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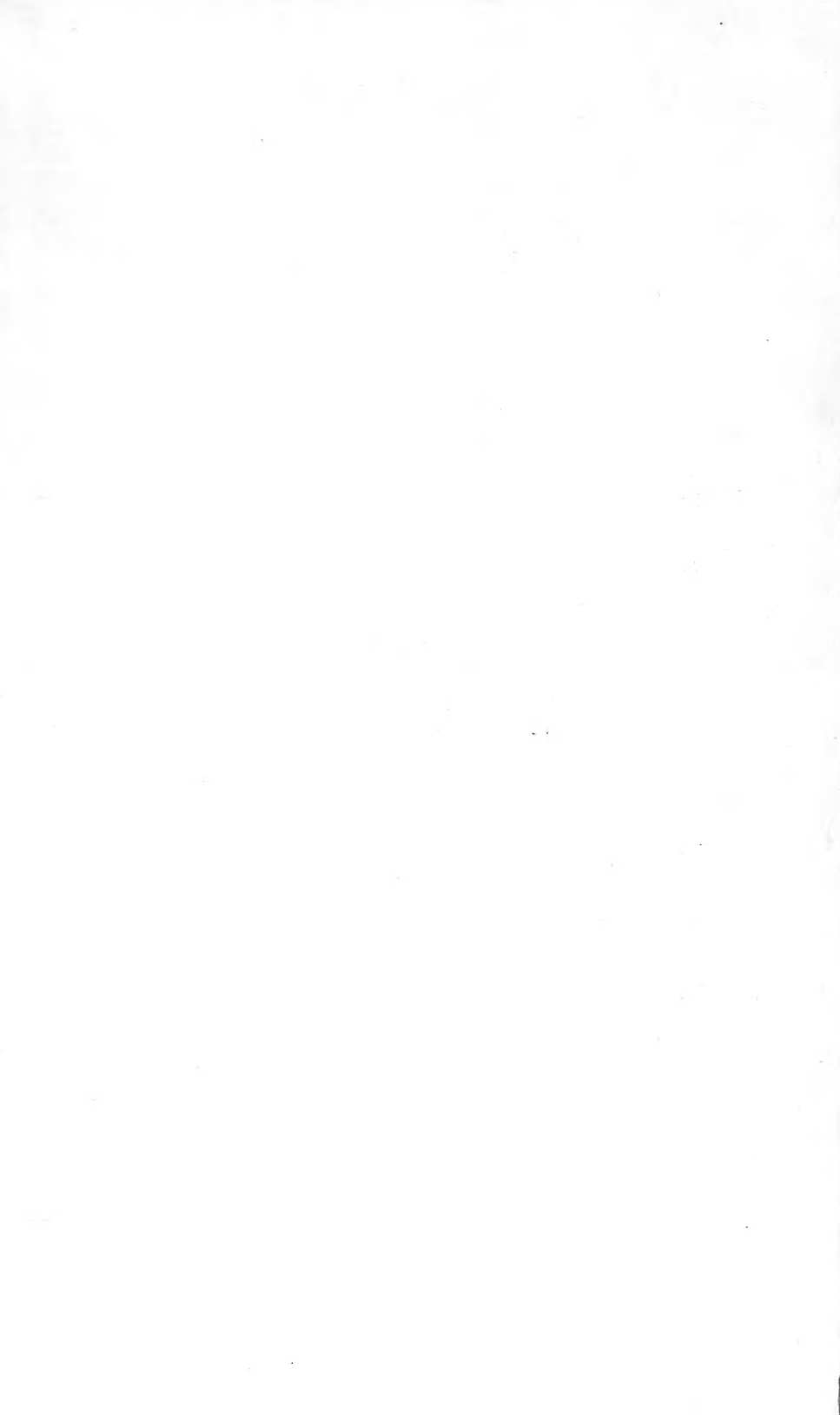
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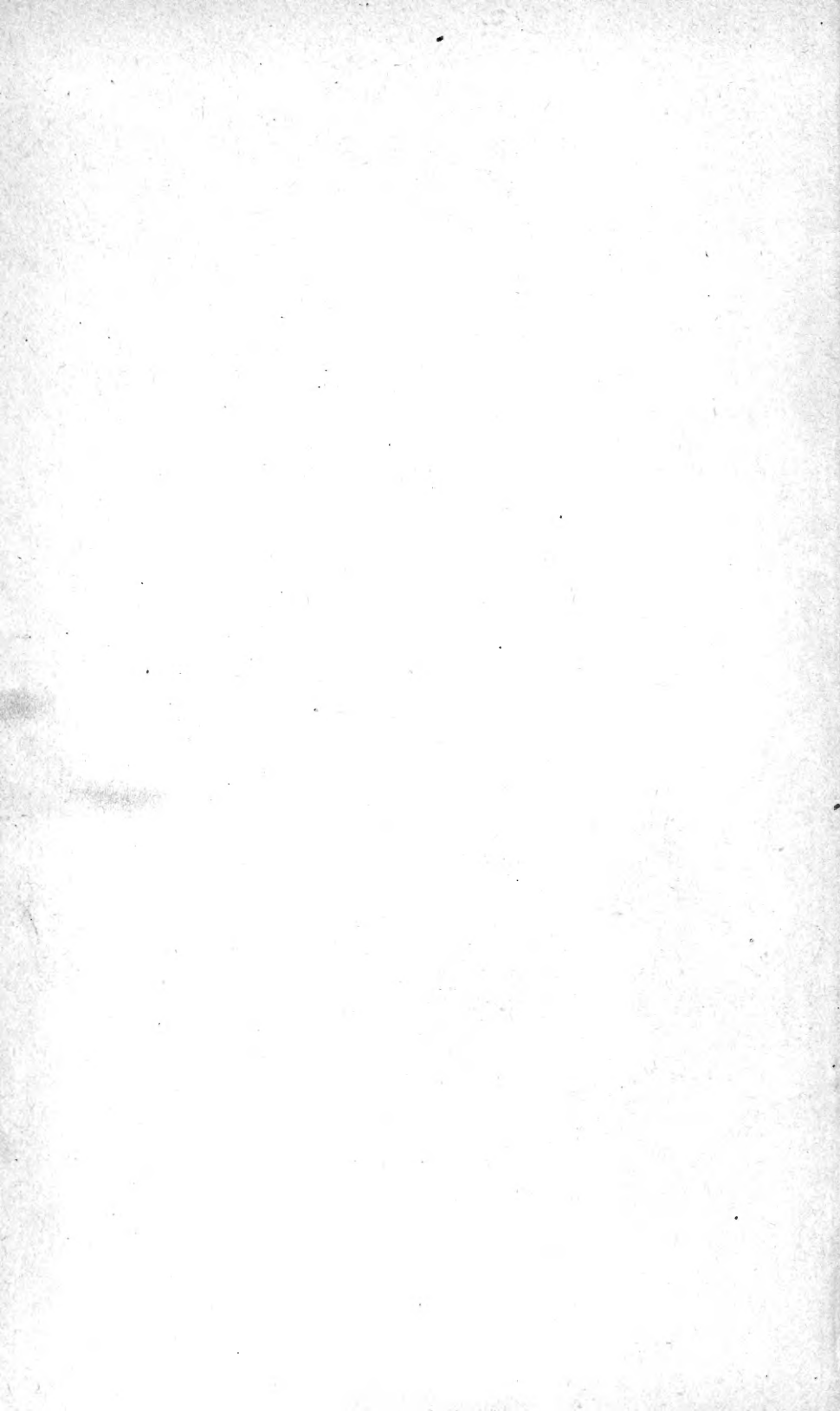
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UNIVERSITY OF ILLINOIS
Agricultural Experiment Station.

URBANA, APRIL, 1900.

BULLETIN No. 59.

ORCHARD MANAGEMENT.

The Agricultural Experiment Station of the University of Illinois has been closely studying the fruit interests of the state, and especially during the last three years attention has been directed to the actual needs and conditions of orchards and other fruit plantations of the commonwealth. During this time visits have been made to many fruit plantations in 64 of the 102 counties of Illinois. During the past year a representative of this Station personally visited a number of fruit areas in ten counties of southern Illinois; seven in central and western Illinois; and seven in northern Illinois. The apple received more thought and study than any of the other Illinois fruits, for in the southern third of the state it is the main fruit crop, while in central and northern Illinois it has a large and increasing place with the landholding class. Not only is the apple the leading fruit of the state, but no crop, whether grown by farmer or commercial orchardist is so universally uncared for as is this king of fruits. This fact is due in great measure to negligence, yet in many instances to lack of proper knowledge of the fundamental principles of orcharding. This bulletin has therefore been written for the Illinois farmers and fruit growers with the hope that its contents may awaken and encourage a new interest in this subject, and also with the purpose of presenting the latest and best teaching on the different phases of orchard management.

Soil and climatic conditions vary so greatly in the state, and sometimes even within the same county that no attempt will be made to lay down specific and definite rules. General principles will therefore be discussed, the operator being left to apply them with such modifications as are necessary to meet his own peculiar or local conditions.

REASONS FOR UNPRODUCTIVE ORCHARDS.

Observations and studies carried on in these many fruit plantations above referred to, and also on the Experiment Station grounds at Champaign leads the Station to offer the following as some of the many reasons why the Illinois orchards are often unproductive.

(1) Too many growers are expecting a crop to be given them without putting forth any efforts themselves after the trees have been set. The apple trees require the same careful attention as do other farm crops.

(2) Lack of moisture is a common cause of failure to the apple grower in this state, especially in southern Illinois. This is because grass and other crops are allowed to compete with the trees for the moisture supplied by rains. Water is just as essential to the apple tree on a hot summer's day as it is to the laborer in the harvest field.

(3) Injuries resulting from attacks of insects or of fungus diseases are a very common cause of failure. These depredators will probably always consider that they have as much right to the products of the farm as does the farmer himself. For this reason he must get his artillery and ammunition and fight the enemy.

(4) Lack of fertility is a very common cause of failure in southern, western, and some sections of northern, Illinois. The apple orchard can not produce a profitable crop unless provided with an ample supply of nitrogen, potash, and phosphoric acid.

