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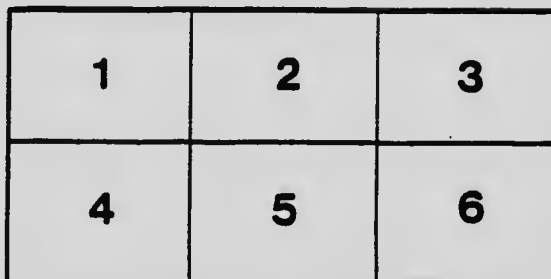
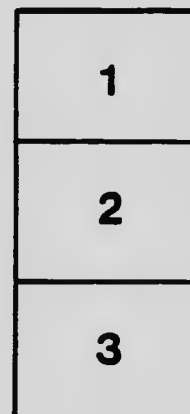
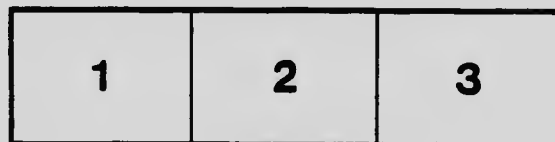
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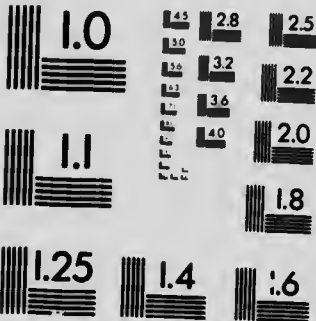
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PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE (HORTICULTURAL BRANCH).

ORCHARD-CULTIVATION AND COVER CROPS.

By B. HOY, B.S.A., ASSISTANT HORTICULTURIST.

FOR many years different systems of orchard-cultivation have been the subject of controversy among progressive fruit-growers. The chief reason for this is, no doubt, the varied conditions of soil and climate that are found in most fruit-growing countries, and nowhere do conditions vary more than in British Columbia. It would be impossible for any one to lay out a system of orchard-cultivation that will be suitable for all of our different conditions; soils vary within a few rods, and the temperature and rainfall in a few miles. The main factors that will determine the system of orchard-cultivation best suited to any particular section of the country are the kind of soil, amount of moisture received, and the length of the growing season. In order to be successful the cultivator must understand the principles of soil cultivation and fertility, study and know his conditions thoroughly, and then adopt the system that is best suited to his conditions. There is no factor in orchard-management more fundamental than the cultivation of the soil. To maintain fertility, to preserve the correct moisture-supply, and to mature the new growth in the fall so that the trees are capable of withstanding cold temperatures are problems that can be worked out by the grower with a thorough understanding of his soil and climatic conditions.

OBJECTS OF SOIL-CULTIVATION.

The three chief objects of soil-cultivation are: (1) To kill weeds; (2) to conserve moisture; and (3) to liberate plant-food.

To KILL WEEDS.

If not held in check, weeds are a menace to the orchard and garden, and should never be allowed to have headway. The best time to kill weeds is just as they appear above ground. Weeds are not only undesirable things to have, but they rob the crops of both plant-food and moisture, and if allowed to go to seed may be a source of economic loss to the community. Co-operation to destroy weeds should be practised in every district. This Province was originally very free from noxious weeds, but the importation of feed-grain and carelessness on the part of our people are encouraging their growth beyond all economic justification.

## TO CONSERVE MOISTURE.

This is one of the most important features of tillage. Moisture in the soil may be in two forms—free water, which is injurious, and can be removed by underdrainage, and capillary moisture. It is in the latter form that moisture is available to plants, and this is the form which our cultivation is intended to conserve. This capillary moisture is essential to the proper chemical action in the soil. Without it plant-food cannot be brought into the necessary soluble form. In dry seasons commercial fertilizers usually give very small returns on this account. All plants contain a high percentage of water, most of them over 60 per cent. of their total weight. While this amount seems large, it is small compared to the quantity evaporated from the leaves of the plant during the progress of growth. Measurements at the various experimental stations show that the evaporated water is several hundred times the weight of the dry vegetable substance produced, varying from 225 to 912 times the weight of the mature dry plant and its crop. From this the importance of an adequate supply of moisture is apparent. Not only is the water necessary as a part of the composition of the plant and for evaporation, but moisture in the soil is necessary if plants are to grow at all. Plant-food is not available, except in a very dilute solution. Practically all the moisture used up is absorbed in this dilute form through the root-hairs of the plant.

