is prepared in the same manner as described for the stock, the tongue being cut, of course, on the lower end of the scion. The scion should be cut to a length of 6 or 7 inches (see Fig. 3, b).

The stock and scion are united by causing their tongues to interlock. In fitting them together it is necessary that the growing areas, *i.e.*, inner bark lines of scion and stock, should be in contact on one side of the union. If the stock and scion have been properly prepared the two pieces will fit perfectly without any overlapping of the ends. The stock and scion should be pushed firmly together so that the pieces will form a fairly rigid union.

After the stock and scion are fitted together they should be bound with string to prevent mechanical injury in handling and to hold the cut surfaces in more intimate contact, thereby preventing drying out and insuring a callousing over of the wound. Number 20 cotton thread is generally used for this purpose. The operation is as follows: Holding the finished graft by the scion in the left hand, begin to wrap the string around the top of the union. Catch the free end of the string under the first or second wrap of the string, then wind the string around three or four times; pass to the lower end of the union by making one or two spiral turns of the string. Wrap the lower end of the union three or four times, and by slipping the string between the end of the scion and the side of the stock, give the string a sharp jerk. The string will break near the graft and the end will remain fast, preventing unwinding (see Fig. 3, c).

Storing the Grafts. — The finished grafts are tied in bunches of 25 to 50 and are then buried in moist sand stock down to a depth of 5 or 6 inches, or they may be packed in boxes in alternating layers of grafts and moist sand. The grafts must

not be permitted to become dry. After a few weeks in storage the wounds will be calloused or practically healed, and the grafts are now ready to set in nursery row as soon as the ground is in condition to receive them. This healing of the wounds in storage, while not absolutely necessary, the amateur will yet find very desirable.

Setting out the Grafts. — The grafts should be set out as early as the ground can be fitted. Prepare the soil by deep plowing and frequent harrowing to fine it. Lay off the rows 3 to 4 feet apart. Make a dibber by sharpening a round stick. It should be about 1 to 1½ inches in diameter by 10 to 12 inches long. Since the finished grafts are 7 to 9 inches long they will require a hole 6 to 8 inches deep. Push the dibber in the soft earth to the required depth, withdraw it and insert the graft, holding it so that one bud only remains above ground level. Again insert the dibber alongside the hole containing the graft and by a sidewise pressure on top firm the soil about the graft. Firm the soil about the top by pressing down with the hands and proceed to set the next graft. The grafts are set 12 to 15 inches apart in the row.

By careful fertilizing and frequent cultivation a large per cent of these grafts will be made large enough to transplant after the first season's growth, or they may be left to make a second season's growth in the nursery row. They are now known as two-year-old trees, and should be removed to their permanent position in the orchard.

Repairing Girdled Trees.

Mice, rabbits and other rodents cause considerable loss each year to the fruit growers of Massachusetts. During periods of deep snow and scarcity of other food these animals resort to the bark of young trees. The work of mice is generally confined to the base of the trunk, since they live beneath the snow. Rabbits, however, may do serious injury not only to the trunk but also to the branches of low-headed trees.

Sometimes the bark is gnawed off in irregular patches, but more often a partial or complete girdling results. These girdles may be relatively narrow, extending up and down the trunk for a distance of 1 to 3 inches, but frequently they are

wide, being 4 to 6 or 8 inches. It often happens that only the outer bark is removed; as a rule, however, the wood is completely bared.

If the girdle is quite narrow, not exceeding 1 or 2 inches, it may be possible to save the tree by mounding with earth, provided the girdled area has not become thoroughly dried by long exposure. This remedy is recommended by many writers on the subject, and by a few practical growers who say they have tried it. This department has not given it a trial and cannot recommend it from experience. It might be well worth while trying out on a few of the less valuable trees.

Where trees are not completely girdled they usually recover, particularly if they be young and vigorous. If the bark remains intact over half of the circumference they may be considered safe. If the bark area is reduced to a quarter, then it will be well to set in one or two bridges on the side opposite to the area of sound bark.

Where trees are completely girdled one of two methods of repairing may be used, depending upon the age or size of the trunk. If trees are quite small, such as one and two year trees, it is often advisable to cleft graft them. The small size of the tree renders any other method a rather difficult process, while the cleft graft is relatively easy and perhaps much more satisfactory. Because of the well-established root system, the scion will make a very vigorous growth, and apparently the tree does not suffer any greater setback than if bridged, and besides a more shapely tree will result. Furthermore, it is less expensive in the amount of time required to do the work.

Bridge grafting is the most satisfactory recourse for trees older than two years. The purpose of the bridge is to provide a channel for the immediate downward flow of the elaborated plant food, since the removal of the bark has destroyed the natural channels of sap flow to the roots. Eventually, however, as the girdled portion becomes thoroughly dried, the circulation of sap between top and roots is taken care of by the bridges, which soon become a part of the tree, enlarging and finally growing together, until after some years an enlargement or ribbed bulge on the trunk of the tree marks the point of injury. Trees that have been bridged do not present

as sightly an appearance as uninjured trees, as eventually the bridges grow together forming an enlargement at the base of the tree. However, if it is a question of losing several years growth on valuable trees, one can afford to disregard a poorly shaped trunk.

Cleft Grafting. — If cleft grafting is to be used it will be necessary to remove the earth from around the trunk to a depth of several inches; and since the part of the trunk uncovered will be wet, some time must elapse before grafting operations can be completed. Usually only a few hours will be required to dry the bark enough so that the wax will stick to it.

With a sharp saw cut off the trunk just below the surface of the ground. The reason for making the cut this low is to hide any unsightliness that may form at the point of the graft union. Next split the stump to a depth of 2 or 3 inches, using a stout knife or a grafting chisel (see "Cleft Grafting," page 60).

When the job is completed the earth is put in place and a stake set to mark the position of the scions. It will generally be found necessary to give the new growth some support during the first summer. If the union is a good one the scion will make a growth of several feet. It should be tied to a stake to prevent its being broken off by the wind. Only one scion should be permitted to grow. Shoots coming from the other should be removed, and at the following spring's pruning if this scion protrudes above the ground, it should be cut off below the surface of the ground.

Bridge Grafting. — Girdled trees that have been set more than two years should be bridge grafted. This process is essentially as follows: —

With a sharp knife cut a small notch just above the girdled portion and one directly beneath it, but below the girdle. The notch should go through the bark and into the wood and is made as follows: Set the knife on the bark above the girdle and force it inward and upward for a distance of a half or three-fourths of an inch. Withdraw the knife and setting it a quarter of an inch below the first incision cut inward and upward allowing the knife to stop when it reaches the point of the first cut. Remove the knife and dislodge the wedge-shaped chip. A similar notch is cut directly beneath this, but

below the girdle. In making this cut the knife is directed downward and inward (see Fig. 4, b).

Scions may be taken from any variety, but must be of the season's growth. On the butt end of a piece of scion wood

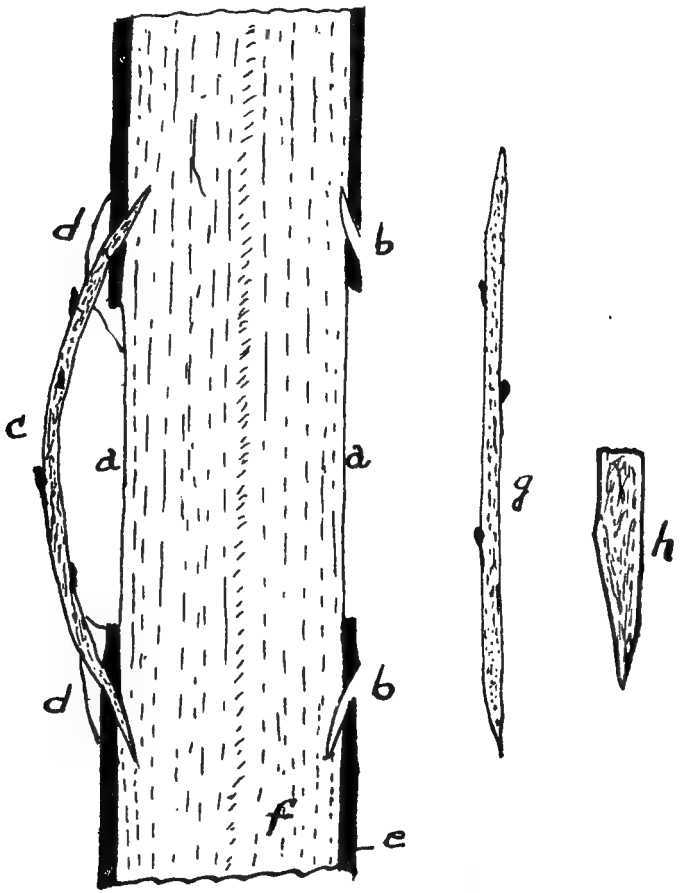

FIG. 4. — A diagram of a longitudinal section of a girdled trunk with one bridge in place: *a–a*, girdled area; *b–b*, notches to receive bridge; *c*, bridge in place; *d–d*, wax over wounds; *e*, bark; *f*, wood; *g*, scion shaped for insertion; *h*, enlarged end of scion, showing manner of cutting the wedge.

cut a wedge about 1 inch in length, making the longer cut on the side that is to be placed next the tree. Measure on the scion wood the distance between the two notches and cut off the scion a trifle longer. Cut a wedge on the upper end the same as directed above. Now insert the wedge at the butt

end of the scion into the lower notch, and by slightly bending force the upper end into the upper notch, using some pressure to force wedges in until the scion is firm (see Fig. 4, c and d). The bend in the scion will serve to keep it in place until it has become united to the tree.

In same manner insert four or more scions around the trunk at regular intervals. Large trees may require six or eight scions, while smaller ones will do well with four or five.

When the scions or bridges are all in place, the wound made by the operation must be thoroughly waxed. Crowd the wax well into the notches and have it meet the scions snugly. If air or water gets into these wounds the scions will not grow and the tree will be lost.

All shoots that start from the scions or from below the girdle should be removed not later than at close of first season's growth.

While in a sense the girdled area will determine the length of the bridge or scions, yet it will be found that if the girdled area is short, a scion considerably longer than is really necessary to just bridge it can be used to better advantage. Scions less than 5 or 6 inches in length will be very difficult to handle unless they are quite thin and pliable.

Trees that have been bridge grafted should receive a more severe pruning than is given uninjured trees.

Budding.

Budding differs from grafting in the amount of wood transferred and in the season of operation. Budding may be defined as the insertion of a bud bearing little or no wood beneath the bark of the stock. Budding may be used for the propagation of all fruit trees. It is more economical of scion wood since single buds only are used. It is, however, more expensive as to stocks in propagating trees since one stock must be used for each tree propagated, while in grafting a well-grown stock may make two or three trees.

Budding is used primarily to propagate new trees, and for top working young trees; it is not as useful in top working old trees as is grafting. The stock for budding should rarely exceed three or four years, and better success will follow the

use of one and two year old stocks. It is the only practical method of propagating the peach and cherry varieties, and it may be applied to any of our orchard fruit trees.

Because of the very nature of the operation, budding must be done when the bark slips easily and when there is a supply of buds properly developed. These conditions are met in this section in the late summer and early fall. At that season the buds

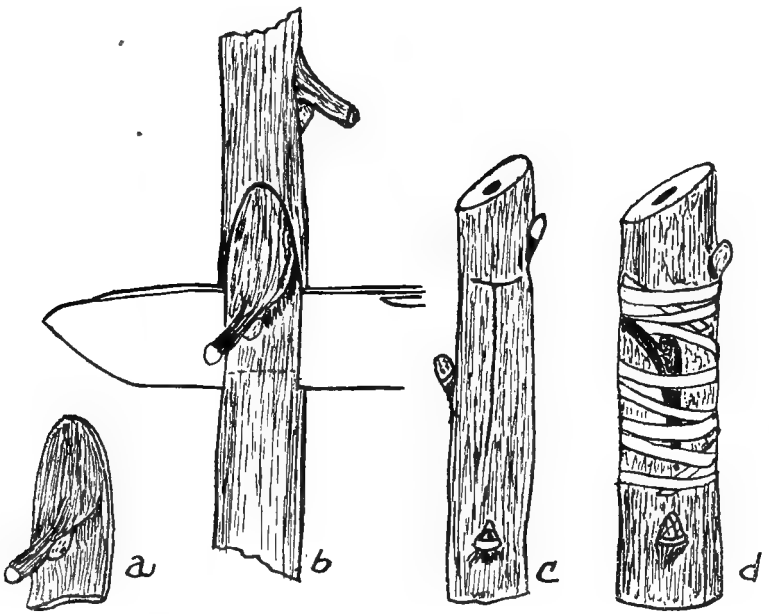

FIG. 5. — Budding: *a*, the bud cut from bud stick; *b*, showing method of cutting bud; knife is started below the bud in cut; *c*, the T cut on the stock; *d*, the finished job, showing the bud in position and the method of wrapping with raffia or string.

growing at the bases of the leaves on the shoots of current season's growth are sufficiently developed to form good scions. In the earlier part of the budding season avoid the buds found near the base and those near the tip of the shoots, taking only those growing in the middle two-thirds of the shoots, since, as a rule, these buds are the best nourished and most matured.

During this period, also, the sap is flowing freely through the cambium, or growing area, and the bark therefore slips readily.

In Massachusetts budding may be done from the middle of August until well into September. No growth is made by the bud until the following season.

In the actual operation of budding the operator first prepares his bud sticks. These are the terminal shoots of the current season's growth. The leaves are cut off, leaving about one-half inch of the petiole or leaf stem. This will serve as a sort of handle and will facilitate the setting of the buds. The bud sticks must be kept from drying out by wrapping in paper, moist burlap or other material. The buds, as needed, are cut from the bud stick as follows: With a sharp knife begin the cut about a half inch below the bud and, by cutting into the wood a little, force the knife underneath the bud, cutting up to the surface about a half inch above the bud (see Fig. 5, a and b). The bud with its small piece of attached wood is ready to insert into the stock.

The stock is prepared by making a longitudinal cut through the bark for a distance of $1\frac{1}{2}$ inches; at the top of this cut a transverse cut is made forming a letter T. If the transverse cut is made with a rolling motion of the knife, the flaps of bark at the angle of the two cuts will be loosened from the wood; otherwise, these flaps must be lifted with point of knife or with the ivory heel of a regular budding knife. The bud is next grasped by the leaf stem as a handle and gently pushed into place until its cut surface lies in contact with the peeled body of the stock with the bud pointing upward. A string of some sort, raffia or No. 20 knitting cotton is then drawn tightly around the stock both above and below the bud in order to hold it firmly against the stock and to prevent the wound drying out (see Fig. 5, c and d). As soon as the bud has united with the stock, which should be within a week or ten days, the string is cut and the bud receives no further attention until next spring, at which time the stock is cut off an inch or two above the bud in order to force the bud into growth. No buds on the stock beyond the one set should be permitted to grow.

In propagating trees the seedlings in the nursery row are budded, the buds being set as near the ground as convenient. The following spring the tops of the seedlings are cut off just above the buds.

In top working trees by budding the buds should be set in wood not more than two or three years old. Hence this method for top working old trees is not as valuable as grafting,

since in budding the desired variety must be set so far from the trunk and scaffold branches as to carry the tree too high.

Growing Stock for Budding and Grafting.

If one is to propagate new trees seedling stock is necessary. This may be purchased from nursery firms or may be grown by the fruit grower.

The first requisite is to secure a supply of seeds. Apple seeds are most easily secured from a cider mill. A small quantity of pomace is placed in a vat or barrel and water is added. Fermentation will start within a few days, causing the pomace to break up and float to the surface while the seeds fall to the bottom. By adding more pomace the desired amount of seed is secured.

Peach and plum seed may be secured from sources where these fruits are grown in quantity or where they are canned or manufactured.

All these seeds sprout more freely if not allowed to become thoroughly dried out. Consequently they require special treatment. Two courses are open, as follows: The seeds are placed in a shallow box and covered with sand. The box is then buried in the earth a few inches below the surface. The following spring the seeds are dug up and sowed in nursery rows. The second course is to plant the seeds immediately after they are removed from the fruits.

Peach and plum seedlings if well cared for should be large enough to bud the fall of their first season's growth. Apple and pear seedlings are large enough for root grafting after one season's growth, but generally require two seasons' growth before budding.

Dwarf Trees.

The apple and pear are the commonest dwarf trees and their small size is due to the slow-growing stock upon which they have been worked.

The apple is dwarfed by grafting or budding on Paradise apple stock. Doucin apple stock produces a dwarf tree which is intermediate between the Paradise stock dwarf and the standard tree. The pear is dwarfed by working it on quince stock. All these stocks may be purchased from nursery firms.

Chapter VI.

SOME IMPORTANT APPLE INSECTS IN MASSACHUSETTS.

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During the last decade, apple growing in Massachusetts has developed greatly. With this growth of the industry has also developed an increased interest in the insect pests of the apple and in the methods for their control. Many persons spray their trees regularly, finding this the only way by which crops of good fruit can be obtained; and while this is only one factor in making a success of fruit growing, it is at least an important one.

Fifteen or twenty insect enemies of the apple are abundant in Massachusetts, and to obtain control over them no one treatment is sufficient, for while several can be handled successfully in the same way, others will entirely escape. In fact, in controlling insects the only rule is to "make the punishment fit the crime."

Some apple insects attack the roots; others the trunk and branches; others the buds and leaves; and others the fruit itself. Fortunately, root-attacking forms are seldom or never abundant enough in this State to become serious pests, and only a few are of importance on the trunk and limbs.

Insects attacking the Trunk and Branches.

The Round-headed Apple-tree Borer.

The adult of this insect is a beetle not often seen, but nevertheless quite abundant. It attacks the pear, quince, thorns, mountain ash and a few other trees as well as the apple, these often serving as a source of supply of the insect from which the apple is kept stocked. Such trees therefore should either be cared for like the apple or not be allowed to grow near the apple orchard.

The beetle, which is about an inch long, pale brown above, with two white stripes along its back, appears in late spring and summer, and lays its twenty-five or thirty eggs singly, here and there, in slits it cuts in the bark of the trees near the ground. The tiny grub, or borer, on hatching from the egg, burrows through the bark to the sapwood and there digs out shallow but broad galleries. The bark over these often dries and cracks, letting out "sawdust" which aids in locating the galleries. After resting during the winter, the borer resumes its work, still feeding on the sapwood, and if the tree is small, or there are several borers present, girdling may result. After a second winter in the tree the borer works into the heartwood and finally turns outward toward the surface. After a third winter of rest it tunnels to the bark, then transforms into the adult beetle, which during the spring or summer escapes from the tree. Eggs are then laid for the next generation.

The life of an individual from egg to adult is three years, but beginning so late in the year that the fourth calendar year thereafter is the year the adult appears. Small, or weak, unhealthy trees suffer most from the attacks of this pest.

Methods for controlling this insect have been experimented with for years, but no entirely successful single way has been found. "Worming" the trees in the fall is perhaps as good as any, so far as results go. To do this, clear away any grass or litter from the base of the trunk and look for "sawdust," tracing this up to cracks in the bark and cutting open the dead bark at these places to find and destroy the borers. If the borers have tunneled deeper into the tree, a flexible, pointed wire can be run into the tunnels to kill them there.

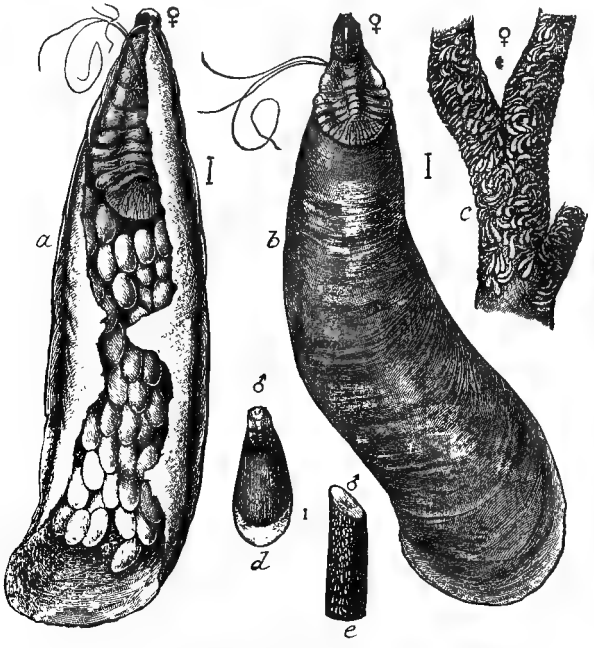
Thick paints are often applied to the trunks to keep the beetles from laying their eggs there. To do this, remove the earth a few inches down around the trunk and paint to about a foot above the ground with pure white lead in raw linseed oil, making it thick and putting on a good coat.

Several layers of newspaper, building paper or cloth can be used also, wrapped around the lower foot or two of the trunk, to act as protectors, but the bottom of the material must go below ground and the top be tightly fitted to the tree so the

beetles cannot get inside and crawl down to where they desire to lay their eggs. The paint or protectors should be put on by the first of June and kept in good condition until the end of August at least.

The Oyster-shell Scale.

This common pest is found on the trunk where the bark is thin, and also on the branches and twigs. The animal itself is concealed during most of the year under a scale it forms, and it is the scale rather than the insect which is therefore



Oyster-shell scale: *a*, under side of female scale, showing eggs; *b*, upper side of same, both much enlarged; *c*, female scales on a branch, natural size; *d*, male scale much enlarged; *e*, male scales on branch, natural size. The fine lines to the right of *a*, *b* and *d* show the real length of the scales. (Howard, United States Department Agriculture, Yearbook, 1894.)

familiar to most people. The scale is generally about a sixteenth of an inch long, narrow at one end and rather broadly rounded at the other. It may be quite straight, but is more often somewhat curved, and resembles a tiny oyster shell in form, whence its name. It may be brown or gray in color.

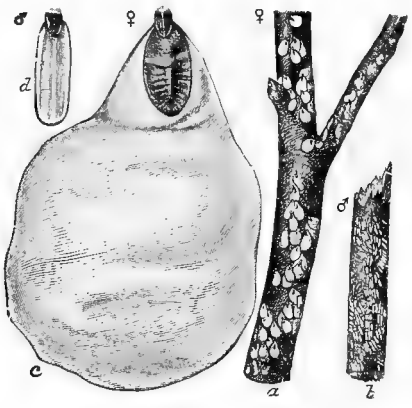
During the winter the dead insect may be found under the

narrow end of the scale, and in the space between it and the other end will be found from fifteen to one hundred very small whitish eggs. These hatch during the latter part of May or early in June, according to the progress of the season, into very tiny whitish animals just visible to the eye, and generally called "crawling young." They crawl about for a few hours to a day or so, then locate at some spot and force their long sucking beaks through the bark until they reach the sap. On this they feed, sucking it into their bodies. Scale soon begins to form over and cover them, and by the end of August these are complete and the insects have become full grown. Eggs are now laid under the scales and the parents die, there being in Massachusetts only one generation a year.

Control for this insect is the same as for the scurfy scale and is given below.

The Scurfy Scale.

This scale in many ways resembles the oyster-shell scale. It differs from it, however, as follows: The scale is shorter and broader, being rather pear-shaped; its color is white instead of brown or gray; and the eggs and crawling young are purple instead of nearly white. In other regards the facts given above for the oyster-shell scale are true for this insect also.

