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Orchard Soil Covers

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FOREWORD

THE FERTILITY of the soil underneath the trees in an orchard may be regarded as the owner's bank account. That fertility is limited—it is not inexhaustible. Every time a crop of fruit is taken off, a check is drawn on that account. When a cover crop is turned down or manures added, a deposit is made. But in many orchards the checks are more numerous than the deposits, and when this theoretical bank account becomes impoverished, the owner's actual bank account is depleted. In many orchards erosion takes away fertility much faster than fruit crops do. To let streams of water run through the orchard, each carrying away its load of precious top soil, is equivalent to turning over the checking privilege to hundreds of irresponsible strangers. Clean cultivation without addition of cover crops or their equivalent depletes the fertility account swiftly and inevitably. Nature spent some millions of years in building up the fertility account; twenty years of poor management will bankrupt it.

Below the range of human vision, there is a vast universe of life that forms a broad and deep foundation for the visible life we know. A top soil filled with decaying organic matter is teeming with this invisible life. Decay is the consumption of organic matter by the minute plants and animals that live upon it. Those orchardists and farmers are usually prosperous who work for the greatest possible development of these invisible helpers. The reason for this is that the roots of plants and trees most readily absorb needed elements after the materials have been acted upon by soil organisms that live on organic matter. Without life in the soil there can be no profitable plant growth, and this universe of invisible life is therefore the most valuable of the many natural forces that the farmer uses. For these reasons the most important effect of continually adding large quantities of organic materials is the development of abundant life in the soil.

Orchard Soil Covers

By

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ORCHARD SOILS REQUIRE ORGANIC MATTER

Cropping removes fertility; cover crops replace it

Loss of humus through continual cultivation, leaching away of soluble plant foods, loss through crop removal, tree growth, and finally soil erosion, are all factors at work continually to break down the fertility and productiveness of cultivated soils. The very process of clean cultivation results in breaking down measurable amounts of humus each year. This alone will deplete soils in time, but if erosion takes its toll also, then the life of a soil may be comparatively short. TO AVOID THESE LOSSES, PLANT COVER CROPS.

Cover crops prevent erosion

Most orchard soils on hill land are eroding rapidly. This may be visible, as is evidenced by the ever-deepening gullies; or it may be the invisible "sheet erosion", which is no less harmful. When muddy water runs off from an orchard, every drop of it is carrying away some of the most productive of the orchard soil. It is the surface soil that is important. "Save the surface and you save all," claimed by a paint company, certainly applies to soils. The yellow or reddish-brown subsoils are worth little in comparison with the dark, fertile top soil. When an owner allows this top soil to wash away he has literally sold his farm down the river. COVER CROPS HOLD THE SOIL IN PLACE.

Organic matter is the life of the soil

The productiveness of all soils depends upon the supply of organic matter, which may be called the very life of the soil. It is important as a direct source of plant food as it contains the entire supply of nitrogen found in the soil, and portions of all the other nutrients required by plants. The availability of other mineral plant foods is dependent upon the action of bacteria, which in turn are dependent upon the organic matter for their life. Soils may be high in plant food yet low in productivity because of a depleted supply of organic matter. Soils that are low in organic matter usually have a comparatively low water-holding capacity, cultivate less readily, and are more subject to erosion than soils that have a greater supply of organic matter. Soils lacking in organic matter dry quickly, wash or erode easily, crust and crack, and do not absorb moisture well. Trees growing on such soils have light-green foliage, make little or no growth, and produce a light crop of low value. Organic matter is the vital part of the soil—it imparts life and fruitfulness. Commercial fertilizers

may also be needed in orchards, as well as organic matter, but one cannot make up for the other.

Cultivation depletes organic matter

Successful orcharding depends upon a system of soil management that maintains or increases soil fertility and soil organic matter, and prevents soil erosion. A rich virgin soil loses its organic matter rapidly when it is continually plowed and cultivated. When these losses continue year after year without replacement, the soil organic matter becomes so depleted that trees lose their vigor, and production falls off. Orchards under such conditions become permanently devitalized and unprofitable. Clean cultivation without the addition of cover crops or their equivalent is one sure method of accomplishing orchard-soil depletion in either irrigated or unirrigated regions. If orchard soils are to be kept productive, provision must be made to supply the necessary organic matter.

Steady annual growth of trees is needed

Fruit and nut trees must have growing conditions that will allow sufficient annual growth necessary for production of heavy crops of the size and quality that the consumer demands. Without this annual growth production and quality decline rapidly. This tree growth is noticeably lacking in soils that have become depleted of soil fertility or have lost the valuable top soil through erosion.

Orchards are severe taskmasters

A downward trend of quality and production in orchards is often charged to increased age of trees. Other older orchards still highly productive show that age is not alone the reason. The drain on the soil to support these orchards has been heavy, and unless fertility has been maintained and the soil protected, lessened production and low quality are natural results. Profitable yields of quality orchard products depend upon eternal vigilance in building and maintaining soil fertility. Means of accomplishing this are limited, especially in the nonirrigated orchard sections of Oregon. Practical methods for building and maintaining organic matter are suggested in this bulletin.