(5) Some orchards in this state which have come to the notice of this Station are unprofitable because of improper pruning or lack of pruning. Light and air are essential for the development and ripening of the apple.

(6) Many varieties of apple trees have been planted without any thought given to their adaptability to the particular soil or climate. Loss in apple growing is often wholly a matter of varieties.

(7) Trees propagated from unproductive stock have been responsible for many failures. Scions should be selected from bearing trees or those which have demonstrated their ability for productiveness.

(8) Sterility as a result of planting an orchard of only one variety is a common cause of failure, in part at least. Cross fertilization is desirable with all fruits.

(9) Excessive climatic conditions, as the February freeze of 1899, or the killing of the blossoms by frost, are oftentimes responsible for unproductiveness.

ORCHARD CULTIVATION.

The orchardist should cultivate his orchard for the same reason that the dairyman feeds and waters his herd. This is because all forms of life are fundamentally of one character. In other words there is a common basis of life existing among all living beings—and this common unity is found to exist in the protoplasm (the living active principle) of the cells which make up these beings. All work, therefore, whether it be the developing of an apple or the secreting of milk, implies waste and this waste is directly or indirectly that of protoplasm. The protoplasm of plants is made out of mineral compounds while protoplasm of animals is made from plants. This then is a difference between the two, yet their composition is alike. All this is only another way of saying that all labor expended, even in maintaining life, means a loss of vital force which must be supplied. The dairyman's herd would not be productive were not this waste supplied in the form of food and water. Left to themselves as were the buffalos, they doubtless could maintain life. So with the orchard; if left to itself, as is often the case, it may live and even produce fruit. But if it is to be productive in a commercial sense, it must be liberally fed and watered. This is best and most economically done by good cultivation. Cultivation, then, is the first and fundamental principle which needs not even the exception to prove it a positive rule for successful orcharding.

All intelligent cultivation of the orchard rests upon the fact that the soil is a storehouse of plant food and also a reservoir for catching and holding water. If the orchard is not cultivated the root system of the trees can not penetrate deeply into the soil for its food and water supply. The first great benefit, therefore, coming from this operation is the pulverizing of the soil, thus giving a greater root-feeding area and at the same time deepening the soil itself. All of this implies an early warming and drying of the soil in the springtime, because when the texture of the soil is poor, that is, when the soil particles become cemented together as the result of heavy rains or injudicious plowing, the land is cold and the root system can not penetrate it or even appropriate the plant food within reach. This pulverizing of the soil also means a lessening of the extremes of temperature and moisture. The first great office of tillage then is that of improving the mechanical condition or the texture of the soil. For this reason this Station is opposed to the application of fertilizers to orchard soils until the land has been so improved in its physical condition that the plant can use what is already in the soil.

The second great office of cultivation is that of supplying or saving the moisture which is needed in such large quantities by orchard fruits. Nature annually supplies the Illinois farmer with an abundance of water for his crops, but the trouble seems to be that the supply comes at a



FIGURE NO. 1.

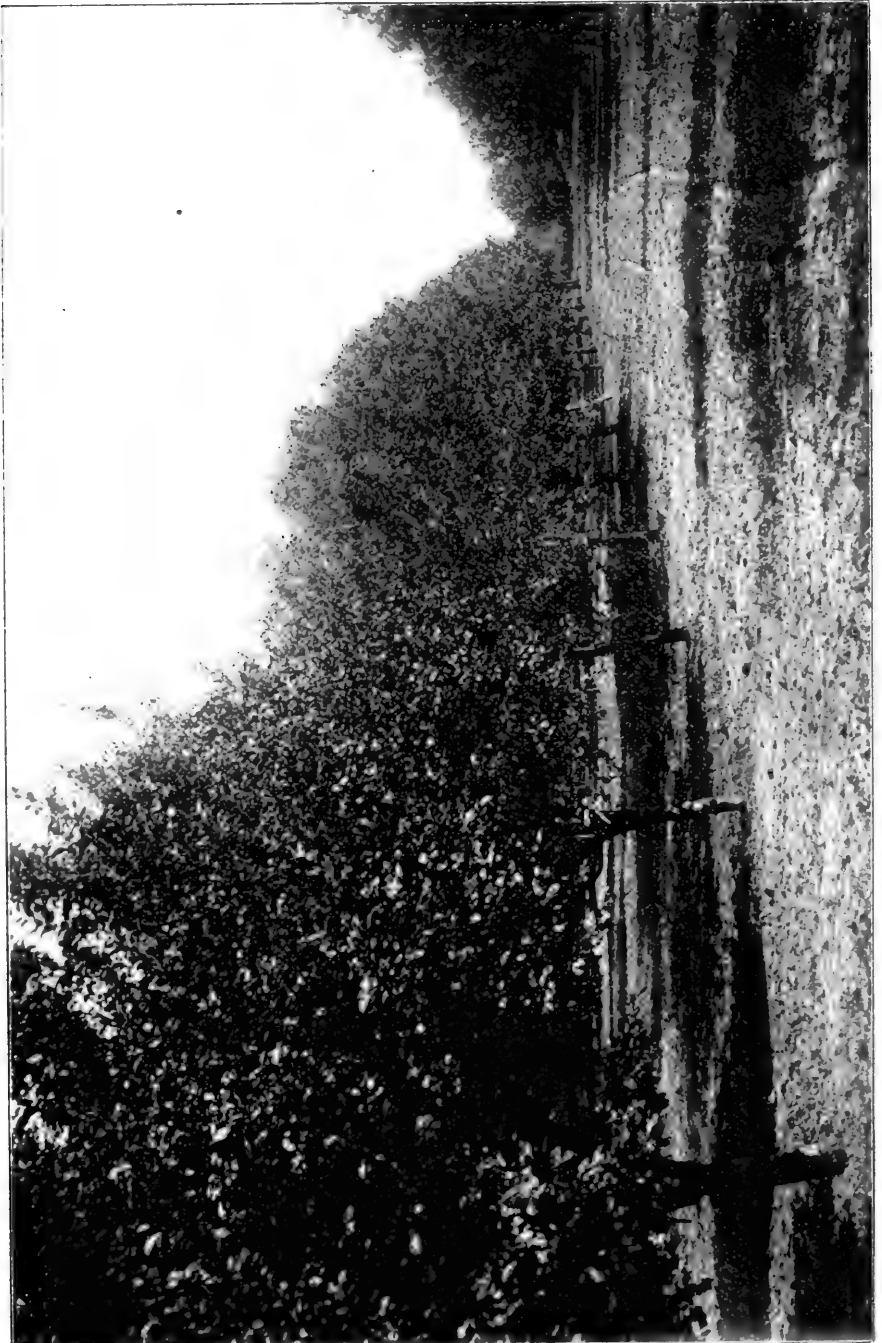


FIGURE NO. 2.

time when least needed. A little investigation, however, readily shows us that this supply should come mainly when the plants are inactive. Further, that because of its physical possibilities the soil can be made to retain this water until needed during the dry summer months. It is a fact that the soil particles hold water in the form of a film on their surface. The surface area of these particles depends on their number or the fineness of the soil. This is readily seen by comparing a cubic foot of marbles 1 inch in diameter with a cubic foot composed of particles $\frac{1}{1000}$ of an inch in diameter. In the first we have an aggregate surface area, according to King, of 27.7 square feet, in the latter instance of 37,700 square feet. This fining of the soil is secured by thorough drainage, hand in hand with judicious and careful cultivation of the soil. If the soil is not well drained naturally, it should be tile-drained, as this is the greatest corrective of hard, impervious soils. It is this removal of superfluous water that prevents the soil particles from cementing together in wet weather and that allows the moisture to come from greater depths to the surface where plants may use it during the dry months.

But this increasing of the water-holding capacity of the soil must be supplemented by a retentive force which will check capillarity at the surface of the soil. The water moves by capillary attraction to the surface where it is evaporated—explained in the same manner as the upward movement of oil in the lamp-wick, or of ink in the blotting-pad. By the breaking up of these capillary spaces next the surface, evaporation will be checked. In the same way a mulching of the surface prevents evaporation. No mulch is so good and economical as a dust mulch procured by cultivation. This same operation having broken up the capillary pores conserves the moisture by checking the evaporation. But it is useless to commence this checking process late in the season when drought is already apparent. No amount of cultivation at this time can correct the fault which should have been prevented weeks before. The careful orchardist will cultivate early in the spring—or as soon as the land will permit it—repeating the operation at least once a week, unless frequent rains should make such an operation needless. As soon as a shower has passed and the land has become crusted and dry on top the harrow should be put to work remaking this dust mulch. Cultivation should commence early in the season, but can usually be stopped early in August, at which time the trees have completed their growth and have commenced to ripen up their wood and fruit prior to the inactivity of winter. At this time much will be gained by a cover crop—the cow pea, vetch, or clover being used as a rule. These cover crops are valuable because they hold the soil in the best physical condition and prevent some of the plant food from escaping, as well as add positive fertility to the soil when plowed under in the

spring. Such crops serve to catch and retain the snow—an important winter protection.

There is still another benefit derived from orchard cultivation—that of increasing the chemical activities of the soil. Air and warmth are just as essential to the chemical processes going on within the soil as is water. The soil is full of minute organisms increasing the necessary nitrates and other food materials required by the plant. Such activities are greatly decreased and sometimes prevented because of lack of cultivation. Cultivation would have supplied the air and warmth and consequent food supply for the plant.

