
University of the State of Missouri.

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

Agricultural Experiment Station

BULLETIN NO. 49.

The Apple Orchard.

- (I) Preparation of Soil for Planting.
 - (II) Influence of Tillage on the Growth and
Vigor of the Trees.
 - (III) Crops to be Grown in an Orchard.
 - (IV) Cultural Methods.
-

COLUMBIA, MISSOURI.

January, 1900.

University of the State of Missouri.

COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

Agricultural Experiment Station.

BOARD OF CONTROL.

THE CURATORS OF THE UNIVERSITY OF THE STATE OF MISSOURI.

THE EXECUTIVE COMMITTEE OF THE BOARD OF CURATORS.

JUDGE NOAH M. GIVAN, Pres't, HON. CAMPBELL WELLS, HON. WALTER WILLIAMS
Harrisonville. Platte City. Columbia.

ADVISORY COUNCIL.

THE MISSOURI STATE BOARD OF AGRICULTURE.

OFFICERS OF THE STATION.

THE PRESIDENT OF THE UNIVERSITY.

H. J. WATERS, B. S. A.	DIRECTOR
PAUL SCHWEITZER, PH. D.	CHEMIST
J. C. WHITTEN, M. S.	HORTICULTURIST
J. M. STEDMAN, B. S.	ENTOMOLOGIST
J. W. CONNAWAY, M. D. C.	VETERINARIAN
N. O. BOOTH, B. Agr.	ASSISTANT IN HORTICULTURE
T. I. MAIRS, B. Agr.	ASSISTANT IN AGRICULTURE
W. B. CADY, B. S.	ASSISTANT IN CHEMISTRY
C. THOM, M. A. Ph. D.	ASSISTANT IN BOTANY
JOHN SCHNABEL	GARDENER
J. G. BABB, A. M.	SECRETARY
R. B. PRICE	TREASURER
C. L. WILLOUGHBY	CLERK AND STENOGRAPHER

The Bulletins and Reports of the Station will be mailed free to any citizen of Missouri upon request. A cordial invitation is extended to all persons to visit the Station grounds at any time. Address, Director Agricultural Experiment Station Columbia, Boone County, Missouri,

The Apple Orchard.

Experiments and Observations on the Preparation of the Soil for Planting Apple Orchards. The Influence of Tillage on the Growth and Vigor of Apple Trees. The Crops to be Grown in an Orchard and Cultural Methods.

By J. C. WHITTEN, Horticulturist.

SUMMARY OF RESULTS.

I. In preparing land for orchards, subsoiling, apparently, has not in any way improved the growth of the trees on the Station grounds; though some practical orchardists report beneficial results on certain land. It is, however, desirable in all cases to plow the land thoroughly before planting. On some land, previous cropping with clover is the cheapest method of subsoiling.

II. Trees planted on newly cleared land, the spring after the timber is removed, usually make splendid growth and endure drouth remarkably well.

III. In clearing timber land for orchards the stumps should be cut low; not higher than one-half their diameter, to facilitate plowing and cultivating between them.

IV. Trees that are well cultivated throughout the season, make more growth, are more vigorous, healthier and produce better fruit than those that are not cultivated.

V. Well cultivated trees make a uniform growth, year by year, not being very unfavorably affected, even by so severe a drouth as that of 1897.

VI. Uncultivated trees do not make uniform growth and are unfavorably affected by drouth.

VII. The principal height growth of trees is made early in the season, when our moisture supply is ample, hence drouth, which does not occur until later in the season does not affect the height growth of that year.

VIII. The unfavorable effects of drouth on uncultivated trees, are noticeable in the wilting of the leaves, in the imperfect development of the fruit, and in failure to properly mature or ripen the wood and buds for the succeeding season.

IX. The unfavorable effects of drouth on uncultivated trees are more apparent the succeeding season than they are during the dry year itself. A marked falling off in height growth, and a generally devitalized condition of the trees, may be looked for, in uncultivated orchards, for a year or two following an excessive autumn drouth.

X. During 1898 more trees died as a result of the previous dry autumn than died during 1897. The unfavorable effects of this drouth are yet (1899) apparent in uncultivated orchards.

XI. During a dry summer and autumn, the orchard soil should be kept in good tilth until the crop of fruit and the wood growth are mature, or until rains come.

XII. During a wet summer and autumn, cultivation should cease early enough (August first) for the growth to be checked and the wood ripened for winter.

XIII. Failure of the wood to mature, in autumn, may be as often due to ceasing cultivation too early as it is to continuing cultivation too late. This is particularly true when trees are loaded with fruit.

XIV. Where orchards are given clean cultivation, some kind of vegetation should frequently be grown between the trees, and turned under the next spring, to improve the soil.

XV. The best crops to grow for this purpose are corn, small fruits, garden vegetables, cow peas, and rye. Nothing should be grown in the orchard which will prevent cultivation of the tree rows themselves.

XVI. Where the land is too steep to admit of general cultivation, it may be seeded to clover, but even then a strip next the trees, should be cultivated.

PLAN OF EXPERIMENT.

Of the large number of enquiries, concerning horticultural matters that are continually being received by the Experiment Station, perhaps none is more frequently repeated than that of how best to cultivate an apple orchard. The leading orchardists of the state generally manage their trees in an exemplary manner. There are, however, a great many orchards, particularly on farms where fruit growing is a subordinate rather than a

leading interest; that would be far more profitable if they received better cultivation. Even among the most successful orchardists, questions arise as to the best methods, and the great diversity of method suggests the need of careful investigation of this matter. During the past five years, the Experiment Station has been gathering data upon the subject of orchard culture.