Young orchards need cover crops

In the young orchard the humus content should be built up while the trees are yet young so as to prepare the soil for crop production and tree maintenance when the orchard is older and the drain on the soil resources is the heaviest. In the older orchards maximum cover crops are more difficult to produce because the trees are large, shade the ground, and offer competition to grain or legume cover crops. Many orchards on dry land are planted too closely; in such orchards a really heavy cover crop is almost an impossibility.

Cover crops may be either nitrogen-gathering or nitrogen-consuming

Cover crops used in Oregon can be classified as nitrogen consumers and nitrogen gatherers. The nitrogen consumers include such crops as winter barley, rye, winter wheat, turnips, mustard, and rape. The nitrogen gatherers include vetches, Austrian winter field peas, alfalfa, sweet clover, crimson clover, and other legumes.

Cover crops of the former group consume nitrogen, phosphorus, potash, and other elements from the soil and are valuable because they save this plant food and return it to the soil when they decay. Otherwise the winter rains and snows might wash away the soluble plant food they have used.

Cover crops of the nitrogen-gathering group likewise take fertility from the soil and in addition gather nitrogen from the air and fix it in the soil for the use of crops to follow. The nitrogen-gathering group is considered the more valuable for orchard soil building. The cover crops in the nitrogen-consuming class should not be discounted, however; they can be grown easily and rapidly and are of value in rebuilding depleted or partly depleted soils.

Acreage requirements of organic materials

When organic matter, in quantities indicated below, is added to an acre of land annually, much is accomplished in maintaining and building soil fertility.

Green legume cover crop, 6 to 7 tons, or
Mixed legume and grain cover crop, 7 to 8 tons, or
Stable manure, 5 to 6 tons, or
Alfalfa hay, 1 ton, or
Clover or vetch straw, 1½ tons, or
Grain straw 1 to 2 tons, to which is added 15 to 20 pounds of actual nitrogen.
Other bulky organic materials, some of which are listed on page 18.

COVER CROPS FOR NONIRRIGATED ORCHARDS

Annual cover crops properly handled and grown in cultivated orchards protect against erosion during the fall and winter months, prevent leaching away of plant food, and return organic matter to the soil.

They increase the water-holding capacity of soils.

They supply the food for continuous bacterial growth, which makes mineral plant foods available.

Cover-cropped soils are more easily cultivated when cultivation is necessary.

Cover crops while growing absorb and hold nitrates and other plant-food elements that are otherwise often lost through leaching.

Cover crops prevent or reduce moisture run-off, aid water penetration, and check or prevent soil erosion.

They catch and hold the leaves shed by the trees.

Cover-crop combinations for Western Oregon north of Josephine County

Annual cover crops suitable for Western Oregon north of Josephine County are as follows:

1. Common vetch, 40 to 50 pounds of seed per acre, with winter barley 60 pounds.
2. Common vetch, 40 to 50 pounds, with winter oats, 60 pounds.

3. When vetch seed is low priced, 75 to 90 pounds of common vetch or Hungarian vetch is often seeded alone.

4. Rye, 90 to 100 pounds, seeded alone on depleted upland soils. Rye should receive more attention for cover-crop use in this region.

5. Winter or hairy vetch, 20 to 25 pounds, with rye, 50 to 60 pounds. This combination is recommended for thin neglected upland orchard soils and in locations where other crops are likely to be winter killed.

6. Hungarian vetch, which grows somewhat slowly early in the spring, can be substituted for common vetch. Hungarian vetch may prove more suitable for cover crops in Western Oregon over a period of years because it is more resistant than common vetch to low winter temperatures and to aphid attacks.

7. Austrian winter field peas, 75 to 90 pounds, are becoming more popular as a cover crop.

8. Austrian winter field peas, 60 to 75 pounds, and one bushel winter barley is a combination often used.

9. Turnips, Pomeranean White Globe, Cow Horn, Purple Top Leaf, and Danish Bortfield turnips are often seeded at the rate of 2 to 5 pounds in August and September.

10. Crimson clover is a cover crop for sandy-like soils, well drained, and comparatively high in fertility. Seed should be inoculated. Plant in August or late July at rate of 10 pounds of seed per acre.

Volunteer weeds and grasses may serve as cover crops

In certain lowland orchards volunteer cover crops, such as chickweed, wild mustard, grasses, and legumes make the growing of a seeded cover crop somewhat difficult or unnecessary. These volunteer crops should be supplemented with an addition of nitrogen fertilizer, such as nitrate of soda or sulphate of ammonia, broadcast 100 to 150 pounds per acre in late January.

When orchard soils have considerable volunteer wild mustard, it may be desirable to increase the stand by the seeding of 2 or 3 pounds of wild mustard seed.