If these statements are true—and both science and practice prove they are—what then is the proper treatment of the soil for the Illinois orchard during its lifetime? The ground should be in a thorough state of cultivation at the time the trees are set, and during the first year no crop should come within three feet of the young tree—this space to widen each year. If the soil has been subsoiled and deeply pulverized the root system will go far down; at least the tendency will be in that direction. On the intervening spaces between these trees should be grown some secondary crop and one which admits of cultivation. This method allows the orchardist to get a paying return from his land while the trees are establishing themselves. But in no instance should a crop for the crop's sake be taken from the orchard after the trees have come into bearing. The greatest difficulty in fruit growing in Illinois has arisen from the fact that these annual returns have enticed the orchardist away from the primary object of the plantation, which is fruit growing. The yearly growing of corn or grain or of a hay crop (Fig. 1) forgetting to care for the trees themselves, would cause an ultimate loss in fruit production ten times greater than the gain derived from the annual secondary crops. But you say—the corn plant shades the ground and therefore prevents evaporation of soil moisture. Did you ever stop to think that the transpiration of moisture from the leaf surface of the corn is greater twice over than that lost by evaporation, from the soil, with the poorest system of cultivation? Now soil, in order to do its best work, that is supply the paying quantities of plant food, must be within 40 % to 50 % of saturation. Or—to state the point another way—the normal soil to the depth of one foot in good state of cultivation contains about 4000 barrels of water per acre. The corn transpires from its leaf surface about 200 tons of water for each ton of dry matter produced. This means a loss of more than 100 gallons of water a day per acre during the corn growing season. The apple tree on the other hand, according to carefully conducted experiments by Anders and Dr. Burrill, transpires 250 gallons, or if there are 35 trees per acre, which is 35 feet apart each way, 8750 gallons in 24 hours from every acre. The enormous quantity of water taken up and given off by our apple trees requires a careful con-

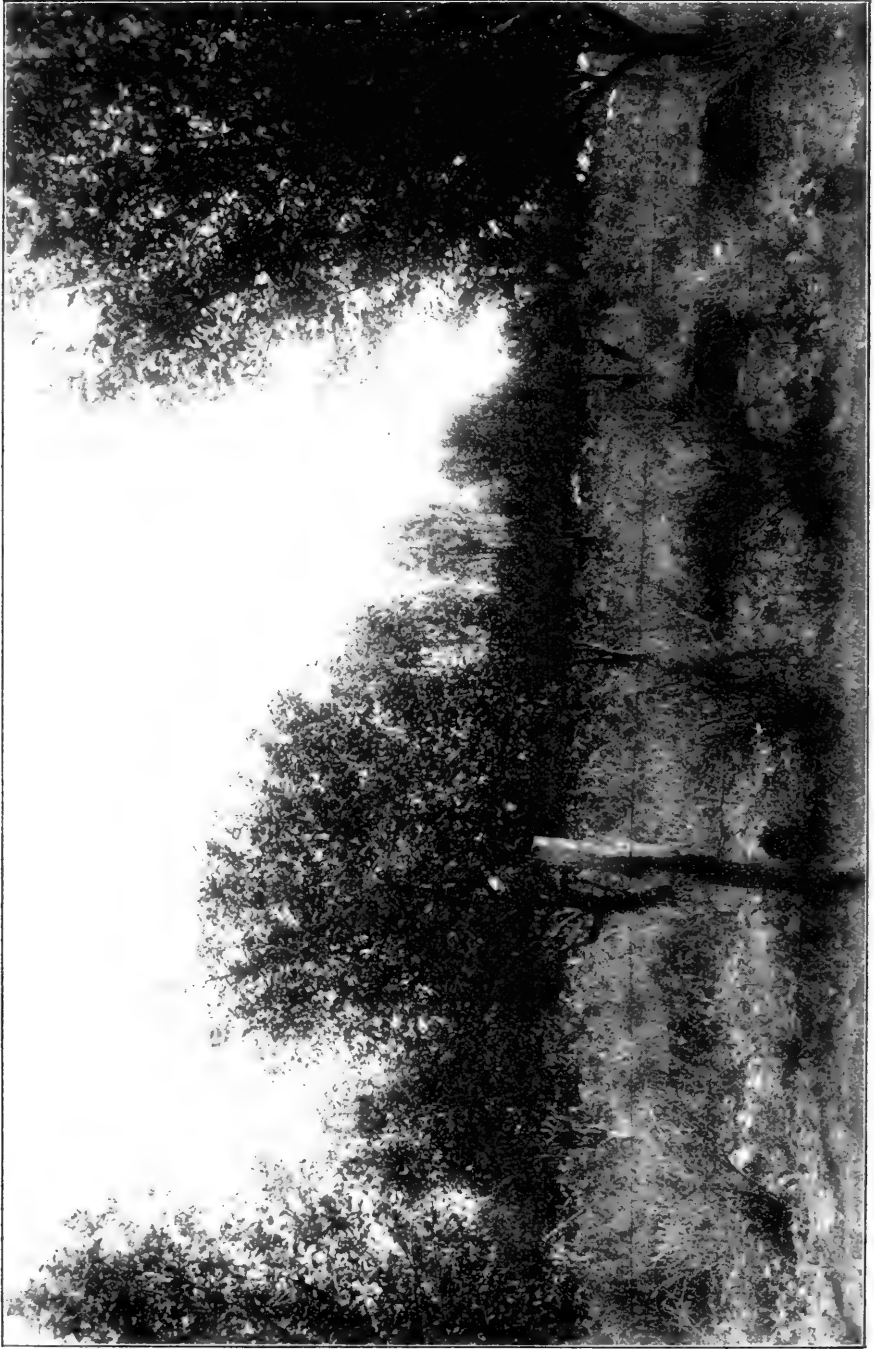


FIGURE NO. 3.

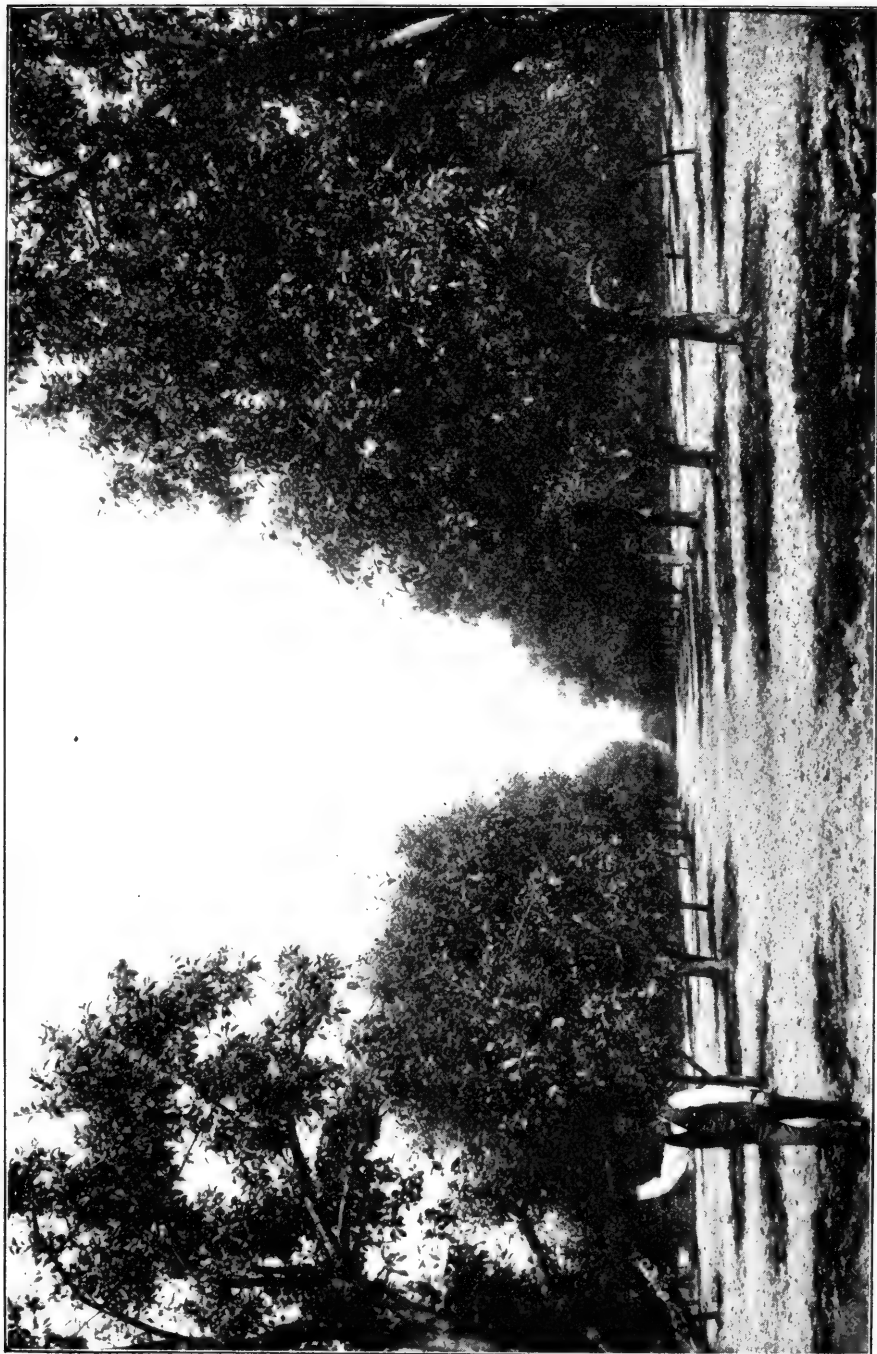


FIGURE No. 4.

servicing or retaining of the water which nature furnishes early in the season. If then we grow corn in the orchard expecting thereby to aid in this supply we are deceiving ourselves and robbing the trees and consequently robbing our bank deposits as well.

But the fact should be emphasized that the success of the orchard or the degree of profit returned from the investment will be measured more accurately by the thoroughness of the early treatment of the orchard than by anything else. These arguments are not intended for the dairyman or stock raiser who uses his land primarily for pasture or hay and whose orchard is simply a secondary or catch-crop consideration. If such a man secures paying returns by these other avenues of production, certainly he is entitled to what fruit may be produced as a secondary crop. But the great number of Illinois orchards are unprofitable because we have been deceived by annual returns gathered, or by secondary crops, and have therefore neglected such treatment as would make profitable returns from the trees themselves. If the orchardist is growing apples for the money there is in the business, he cannot afford to excuse his negligence and loss by saying that Mr. Brown or Mr. Smith got paying returns from orchard fruits in cropped or sod lands. Because an orchard has done well in sod does not say that it would not have done better in cultivation. Finally, speaking one word to the man with the unprofitable old orchard:—If you are satisfied with the returns from the same, continue as you are doing; otherwise give cultivation which is the basis of successful orchard management, and follow it up with pruning, spraying, and the other necessary means to success.