The Experimental Orchards.—Since 1894, several hundred trees have been planted, every year, upon the Horticultural grounds. There have also been growing on these grounds, orchards planted in 1872 and 1878, respectively, besides numerous trees planted for various purposes during the past 35 years. There are, also, three orchards of bearing age, on the College farm, that have been useful in studying this subject. Some of the large commercial orchards near Columbia have furnished valuable data. A number of the latter have been of particular interest, as among them may be found orchards that have been very differently managed with respect to cultivation of the soil, but that have been sprayed, pruned, and otherwise treated with equal skill and care. The largest commercial orchards in the state have been frequently visited and studied, and we have had the hearty cooperation of practical fruit growers in carrying on these investigations.

As another factor of interest, the excessive drouth of 1897, during which almost no rain fell for three months, furnished an admirable opportunity to study the effect of different kinds of treatment of orchards during dry autumns.

I. PREVIOUS PREPARATION OF THE SOIL.

Among our best apple growers there is a diversity of opinion as to the merits of subsoiling, some advocating it as being a very profitable operation, others claiming that thorough plowing is sufficient and that subsoiling does not pay.

Preparation of Old, Well-Tilled Land.—The Experiment Station orchard planted in 1895, is on a heavy clay loam. The land slopes sufficiently to give good surface drainage. The soil is rich and retentive of moisture. It holds water too well to be a typical orchard soil. It had been cultivated in hoed crops for years, but kept in a good state of fertility by frequent manuring.

Before planting the trees in spring, one half of the plat was subsoiled as deep as a strong pair of horses could draw the subsoiler in each furrow, behind the plow. The other half was plowed in the same manner as the first, except that the plow was not followed by the subsoiler.

For the first few months the subsoiled ground was slightly looser, but no difference was noticed in the growth of the trees or in the subsequent condition of the land. By mid-summer the land all seemed to have settled alike, and since that time has required practically the same cultivation and stirring. The soil in this orchard is very fine and subject to washing in spring and during heavy rains. No difference could be detected in the amount of washing on the subsoiled plat and that which was not subsoiled.

We do not by any means conclude that subsoiling may not be beneficial on certain soils, but this, and other experiments on the Station grounds, lead us to believe that subsoiling is not to be universally recommended. If orchards are to be planted on similar, rich, deep, clay loams, that have been well tilled for a series of years, we would recommend only deep, thorough plowing.

Preparation of Newly Cleared Land.—The question is frequently asked, by those who contemplate planting orchards on forest lands: How long should the land be cleared before planting, and what are the best crops to grow and the best methods to pursue in subduing stump lands for planting fruit trees?

From experiment and observation, we believe that trees should be planted the spring after the timber is cut off. This is practiced on the large fruit farms in the Ozark region with excellent results, the young trees making as good, if not better, growth the first year, among the stumps, as they do when planted on older, well-tilled soil. Hon. L. A. Goodman, who has superintended the planting of thousands of acres of orchards in Missouri and elsewhere, says: "I have never failed to get good growth on young trees when they were planted among the stumps, as soon as the timber was removed; and the trees stand the drouth."

In a recent experiment by the writer in planting very steep, rocky, bluff lands, the timber was cut off in winter the brush burned in early spring, and the trees planted. On account of the steepness of the land a strip six or seven feet wide was plowed for each row of trees, leaving the rest of the land undisturbed to prevent washing. As the soil is very rocky a single

shovel, or "bull tongue" plow carrying a root cutter in front, was used. This implement stirred rather than turned the soil, and cut the roots to facilitate the subsequent use of a single shovel cultivator, in keeping down weeds close to the trees. Aside from cultivating and hoeing along the rows of trees, the only attention that has been necessary has been to keep down the sprouts and to mow the weeds and small growth with a bush scythe.

Treated in this comparatively inexpensive manner the trees have made a very satisfactory growth. The natural woods mould together with the sprouts which are left to decay on the ground, form the best kind of a mulch to prevent washing the soil, and keep it cool and moist during dry weather. The decaying stumps permit the fruit trees to root down deeply in their places. Altogether this newly cleared bluff land, too steep and rocky for ordinary tillage, is an ideal place for an orchard, and requires far less cultivation than land that has long been tilled and thoroughly subdued.

In removing timber for orchard planting it is advisable to cut the trees as near the ground as possible in order that whiffle trees and implements may not so readily catch on the stumps in working the land. A good general rule is to leave no stump higher than one-half its diameter.

Figure I, shows how the native forest trees fit the soil, to a great depth, for the immediate reception of the roots of apple trees. This cut shows a section of a steep, rocky hillside, cut down to a depth of eight feet, and illustrates how the roots find their way down among the rocks. On the left hand side, mats of small fibrous roots may be observed, filling a crevice between the hard limestone and a softer stratum below. Near the center a large oak root may be seen making its way around a hard section of the ledge and back into a softer stratum. At the right a root has penetrated a small seam and actually enlarged the opening in the limestone.

In some places the dark surface soil and woods mould have washed down around the roots to a depth of four or five feet.

This is the hillside referred to in previous pages, which was planted to fruit trees as soon as the forest trees were removed. Examination at the present time shows that the roots of the fruit trees readily go down where the forest tree roots have opened up the way.

