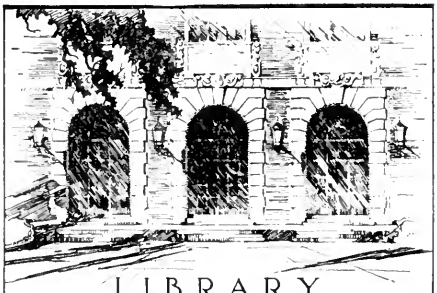

AGRICULTURE

UNIVERSITY OF ILLINOIS.

Agricultural Experiment Station.

URBANA, JUNE, 1898.

BULLETIN NO. 52.

ORCHARD CULTIVATION.

Throughout large sections of Illinois may be found the rotting remnants of once extensive orchards, representing large original expenditures of both labor and money. The frequency with which such localities are met would almost seem to justify the statement, usually heard in the neighborhood where such "worn out" orchards are found, that the soil is not fitted for the growing of fruit. On the other hand, the enormous apple and other fruit production in other parts of the state, and frequently in localities not far distant from those first mentioned, makes it evident that the reason so often assigned cannot be the correct one.

On examination and inquiry it will be found to be almost invariably the case that the *true* reason for the failure or dying out of an orchard is the lack of sufficient, or the entire absence of, proper cultivation and care. While the Illinois agriculturist has been devoting his time and attention to the care of his field and garden crops, it is too often the case that his orchard has been left to care for itself, with the above mentioned result.

The commonest cause of failure of orchards in Illinois may be traced to the ill effects of summer drouth, though perhaps it is more commonly referred to freezing in winter. The connection really existing between these two destructive agencies has not been often recognized. The fact that certain varieties of apples, usually accounted hardy even to our most northern limits and in exposed situations, sometimes fail after a winter not noted for severity has at different times attracted

attention, but the significance of such failure does not seem to have been duly appreciated. On consulting the records it is found that orchard injuries and exceptionally severe winters do not coincide. It often happens that apple trees come through in good condition during what appear to be the hardest winter trials while they sometimes perish, or at least evidently suffer, during much less rigorous seasons. The autumnal condition of the trees clearly has to do with the results, and this again depends upon the developments of the growing season. One of the worst things that can happen to trees is the failure of a sufficient supply of soil moisture, when, during midsummer, the leaves are normally sending into the air surprisingly large quantities of water obtained solely through the roots. A continuous and sufficient supply of water is essential for all the vital processes of vegetation. Apple trees severely suffer when not so supplied. They may live under otherwise favorable conditions, but they can neither properly mature a crop nor prepare for one the succeeding year without sufficient moisture.

More especially and aside from its direct baneful effects injury is likely to follow a summer drouth in a well known way. A scant supply of water tends to check growth, to ripen that already gained, and then to terminate in effect the season's period of development. The tree so untimely maturing its season's growth is somewhat in the condition it should be at the close of the year. Subsequent spring-like influences cause a second development of activity, and more or less resumption of growth late in the year. The tree now goes into winter in poor condition to withstand even the ordinary vicissitudes of the season. It suffers not so much because of severe climatic influences as because of its own abnormal, if not enfeebled, condition. It is therefore of the utmost importance to care properly for the orchard in the summer, if we wish to avoid disaster in the winter. There is no way usually practicable by which the soil can be kept continuously moist through the summer except by preventing the evaporation of water from its surface by a dust mulch. To make and keep this dust mulch, frequent shallow cultivation must be practiced. The principal object of this bulletin is to show the value of such cultivation in orchards by reporting results of experiments described herein and to show the methods by which the work has been done.

In 1887-8 a series of experiments in orchard cultivation and management was begun at this Station. During the first two or three years the work was not very systematic, but the general results showed that the effect of the cultivation was to conserve the soil moisture. In 1890 a portion of ground was set aside for the further and more systematic development of this experiment. Six rows of trees were planted in this subdivision of the orchard—three of Ben Davis and three of Grimes

Golden. This new plantation was then divided into five plats. The first of these was cultivated clean, the second cropped with oats, the third with corn, the fourth with clover, while the fifth and last was seeded with blue grass.

This system of cropping and cultivation has been since continued, and the results of the experiment are shown in the accompanying illustrations and tables.

Plate 1 shows a typical tree from each of the five plats. The marked inferiority of the trees from the oats and grass plats, particularly the latter, may be seen at a glance; while the superiority of the one from the clean cultivation plat, as regards vigorous and healthy appearance and wealth of foliage, is almost as equally apparent. Plate 2 and its accompanying table (p. 109) and Plate 3 are further illustrations from the same trees that are shown in Plate 1. The character of foliage and marked difference in diameter of trunk, especially between the trees from the clean cultivation and corn plats and that grown in blue grass, is particularly well brought out in Plate 3.

Plates 4 to 6, inclusive, are further illustrations of the same contrast, and show the appearance of the trees in the plats. The stunted condition of the trees in the grass plat (Plate 6) as contrasted with the fine, healthy appearance of those having had the clean cultivation (Plate 4) and those in the corn plat (Plate 5), is particularly striking, and should, when it is remembered that the plats are situated side by side and within a few feet or rods of each other, prove a fruitful source of reflection to the thoughtful orchardist or agriculturist.

Tables 1 and 2 following give measurements of one row each of the two varieties in the portion of the orchard devoted to the cultivation experiment.

It will be noticed from these tables that the trunks of the trees in the corn plat average about the same or slightly larger than those in the clean cultivation plat. From this, if all the circumstances of the case were not taken into consideration, the erroneous conclusion might be drawn that cropping the orchard with corn was beneficial to the trees. The trees were planted only fifteen feet apart each way, and after the first two or three years the intervening spaces were so shaded that the corn attained a growth of something less than one half the normal size. The result would undoubtedly have been different had the trees been set farther apart, and the corn allowed opportunity to attain its full growth and development during the latter years of the experiment; and it has been shown by experiments elsewhere that the cropping of mature orchards where the trees are set wide apart, with corn, has a deleterious effect on the trees.