The actual cultivation of the orchard is neither a hard nor complicated operation. The tools used are such as are found, or at least should be found, on every well-managed farm. The plough, which is the greatest and most economic pulverizer of the soil, should be used for the first spring cultivation, especially in the young orchard. Any of the ordinary breaking plows will be found entirely satisfactory. This implement is usually followed by the disc and spring-tooth harrows. Even in orchards not plowed, especially old ones, the disc harrow will be found entirely satisfactory. It can be made to cut even stiff bluegrass sod and should always be used for reducing the lumps resulting from fresh plowing. Its action, however, is such as to leave the soil in small ridges, thus increasing the surface area exposed to evaporation by wind and sun. It should therefore be followed with some smoothing harrow which gives a more even and more finely pulverized surface. Most lands, especially those having a tendency to cement together during heavy rains, will require a thorough discing as soon as the land becomes sufficiently dry. This followed by the smoothing harrow and the operation repeated at intervals of one week during the period of no rain, or drouth, will thoroughly conserve the soil water by forming a blanket

or dust layer which is the best kind of mulch. The most important tool, therefore, after the early operations which have deeply pulverized the soil, is the fine-toothed smoothing harrow. The spring-tooth harrow is a very desirable implement for breaking the crust after heavy rains, answering the purpose as well if not better than the disc harrow besides being much easier on the team.

The cultivation should be carried as near to the trunks of trees as is possible. The tools mentioned above allow of working close to the trees provided they are not headed below three or four feet. Even in such a case, especially with some varieties, overhanging tops interfere unless the harness used has no projecting hames or terrets. According to the experience of this Station the Sherwood harness is one of the most satisfactory for this kind of work. It has no whiffletrees with which to scar or bruise the trees and no other projections of any kind.

The cost of cultivation is a most important consideration and should not be overlooked in this discussion. Our best growers in this state have found that the cultivation of an orchard costs less than that required by corn or any other farm crop. The exact expenditure, however, will be governed entirely by the conditions existing in each orchard and by the weather conditions. It has been found at this Station (Fig. 6) that \$16 per acre covers the cost of discing three times, and harrowing three times with the spring-tooth harrow and seven times with the smoothing harrow. This may seem high indeed for a single season's outlay, but when it is remembered that there are fifty trees to the acre in this orchard it will be seen that the cost per tree was but thirty-two cents for the season. Moreover, these trees bore heavily, kept a luxuriant foliage to the end of a very dry season, made an excellent growth, and went into the winter in first-class condition with plenty of fruit buds for next season's crop; all of which emphasizes the fact that the actual cost was comparatively low when compared with the benefit derived therefrom.

PRUNING ORCHARDS.

During several years the Illinois Experiment Station has been conducting experiments in pruning fruit trees. Results of these experiments will appear in detail in a separate publication. These investigations convince us that the practice of pruning apple trees is one too often neglected in this state. It seems well, therefore, to say a few words on the subject at the present time.

Pruning is the removal of superfluous branches, thus allowing a free circulation of air in the tree tops; and admitting light to the remaining inner branches of the tree. Its object is simply that of securing more and better fruit. When trees are left to themselves the branches crowd one another and do not give sufficient room and sunlight and air

for the developing of fruit on the inner branches. Moreover, fruit which is developed on unpruned trees can not be readily protected from apple scab and codling moth, as well as other diseases and insects. The cost of spraying is much less in point of time and material saved on trees which are judiciously pruned. Cultivation, too, is carried on with greater ease and effectiveness in the pruned orchard. Harvesting of fruit also is greatly facilitated in those trees which are properly pruned.

The ideal pruning is that which commences in the nursery rows when the trees are a year old and continued each year until the trees have served their usefulness in the orchard where they have borne fruit for many years. It is therefore an operation which commences with the nurseryman, and it is his office to see that the trees are symmetrical and with the limbs at the proper distance from the ground. The best and in fact the common way with the majority of nurserymen is to remove, just after they have started, the buds which are found below the point where the head of the tree is to be and other undesirable places. This is readily and quickly done by rubbing off these young shoots or buds with the hands. It may be necessary to repeat this operation during the first one or two seasons. The second season when the trees are transplanted remove all superfluous limbs close to the body of the tree with a sharp knife, cutting back the remaining three to six fully one-half of the previous year's growth. This is the time when the orchardist should receive the tree, yet it is common practice to wait until the plant has attained its second or third year. In any case, the year the trees are finally set in the orchard they should be well headed in, cutting to a bud, which on upright varieties will be left on the outside and on the more straggling varieties, as the Minkler, is left on the inside. This bud is to form the new limb and take its place with its fellows in forming the main branches of the tree. If one desires higher headed trees than those which the nurseryman has to furnish he simply needs to take up a leader, starting the head at the desired point and removing the lower branches. Each year after the trees are planted they should be gone over carefully, and a limb removed here or there, the object being to prevent rubbing of branches and to allow the top to be free and open. (Fig. 8.) The best time to do this, all things considered, is, for Illinois, during the months of March and April. The orchardist has more leisure at this time, the limbs can be clearly seen against the sky and the tree does not suffer as it does when wounded during the colder months.

As stated above the best pruning is that which is done with the hand by rubbing off the buds before the undesirable limbs have had an opportunity to develop to any great extent. If the operation is repeated each year there will never be any large limbs to remove; at least a saw will rarely be required. Wherever possible the pruning knife or the pruning shears should be used instead of the saw. Try to make as

smooth a cut as possible. After the orchard has been gone over with respect to pruning, all wounds left thereby should receive a coat of white lead paint which has been mixed with linseed oil. There are many other materials used for this purpose, but our experiments here seem to show that white lead paint is the most desirable from the point of expense and efficiency.

In concluding these brief remarks on the subject of pruning the fact expressed above must be reiterated, that this is an operation too commonly neglected by the Illinois orchardists.

ORCHARD FERTILITY.

The notion prevails in the minds of many apple growers that apple trees do not require as much plant food proportionately as do other crops. That this notion is wholly erroneous is shown by the result of carefully conducted experiments by Roberts published in Bulletin 103 of the Cornell University Experiment Station. These show that the growing of thirty-five apple trees per acre, which makes the distances between trees thirty-five feet, in twenty years production of foliage and fruit, averaging ten bushels per tree, requires plant food in the form of nitrogen, potash, and phosphoric acid in value amounting to \$207.45. This twenty years commences with the time the trees are thirteen years of age, continuing until they are thirty-three years old and it is assumed that during the five years from thirteen to eighteen they would average five bushels per tree per year, ten bushels per tree per year during the next five and fifteen bushels per tree per year during the remaining ten years. This, however, does not take into account the enormous amount of fertility which was required to develop the great amount of wood represented by thirty-five trees per acre. Compare this with the amount of fertility removed by a wheat crop. In twenty years cropping with an average yield of fifteen bushels per acre and seven pounds of straw to three pounds of grain, the total value is \$128.23 removed in the shape of nitrogen, potash, and phosphoric acid, or \$79.22 less than that required to supply the waste in fruit and leaves of the apple orchard.

No intelligent farmer would expect to grow wheat on the same area for twenty years without the best of cultivation and fertilizing; yet everywhere we find apple growers asking their soil to support a much greater drain than wheat would cause. It is known that some fruit growers are asking their land to support apple trees for forty years in addition to annual secondary crops, and this, too, without giving manures or even cultivation. (See Fig. 3.)

The question of the fertility of orchard soil is one which has hitherto received little or no attention from Illinois fruit growers. This is largely because of the fact that throughout a large portion of the state the soil is exceedingly rich in plant food. In fact, a considerable area,