Preparation of Hard-Pan Land.—There are quite large areas of land in this state, otherwise admirably adapted to fruit culture, which have a thin shell of hard-pan near the surface. The soil above this hard-pan is a rich, gravelly loam, and below it the earth is gravelly and well suited to the reception of fruit

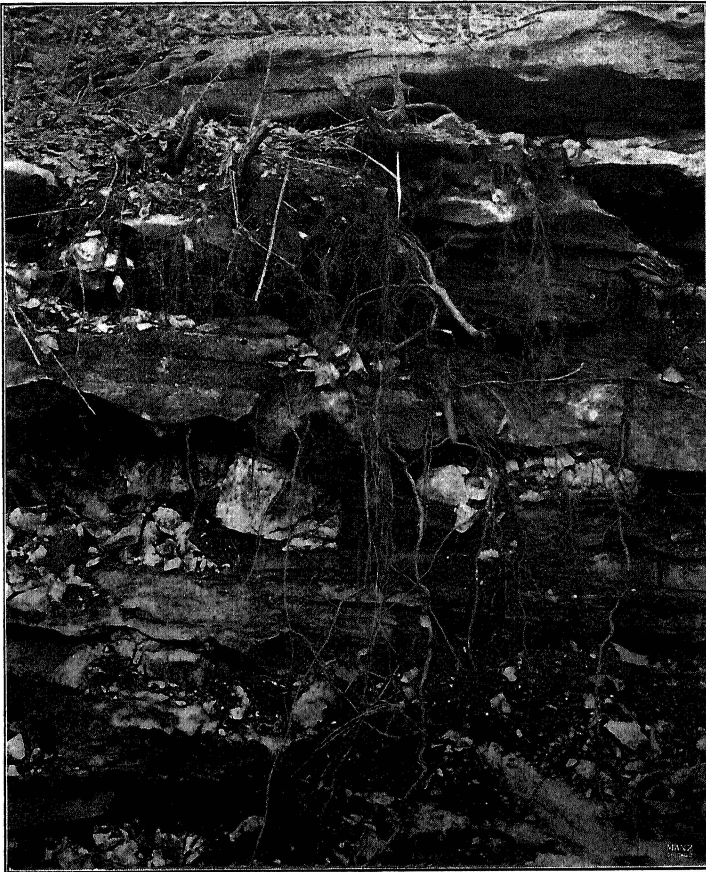


Figure I. Forest tree roots opening up a rocky subsoil.

tree roots. Wherever this hard-pan can be penetrated by the roots, fruit trees succeed admirably. In some cases, however, the tree roots refuse to penetrate this hard-pan, but run laterally near the surface and suffer from drouth. In many cases this hard pan has been successfully opened to let the roots down, by exploding a small charge of dynamite, in the bottom of each tree hole, before planting. This is a somewhat expensive method, however, and hardly to be recommended since the

difficulty may be overcome by previous cropping. Deep plowing, and growing clover has in many cases opened up and softened this subsoil and fitted it for the reception of tree roots. Clover is in many cases the cheapest subsoiler we have. Its deep growing roots literally bore out the hard-pan and make it porous. In cases where a stand of clover can not be secured, cow peas may be used to advantage. A few crops of cow peas, which succeed well, will fit the land for the subsequent growth of the clover. Cropped to cow peas or clover, the soil becomes more retentive of moisture, which softens the subsoil or hard-pan, and enables the roots to penetrate it.

II. RELATION OF CULTIVATION TO THE GROWTH AND DEVELOPMENT OF APPLE TREES.

In order to obtain more definite information concerning the relation of cultivation to the general welfare of apple trees, observations have been made upon several orchards which have been differently managed during the last five years.

Measurements have been taken of the average annual growth of trees receiving good cultivation, of those receiving partial cultivation, of those in clover and some in blue grass sod. In taking these measurements, a strenuous effort has been made to truly represent the average growth of trees under these various conditions of culture. Measurements have been confined to the leading branches of normal trees. Where trees have suffered from blight, accident or other conditions unusual to other trees in the same orchard, they have been rejected. Wherever pruning has abnormally affected the growth, such trees have not been considered. Measurements were made of all the leading branches on about six hundred trees, through four seasons' growth.

The following table shows the average annual growth of trees that have received different kinds of cultivation during the past four years, and the rainfall for each month of the growing season for five years:

TABLE SHOWING INFLUENCE OF CULTIVATION AND CARE UPON THE GROWTH OF APPLE TREES.

No.	Variety.	Age in Years.	Growth in Inches.				Kind of Cultivation.
			1895	1896	1897	1898	
1	Ben Davis...	7	17.6	21.7	23.2	24.5	Clean cultivation throughout each growing season.
2	Ben Davis...	11	12.1	12.4	16.6	14.5	Clean cultivation until 1895; since then clean cultivation until June, when cover crop of cow peas or clover was sown.
3	Ben Davis...	14	17.0	9.5	16.2	10.8	Clean cultivation until 1895; then seeded to clover, clover giving way to bluegrass in 1898.
4	Jonathan....	9	17.2	9.3	13.6	11.0	Cultivated with corn between trees until 1895. In clover since 1895; space cultivated under each tree throughout each summer.
5	Jonathan....	10	7.3	6.6	11.4	9.6	Clean cultivation until 1895. Since then clean cultivation until June, when crop of cow peas or clover was sown.
6	Genet....	30	4.2	6.1	10.4	6.6	In bluegrass and clover; some cultivation around each tree.
7	Genet....	30	3.6	5.5	8.9	4.4	In bluegrass pasture.
8	Genet.....	14	13.0	9.3	11.2	7.4	In clover; no cultivation since 1895.
9	Miscellaneous varieties....	15	11.0	11.8	19.6	12.0	Plowed each spring, cultivated, seeded in summer to cow peas, rye or wheat.