Two types of water are mentioned above—free water, which is subject to gravity, and capillary water, which is not. Part of the water which falls as rain enters the soil, the portion that runs off varying with the character of the rainfall and the absorptive power of the soil. On entering the soil, the water which is visible as water, and which flows down by force of gravity, is known as free or gravitational water. That which is retained by the soil-particles, and which is only apparent by the darkened colour of the soil, is capillary water. On it plants are dependent for both food and water. This water is held in a thin surface film around each soil-particle, and can be attracted from one particle to the other when the particles touch each other. When the surface soil becomes dry by evaporation, this water flows naturally to the dry surface particles from those below, so that there is always a slow continuous movement upwards. This upward movement is illustrated in a small way by placing a large, dry clod of earth in a saucer of water, the upward flow becoming at once apparent. This process of upward movement and evaporation is continuously in operation in the soil, and the capillary water not absorbed by the roots of plants eventually evaporates in this way.

The free or gravitational water gradually sinks to its own level. A part of it escapes as seepage or drainage, and, as evaporation takes place from the surface, the free water becomes capillary water, and is so absorbed. The proportions of precipitation which become free or capillary vary with the soil. The greatest loss occurs in sand or gravel; the loams, humus, and clays are capable of absorbing the largest amounts of water.

The two essential points in conserving moisture are, therefore:—

- (1.) To have the soil in that condition in which it will take in and absorb, as capillary moisture, the maximum amount of rainfall or irrigation.
- (2.) When the water is in the soil, to practise those methods which will retain the greatest amount in available form.

The soil to absorb the greatest amount of moisture must be in a loose, friable condition. The amount of run-off is several times as great when the

soil has been allowed to become compact. Deep ploughing, subsoiling, and growing deep-rooted crops will do much on many soils to open them up to greater depths, to increase the rapidity of percolation, and to increase the water-holding capacity.

The moisture after it has soaked into the ground is conserved by keeping a loose layer of earth, 3 or 4 inches in depth, on the surface. As stated above, there is a continuous upward movement of water in the soil. This movement is greatest and the evaporation loss is most serious when the soil is compact. By separating the soil-particles, so increasing the distance between them, this upward movement of water is checked, for it cannot go on unless the particles of soil lie close together.

Besides cultivation, in sections subject to hot, drying winds, wind-breaks should be planted around the orchard. This will do much to lessen the amount of evaporation and will serve many other desirable purposes. Carolina poplars make an excellent wind-break when planted close to each other. For the best results a double row should be used, planting the trees alternately in each row. Plant them 12 feet apart.

#### TO LIBERATE PLANT-FOOD.

Moisture, warmth, air, and organic matter are all necessary to liberate plant-food. Cultivating well to conserve moisture makes better air-circulation and tends to keep the soil warmer and of a more even temperature. The supply of organic matter which is so necessary for bacterial and chemical action can be kept up best by the use of barnyard manure, the rotation of crops, and, in the orchard, principally by the sowing of suitable cover crops.

#### METHODS OF HANDLING ORCHARD SOILS.

Spraying and pruning are two very important and necessary orchard practices, and their value in the production of good fruit is hard to over-estimate; but it is a fact that many growers, in studying and experimenting with spraying and pruning, neglect, and in some instances forget entirely, to give the management of the soil the consideration that it deserves and must have if its productivity is to be maintained. By intelligent handling of the soil much can be done to increase the production of No. 1 fruit with less risk to the grower, and in many instances at a smaller cost of production. There are several different systems of handling orchard soils and many variations of each system. Clean cultivation is the system that is practised more than any other. Ever since the trees were planted the majority of our growers have followed this system, and are continuing to do so without giving the subject very much consideration. In many cases the young trees have made a very rapid growth and are healthy and vigorous. This is as it should be, and a little reasoning will show why. If the benefits of tillage are studied, it will be seen that the physical condition of the land is improved, that moisture is conserved, and that plant-food is liberated. Without giving the subject further thought, or having an intelligent understanding of it, it would seem that clean cultivation was the proper thing and should be continued indefinitely. The soil that most of the trees were planted in was new and had never been cropped. The tilling of this new soil brought about the most favourable conditions for growth to take place. For centuries the natural vegetation had been growing and fertility had been accumulated. This supply of plant-food accounts, in a large degree, for the productivity of virgin soils as soon as they receive good cultivation. After a few years