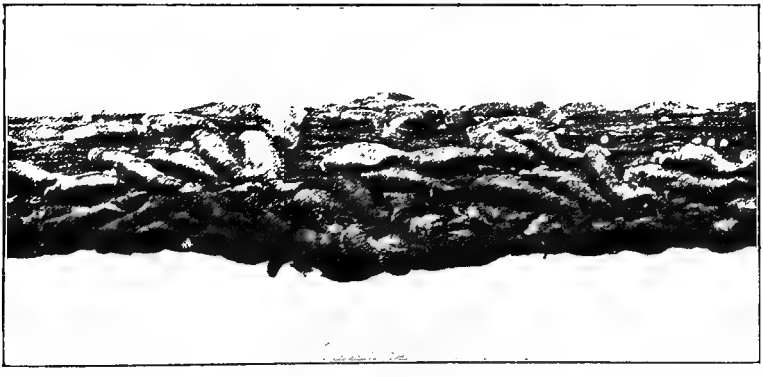


Scurfy scale: *a*, female, *b*, male scales, natural size, on twigs; *c*, female scale, much enlarged; *d*, male scale, much enlarged. (Howard, United States Department Agriculture, Yearbook, 1894.)

Control for the oyster-shell and scurfy scales can to some extent be obtained by spraying infested trees with the lime-sulfur wash as given under the San José scale below. In most cases, however, this is not sufficient, and spraying with nicotine sulfate, 40 per cent, using 1 part of this in about 600 parts of water as soon as the crawling young are seen, followed by a second treatment about ten days later, is desirable. Kerosene emulsion (see directions for making on page 108) may be used instead of the nicotine sulfate, but is not as effective.

The scurfy scale.

The San José scale.



The oyster-shell scale.

THREE COMMON ORCHARD SCALES (TWICE NATURAL SIZE).

It should be noted that scales remain on the tree a long time after the insects which produce them are dead, before weathering off, so that a tree largely freed from these pests may appear badly infested when this is really not the case.

The San José Scale.

The San José scale has been present for nearly thirty years in this State, and has caused much loss in apple orchards, as when abundant it is a very serious pest. Fortunately, most apple growers are now able to recognize this insect and know how to treat it.

The fully formed scale is nearly circular, quite flat, but rising gradually from its edge toward the center where there is a hump or nipple, usually surrounded by a slight depression. Its color at this time is generally brown or dark gray. At the beginning of winter, scales of various ages may be present on a tree, but the younger and the oldest ones die during this period, leaving only those from one-third to two-thirds grown to continue the race the following season.

These insects under their scales resume their sucking of the sap from the tree in the spring and become adult in June. The production of young now begins, and here there is an important difference in the life of this insect from that of the oyster-shell and scurfy scales, whose eggs all hatch at about the same time. With the San José scale no eggs are laid. Instead, this insect produces living young, a few every few days for a period of about a month, the total number per female being about a hundred. These crawling young resemble those of the other scales in size and structure, but are bright lemon yellow in color and can be recognized in this way. Their habits at first are like those of the other kinds, but, after settling down to feed, they form a pure white waxy scale over themselves, circular in outline, so that in this stage they look like very tiny dots of white wax on the bark. Later, as they grow, this scale becomes larger and changes color, being black, gray or either of these colors, more or less mixed with white. By the time the insect beneath has become adult, however, the scale is quite uniformly gray or brown and about the size of a pinhead. About a month is required for the in-

sects to reach maturity and begin reproduction in their turn, and as their parent may only be ceasing the production of young by this time, there is, in consequence, an almost constant appearance of young from about the middle of June until cold weather puts an end to the process, at which time there will probably be all stages of the insect present at once. There are usually only three generations a year in Massachusetts, though, with the longer seasons, four or even more may occur in the South.

Different stages of the San José scale, enlarged five times. (From Virginia State Crop Pest Commission Bulletin, 1904.)

Increase from the scales coming to maturity in the spring is usually about 100 per female. In the later generations it is nearer 500, so that a tree having only a few scales on it in the spring can easily have millions on it by the following winter, and be in very bad condition or even dying from the lack of the sap these insects have abstracted from it.

Control of this pest cannot be like that for the oyster-shell and scurfy scales, which was based upon the appearance of all the delicate, unprotected, crawling young at about the same time. Here a treatment aimed at the destruction of these young would have to be repeated every ten days or two weeks from the end of June until into October, — evidently a costly and impracticable method. Accordingly, the plan adopted is to treat this scale, during the winter months or in spring before the buds open, with a material strong enough to get at the insect under its protecting scale and kill it there. At this time there are no leaves to interfere with the thorough appli-

cation of a spray, and the tree being dormant is less liable to injury by strong sprays than during the growing season.

A number of materials have been used in spraying for the San José scale, but at the present time only three or four appear to have any great value. These are the lime-sulfur wash, miscible oils, and dry sulfur compounds. The lime-sulfur wash is now usually purchased in concentrated liquid form and diluted with water for use, the amount of dilution being generally about one of the wash to eight or nine of water, according to directions sent with it. For best results though, its density should be determined with a Beaumé hydrometer, and the amount of water to add will vary with the density of the wash. Tables giving the amount for the different densities can be obtained from the Agricultural Experiment Station at Amherst, and almost any drug store can obtain a Beaumé hydrometer for liquids denser than water at a cost of not more than a dollar or two.

Spraying with the properly diluted material can be made at any time during the winter or spring until the buds begin to open, but somewhat better results are obtained by spraying as late as possible.

The miscible oils are also nearly always purchased ready made, needing only dilution with water. They have one advantage over the lime-sulfur wash in that they spread over the surface of the bark more from where they strike it. On the other hand, many cases of injury to trees have been reported following the use of these materials, particularly where they are used spring after spring for several years. How serious this injury is cannot be said to have been fully determined as yet, but there is certainly some liability to it, and many fruit growers now follow the practice of spraying with lime-sulfur for two years and use the oil every third year only.

The inconvenience of shipping liquid materials, and other difficulties involved, has led to the recent appearance on the market of dry sulfur compounds, these being for the most part combinations of sulfur with lime, barium, magnesium or sodium. From the standpoint of convenience these are much better than the liquid lime-sulfur concentrate, but chemical

analysis would indicate that they should be less effective than the other. Still, many reports of success with them have appeared, and while sufficient time since their being put on the market has not yet elapsed to permit a final verdict as to their actual value, it would at the present time seem probable that some of them at least may have come to stay. The writer does not care to advise either in favor of or against their use as yet, believing that they are still in more or less of an experimental stage.

Whatever the material used, the spraying should be done with a nozzle throwing the spray in the form of a very fine mist, and the purpose be to reach every part of each limb, branch and twig, but stopping the treatment of each part just before it would begin to drip, as every drop thus lost means so much less to do its work on the tree. If spraying must be done on windy days, it may be impossible to reach the leeward side of the trees. In that case, the trees can be "patched up" on their unsprayed sides when the wind is blowing in the opposite direction, or on calm days or mornings before the wind starts blowing. The scales are so small that only the most thorough work will reach them all, and only those reached by the spray will be killed, for after once settling down and forming its scale the insect never moves again.

All of the scale insects considered above are sometimes found on the leaves and also on the fruit of trees, particularly when the trees are heavily infested.

Insects attacking the Buds and Leaves.

Apple Plant Lice or Aphids.

There are three kinds of aphids which attack the apple in the Eastern States, but only two of them appear to be of much importance in Massachusetts. These are the green apple aphid and the rosy apple aphid.

The green apple aphid lays tiny shining black eggs on the smaller twigs of the tree in the fall. These hatch about the time the buds begin to open in the spring, and the young aphids suck the sap from these buds and check their growth, often seriously. As the leaves develop the insects feed on

them also, causing them to curl somewhat, and this also interferes with the proper growth of the tree. In a short time these aphids become full grown and begin to produce living young which feed on the leaves, like their parents. Generation after generation is quickly produced, and as a dozen or more generations are produced during the summer, and as each adult produces fifty or more young, favorable seasons result in an enormous abundance of these insects, all of which are removing from the tree the sap it needs. Thus growth is checked, the apples are stunted, or at least undersized, and the loss to the fruit grower is large.

Twig of apple, showing plant lice. (About natural size.)

When cold weather comes in the fall a change of life takes place. Eggs are laid on the twigs and these hatch the following spring, the aphids on the tree dying.

The rosy apple aphid has a rather different life. Its eggs are laid on apple twigs in the fall and hatch at about the same time in the spring as those of the green apple aphid. The aphids work on the buds and leaves also, but on the latter much more curling is caused by the feeding than in the case of the other kind.

After a few generations on the apple in the spring, however, the rosy apple aphids leave the apple trees and go to plantains, particularly the narrow-leaved plantain, and here they feed and reproduce during the summer. In the fall these insects migrate back to the apple, where as cold weather comes on they lay their eggs. The average number of young produced by an individual of this species is about 175, and the number

of generations is probably from 15 to 20, so that here, too, these insects may become extremely abundant and do much injury. They frequently suck the sap from the blossom buds, sometimes preventing some of the fruit from setting, and stunting and deforming many which do set.

Plant lice are best controlled by spraying the trees thoroughly, just as the buds are opening, with nicotine sulfate, 40 per cent, 1 part, water, 800 parts. Two or 3 pounds of common laundry soap can advantageously be added to each 50 gallons of this spray. If it is desired for any reason to apply Bordeaux mixture or lime-sulfur at the same time, the soap must not be put in. Spray through a very fine nozzle and repeat ten days or two weeks later if aphids are still present.

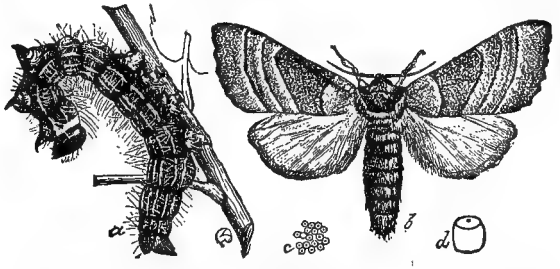
The Leaf Hopper.

The leaf hopper, a tiny greenish insect not very much larger than a plant louse, has been very injurious in apple orchards during the last two or three years. It is found during the spring months and again in the early fall mainly on the under side of the leaves, sucking the sap and giving them a speckled appearance, and in some cases drying them up and causing them to turn yellow and fall off. In the particular cases observed in this State, it does not seem to be the true apple leaf hopper but an allied species, which does not cause a curling of the leaves to any such extent as the apple leaf hopper. Lacking more complete, detailed knowledge of this insect, we must rely on the general facts about the life histories of members of this group to aid in determining when and how to attempt control. In general, all the leaf hoppers for a time suck sap from the plants on which they feed, growing and by degrees developing wings. After a month, more or less, of this, the wings become full sized, the insects mature and they can then fly about. At this time they are much harder to reach by spraying than earlier, so spraying should be done when these insects first appear in the spring — while they are young — and again in the fall under similar conditions, taking them before they can fly, in each case. Nicotine sulfate, 40 per cent, is known to be a good killing material for

leaf hoppers in general, and should prove effective here also, the difficulties in its use being the same as with plant lice, viz., that the insects must be actually touched by the spray if they are to be killed, and that they are very small. Only thorough spraying, using every effort to reach the under side of the leaves where most of the hoppers are found, will give satisfactory results. The strength of spray to use is the same as that advised for plant lice above.

Caterpillars.

Numerous caterpillars are found feeding on apple leaves, but in the majority of cases spraying with arsenate of lead as soon as they are noticed will quickly kill them. Among the common kinds noticed is the tent caterpillar, which goes out each morning from white webs or tents spun in the forks of branches during the spring. Spraying with arsenate of lead will easily control this pest, and a special treatment for it is usually unnecessary if the codling moth treatment given below is carried out: The gypsy moth and brown-tail moth cater-



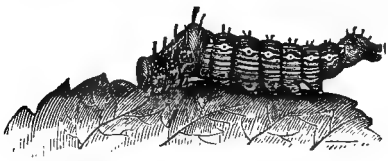
Yellow-necked apple-tree caterpillar: *a*, caterpillar, showing characteristic position when disturbed; *b*, adult moth; *c*, cluster of eggs, natural size; *d*, side view of one egg much enlarged.

pillars are also often abundant on the trees during the spring months, at least in Eastern Massachusetts. All of these spring-feeding caterpillars can be kept under control by spraying once or twice. If the fruit grower is on the alert to discover them as soon as they begin work, and treat them before they have had time to do much harm, he need not fear much injury to the trees by them.

In August or even early September other caterpillars are liable to appear on the trees. Some, such as the yellow-necked

apple-tree caterpillar and the red-humped caterpillar, feed in groups and may completely strip a limb of its leaves. Where such a limb can be reached easily, removing the caterpillars by hand — as they are all close together — and killing them may be easier than spraying the tree, though if handwork for any reason is undesirable, spraying will be effective.

Sometimes in early fall small thin webs appear on some of the limbs, increasing in size as time passes, until in September they may be nearly as large as a bushel basket. These are the webs of the fall webworm, and may be distinguished from those of the tent caterpillar by the facts that they occur in late summer instead of May and June and that they are not placed in forks, but cover the branch. The caterpillars of this



Red-humped apple-tree caterpillar.

Moth of red-humped apple-tree caterpillar.

insect feed on leaves under the web, and when these are all eaten, extend the web over more before eating them.

When these webs are small they can be removed, limb and all, with the caterpillars inside and be destroyed. If they cannot be reached easily, or too much of the tree would be removed by doing this, spray all around the nest with arsenate of lead so that the next leaves to be covered by the web shall be well poisoned.

With all the leaf-feeding caterpillars, success in control is obtained by attention to two points: watch the trees so that the caterpillars may be treated before they get too much of a start; and spray thoroughly, leaving no unsprayed leaves for them to feed on.

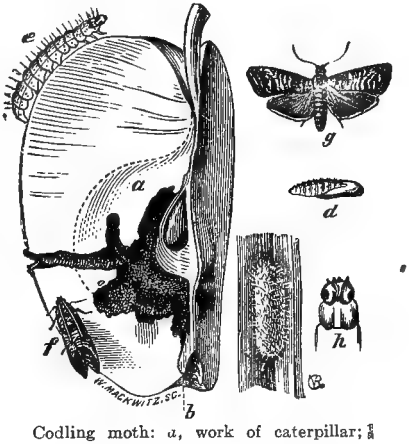
Insects attacking the Fruit.

Four insects are quite serious enemies of the fruit of the apple in Massachusetts. These are the codling moth, or apple worm, the apple maggot, or railroad worm, red bugs, and the plum curculio.

The Codling Moth.

This is one of the most important pests of the apple in this country. The writer has been accustomed to spray his trees for this pest in the approved way, and in 1919 a count of the apples gathered from one tree, which had been sprayed regularly for several years, showed that only about 10 per cent of the fruit was wormy. In 1920 this tree was not sprayed, and a similar examination of the fruit gathered showed over 90 per cent wormy. The average cost of spraying an apple tree, even when the work is hired, is less than $2, so that it pays well to spray, as has been repeatedly shown for large orchards as well as in the case of the single tree referred to.

The codling moth caterpillar winters near the apple tree and nearly always under some loose piece of bark on the trunk or one of the limbs. In the spring it changes to a small dark-colored moth which flies at night, is not attracted to lights, and is therefore seldom seen. It comes out a week or two after the apple blossoms fall, and lays its eggs singly, here and there, on the young leaves, twigs and on the fruit which is now beginning to form. About a week later the eggs hatch, and the tiny caterpillars feed a little on the leaves but soon crawl to the fruit, where from sixty to eighty of every hundred go to the blossom end and bore inward to the core. The others appear to bore in through the side of the fruit.



Codling moth: *a*, work of caterpillar; *b*, point of entrance; *d*, pupa; *e*, full-grown caterpillar; *f*, *g*, moth; *h*, head of caterpillar; *i*, cocoon.

Around the core the caterpillars now feed for about a month until full grown. They then bore out, generally through the side of the fruit, and crawl down the tree until they find pieces of loose bark where they can go. Each now, under a piece of bark, gnaws out a little oval cavity which it lines with silk, and in this the caterpillar changes over into the moth.

In most cases this last change does not occur in Massachusetts until the following spring, there being but one generation a year. A few of the caterpillars which finish feeding early, however, may undergo this change and produce moths which appear in August, and at once lay eggs for a second generation the same season. The caterpillars which hatch from these eggs enter the fruit at any point and are usually the ones found in late apples when these are gathered, though they may be the very latest members of the first generation.

The usual method of control for this pest is to spray the trees with arsenate of lead just after the blossoms fall. At this time there is a little depression or cup at the blossom end of the apple, with five green projecting lobes (sepals of the blossom) surrounding it. After about ten days these bend inward and close up the opening of the cup. The caterpillars which enter at the blossom end of the fruit either push their way between or bore through these lobes, enter the cup and start boring their way toward the core from its bottom. If, therefore, poison can be placed in this calyx cup, as it is called, while its top is still open, the caterpillars entering later must feed upon that on their way into the fruit.

In spraying to accomplish this, therefore, the purpose should be as far as possible to direct the spray against the blossom ends of the little apples and place the poison in the calyx cup. When the lobes close together later, they will aid in preventing rains from washing out the poison before the caterpillars arrive.

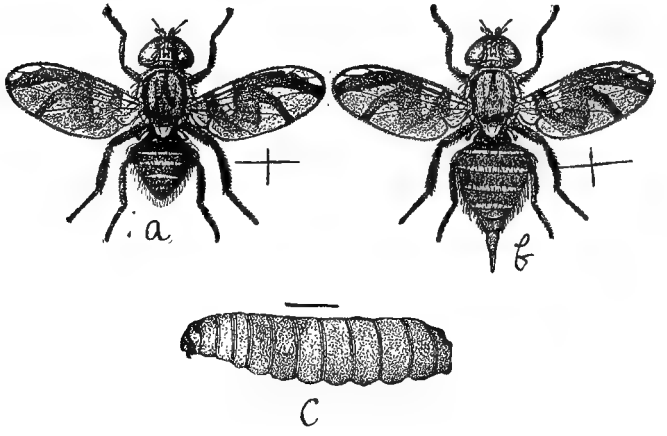
A later spraying with arsenate of lead, usually about the 15th or 20th of June, is also frequently given. The purpose of this is to poison the leaves on which the caterpillars feed somewhat before going to the fruit. As some of the insects do not enter the fruit at its blossom end but elsewhere, this second spraying is largely for the purpose of killing those which would not be reached by the poison in the calyx cup.

In spraying, use a rather fine nozzle giving small droplets of spray, and considerable pressure at the pump to force the droplets into the calyx cups as much as possible. Three pounds of the paste arsenate of lead (or $1\frac{1}{2}$ pounds of the powder) in 50 gallons of water is the usual mixture for both appli-

cations. If a combination either with Bordeaux mixture, lime-sulfur or nicotine sulfate, 40 per cent, is desired, this is perfectly possible, provided certain precautions in the mixing of the materials are followed. These precautions are discussed on page 112.

The Apple Maggot.

The apple maggot, often also called the railroad worm, is frequently a serious pest in Massachusetts. The adult insect is a fly smaller than the house fly, with black or dark bands across its wings, which appears about the middle of July. It lays its eggs singly in holes it makes in the skin of the apple, and the little white maggots which hatch from these eggs tunnel through the pulp in all directions. While the maggots are very small the tunnels close up and make rather tough,



Apple maggot: *a*, adult male fly; *b*, adult female fly; *c*, maggot; all much enlarged.

fibrous lines, but after the maggots get larger the tunnels remain open and the pulp around them turns brown and decay follows, often making the fruit entirely soft and worthless.

When the maggot has completed its feeding it leaves the fruit and enters the ground, where it changes into the adult fly. A few of the maggots which finish feeding early may change into flies the same fall, and in these cases eggs are laid on late apples, which are therefore liable to be infested without showing it when they are picked. Most of the late

fall apples, however, are attacked by flies of the first generation, for these do not all appear at the same time, some coming several weeks later than the first ones.

The flies have the habit of feeding somewhat at the intervals between laying their eggs, and this habit is taken advantage of in controlling the insects. Spraying the trees with arsenate of lead, 3 pounds of paste (or $1\frac{1}{2}$ pounds of the powder) in 50 gallons of water, applied just about the time the first flies appear, and a second time about two weeks later, seems to keep this pest in check. At first molasses was added to this to attract the flies, but recent tests do not indicate any better results from this than from the arsenate of lead alone.

Gathering and destroying fallen fruit promptly is also a good control method, but it requires so much labor that this method is not often made use of.

Red Bugs.

These are rather recent apple pests in Massachusetts, or, at least, they have only attracted attention during the last eight or ten years. The injury is undoubtedly caused by several kinds of insects which are closely related, but those first observed were partly red, thus giving the name to all, whether red or not, which affect apples by puncturing the skin and sucking the juices.

The damage to the apples is done mainly late in May and in June. The tiny young, which in size and general appearance somewhat resemble plant lice, crawl over the small apples and plunge their beaks into the flesh. The effect of this is that the parts there become hardened or woody and discolored. The apple will continue to grow after this, but at the places where the punctures were made it will be less developed than elsewhere, forming hollows or pits on the surface and making the apple, as a whole, malformed, irregular, and greatly reducing its value. Such apples often remain quite small, also, and are very noticeable when the crop is being gathered.

Nicotine sulfate, 40 per cent, 1 part, water, 800 parts, with the addition of about 3 pounds of any common laundry soap to each 50 gallons of the water, has thus far proved the most

effective method for controlling this insect. This is very thoroughly sprayed over the tree through a fine nozzle, just before the blossoms open. In some cases repeating this treatment just after the blossoms fall has also been advisable. Where this is the case, the nicotine sulfate can be combined with the arsenate of lead "calyx cup" spray to advantage.

The Plum Curculio.

This well-known pest of plums, peaches and cherries injures the apples also, and sometimes quite seriously. In the spring while the apples are small the adult beetle, or curculio, makes holes in the skin of the fruit here and there, and in each places an egg. It then cuts a crescent-shaped slit in the skin so as to partially enclose the hole containing the egg.

Plum curculio.

It is not probable that many, if any, of the young which hatch from these eggs are able to develop in the apple. The effect of the puncturing and slitting, however, upon the fruit is to produce unsightly scars and blemishes, besides injuring the pulp of the fruit near these places, making it hard.

In late summer and fall the curculio also injures the apple, but in a different way. At this time it eats into the apples, making small holes an eighth of an inch or more deep and about an eighth of an inch across. The skin and flesh around the edge of this hole turn black, and the value of the apple is greatly reduced.

To prevent or at least check the work of this insect on apples, the two sprays recommended for the codling moth are of value. If the curculios are abundant though, an additional treatment with arsenate of lead, nine or ten weeks after the blossoms fall, is of advantage. Measures for controlling this pest on the other fruits it attacks will of course reduce the number of these insects, leaving fewer to cause trouble with the apples.

Chapter VII.

DISEASES OF THE APPLE IN MASSACHUSETTS.

A. VINCENT OSMUN, PROFESSOR OF BOTANY, MASSACHUSETTS AGRICULTURAL COLLEGE.

The enormous development of the apple-growing industry in this country during the last two decades has brought increasing competition, and growers have come to realize that their business must stand or fall on the quality of the fruit they produce. Only clean fruit, that is, fruit free from blemishes caused by insects or diseases, can meet the competition and market demands. An added incentive to the production of clean fruit is furnished by the new State law to regulate the grading and packing of apples. And surely every real wide-awake apple grower takes pride in producing clean, high-class fruit, regardless of regulatory laws. Naturally, the grower who is interested in the quality of fruit which he grows wishes to know something about the diseases which he is forced to combat.

Diseases of the apple are of two sorts: (1) those caused by microscopic organisms (fungi and bacteria); and (2) those due to unfavorable weather, or cultural conditions, or functional disorders. The first group are known as parasitic diseases and the second group are called nonparasitic or physiological diseases.

Parasitic diseases are caused by bacteria or fungi growing and feeding on the surface or in the tissues of the host, and specific organisms may attack root, trunk, twigs, leaves or fruit, thus bringing about a diseased condition.