Winter grains may be used as cover crops in unirrigated regions of light rainfall

Winter grain, 90 to 120 pounds per acre, preferably rye, is recommended for unirrigated regions of light rainfall. Rye grows in cooler weather than wheat and may be turned down earlier in the spring. In areas of light rainfall legume cover crops seldom make much growth. Winter grains are more successful.

COVER CROPS FOR IRRIGATED ORCHARDS

Legume cover crops are used in irrigated areas

Alfalfa is the permanent cover crop most generally used in irrigated orchards. Biennial sweet clover may be used. The latter will often maintain itself by reseeding if cultural conditions are favorable.

Grimm alfalfa or northern-grown hardy strains of common alfalfa are quite satisfactory. It is important that these alfalfas be purchased from reliable sources. Ladak is a new variety that is gaining in favor in Oregon because of its winter hardiness, long life, and resistance to disease.

A low-growing type of sweet clover is desirable, and there are many variations in both the yellow blossom and the white blossom biennial sweet clover.

A firm, well-prepared seed bed is necessary for alfalfa or sweet clover. Irrigation rills should be close enough together to maintain moisture while the crop is being started.

Legumes and grains for Eastern and Southern Oregon

Cover-crop combinations for irrigated orchards in Eastern and Southern Oregon include:

1. Alfalfa for a permanent orchard cover crop, 12 pounds.
2. White biennial sweet clover, 20 pounds.
3. Oats, rye, vetches, and Austrian winter peas for annual cover crops. (For rate of seeding, see pages 5-6.)
4. Red clover, 12 pounds.

Soy beans, sour clover, or buckwheat suggested for summer cover crops for Southern Oregon irrigated orchards

Soy beans seeded late in April in Southern Oregon offer opportunities for a summer cover crop. The Manchu variety at the rate of 60 pounds per acre should be used and the seed should be inoculated. This crop will need plenty of water.

A suggested summer cover crop for Southern Oregon is sour clover, a yellow-flowered annual, seeded 10 or 12 pounds per acre in May or June. This seed may be obtained from southern seed houses.

Buckwheat has possibilities as a summer cover crop. The seeding rate is 40 to 60 pounds per acre.

Warning

Summer cover crops such as are used in warmer sections of the United States have not proved of value in Oregon. These include Sesbania, Crotolaria, beggar weed, and Kudzu.

SEEDING COVER CROPS

Time of seeding cover crops

Cover crops should be seeded preferably in late August or early September for grains, vetch, and winter peas.

Turnips and crimson clover have been seeded in late July or early August with success in young orchards on sandy-like soils; otherwise seed in September.

Cover crops on irrigated soil are seeded mostly in the early spring on a firm seed bed after damage of frost is past.

Legume cover crops should be inoculated on soils where such crops have not been grown in recent years. Inoculation costs are small and inoculation of seed is at all times a safe and profitable practice.

Drilling is preferred

Drilling in orchard cover crops between the tree rows is to be preferred to broadcasting and harrowing to cover the seed. Drilling gives better coverage of seed and results in more uniform stands and a more even growth early in the season. Care should be taken to seed as close to the trees as possible as complete coverage of the soil with a cover crop lessens erosion possibilities. For small seed, such as grass or clover, the seed bed must be firm.

A seeding method to lessen erosion

Cover crop of winter grain and vetch seeded on the contour in a young filbert orchard, 1936.

Cover crops seeded in this manner in hillside orchards do much to check soil erosion during the rainy fall and winter months.

Harrow on the contour

When cover crops are seeded by drilling or by harrowing to cover the seed the contour of the land should be followed. This will avoid making small rills that may lead run-off directly down a slope and thereby cause excessive erosion.

ORCHARD CULTIVATION

In nonirrigated orchards cover-crop growth should be stopped in early spring

Because of the large quantities of stored soil moisture that cover crops use when they are allowed to grow in the orchard in the late spring, early

cultivation to stop this cover-crop growth is necessary in the nonirrigated regions. It does not take much growth to weigh a pound, but 500 to 800 pounds or more of water must pass out through the leaves of plants to produce one pound of dry matter.

In recent years growers are practicing shallow tillage in cultivated orchards. Cultivation to turn down the cover crop can be a light disking or plowing about mid-April provided that the soil becomes dry enough for tillage. If the season is exceptionally early this tillage should take place the first part of April.

Excess cultivation causes losses

Cultivation of orchard soils following the working in of the cover crop should be only enough to keep down weed growth. Weeds consume moisture and plant food needed by the trees. Experiments have shown that cultivation beyond the control of weeds has but little value. Extra cultivation in such cases becomes only an added expense. Furthermore, unnecessary stirring of the soil results in actual waste of moisture to the depth of cultivation. Constant stirring of the soil with subsequent exposure to air and sunlight aids rapid decomposition and waste of valuable organic matter from the soil. Soils that have been excessively cultivated are more subject to erosion because the protecting trash and much of the organic matter from the surface soil have been destroyed. A soil that has been cultivated to a dust mulch will puddle and become compact when the first rains fall. Such a soil condition does not allow the water to soak into the soil; it promotes rapid run-off and serious erosion.

