ORCHARD SOILS NEED COVER CROPS

Approximately one hundred thousand acres of nonirrigated orchards are located in Oregon areas of light summer rainfall. These orchards lie mostly in western Oregon and in Wasco County. Clean cultivation of such orchards is practiced from early spring through the summer months to save the stored soil moisture for tree use. Good management in such orchards includes the growing of annual cover crops, sown in the fall and turned under in the spring.

Annual cover crops properly grown and handled year after year contribute much to orchard soil building and maintenance.

Cover crop practices increase the water-absorbing capacity of soils.

Cover crops are a source of supply of organic matter for continuous bacterial growth that makes mineral plant foods available.

Soils on which cover crops are grown regularly are more easily cultivated.

Growing cover crops utilize and hold nitrates and other plant food elements that may otherwise be lost through leaching.

Cover crops reduce moisture run-off and aid water penetration into the soil. Soil erosion is therefore reduced.

Growing cover crops hold the leaves shed by trees.

Selection of cover crop varieties adapted to an area is necessary to obtain the greatest cover crop growth.

Legume cover crop seed should be inoculated. Early and mid-February applications of sulphate of ammonia or ammoniated phosphate have increased growing cover crop yields materially when used in adequate amounts.

Nitrogen and phosphorus fertilizers aid fall-seeded cover crops.

Orchardists sometimes have difficulty growing legume cover crops in old orchards where cover crops have not been grown for some time. Under such conditions the growing of rye heavily fertilized may be necessary for 2 or 3 years to build the soils to a point where legumes will grow.

Cover Picture—
Rosen rye and hairy vetch in a Marion County cherry orchard. Dark strip in front of observer had a fall application of 16-20-0 ammoniated phosphate. Cost for 200 pounds per acre $8.00; increased cover crop yield 3,200 pounds per acre.
Orchard Soil Covers

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Organic Matter

Continuous cultivation depletes organic matter

Successful orcharding is dependent upon a plan of soil management that provides for the addition of organic matter regularly and in amounts to build fertility and reduce erosion to a minimum. 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 nonirrigated orchards. If orchard soils are to be kept productive, provision must be made to supply the necessary organic matter.

Cover crops replace fertility

Loss of organic matter through 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 organic material each year. This alone will deplete soils in time, but if erosion takes its toll also, then the productive life of a soil may be short. To reduce and lessen these losses grow cover crops in the orchard as a regular practice.

Cover crops prevent erosion

Most orchard soils on hill land erode rapidly. This may be visible in the form of ever-deepening gullies; or it may be the invisible "sheet erosion," that is no less harmful. When muddy water runs off from an orchard, every drop of it is carrying away some of

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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 to 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 help to hold the soil in place.**

**Organic matter is the life of the soil**

The productiveness of all soils depends upon the supply of active or relatively fresh organic matter, which may be called the very life of the soil. It is important as a direct source of plant food since 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 easily, and are more subject to erosion than soils that have a greater supply of organic matter. But as soil high in old or inert organic matter also may be low in productivity, new supplies should be added continually.

Soils low in organic matter puddle and run together. They are difficult to cultivate and moisture penetrates slowly causing surface run-off and erosion. 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.

**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 crop 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**

Organic matter is the life of the soil, but while organic matter is important to a fertile soil, it is not necessarily true that the soil with the highest percentage of organic matter is the most productive.
It is the annual destruction of organic matter through bacterial and chemical decay that makes mineral plant foods available for vigorous crop growth. Organic matter supplies both the energy and the raw material to make a fertile soil. Continued production requires new supplies each season.

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 alone is not 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 orchards. Practical methods for building and maintaining organic matter are suggested in this bulletin.

**Young orchards need cover crops**

In the young orchard the organic content of the soil 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 cover crop plants. The trees in many orchards are planted too closely; in such orchards a really heavy cover crop is almost an impossibility.