of clean cultivation the soil does not respond as it did the first two or three years. The reason for this is that cultivation hastens the decay of organic matter, and when this is not replaced the productive power of the soil is very much impaired. Besides depleting the soil of its humus, clean cultivation, as generally practised, produces other harmful results, either directly or indirectly. Some of these harmful results may be summed up as follows:—

(1.) Plant food is being made available all summer; much of this is lost by leaching in the fall and early spring when the trees are not active.

(2.) In climates where the rainfall is light there is not any protection on the ground, and the conditions are favourable for injury by freezing.

(3.) There is a great danger of forcing the trees into a late growth in the autumn, and they enter the winter in a condition that they may easily be frozen.

(4.) On hillsides or where the soil is of a loose nature there is more danger of its washing during the spring thaws and heavy rain-storms.

(5.) On moist, fertile soils heavy, rank wood-growth and tardy bearing trees are often the result of excessive clean cultivation.

(6.) Poorly coloured and oversized fruit are generally the result of over-irrigation and too much cultivation.

The last two conditions resulting from excessive clean cultivation are only of rare occurrence; they are found in one or two sections of the Province where the soils are naturally rich in organic matter and receive a large amount of moisture. It is also true that too much wood-growth is resulting from clean cultivation in the young orchards on some of the new land, but after the trees begin to bear fruit, the reverse, like in all other fruit-growing countries where this system is practised, is generally to be found.

#### COVER CROPS AS WINTER PROTECTION.

Many trees are lost annually in the colder sections by winter freezing, which can be attributed to three main reasons: (1) Very cold weather in winter, often accompanied by cold, drying winds; (2) the planting of tender varieties of trees; and (3) cultural methods.

It is not possible to control the weather, but if precaution is taken in choosing the varieties to plant and such methods of culture that experience has shown to be the best are adopted, winter injury will be reduced to a minimum. Cold weather in the winter months injures fruit-trees in many different ways, but there are two conditions in which trees may enter the winter and be most susceptible to frost. Either the soil and the trees may be too dry, the wood may be forced into a late growth in the fall of the year and enter the winter in a soft, immature condition. Both of these conditions have been experienced here. Soft, immature wood, the result of late growth, favours all sorts of top-injury, while very dry soil conditions generally favour root-killing. When the trees are allowed to grow late in the fall, the result is immature wood; the cells are overcharged with sap and water and in a very good condition for freezing to take place. Where cultivation is checked early and some cover crop sown, or where an orchard is in sod, the injury is never so great, because the trees have a chance to ripen their wood in the autumn and the ground is not frozen to as great a depth. Root-freezing rarely ever takes place where there is some sort of a cover crop growing between the trees during the winter months.

Dry-freezing generally takes place on exposed knolls, light, sandy, or gravelly soils, and on shallow soils underlain with hard-pan, bed-rock, or

gravel. Under these conditions the trees are very shallow-rooted and the soil dries out very rapidly. The result is a freezing of the roots of the tree. The water is drawn from the protoplasmic-cell contents and frozen in the intercellular spaces, from which it evaporates very rapidly. This in effect is a condition of drought, and steps should be taken to guard against it. Having some crop between the trees during the winter, to form a mulch that will catch and hold the snow, prevent evaporation, and prevent deep penetration of frost, and irrigating after all growth ceases in the fall, are the necessary precautions to take against the trees freezing dry.