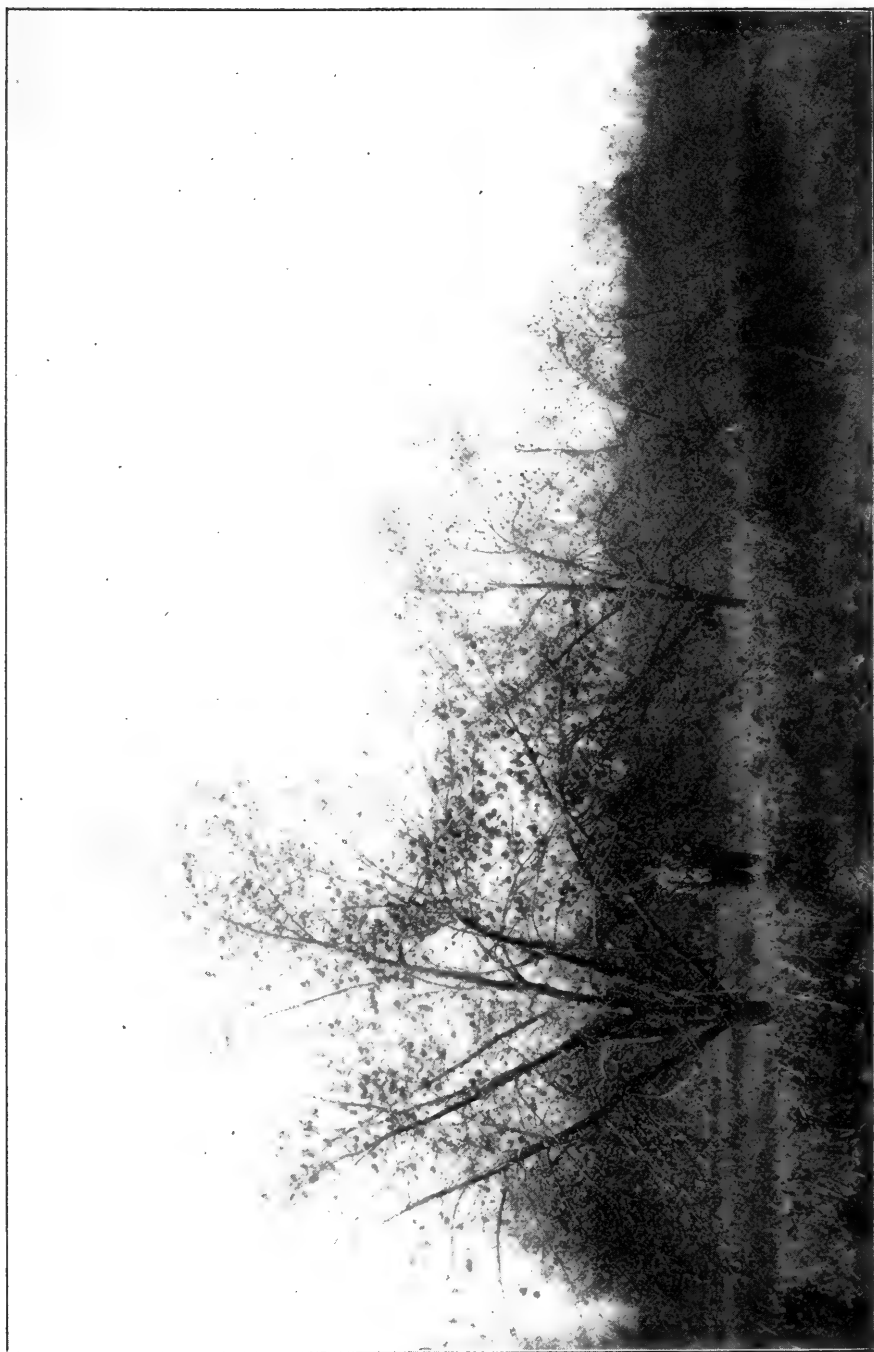


FIGURE NO. 5.

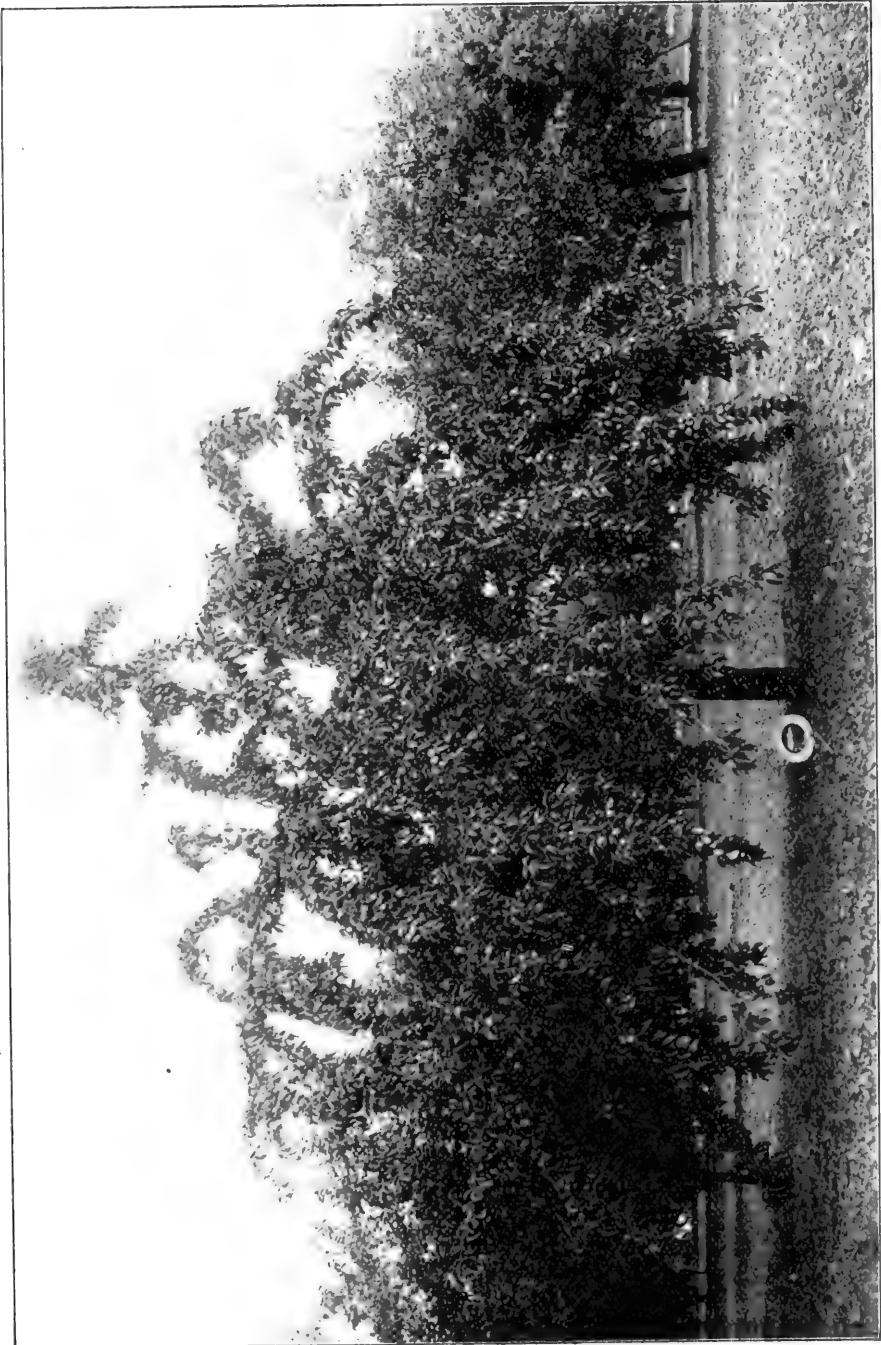


FIGURE No. 6

especially the central portion, is so rich in the elements of plant food as often to cause an excessive growth of the woody portion of the tree, thereby diminishing its fruit production. On this account few growers of orchard fruits in what is termed the corn belt of the state would think for a moment of applying fertilizers to their orchard soil. This, however, is no reason why the fruit growers in the southern third of the state or in parts of northern Illinois should think that their soil can be uniformly productive without the application of some of the elements of fertility either in the form of applied manures or by the growing of green crops. After a careful study of the question we are thoroughly convinced that there are hundreds of apple orchards in this state which are literally starving to death. In other words, these orchards are on soils whose fertility has either been exhausted or made unavailable by injudicious management.

At this point it is necessary to define what is meant by the word fertility. In its broadest sense fertility is a word used to designate the productive power of the soil. This productive power may be due in large measure to the physical condition of the soil rather than to a liberal supply of the chemical constituents necessary for great productivity. Or on the other hand a soil may be wholly unproductive yet contain excessive quantities of plant food, because of the poor physical condition of the soil. All this means that the plant food within the soil counts for nothing if the plant can not get it. We have already emphasized the importance of thorough tillage for making available what plant food there is within the soil. Yet as above stated, even with the best management of the soil in this particular, it may still lose so much plant food that it is necessary to supply commercial fertilizers or other manures.

Of the thirteen elements which the soil may contain and which may be used by plants only three are ever lost in such quantities as to make their restoration necessary. These are nitrogen, potassium, and phosphorus. Of these three the one most readily lost is nitrogen. This element, which comprises four-fifths of the air, combined with other elements becomes available to the plant. It is the element which is responsible for the rapid development and early formation of our apple trees and other plants. Phosphorus, in the form of phosphoric acid, is necessary in order to give strength and firmness to plants and, next to nitrogen, is, all things considered, the most important element of plant food. While needed only in relatively small quantities by plants it is lacking in many soils. Potash comes next to phosphorus in importance and is the most important constituent for fruiting plants, at least those that are expending their energies in that direction.

Nitrogen.—The yellowing of the foliage and stunted appearance of the tree is a pretty sure indication that the soil is deficient in nitrogen.

An insufficient supply of nitrogen tends to dwarf plants. Good stable manure, if well taken care of, that is, not allowed to leach by rains, will supply to the soil liberal quantities of this plant food. Other sources of nitrogen for plants are the various nitrates, ammonia, and some animal or plant compounds. Sodium nitrate is the most important commercial fertilizer containing nitrogen. A hundred and twenty-five pounds of this salt would probably be the minimum amount per acre. But its use is advisable only after other means have failed. This might also be said of barn-yard manure. By all means the cheapest way of securing nitrogen is by thorough tillage, which increases or hastens nitrification, and by green manuring. If these two latter methods are practiced there will rarely ever be occasion to resort to commercial fertilizers.

By green manuring is meant the growing of some crop in the orchard, especially those leguminous or nitrogen forming plants, which, when turned under and decomposed, add nitrogen and other food material to the soil. The greatest good, however, derived from this operation is the addition to the soil of large quantities of humus or decaying vegetable matter which greatly improves the physical condition of the soil, thereby increasing its power to hold plant food and moisture. What crops are most advisable for this purpose depends almost entirely upon soil and climatic conditions. They are usually confined to some of the clovers, peas, beans, vetches, or lupines. Wherever clovers or vetches succeed well they should be used. In the greater portion of Illinois, however, especially in the southern part, cow peas and soy beans are in greatest favor.

These leguminous plants are enabled to take up the free nitrogen of the air by virtue of small nodules or tubercles formed on their roots as a result of the activity of microscopic forms of life known as bacteria. It is now clearly known that if these organisms are not present in the soil the leguminous plants are unable to use the nitrogen of the air. As a result of this, soil inoculation is often resorted to. This simply consists of taking soil where these plants are found to grow luxuriantly, and have an abundance of the tubercles above referred to, and sowing the same on a new area, a few handfuls of soil often sufficing for an acre of ground. The exact physiological processes gone through with by plants in securing this free nitrogen is not definitely known.

Phosphorus.—Phosphoric acid is applied to the soil as a direct fertilizer in the form of superphosphates, bone compounds, etc. Dissolved South Carolina rock is a common commercial form of this manure. Usually, however, if soils are well cared for this element will not be lacking.