RAINFALL IN INCHES DURING THE GROWING SEASON FOR EACH OF THE PAST FIVE YEARS.

MONTH.	1894.			1895.			1896.			1897.			1898.		
	No. of rainy days.	Total fall.	†Above or —below normal.	No. of rainy days.	Total fall.	†Above or —below normal.	No. of rainy days.	Total fall.	†Above or —below normal.	No. of rainy days.	Total fall.	†Above or —below normal.	No. of rainy days.	Total fall.	†Above or —below normal.
April	17	2.02	-1.84	10	1.04	-2.82	13	3.08	-0.78	12	4.83	+0.97	13	2.76	-1.10
May	13	4.33	-1.25	17	6.09	+0.51	15	5.61	+0.03	9	3.19	-2.39	19	8.39	+2.81
June	12	3.04	-2.03	14	5.78	+0.71	11	4.33	-0.74	15	6.59	+1.52	13	9.02	+3.95
July	9	1.20	-3.05	11	4.93	+0.68	11	3.79	-0.46	8	4.28	+0.03	12	4.60	+0.35
August	7	1.29	-1.41	9	2.30	-0.40	6	1.85	-0.85	8	1.89	-0.81	6	0.47	-2.23
September....	11	7.57	+3.87	6	1.48	-2.22	15	3.61	-0.09	2	0.51	-3.19	11	5.43	+1.73
October....	12	0.98	-0.53	3	0.25	-1.26	7	2.45	+1.94	4	0.69	-0.82	11	2.61	+1.10



Figure II. Six year old orchard in sod, showing poor growth due to lack of cultivation and general care.

The nine orchards mentioned in the table are similar with respect to soil and location. Unfortunately the same varieties do not occur in all the orchards, yet, taken as a whole, these measurements, studied in connection with the table of rainfall, furnish much valuable information.

First, it will be noticed that *the greatest growth has been made by those orchards that have been cultivated most.* It might be expected that the young trees in orchard No. 1 would make more growth than old, bearing trees, but a comparison of Nos. 6 and 7 shows that trees that have received some cultivation have made more growth each year than have those in sod. A close study of these orchards makes the value of cultivation even more apparent than the table would indicate. Cultivated trees are uniformly healthier, more vigorous and produce larger fruit than those that are not cultivated. Figures II, III and IV show the difference between well cultivated trees and those in sod.

Second, *cultivated trees make a more uniform growth than do those that are not cultivated.* This is much more important



Figure III. Fifteen year old orchard in sod. Shows lack of care and cultivation.

than the amount of growth. It will be observed that the uniformity of growth bears a very direct relation to the amount of cultivation given. Orchard No. 1 has made the most uniform growth and it has received thorough and constant cultivation during spring and summer. It has uniformly increased in growth and vigor each year. Only hoed crops have been planted between the trees, and these crops and the tree rows themselves have been thoroughly cultivated and hoed. Orchards Nos. 2, 3 and 5, that have received fairly good cultivation have made more uniform growth than those in sod.

The more the trees are cultivated the less they are affected by the unfavorable influences of drouth. This statement is not too sweeping. It is the most important point in orchard cultivation in this state. Reference to the tables would, at first thought, seem to contradict this statement. For 1897 was a notably dry summer, yet the average length growth of trees was good, while 1898 gave a larger rainfall than any other season recorded in the table, and yet growth that year was small. A careful study explains this apparent contradiction and bears