Howard Merriam, of Goshen, Oregon, makes the following statement regarding his experience with shallow cultivation:

> "I have practiced shallow cultivation for three seasons just deep enough to stop the growth of cover crops. My orchard has improved, and in my opinion improvement is continuing. With my present knowledge of shallow cultivation, I would hesitate to return to the practice of deep and frequent cultivation in my apple orchard."

Cultivation kills permanent cover crops

Deep cultivation of an established alfalfa cover crop shortens its life. This practice should be reduced to a minimum or avoided entirely. Experimental evidence at the Prosser Experiment Station in Washington shows no additional benefits to the soil from disking or working in the alfalfa cover crop.

The rod weeder is valuable for orchard cultivation

The rod weeder is regarded favorably as an orchard-cultivation tool in the nonirrigated sections of the Willamette Valley where the acreages are large enough to warrant the investment. It is a most effective weed-killing implement and leaves the soil in ideal condition for absorbing moisture.

Robert Warrens, of Forest Grove, comments as follows on rod weeders in connection with orcharding:

> "My investment in a rod weeder is one of the best I have made on the farm. I would not be without it, especially for orchard cultivation."

COVER-CROP AIDS

Commercial fertilizers increase cover-crop growth

In some orchard soils cover crops will not make satisfactory growth because they are too depleted of fertility to support heavy plant growth. This situation often may be remedied by the application of commercial fertilizers. Nitrogen and phosphorus are the two elements that are usually lacking in a badly depleted soil. If phosphorus is lacking, some form of available phosphorus fertilizer should be applied to the soil that will add approximately 60 pounds of phosphoric acid (P_2O_5) per acre. This may be applied at seeding time in the fall or as a top dressing in late January or February. A complete fertilizer may be needed on some soils.

In irrigated orchards where humus has become depleted or spray residue hinders the establishing of new cover crops, this difficulty in certain cases has been overcome by the addition of barnyard manures or other bulky organic materials a year in advance of seeding the cover crop.

Barnyard manure is a "cure-all" for many soil ills

When barnyard manure is available, applications made at the rate of 8 to 10 tons per acre will usually make it possible to grow satisfactory cover crops on most orchard soils. The barnyard manure not only furnishes plant food for the cover crops and trees, but also aids in building up the supply of organic matter. As manure is low in phosphorus, the application of three to four hundred pounds per acre of superphosphate with this application of manure will result in greater benefits to the orchard. Most growers know and appreciate the value of barnyard manure. The difficulty is that there is not enough manure available to supply orchard needs. It is necessary to use other or equivalent methods of building the soil so that a satisfactory cover crop can be grown.

Straw or other organic material aids in establishing cover crop

As a substitute for barnyard manure, straw or other crop-residue material may be added to the soil to supply this need. Leguminous crop residue such as alfalfa hay, clover hay, vetch straw, or pea straw used at the rate of 2 to 3 tons per acre will prove a satisfactory substitute for barnyard manure without the addition of any other material. Unfortunately, grain straw cannot turn directly and completely into humus because it is short of nitrogen. In the process of decay straw must get nitrogen from some other source or else two-thirds of it passes off into the air and is lost. Fifteen to twenty pounds of commercial nitrogen applied with each ton of straw will prevent this loss.

Straw rots more completely on the surface than it does when plowed under, but makes more humus when worked into the soil. Consider the fence post—when an old post is dug out, where is it decayed? Therefore, when straw is added to an orchard soil, it should be disked in lightly, not plowed down. There is another reason for this, too. If a man owns a rotary rod weeder, he can run his weeder below the lightly disked straw, whereas a heavy cover of straw plowed down is worked with difficulty if at all. Straw on and near the surface will usually stop erosion completely, whereas this effect is much less if the straw is plowed down.

Lime helps legumes on acid soils

In Western Oregon many of the hill soils on which orchards are grown are very low in lime. These soils are often referred to as acid soils. The supply of lime in the soil may be so depleted that legume cover crops

Fertilizers increase cover-crop tonnage

Nitrogen alone or with phosphorus and potash applied to orchard soil near Dallas, Oregon, gave nearly 300 per cent increase yields of cover crops.

Plot 1 received sulphate of ammonia alone in 1929, 1930, and 1931.

Plot 2 was unfertilized for three years.

Plot 3 received sulphate of ammonia and sulphate of potash for three years.

Plot 4 received sulphate of ammonia and superphosphate for three years.

Plot 5 received nitrogen, phosphorus, and potash for three years.