#### COVER CROPS AS HUMUS-FORMERS.

The maintenance of the productive power of soils depends in a large degree upon the upkeep of the vegetable or organic matter in the soil. This must be kept up to supply the humus to the soil. Humus is not a definitely defined substance, and suffice it to say here that it is one of the last stages in the decomposition of vegetable or animal matter in the soil. Originally this was supplied by nature, but when orchards were planted and clean cultivation adopted, especially in districts where the natural vegetation was small, the supply of humus was soon depleted. Humus is necessary to productive soils, and its benefits may be summed up as follows:—

- (1.) A well-drained soil rich in humus is rich in nitrogen.
- (2.) Evidence shows that in the process of the formation of humus, acids are produced which are capable of dissolving mineral plant-food, and in all probability this is how they become available to the plant.
- (3.) Humus increases the water-holding capacity of light soils by consolidating them and making them less porous. It acts as a soil sponge.
- (4.) It ameliorates heavy soils, making them less liable to bake and puddle, so that proper aeration is secured.
- (5.) Humus generally increases the warmth of the soil. The dark surface draws more heat than a lighter-coloured one.
- (6.) Humus furnishes food material for bacterial action in the soil.

There are not many farmers who will deny the fact that, in spite of the low percentage of plant-food in barnyard manure, it is the best general manure known. The fact is, it serves two purposes, adds organic matter as well as plant-food to the soil, and the former is often more necessary than the latter. In this country, where it is impossible to obtain barnyard manure in sufficient quantities, green manures must be used, and it behoves every fruit-grower and farmer to keep up the supply of humus in the soil. Without humus, as the circular on commercial fertilizers (No. 28) makes clear, artificial manures cannot be used economically, and in districts of light rainfall the depletion of humus in the soil will reduce its moisture-holding capacity, and it will only be a short time until there will be a decided decrease in the size of the crops produced. This has been the history of all the agricultural countries that followed the general cultural methods that are at the present time followed in British Columbia. To prevent the depletion of humus in orchards, cover-crops of some nature are the cheapest and best way.

#### SYSTEMS OF COVER-CROPPING IN GENERAL USE.

Three systems of cover-cropping that are in general use and giving satisfaction under the proper conditions are alfalfa and red-clover sod, summer cover-crops, and annual cover-crops.

Growing red clover between the trees is an old practice with fruit-growers, and under the proper conditions it is giving good results.

From 10 to 12 lb. of seed is sown per acre in the spring, and the crop is left down for a couple of years and then turned under. This system is a very good one where the soil is lacking in nitrogen and there is a sufficient supply of moisture present for both the trees and the clover-crop. A very good way to handle this crop is to sow a third of the orchard down each year. This will distribute the work and will not necessitate ploughing the whole of the orchard any one year. Whether or not it is advisable to make hay out of the clover will depend entirely on conditions. If the soil is very light and devoid of organic matter, all the growth should be cut and left on the ground to rot, but on average soils one crop at least can be taken off without any harmful results; it is always advisable to leave one good crop a year on the ground. When sowing clover it is always well to leave space enough to cultivate near to the tree, because attention to moles and mice is always necessary when an orchard is turned over to soil, for they very often prove serious pests.

Alfalfa as a sod crop in the orchard is just coming into use, and the advisability of sowing it in orchards is discussed a great deal at the present time by progressive fruit-growers. The chief objections to it are that it is difficult to get rid of once it gains a good foothold in the orchard, and that, like other sod crops, it robs the trees during the growing season. In actual practice alfalfa under certain conditions is giving good results. On soils underlaid with open subsoils alfalfa should be a good crop because of its deep rooting. Good results are being secured by sowing alfalfa in orchards, leaving room enough to get around the trees with a cultivator. As the trees grow, one or two furrows are ploughed away annually, thus widening the distance between the alfalfa and the trees. Another system is to grow it in rows, so that the ground can be cultivated between the rows. The crop is then cut before it seeds, so as to prevent the seed dropping and germinating between the rows.

Sufficiently good catches of alfalfa have been secured in orchards by sowing 6 lb. of seed to the acre. Two and three times this amount is generally used. If the seed is of good quality and the soil in good condition, this amount should give a thick enough stand. The same precautions should be used with alfalfa as with clover.

#### SUMMER SHADE CROPS.

This is the term given to annual crops grown between the tree-rows, sown in the spring and ploughed under in the fall. Where winter protection is of minor importance, this is a good practice to get humus into the soil. Red clover, Canada peas, and vetches make excellent crops for this purpose. They all add nitrogen directly to the soil and are good humus-formers.