Where the causal organism of a disease is known, a remedy for the disease, based on control of the organism, can usually be worked out. In fact, every grower should understand that intelligent attack on any parasitic disease must have back of

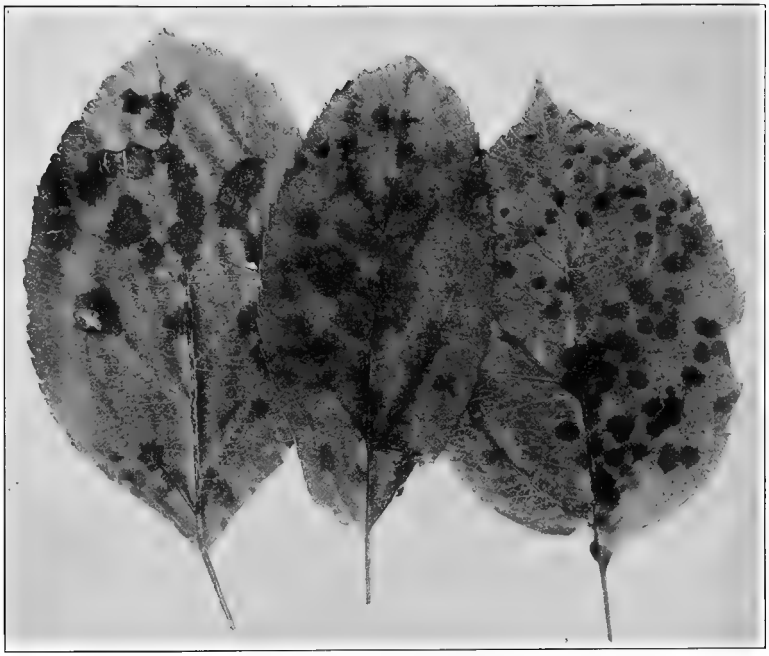


FIG. 1. – Scab on apple leaves.

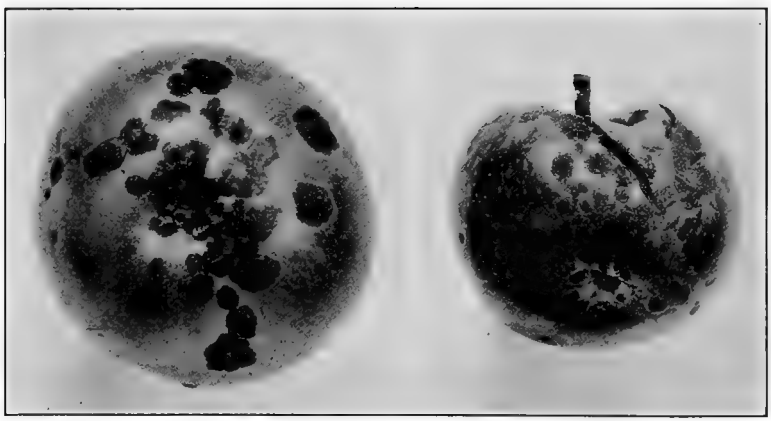


FIG. 2. — Scab on apple fruit, showing cracking (right).

it a knowledge of the life history and habits of the organism which is the primary cause of that disease.

The nature of nonparasitic or physiological diseases often is obscure, but where the underlying cause can be determined the remedy usually lies in changing or avoiding conditions which produce it.

In addition to the diseases which occur primarily in the orchard, there are a number which commonly affect the fruit only in transit and storage. Some of the diseases which attack fruit in the orchard continue to develop after it is harvested and placed in storage.

The economic importance of controlling apple diseases is indicated by the total loss due to diseases in the United States for 1918 which was estimated at about 20,000,000 bushels. In Massachusetts alone, the loss has been estimated at over 150,000 bushels. In 1920, in one small section of the State, the value of the crop was reduced fully $200,000 by diseases.

Descriptions of the more common diseases of Massachusetts apples follow.

Scab.

This disease probably causes more loss to the apple crop of the State than any other, though relatively few varieties are seriously affected by it. Among the more susceptible of the varieties commonly grown in Massachusetts are McIntosh, Fameuse (Snow), Fall Pippin and Rhode Island Greening. Scab is not ordinarily a serious disease in Western Massachusetts, but in the eastern part of the State, especially on the McIntosh, it assumes great importance.

Scab is caused by a fungus, *Venturia inæqualis*, which attacks young twigs, leaves, blossoms and fruit. Its occurrence on twigs is rare. On the blossoms, it infects chiefly the pedicels and calyx, and may sometimes cause severe blossom drop. The disease is most in evidence on the leaves and fruit. The first appearance on the leaves is in the spring. It then occurs on the lower surface as a web-like growth, brownish or olive-brown in color. Later, velvety spots of the same color form on the upper surface. Scab spots exhibit considerable variation in shape (Fig. 1), but the most common are approximately round, with a finely fringed margin. On both upper

and lower surfaces of the leaf, the growth of the scab fungus has a tendency to follow the veins. The round spots often become raised on the upper surface, causing a corresponding depression on the lower side. Similar spots, but darker in color, form on the fruit just beneath the waxy outer layer or cuticle. (Fig. 2.) This cuticle soon becomes ruptured over the spots, giving them a scab-like appearance, which suggests the common name of the disease. Cracking of the fruit often accompanies severe infection. (Fig. 2.)

Scab does not in itself cause rotting of the fruit, but in storage other fungi may gain entrance to the flesh of the fruit through the scab lesions and set up decay. These are discussed under "Storage Rots."

Black-Rot.

Authorities differ as to the importance of black-rot. Without question, however, this disease is the cause of considerable loss in Massachusetts, and in the eastern part of the State it is second only to scab in importance.

The cause of black-rot is a fungus, *Physalospora cydoniæ*. This fungus gains entrance to the flesh, causing it to decay. Usually a single decayed area is produced which spreads until the entire apple is involved. In the early stages of decay the spot is brown, often marked by zones or rings, and after a time the surface of the spot becomes dotted with minute black pimples under which are the fruiting bodies of the fungus. The rotted area eventually turns black, whence the name. In the later stages of decay, fruit affected with this disease becomes wrinkled and finally shrinks into dry, hard mummies. (Fig. 3.)

Any part of the fruit may be attacked by black-rot, but it most often starts at a wormhole or at the calyx end. In the latter case, it is sometimes called blossom-end rot. (Fig. 4.) Blossom-end rot frequently may be traced to spray injury incurred at the time of the so-called calyx spray, when the nectaries of the blossoms are exposed and easily burned by the spray materials.

Characteristic brown spots are produced on the leaves by the black-rot fungus. (Fig. 5.)

FIG. 3. — Black-rot, advanced stage, showing black fruit dots.

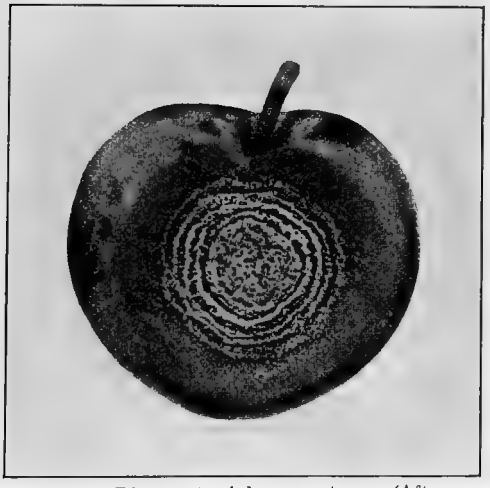


FIG. 6. — Bitter-rot, pink spore stage. (After Illinois Experiment Station, Bulletin 118.)

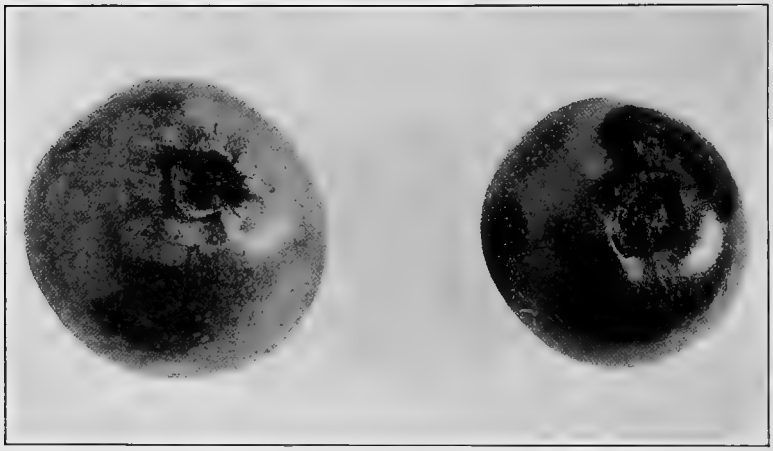


FIG. 4. — Showing result of spray injury at blossom-end of fruit and black-rot following (right).

FIG. 5. — Leaf-spot caused by black-rot fungus. (From U. S. D. A., B. P. I., Bulletin 121.)

Bitter-Rot.

In Massachusetts, bitter-rot is of comparatively little importance. In other parts of the United States, notably the middle Atlantic and middle western States, it is in some years the most destructive disease in the orchard.

The causal fungus, *Glomerella cingulata,* produces a dry, bitter rot of the apple flesh. The disease usually begins in July or August as small, round spots, brown in color. These spots soon become sunken and increase in size, usually exhibiting a series of raised concentric rings. (Fig. 6.) Minute black fruiting bodies develop in the rotted area either in concentric rings or scattered. These bodies eventually discharge small masses of pink spores which disseminate the disease. In the final stages of the disease the fruit becomes shriveled into a hard, dry mummy.

Brown-Rot.

Brown-rot is important chiefly as it affects some early varieties, such as Red Astrachan and Yellow Transparent. The amount of loss which it causes is not large. It is caused by the same fungus, *Sclerotinia cinerea,* which produces brown-rot of peach, plum and cherry. The fungus usually gains entrance to the fruit through a wormhole or other injury.

The disease starts as a small brown spot, which rapidly spreads through the entire fruit as a soft rot. Often the rotted fruit turns black, and the disease may be mistaken for black-rot. It remains more or less smooth on the surface and does not shrivel and wrinkle as in the case of black-rot. In warm, moist weather small grey tufts of spore masses form on the surface of the rotted area.

Sooty-Blotch and Fly-Speck.

The name, sooty-blotch and fly-speck, is indicative of the appearance of this disease. (Fig. 7.) The causal fungus, *Leptothyrium pomi,* is entirely superficial in its attack on the fruit, and its effect is merely to form surface blemishes; however, the disease must be considered of considerable importance because of the greatly reduced market value of fruit disfigured by it.

Sooty-blotch and fly-speck is usually at its worst in old orchards which have not been kept properly pruned to admit light and air. It is common, also, on trees shaded by buildings and on roadside trees exposed to dust.

Fruit-Spot.

This disease is also known as Brooks-spot and brown-spot of Baldwin. It is not, however, confined to the Baldwin, and, in fact, other varieties, such as Yellow Transparent, Yellow Bellflower and Tolman Sweet, are often more seriously affected by it.

Fruit-spot is more serious in New England than in other sections, and in some years it has very greatly reduced the value of the apple crop in this State.

The cause of fruit-spot is a fungus, *Phoma pomi*. The disease first manifests itself in August. On red-skinned fruit, the small, round spots are deeper red, and on green skin they are darker green. The spots are usually most numerous about the blossom end of the fruit. At first the spots are but slightly sunken and each centers about a lenticel or breathing pore. Later, the spots deepen in color or turn brown and become more sunken. They do not become large. (Fig. 8.) Immediately beneath the surface of the spots the flesh of the fruit becomes discolored, but this never extends deeply. Minute black fruiting bodies of the causal fungus appear in the spots in their later stages of development.

Bitter-Pit or Stippen.

Baldwin fruit-spot is perhaps a more common name for this disease. It is, however, misleading, because the King, Rhode Island Greening, Northern Spy and other varieties are commonly affected, though the Baldwin is, perhaps, the most susceptible. Bitter-pit is among the important apple diseases of the State, and in some years it may be ranked as the most serious. It does not destroy the fruit through decay, but so reduces the quality as to render it unfit for market.

The cause of bitter-pit is obscure. It is not due to attack by a parasitic organism, and is therefore classified as a physio-

FIG. 7. — Sooty-blotch and fly speck on apple fruit.

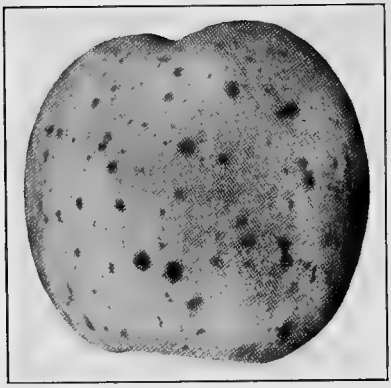


FIG. 8. — Fruit-spot. (From Maine Experiment Station, Bulletin 185.)

FIG. 9. — Bitter-pit or Stippen.

logical disease. The prevailing opinion of those who have studied the disease is that it is caused by disturbed water relations. Seasonal conditions, such as frequent winds accompanying low humidity, high temperatures and bright sunlight, which promote loss of water by transpiration, may be factors. Sudden or fluctuating changes in temperature and alternating wet and dry periods during the latter part of the growing season seem to favor development of the disease.

Bitter-pit may appear on the fruit after it is half grown, but it is seldom noticed by the orchardist until the fruit is nearly mature. The first outward sign of the disease is when slightly sunken spots appear scattered over the surface of the fruit, usually most numerous near the calyx end. They are nearly round, seldom over an eighth to a quarter of an inch in diameter, and might be taken for hail bruises. (Fig. 9.) They increase in number as the fruit matures. With age, they become brown in color and deeper, but the skin covering them does not rupture. The flesh beneath each spot is brown, dry and corky. Brown streaks or spots of corky tissue, not connected with surface spots, extend through the flesh. Affected fruit is usually somewhat bitter to the taste.

Bitter-pit is often mistaken for fruit-spot. The spots of this disease are, however, usually larger, more uniformly round and deeper than those of fruit-spot and the discolored, corky streaks extend deeper into the flesh.

The disease may continue to develop in storage, but this is preventable through control of temperature and ventilation. Fruit affected with bitter-pit should be stored at a uniform temperature between 30 and 33 degrees F. Higher temperatures permit development of the spots.

Bitter-pit cannot be controlled by spraying, although the maintenance of a healthy leaf growth by keeping other diseases in check is probably beneficial in reducing the amount of this trouble. There is, in fact, no definitely known method of control for the disease. Certain orchard practices, however, tend to reduce it to a minimum. Judicious pruning, to keep the set of fruit evenly distributed on laterals, and good soil drainage are among the most important things to consider. Usually there is less of the disease on apples borne on laterals

than on those on main branches. The practice of thinning fruit to keep the yield regular tends to reduce the disease, but in cases of severe thinning to produce very large fruit, the disease is likely to occur in great severity. Bitter-pit may occur in the best-managed orchards and probably few varieties are immune.

Spongy Dry-Rot.

But little importance attaches to this disease in the orchard, but in storage it may sometimes cause considerable loss. We have never observed it on fruit still clinging to the tree except where a branch had bent down and the fruit rested on the grass or ground beneath. It is, however, commonly found on windfalls beneath the tree, and it is likely that the causal fungus, *Volutella fructi*, is normally a wound parasite.

In storage, the trouble spreads through contact, but is held in check by low temperatures. Avoidance of bruised or scarred fruit will do much toward keeping this rot out of the storage package. The appearance of Volutella-rot is somewhat like that of black-rot, for which it is often mistaken in storage. The rotted area is, however, more sunken and the decayed tissue is dry and spongy. The surface of the spot is black, and the skin becomes roughened when the fruiting bodies of the fungus, which are more closely clustered than in black-rot, break through it.

Apple Rust.

Apple rust is important in Massachusetts, as a rule, only to the growers of Wealthy and Jonathan. Other varieties commonly grown in the State are little affected by it. In the middle Atlantic States, the York Imperial is very susceptible. Rust is much more destructive on quince than on apple in this State.

Apple rust is caused by a fungus, *Gymnosporangium*, which not only lives on two radically different hosts — the apple and the red cedar — but is absolutely dependent on both of these hosts for the completion of its life cycle, and, in fact, for reproduction and dissemination.

In regions where red cedars abound the galls or "cedar apples," which are the winter stage of this disease produced

FIG. 10. — "Cedar apples" on red cedar, with "horns" partially extended (winter stage of apple rust).

on the cedar, are a familiar sight. (Fig. 10.) These galls are dull reddish brown in color and vary from the size of a pea up to nearly 2 inches in diameter. On the surface are scattered small circular depressions. In the spring, brown horns about an inch long protrude from these depressions, and in rainy weather these horns become gelatinous and bright orange in color. At such times, when there are many "cedar apples" on a cedar tree, the tree appears at a distance to be in blossom. It is from these gelatinous horns that the spores of the causal fungus spread in the spring to the apple. On infected apple leaves small yellow spots develop, and these soon become larger and orange-colored. Clustered in these spots, on the lower side of the leaf, are minute cuplike bodies in which the spores of the fungus are formed. These give the name "cluster-cup" stage to the summer form of apple rust. (Fig. 11.) The fruit may be similarly affected, usually at the calyx end. From this stage the spores are blown to the cedars, which thus become infected to produce the "cedar apple" stage.

Apple rust cannot be spread from one apple tree to another, nor from cedar to cedar; hence, if either host is absent from a region, the fungus cannot complete its life cycle and therefore becomes exterminated in that area.

The obvious line of attack on apple rust in the orchard is therefore through destruction of all the cedars within infection distance of the orchard. In regions where the disease is most serious it has been determined that the cleaning up of cedars within a radius of 1 mile of the orchard will reduce infection to a very small amount and that 2 miles' clearance will practically free the orchard of rust. In Massachusetts, where infection is seldom very heavy, a clear radius of half a mile should be sufficient to keep the orchard relatively free of rust.

It is not, of course, always possible for one man to control the land over such a wide area, but co-operation among neighbors will accomplish much and is worthy of a trial. In some States there are laws which require the destruction of all cedars which menace an orchard.

Fire-Blight.

This disease is not of great importance in the apple orchard. A large amount of twig blight, one form of the disease, often occurs, but this seldom is extensive enough to reduce a crop materially or menace the trees attacked. When the disease takes the form known as "collar-blight," it is likely to result fatally, but seldom are many trees in an orchard affected. The disease is much more destructive to the quince and pear, and may spread from these hosts to the apple.

Fire-blight is caused by a bacterium, *Bacillus amylovorus*. It attacks blossoms, fruit, twigs and bark of limbs and trunk. The disease first appears in the spring on full-blown blossoms. These suddenly turn brown and wilt. In this stage the disease is commonly called "blossom-blight." From the blighted blossoms the disease spreads downward to the spur on which the leaves die. At the same time, the stage called "twig-blight" may develop. On young twigs the leaves turn brown from the tip downward. The dead leaves droop and cling tenaciously to the dead twig, and have the appearance of having been scorched. (Fig. 12.) Cankers often form on the limbs, and these are usually traceable to blighted twigs which may frequently be found rising from the cankered area. (Fig. 13.) Such cankers may spread until a limb is girdled, but more often their development is checked by dry, warm weather conditions.

The most serious form of fire-blight on the apple is the so-called "collar-blight" or "crown-rot." This occurs as a dead area or canker in the bark near the base of the trunk. (Fig. 14.) Infection in such cases is usually through water sprouts. These cankers have a sunken, smooth surface and may increase in size until midsummer. They are likely to continue development the following year, and, unless permanently checked, usually completely girdle the trunk, causing death of the tree. Usually, the first sign of collar-blight is a yellowing and reduction in size of the leaves on one or more large branches.

Successful control measures have not been worked out. In a young orchard or in the nursery, it is easy to cut out and burn all blighted twigs as they appear, but in older orchards

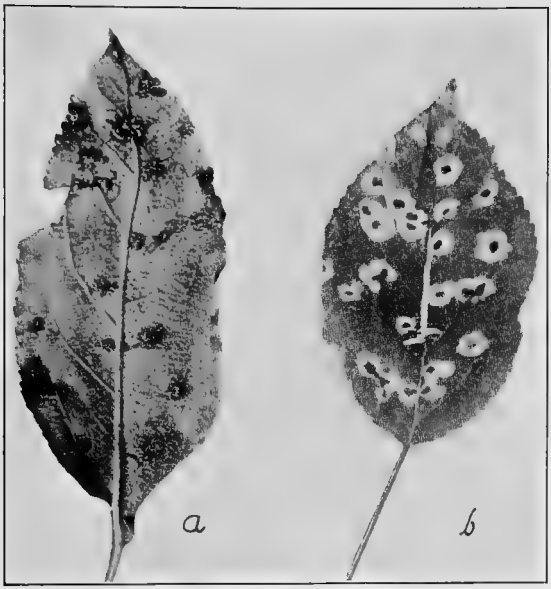


FIG. 11. — Rust on apple leaves: (*a*) on under surface (summer or cluster-cup stage), (*b*) on upper surface. (After Illinois Experiment Station, Circular 241.)

FIG. 12. — Fire-blight (twig-blight phase). (After Illinois Experiment Station, Circular 241.)

FIG. 13. — Fire-blight (twig-blight and canker phases). (After University of Wisconsin Service, Circular 70.)

FIG. 14. — Fire-blight (collar-rot phase). (From Pennsylvania Experiment Station, Bulletin 136.)

it is doubtful if the results pay for the labor of the operation. In cases of severe infection it is worth while to clean up the cankers on the limbs. Cases of collar-blight should be treated as cankers. (See general treatment under "Cankers," page 100.) It is seldom, however, that such treatment is entirely successful, especially if the canker has gained much headway. Sometimes bridge grafting is resorted to, but in most instances replacement of the affected tree is advisable.

Cankers.

The term "canker" is applied to a diseased area or lesion in the bark. Cankers are usually common in old and neglected orchards. In young and well-managed orchards they are relatively unimportant as a rule. When renovation of an old orchard is undertaken, cankers are likely to present one of the chief problems, for often, when long neglected, they may involve considerable areas on main limbs and trunks, and in such cases heroic measures often are necessary to save a tree.

Several kinds of cankers occur on apple trees in Massachusetts, and these are caused by different organisms.

Black-Rot Canker.

This is caused by the same fungus that produces black-rot of the fruit and spotting of leaves. Cankers commonly form on older limbs, but this is by no means always the case, and younger branches and even new twigs may be attacked. On limbs, the cankers usually start on the upper side. A discolored, sunken patch forms in the bark and this later becomes dark brown or nearly black. A distinct crack or crevice soon divides the diseased from the healthy bark, and late in the season small black fruiting bodies of the causal fungus may appear scattered over the diseased surface. A roll of corky tissue develops along the limiting crevice, usually on one side. This is evidence of the effort of the tree to heal the injury by the formation of new tissue. The following year, however, the canker may spread through and beyond this corky barrier and finally girdle the limb. At first the diseased bark remains closely pressed against the underlying wood (Fig. 15), but

later it cracks away, exposing the wood. (Fig. 16.) A badly cankered limb bears other evidence in the form of yellow leaves, and where the limb is completely girdled the leaves above become yellow, then brown and the bark and fruit shrivel.

Bitter-Rot Canker.

This canker is caused by the same fungus as bitter-rot of the fruit. It is similar to the black-rot canker, but usually the diseased bark becomes much cracked and remains clinging to the wood. It is much less common in this State than black-rot canker.

European Canker.

This is probably the most destructive of fruit diseases in Europe. In Massachusetts, however, it cannot be considered serious. The causal fungus, *Nectria ditissima,* probably in most cases gains entrance to the host tissues through wounds. Both young and old limbs are attacked, and frequently these cankers follow hail injury.