Fertilizers were used at the following rates:

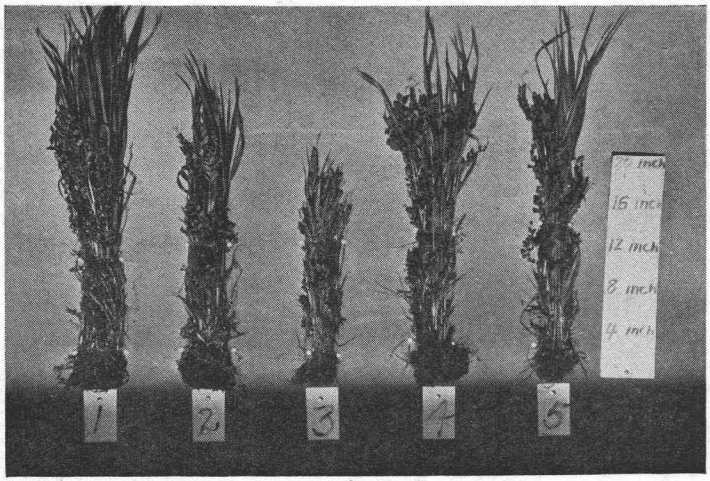
Sulphate of ammonia—4 pounds per tree.

Superphosphate—7 pounds per tree.

Sulphate of potash—2 pounds per tree.

cannot be grown. *This situation can be remedied only by the application of some form of lime.* Usually ground limestone is the most economical. Applications are made at the rate of one to two tons per acre, based on results of a soil test that may be obtained at the office of the county agricultural agent. Ordinarily lime will show no direct benefit to the trees when applied to orchard soils. If the application of lime makes it possible to grow a good cover crop, however, the trees will shortly begin to show their appreciation.

Melbourne soil responds to fertilizers



Nitrogen alone or combined with superphosphate, or with superphosphate and potash, increased growth of vetch and oats cover crop on Melbourne soil at Forest Grove, Oregon. The fertilizers were applied February 18, 1928. Photographed April 25, 1928.

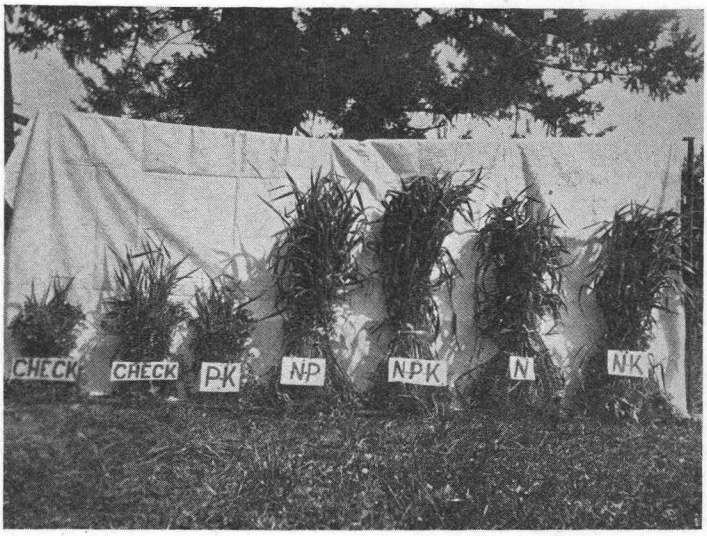
Rates of application:

No. 1. Sulphate of ammonia, 180 pounds per acre.
No. 2. Nitrate of soda, 200 pounds per acre.
No. 3. Unfertilized plot.
No. 4. Sulphate of ammonia, 90 pounds, and superphosphate, 200 pounds per acre.
No. 5. 5-7-8 Fertilizer, 500 pounds per acre.

February applications of nitrogen-carrying fertilizers aid in soil building

Lack of nitrogen may be corrected by the addition of nitrogen-carrying fertilizers applied as a top dressing in February at the rate of twenty to forty pounds actual nitrogen per acre. Under Western Oregon conditions, where soils are inclined to be low in lime, nitrogen fertilizers *having*

Fertilizers increased walnut orchard cover crops



Fertilizers on barley and vetch cover crop, Nutcroft walnut orchard, Washington County, 1929-1930.

Rates of application of nitrogen, phosphorus, and potash annually were:

Sulphate of ammonia, 320 pounds per acre.
Superphosphate, 15 per cent, 560 pounds per acre.
Sulphate of potash, 160 pounds per acre.

Soil type, Olympic clay loam.

Wherever nitrogen was used in this demonstration there was greatly increased cover-crop growth with the balance slightly in favor of the nitrogen, phosphorus, and potash combination.

a basic reaction, such as sodium nitrate, calcium nitrate, or calcium cyanamid, should be used. The continued use of ammonium sulphate under these conditions results in increasing the soil acidity.

If both nitrogen and phosphorus are lacking, these elements may be added either as separate fertilizers or in the form of ammonium phosphates that contain both nitrogen and phosphorus. The use of complete fertilizers is the practice of some orchardists.

Simple soil tests aid

An approximate idea of the need of phosphorus fertilizers may be determined from a soil test. Lack of nitrogen is often indicated by a small growth and a light green or yellow appearance of any crop that may be growing. The grower himself should determine by actual trial the advisability of using these fertilizers. When one suspects that the cover crop may need fertilizer, and plant food is applied in the form of commercial fertilizer, a small portion of the orchard should be left unfertilized in order to determine whether or not the practice is profitable.