#### ANNUAL COVER CROPS.

This method of handling orchard soils is at the present time considered the best one for all ordinary conditions. It consists of clean cultivation in the early part of the season up to the middle of July or the 1st of August, when all cultivating and irrigating is discontinued, and some crop is sown that will make a good growth before cold weather sets in. This crop will form a protection over the ground during the winter, and when turned under in the spring is of great benefit to the soil. These crops have been tried

with good results, but are not grown nearly as much as the benefits derived from them would warrant.

#### KIND OF COVER CROPS TO GROW.

Almost any crop that will make a good growth in the fall of the year and form a cover over the ground in the winter, provided the seed is not too expensive, is a good crop to grow. There are a great number of crops that can be grown, but we can divide these into two main divisions—the legumes and the non-legumes. The legumes are the plants which belong to the clover family, such as peas, beans, vetches, etc., and the non-legumes are all of those not included in this family of plants. The advantage of a legume over a non-legume is that the legume is capable of gathering nitrogen from the air and storing it in its roots. They increase the nitrogen-content of the soil, as well as furnish humus. Where the soil is lacking in nitrogen, which can be recognized, provided the soil is well drained and has good treatment, by a poor, stunted growth and pale-green leaves, a leguminous crop is the one to grow, for this is the cheapest and best means of supplying nitrogen to the soil. Another factor to consider in choosing the crop to grow is whether or not the crop will stand the hard frosts of the winter. If it is desired to protect the roots of the tree, a hardy crop should be chosen. Rye is one of the best crops we have in this respect. It grows readily on most all soils, is hardy, and when sown at the rate of about 90 lb. to the acre, furnishes an excellent mat over the ground during the winter, which will catch and hold snow and prevent a great deal of washing on hillsides in the spring. Where orchards are planted on hillsides, a crop that does not kill by frost should be used, for it prevents the washing-away of a great deal of valuable soil. Winter wheat has given good results, and can often be secured easier than some of the other crops. Sow 90 lb. to the acre.

Buckwheat is a good crop to grow on heavy clay land. It germinates readily, and is valuable in putting land in good tilth. It does not afford much winter protection, and is not to be recommended for that purpose. Sow 60 lb. to the acre.

Turnips have been used to some extent, but the results obtained from their use have not been very satisfactory. Sow 1 lb. to the acre.

Rape is often used as a cover crop, sown at the rate of about 6 lb. per acre, but is not of much value as a winter protection.

Of the leguminous crops, we have the clovers, vetches, and peas. Hairy or winter vetch has been grown with very good results, but the price of seed is so high it can only be recommended where the soil is lacking in nitrogen. It is the best of the leguminous cover crops, as it forms a close, heavy mat on the soil during the winter months and does not kill out easily. Sow about 50 lb. to the acre.

Crimson clover in districts where it grows well makes an excellent cover crop if sown from 12 to 15 lb. of seed to the acre.

In the above notes only those crops that have been tried out have been discussed, and of all the crops mentioned, rye is, for all ordinary purposes, giving the best results. A mixture of rye and hairy vetch makes an excellent crop. It is also a good plan to mix in some turnip or rape seed when using crimson clover.

#### TIME TO SOW THE COVER CROP.

The time at which to sow the cover crop will vary with conditions, and it is impossible to lay down any hard-and-fast rules governing the time to

sow. This will depend upon the growth the trees are making, the amount of moisture in the soil, the size of crop the trees are carrying, and the earliness or lateness of the district.

Where trees are making a rank growth and not coming into bearing as soon as they should, sowing down the orchard to one of the sod crops is a good plan, or sowing the cover crop early in the summer. This will tend to check growth. This is also a valuable practice where trees are growing oversized, poorly coloured, and poor-quality fruit due to excessive growth.

In sections where the rainfall is light and there is no irrigation, sow the crop early enough so that it will make a good growth before cold weather and have a good amount of growth to turn under in spring. This will be from the 1st to the middle of August under most conditions. In these dry sections where moisture is scarce, cover crops are very important in increasing the moisture-holding capacity of the soil. Sow one at least every other year.