Nectria-canker usually takes the form of an open wound, which is accompanied by swelling of the surrounding live tissue. Zones or folds of tissue border the wound, and these distinguish this canker from all others. Crotch infections are not unusual. Types of Nectria-canker are shown in Fig. 17.

Nail-Head Canker.

This is the least important of the cankers occurring in the State, and it has only recently been found within our borders. It is a serious disease in the Mississippi Valley, but is not likely to become common here. The cause is a fungus, *Nummularia discreta.*

In a general way, the treatment for all cankers is the same. It consists chiefly in cutting out and disinfecting wounds. Infected twigs and small branches should be pruned off where this will not materially injure the tree. On large branches and trunks, cankers should be cut out, using the utmost care to *remove all diseased tissue down to the healthy wood and back into the healthy, living bark.* Where possible, the wound thus made should be shaped with a sharp point at each end and

FIG. 15. — Black-rot canker on small branch, with dead twig extending from diseased area.

FIG. 16. — Black-rot canker (advanced stage, showing exposed wood in center).

Fig. 17. — European cankers.

curved sides, the long diameter extending lengthwise of the limb or trunk. A wound shaped in this manner will heal much more readily and completely than one with rounded or square ends or one extending crosswise of the limb or trunk.

After the cutting-out process is completed, the surface of the exposed wood should be disinfected with a 1–1,000 solution of corrosive sublimate, and as soon as this dries a coat of good lead paint should be applied, using great care to cover every bit of the surface. Painting over should be repeated every year until the wound is entirely healed. Coal tar and asphaltum are often used for coating wounds. The former is apt to cause injury, and the latter is difficult to prepare. Paint, if of good quality and applied each year, has been found as satisfactory as any substance used. Tools used in cutting out cankers should be wiped frequently with a cloth or sponge wet in the disinfecting solution in order to avoid carrying infection from one cut to another. It is also important that the operator wear rubber boots or overshoes, as any wounds made in the bark are easily infected by canker parasites.

In cleaning up an orchard infected with cankers, one must use judgment as to what limbs to remove and what cankers to treat by cutting out. It is sometimes better to sacrifice a large bearing limb if the canker has so far advanced as to weaken or nearly girdle it. But where cankers on such limbs are small enough to respond to treatment, the limbs should be retained.

Burning of diseased twigs, branches and bark, removed in the cleaning up of an orchard, is an important part of the operation, as these remain a serious source of further infection if left lying about.

Spraying probably is only indirectly beneficial in the control of cankers. Keeping fruit-rots and leaf-spots in check by this means undoubtedly reduces the amount of canker infection. On the other hand, by keeping an orchard clear of cankers, the amount of fruit-rots and leaf-spots caused by the same fungi may be greatly reduced, for the cankers are constant sources of infection.

Crown-Gall.

Crown-gall is of importance chiefly in the nursery. It is not unusual to find whole blocks of nursery trees affected by this disease. Affected trees, when set in the orchard, sometimes grow out of the disease, but they are more likely to show retardation in growth and stunted development. Crown-gall is not confined to the apple but attacks many kinds of plants and trees. The disease also is known as crown-knot, root-gall and, in one form, as hairy-root.

The causal organism of crown-gall is *Bacterium tumefaciens*. It infests cultivated soils and lives in old galls of a great variety of plants. It is doubtless true that some soils become more badly contaminated with the organism than others.

The most familiar and common form of the disease occurs as galls at the base of the trunk or on the branches. In the nursery, a large proportion of these galls form just above the union of scion and stock. They are usually an inch or two in diameter, but may be larger, and, when developed, hard and rough. (Fig. 18.) A second form of the disease, less common than the galls, takes the form of an excessive development of fibrous roots, which grow in dense clusters, suggesting the name, hairy-root. (Fig. 19.)

Control of crown-gall is largely a matter of sanitation and avoidance. The nurseryman should use the utmost care in preparing his stock. Grafting instruments should be frequently disinfected in a 1–1,000 solution of corrosive sublimate; the graft union should be carefully made and wrapped. Where the disease is discovered in the nursery, affected trees should be promptly removed and burned. If a large number of nursery trees are diseased, they should be cleaned out and the land planted to other crops for several years. No method of disinfecting the soil for this trouble is known.

Orchardists should insist on clean nursery stock when selecting trees for new orchards, and every tree should be carefully inspected before setting. All that show any evidence of crown-gall or hairy-root should be rejected.

FIG. 18. — Crown-gall at junction of scion and stock on nursery tree.

FIG. 19. — Hairy-root (a phase of crown-gall) on nursery tree.

Storage Rots.

As every orchardist can testify, the loss from disease does not end with the placing of fruit in storage. Most of the diseases which occur on the fruit in the orchard may continue to develop after harvest, and sometimes the shrinkage of the crop due to this is greater than on the tree. Scab, black-rot, bitter-rot, brown-rot, spongy dry-rot, fruit-spot and bitter-pit, all of which develop more or less on stored fruit, already have been described. In addition, there are several rots which occur only after the fruit has left the tree.

Blue Mold.

The rot caused by this fungus, *Penicillium expansum*, is the most common and destructive of all storage troubles. It is frequently called soft-rot, and this name is descriptive of the disease. The rotted tissue is light brown and watery and has a musty odor and taste. On the surface of the rotted fruit there develop white tufts of the mold, which soon turn blue-green in color. From these tufts myriads of minute spores are given off and each is capable of starting a new rotten spot. (Fig. 20.)

Apparently the fungus is unable to penetrate the sound skin of the fruit. Bruises, wormholes, scab or other disease spots, stem punctures or any other wounds offer easy access, and once the fungus gets into the flesh it causes rapid decay of the fruit. The disease spreads from one fruit to another, either through contact or by scattering of the spores. Soft-rot is primarily a disease of overripe or injured fruit.

Cold retards development of the fungus, but apples which have become overheated may continue to rot when affected by it, even after being cooled to cold-storage temperatures. Fruit that is carefully picked, sorted and packed and placed in storage at 32 degrees F. within forty-eight hours after picking will escape much of the trouble from this source. Wrapping with paper to prevent contact will do much to reduce the amount of soft rot.

Pink-Mold.

This fungus, *Cephalothecium roseum,* occurs only on stored fruit. It occasionally follows scab, growing on the scab spots through which it enters the flesh of the apple, causing it to decay. The decayed flesh is firm, corky and bitter to the taste. The presence of the mold is evidenced by pink tufts on the surface of the fruit. It develops slowly in cold storage. This trouble is of little importance in Massachusetts.

Scald.

This trouble is often very disastrous to apples which have been improperly handled and stored. It is not caused by an organism, but by gases given off by the fruit itself. It is usually evident as an irregular, spreading area on the green side of the fruit. The brown discoloration extends but little beneath the skin, and only after other rot-producing organisms have entered through the injured area does the flesh become decayed. Scald is usually the result of storing under poor ventilation, which allows the gases to accumulate. It is more apt to occur on fruit that is picked green than that which is well ripened on the tree. Large quantities of warm fruit placed in a poorly ventilated room are likely to develop scald. High temperatures promote scalding. Stored in ventilated containers in well-ventilated rooms at low temperatures, apples will not become badly scalded. By wrapping the fruit in oiled paper, scald may be entirely prevented. Oils absorb the gases which cause scald.

MISCELLANEOUS INJURIES.

All the aforementioned troubles of the apple have definite, distinctive characteristics which stamp them as definite diseases. Most of them are due to the parasitic attack of specific organisms, but a few are brought about by purely physical agencies which interfere with normal functions and life processes of the host.

Among these latter may also be classed such injuries, and their effects on the tree or fruit, as sun-scald, frost-cracks, winter-injury, spray-injury and a variety of other mechanical

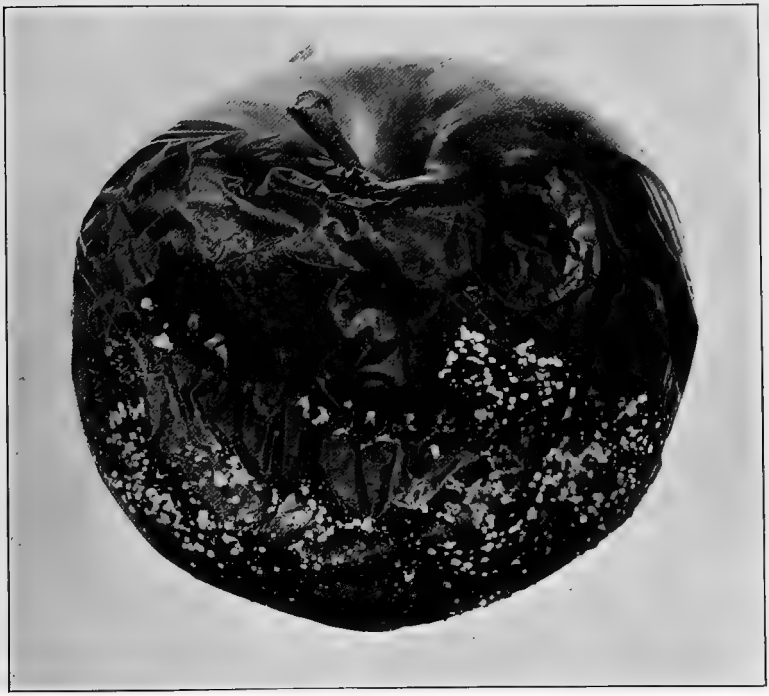


FIG. 20. — Blue-mold or soft-rot of apple fruit, showing white tufts of mold on surface.

injuries. These, though not perhaps distinctive diseases, are, nevertheless, troubles which every orchardist is forced to deal with more or less. It is not, however, the purpose of this chapter to discuss these troubles. They are, for the most part, closely associated with orchard management or mismanagement, and through proper attention to all of the many details of orchard management their occurrence may be reduced to an inconsequential minimum.

General Control Measures.

Spraying the apple orchard with fungicides or with fungicides and insecticides combined is absolutely necessary for the production of clean, sound fruit. Spraying, however, is not a panacea for all the diseases to which the apple is heir. Neither will spraying *cure* a disease. The object of applying a fungicide is, rather, to prevent or control disease by killing or inhibiting the development of parasitic fungi. To be effective, therefore, the spraying schedule must be based on knowledge of the life histories of the fungi to be combated. It is an important function of the plant pathologist to work out life histories of these parasitic organisms, and find out, if he can, the vulnerable points in the different stages of their development. With this accomplished for any disease, it is then usually possible to work out an effective spray schedule. On such knowledge are all control measures based, and the spray schedule given in another section of this publication is the result of such fundamental work by the scientist. Obviously, physiological diseases are not much affected by spraying.

In addition to spraying, general orchard and storage sanitation, regulation of conditions and approved cultural and other management details must be practiced in order to assure a satisfactory product. Where combative measures other than spraying are necessary, they are discussed in connection with specific diseases.

Directions for spraying are given in the "Spray Schedule for the Apple" (page 113) and for preparing fungicides in the chapter on "Insecticides and Fungicides for the Apple" (page 106).

Chapter VIII.

INSECTICIDES AND FUNGICIDES FOR THE APPLE.

H. T. FERNALD AND A. V. OSMUN.

Insecticides and fungicides for use by apple growers are few in number, many which were formerly on the list having now been discarded. Insecticides are of two classes, viz., the stomach poisons and the contact insecticides. Where the insect bites off and swallows solid food, such as leaves, the best material to use is a stomach poison sprayed or dusted onto the tree. The insect eating this substance on its food is poisoned and dies. If, on the other hand, the insect sucks the sap from the tree, no stomach poison put on will reach it, and materials applied so as to actually hit it must be resorted to. These contact insecticides, as they are called, kill the insects they touch, and only those. As many of the sucking insect pests of the apple are extremely small, it is difficult to reach them all by the spray, so very thorough spraying must be done with these materials if all the insects are to be reached and destroyed.

Fungicides are applied only for the control of diseases known to be caused by fungi which at some stage in their life cycles grow on the surface of the host where the spray or dust can come in contact with them. Fungicides are toxic to the fungi for which they are applied.

Insecticides.

Stomach Poisons.

Arsenate of Lead. — This is the standard stomach poison for orchard use. It comes both as a paste and as a powder. The latter is for spraying and also for dusting the trees, using an air gun or bellows, a number of forms of which are on the market. In dusting, the powder should be thoroughly mixed

with sulfur or gypsum, and this mixing is difficult without special machinery. Dust mixtures are now on sale, however, the more usual proportions of the materials being 85 per cent of sulfur or gypsum and 15 per cent of arsenate of lead. The sulfur is of some insecticidal value and is therefore probably the better mixture to use.

As a spray the usual formula is —

Arsenate of lead, paste (pounds),	3
Water (gallons), .	50

If the powder is used instead of the paste, take $1\frac{1}{2}$ pounds instead of 3 pounds. Its price is higher, but there is about twice as much poison in a pound of powder as in the paste.

In preparing the paste, stir it up thoroughly in a little of the water, to get a uniform mixture before adding the rest of the water.

The paste will be of little value after it has once been allowed to dry, and it is also injured by freezing.

Arsenate of Lime. — This is a rather recent spray material, which like arsenate of lead can be obtained either as a paste or a powder. There is more arsenic in the latter, but as the price is correspondingly higher there is little difference between the two forms from this standpoint.

This material cannot be used with safety on leaves unless an excess of lime is present. Accordingly, the usual formula is —

Arsenate of lime, paste (pounds), .	2
Quicklime (pounds),	2 to 3
Water (gallons), . .	50

For the powder take —

Arsenate of lime, powder (pound),	$\frac{3}{4}$
Quicklime (pound),	1
Water (gallons), . . .	50

In either case slake the quicklime in some of the water; strain it into the rest of the water and then mix in the arsenate of lime.

This substance is cheaper than arsenate of lead, but has not been used long enough so that one is always sure of the results which will be obtained. At the present time it seems to be a promising insecticide, provided care is taken in mixing to add lime enough to prevent burning the leaves.

Contact Insecticides.

Nicotine Sulfate, 40 Per Cent. — This material is on sale under various trade names selected by different manufacturers. It is rather expensive, but is so much diluted for use that a little of it goes a long way as a spray.

One part of the nicotine sulfate is usually mixed with about 800 parts of water. For a barrel pump, which holds about 50 gallons, the proportions are —

Nicotine sulfate, 40 per cent (pint),	½
Soap (pounds),	2 to 3
Water (gallons),	50

Sometimes it can be used stronger than this for particularly resistant insects, and in a few cases 1 part in 1,000 parts of water (three-eighths of a pint in 50 gallons of water) is strong enough, but 1 in 800 is the standard dilution.

This is the best contact insecticide for plant lice, crawling young of scale insects, etc., but if it cannot be obtained, kerosene emulsion, though not quite as effective, and troublesome to prepare, may be used instead.

Kerosene Emulsion. — This is prepared as follows: —

Common laundry soap (pound),	½
Soft water (gallon),	1
Kerosene (gallons),	2

Dissolve the soap in the water (most quickly done by heating the water), remove from the fire, and add the kerosene. Now, with a small hand spray pump and fine nozzle, spray this mixture out of the pail or whatever it is in back into the pail again through the pump, thus thoroughly mixing or "churning" the materials. If this is properly done the mixture should soon become milky, then gradually thicken until it goes hard through the pump. This thickened material is

the stock mixture and should keep for a month. In time it will break up again and the oil, separating out, will appear on the surface. It is then no longer fit to use.

For use against plant lice, crawling scale insects, etc., take 1 gallon of this stock mixture, mix thoroughly with about 9 gallons of water, and spray. For more resistant insects, mix 1 gallon of the stock with 4 or 5 gallons of water.

If the materials fail to thicken while being "churned," it is probably because hard water has been used. In that case add a little borax or soda to soften it.

Lime-sulfur Wash. — This wash was first developed as a scale killer and this is still its chief use as an insecticide. It has been found, however, that it is also a valuable fungicide, and is therefore of greater value than was at first thought. It was originally made by boiling together varying amounts of lime and sulfur (usually 15 pounds of each) in 50 gallons of water for about an hour, but the time and labor involved has led to its being produced and put on sale in concentrated form, requiring only dilution with the proper amount of water to make it ready to spray. The usual directions for dilution to use during the winter months, while the trees are dormant, are to mix 1 gallon of the concentrate with 8 or 9 gallons of water, but different brands vary somewhat in this. Further suggestions for using it are given in Chapter VI under the heading "San José Scale."

However diluted, the results obtained will depend to a great extent on the thoroughness with which it is applied. Careless spraying will fail to reach many of the scales, and those left will reproduce rapidly enough to injure the tree seriously in such cases.

For summer use on badly infested trees the concentrate must be diluted much more than for winter spraying. Treatment for scales during the summer is always made under such disadvantages that only trees so heavily infested as to make it doubtful whether they will live through the season are given this spray. If it seems necessary, however, 1 gallon of the concentrate is usually diluted with about 30 to 40 gallons of water. The exact amount to dilute for summer as well as for winter work is best learned by getting the reading of the

concentrate by a Beaumé hydrometer and consulting the dilution table referred to under the heading "San José Scale."

Miscible Oils. — There are a number of these oils on the market under trade names. As their composition is more or less secret and probably differs with the different brands, dilution should be according to directions given by the manufacturers.

Dry Sulfur Compounds. — So little is known of these as yet that all which can be said of them is to follow the directions accompanying them as to mixing with water. Their possible merits and other points about them are considered under the heading "San José Scale."

Fungicides.

Lime-sulfur Solution. — Lime-sulfur has proved to be an efficient and effective apple fungicide in western Massachusetts and for that section it is at present recommended above all others.

It is usually more convenient to buy the concentrated solution than to prepare it. A number of reliable brands are on the market. Those sold under a guarantee of 32 to 34 degrees Beaumé test may safely be used for spraying fruit trees. The directions furnished by manufacturers for the dilution of their own products can usually be relied upon. The usual dilutions are 1 gallon to 8 or 9 gallons of water for winter spraying, and 1 or $1\frac{1}{4}$ gallons to 50 gallons of water for summer treatment. It should be used as soon as possible after diluting and not be allowed to stand over night, if this can be avoided. If this, or the concentrate, must be left open, pour a very little kerosene on the surface to keep air away from it as much as possible.

Bordeaux Mixture. — Bordeaux mixture is sometimes used for spraying fruit trees, but it is not recommended for this purpose by the writers because of the severe burning of fruit and foliage which it is likely to produce. In a dry May it may not cause serious injury, but one cannot predict what the weather conditions will be, and the risk incurred in applying copper mixtures to the apple is too great to be worth trying. It is probably true that this material is the most effective

fungicide known for certain apple diseases. However, the injury which may result from its use is often much more serious than the diseases which it is meant to control. It is better, therefore, to use some other substance which is known to be effective, for the most part, in controlling these diseases. For the present, concentrated lime-sulfur is recommended as a substitute for Bordeaux mixture. It seldom causes serious injury and usually gives very satisfactory control.

It is fair to state, however, that in certain sections of the State, notably in the eastern part, control of scab and black-rot often is not obtained with the use of lime-sulfur when applied according to the schedule used in other sections. In fact, so many disastrous failures to get control have followed the use of this mixture that great need of investigation to establish better control measures in eastern Massachusetts is indicated. Until such work is carried out, definite directions for the control of scab and black-rot in the orchards of that section cannot be given with any degree of confidence.

Sulfur Dust. — Sulfur dust has been used with considerable success in New York, Illinois, Michigan and Nova Scotia, but it has not been given sufficient trial in this State to warrant the recommendation of its use at this time.

Copper Sulfate-lime Dust. — The use of a copper sulfate-lime dust in Nova Scotia has met with some success, but this has not been tried in Massachusetts.

Corrosive Sublimate. — This substance is used for disinfecting pruning and renovating tools and the surface of wounds before painting. (Corrosive sublimate, 1 part; water, 1,000 parts.)

Corrosive sublimate may be purchased in tablet form at drug stores. One tablet dissolved in 1 pint of hot water makes a 1–1,000 solution.

Corrosive sublimate is very poisonous. It should be plainly labeled and kept out of reach of children and farm animals. The solution should not be made in metal containers as most metals are corroded by it.

Combined Insecticides and Fungicides.

Where control of insects and diseases is needed at about the same time, a combination of an insecticide and a fungicide is desirable to save time and labor by putting on the two together as a mixture. To combine the desired insecticide and fungicide, however, is not always a simple task, as the two materials may change on mixing and produce substances which would be injurious. Precautions in making such mixtures must therefore be taken.

Lime-sulfur, Lead Arsenate and Nicotine Sulfate (Winter Strength).

Commercial lime-sulfur (gallons),	6
Lead arsenate, powder (pounds), 1½, or paste (pounds),	3
Nicotine sulfate, 40 per cent (pint),	½
Water, to make (gallons)	50

This is the mixture to use for the first spraying (see "Spray Schedule," page 113).

Lime-sulfur, Lead Arsenate and Nicotine Sulfate (Summer Strength).

Commercial lime-sulfur (quarts),	5
Lead arsenate, powder (pounds), 1½, or paste (pounds),	3
Nicotine sulfate, 40 per cent (pint),	½
Water, to make (gallons)	50

This is for the second and third sprayings (see "Spray Schedule," page 113).

Lime-sulfur and Lead Arsenate (Summer Strength).

Commercial lime-sulfur (quarts),	5
Lead arsenate, powder (pounds), 1½, or paste (pounds),	3
Water, to make (gallons)	50

This is the mixture to use for the fourth spraying (see "Spray Schedule," page 113).

Combination Insecticides.

Arsenate of Lead and Nicotine Sulfate. — In cases where chewing and sucking insects are present but no treatment for fungous diseases is necessary, arsenate of lead may be pre-

pared as usual and nicotine sulfate, 40 per cent, can be added, the 50 gallons of arsenate of lead spray taking the place of the 50 gallons of water given under the directions for preparing the nicotine sulfate, 40 per cent.

Lime-sulfur Wash and Nicotine Sulfate. — This combination is rarely used, but can be prepared, if desired, by adding one-half pint of nicotine sulfate, 40 per cent, to the 50 gallons of lime-sulfur. The soap usually added to the nicotine sulfate must *not* be added in this case.

SPRAY SCHEDULE FOR THE APPLE.

First Application. — *Time:* Just as the buds are opening. This is known as the "delayed-dormant spray," and now takes the place of the application formerly made when the tree was wholly dormant. *What to use:* Lime-sulfur, lead arsenate and nicotine sulfate (winter strength) as given under the heading "Combined Insecticides and Fungicides," page 112. *For:* San José scale, aphids, bud moth; scab, and possibly effective against some other diseases.

Second Application. — *Time:* When the buds first show pink but before they open (the "cluster-bud spray"). *What to use:* Lime-sulfur, lead arsenate and nicotine sulfate (summer strength) as given under the heading "Combined Insecticides and Fungicides," page 112. *For:* Aphids, bud moth, tent caterpillar, red bug, brown-tail moth, gypsy moth, curculio; scab, and possibly other diseases.

Third Application. — *Time:* As the petals fall or within a week after falling begins; never when the tree is in actual blossom. This is called the "calyx spray" because at this time the petals are gone and the calyx is wide open. *What to use:* The same as for the second application. *For:* Codling moth, curculio, red bug, aphids, brown-tail moth, gypsy moth; scab (this and the second applications are probably the most important in the control of scab), fruit-spot, black-rot and leaf-spot.

Fourth Application. — *Time:* Plan to complete this spraying

within two weeks after the third. Possibly it may be delayed until three weeks after the third, but this will depend on the season and perhaps the section of the State. *What to use:* Lime-sulfur and lead arsenate (summer strength) as given under the heading "Combined Insecticides and Fungicides," page 112. *For:* Codling moth, curculio, lesser apple worm and any other chewing insects which may be present; scab, bitter-rot, black-rot, sooty-mold and fly-speck, brown-rot, fruit-spot.