Legume crops are heavy sulphur users

Legume cover crops are heavy feeders on sulphur. Many Oregon soils are low in this element. In Western Oregon the lack of sulphur may be corrected by the use per acre of 100 pounds of land plaster, applied in the fall or early spring. On Eastern Oregon and Southern Oregon soils it may best be supplied through the use per acre of 100 pounds of soil sulphur every two or three years. Where the spray program includes the use of lime-sulphur sprays, enough sulphur residue ordinarily will fall to the ground to supply the needs of the cover crop and extra applications are unnecessary.

Overcrowded trees need thinning

In older orchards it is often impossible to grow cover crops because of the extreme competition offered by the trees themselves for moisture and plant food. Usually if the trees are so closely planted that a cover crop cannot be grown successfully, the orchard crop itself suffers. Where such is the case it is often advisable to pull out enough trees to permit the growth of a cover crop. It takes will power to pull out fine large trees, but where carefully done such removal has proved profitable, increasing the vigor and yield of the remaining trees, and the quality of product. Where orchards are failing and unprofitable because of overcrowding, a tree-thinning program is certainly worthy of consideration.

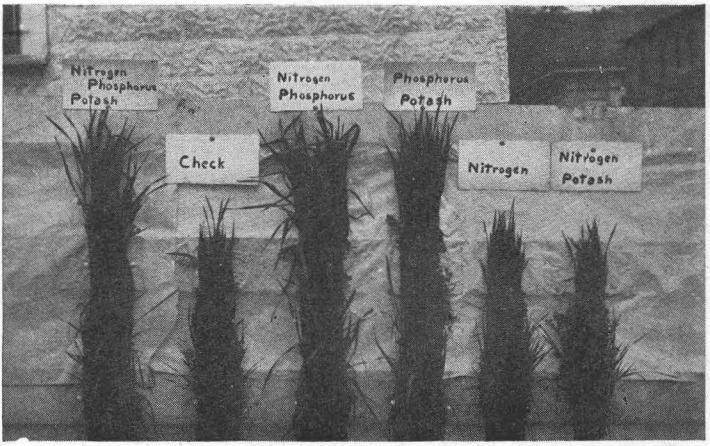
Irrigation is an aid to cover crops

Orchardists in Western Oregon are finding that irrigation of orchards pays in increased yields and quality of product. On many orchards the installation and operation of an irrigation system would pay by increased growth of the cover crop if for no other reason. Where orchards are irrigated it is possible to seed cover crops early in the fall with the assurance that a good stand will be obtained without depending on fall rains, which are sometimes late in coming. The orchardist is then assured of sufficient cover-crop protection during the winter months.

The orchardist who irrigates can wait in the spring until the cover crop has reached a stage of maximum growth before working it into the soil because with irrigation there is sufficient moisture for both trees and cover crop.

With irrigation Western Oregon growers can adopt permanent cover-crop practices similar to those in the irrigated section in Eastern Oregon, thus eliminating the necessity of cultivation as now practiced on unirrigated tracts.

Phosphorus increased cover-crop yield on Aiken soils



Wherever phosphorus was used in fertilizer combinations on Clackamas County Aiken soil, marked response in cover-crop growth was obtained.

Rates of application per acre were: sulphate of ammonia 270 pounds; superphosphate 475 pounds; and sulphate of potash 135 pounds.

Left to right

Plot 1. Nitrogen, phosphorus, and potash.
Plot 2. Unfertilized.
Plot 3. Nitrogen and phosphate.
Plot 4. Phosphorus and potash.
Plot 5. Nitrogen.
Plot 6. Nitrogen and potash.

SOD COVERS

Sod mulches are common in Eastern States

Sod mulches for unirrigated orchards are now receiving consideration. Sod mulches have their limitations, but they may be advisable for fast-eroding hillside orchards. It is evident that there must be changes in the system of managing orchards in hillside areas where soil erosion is heavy enough to cause anxiety regarding the future value of these lands for agricultural purposes.

Orchardists of the eastern part of the United States have had some experience with sod mulches. A review of literature on the subject shows that the value of sod mulches in orchards varies somewhat according to the soil type, soil depth, the summer moisture supply, and the length of time such sods are maintained.

Sod mulches not proved for Oregon conditions

Any contemplated change to sod mulches in unirrigated orchards which have been cultivated for years may well receive careful consideration before the move is made. Orchard sod mulches have not been used in Oregon nonirrigated orchards except in a very limited way, and their use has been only partly successful.

For those orchardists who wish to try out the sod mulch, the following suggestions are made for trial only. These suggestions are not to be considered as definite, tried recommendations for sodding down commercial orchards in nonirrigated sections of Oregon.