Potash.—Potash may be secured in the form of muriate of potash, which is probably the most reliable. Kainit or German potash salts

and wood ashes are other forms of this commercial fertilizer, for the bearing orchard at least. Five hundred to seven hundred pounds of muriate of potash, or forty or fifty bushels of wood ashes, is a liberal dressing per acre for orchards.

The following formula is suggested for Illinois orchard lands located outside of the "black soil" areas:

Ground bone.....	100 pounds.
Acid phosphate.....	100 pounds.
Muriate of potash.....	100 pounds.
Nitrate of soda.....	125 pounds.

This amount per acre applied in the springtime and either plowed under or disced into the soil will be found sufficient for those orchards bearing annual crops of fruit. The above formula, however, should be supplemented by special fertilizers or otherwise varied to suit any particular orchard whose soil conditions are peculiar to itself.

It should be understood that this discussion does not encourage the use of commercial fertilizers. There are instances, however, where these must be resorted to. Illinois orchardists should largely confine themselves to cultivation and green manuring for supplying the necessary plant foods.

SPRAYING.

The spraying of horticultural plants with solutions to protect them from their many enemies is an operation with which the fruit growers all over the country are now more or less acquainted. It is, however, an operation coming at a season of the year when the farmer is busiest. This, together with the fact that it is attended with many disagreeable features, makes it necessary that the most accurate and condensed information shall be given on the subject. For this reason the Illinois Experiment Station, as well as nearly all other State Experiment Stations, is constantly experimenting with the new insecticides and fungicides which are put upon the market and at the same time getting the most accurate information on *why*, *when*, and *how* spraying should be done.

If attention be limited to the spraying of apple trees for the purpose of protecting them from the ravages of the apple-scab fungus and the codling moth, the two most common and most destructive enemies to the apple growing industry of Illinois, the following is the best information that can be given upon that subject at the present time:

APPLICATIONS.

(1) Use always, excepting perhaps for first application, the combined mixtures of Bordeaux and Paris green. The former is for the apple-scab fungus, while the latter is for the insect, codling moth. They are both just as effective when applied together and time and money are saved thereby. Make these solutions according to formulas given below.

(2) The *first* application of the Bordeaux mixture (1, page 391) should be made to the trees after the leaf buds have commenced to expand and may be continued until the flower buds open. This space of time will vary greatly with different varieties.

(3) The *second* application of the Bordeaux-Paris green solution (4, page 393) should be made immediately after the blossoms fall and may be continued indefinitely. Do not under any circumstances delay this second application. The sooner it can be done after the blossoms have fallen the greater will be the results obtained. The blossoming period, therefore, governs the operator and he should not depend upon anything or anybody else, but allow the tree to determine when he should commence. From fifty to ninety per cent. of the fruit that would otherwise be ruined by the codling moth can be saved by spraying at this time. Not only that, but the apple scab fungus which is in the height of its development at this time is greatly and sometimes almost entirely checked at this period. The point then is to be ready with spraying apparatus and solutions to attack these two enemies at this critical moment; in a few days the young larvae will have entered the forming apple and be beyond our reach with Paris green; in a few days, too, the apple scab fungus may have reached so far in its development as already to attack the young apples or their stems, in which case the food supply would be cut off and the fruit fall prematurely, as was the case in 1898. A loss of more than \$3,000,000 to the fruit growing industry of this state would have been saved had the Illinois orchardists sprayed their trees during that season. This was abundantly proved by experiments conducted at this Station and by the fact that several orchards in this state which were so treated gave handsome returns to their owners.

(4) A *third* application of this Bordeaux-Paris green mixture will be advisable and in fact necessary should the season prove a wet one. The more moisture, other things being equal, the more readily will the apple scab fungus develop. This means that as soon as the shower has passed the spraying machines are started and kept going until again prevented by rain. Patience and persistency are the things which count for most in this work. It is a question, too, of dollars and cents with the grower, and where in Illinois is there a man attempting to grow apples who would not gladly spend from seven to fifteen cents per tree when thereby he would get from one hundred to five hundred per cent. more fruit? This spraying then is simply a business proposition, for the fruit grower who is growing the fruit for the income it brings him. Without perfect fruit there is no money in the business, and the only way to secure perfect fruit is to spray in a businesslike and systematic way. But as we have already said spraying is not only necessary in order to secure perfect fruit, but quite often even any fruit, as was the case in 1898.

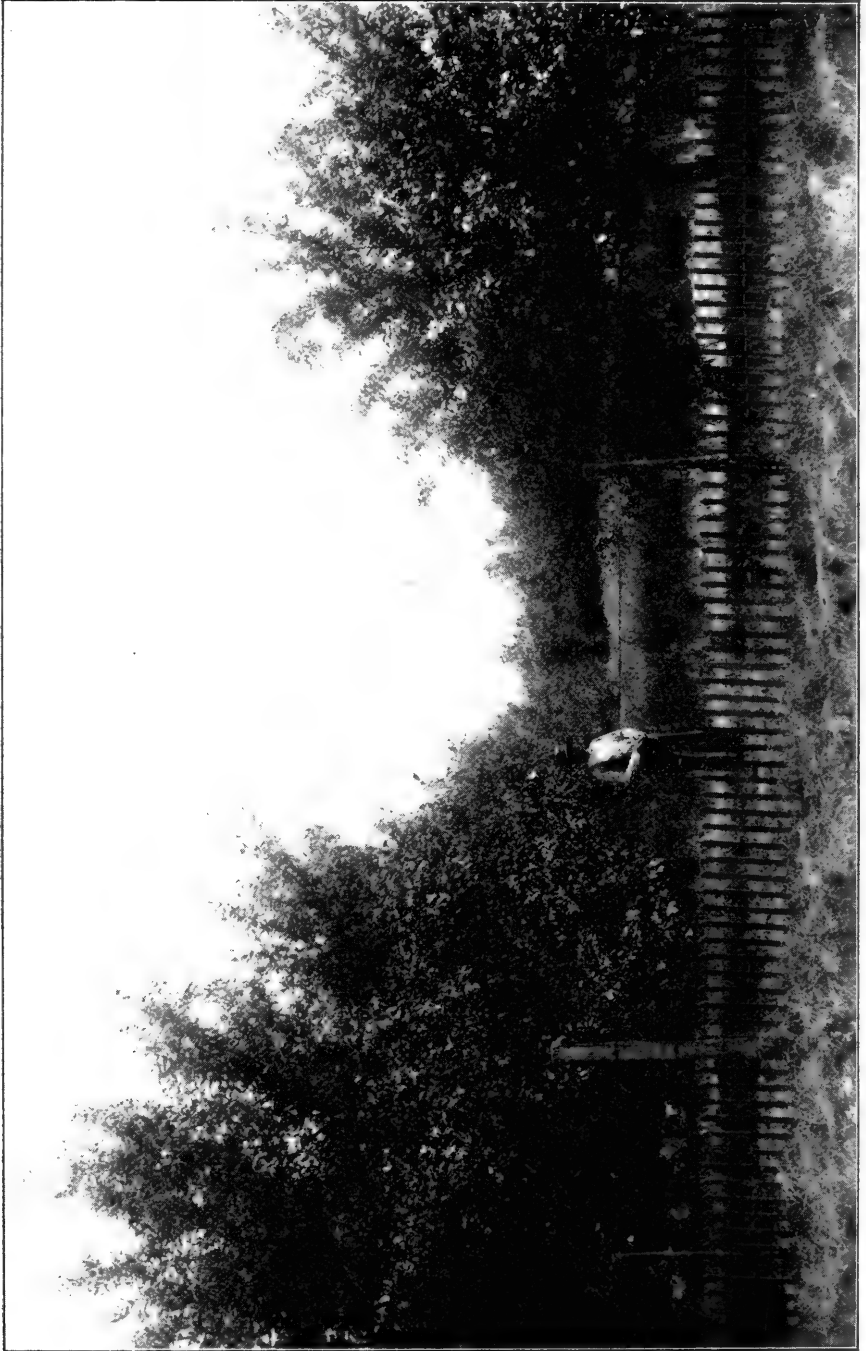


FIGURE NO. 7.

(5) A *fourth* application during some seasons will be found advisable and may be made in one or two weeks after the third application. The third one following in a week or ten days after the second.

(6) These applications above referred to will be found sufficient to keep in check other forms of fungus and insect enemies, but in the case of the rots attacking mainly the fruit, later applications will be necessary. This is also true of the canker worm and other leaf-eating insects which may make their appearance. In such cases, however, special solutions other than those above referred to will doubtless be needed.

SOLUTIONS, HOW MADE.

(1) Normal Bordeaux mixture has its ingredients in this proportion: Copper sulphate, 6 lb.; quick lime, 4 lb.; water, 45 or 50 gallons.

This mixture should be made fresh as it is needed, for it loses its fungicidal value in a day or two after mixing. It is therefore convenient to make up stock solutions of the copper sulphate and lime separately. This is done by dissolving the copper sulphate or blue vitriol, as it is commonly called, in water at the rate of one lb. to the gallon. The quick lime may also be prepared at the rate of one lb. to the gallon. As the copper sulphate dissolves slowly in cold water it should be suspended near the surface of the same, otherwise hot water would be necessary. The following detailed directions may be found helpful: Weigh out 50 lb. of copper sulphate. Put this in a grain sack and suspend in the top of a fifty gallon barrel of water. As the crystals dissolve the solution settles to the bottom. This will require twelve or fifteen hours. Stir up the solution and take six gallons of the liquid, which gives the six lb. of copper sulphate. Pour this into the fifty gallon barrel to which is attached the spray pump. If a larger vessel is used take out a proportionate amount. Next slack fifty lb. of stone or quick lime in fifty gallons of water. When the slacking is complete add four gallons of this solution to the six gallons of copper sulphate already put into the spraying barrel. Now add sufficient water to make up the fifty gallons, stirring while doing this. If two or three teams are to be kept going several such vessels of stock solutions may be preparing, or larger vessels used.

(2) A weaker Bordeaux solution may be made by using 4 lb. of copper sulphate, 4 lb. of lime and 50 gallons of water. This solution is to be used for the third and fourth applications and where No. 1 is found to burn the foliage.