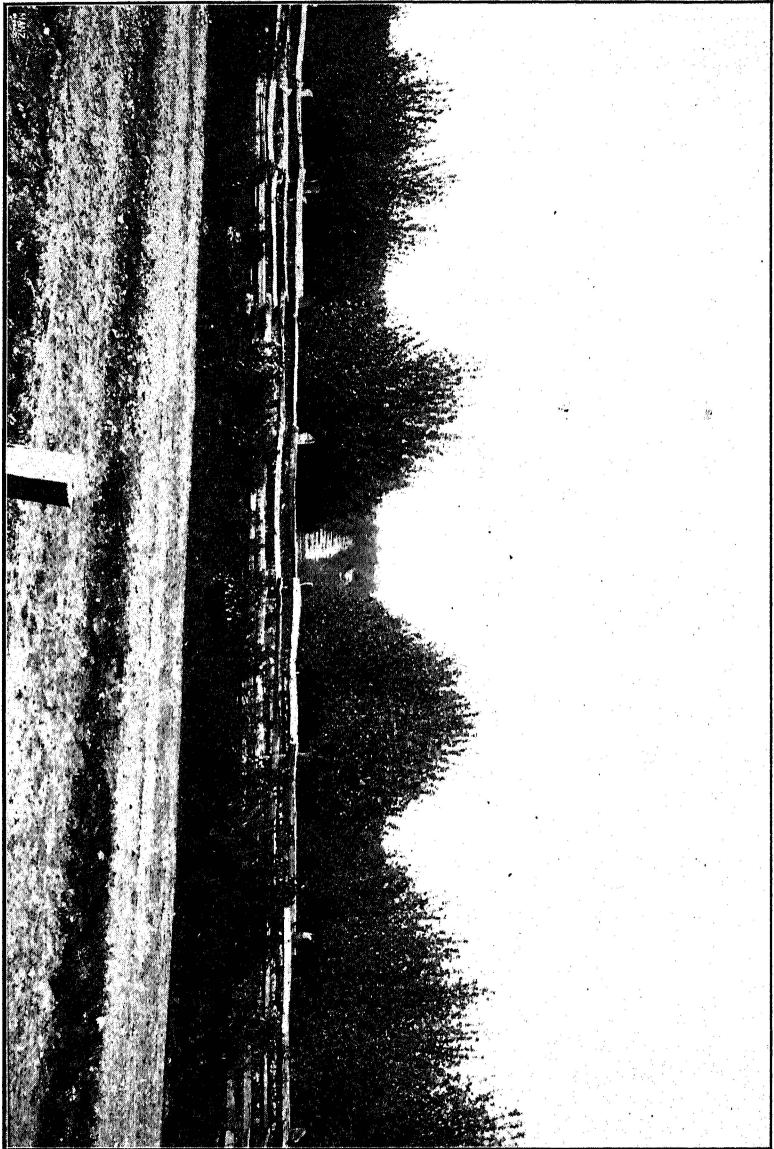


Figure IV. Ten year old orchard, showing remarkably fine growth as a result of good cultivation and general care.

out the statement that cultivation opposes the unfavorable influences of drouth.

It must be borne in mind that trees make their greatest height growth, here, in May and June. In later summer and autumn, food material is elaborated and stored in this new growth, it thickens, its buds are enlarged and more fully developed, and its tissues generally perfected. This is commonly termed the "ripening" of the wood. This storing up of food during late summer and autumn has much to do with the growth that will be made the subsequent spring. A severe drouth in late summer and autumn often so devitalizes uncultivated trees as to seriously affect their growth and vigor for several subsequent years.

During the spring and early summer—the period of height growth—our rainfall is always ample for well established trees. If drouth occurs, it is always in late summer and autumn. From this it will be seen that trees may make abundant height growth, early in the season, and that this growth may suffer from drouth later in the year, and fail to properly perfect itself.

To more fully illustrate this point, the rainfall has been recorded in the table for 1894, one year before the measurements of growth began to be recorded. It will be observed that the last part of the years 1894 and 1897 were marked by severe drouths, and that the average growth of uncultivated trees fell off to a marked degree during the next year or two after each of these dry seasons. Where trees were well cultivated, to conserve the moisture in the soil, this falling off of growth was not noticeable.

The unfavorable effects of drouth upon uncultivated trees may not be so apparent during the dry year itself as it is one or even two years later. This fact often leads to a misunderstanding on the part of some growers. During 1897 the Station received a number of letters asking how to protect trees from drouth, and how late in the autumn trees ought to be cultivated. During 1898, and even 1899, a great many more letters were received, asking why fruit trees were dying off. In many cases it was remarked that the trees stood the drouth of 1897, and made good growth, yet in 1898 and 1899 they were "dying from some mysterious cause." In nearly every case this mysterious dying of fruit trees, during the last two years, was due to the effects of the drouth of 1897, which were not quite sufficient to kill the trees outright. Hon. J. C. Evans, one of the most experienced growers in the state recently (June, 1899) said concerning the serious effect of the drouth of 1897 "the end is not yet." This statement often may be safely used, concerning

dying trees, for at least two years after an exceptionally dry summer and autumn.

The foregoing emphasizes the need of uniform cultivation, as will be seen upon reflection, since the devitalizing effects of unfavorable conditions are not always immediately apparent. Orchards are sometimes seeded down to grass to throw them into bearing or to save cultivation. If this practice is prolonged until the trees are very much injured by a dry season, this injury may not be apparent to the grower until serious loss has been sustained, or until the drouth, has passed and the grower may fail to attribute subsequent failure of the trees, to the proper cause.

Again, trees that make fluctuating growth are less liable to endure drouth without injury. It is probably that trees suffered worse from the drouth of 1897 than they would if they had not made unusual height growth that year. The abundant twig and leaf growth of the early part of the season called for an unusual amount of food supply and moisture in autumn to perfect this growth. Since the twigs and leaves were sufficiently abundant to evaporate more moisture than the roots could supply, the trees suffered. A less abundant twig and leaf growth would, no doubt, have required less water and consequently suffered less.

The proper time to cease cultivation in autumn is a question frequently asked. Some growers set a definite date, say the first of August, after which cultivation is not to be recommended. It is claimed by some growers that cultivation after a given date will stimulate a late autumn growth and prevent the wood from properly maturing for winter.

Experiment seems to indicate that there is no fixed date upon which cultivation should cease, but that this should be governed by the condition of the trees, the weather and other conditions. There is no doubt that a late autumn growth, which sometimes induces trees to open flower buds and wood buds that should have remained dormant until spring, is very undesirable. It is probable, however, that ceasing cultivation too early may be as conducive to this undesirable condition of trees, as is cultivating too late. It is also probable that proper cultivation, at the right time, may do much toward correcting this tendency toward late growth which is sometimes induced by unusual weather conditions.

During 1897, when drouth began in August and continued until winter, some of the trees at the Station were cultivated until late in the season and went into the winter with the surface

of the soil fine and in good tilth. During this year they were apparently benefited by late cultivation. The trees had made good height growth early in the season and needed the best conditions possible to aid them in withstanding the autumn drouth and in maturing their buds for winter. The soil was dry enough so that no amount of cultivation could induce too much or too late growth.