The above schedule is recommended for all parts of the State except the extreme eastern section. It is probable that there should be some modifications of it for that region, but a definite program cannot be offered until investigational work has been done on which a new schedule may be based. It is possible that a greater number and more frequent applications of fungicides may prove necessary for eastern Massachusetts.

On the other hand, certain of the applications in the schedule might be omitted in some orchards without material reduction of control. At present, experience and judgment must govern one in determining whether this may safely be done.

In a wet or cloudy summer season, where sooty-blotch and fly-speck have been prevalent in previous years, an application of lime-sulfur in August will be beneficial in checking this disease.

No apple grower can afford to omit the second and third applications, — the so-called cluster-bud and calyx sprays.

Chapter IX.

APPLE STORAGE ON THE FARM.

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The problem of storage for the apple crop probably comes at some time or other to every grower. There can be little doubt that in some form storage is essential to successful orcharding. Many should think of it for themselves on their own farms, while others should look at the question as one of co-operation and think of it in the form of a central storage house for a group of growers. Some are apt to be satisfied with the commercial warehouse, but very frequently the grower in this latter class is at the mercy of the speculator.

Common storage is a successful way to handle the crop of the grower with an average acreage. This is the type which is sometimes known as frostproof storage and can be very successfully operated in Massachusetts. Much more can be accomplished with this type of storage than is generally realized if proper use be made of low night temperatures of the fall. It is a good business proposition for our growers to own either individually or collectively a common storage cellar.

Of course it is necessary that those holding fruit be able to wait for their money, which is one of the objections to storage.

There is a good deal of misapprehension as to the function of a storage house in the preservation of fruit. A fruit is a living organism in which the life processes go forward slowly in low temperatures, but do not cease in the lowest temperature in which the fruit may be safely stored. When the fruit actually reaches the end of its life it dies of old age. The storage house is designed to arrest these ripening processes in a temperature that will not injure the fruit in other respects, and thereby to prolong its life history. It follows

that the behavior of different apples or different varieties of apples in a storage room is largely dependent on their condition when they enter the room. In general it is the function of the storage house to furnish a uniform temperature of the desired degree of cold throughout the storage season.

There are various conditions that affect the keeping quality of apples in storage of which the following are most important: —

(*a*) *The Condition of the Fruit.* — The behavior of apples in storage depends upon their condition when they enter the room. No two lots should be expected to act alike unless they are in a similar condition when stored. If one lot ripens more than another after being picked and before being placed in storage, it will deteriorate more quickly in the storage house. In other words, it is nearer the end of the life cycle when it is stored.

(*b*) *Temperature for Keeping the Apples.* — The commercial practice of 31 to 32 degrees Fahrenheit in the warehouse will hold back the ripening of the fruit more than a higher temperature. It also checks the development of diseases if disease germs are present. When the fruit is removed from the warehouse to a warmer temperature it remains in good condition longer when taken from a temperature of 31 or 32 degrees Fahrenheit than when removed from a higher storage temperature. Under favorable conditions winter varieties of apples may be stored satisfactorily throughout the season in a temperature of 34 to 36 degrees. This higher temperature is adapted to farm storage houses and warehouses in which the fruit can be placed soon after picking.

(*c*) *The Time to pick Apples for Storage.* — The ideal apple for keeping in cold storage is fully grown, highly colored and still hard when picked from the tree. The scarcity of labor, the difficulty that is experienced in getting cars for the transportation of apples, and the frequent congestions in the freight traffic and the railway terminals often make it necessary to begin picking the crop relatively early in the season, so that many apples which are not in first-class condition for long keeping go into storage. These difficulties are an argument in favor of having the storage cellar located on the farm.

(*d*) *Effect of Color.* — Keeping quality is often correlated

with the degree of coloring up of the fruit. Colored varieties of apples should, if possible, be picked only after they are well colored but while they are still firm and solid.

(*e*) *Storage promptly after picking.* —A large proportion of the difficulties in the storage of apples are the results of delaying the storage after the fruit is picked. The apple ripens more rapidly after being picked than when hanging on the tree and maturing in the same temperature. The ripening that occurs between picking and storage shortens to that extent the life of the fruit in the storage house. This makes it extremely important to get the fruit from tree to storage as soon as is possible after picking.

(*f*) *Influence of the Type of Package.* — There is a wide difference of opinion concerning the comparative value of ventilated and closed packages for apple storage. One of the largest growers of apples in Massachusetts, with a total at the present time of nearly 7,000 trees in all stages of growth from two years up to fifty years, is using discarded orange boxes most successfully as the means of storing his fruit. The fruit is placed in these orange boxes immediately on picking and then carried to the storage house. Bushel boxes as storage containers are used by many farmers who are successful in holding their fruit. These boxes are filled in the orchard and either hauled directly to the storage and placed therein or are stacked up outside over night for cooling and then placed in the storage in the early morning. Apples should never be piled in the orchard.

In handling apples for storage, the ideal is reached when the fruit can be taken directly from the trees to the warehouse. This should, however, be done only when the weather is cool; if the weather is hot they should be precooled as noted above. If shipped distances, of course the same effect on the fruit is obtained when the fruit is placed in refrigerator cars for transportation. So far as the keeping quality of the fruit is concerned it is undoubtedly true that the warehouse near the orchard is the most satisfactory.

Storage has also undoubtedly had a good effect in raising the standard of production by the growers. They must have good fruit for storage; and since storage gives better prices, it is an argument for raising better fruit.

No fruit should ever be placed in storage that has not been thoroughly sprayed. In rare instances unsprayed fruit may look as well as the sprayed product, but experience has shown that it never keeps as well. Proper spraying affects the fruit so thoroughly that it has great resistance to external bacteria.

Storage in bulk should not be attempted if it is possible to avoid it. If conditions make it necessary to store in bulk just care must be exercised to get the bins of not too large a size and separated by spaces for air circulation. It is possible to keep good hard fruit of some winter varieties in bins if these receptacles be not over 2 by 3 feet high and as long as may be convenient.

A dark storage is very necessary. The presence of light hastens the ripening even if the temperature is kept low, and in some cases impairs the flavor of the fruit.

The chief advantages of good storage facilities, looking at the problem from the standpoint of the grower, are, first, that it makes him independent of the commercial buyer. If the buyer knows the grower has no satisfactory place to store his apples he will naturally lower the price that he offers for the fruit. On the other hand, if the fruit buyer realizes that the apples are safe and can be held successfully he will be more inclined to pay the grower a fair price for his crop. Good storage facilities in fact put the transaction on a plane of equality for both the grower and the buyer. This comfortable feeling of independence on the part of the grower is often worth to him all that a storage cellar will cost.

Second, good storage facilities will keep the fruit in better condition, and in consequence make it sell for more when it is disposed of.

Third, the ultimate consumer, who is the final judge, will be much better pleased with fruit coming from good storage and will be more apt to want another barrel. It is a well-known fact in the business world that the profit in merchandizing comes from the repeat orders.

Fourth, good storage delays the marketing of the fruit and in this way improves the price. Baldwins, for example, sell for more in December than they do at picking time in October. They also sell for more in March or April than they do in De-

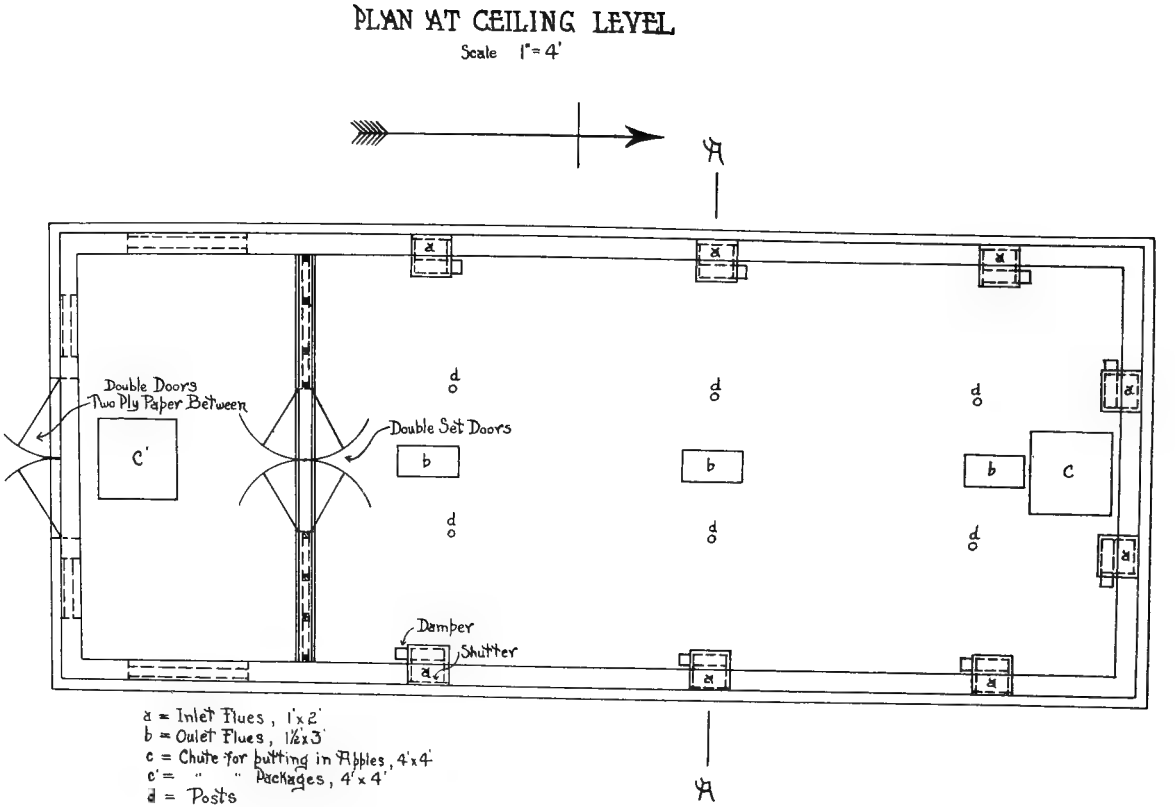


FIG. 1. — Plan of model storage cellar.

cember. Nothing is more demoralizing to the apple market than that first-class fruit be forced into competition with windfalls and fruit from unsprayed orchards.

A study of the prices for Baldwin apples covering a period of six years, 1912 to 1917, inclusive, showed average price at harvest time, September 15 to November 15, was $2.45 per barrel. During the same period of years the market price over what makes up the common storage period, December 1 to April 1, was $3.75 per barrel.

As an illustration, assume that a farmer had a crop of 500 barrels and that he possessed a good storage cellar, an allowance of 10 per cent being made for shrinkage: —

Value of 500 barrels at harvest price,	$1,225 00
Value of 450 barrels out of common storage,	$1,687 50
Gain,	$462 50
Per cent of gain on 500 barrels,	37

If this comparison were made inclusive of the 1918–19 and 1919–20 crops, the percentage of gain would be much higher.

Fifth, another advantage of storage is the fact that it is a food saver. During the war we were continually urged to save food. It is now necessary to practice the same conservation though perhaps a better name for the principle would be thrift. A great many thousands of bushels of apples are annually allowed to go to waste in Massachusetts because the grower has no facilities for storing his crop. This is food waste and could be saved by having proper storage facilities.

Sixth, good storage facilities help the labor market. When help is scarce at harvest time it is worth while having a storage building or cellar close by the orchard so that the time consumed by hauling to the railroad station, if one is shipping to commercial storage, may be saved and these men put to work picking apples.

Seventh, storage has a large influence in extending the apple market. Many of the summer and fall varieties may now be shipped to distant domestic and foreign markets in refrigerator cars or even in refrigerator compartments on shipboard. If the fruit has been properly handled between the orchard and the warehouse as well as in the warehouse, the

late-keeping varieties can be withdrawn from common storage in the winter and shipped to Europe and arrive in satisfactory condition. This export may be carried out in common holds in vessels, providing they have good ventilation. These late-keeping varieties stored in cold storage may be exported in refrigerated shipping compartments as late as the middle or last of May and give satisfactory returns on the foreign market.

Eighth, storage is one of the most important influences in raising the standard of American orcharding. There is an increasing demand on the part of the consumer for fruit of a higher quality, of better appearance, and of better physical condition. The old-fashioned method of handling the apple crop when the fruit was roughly handled, poorly packed and improperly preserved will not satisfy the present-day consumer. Poorly grown fruit or improperly handled fruit does not keep well in storage and therefore is not profitable.

There are two main types of fruit storage, — those using some mechanical means of lowering the temperature below that of the outside air, called cold storage, and those depending upon temperatures secured from atmospheric changes and called cool or common storage. The first class may be subdivided into those using ammonia refrigeration and those using ice. The second class embraces many different types of building, and there are also pits and trenches which embody the same general principles and are constructed to suit given conditions.

Few producers in Massachusetts are handling sufficient quantities to warrant the ownership of mechanically cooled storages. There are some districts where large production by closely grouped farms offers a field for the promotion of co-operatively owned cold-storage plants, but this chapter is intended for those interested in common storage and no attempt will be made to discuss refrigerated storage.

Six fundamentals must be kept in mind in constructing an apple storage: —

1. Maintenance of low temperatures.
2. Protection from frost.
3. Protection from heating.
4. Protection from changes in temperature.
5. Provision for sufficient moisture.
6. Avoidance of a wet and stagnant atmosphere.

FIG. 2. — Storage house of E. F. Shumway, Belchertown. Made by reconstructing an abandoned house cellar. Cost about $900. August, 1920.

Air-cooled storages are usually built partly or entirely under ground because the earth acts as an insulator. The depth of the earth depends on the location of the cellar. It should be covered deep enough so that frost cannot enter the storage room in the coldest weather. A deep covering gives better satisfaction the year round because it keeps out the extreme cold in the winter and keeps out the heat of the summer.

The ventilation system of an air-cooled storage must be correctly designed and very carefully operated. Intakes and outlets must be carefully constructed and placed to give a good circulation. No ventilating system, however carefully installed, will give satisfaction unless properly operated. On cold nights during the fall the system must be working at its maximum. The ventilators should be kept open during the nighttime as long as the cold fall weather lasts.

Since storage cellars are usually built under ground, they should be constructed of some material which will easily withstand the action of moisture. Concrete is a first-class material for storage cellar construction. Concrete construction is not overexpensive, is easy to build, is waterproof, ratproof and permanent.

The construction of a storage especially for apples is often advisable for the grower who has a large production of winter varieties. Its size is of course dependent on the quantity of fruit it is desired to store, but if one keeps in mind the fact that a bushel of fruit plus air space and alleys will occupy about $2\frac{1}{2}$ cubic feet of space, it will be comparatively easy to figure the size necessary.

The type of building and its size are dependent on local conditions. An average 10-acre orchard will produce 2,500 to 3,000 bushels in a good crop. The grower with a crop of this size will need a cellar of approximately 7,500 cubic feet capacity since an allowance per bushel of $2\frac{1}{2}$ cubic feet is needed to provide storage space with necessary air spaces and alleys.

The location should be carefully selected. It should, if possible, be located on a side hill of slight slope but with sufficient rise to assure good drainage and to make the excavation work as easy as possible. It is best if one side and one end may be below the ground level. The shape of the cellar

will largely depend on the "lay of the land," but, as a general rule, if the length be twice the width it will work out well. The storage should be located as near the center of production as possible, keeping in mind ease of reaching it and ease of getting out with fruit for market. As a general proposition it is best not to make the cellar more than 8 feet deep in the clear, that is between floor and ceiling. If the grower is using bushel boxes with 1 inch risers, this will permit of stacking eight or nine high, which is as much as is easy to handle.

The walls may be of concrete, masonry, brick or hollow tile. For most localities, however, it is probably best to use concrete. In the greater part of Massachusetts it is possible to obtain easily the necessary sand and gravel. In making the excavation a little care in keeping the banks as nearly perpendicular as possible will make it necessary to build but one form for the concrete. The face of the bank can be used for the other side of the form. The walls should be at least a foot thick at the top and should be more than that at the bottom, especially if one contemplates the erection of a building over the cellar. The walls should go at least 18 inches below the floor level of the cellar so that rats will not burrow under. In building a wall of this thickness heavy rocks can be used, being careful to get the concrete well down around them. In building the wall of course gaps will be left wherever ventilators, windows and doors are to be placed.

The floor of the cellar should be dirt except in special cases when the soil is very wet or where an easily applied supply of water is available. This dirt floor will supply the necessary moisture. In cases where a water supply can be easily utilized a concrete floor may be laid, provision for conducting the water being made as circumstances may demand. Successful methods have been used which included a shallow trench around the edge of the floor into which the water could be turned as occasion demanded. Another method has been to dig a series of shallow blind wells which were connected by pipes from well to well and drained outside the cellar. If the water from a spring can be carried into the cellar and a stream kept constantly running, it will not only provide moisture but will help in equalizing the temperatures.

FIG. 3. — Storage house in Auburn, owned by the Auburn Fruit Company of Worcester.

The ceiling of the cellar should be of sheathing paper covered with boards. It must be tight. If there is to be a building over the cellar its floor will make the other side of an air space for protection from cold. If no building is put over the cellar the ceiling timbers should be tightly boarded over on their upper sides.

The ventilating system used in common storage houses depends on the natural law that warm air rises. It consists of a series of cold-air inlets and warm-air outlets. The inlet flues should be placed in position so that they open to the outer air at the ceiling of the cellar and just above the ground level on the banked side of the cellar. Unfortunately there are not available any accurate data as to the relative size of these openings to the size of the cellar. In some localities a ratio of 1 square foot of inlet per 1,000 cubic feet of cellar space has been found satisfactory, while in others it has been necessary to increase this proportion greatly. It is easier to err on the side of too little rather than too much. These openings should be not less than 12 by 24 inches in size, and the flues running from them should extend to within 6 inches of the cellar floor. They should be equipped with tightly fitting shutters and dampers.

This space between shutter and damper gives the air-space protection needed to keep out frost. These flues must be of tight construction to insure efficient working. There should be one for each 15 feet of length of wall. This allowance is in accord with the best information available at the present time.

Warm-air outlets to furnish the rest of the circulation system should be placed in the middle of the lengthwise center of the cellar, leading from the ceiling up through the roof. They act in the same way as the chimney of a house, giving a draft that sucks out the warm, foul air. They should be of a size to equal approximately in total the square foot area of the inlet flues, but will need to be only one-half the number. They should be equipped with tightly fitting shutters at the ceiling and dampers above.

In constructing a storage cellar it is advisable to build a packing room as an adjunct to the plant. This may well be

built on the open side and should be separated from the cellar proper by a stud and board partition. It should be of a size to permit of the running in of the truck or wagon and give room for efficient work by two or three men. If a grader is used it will need to be much larger than if such is not the case. The doors from the packing room to the storage room should be of a size and location to permit the trucks and wagons to run into the cellar if possible. This will help to reduce the man labor in getting the fruit into the cellar. All doors should fit tightly and those on the outside should be double. Plenty of windows should be allowed for in the packing room. It should have a board floor for the comfort of those working there. The packing room is sometimes placed above the storage, but this is an inefficient and expensive location for it even if an elevator be installed.

All openings, doors, windows and inlet flues should be provided with screens made from four to the inch cellar window wire as protection against rats.

Many farmers have on their places old barn cellars or even old house cellars which, with the expenditure of a little money and labor, may be made into very efficient common storage houses. Most of these old barn cellars were built so that they have three sides below the ground level and the fourth side open.

The first thing necessary to do is to clean up the cellar, thoroughly removing all manure and, so far as possible, the saturated dirt. The walls should be repaired where necessary and pointed up all round. A concrete footing 4 or 5 inches thick and going down below the foot of the wall for 18 to 24 inches is excellent insurance against rats. This footing should be put in on all four sides, and on the open side will serve as a foundation for the stud and board wall it will be necessary to construct. This wall should be built of 2 by 4 inch studs spaced 16 inches, covered on both sides with sheathing paper or one-ply roofing paper, and then with matched boards. The outer side should be waterproofed with shingles or two-ply roofing paper. The remainder of the work in reconstruction will follow the foregoing directions for new construction.

It is good practice to put up a building over the storage

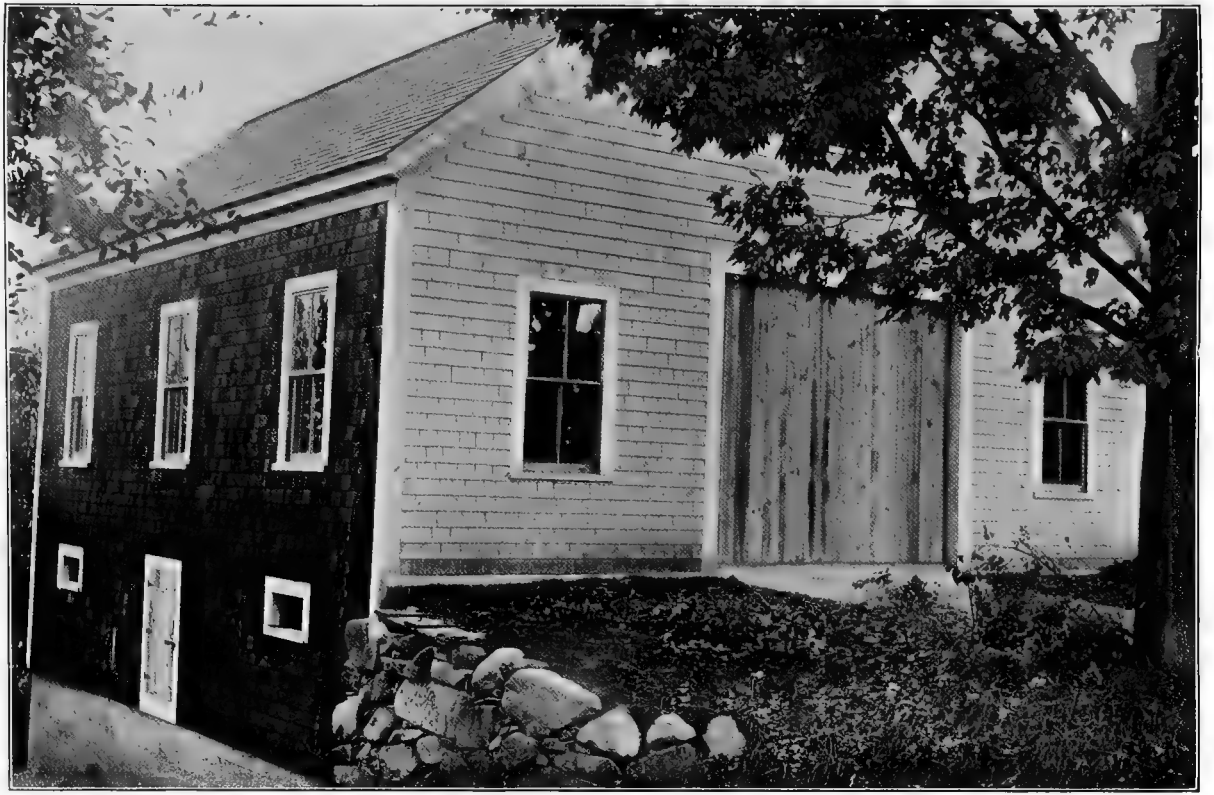


Fig. 4. — Storage cellar and packing house of C. D. Wetherbee, Stow. Built 1920. Capacity, 3,000 bushels. Equipped with elevator to bring up apples from cellar to packing room.

cellar. This may be of stud and board construction covered with shingles or roofing paper, or it may be framed and covered with shiplap. It can be most satisfactorily used as a storage for empty boxes, as a shop for assembling boxes and barrels, and as a storage room for orchard equipment. If walls and ceiling be sheathed over it can well be used as an apple storage for the part of the crop which it is desired to move early in the season before really cold weather sets in.