(3) Paris green, 1 lb.; 150-250 gals. of water.

Do not put the dry Paris green powder into water expecting to mix it thoroughly therein. Put one pound of this powder into a gallon jug then fill the same two-thirds full of water. Cork and churn the jug



FIGURE NO. 8.

violently for a few minutes when every particle of the powder will be brought in contact with the water. Add this concentrated solution in such proportion as to give the desired amount to the larger quantity of liquid, with which it will readily and thoroughly mix. In other words, after thoroughly mixing, fill the jug, then pour out one quart of the solution which will contain four ounces of the powder in suspension. This four ounces is the quantity required for the fifty gallons of Bordeaux already made.

(4) Bordeaux-Paris green solution:—

Copper sulphate, 4 to 6 lb.

Quick lime, 4 lb.

Paris green, 4 oz.

Water, 50 gallons.

(5) Arsenite of lime solution:—

White arsenic, 1 lb.

Quick lime, 2 lb.

Water, 4 gallons.

This latter is a stock solution which should be kept in a closed vessel. It should be boiled forty-five minutes and a small quantity of iron tannic* added to give it a black color, thus making its poisonous nature apparent or at least calling attention to that fact. Three quarts of this concentrated solution will be sufficient for each fifty gallons of spraying solution and may take the place of the four ounces of Paris green in No. 4 above. Being much more effective than the Paris green and only one-third as expensive it is to be recommended. The greatest care, however, should be exercised in its preparation and in cleaning all vessels which have contained the same, thus avoiding danger from poison. Because of the danger resulting from its use in careless hands it is to be hoped that all drug stores may prepare the concentrated solution, selling the same in preference to the unmixed materials.

(6) Various substitutes for Paris green, other than the arsenite of lime, are upon the market, but so far we do not feel warranted in recommending them.

MACHINERY.

Never buy a cheap iron pump for spraying purposes. It rarely lasts long and, moreover, is attacked by the copper sulphate or Bordeaux solutions. The desirable points in a pump may be summed up as follows: All working parts should be made of brass. There should be no leather or rubber valves. There should be no stuffing-box nor should the parts be fastened together with iron bolts or screws. In fact, the brass or alloy pumps are in the end the cheapest, since they are in every

*Iron tannic may be made by dissolving 15 grains tannic acid in 6 oz. water then adding 1 dram of tincture of iron. This will color several gallons of the arsenite of lime.

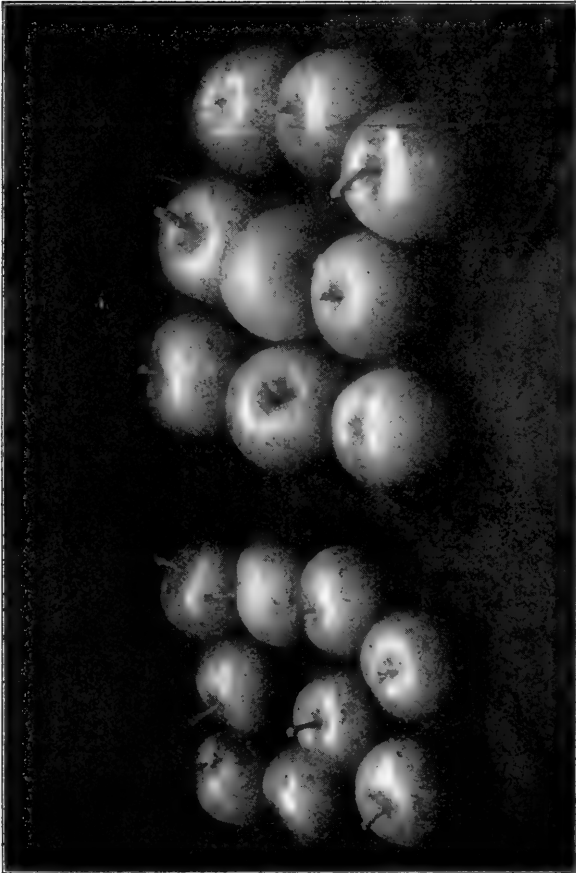


FIGURE NO. 9.

way more durable, and are not corroded by the liquids used or by simple exposure. A pump that stands above the barrel or has any projection whatever is unsteady, especially when there is little solution in the barrel; and moreover it is likely to catch on the limbs and be a nuisance generally.

The Eclipse pump, manufactured by Morrill & Morley, of Benton Harbor, Michigan, has been found at this station to be one of the best pumps on the market. Those parts of the machine coming in contact with the liquid are brass.

The pump should be mounted on a fifty gallon oil cask or a wooden tank especially prepared for the purpose. Each pump should be provided with two leads of hose with brass shut-offs at the pump and also at the base of the bamboo rod. The bamboo extensions or rods are for the purpose of carrying the nozzle up into the tops of the trees, thereby insuring a more thorough job than could be otherwise done. They are light, durable, and an indispensable acquisition to spraying apparatus. The nozzle used may be the double Vermorel nozzle, which gives a fine misty spray and is without doubt the best nozzle in the market. Rubber tubing of hose $\frac{3}{8}$ inch or $\frac{1}{2}$ inch, three or four ply, is necessary and can be bought for from twelve to twenty cents per foot. The cheaper grade of hose should never be used for spraying purposes. The other accessories in the way of apparatus are brass couplings and hose clamps, reducers and pipe tongs, monkey wrench, hammer, etc.

Another very important acquisition is the copper strainer, twelve inches in diameter with brass wire cloth mesh, through which all spraying solutions should be strained to prevent particles of dirt, lime or other material from entering the pump and clogging the nozzles. Burlap or other cloth strainers should not be depended upon.

In order to make the work as agreeable and expeditious as possible all of these accessories above described and perhaps others should be provided without fail. When this is done and the operator goes about his work knowingly, that is—knowing what he is spraying for—the work is simple and an actual pleasure because of the ten-fold benefits derived therefrom.

In this brief description no attempt has been made to tell how to combat all of the many nuisances with which the fruit grower has to contend. Having confined our attention to the two most destructive enemies of the apple orchard the way will have been made easier for a clear understanding of the operations necessary in contending with other diseases and insects; information concerning which will be given gladly upon application.

JOSEPH CULLEN BLAIR,
Assistant Horticulturist.

DESCRIPTION OF PLATES.

Figure No. 1 is a photograph taken in July, 1899, showing a six-year old Illinois orchard. The trees were small and very unhealthy looking. With the exception of small circles around the trees no cultivation has been given; heavy crops of hay have been taken off annually. Note the weeds at the left which are nearly as high as the trees themselves. Compare this view with photograph No. 2.

Figure No. 2. This is a photograph taken in July, 1899, in the seven-year old orchard at the Agricultural Experiment Station of the University of Illinois. The trees had an abundance of green, luxuriant and healthy looking foliage. Note the absence of grass and weeds. This orchard has been given clean cultivation constantly and has been sprayed. Compare this view with Figure No. 1.

Figure No. 3. A view in an Illinois orchard where the land has been overcrowded, being obliged to support apple trees thirty feet each way, with pears, peaches, small fruit, grass and weeds besides. Such overcrowding is asking too much of any soil unless thoroughly cultivated and manured, and even then the advisability of such a practice is questionable.

Figure No. 4. A photograph taken last September in Mr. Aldrich's old apple orchard at Neoga, Illinois. Note the fine healthy appearance of these old trees due to thorough cultivation, spraying and pruning. This orchard produces annually heavy crops of fruit. Compare this view with Figure No. 3 and Figure No. 5.

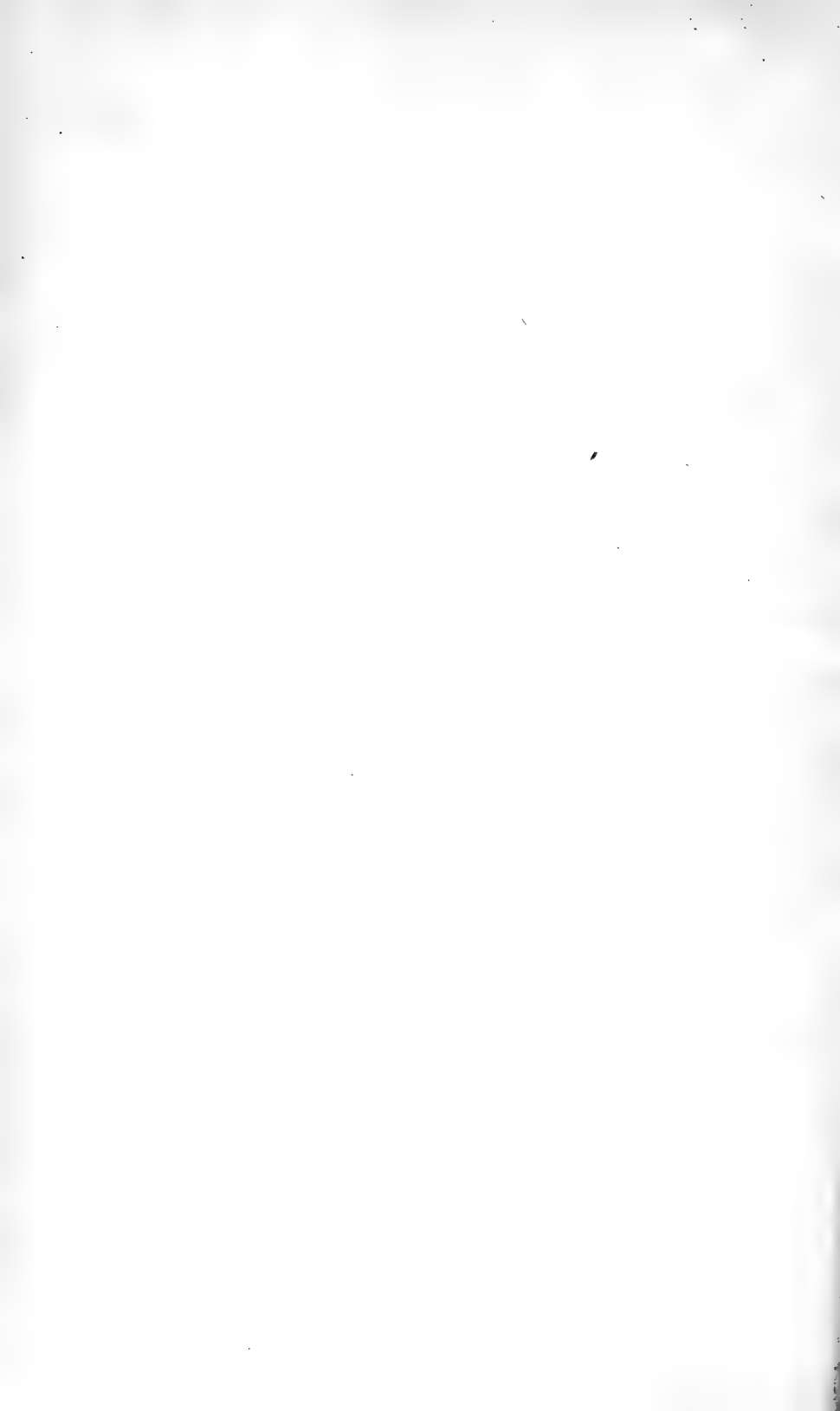
Figure No. 5. A photograph taken last September in an Illinois orchard. This shows defoliated trees and small sized inferior fruit resulting from lack of cultivation and spraying. Compare with Figures No. 4 and No. 6.