TABLE 1. ROW 3, BEN DAVIS

Tree No.	Diameter of trunk at surface of soil, inches.	Diameter of trunk 1 ft above surface of soil, inches.	Height, feet, inches.		Diameter of top. feet, inches.		
1.....	18½	16½	19		16		Cultivation.
2.....	19¾	17½	18	6	15	4	"
3.....	20	16½	19	9	15		"
4.....	18½	16¼	18		15		"
Av. for plat....	19 3/16	16 11/16	18	9¾	15	4	
5.....	16	14	18		13	6	Oats
6.....	14¼	12¼	17		12		"
7.....	18½	15½	18	6	13	10	"
8.....	17¾	15¼	18	6	14	8	"
Av. for plat....	16 11/16	14¼	18		13	6	
9.....	21	18¼	18	6	15		Corn.
10.....	19½	16¾	18		14		"
11.....	22	18½	18	3	15		"
12.....	20¾	17½	18	6	13	6	"
Av. for plat....	20¾	17¾	18	3¾	14	4½	
13.....	20¾	19	19	9	15	6	Clover.
14.....	19	17½	17		15		"
15.....	18½	16	17		13		"
16.....	16¾	14¾	16	6	12		"
Av for plat....	18¾	16¾	17	6¾	13	10½	
17.....	8¾	7¾	10	6	7	6	Grass.
18.....	10	9¼	11	6	9		"
Av. for plat....	9⅜	8½	11		8	3	

TABLE 2. ROW 6, GRIMES GOLDEN.

Tree No.	Diam. of trunk at surface of soil, inches.	Diam. of trunk 1 ft. above surface of soil, inches.	Height, feet, inches.		Diam. of top, feet, inches.		
1.....	9¾	8¼	13	4	8	6	Cultivation.
2.....	13½	12	14	9	11	9	"
3.....	13¼	11¼	14	6	10		"
4.....	12½	10¾	14		10		"
Av. for plat....	12¼	10½	14	1¾	10	0¾	
5.....	11	9¾	13		8	6	Oats.
6 (dead '97)....	6¾	6	8	6	5	4	"
7.....	9¼	8	13		8	6	"
8.....	9	8¼	13		8		"
Av. for plat....	9	8	11	10½	7	7	

TABLE 2—CONTINUED.

Tree No.	Diam. of trunk at surface of soil, inches.	Diam. of trunk 1 ft. above surface of soil, inches.	Height, feet, inches.	Diam. of top, feet, inches.	
9....	16¼	13¾	16	12	Corn.
10.....	15¼	13	14 6	9 6	"
11.....	12½	10½	13 6	10	"
12.....	14¼	12½	15	11	"
Av for plat ...	14½	12 7/16	14 9	10 7½	
13.....	12¼	10¾	14 3	9 9	Clover.
14.....	7½	6½	11	6 6	"
15.....	10½	9½	12 3	9	"
16.....	12	10¼	14 2	10 6	"
Av. for plat....	10¼	9¼	12 11	8 11¼	
17.....	7½	7¼	11 6	5 6	Grass.
18.....	8¾	8	11	9 6	"
Av. for plat....	8⅛	7⅜	11 3	7 6	

TABLE 3. MEASUREMENTS OF SPECIMENS IN PLATE NO. 2.

	Butt.	Middle.	Crotch.	Plat.
No. 1.....	18 in.	16½ in.	16¼ in.	Cultivation.
" 2.....	14 5/8 "	13½ "	13½ "	Oats.
" 3.....	18½ "	17 "	16¾ "	Corn.
" 4.....	17¼ "	15½ "	15¼ "	Clover.
" 5.....	10½ "	9¾ "	9½ "	Grass.

The effect of cultivation on the root system of the trees is shown by the following measurements of the main roots of each of the trees shown in Plates 1, 2 and 3:

Cultivation Plat.—Root 8 feet 6½ inches long. At 3 feet 6 inches away from the trunk it started down. It went down until it reached a point 5 feet below the surface, when it ran horizontally. Ends rather stiff and blunt. No fine fibers at the end. Two feet from the trunk it measured 1¾ inches in circumference. Numerous fibers in the soil were cut in digging.

Oats Plat.—Root 14 feet 4 inches long. Nine feet away from trunk it was only 15 inches down. It then turned downward, the end being 3 feet 8 inches down below the surface. But few small rootlets. Two feet away from the trunk the root was 4 inches in circumference. Roots were long and whiplike, with little tendency to branch out.

Corn Plat.—Root 15 feet 8 inches long. Eleven feet away from the trunk it divided up into four branches, two of which started down; the third turned laterally and the fourth appeared to be a continuation of the main root. The latter is included in the total length. One branch started down and reached 4 feet 4 inches below the surface. The root had a great number of small roots along its length, with many smaller branches. The main root 2 feet from stump was 4¾ inches in circumference, and each of the four branches was almost one inch in circumference.

Clover Plat.—Root 8 feet 4 inches long. Three feet 6 inches away from trunk it turned down. It was then 1 foot down below surface. It ran straight down 4 feet 6 inches more. At 2 feet away from stump root was 4 inches in circumference. Root had but few branches and almost no fibers when compared with other plats.

Grass Plat.—Root 10 feet 8 inches long. Ran out horizontally. The end was 18 inches below surface. One branch started at 15 inches away from trunk and ran down 4 feet 9 inches. Two feet away it was 1¾ inches in circumference. Root small. Horizontal root much branched near the end.

Here the superiority of the clean cultivation is at once apparent. The root system is compact; and instead of lying near the surface of the ground where it is easily reached by drouth and meteorological disturbances, it strikes deep into the soil. This is the direct effect of the conservation of moisture in the subsoil by the protecting mulch formed at the surface by the cultivation and tillage. These have so fitted and prepared the soil that the plant is enabled to get its food at home; while the moisture that has been kept from evaporation by pul verizing the surface soil has enabled the roots to strike deep, thus giving the plant a firm and compact basis. This is well contrasted with the oats and grass plats, where the roots grew shallow and ranged wide from the tree.

The deep cultivation in the clean plat also kept the roots from spreading near the surface by keeping them pruned there until they were forced to strike deep. The corn plat, on the other hand, was never cultivated over three inches deep. The roots of the trees were not obliged to strike deep for their nourishment, so as to use what was in the ground nearest them, but spread widely just below the range of cultivation. This would lead to the conclusion that the growth of the trees in this plat was due in some measure to the peculiar fitness of the land for the purpose, rather than to anything inherent in the shallow cultivation.