Again, in 1898, there was a very abundant rainfall throughout the spring and early summer. In May, June and July the rainfall was much above the normal amount. Conditions for growth of well established and well managed trees were unusually good. In August the weather became very dry and hot—less than half an inch of rain falling during the month. As is usual in such cases, trees suffered more from this drouth than they would, had the early part of the year been less favorable to growth. Where trees were not well cultivated their leaves wilted, and in some cases began to fall. September and October were unusually warm and wet. Trees that had begun to shed their leaves in August, started a new growth as the rains came on, and in many cases blossomed. Trees that were well cultivated in August suffered less from drouth, made normal growth and were not so unfavorably affected by the rainy weather of September and October.

The value of cultivation in August of that year was particularly marked in peaches and in some of the flowering shrubs. Peaches that were bearing fruit were particularly benefited by having the ground kept in good tilth until the rains came in September. Many lilacs, bush honey suckles, spiraeas and other shrubs that were allowed to suffer from the drouth in August, came into bloom in September and October, while those that were so cultivated as to better endure the August drouth, carried their buds into the winter in a normally dormant condition, and profited thereby.

It is a fact worthy of note, here, that trees which lack vigor are liable to shed their leaves and become dormant early in the season. Their store of energy is small and more quickly exhausted, resulting in a shorter season of growth. If such trees become partially dormant in late summer, they are particularly liable to be stimulated into a spring like growth, later in autumn, if conditions are favorable. This in a measure accounts for the unusual tendency of trees that had been weakened by the drouth of 1897 to shed their leaves during the dry August of 1898, and subsequently to make a prolonged autumn growth. It also emphasizes the desirability of thorough cultivation.

When conditions for growth are favorable throughout the season, and trees are making abundant growth, it is no doubt best to cease cultivation in ample time for the wood to ripen, say the first of August.

If drouth comes on in late summer or early autumn it may be best to keep the land in good tilth in order to conserve sufficient moisture to enable the trees to properly mature their tissues.

If trees are carrying a heavy crop of fruit, during a dry autumn, they may require cultivation until the crop is gathered. Cultivation at such a time, so far from promoting late autumn growth, is usually necessary to enable the tree to mature its fruit without loss of vitality.

The more abundant the growth, early in summer, the later will cultivation be necessary, to properly mature this growth, provided the weather is dry and hot during late summer and early autumn, or if the trees are heavily loaded with fruit.

One of the most favorable conditions for abnormal autumn growth is to cease cultivation just before a dry hot August. Under these circumstances the trees suffer from lack of moisture and enter their dormant state prematurely. If warm, rainy weather follows in autumn, the trees often begin spring-like growth and activity at the time they should become dormant for winter.

III. CROPS TO BE GROWN IN ORCHARDS.

While the benefits of clean cultivation of orchards have been emphasized in the foregoing pages, it should be borne in mind that it is very undesirable to allow the soil to constantly remain bare of vegetation. It is highly desirable to frequently grow and turn under some kind of crop. A bare soil loses some of its fertility, its humus is soon burned out, it becomes unproductive and hard like a road bed; it is less readily penetrated by rain, which, flowing off over the surface, forms washes or cuts; it more quickly loses its moisture during dry times and has a greater tendency to bake and remain lumpy.

To overcome these difficulties some kind of vegetable matter should be frequently plowed under. Other things being equal, the best crop for this purpose is one that may be given clean culture with the trees, or one that may be sown after cultivation ceases in late summer or autumn, and plowed under the following spring.

There are three principal reasons for growing some kind

of crops between the rows of fruit trees. First, to utilize the land while the trees are young, and thus wholly or in part to pay for the cultivation of the orchard until it begins to produce fruit. Second, to produce vegetable matter to be plowed under and thus add humus and fertility to the soil and to increase its power of enduring drouth. Third, to prevent washing of the soil. The same crop may serve any or all three of these purposes. Incidentally, there are other reasons for growing cover crops in orchards, but these are the principal ones observed in this state.

Corn is grown more extensively in young orchards, in this state, than is any other crop. Where the land is rich enough to produce good corn it is no doubt one of the most profitable crops to grow in large orchards, until the trees begin to bear fruit. Large crops may be produced where the soil is rich. It admits of clean cultivation of the trees, and large areas may be cheaply cultivated. In many of the largest orchards in the state, corn grown between the trees pays for their cultivation until they reach bearing age.

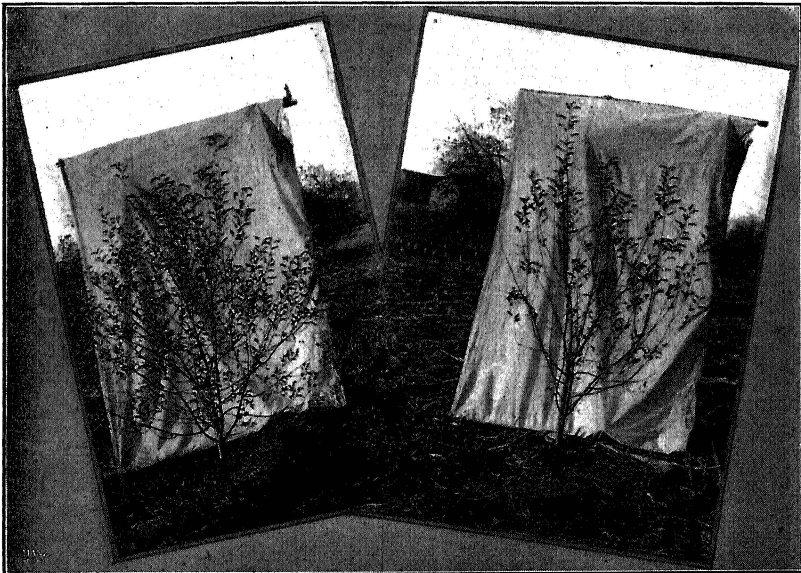


Figure 7. Tree on left shows uniform growth and proper spread of branches of tree having plenty of room.