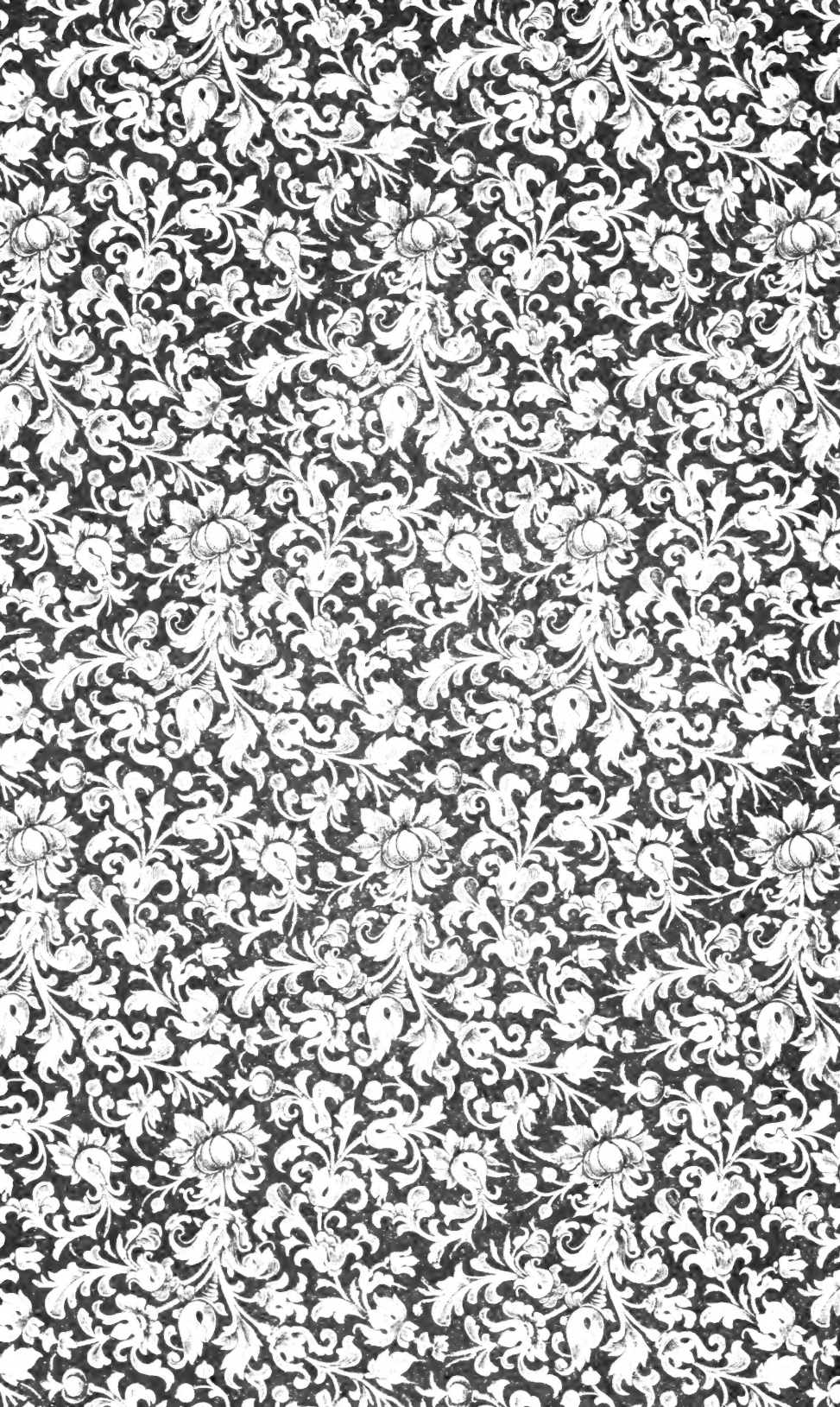
Figure No. 6. A photograph taken in September in the old orchard at the University of Illinois. This view shows the result of careful cultivation, spraying and pruning. Compare with Figure No. 5.

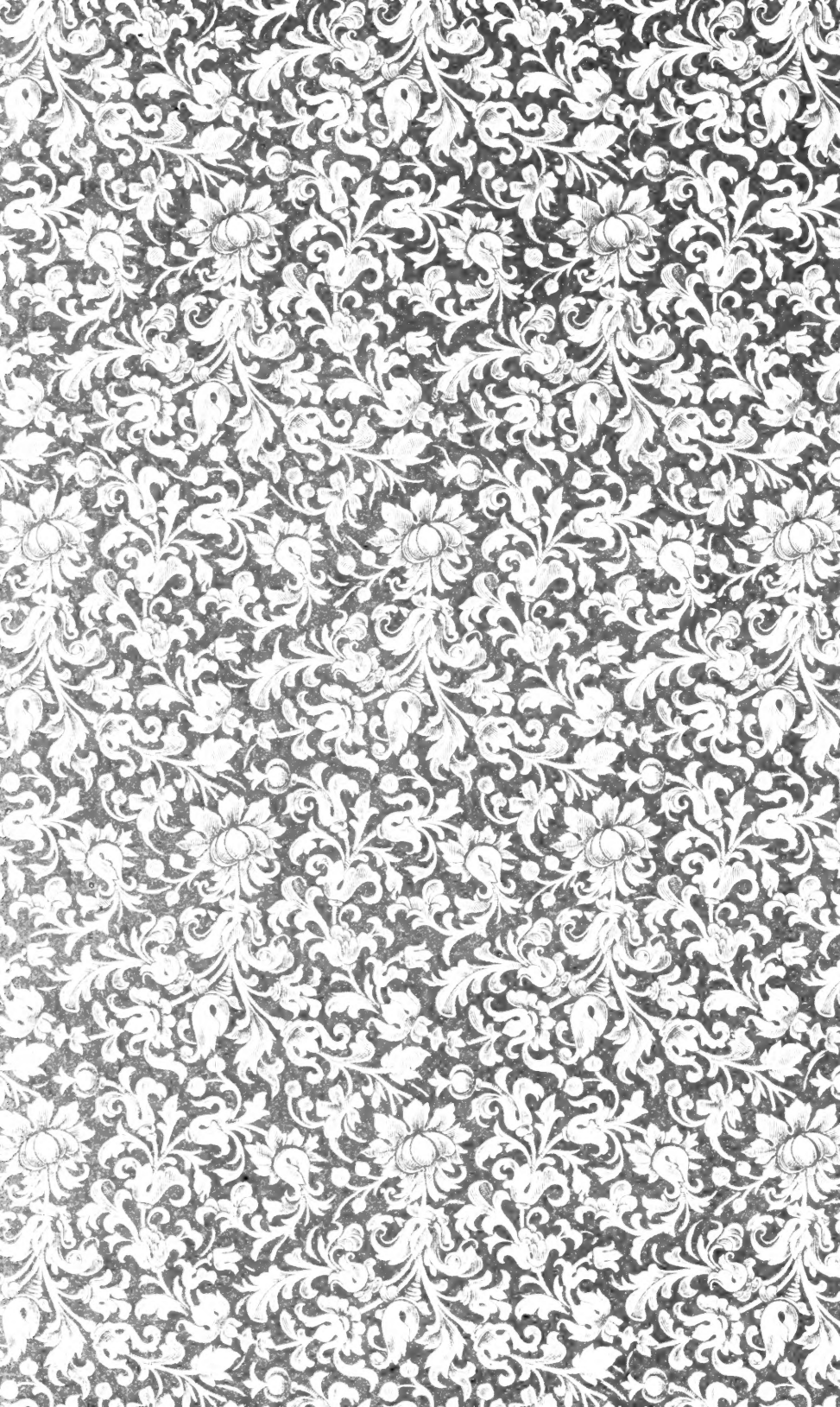
Figure No. 7. A photograph of an Illinois orchard showing the difference in size of trees resulting from a difference in method of treatment. The trees on the right are stunted and are much inferior to those on the left, which are the same age. This dwarfing is due to the injudicious cropping of the land with oats and for one season only.

Figure No. 8. This photograph shows a renovated old apple tree in Mr. Aldrich's orchard. Note the healthy foliage and good supply of excellent fruit resulting from careful pruning together with cultivation and spraying.

Figure No. 9. This photograph shows, at the left, nine Winesap apples which were the best to be found on unsprayed trees; at the right are shown nine of the best fruit of the same variety taken from adjoining rows which were sprayed. Three each of these sets were selected independently by the three gentlemen, Mr. Jolly, Mr. Aldrich and Mr. R. A. Simpson, while visiting the latter's orchard in Richland county, Illinois, last July. These well illustrate the character of fruit produced upon the sprayed and unsprayed portion of Mr. Simpson's orchard.







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