Orchard sod rotation reported advisable

Reports indicate that blue grass is the principal sod crop in use in eastern orchards and that orchards are reported doing fairly well under a managed system of sod-mulch rotation wherein nitrogen is added regularly to stimulate tree and grass growth, but that a heavy blue-grass sod should be plowed or cultivated every four or six years or the sod will check tree growth.

Fertilizer requirements for sod orchards are heavy

The Missouri State Fruit Experiment Station (Bulletin 28, 1934) reports: "The fertilizer requirements for orchards in sod are greater than tilled orchards. The grass as well as the trees uses the fertilizer. Grass with fertilizers is a practical method of soil management in bearing orchards even on land that is conveniently tilled."

The Missouri Station continues: "In a general way tillage is the preferable method of soil management, especially for young orchards. . . . Grass without fertilizer is an unsatisfactory method of orchard soil management."

Pennsylvania State College (Bulletin 261, 1931) reports: "Heavy applications of nitrogen to an orchard in blue grass sod stimulated both grass and trees at first. If a heavy blue grass sod is not plowed every four to six years, however, the sod will check tree growth, and the tree response to even very heavy applications of nitrogen will be meager since the blue grass steals the nitrogen intended for the trees."

Orchard sod mixtures are suggested for trial

Any sod mulch maintained in our unirrigated orchards should be that which makes a minimum amount of growth during the dry summer season. Eastern states get summer rainfall—we do not. The Oregon Agricultural Experiment Station suggests the following new crops that may be worth a trial in orchards where it appears advisable to establish or try out sod:

1. Bulbous blue grass (Poa Bulbosa) at the rate of 10 pounds per acre and Bur clover, 3 pounds per acre. This crop should be seeded in the fall.
2. Rat-tail fescue and hop clover. Seeding rates for this crop are: rat-tail fescue, 15 pounds per acre, and hop clover, 4 pounds per acre. Seed in the fall.

Orchardists who try permanent-sod cover crops should be in a position to add nitrogen fertilizers to the soil annually. If and when tree growth slows down, these sod orchards should be plowed and cultivated.

Annual applications of commercial nitrogen fertilizers in liberal amounts, or barnyard manures, are reported necessary, with a probable occasional application of phosphorus, or phosphorus and potash. Winter blue grass and the other grasses and clovers mentioned above make their growth early in the spring. To prevent weeds and other grasses from using the stored moisture supply, the sod should be mowed closely one or more times in the late spring and the cuttings allowed to remain on the soil.

Sod orchards involve a fire hazard

Growers who establish sod mulches in orchards must realize that there will be a fire hazard during the dry season when the entire orchard is held in sod. Cultivated strips may be used as a guard against fire spread.

Pasturing sod orchards usually inadvisable

Alfalfa or grass crop has very little soil-improving action if the entire crop is removed each season. To get the best results the cover crop should be neither pastured nor cut for hay. The practice of close pasturing may be fine for the livestock, but does not help to fill boxes in the packing shed.

When sod orchards are closely pastured, the soil is called on to support two crops instead of one. Continuous close pasturing will defeat the main purpose for which sod is established, namely, the providing of a large supply of humus for soil building.

With trees such as walnut, filberts, and prunes, where the fruit or nuts are picked from the ground, permanent cover crops have serious disadvantages. Ladino clover as a permanent cover crop may be an answer to these objections because it is a flat growing crop and can be clipped or closely pastured just previous to harvest time so as not to interfere seriously with the harvesting operations. Ladino clover should be sown on a firm seed bed early in the spring at the rate of 4 or 5 pounds of seed per acre.

Legume cover crops under irrigation sometimes not plowed or disked

The use of sod mulches in unirrigated orchards should not be confused with the well-established practice in the Northwest of growing

alfalfa, sweet clover, red clover, and other crops as a permanent cover crop in irrigated orchards.

Cover crops in irrigated orchards in certain instances are not being plowed or disked. They are sometimes rolled or dragged to flatten them. The legume growth is allowed to accumulate as a residue for soil building. In the report of the Oregon State Horticultural Society for 1936, R. A. Collins, an irrigated-pear grower of Hood River, says:

"I do not believe in any plowing and very little disking in an orchard. My heaviest yields are where I have not disked for five years."

FERTILITY VALUES IN ORGANIC MATTER

The chief needs of trees are for nitrogen, phosphorus, and potassium

Trees need a long list of plant foods, but the leading elements taken in quantity from the soil are nitrogen, phosphorus, and potassium. These are also the elements commonly carried in commercial fertilizers. In commercial fertilizers these elements are indicated by symbols. Thus a fertilizer listed as 10-4-2 means that it carries 10 per cent of nitrogen, 4 per cent of phosphoric acid, and 2 per cent of potash. These are for convenience labeled N, P_2O_5, and K_2O. Analyses of some of the common materials used for soil-building purposes are shown below.