Tree on right shows premature shedding of leaves below and smothering of branches due to growing corn too close to tree.

It should be borne in mind, however, that corn growing in orchards may be overdone. Corn requires large quantities of plant food and of moisture. Clean cultivation of this crop also rapidly burns out the humus of the soil, thus reducing its capacity for withstanding drouth, rendering it more subject to wash, and depleting its fertility.

One of the most frequent mistakes made is in planting the corn too close to the trees, thus overshadowing them and preventing a proper spread, and development of their lower branches. Figure V illustrates well, the unfavorable results of planting corn too close to trees two years after they were set. In planting corn at least one row should be left out where the trees occur, and as the orchard gets older, even more space than this should be given the trees. In all cases, enough space should be given to permit both corn and trees to make their maximum lateral spread, without touching each other at the end of the season.

Some progressive growers plant two rows of soy beans or cow peas, between the corn and the trees, and turn in hogs to eat this crop in autumn. These leguminous crops and corn make a balanced ration for hogs, and the low growing plants next to the trees favor proper development of the orchard.

Small fruits may be grown with profit in small orchards, especially where markets are easily accessible. The growth of any of the berries does not oppose proper development of the trees.

Garden vegetables, since they require thorough cultivation and, generally, leave some vegetation on the ground, are excellent orchard crops.

Cow peas and *soy beans* are often the best orchard crops, especially where the soil is poor or subject to wash. These crops fertilize the land and increase its capacity for resisting drouth. They should be planted in June. If planted in rows, to admit of cultivation for a time, it is better for the trees. If sown broadcast, space should be left near the trees so they can be cultivated as late as desired. The cow peas may be cut for hay, or better yet, pastured with hogs in autumn. Where cow peas or soy beans are grown, it is usually best not to plow them under until spring. Some such crop, lying on the ground for a winter cover is usually very desirable. Where the land is not very rich, these are the best crops to alternate with corn. Figure VI shows cow peas in an orchard on the Station grounds. At the left, the entire growth of the peas is shown; at the right, the peas were cut for hay, and the autumn growth from the stubble may be observed.

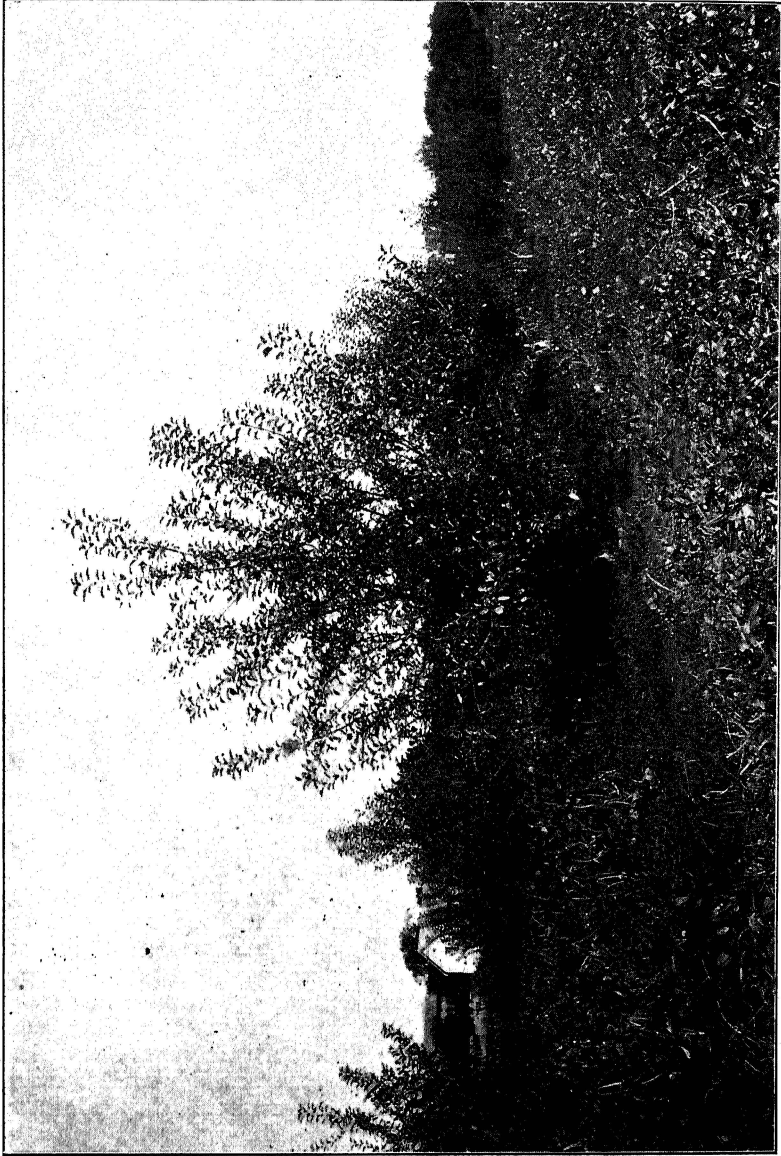


Figure VI, Cow peas in Station orchard. Full growth at left, stubble showing second growth at right.