**Cover crops either gather or consume nitrogen**

Cover crops used in Oregon can be classified as nitrogen consumers and nitrogen gatherers. The nitrogen consumers include such crops as oats, barley, rye, wheat, turnips, mustard, and rape. The nitrogen gatherers include vetches, Austrian winter field peas, alfalfa, sweetclover, 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 discontinued, however; they can be grown easily and rapidly and are of value in rebuilding depleted or partly depleted soils.
Acreage requirements of organic materials

Orchard soil maintenance and upkeep may, in general, be achieved by adding definite amounts of organic matter per acre annually. The following are suggested amounts of different materials that can be used for this purpose:

- Green legume cover crop, 6 to 7 tons per acre, 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 22.

Select suitable cover crop varieties

Cover crop varieties should be selected for winter hardiness and for their fast growing qualities in early spring.

- **RYE.** Rosen rye is a leader for winter hardiness and is recommended for cover crop use in eastern Oregon wherever it is advisable to use rye. Abruzzi rye is faster growing in the early spring. It is semi-hardy. Abruzzi rye is recommended in western Oregon.
- **BARLEY.** Cascade winter barley is recommended for cover crop use in western Oregon. Winter barley is not recommended for cover crop use in eastern Oregon.
- **VETCHES.** Willamette vetch is recommended for western Oregon. For a winter hardy vetch that withstands severe winter weather, use hairy vetch. Hairy vetch is best for eastern Oregon.
- **PEAS.** Austrian winter peas make an excellent winter hardy cover crop for either eastern or western Oregon and can be used in place of vetch or in mixtures with vetch.

Nonirrigated Orchards

**Western Oregon north of Josephine County**

Annual cover crops suitable for western Oregon north of Josephine County are:

1. Willamette vetch, 40 to 50 pounds of seed per acre, with winter barley, 60 pounds.
2. Willamette vetch, 40 to 50 pounds, with winter oats, 60 pounds.
3. When vetch seed is low priced, 75 to 90 pounds of Willamette vetch or Hungarian vetch seeded alone.

4. Winter rye, 90 to 100 pounds, seeded alone on depleted upland soils. Rye should receive more attention for cover-crop use in this region. Some orchards have used rye cover crops for years. Use nitrogen fertilizer with it.

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 Willamette vetch. Hungarian vetch is more resistant than Willamette vetch to aphid attacks.

7. Austrian winter field peas, 75 to 90 pounds, make a good cover crop.

8. Austrian winter field peas, 60 to 75 pounds, and 1 bushel Cascade winter barley.

9. Pomeranean White Globe, Cow Horn, Purple Top Strap Leaf, or 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 well-drained soils high in fertility. Seed should be inoculated. Seed in August or late July at rate of 20 pounds of seed per acre.

**Volunteer weeds and grasses as cover crops**

In certain lowland orchards volunteer cover crops, such as chickweed, wild mustard, grasses, and legumes make the growing of seeded cover crops somewhat difficult or unnecessary. These volunteer crops should be supplemented with 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 mustard seed.

**Winter grains for dry, nonirrigated regions**

Winter grain, 90 to 120 pounds per acre, preferably winter rye, is recommended for eastern Oregon nonirrigated regions of light rainfall. Rye grows better 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.
Irrigated Orchards

Legume cover crops for irrigated areas

Alfalfa is the permanent cover crop most generally used in irrigated orchards. Biennial sweetclover may be used. The latter will often maintain itself for 5 years or more by reseeding. Eventually permanent grasses, such as bluegrass, usually take over and drive the sweetclover out.

Grimm alfalfa or northern-grown hardy strains of common alfalfa are quite satisfactory. It is important that certified seed be used. Ladak is superior in eastern Oregon because of greater disease resistance, winter hardiness, and resistance to insects such as aphids. Orestan and Ranger are longer-lived in eastern Oregon than other varieties.

Yellow blossom sweetclover is lower growing than white and volunteers more readily. The tall-growing white sweetclover may interfere too much with harvesting and other orchard work.

White Dutch or Ladino clovers make ideal permanent cover crops. They are low growing, yet produce abundant, high quality organic material.