If no building is to be put up over the cellar the ceiling beams should be boarded over on their upper sides and a roof put on. With good tight ceiling and roof no danger of frost getting in should exist.

After constructing the storage cellar the problem of holding the fruit is only partially completed. No storage however carefully planned and correctly built will successfully hold poor fruit; neither will it hold good fruit in marketable condition unless properly managed.

Producers in Massachusetts who are practicing storage do so with one of two objects in view. One class is storing apples of the higher grades that are sized and packed at harvest time and are not, as a rule, repacked but are shipped as market conditions demand. Generally speaking, apples stored in common storage under these conditions go to market early in the winter. The second group, and much the larger number are enrolled in this class, store direct from the trees, making no attempt to grade or size the fruit until it is packed out for market.

Certain growers have made a practice of running the fruit over a sizing machine as it goes into the cellar and have not lost anything in keeping quality. For a grower who is marketing several grades this would appear to be good practice since it permits of stacking a given size by itself, which facilitates filling an order for that size fruit. Fruit to be thus handled needs to be especially hard and firm so that no appreciable damage by bruising will be done by the machine.

The boxes of fruit should be piled in a careful manner. If boxes with no risers are used strips of 1-inch thick lumber should be placed on the tops of the boxes before putting on the next layer. This will allow a circulation of air over the

top of each box. Alleys should be left open in front of each cold-air inlet flue and a space of 6 inches to 1 foot left open between the wall and the piles of boxes.

During the fall season all openings, including doors and windows, should be left open through the nights and closed in the mornings. This is in order to bring in as rapidly as possible the cooler air and to confine it there. A little attention to this matter is worth many dollars in holding the fruit. Close attention to the temperature outside and in will pay many times over. Thermometers should be placed in the cellar so that accurate knowledge of the temperature may be had.

During the storage season occasional use should be made of the ventilating system so that the air may not become stagnant. Select a day when the outer temperature is neither too warm nor too cold and open the whole system for a few hours. If the flues are properly designed and built it is possible to change the air very rapidly.

No storage cellar is a bit better than the fruit in it and the method used in managing it.

There are many successful storage cellars in use in Massachusetts and examples of several types may be of interest.

The Auburn Fruit Company of Worcester has, at its orchard in Auburn, a cellar built for apple storage some years ago. It has been uniformly successful for holding the fruit. This cellar is built with concrete walls, below ground level on two sides and one end and has a packing room at the other end. It has a shed construction building over it which is used for package storage.

R. C. Cobb of Littleton and A. N. Calkins of Harvard have successfully reconstructed old barn cellars into efficient apple storages. E. F. Shumway of Belchertown has a good storage cellar made by roofing over an abandoned house cellar. The Williamsburg Fruit Growers Association has a co-operative storage and packing plant constructed from an old barn. Any of the above will gladly show people interested how their plants were built and what the results are.

Chapter X.

APPLE PACKING FOR MASSACHUSETTS GROWERS.

ALBERT R. JENKS, WEST ACTON, MASSACHUSETTS, FRUIT GROWER.

The commercial importance of the apple crop in Massachusetts has grown rapidly during the past decade. Improved methods of harvesting, sizing, grading, packing, storing and marketing have had a great influence in helping make the apple crop profitable to its producers. These methods must be improved upon and be more generally practiced if the State is to maintain the reputation being developed, and is to continue to market her rapidly increasing crop at a price which will return to the growers cost of production plus a reasonable profit. The rapid development of interest in apple by-products with their apparently unlimited market forms an excellent outlet for culls and lower grade apples, so that one should not hesitate to remove these grades of apples from their better marketable grades.

Improved methods of picking must precede any advance in the packing of apples. Too little thought oftentimes is given to this phase. Apples may be excellently grown and finely packed, but unless they are carefully picked they will not bring the highest market price. It is very hard to know just when an apple has reached the stage when, if picked, it will keep the longest and still retain the highest quality for culinary and dessert purposes. The time will vary according to the soil, its moisture content, the variety of apple, the stock, the season, the exposure and the purpose for which the fruit is sold. Experience is necessary to determine this point, but there is less danger of picking too early than too late. A fair test of ripeness is to lift the apple gently and twist it slightly. If it parts readily from the spur, the apple is ripe enough to pick. If the apples are to be placed in ordinary storage they

should be picked earlier than if they are to be put into cold storage. One must not, however, pick apples too green, because they are more likely to scald in storage. Experience during the past few years has proved that apples must be picked several days earlier than they have been in order to obtain satisfactory results from storage.

Harvesting.

In picking apples, handle them as carefully as eggs. Employ help who can pick with two hands. The recent labor shortage has forced fruit growers to use women, boys and girls to help harvest the fruit. Farmerettes have in the majority of cases proved very satisfactory. Many fruit men report that the farmerettes have been the most satisfactory help which they have ever had at harvest time, and they prefer to continue employing them as long as they are available.

Great care should be exercised not to detach the stems, because when a stem is pulled out it breaks the skin; this allows the bacteria to enter the apple, resulting in rot and disease in an otherwise sound apple. Many markets refuse apples with 25 per cent of the stems missing. Equal care should be exercised in picking apples to leave all fruit spurs unbroken upon the limbs. Each broken spur means that several apples are deducted from the next three or four years' crops. This is an absolutely unnecessary loss if due care is exercised. Help should never be allowed to climb into the trees while picking, especially young trees, because broken branches and bruised limbs are bound to result from such a procedure. Wounds and bruises upon the limbs constitute ideal conditions under which canker and other diseases start and flourish. Light, strong stepladders should be used for low trees; for taller trees, light pointed ladders, which will fit into crotches in the limbs, are better then straight ladders. Extension ladders are necessary for very tall trees.

There are many kinds of picking bags, buckets and baskets upon the market. Most growers prefer the oak, splint, half-bushel basket which has a swinging bale, allowing the basket to be lowered into the barrel or other receptacle and the contents poured out without any danger of bruising the fruit.

The baskets should first be oiled, thus making them more durable; they should then be padded with canvas or burlap. Picking receptacles that open from the bottom are not entirely satisfactory at present, and picking bags tend to bruise the apples more or less. Heavy wire bent in the form of the letter S, with the upper part large enough to put over limbs and the lower part to fit the handle of the basket, are very useful. This will enable the pickers to use both hands. It is quite essential that practically all the picking be done by hand, as, up to the present time, the patent pickers have not been so perfected as not to bruise the fruit, or else they are deficient in other ways. Patent pickers may be used for stray, scattered apples.

The question of field receptacles for the apples now arises. The field receptacles to be used will depend upon what is available or easily obtainable, upon whether the apples are to be sold shortly after being harvested or are to be stored, and upon what sort of a container they are to be sold in.

There are several different types of field receptacles in use in the State. They vary according to the section of the State. The growers in eastern Massachusetts have been marketing their apples almost entirely in the so-called Boston produce box which contains $1\frac{1}{5}$ bushels. They have also used this box as a field and storage container. These growers are now adopting a smaller box which will hold a United States standard bushel by cubical contents within the tolerances of the law.

This package stores well when empty, can be used over and over again, stacks well in storage and on trucks, and when full is not too heavy to handle easily. Excellent ventilation for the apples while in storage is provided by the use of risers upon the ends of the boxes. Growers in the central and western parts of the State are rapidly adopting this package as a field and storage receptacle.

Orange, grape-fruit and cracker boxes are used by several of the large, progessive growers. These ordinarily can be obtained at little cost and furnish excellent ventilation. Second-hand barrels are used extensively in the western part of the State for field and storage receptacles.

Market Packages.

As previously suggested, eastern Massachusetts apples are almost entirely marketed in the produce box. The bushel produce box now being adopted as a standard package is $17\frac{1}{2}$ by $17\frac{1}{2}$ by $7\frac{1}{16}$ inches inside dimensions. The ends are made of not less than five-eighths inch and the sides and bottom of three-eighths inch material. Risers are also being standardized and are not higher than five-eighths inch and are generally five-eighths by five-eighths inch. The wording upon at least one side of the package, in bold Gothic type of at least 1 inch in height, is as follows: "Standard Box For Farm Produce U. S. Standard Bushel." This produce box is by legislative action a standard produce box in Rhode Island. It is used for vegetables and fruits and can be used over and over again. It is hoped that the other New England States will adopt the same size bushel produce box so that the different States will have an interchangeable package.

This box has many advantages for use in near-by markets, and a large percentage of Massachusetts apples are at present sold within the State borders. The box is easily and quickly packed, and is at present a credit package, which means that the grower obtains a portion of his original package investment back from the man who purchases his apples. These boxes cost from 20 to 32 cents apiece, and the credit or exchange value is 15 cents, so that considering the credit value growers are able to market their fruits in these packages at a much less package cost than when using barrels, apple boxes, stave baskets, or 14-quart peach baskets.

Some Massachusetts growers have tried out the standard apple box. This is at present used by northwestern apple growers for all the apples which they ship. The dimensions of the standard box are $10\frac{1}{2}$ by $11\frac{1}{2}$ by 18 inches inside measurement. The box contains a trifle less than a standard bushel, but when it has the necessary bulge it accommodates more than a bushel. Apples are generally sold by the number in the box and not by weight or measure.

The ends of the box should be of one piece, three-fourths of an inch thick, with the grain running crosswise; the sides

should be one-fourth to three-eighths of an inch thick and of one piece; the tops and bottoms should be of two pieces each, a little less than one-fourth of an inch thick, the two pieces making them more elastic. There should be two cleats for the top of the box and two for the bottom on each end. These hold the top and bottom securely, as the bulge has a tendency to push the thin boards over the nail heads. The boxes generally come knocked down, and can be put together during rainy weather, before the season opens. Four nails should be used for the sides, at each end. Fourpenny or fivepenny cement-coated nails are the best; they hold better.

Many Massachusetts growers attempted using the standard apple box before they had fruit of high enough quality to warrant placing it in such a package. These growers in all too many cases also did not understand proper grading and packing, so that distributors and consumers have often been disappointed in condition and quality of these apples. Massachusetts grown and packed fruit in standard apple boxes therefore has in many cases not the best of a reputation. A few individual growers of really high-class fruit are building up a fine reputation for their product and find an unlimited market right at home.

The standard apple box probably will be used more extensively in the future when Massachusetts McIntosh, Gravensteins and Wealthies are grown so extensively as to supply all of the local demand for them and still have a surplus for shipping to near-by States and more distant markets. There is little doubt but what within a few years McIntosh growers will have to look outside of the State for satisfactory markets for their very rapidly increasing crop. The standard apple box is an excellent package for distant markets.

Some growers near Springfield, Massachusetts, have been using the 14-quart peach basket. This has been a fine package in that it contains just about the right quantity of apples for a family to purchase and use up before loss from deterioration starts. It has filled a long-felt want for a small package. It has many drawbacks, such as being a poor package for hauling to market and stacking in the market or in the retail store. This package probably will have to give way to the proposed

standard half-bushel box, which is $12\frac{3}{8}$ inches in length, $12\frac{3}{8}$ inches in width, and $7\frac{1}{16}$ inches in depth, all inside dimensions, the size of material in ends, bottoms and sides to be similar to the bushel box. The writer believes that this package is destined to become very popular with growers of high-class apples who cater to roadside stands, fruit stores and retail store trade. It is hoped that like the bushel produce box it may in time become a credit package.

The apple barrel is standardized by Federal and State law. The barrel is at present used for the larger share of the crop of the western part of the State. It is an excellent package for use in exporting apples or in selling average grade apples outside of the State. Owing to the frequent difficulty of obtaining apple barrels, one should order them in advance of the time they are needed. Use only new barrels for the best grade and perhaps for the second-best grade. If second-hand barrels are used at all they should be carefully cleaned. Hardwood barrels with elm hoops are the best.

Four-quart wire-bale baskets are coming into common use for fruit stand and roadside stand trade. They are easily packed with the different sized apples. Corrugated packages are now so expensive that they are used but little in commercial packing. Hampers, flat tills, and other types of small packages are not used to any great extent commercially. They likely will be developed for specialized markets.

The universal bushel is a stave bushel of United States Standard cubic contents within the tolerances of the law. It is an attractive package which is used very extensively in apple-growing sections outside of Massachusetts. The shortage and high price of boxes and barrels already is tending to develop an interest in this package among growers in Massachusetts and it is likely to get into very general use in the State during the next few years.

If one plans to pack his apples in barrels it is always a debatable question whether the packing should be done in the field or in the packing shed. Local conditions oftentimes decide this question. It is generally better, however, to haul the apples to a central packing place, as the facilities for better and more rapid work can there be provided. Barreled

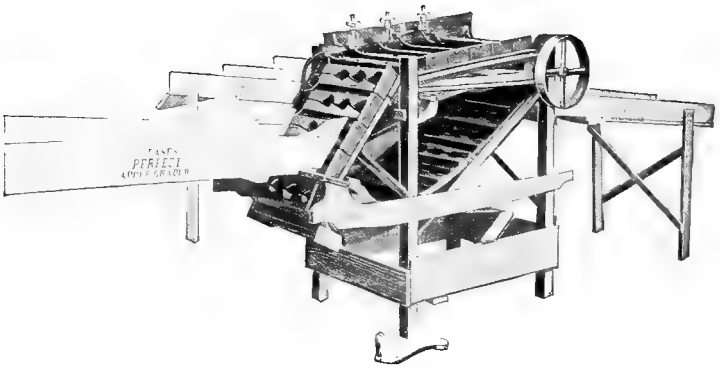


FIG. 1. — The Pease grader.

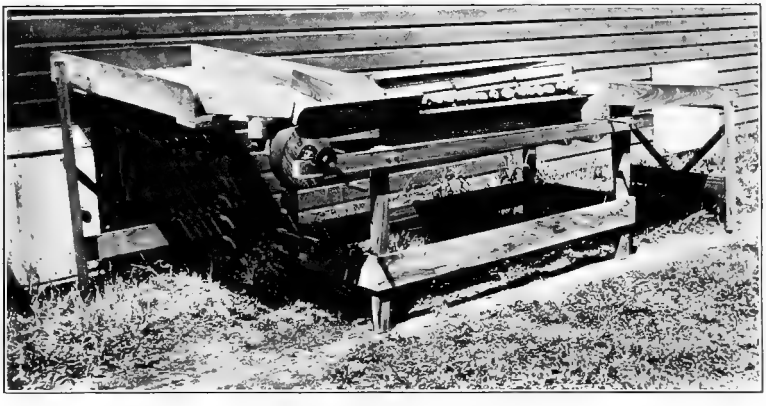


FIG. 2. — The Gifford grader.

apples thus packed generally bring 15 to 25 cents more a barrel, because, as a rule, the work is done better. Then, too, if the apples are brought immediately to a central packing house, they generally have an opportunity to become cool before they are placed in the barrels. This adds to their keeping qualities very materially. If the varieties are in large, compact blocks in the orchard, and the packing shed is quite a long distance away, it undoubtedly is cheaper to pack the apples in the field. In this case, one needs no field receptacles, as the pickers can empty their baskets directly upon the sorting table. When the packing-shed plan is followed, cheap but firm barrels are probably the best field receptacles. These should be filled not more than four-fifths full. A low-down spring wagon, with a broad platform and broad wheels which will turn in under the platform, should be used. Bolster springs have been placed upon the market. By using these springs almost any wagon may be made suitable for orchard use. Fruit hauled on such a wagon will be bruised but very little. Large market express wagons are used in eastern Massachusetts for hauling apples to the packing shed or storage.

Sizers.

Sizers, or graders as they are oftentimes erroneously called, are to be found on most of the larger fruit farms in the State. Reports received from the manufacturers and dealers of sizers show that there are between fifty and sixty in the State at present and they are increasing at the rate of about thirty each year.

The sizers are of several different types, but the two most common ones are shown in Figs. 1 and 2. The machines do very excellent work in sizing all varieties of apples, peaches and pears. One may run over each hand machine about four hundred fifty bushels daily. It is an easy matter to adjust the machines to grade different varieties of fruit to sizes desired. They give three to five sizes, and size the apples with very little error. Such outfits usually pay for themselves in one season in saving of labor where one has many apples to size, grade and pack.

Barrel Packing.

Many different types of tables are in use for sorting apples for barrel packing. The most common table is called the end-delivery table, and is a very good table for use when one is careful not to handle the apples roughly. The dimensions are as follows: Length, 7 feet; width at back, $3\frac{1}{2}$ feet; height at front, 32 inches; height at back, 36 inches; height of side boards, 6 inches.

Spaces are left between the boards in the bottom of the table for the dirt and leaves to sift through. The boards must be of a soft wood and smoothed off, in order not to injure the fruit. The back of the table is purposely made 5 or 6 inches higher in order that the apples may roll down toward the front.

It is necessary to have three men working at such a table to get the best results. An upturned barrel is placed at the end of the table. On this is placed a basket for a certain grade, — the grade which is running the smallest. A man stands at the side of the table and sorts. He has one or two upturned barrels beside him which hold the baskets for other grades. The grade which composes the bulk of the apples is allowed to run down the table into the barrel. The third man in the crew knocks the tail end out of the barrels, picks out the facer apples, puts them into the barrels and empties the baskets of the two sorters into their proper barrels. Three men working in a crew in such manner will average about 40 to 45 barrels per day. One extra man can head up and stencil all the barrels put up by three such crews.

A heavier table is often used in packing-house work. It is 9 feet long, 6 feet wide and 33 inches high in front, with the table running lengthwise. The back of the table is 38 inches high and the side 8 inches high. The bottom is slatted, as in the end-delivery table. Three men are needed in the sorting crew, as at the other table. The only advantage of this table is the fact that more field barrels can be emptied upon it at one time.

The actual packing of the barrel consists in placing a cor-

rugated head on the bottom of the barrel. The final top of the barrel is the bottom as it is being packed. If the quality of the apples warrants it, a fancy lace paper circle is next put into the barrel. An oiled or paraffined paper circle is put in next, which prevents any dirt which may possibly sift into the barrel through the cover from coming in contact with the fruit, and also prevents excessive moisture transpiration from the apples. The head of the barrel is now faced with uniform-sized apples of a grade which is typical of the contents of the barrel. These apples should be of good color, or at least show good color around the stem ends. Stemmers or small shears should be used to cut the ends from the long stemmed varieties, so that they will not puncture the oiled paper circle and will rest more evenly upon the face end. This is sometimes omitted in strictly commercial work. The face layer is put in stem end down, in concentric circles. The outside or larger circle is placed first, of a uniform-sized apple which will just fill the circle snugly. Each concentric circle is placed in the same way. The center will require one, two, three, four or six apples, varying in accordance with the sizes of apples used. The next layer is placed the same way by some growers, especially for their extra fancy and exhibition barrels. Most commercial growers now make the second layer by placing the heavy-colored cheek of the apples in the cavities formed between the apples of the face layer. This method makes the barrel look much better when opened. About a bushel of apples is next carefully emptied upon these two face layers, before the barrel is shaken at all. The barrel should be carefully shaken then, and after each succeeding basket is put in, until it is full. The shaking, or "racking" as it is called, tends to work the apples down into all of the cavities. In this way a compact package is secured and possibility of bruising is eliminated.

The height to which the barrel should be filled varies according to varieties, and opinion on this point differs in different localities. It should be just high enough so that when the head is pressed in all apples will be held firm, and yet not so tight as to bruise them. The last layer should be placed with stem ends uppermost. This makes it easier to put the

head in, and if by mistake the bottom should be opened, it would present a much better appearance. A corrugated head is also used at the tail end as it helps to prevent bruising when the tail is pressed in. It should be nailed in place with six three-and-a-half-penny nails. It is advisable also to nail liners to the tail end of the barrel. The barrel is reversed, and if it is to be shipped a long distance the head should also be nailed in a like manner as an added precaution.

Barreled apples if held for any length of time should be placed on their sides. They should be packed in a car in this way. This method of storing prevents the fruit in a barrel from bearing the weight of other barrels, because the package itself bears it and prevents apples in the barrel from becoming slack.

The following score card, or some slight modification of it, is generally used for judging the barreled apples: —

Apples.		
Texture and flavor,	100	
Size,	100	
Color,	150	
Uniformity,	150	
Freedom from blemishes,	150	
	—	650
Package.		
Staves,	10	
Hoops,	10	
Heads,	10	
Nailing,	20	
Marking,	20	
	—	70
Packing.		
Facing,	70	
Tailing,	60	
Pressing,	70	
Racking,	80	
	—	280
		1,000

Apple Box Packing.

The western growers have succeeded wonderfully with the apple box. This is due entirely to the fact that they were

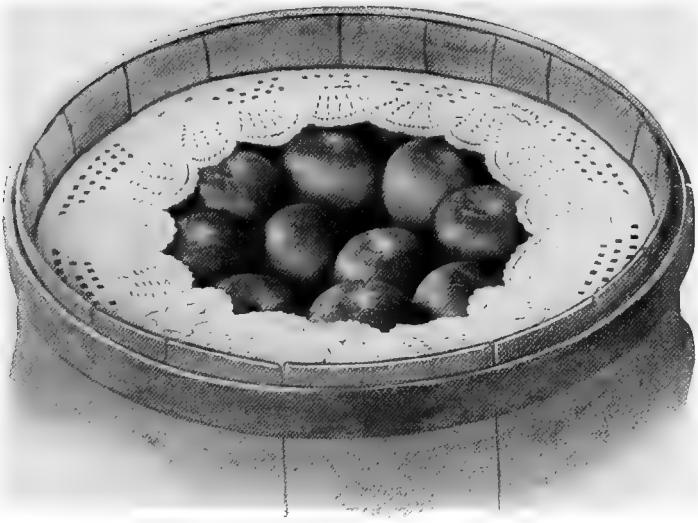


FIG. 3. — A well-packed barrel of apples. The "lace circle" adds to its attractiveness, and with good apples it is good business to use it.

FIG. 4. — The different kinds of packs. Beginning at the left, (1) offset; (2) square; (3 and 4) diagonal.

compelled to pack high-grade apples, and have developed their apple-sizing machinery so that it is very accurate. They are careful packers and so expert at it that their packing cost is not prohibitive.

The Box Packing Table.

The box packing table, such as is shown in Fig. 5, is about 3 by 4 feet, made of 6 by 1 inch boards with 2 by 4 inch joists as posts. A stout canvas is stretched across the top of the boards. An old piece of rubber hose may be nailed along

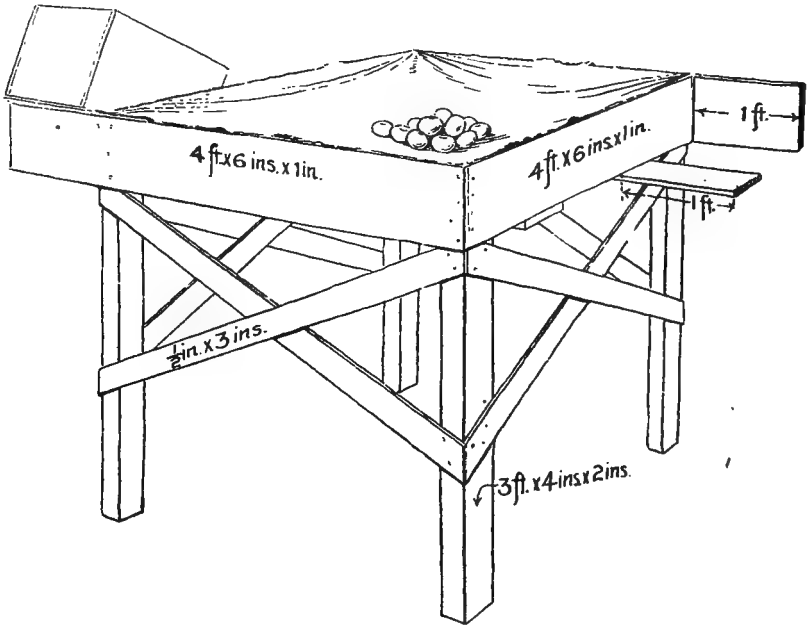


Fig. 5. — A convenient type of packing table.

the top of the boards over the canvas to protect the apples from bruising. Shelves for holding the apple box are made at a slant on opposite corners of the table. Extra shelves may also be made under the table for holding wrapping paper and other packing accessories, thus saving a lot of the packer's time by having everything convenient.