Clover is a desirable orchard crop for hillsides where the soil has so great a tendency to wash as to prevent general cultivation. Where young orchards are to be seeded to clover, it should be sown in strips, running across the hillside, between the rows, to prevent washing, and the trees should be given clean cultivation until they are well established. Orchards on the deep, rich, porous, "loess" formation, along the rivers, seem to thrive exceedingly well even when kept in clover for years. Hon. N. F. Murray, one of the most successful fruit growers of northwest Missouri, says with regard to growing clover in orchards: "While I generally recommend clean cultivation for orchards, and practice it on level lands, I must make this one exception to clean cultivation, where clover and apple trees thrive together so successfully as they do on our river hills." A study of orchards in the vicinity of Columbia, shows that those in clover thrive better than do those seeded to any other hay crop except cow peas.

It should be borne in mind, however, that orchards do not thrive in clover, except in those localities where clover succeeds well enough to keep down grasses and weeds. An orchard can not be said to be in clover when the clover is crowded out by other growth.

Rye has given excellent results, as a winter cover crop in the Station orchard. It may be sown after cultivation is nearly over and will generally make a good growth to be turned under the following spring. It is best to sow it in strips between the rows, so cultivation may be continued, if necessary, close to the trees. Rye is an excellent crop to prevent washing of the soil in winter and spring.

Buckwheat has been recommended by some growers as an excellent cover crop for orchards. The arguments that have been used in its favor are that it may be sown late, after the orchard has received spring and summer cultivation, that it makes a good winter cover crop, and that its abundant growth supplies, when plowed under, humus to the soil.

We have repeatedly tried buckwheat on various parts of the Station orchards and in each case the results were very unsatisfactory. After plowing it in, in spring, the soil had a tendency to remain lumpy, to bake, to wash badly and did not withstand drouth. In fact it was, in each case, worse than no cover crop. While it may be useful on some soils, it has not been found desirable on the Station grounds.

IV. CULTURAL METHODS—IMPLEMENTS.

So much depends upon the kind of soil, its freedom from obstructions, such as stumps and stones, the manner in which the orchard is to be managed and other conditions, that no single set of implements can be recommended for all orchards. Implements which are used on the farm for general tillage will usually serve to cultivate the orchard in a proper manner. The aim should be to thoroughly and deeply pulverize the soil, between the trees, in spring, and then to keep the surface fine and loose, to the depth of two or three inches, throughout the season. The implements that will accomplish this under a given set of conditions are suitable. An implement that may be just the thing to stir the surface soil when it is loose, dry and mellow, may be almost useless for the purpose of stirring a heavy soil that has become firm after a rain, or for killing strong weeds that have once gained a foothold.

The cutaway or spading harrow is one of the most serviceable tools we have tried at the Station, for turning under light cover crops and pulverizing the soil in early spring. The soil is a deep, heavy loam which packs quite firmly and this same implement is useful in pulverizing the soil after heavy rains or when prolonged wet weather has prevented cultivation until weeds get strongly rooted.

This harrow is reversible, so it may be set to turn the earth either toward the trees or away from them. It is also extensible, so its two sides may be spread wide apart, for the purpose of cultivating under the trees.

The Acme harrow is generally used to break light crusts after rains, and to smooth and level the soil after it is turned by the cutaway.

Spike toothed harrows, capable of being set so their teeth will slant forward or backward, are used to keep the soil stirred and fine, after it has been pulverized by means of other implements.

The Breed's weeder is sometimes useful in stirring the surface soil when it is fine and loose. The Station soil is too heavy for its extensive use, or for breaking a crust after a rain. In a light soil it would no doubt be very valuable.

The Planet Jr. cultivator is used where crops are planted in narrow rows, between the trees. Coarse teeth, or shovels are employed when the ground is firm after a rain, and spike teeth are adjusted for stirring the soil when it is light and fine.

The spring tooth cultivator, mounted on wheels, is popular

on stony ground, particularly on some of the slopes of the Ozarks. On stumpy land a strong heavy A harrow is often used. Where the land is very rough a double shovel, or a bull tongue frequently is employed.

CULTIVATION OF OTHER ORCHARD FRUITS.

The peach should be cultivated as previously recommended for apples. It has been claimed by many that since the peach makes a very rank growth, and frequently prolongs its growth until late in autumn, cultivation should cease very early, in order to give the wood time to ripen for winter. This may be true if there is abundant rain in August and September. If late summer and early autumn are dry and hot, or if the trees are carrying a heavy crop, our experience indicates that the land should be kept in good tilth until the crop is harvested. Peach trees are more liable to suffer from immaturity of tissues, due to insufficient moisture in August or September than they are from immaturity of tissue induced by prolonged autumn growth.

Standard pears and cherries usually succeed best if the land is cultivated until they reach bearing age, and then seeded to clover. Dwarf pears should be given the best of cultivation. Plums do best under clean cultivation but the Americans will succeed fairly well in clover or even in blue grass pasture. Japanese plums should be treated about the same as the peach.