*FERTILIZER CONSTITUENTS IN A TON OF MATERIALS AVAILABLE FOR SOIL BUILDING

	Pounds per ton		
	N	P_2O_5	K_2O
Manure	10	5	10
Alfalfa	49	10	42
Red clover	42	10	40
Crimson clover	42	9	30
Sweet clover	40	11	37
Clover straw (Hopkins)	29.4	3.6	20.8
Wheat straw	10	3	12
Oat straw	12	4	25
Vetch hay	56	15	46
Brake fern (estimated)	23	7	20
Sheep manure (dry)	38	25	23
Poultry manure (fresh)	20	16	8
Turnips (roots)	5	2	9
Turnips (tops)	8	2.4	11
Field-pea straw	28	7	20
Raspberry leaves	27	5.4	1.26
Apple leaves	20	3	7
Oak leaves	16	7	3
Corn stalks	4	1.2	11
Plum leaves	15	3.4	16
Pear leaves	14	2.4	8

* *Fertilizers and Crops,* Vanslyke, unless otherwise stated.

Organic matter has money value

There is no way of computing closely the entire value of cover crops because organic matter cannot be bought as such on the market. A soil filled with plant food but lacking in organic matter is comparable to a man in the middle of a desert with plenty of food and water locked in an inaccessible vault for which he has no key. This man might starve because the food and water are not available to him. Organic matter is the key which unlocks soil fertility; without it mineral plant foods are not available to

the plant. Disregarding the value of the humus and sulphur, however, and basing an estimate only on the commercial value of the average standard mineral content, the cash values of some of the ordinary organic materials used in orchards are as follows:

Material	*Value per ton*
Alfalfa hay	$6.57
Clover straw	4.37
Apple leaves	2.09
Wheat straw	1.49
Manure	1.55
Red-clover hay	5.66

These values are only a small part of the total worth of these materials in orchards. The humus they impart is worth more than the elements that have a market price. *Spoiled clover and alfalfa hay* or clover and alfalfa chaff and straw are valuable soil builders when incorporated in the soil. They should never be burned or otherwise destroyed.

REDUCING ORCHARD SOIL EROSION

Check destructive water run-off

In many orchards there are natural depressions or draws that must carry certain amounts of run-off water during the winter months. It would be desirable, as a method of erosion control, to seed these waterways to some erosion-resisting perennial grass. Temporary control is possible in these draws through the use of straw check dams. These dams should be placed closely enough together so that the water falling over one dam does not have an opportunity to wash away soil before it is slowed down by the next dam. Effective straw dams may be constructed easily by making a small trench 5 or 6 inches deep across the gully. Straw is then laid along this trench and a portion of it rammed tightly into the trench by means of a shovel or spade. If the draw is to carry very much water, straw spread loose and not tied down may shift or float away, or pile up and result in rather serious washing of the soil.

A straw mulch helps

Grain straw, clover straw, or other bulky refuse may also be spread over the orchard at rates of 1 to 2 tons per acre and lightly disked in. This straw protection helps to check the run-off and thus lessens soil erosion. These straw mulches have one very important advantage over cover crops— they do not use stored soil moisture.

Contour strips of straw disked in are an aid. Likewise, cover-crop strips of winter grain seeded on the contours at the rate of 150 pounds per acre may be used.

Contour planting is practical

A few orchards on steep lands in Oregon have been planted on the contour and all subsequent working has been on the contour. This makes a ragged looking orchard to one accustomed to taking pride in straight

rows, but unquestionably contour planting helps to hold the soil in place. Persons contemplating setting out a new orchard on sloping land should seriously consider contour planting. In European countries where they have learned to hold the soil by centuries of experience, all hillside planting of orchards or vineyards is done on the contour.

Contour furrows are easy to make

For cultivated hillside orchards, furrows plowed across the slope on a grade that will permit carrying off the surplus run-off of fall and winter moisture, without washing, are an aid. These should be made annually following cover-crop seeding. A safe grade for these furrows depends on the soil type. Usually this would not exceed one-half of 1 per cent, or 6 inches to 100 feet. The water may be led to grass waterways where it may be carried away without causing erosion. Such furrows on flat grades will also help the penetration of moisture from the winter rains.

The vertical distance between these furrows will depend on the slope and the soil type. Usually a furrow for every 5-foot difference in elevation will give effective control.

In some sections and on some soils it may be desirable to make these furrows permanent in nature. They then become terraces. This may be done by constructing a heavier furrow by use of a ditching machine or a road grader. The channel and sides of the furrow or terrace may be seeded to some perennial grass. This will afford a permanent waste-way for excess water.

Orchardists near The Dalles believe that a chisel used following the contours opens the soil and so helps the winter moisture to seep into their deep soils. The use of the chisel in more shallow orchard soils may be questionable because the trees may be shallow rooted.

Cultivate on the contour

On land subject to erosion the last orchard working each season should be across the slope, never down the hill. Harrow tracks running down hill serve as miniature ditches to lead the water off from the orchard. Many disastrous gullies have been started by water following truck or wagon tracks straight down the hill between the rows.

Strips of permanent sod following the contours will assist materially in slowing and stopping water run-off.

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