As the object of prime importance in the cultivation of the orchard is the conservation of the moisture which is essential to the growth of the trees, and the fitting of the trees to utilize all the food in their

immediate vicinity, it follows that no crops which have a tendency to deplete these stores of moisture and food should ever be allowed in the orchard. *Under no circumstances should hay or any grain crop be grown on orchard land.* In the orchard of Mr. H. A. Aldrich of Neoga, Ills., may be seen an example of this, if anything further in that line be needed. In that orchard is a plat of trees, all planted at the same time, one half of which has been permanently set back by a single year's cropping with oats.

Corn or any other hoed crop may be used in the orchard during its first two or three years, but it is inadvisable to continue cropping of any description for a much longer period—certainly not after the trees have arrived at bearing age. Nothing should be taken from the orchard after that time but the fruit. Occasionally an orchard may be seeded and allowed to go a year or two in sod; but no hay should ever be cut, and usually as the strength of sod increases the amount of foliage and fruit will decrease. If the soil is lacking in organic matter an occasional crop of clover or cow peas may help the orchard, but this should be plowed under at the end of the season and not removed from the ground.

Two illustrations may be given to show the actual effect of cultivation in the preservation of soil moisture. The fall of 1897 was an exceedingly dry one. Careful analyses made of soil samples from the plats devoted to the cultivation experiment during October, 1897, showed for the first 27 inches an average percentage of moisture for the various plats approximately as follows:

Clean cultivated	12 per cent.
Corn	12 "
Clover	10 "
Oats	8 "
Grass	8 "

When it is borne in mind that the amount of moisture must exceed 10 per cent to make it available to the plant to any extent, the superiority of the clean cultivated and corn plats (the latter of which was, as has been said, practically clean cultivated also), so far as the amount of moisture is concerned is apparent.

The other illustration is that of the main orchard at the Experiment Station, which is shown in Plate 12. During the entire season of 1897 it was kept in a good state of tilth, and in spite of the extreme drouth held its wealth of foliage during all the dry weather and bore an abundant crop of fruit.

Tools and Processes.

The actual process of orchard cultivation is neither a hard nor complicated operation, since the tools used are such as are found on

nearly every farm. The tools used in orchard cultivation at the Experiment Station are shown in Plate 7. The plow is the ordinary breaking plow, and is used for the first spring cultivation. It is then followed by the disc and spring-tooth harrows. The disc harrow in use at the Station is, as may be seen from Plate 7, No. 2, and Plate 8, of the spading or cutaway type, but the ordinary disc harrow with solid discs is as good for all practical purposes.

If the spring is dry and the plow and disc harrow have left hard lumps, it is well to go over the orchard with a roller (Plate 7, No. 4) for the purpose of thoroughly reducing them and the first spring preparation of the soil for the growing season is then completed by going over the entire orchard with a smoothing harrow. The first stages of the spring cultivation as carried on at the Station are shown in Plate 8, a view in the main orchard.

For later cultivation by all means the most desirable implement to use is the spring-tooth harrow (Plate 9), although the disc harrow is also extremely useful for this purpose. Either of these, however, should be followed by a smoothing harrow for the purpose of reducing the ridges left by the former tool and the evaporating surface thus afforded.

Cultivation should be carried as near to the trunks of the trees as possible. As the best length of trunk is rather under than over four feet, care must be exercised in working under overhanging tops. The implements mentioned all allow of working close up to the tree, but the style of harness to be used with them is an important consideration if the trees are not to suffer. The harness for orchard work should have no projecting hames or terrets, leather loops being used in place of the latter. As long whiffletrees are apt to scar and bruise the trees unless extreme care is used, a harness arranged to draw by a single chain instead of ordinary traces is preferable. One of the Sherwood type (No. 1, Plate 8), is the most satisfactory for this kind of work.

After heavy rains the surface should be broken up with the smoothing harrow, and after very heavy rains it may be necessary to use the spring-tooth and even the disc harrows for this purpose. In seasons when rain is plentiful this will be sufficient, and will also keep the orchard free from weeds; but in very dry years, such as was the growing season of 1897, a fine soil mulch should be kept on the surface by weekly cultivation. This is important, as in such seasons all of the soil moisture is needed by the trees, and none should be allowed to escape by evaporation.

Cost.

The cost of cultivation is a most important item, and should not be overlooked in this connection. During the season of 1897, the

main orchard at the Experiment Station was cultivated thirteen times after the spring plowing—three times with the disc, three times with the spring-tooth harrow, and seven times with the smoothing harrow. In an exceptionally dry season, such as that was, the ground should be gone over about once a week during the growing season. The cost of these cultivations was $16.00 per acre. This may seem high for a single season's outlay, but when it is remembered that there were 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. As the trees bore heavily, kept a luxuriant foliage to the very end of an extremely dry season, made a good growth, and went into the winter in first-class condition, it will be seen that the cost was comparatively low when placed alongside the benefits derived.

Preparation of the Soil for Planting Orchard Trees.

The foregoing remarks are applicable to growing orchards, but for the preparation of the soil for setting out new fruit plantations more is necessary. As land appears more uniform under grass or grain crops, it is well to put in some hoed crop, such as potatoes or corn, for a year or two previous to the setting of the orchard. This will enable the owner to get better acquainted with the soil peculiarities than he otherwise could.

If the land is not naturally well drained it should by all means be tile drained, particularly if it has a stiff and rather impervious subsoil. This is of greater importance even than subsoiling, as the results of the latter can only remain for two or three years at the outside. Subsoiling may start the root system down properly, but if the subsoil is of the kind above mentioned it will in time relapse into a state of impenetrability if not under drained.

Ordinarily all orchard land should be thoroughly gone over with a subsoil plow (Plate 10) before trees are set—always so, if there is a hard subsoil within two feet of the surface. On some light prairie soils where the hard subsoil is much lower than this, the subsoiling is superfluous.

It should always be borne in mind that the care the orchard gets during its first six or eight years largely determines its ultimate fate, and that the directions before given in regard to the care and cropping of the young orchard are doubly important when viewed in relation to its subsequent life.