Under ordinary conditions in most of the fruit-growing sections of this Province, cover crops should be sown by the 1st of August.

#### **SOWING THE CROP.**

Many make the objection that a cover crop will not catch in the fall. This may be true on soils very devoid of organic matter, but where a proper system of soil-management has been maintained in the early part of the season, there will be little trouble in getting such crops as rye, wheat, buckwheat, etc., to catch, and the second year there will be still less trouble. If a seeder can be secured, the seed can be sown in the damp earth just below the mulch with little difficulty. Otherwise the seed can be sown broadcast, and, as a rule, an ordinary smoothing-harrow will cover it deep enough to secure good germination.

#### **PLOUGHING DOWN COVER CROPS.**

Cover crops should be ploughed under early in the spring. Many who have grown cover crops have had poor results, even to the extent of injuring and stunting the growth of the orchard, and for that reason have discontinued using them and are condemning their use. This is a mistake, for after investigating the difficulty it has been found that it was not the cover crop that did injury, but the method by which it was handled. Plough it under as soon as the land is fit to work in the spring, when the crop can be easily turned under. If one has a very large acreage and not sufficient teams, a fast-growing crop, such as rye, may get ahead and be difficult to turn under if not taken early. If allowed to grow up to make hay or seed, it takes the moisture and plant-food from the trees just at the time they need it most. This was what happened with many of the growers, and the use of cover crops was discouraged in their districts.

#### **COST OF COVER CROP.**

The seed and time taken to sow are the only costs connected with a cover crop where the orchard soil is ploughed every year, so the cost will vary with the kind of crop grown. When the value of the crop is considered, this cost is a mere trifle, for the improvement in soil conditions alone on many places would result in making the soil so much easier to work that it would more than cover the cost of the crop, besides the value in enriching the soil.

In irrigated districts where the soil is light, the use of cover crops will reduce the amount of irrigating after the first couple of years by increasing the moisture-holding capacity of the soil.

## SUMMARY.

- (1.) Cultivation is necessary to conserve moisture, kill weed-growth, and liberate the maximum amount of plant-food.
- (2.) Cultivation hastens the decay of organic matter, which must be supplied to maintain the productiveness of the soil.
- (3.) Three systems of cover-cropping in the orchard-sod crops, shade crops, and annual cover crops.
- (4.) Alfalfa and red clover sometimes grow with successful results where the moisture-supply is sufficiently large to supply trees and crop with moisture.
- (5.) Gophers, moles, and mice are bad in sod crops.
- (6.) Sod crops may be used as a means of checking growth of too rank-growing trees on strong soil.
- (7.) Where alfalfa is grown, disk deeply every spring with alfalfa-disk.
- (8.) Shade crops are valuable humus-formers, but can be used only in irrigated sections or where there is a heavy summer rainfall.
- (9.) Clean cultivation with annual cover crops is the best system under ordinary conditions.
- (10.) Cover crops serve many purposes:—
  - (a.) They check late growth and induce early maturity, lessening the liability of freezing;
  - (b.) Prevent root-freezing by forming a mulch, preventing deep penetration of frost and holding the snow better;
  - (c.) They prevent the washing-away of soil during heavy rain-storms and spring thaws;
  - (d.) They prevent the leaching-away of plant-food in the fall and early spring by using it in their growth, and where turned under give it back to the soil in the spring;
  - (e.) Where turned under they add humus to the soil, which increases the moisture-holding capacity of light soils and opens up heavy soils, making them easier to work. If it is a legume, nitrogen is added to the soil;
  - (f.) When sown early, cover crops are valuable to check the growth on rank-growing, tardy-bearing trees. A good way to start them fruiting.
- (11.) Rye for all ordinary purposes makes one of the best cover crops.
- (12.) Sow the cover crop from middle of July to middle of August, depending on conditions.
- (13.) Grain-drill the best implement to use in sowing.
- (14.) Plough the crop under as soon as soil will permit in the spring. Do not allow the crop to get ahead.
- (15.) Purchase seed of wheat or rye a year ahead, for the same season's crop is not always threshed at the time for sowing.

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