Grading.

As the apples are placed upon the table they are generally graded for size and color. It requires as much skill to grade apples well as it does to pack them well. Sizing is oftentimes done by machine. An amateur starting to grade for size by hand should have a thin board convenient, with holes of the different diameters cut in it. Occasionally, when in doubt, he can try the apples in the different sized holes. It takes a great deal of practice for one to become an efficient grader, although some people learn very rapidly. Two men can pack to good advantage at one table. One may pack a certain size while the other is packing some other size, thus keeping the table fairly well cleaned off.

Lining the Box.

The box is lined on the bottom, sides and top with two pieces of paper each 18 by 24 inches. These are placed so that they overlap about 2 inches in the bottom of the box. They are long enough to cover the sides and the top, lapping over about 2 inches when the box is packed. The ends are rarely lined. Many growers crease these papers where the sides meet the bottom, which is really the top of the box, so that when the bulge is pushed down the paper will not be torn.

Wrapping.

All apples should be wrapped in tissue paper. This helps to retain the moisture content of the apples and also makes a cushion between them. In case an apple should decay, the paper prevents the rot from spreading. Apples also pack more firmly when wrapped. Wrapping paper can be obtained either plain or printed. Oftentimes the large orchardists have their brand or trade name printed upon the wrapper. This makes it cost a little more, but it is a good form of advertising. The white tissue is the best, although different colors are used. It comes in different sizes, which are used according to the size of the apples. The common sizes are 9 by 9 inches, 10 by 10 inches and 11 by 11 inches. Supplies of the three sizes

should be kept on hand; the 10 by 10 inch size, however, is most largely used.

Many beginners at apple packing have difficulty with the wrapping of the apple. Wrapping methods vary among different packers. The points sought for are speed and an attractive appearance when wrapped. The paper is taken with the left hand towards one corner. The apple is placed in the paper, blossom end down; the four loose corners are folded in; the left hand places the apple in the box. By placing the blossom end downward in the hand, the surplus loose corners are wrapped around the stem end, thus protecting the apples with which it may come in contact.

Layer papers are used in the top and bottom of the box inside of the lining paper; they are also used between the layers of apples, in order to raise the height of the pack when necessary. The paper comes in different colors and weights, but a medium weight, white, rough cardboard, 11 by 18 inches, is the best.

A shelf should be made to put on the apple box to hold the wrapping paper, such as is seen in Fig. 6. Thumb-cuts should also be provided to put upon the thumb of the left hand for grasping the single sheet of wrapping paper.

Packing.

The packer is now ready for work. He stands in front of the box, with wrapping paper on the shelf and apples at his right upon the table. With his left hand he grasps a sheet of wrapping paper at the corner, while with his right he grasps a certain sized apple which he is about to pack. The experienced packer knows at a glance what pack he must use to have every apple tight in the box, and also how many apples he will need to pack the box.

There are three systems of packing in use, the straight, the diagonal, and the offset. The diagonal, however, is used almost entirely. It is the hardest to pack, but it is by far the most attractive and the most efficient. Apples in a square pack generally become bruised in shipment, because each apple is placed directly over the other. Apples may vary more in size in diagonal packing than in square packing;

they also tend to bruise much less in this pack, because each apple rests in the space between two or four others. The offset pack presents more empty space to the critical purchaser when he takes off the side of the box to look at the apples; therefore, it should be used only when necessary.

The size of an apple is always considered as the greatest distance from cheek to cheek, and not the distance from stem end to blossom end. A well-packed box of apples should always have a bulge of three-fourths of an inch upon both top and bottom. The top and bottom bulged in this way act as springs to hold all the apples tightly. This bulge is most easily attained by selecting apples with a little greater diameter for use in the middle of each layer. As the box is packed this bulge will be about $1\frac{1}{2}$ inches in the middle, but when the bottom is nailed on, the top of the box will spring out, thus making both top and bottom equal. (See Fig. 7 for illustration of bulge.) The pack should be but little in excess of the height of the box at the ends. This generally comes all right because of the size of the box and the kind of pack selected for the several sizes of apples. Apples which have a diameter of $2\frac{3}{8}$ inches make a five-tier pack of either 188, 198, 200 or 225; $2\frac{5}{8}$ inches in diameter make a four and a half tier pack of either 138, 150, 163 or 175; $2\frac{7}{8}$ inches in diameter make a four-tier pack of either 113 or 125; $3\frac{1}{8}$ inches in diameter make a three or two and a half tier pack of either 36, 48, 56, 64, 72 or 80. The number varies with the variety, owing to their different shapes and thicknesses.

It is sometimes a hard question for beginners to decide when to use the different packs, such as the 4–4, 4–3, 3–3, 3–2 or the 2–2. This varies with the size and shape of the apple being packed. The 2–2 and 3–2 are the packs most in favor among fruit growers. It is advisable to pack the apples upon their cheeks whenever possible, as they present a much better appearance. A few of the varieties and sizes require stem-end packing. Experience and long-continued practice will overcome most of the difficulties experienced by beginners in box packing.

In the 2–2 pack, start by placing one apple in the lower eft corner and another apple halfway between the cheek

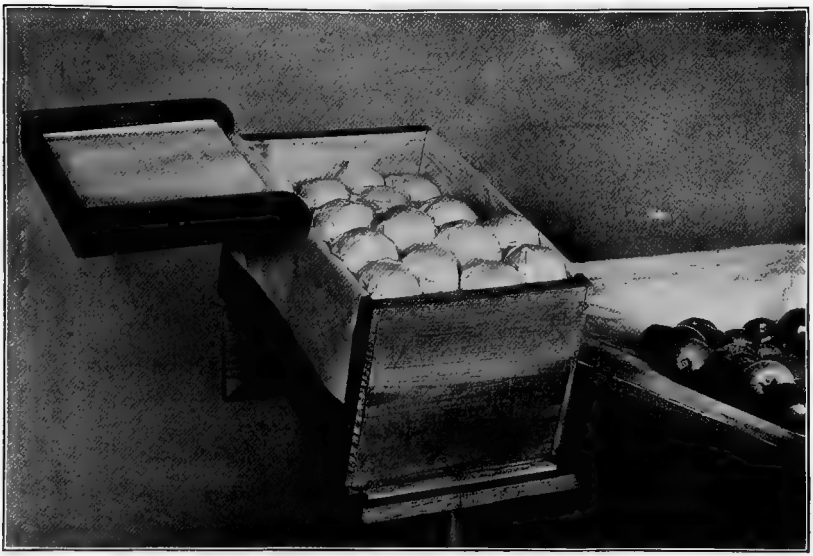


FIG. 6. — Box partially packed, showing construction and position of hod.

FIG. 7. — The bulge. The box at the left shows too little bulge, the one in the center the proper bulge, and the one at the right too much.

of the first apple and the opposite side of the box. The next two apples are placed into the equal spaces formed by the first two apples. The operation of placing two apples in the cavities left by the last two apples should be continued until the end of the box is reached. The layer of apples should be pulled down towards the packer, which will then leave sufficient space to insert two more apples. These last two apples will cause all the others to become firm in the box. If the apples are of such a size that layer papers are necessary to raise the height of the apples, a paper is inserted after the first layer is complete. The second layer in the box is packed in the same way, except that the first apple is placed in the lower right corner. This means that all the apples in this layer are placed in the pockets formed by the apples in the first layer, and that when the box is nailed no apple will be bearing the entire weight of any other apple. Each succeeding layer is packed in the same way, being careful that each layer is started so that the apples will be in the pockets formed by the apples of the preceding layer.

The 3–2 pack is very similar to the preceding 2–2 pack, except that three apples are used in alternate rows instead of two. This means that the 3–2 pack requires a much smaller apple. This pack is started by placing one apple in each lower corner and one in the center of the space between these two apples. Two apples are next placed, partly filling the cavities formed by the three apples. These two apples leave three cavities which are filled by three apples, etc., until the first layer is completed. In starting the second layer, two apples are used, then three, etc., thus filling the small pockets formed by the apples in the lower layer.

The 4–4 pack is the square pack (see Fig. 4). The apples must be of such a size that four of them just fit into the box across the end. These are placed, and then four more, etc., until the layer is completed. The next three or four layers are packed in the same way, which means that every apple except those in the upper layer of the box must bear the entire weight of one or more apples above it upon its cheek. This invariably means a blemish upon the cheek, which immediately lowers the price.

After the box is packed, a layer paper is placed upon it, the ends of the lining paper which have been hanging loose on the side are folded over the apples, the box taken to the box press, and the bottom nailed on. Box presses are upon the market and can be purchased very cheaply. Oftentimes they are made at home.

Boxes when piled upon each other should always be placed upon their sides. They pile better and the fruit is not damaged by this method.

The following score card, or some slight modification of it, is generally used for judging the box apples: —

Apples.		
Texture and flavor,	100	
Size,	100	
Color,	150	
Uniformity,	150	
Freedom from blemishes,	150	
	—	650
Package.		
Material,	30	
Marking,	10	
Solidity (nailing, cleats, etc.),	10	
	—	50
Packing.		
Bulge or swell,	100	
Alignment,	20	
Height of ends,	60	
Compactness,	80	
Attractiveness and style,	40	
	—	300
		1,000

Packing in Bushel Produce Boxes.

There has been up to the present time very little effort made to really pack apples in the produce box. The so-called jumble pack is the usual pack. A few of the growers of better grade apples have been "placing" their apples in boxes. This has meant selecting apples of a certain size which when placed

in rows in the box would just fit. Three such layers with or without layer paper have usually been placed in the package. Sometimes four layers are used.

The general use of the standard bushel produce box, with the certainty that it is likely to be used as a closed package within a few years for the shipping of McIntosh apples into adjoining States, makes it necessary for growers to practice a good system of packing. At present, because of the recent adoption of this type of practice, the writer, as well as the commercial growers, has no well-defined system. The system is likely to be worked out along one of the three following lines or, possibly, along all lines: —

A system at present in use with the large sized box, which without doubt can be worked with the standard produce box, is to use what is called a packing pad. This packing pad is nothing but a thin board covered frame which in turn is covered with heavy felt. The felt is cut of a size so that it just fits into the box. A four-sided box without top or bottom is laid upon this packing pad which is on the packing table. Apples are placed in stem end or cheek down in rows upon the felt. Care is usually taken to select a size so that a certain number will just fill a row, and give the same number of rows. The next layer of apples is placed in with the cheeks filling the holes formed by each three or four apples beneath. The remainder of the apples are placed in, being careful to fill all space well. As the box is being filled, it may be slightly racked, which tends to shake all apples down into the lowest holes. The top of the box is leveled off as best it can be by placing some apples on their cheeks and others upon their stem ends. These apples are used for near-by markets and are shipped in open packages; therefore, very little pressing should be necessary when nailing the solid bottom on. As soon as this is nailed on, the package is reversed and the packing pad removed; the package is now ready for market and presents a fine appearance. Those orchardists who have used this system or a modification of it report that it does not require much additional time and that the package will generally sell for 25 to 50 cents more, which pays them well for their time.

This system can be very easily modified for the packing of apples in closed packages for interstate or foreign trade. A packing pad is not needed. The bottom, which will be the permanent top, is nailed on first, instead of the permanent bottom. Corrugated layer paper is placed in the package, smooth side up. The remainder of the packing is done as suggested above, except that in smoothing the top off care should be exercised to get the level of the apples about one-third of an inch above top of box. A corrugated layer paper is placed on, and the top which will be the permanent bottom is pressed down with a box press. After the top is nailed the package is reversed, stenciled or marked, and is ready for long-distance shipment or storage.

The system of rowing apples and placing three or four such layers in the box, one apple upon the other, doubtless will be continued by apple growers when using the standard bushel box.

The jumble pack undoubtedly will be very generally used for packing the bulk of the apple crop in the standard bushel box. This pack should be greatly improved upon during the next few years. As practiced at present it consists of simply placing the apples in the packages by grades. The apples on the top are generally carefully placed so as to give a fairly level surface and good appearance. So far as possible, growers attempt to show the cheek of the apples.

Risers.

Risers are blocks or strips of wood nailed upon the ends of the boxes so that other boxes may safely be placed upon them without danger of bruising the apples. The size of the risers has varied from three-sixteenths of an inch to 2 inches in thickness. The growers are standardizing the size at present so that the larger share from now on will be of the five-eighths of an inch size.

Slats.

Slats are, as the name suggests, laths or thin narrow strips of board, and are nailed across the top of the box or on top of the risers. Two are ordinarily used, one on either side about 1 inch in from the side. If three or more slats are used, the package is deemed a closed package, and must conform to the Massachusetts apple grading law.

Chapter XI.

LAWS AND REGULATIONS ON APPLE GRADING AND PACKING.

WILFRID WHEELER AND H. LINWOOD WHITE. REVISED BY W. A. MUNSON.

INTRODUCTION.

The purpose of a grading law is to furnish a common denominator by which sellers and buyers may trade in a particular commodity in language which means the same thing to both of them. As long as each individual grower has his own idea of what is meant by a "Fancy," a "No. 1" or a "No. 2" apple, such a common denominator is, of course, impossible. Apple grading legislation has furnished this standard for the apple business.

The first grading law in the east was passed in Maine in 1910; this was followed by a law in New York in 1914; in Vermont, Connecticut and Massachusetts in 1915; and in New Hampshire in 1917. Apple grading laws have also been passed in ten or more other States.

This chapter contains the text of the United States Standard Barrel Law, the United States Apple Grading Law and the Massachusetts Apple Grading Law, and also the regulations which have been adopted by the Massachusetts Commissioner of Agriculture, under the authority granted by sections 105 and 110 of the last-named law. Cuts of model stencils will also be found on the following pages.

THE MASSACHUSETTS APPLE GRADING LAW.

The Massachusetts Apple Grading Law is an act to regulate the grading, packing, marking, shipping and sale of apples in closed packages. It applies to all apples in closed packages, packed or repacked in Massachusetts, and intended for sale either within or without the State, and also to apples grown in other

States when such apples are graded and branded as conforming to the Massachusetts standard.

The law, and the regulations authorized thereby, went into effect July 1, 1916. Slight amendments were made by the Legislatures of 1917 and 1918, and the law was codified in 1920.

The law provides a maximum penalty of $50 for the first violation and $200 for subsequent violation.

The regulations under the law appeared as of May 1, 1918, and July 1, September 19, and December 10, 1919.

UNITED STATES STANDARD BARREL LAW.

The Federal Standard Barrel Law was passed under the constitutional authority granted Congress by section 8 of Article I of the Constitution, giving authority to the Federal Congress to fix weights and measures. The law fixes a standard for the barrel just as standards are fixed for the quart, peck or bushel. This standard supersedes all State standards, but the specifications coincide with those of the Massachusetts standard barrel. This act is enforced by the Bureau of Standards of the Department of Commerce, and the regulations under it will be found in Bureau of Standards Circular No. 71, issued September 18, 1917.

UNITED STATES APPLE GRADING LAW.

The United States Apple Grading Law, popularly known as the "Sulzer Bill," is an optional law which defines three standard grades and provides a penalty for misbranding. The law applies only to apples intended for interstate commerce. In order to avoid the jurisdiction of the Massachusetts act, apples packed in this State must be intended for shipment in interstate commerce, and packed and branded in accordance with the Sulzer bill. The relation between the Sulzer bill and the Massachusetts law is laid down in section 114 of the Massachusetts law.

EXPLANATION OF REQUIREMENTS.

The specific requirements of the Massachusetts Apple Grading Law, the United States Standard Barrel Law so far as this applies to apple barrels, and the regulations, are herewith tabulated for ready reference.

"CLOSED PACKAGE" DEFINED.

Regulation No. 1. — A barrel, box or other container, the contents of which cannot be seen sufficiently for purposes of inspection without removing nails, wire, hoops or metal, cloth or paper strips, or similar seals or contrivances which cannot ordinarily be removed without mechanical assistance or without destroying the usefulness thereof, except that string or tape unless sealed shall not be considered as having been destroyed when cut, broken or removed, shall be a "closed package" within the meaning of the law.

The following kinds of containers are hereby declared to be "closed packages:" —

Barrels provided with the usual closely fitting heads.

Barrels covered with burlap or other material through which the apples cannot readily be seen.

Boxes, including covers, made entirely of close-fitting boards when the covers thereof are nailed or otherwise securely fastened.

Boxes or cartons of corrugated paper, cardboard, metal or other material, the covers of which are sealed or otherwise fastened in such a manner as to prevent opening without damaging either the fastener or the container.

Boxes with slatted covers are considered closed packages. The branding or marking of these boxes may be on sides, top, or on paper top under slats with printed matter showing through.

Baskets with slatted covers are considered closed packages. The branding or marking of these baskets may be on sides, top, or on paper top under slats with printed matter showing through.

Baskets, the covers of which are sealed or otherwise fastened in such a manner as to prevent opening without damaging either the fastener or the container.

"STANDARD BARREL" DEFINED.

Staves: length, $28\frac{1}{2}$ inches; thickness, not greater than $\frac{4}{10}$ of an inch.

Heads: diameter, inside of staves, $17\frac{1}{8}$ inches; distance between (inside measurement), 26 inches.

Bulge: circumference (outside measurement), 64 inches.

Capacity: 7,056 cubic inches.

Any barrel of a different form than this but of the same capacity, no matter what its dimensions, is a standard barrel. A flour barrel is a standard barrel.

Apples must not be sold or offered or exposed for sale in any barrel that is of less capacity than 7,056 cubic inches, except that subdivisions of the standard barrel known as the third, half and three-quarters barrel may be used, provided their

capacities, respectively, are at least one-third, one-half or three-quarters the capacity of the standard barrel (United States Standard Barrel Law).

"Standard Apple Box" defined.[1]

Length, 18 inches (inside measurement).
Width, $11\frac{1}{2}$ inches (inside measurement).
Depth, $10\frac{1}{2}$ inches (inside measurement).
Capacity, not less than $2{,}173\frac{1}{2}$ cubic inches.

A box of different dimensions or of a different capacity is *not* a standard box, but may be used for packing apples of standard grade for sale or distribution.

"Standard Grades" defined.

For purposes of comparison the requirements for the several grades are grouped below: —

Apples when sold, or offered or exposed for sale in closed packages and not conforming to the specifications for the "Fancy," "A" and "B" grades or, if conforming, not branded in accordance therewith, shall be classed as "Ungraded," and so branded.

	"Fancy."	"A."	"B."	Ungraded.
Variety,	Only one variety in the same package.	Only one variety in the same package.	Only one variety in the same package.	
Maturity,	Well matured but not over-ripe.	Well matured but not over-ripe.	Well matured but not over-ripe.	
How picked,	Hand-picked.			
Color,	Above medium in amount for the variety. Proportion of surface to be colored fixed by regulation (page 150).	Medium in amount for the variety. Proportion of surface to be colored fixed by regulation (page 151).	No color requirement.	
Shape,	Normal.	Normal.	Practically normal.	
Size,	Good and reasonably uniform. Minimum size to be stated on the package. Minimum for each variety determined by regulation (page 151).	Minimum size to be stated on package.	Minimum size to be stated on package.	Minimum size to be stated on package.

[1] This is not the Boston bushel box, the dimensions of which are $18 \times 18 \times 8$ and the capacity 2,592 cubic inches.

N.B. — There is no United States standard bushel box.

	"Fancy."	"A."	"B."	Ungraded.
Condition, . .	Sound.	Sound.		
Diseases and fungous injury.	Free from, such as scab, sooty fungus, cedar rust, etc.	Practically free from, such as scab, sooty fungus, cedar rust, etc.	Practically free from, such as scab, sooty fungus, cedar rust, etc.	
Insect injuries, .	Free from, such as result from codling moth, scale, curculio, etc.	Practically free from, such as result from codling moth, scale, curculio, etc.	Practically free from, such as result from codling moth, scale, curculio, etc.	
Bruises and other mechanical injuries.	Free from, except those resulting from packing.	Practically free from, except those resulting from packing.	Practically free from defects that materially injure the appearance or useful quality.	
How packed, .	Properly, in clean, strong packages. The fruit should be properly stemmed and tailed and the face or shown surface must be a fair representation of the contents. The specimens should be packed firmly but not bruised. Packages should be strong enough to prevent mechanical injury to the fruit in handling.	Properly. The face or shown surface must be a fair representation of the contents.	Properly. The face or shown surface must be a fair representation of the contents.	
Tolerance, . .	Apples, on any one defect, or on a combination of defects, may be not more than 3 per cent below specifications.	Apples, on any one defect, or on a combination of defects, may be not more than 5 per cent below specifications.	Apples, on any one defect, or on a combination of defects, may be not more than 10 per cent below specifications.	

Color in the Three Grades.

Regulation No. 2. — Color shall refer to amount and not to shade.

The color of apples branded "Massachusetts Standard Fancy Grade" shall cover at least 75 per cent of the surface in the case of red varieties, such as Baldwin, Tompkins King, Esopus Spitzenburg, Jonathan, McIntosh, Ben Davis, Sutton, Alexander, Wealthy, Fameuse, and the like; at least 60 per cent in the case of varieties having slightly less red color than the above, such as Hubbardston, Gravenstein, Northern Spy, Rome, Oldenburg, Wagener, and the like; and at least 10 per cent in the case of varieties having still less red color, such as Maiden Blush, Winter Banana, and the like. Yellow or green varieties, such as Rhode Island Greening,

Grimes Golden, Yellow Newtown, and the like, must have the characteristic green or yellow color of the variety; the presence or absence of a blush need not be considered.

The color of apples branded "Massachusetts Standard A Grade" shall cover at least 35 per cent of the surface in the case of red varieties, such as Baldwin, Tompkins King, Esopus Spitzenburg, Jonathan, McIntosh, Ben Davis, Sutton, Alexander, Wealthy, Fameuse, and the like; at least 20 per cent in the case of varieties having slightly less red color than the above, such as Hubbardston, Gravenstein, Northern Spy, Rome, Oldenburg, Wagener, and the like; and at least 5 per cent in the case of varieties having still less red color, such as Maiden Blush, Winter Banana, and the like. In the case of yellow or green varieties, the presence or absence of color need not be considered.

The presence or absence of color in the case of apples branded "Massachusetts Standard B Grade" need not be considered.

Minimum Sizes in the "Massachusetts Standard Fancy Grade."

Regulation No. 3. — The minimum sizes of apples sold as apples of "Massachusetts Standard Fancy Grade," when measured at right angles to the stem and blossom end, shall be as follows, for the several varieties: —

First Group: Diameter, 2½ inches; Fameuse (Snow), Golden Russet, Red Canada, Roxbury Russet, Williams, Yellow Transparent.

Second Group: Diameter, 2¾ inches; Baldwin, Ben Davis, Hubbardston, McIntosh, Oldenburg, Palmer Greening, Red Astrachan, Sutton, Wagener, Wealthy, Yellow Belleflower.

Third Group: Diameter, 3 inches; Fall Pippin, Gravenstein, King, Northern Spy, Rhode Island Greening, Rolfe, Rome Beauty.

Fourth Group: Diameter, 3¼ inches; Twenty Ounce, Wolfe River.

MARKS REQUIRED ON CLOSED PACKAGES.

Statement in a conspicuous place on the outside of the package in plain letters (not less than 36 point Gothic) of the —

1. **Place**: name of State in which the apples were grown.
2. **Grade**: legal designation.