To give final emphasis to the foregoing remarks, reference is made to the accompanying illustrations (Plates 11, 12 and 13). Plates 11 and 13 show an Illinois orchard in which systematic cultivation has not been carried on. Plate 12 is a view in the main orchard of the Experiment Station. It was taken in September, 1897, at a time when a large

majority of the apple orchards throughout the state were almost completely defoliated as a combined result of drouth and apple scab. The tree in the foreground with its wealth of foliage and bending under the weight of its load of fruit tells its own story, and stands forth in marked contrast to the preceding picture. From it there can be but one conclusion drawn—that while other things have greater or less effect upon an orchard's health and condition, the prime requisite to successful orcharding in Illinois is thorough and systematic cultivation.

THOMAS J. BURRILL, PH.D.,
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DESCRIPTION OF PLATES.

Plate 1. A typical tree from each of the five plats.
- No. 1. Tree from cultivated plat.
- No. 2. " " oats "
- No. 3. " " corn "
- No. 4. " " clover "
- No. 5. " " blue grass "

Plate 2. Trunks and cross section of the five trees shown in Plate 1.

Plate 3. Cross section of trunks and one year's growth of twigs with their foliage of the five trees shown in Plate 1.

Plate 4. View of a portion of the oats and clean cultivation plat.

Plate 5. View of a portion of the corn and oats plat.

Plate 6. View of a portion of the clover and blue grass plats.

Plate 7. Tools used in orchard cultivation at the Illinois Experiment Station.
- No. 1. Plow.
- No. 2. Disc harrow.
- No. 3. Spring-tooth harrow.
- No. 4. Roller.
- No. 5. Smoothing harrow.

Plate 8. The first stages of spring cultivation as carried on at the Illinois Experiment Station.

Plate 9. Spring-tooth harrow.

Plate 10. Subsoil plow.

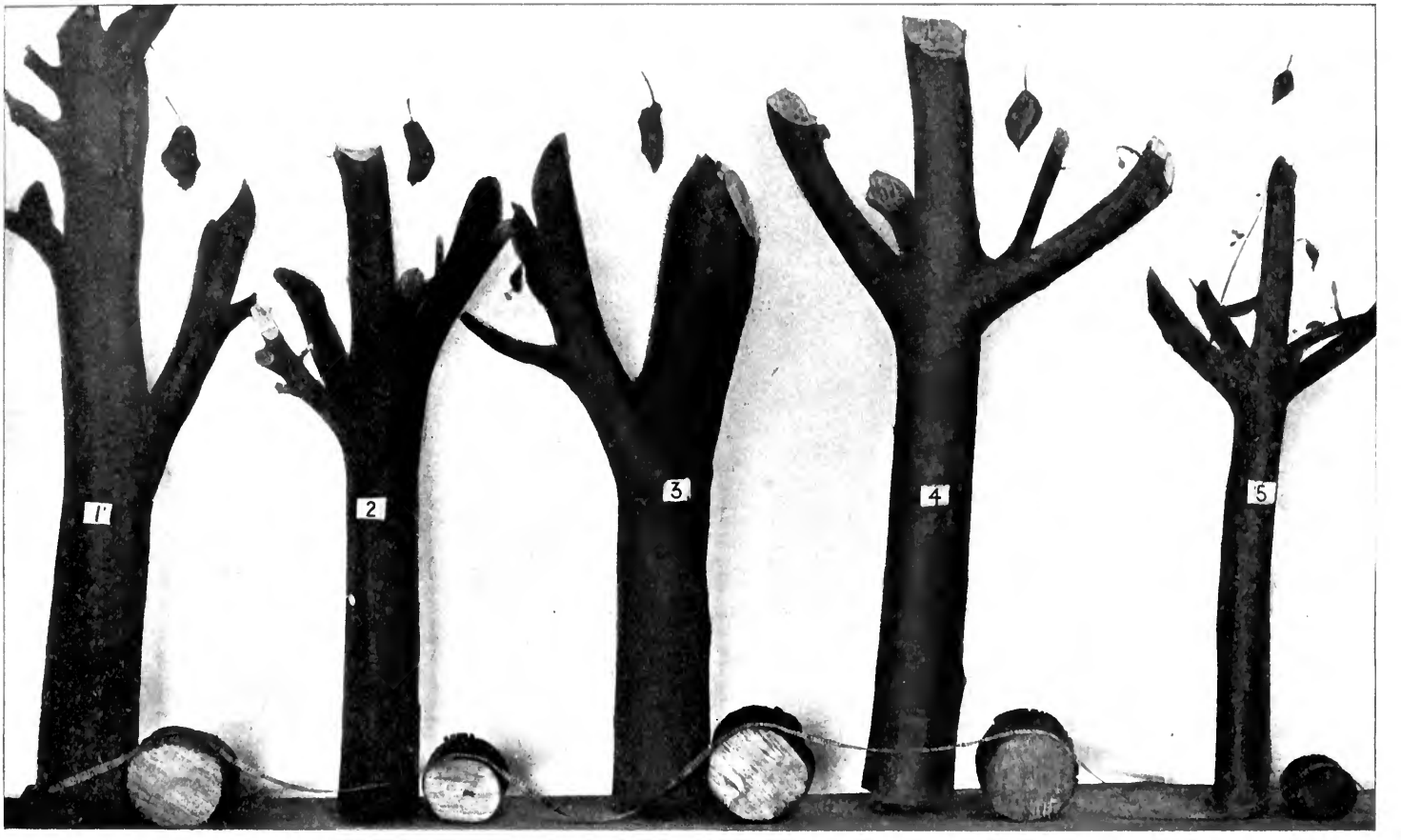
Plate 11. An uncultivated young orchard as seen on an Illinois farm.

Plate 12. A cultivated orchard as seen on the Experiment Station grounds, Dominie apple tree in the foreground.

Plate 13. An uncultivated and otherwise neglected old orchard as seen on an Illinois farm.

Plate No. 1

Plate No.2



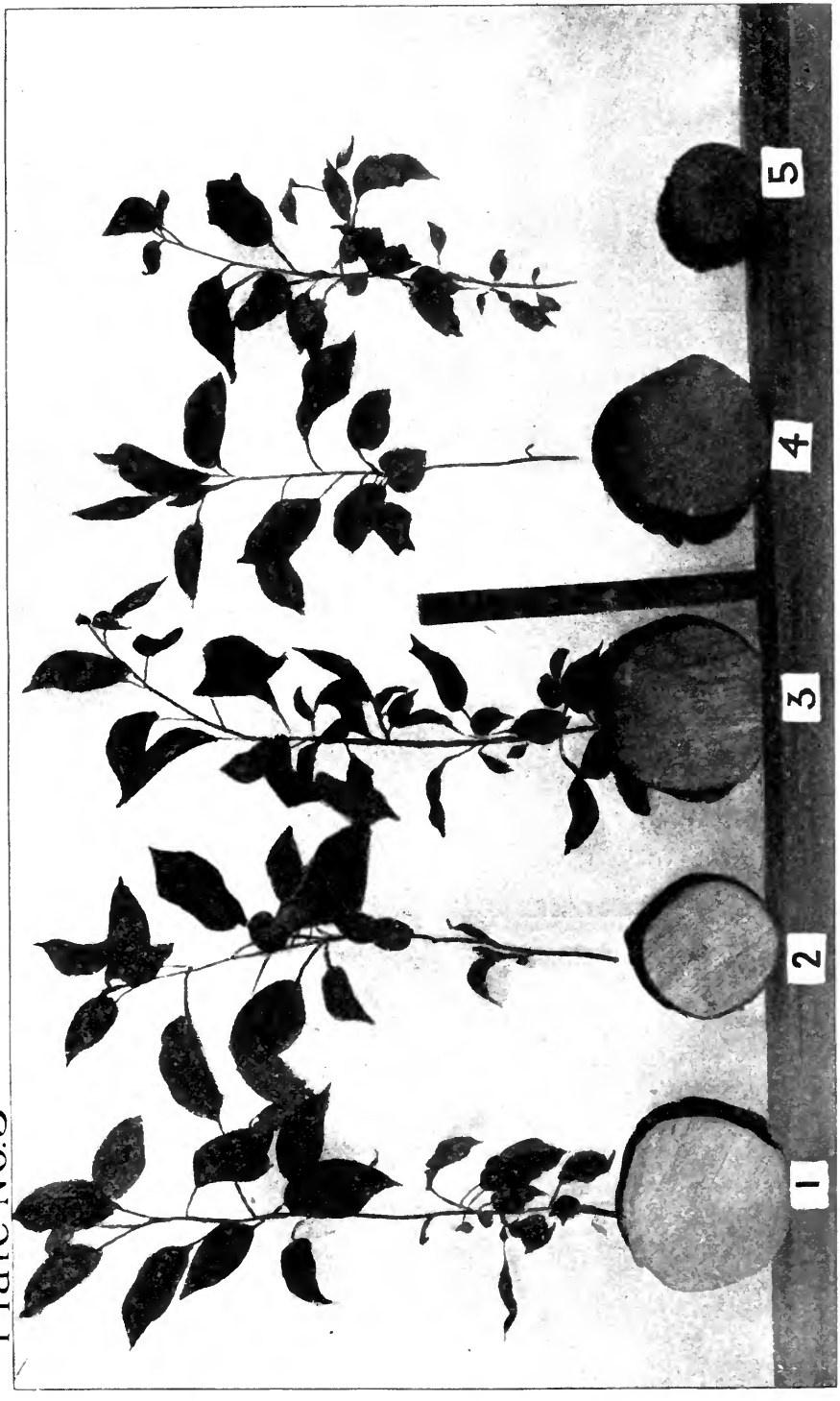


Plate No. 3

Plate No. 4

Oats Plat. Clean Cultivation.

Plate No.5

Corn Plat. Oats Plat.

Plate No.6

Blue Grass Plat. Clover Plat.