Regulation No. 4. — The grade of apples contained in a package shall be indicated by the term "MASSACHUSETTS STANDARD FANCY GRADE," "MASSACHUSETTS STANDARD A GRADE," "MASSACHUSETTS STANDARD B GRADE," or "MASSACHUSETTS UNGRADED," as the case may be.

3. **Size**: minimum size in all grades. In the "Massachusetts Standard Fancy Grade" the minimum size must be not less than that specified in the regulations (see above). The abbreviation "Min." may be used for the word "minimum." Mini-

mum sizes shall be stated in variations of one-quarter of an inch, such as 2 inches, 2¼ inches, 2½ inches, 2¾ inches, 3 inches, 3¼ inches, and so forth, in accordance with the facts. Minimum sizes may be designated by figures instead of words.

4. **Contents**: *Barrel*, — quantity expressed by the term, "ONE STANDARD BARREL," or by a statement of the measure (the Massachusetts standard bushel of apples sold at retail is 48 pounds), or of the weight in pounds. The term "ONE STANDARD BARREL," or the abbreviation "ONE ST'D. BBL.," will be acceptable to the United States Department of Agriculture and the Division of Standards, Massachusetts Department of Labor and Industry, as a proper and sufficient statement of the contents of a barrel, regardless of whether it is sold at wholesale or retail in intrastate, interstate or foreign commerce. This term will be considered also as applying to the barrel itself. *Box*, — quantity expressed in terms of measure, weight or numerical count. In interstate commerce the marking to show merely the number of apples in a box is not sufficient; the minimum size of the apples must also be given (Opinion No. 61, Secretary of Agriculture, Washington, District of Columbia).

5. **Variety**: true name, that is, the name by which the variety is known on the market. Commercial abbreviations may be used. If not known the expression "VARIETY UNKNOWN" may be used.

6. **Packer**: name and address of person by whose authority the apples were packed or repacked. If repacked the package shall be so marked. (Name and address of farm will comply with this requirement.)

Order of Statements on Barrels.

Regulation No. 5. — The statements required by the law, and by the regulations adopted thereunder, shall appear on one end of the barrel in the following order: —

1. Name of the State in which the apples were grown.
2. Grade.
3. Minimum size.
4. Quantity of contents.
5. Variety.
6. Name and address of packer or repacker.

Regulation No. 6. — The word "MASSACHUSETTS" as used on packages containing apples grown in Massachusetts shall be considered as showing the State in which said apples were grown as well as applying to the grade.

Marking of Closed Packages.

Color of Ink to be used.

Regulation No. 7. — All letters and figures relating to grade or brand, including private marks, used in marking or branding a closed package packed in accordance with the provisions of the law shall be in ink of one color.

Barrels.

Only block letters and block figures of a size not less than

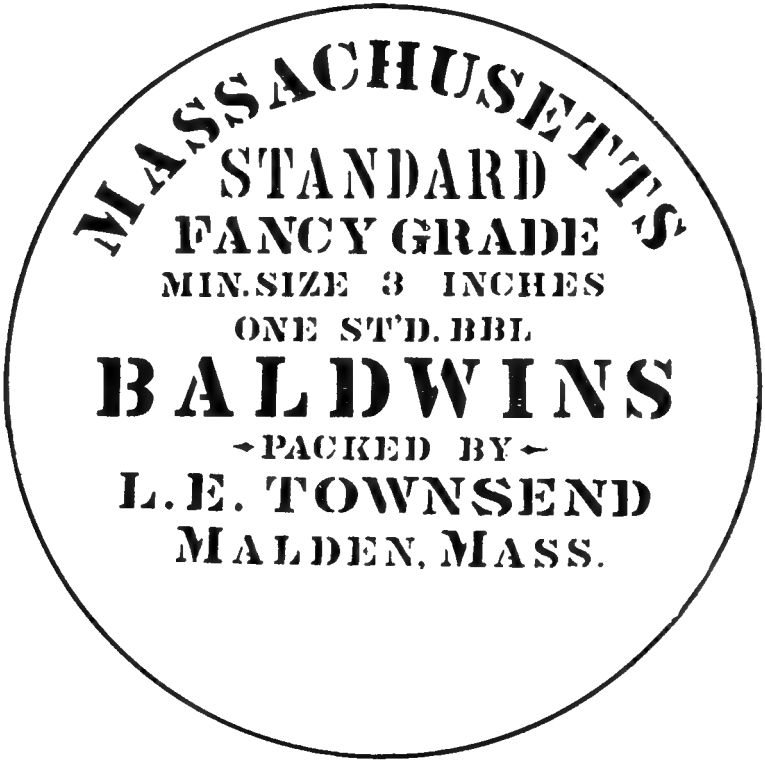
36 POINT GOTHIC

(one-half an inch high) may be used in stating on the outside the information required.

Covering Open Package.

Regulation No. 8. — Any person or firm who covers or authorizes to be covered an open package of apples consigned to them, which is intended for sale or distribution, or which is intended to be offered or exposed for sale or distribution, is considered to have repacked it; and such package must be branded in compliance with the Massachusetts Apple Grading Law, and must bear all statements required by sections 101, 102, 103 and 104, and in accordance with the provisions of section 105 of said law.

The following is a reduction of a photograph of a well-balanced barrel stencil. Notice that space is left at the bottom for name and address of consignee.



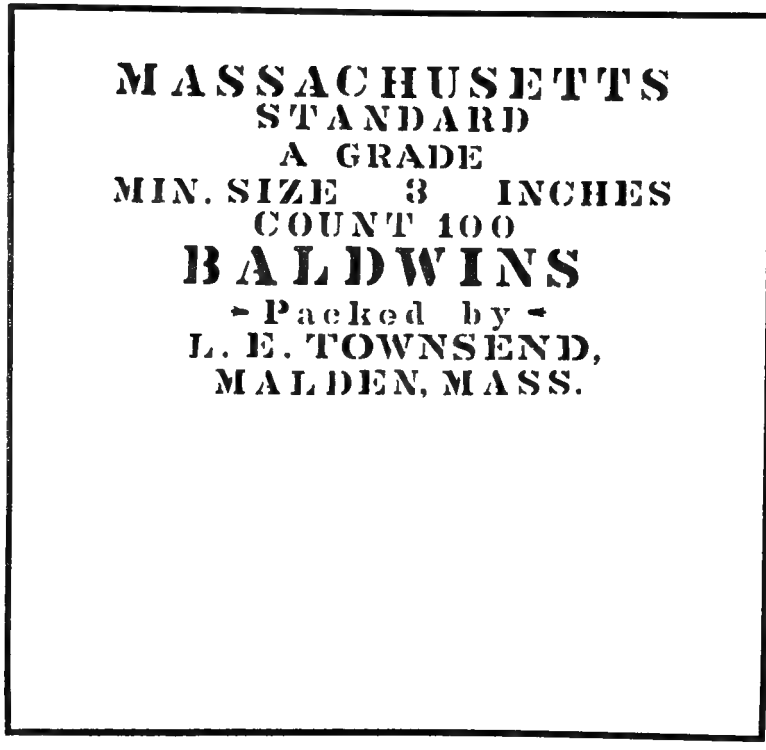
Another style of stencil is illustrated below. With the exception of the words "PACKED BY," the letters, before reduction, were all 36 point Gothic. This allows more space for other marks, but does not in any way alter the provision that such other marks as refer to grade or brand must *not* be more conspicuous than the marks required by law.

NOTE. — Where apples are marked "Ungraded," the word "standard" must be omitted.

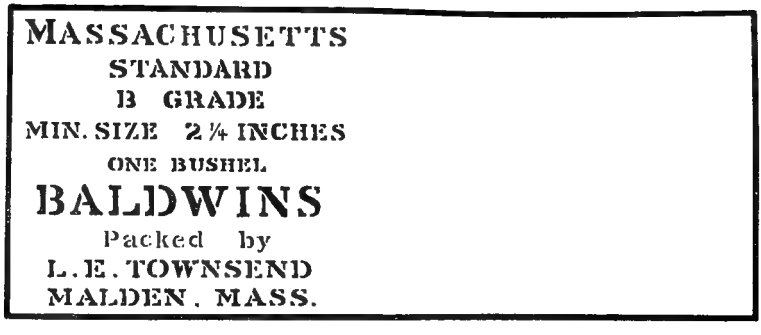
Packages Other than Barrels: How Branded.

Regulation No. 9. — The branding or marking of closed packages other than barrels shall be in letters and figures of such a size that the statements required by sections 103 and 104 of the law and by the regulations shall, when properly spaced, cover at least one-half the outside of one end of the package or at least one-half the label affixed thereto.

This is illustrated by the following: —



or



Other Marks.

The packer or distributor may put any marks on the package other than those required by law, provided, however, that such marks as relate to grade or brand are not inconsistent with, or more conspicuous than, the required marks. This gives an opportunity for the grower or packer to affix his own brand, or name of farm, and facts concerning the quality or other characteristics of the apples.

In the case of the type of label illustrated below, the brand is subordinated to the grade. The words "Townsend Farm," however, might be as conspicuous as the words "Massachusetts Standard Fancy Grade," but should not be more conspicuous. The name of the variety might be substituted for the word "Apples," and the label would then read, for example, "Townsend Farm Baldwins."

MASSACHUSETTS
STANDARD FANCY GRADE
TOWNSEND FARM
APPLES

GROWN AND PACKED BY
L.E.TOWNSEND
MALDEN, MASS. U.S.A.

VARIETY MIN. SIZE INCHES COUNT

Regulation No. 10. — Such marks as "No. 1's," "No. 2's," "XX," "XXX," "Extra," and the like shall not be used on closed packages.

Cold Storage Regulation.

Regulation No. 11. — In order that an inspection can be made of apples which have been in cold storage, as provided for in section 109 of the Massachusetts Apple Grading Law, owners of closed packages of Massachusetts apples in cold storage, who have not received a Massachusetts certificate of inspection, are hereby required to notify the Department of Agriculture of the intended date of removal of such apples.

APPENDIX.

UNITED STATES STANDARD BARREL LAW.

[PUBLIC — No. 307 — 63D CONGRESS.]
[H. R. 4899.]

AN ACT TO FIX THE STANDARD BARREL FOR FRUITS, VEGETABLES, AND OTHER DRY COMMODITIES.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the standard barrel for fruits, vegetables, and other dry commodities other than cranberries shall be of the following dimensions when measured without distention of its parts: Length of stave, twenty-eight and one-half inches; diameter of heads, seventeen and one-eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty-four inches, outside measurement; and the thickness of staves not greater than four-tenths of an inch: *Provided,* That any barrel of a different form having a capacity of seven thousand and fifty-six cubic inches shall be a standard barrel. The standard barrel for cranberries shall be of the following dimensions when measured without distention of its parts: Length of staves, twenty-eight and one-half inches; diameter of head, sixteen and one-fourth inches; distance between heads, twenty-five and one-fourth inches; circumference of bulge, fifty-eight and one-half inches, outside measurement; and the thickness of staves not greater than four-tenths of an inch.

SECTION 2. That it shall be unlawful to sell, offer, or expose for sale in any State, Territory, or the District of Columbia, or to ship from any State, Territory, or the District of Columbia to any other State, Territory, or the District of Columbia or to a foreign country, a barrel containing fruits or vegetables or any other dry commodity of less capacity than the standard barrels defined in the first section of this Act, or subdivisions thereof known as the third, half, and three-quarters barrel, and any person guilty of a willful violation of any of the provisions of this Act shall be deemed guilty of a misdemeanor and be liable to a fine not to exceed $500, or imprisonment not to exceed six

months, in the court of the United States having jurisdiction. *Provided, however,* That no barrel shall be deemed below standard within the meaning of this Act when shipped to any foreign country and constructed according to the specifications or directions of the foreign purchaser if not constructed in conflict with the laws of the foreign country to which the same is intended to be shipped.

SECTION 3. That reasonable variations shall be permitted and tolerance shall be established by rules and regulations made by the Director of the Bureau of Standards and approved by the Secretary of Commerce. Prosecutions for offenses under this Act may be begun upon complaint of local sealers of weights and measures or other officers of the several States and Territories appointed to enforce the laws of the said States or Territories, respectively, relating to weights and measures: *Provided, however,* That nothing in this Act shall apply to barrels used in packing or shipping commodities sold exclusively by weight or numerical count.

SECTION 4. That this Act shall be in force and effect from and after the first day of July, nineteen hundred and sixteen.

Approved, March 4, 1915.

UNITED STATES APPLE GRADING LAW.

"THE SULZER BILL."

[PUBLIC — No. 252 — 61ST CONGRESS.]
[H. R. 21480.]

AN ACT TO ESTABLISH A STANDARD BARREL AND STANDARD GRADES FOR APPLES WHEN PACKED IN BARRELS, AND FOR OTHER PURPOSES.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the standard barrel for apples shall be of the following dimensions when measured without distention of its parts: Length of stave, twenty-eight and one-half inches; diameter of head, seventeen and one-eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty-four inches outside measurement, representing as nearly as possible seven thousand and fifty-six cubic inches: *Provided,* That steel barrels containing the interior dimensions provided for in this section shall be construed as a compliance therewith.

SECTION 2. That the standard grades for apples when packed in barrels which shall be shipped or delivered for shipment in

interstate or foreign commerce, or which shall be sold or offered for sale within the District of Columbia or the Territories of the United States shall be as follows: Apples of one variety, which are well-grown specimens, hand picked, of good color for the variety, normal shape, practically free from insect and fungous injury, bruises, and other defects, except such as are necessarily caused in the operation of packing, or apples of one variety which are not more than ten per centum below the foregoing specifications shall be "Standard grade minimum size two and one half inches," if the minimum size of the apples is two and one half inches in transverse diameter; "Standard grade minimum size two and one-fourth inches," if the minimum size of the apples is two and one-fourth inches in transverse diameter; or "Standard grade minimum size two inches," if the minimum size of the apples is two inches in transverse diameter.

SECTION 3. That the barrels in which apples are packed in accordance with the provisions of this Act may be branded in accordance with section two of this Act.

SECTION 4. That all barrels packed with apples shall be deemed to be below standard if the barrel bears any statement, design, or device indicating that the barrel is a standard barrel of apples, as herein defined, and the capacity of the barrel is less than the capacity prescribed by section one of this Act, unless the barrel shall be plainly marked on end and side with words or figures showing the fractional relation which the actual capacity of the barrel bears to the capacity prescribed by section one of this Act. The marking required by this paragraph shall be in block letters of size not less than seventy-two point one inch gothic.

SECTION 5. That barrels packed with apples shall be deemed to be misbranded within the meaning of this act —

First. If the barrel bears any statement, design, or device indicating that the apples contained therein are "Standard" grade and the apples when packed do not conform to the requirements prescribed by section two of this Act.

Second. If the barrel bears any statement, design, or device indicating that the apples contained therein are "Standard" grade and the barrel fails to bear also a statement of the name of the variety, the name of the locality where grown, and the name of the packer or the person by whose authority the apples were packed and the barrel marked.

SECTION 6. That any person, firm or corporation, or association who shall knowingly pack or cause to be packed apples

in barrels or who shall knowingly sell or offer for sale such barrels in violation of the provisions of this Act shall be liable to a penalty of one dollar and costs for each such barrel so sold or offered for sale, to be recovered at the suit of the United States in any court of the United States having jurisdiction.

SECTION 7. That this Act shall be in force and effect from and after the first day of July, nineteen hundred and thirteen.

Approved, August 3, 1912.

MASSACHUSETTS APPLE GRADING LAW.

GENERAL LAWS, CHAPTER 94.

INSPECTION AND SALE OF FOOD, DRUGS, AND VARIOUS ARTICLES.

Sections 1 (part), 100 to 107, inclusive, 109 to 114, inclusive.

"Closed Package" defined.

SECTION 1. . . . "Closed package" in sections one hundred to one hundred and seven, inclusive, one hundred and nine, one hundred and ten, one hundred and twelve and one hundred and thirteen, shall mean a barrel, box, or other container, the contents whereof cannot be sufficiently inspected without opening it. . . .

Standard Barrel and Box for Apples.

SECTION 100. The standard barrel for apples shall be of the following dimensions when measured without distension of its parts: length of stave, twenty-eight and one half inches; diameter of heads, seventeen and one eighth inches; distance between heads, twenty-six inches; circumference of bulge, sixty-four inches, outside measurement; and the thickness of staves not greater than four tenths of an inch: *provided*, that any barrel of a different form having a capacity of seven thousand and fifty-six cubic inches shall be a standard barrel.

The standard box for apples shall be of the following dimensions by inside measurement: eighteen inches by eleven and one half inches by ten and one half inches, without distention of its parts; and shall have a capacity of not less than two thousand one hundred and seventy-three and one half cubic inches.

Standard Grades of Apples.

SECTION 101. The standard grades of apples when packed or repacked in closed packages within the commonwealth shall be as follows: "Massachusetts Standard Fancy" shall include only

apples of one variety which are well matured specimens, hand-picked, above medium color for the variety, normal shape, of good and reasonably uniform size, sound, free from disease, insect and fungous injury, bruises and any other defects except such as are necessarily caused in the operation of packing, and shall be packed properly in clean, strong packages; *provided*, that apples of one variety which are not more than three per cent below the foregoing specifications may be graded as "Massachusetts Standard Fancy".

"Massachusetts Standard A" shall include only apples of one variety which are well matured specimens, properly packed, of medium color for the variety, normal shape, sound, practically free from disease, insect and fungous injury, bruises and other defects except such as are necessarily caused in the operation of packing; *provided*, that apples of one variety which are not more than five per cent below the foregoing specifications may be graded as "Massachusetts Standard A".

"Massachusetts Standard B" shall include only apples of one variety, which are well matured, properly packed, practically normal shape, practically free from disease, insect and fungous injury or any other defect which materially injures the appearance or useful quality of the apples, but they may be less than medium color for the variety; *provided*, that apples of one variety which are not more than ten per cent below the foregoing specifications may be graded as "Massachusetts Standard B".

Apples not conforming to the foregoing specifications of grade, or, if conforming, not branded in accordance therewith, shall be classed as ungraded and so branded.

Other Designations Forbidden.

SECTION 102. The marks indicating the grade, as described in the preceding section, shall not be accompanied by any other designation of grade or brand which is inconsistent with, or marked more conspicuously on the package than, the marks required by section one hundred and four.

Minimum Size. Term defined, etc.

SECTION 103. The minimum size of all apples in all grades, including ungraded apples as defined in section one hundred and one, shall be marked upon the package, and shall be determined by taking the transverse diameter of the smallest fruit in the

package at right angles to the stem and blossom end. Minimum sizes shall be stated in variations of one quarter of an inch, such as two inches, two and one quarter inches, and so forth, in accordance with the facts. Minimum sizes may be designated by figures instead of words. The word "minimum" may be designated by using the abbreviation "min."

Certain Information to be marked on Closed Packages of Apples.

SECTION 104. Each closed package of apples packed or repacked within the commonwealth and intended for sale within or without the commonwealth, shall have marked in a conspicuous place on the outside of the package in plain letters a statement of the quantity of the contents, the name and address of the person by whose authority the apples were packed, the true name of the variety, and the grade and minimum size of the apples contained therein, in accordance with sections one hundred and one and one hundred and three, and the name of the state where they were grown. If the true name of the variety is not known to the packer or other person by whose authority the apples are packed, the statement shall include the words "variety unknown", and if the name of the state where the apples were grown is not known, this fact shall also be set forth in the statement. If apples are repacked, the package shall be marked "repacked", and shall bear the name and address of the person by whose authority it is repacked, in place of that of the person by whose authority they were originally packed.

Branding and Marking of Barrels.

SECTION 105. The branding or marking of barrels under sections one hundred and one to one hundred and seven, inclusive, and one hundred and twelve shall be in block letters and figures of a size not less than thirty-six point Gothic. The commissioner of agriculture shall prescribe rules and regulations as to the lettering to be used in branding or marking other closed packages.

Adulterated Apples. Term defined.

SECTION 106. For the purposes of sections one hundred to one hundred and seven, inclusive, one hundred and nine, one hundred and ten, one hundred and twelve and one hundred and thirteen, apples packed in a closed package shall be deemed to be adulterated if their measure, quality or grade does not con-

form in each particular to the brand or mark upon or affixed to the package, or if the faced or shown surface gives a false representation of the contents of the package

Misbranded Apples. Term defined.

SECTION 107. For the purposes of sections one hundred to one hundred and seven, inclusive, one hundred and nine, one hundred and ten, one hundred and twelve and one hundred and thirteen, apples packed in a closed package shall be deemed to be misbranded:

First. If the package is packed or repacked in the commonwealth and fails to bear all statements required by sections one hundred and one, one hundred and three and one hundred and four, made as required in section one hundred and five.

Second. If the package, whether packed or repacked within or without the commonwealth, is falsely branded or bears any statement, design or device, regarding the apples contained therein, which is false or misleading, or if the package bears any statement, design or device indicating that the apples contained therein are of a specified Massachusetts standard grade, and said apples, when packed or repacked, do not conform to the requirements prescribed for such grade.

Sale of Cold-storage Apples regulated.

SECTION 109. Apples which have been in cold storage shall not be sold or distributed, or offered or exposed for sale or distribution, in closed packages until they have been inspected in accordance with rules and regulations prescribed by the commissioner of agriculture.

Commissioner of Agriculture to make Rules and may enter Certain Places.

SECTION 110. The commissioner of agriculture shall make and may modify rules and regulations for enforcing sections one hundred to one hundred and seven, inclusive, one hundred and nine and one hundred and twelve, and shall, either in person or by his assistant, have free access at all reasonable hours to each building or other place where apples are packed, stored, sold, or offered or exposed for sale. He may also, in person or by his assistant, open each box, barrel or other container, and upon tendering the market price may take samples therefrom.

Prosecution for Violation of Certain Sections.

SECTION 111. The commissioner of agriculture and his duly authorized assistants shall have authority to enforce sections one hundred to one hundred and seven, inclusive, one hundred and nine and one hundred and twelve, and to prosecute all violations thereof.

Penalty for Adulterating, Misbranding, etc., Apples.

SECTION 112. Whoever adulterates or misbrands apples within the meaning of sections one hundred and one to one hundred and seven, inclusive, and one hundred and nine, or packs, repacks, sells, distributes or offers or exposes for sale or distribution, apples in violation of any provision of sections one hundred and one to one hundred and seven, inclusive, one hundred and nine and one hundred and thirteen, or apples so adulterated or misbranded, or wilfully alters, effaces or removes, or causes to be altered, effaced or removed, wholly or partly, any brands or marks required to be put upon any closed package under section one hundred and four, shall be punished for the first offence by a fine of not more than fifty dollars, and for a subsequent offence by a fine of not more than two hundred dollars.

Certain Exemptions from Penalties.

SECTION 113. No person who sells or distributes or offers or exposes for sale or distribution apples adulterated or misbranded within the meaning of sections one hundred and six and one hundred and seven, shall be deemed to have violated any of the provisions of sections one hundred to one hundred and seven, inclusive, one hundred and nine and one hundred and twelve if it appears that he acted in good faith solely as a distributor, or if he furnishes a guaranty signed by the person from whom he received the apples, together with the address of such person, that the apples are not adulterated or misbranded within the meaning of said sections. In such case, the person from whom the distributor received the apples shall be liable for the acts of the distributor, if he relied upon the guaranty, to the same extent that the distributor would have been liable under said sections.

Apples in Interstate Commerce exempted.

SECTION 114. Apples shipped in the course of interstate commerce and packed and branded in accordance with the act of congress approved August third, nineteen hundred and twelve, and known as "The United States Apple Grading Law", shall be exempt from sections one hundred and one to one hundred and seven, inclusive, one hundred and nine, one hundred and ten, one hundred and twelve and one hundred and thirteen.

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