Plate No.7

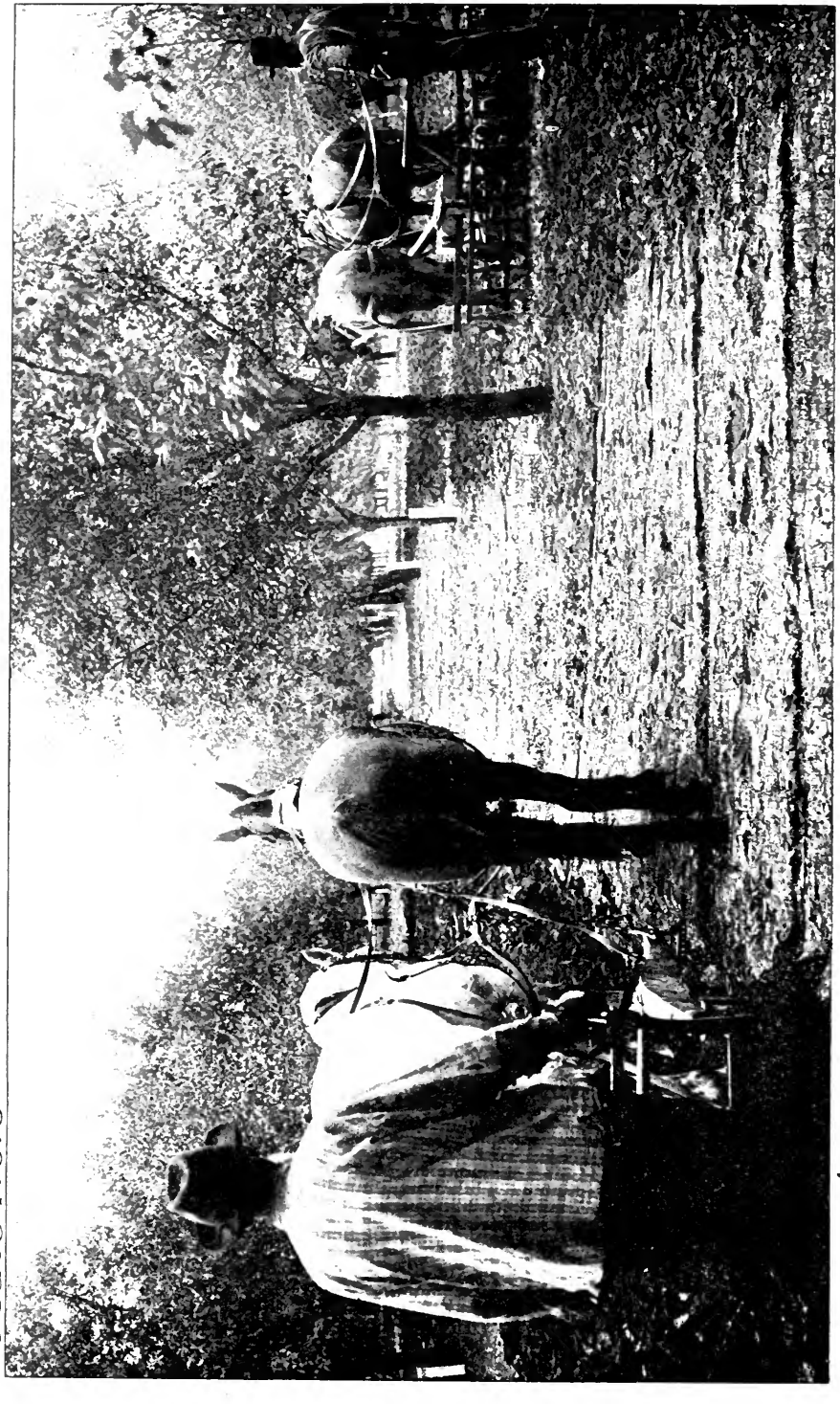
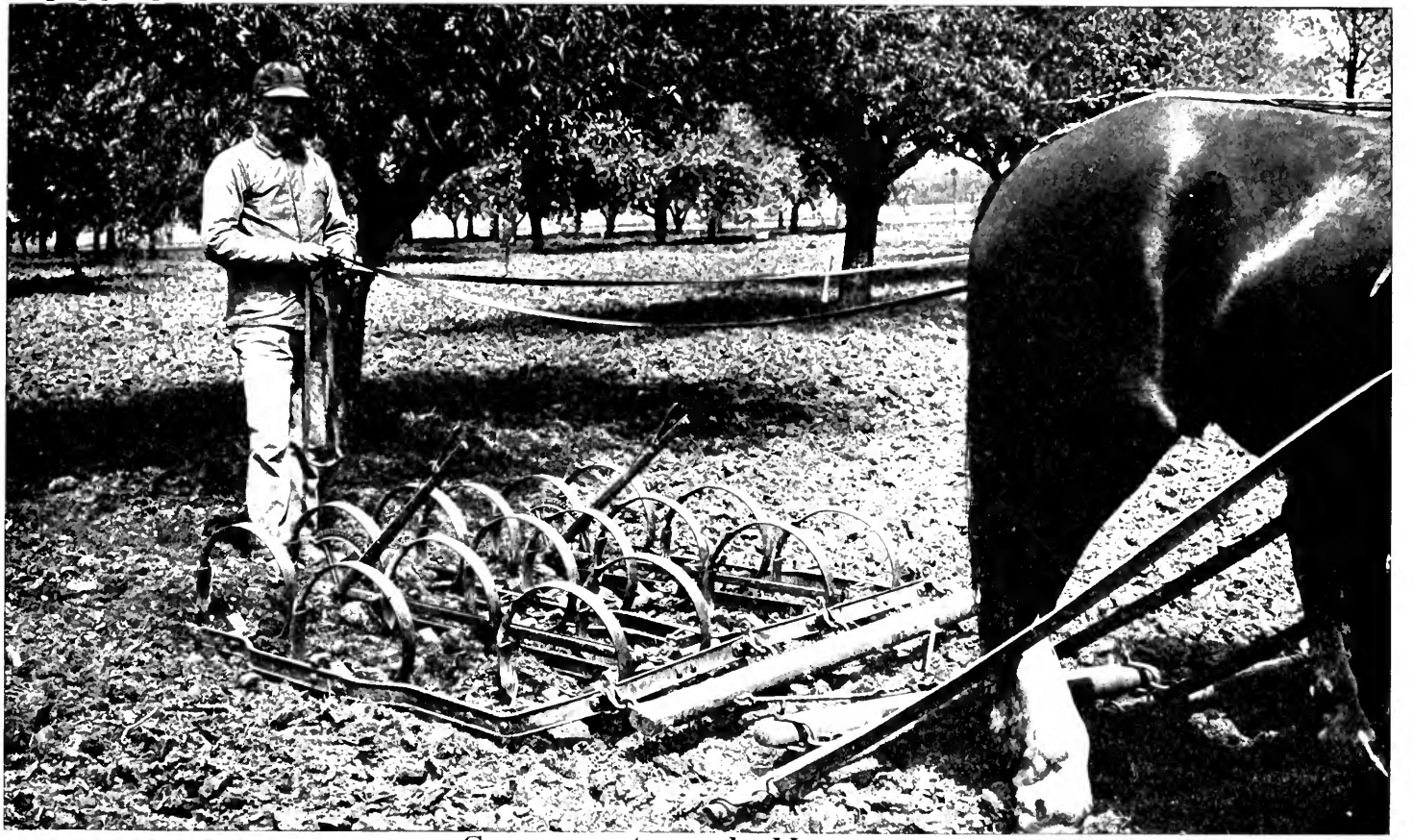


Plate No. 8

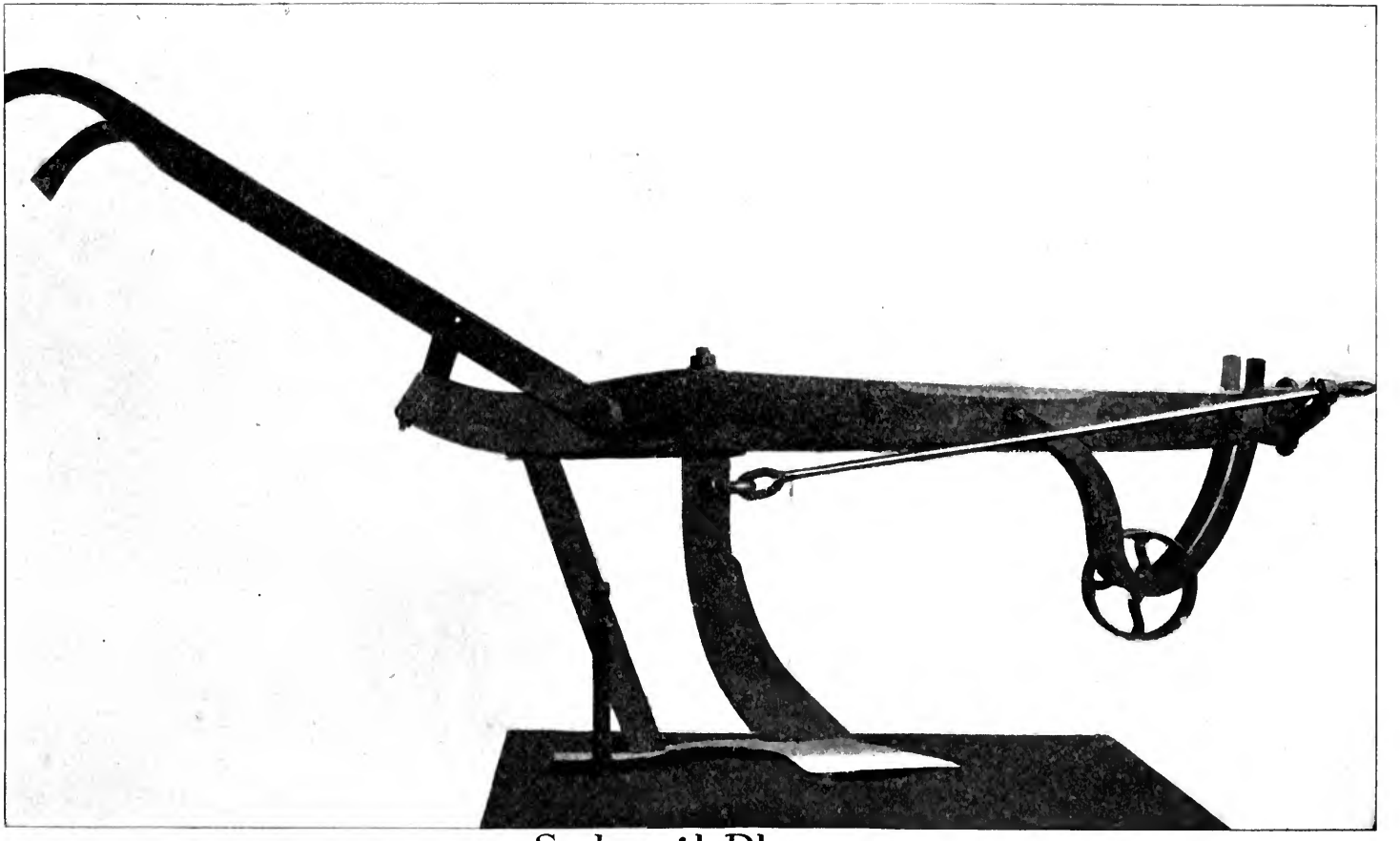
1 2

Plate No. 9



Spring-tooth Harrow.

Plate No.10



Subsoil Plow.

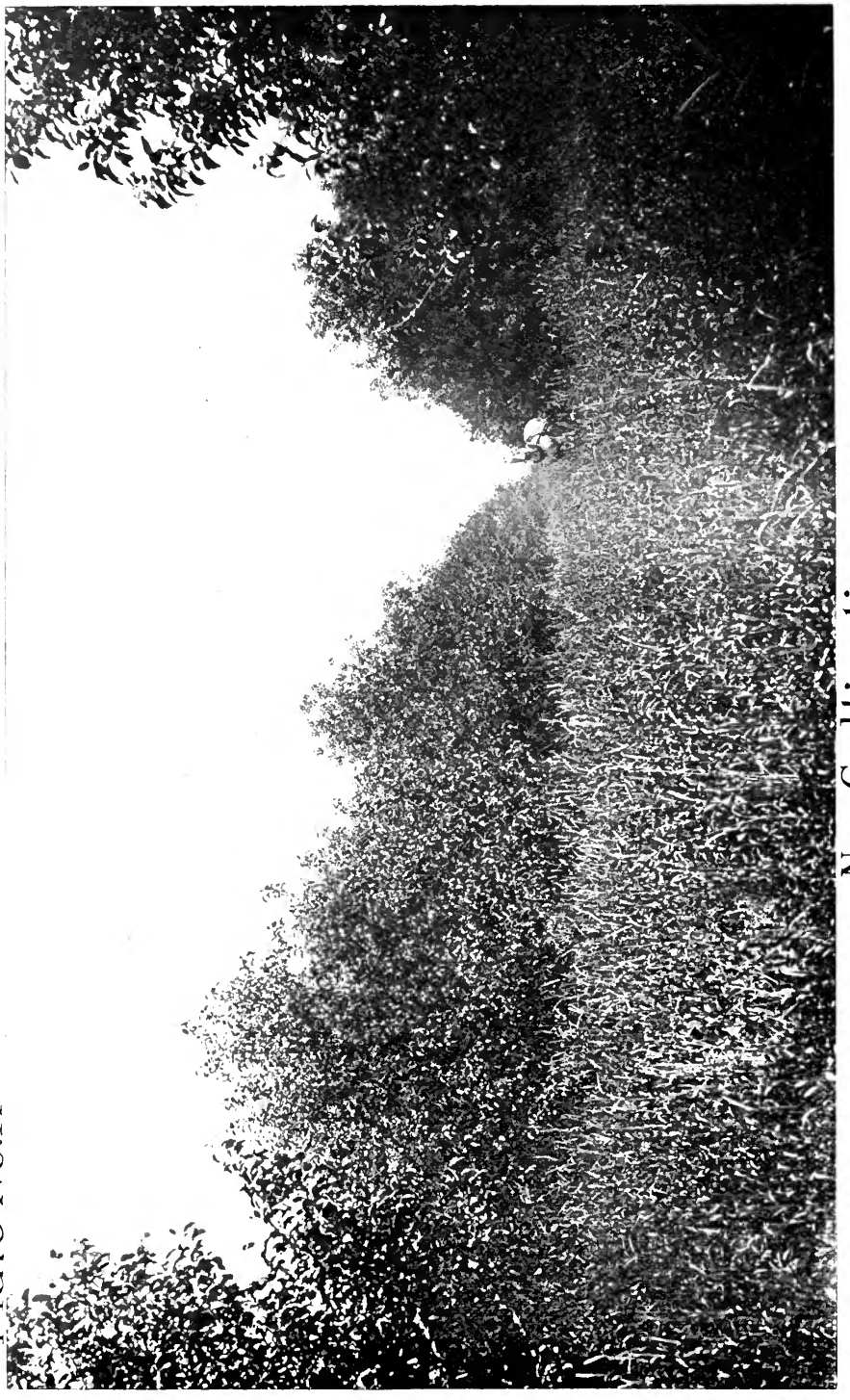


Plate No. II

No Cultivation.

Plate No. 12

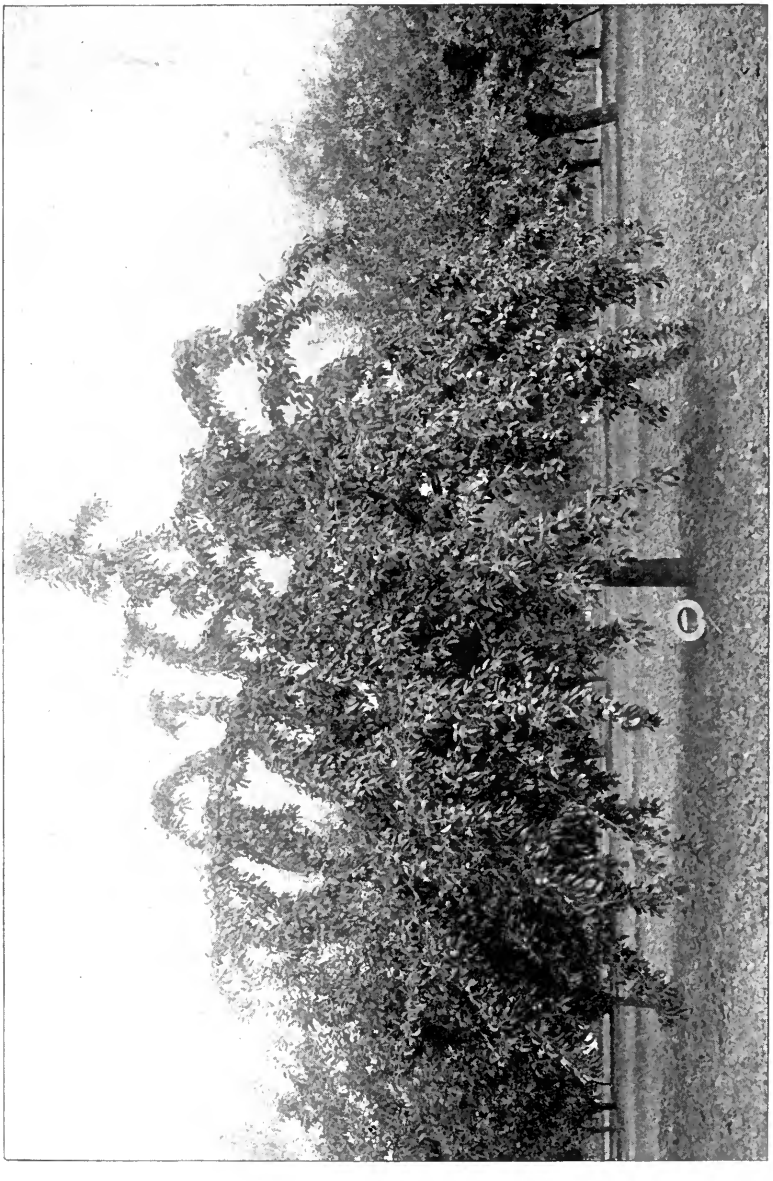
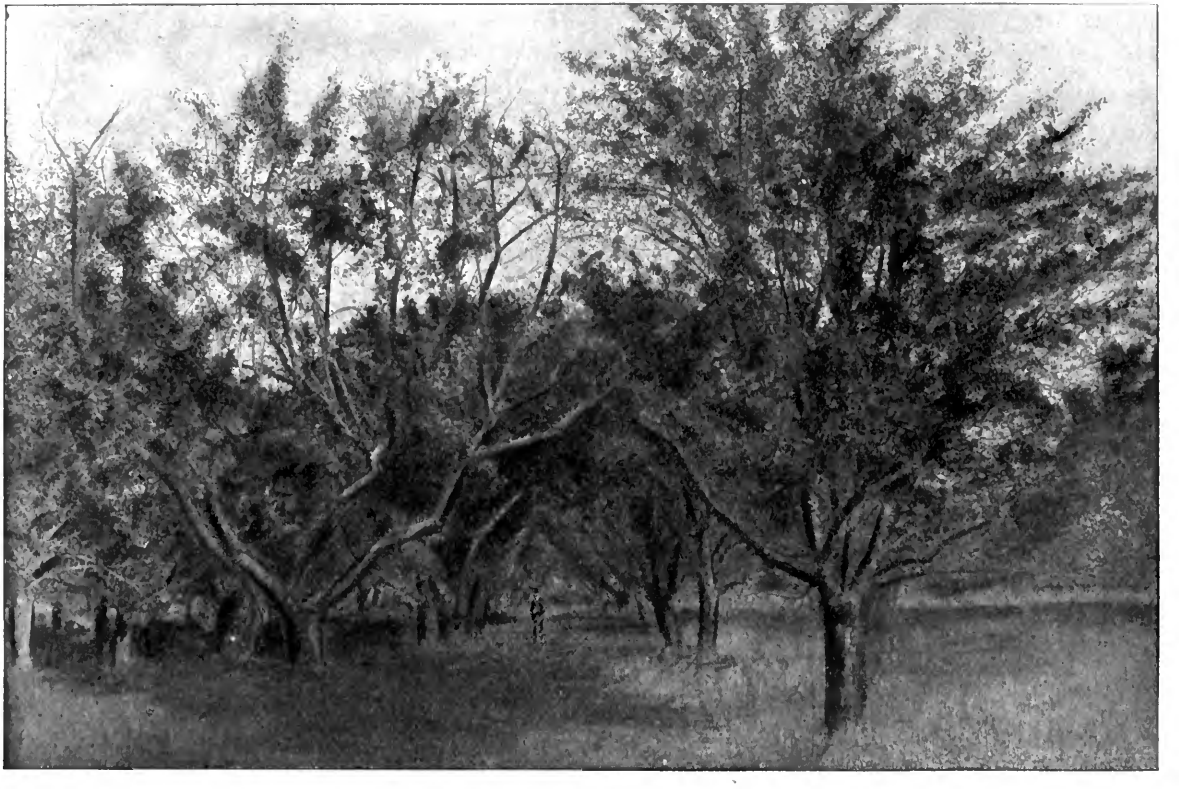


Plate No. 13



An uncultivated and otherwise neglected old orchard as seen on an Illinois farm.