A firm, well-prepared seedbed is necessary for alfalfa or sweetclover. Irrigation rills should be close enough together to insure even water distribution while the crop is young.

Legumes and grains for eastern and southern Oregon

Cover crops for irrigated orchards in eastern and southern Oregon include:

1. Alfalfa for a permanent orchard cover crop, 12 pounds of seed per acre.
2. Yellow biennial sweetclover, 20 pounds.
3. Oats, rye, vetches, and Austrian winter peas for annual cover crops. (For rate of seeding, see page 7.)
4. Red clover, 12 pounds per acre.
5. Ladino or white, 3 to 4 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, Kudzu, lespezea, soybeans, and lupines.
Seeding Cover Crops

Time of seeding cover crops

Annual winter cover crops of grains, vetches, and winter peas should be seeded preferably in late August or early September in nonirrigated orchards. Where irrigation water is available the seeding may be earlier, except in nut orchards.

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

Permanent cover crops on irrigated soil are seeded mostly in the early spring on a firm seedbed after damage of frost is past.

Legume cover crops should be inoculated. Inoculation costs are small and inoculation of seed is at all times a safe and profitable practice. Use the bacterial cultures prepared for each legume.

Drilling is preferred

Drilling in orchard cover crops between the tree rows is 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. Care should be taken to seed as close to the trees as possible since complete coverage of the soil with a cover

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

Cover crops seeded in this manner in hillside orchards do much to check soil erosion during the rainy fall and winter months.
crop lessens erosion. For small seed, such as grass or clover, the seed bed must be firm.

**Cross seeding cover crops**

Occasionally an orchardist seeds cover crops two ways across the orchard. This practice plants a cover crop on that strip of land usually left bare by the one-way seeding. The cover crop is seeded double in part of the orchard, but this is beneficial since it places a heavy cover crop seeding in the area where the cover crop is most likely to grow. Cross seeding is especially valuable on hill soils subject to erosion.

The last seeding in the case of cross seeding a hillside orchard should follow the land contour as nearly as possible.

**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**

**Stop cover crop early to save moisture**

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 1 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. Disking is preferred to plowing because it is most important that the organic matter be thoroughly mixed with the top soil.

Deep plowing or diskimg is not necessary to turn under the cover crop or other organic matter. In fact, organic material from a cover crop or from straw or manure is much more effective when not buried too deeply. The bacteria responsible for decay require air and warmth. Air is much more plentiful near the surface, and the soil is much warmer there than it is at a depth of 8 or 9 inches.

The depth of initial tillage is unimportant. Two to four inches are enough if the cover crop is killed completely.
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 little or no value. Extra cultivation is 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 cultivated excessively 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. The dust mulch forms a surface crust after a hard rain that sheds water like a tin roof.

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. Cultivation is again wasted effort and it is harmful to the alfalfa.

Tools for cultivating nonirrigated orchards

Overuse of the disk and drag has seriously hurt many orchards. Continued use of the disk throughout the season stirs the soil deeper than necessary, causing excessive loss of organic matter through oxidation; moisture is lost from the soil to the full depth that it is stirred; and many of the valuable feeder roots are destroyed. Continued use of a drag or clod-masher on clayey soils, either alone or alternately with the disk, creates a smooth dusty surface that puddles with the first few drops of rain, sealing the surface against moisture penetration and causing unnecessary erosion. An effective cultivator should destroy the weeds and at the same time leave protecting clods and trash on the surface. The "trashy fallow" now used by progressive wheat farmers in the summer-fallow areas is equally effective in orchards.

Some orchardists have found the revolving rod weeder an ideal implement. Of the different rod weeders, the center drive type is the best adapted to orchard work. It is much easier to handle around the trees than the end drive weeder.
Field cultivators of the duck-foot type are also good in orchards. Those equipped with sweeps 14 inches wide or wider will do a better job than those with narrow sweeps. Sweeps should overlap several inches.

A Cover Crop Comparison

_Crop selection plays an important part in orchard cover crop yields._

Rosen rye and winter oats (at left), and smooth hairy and common vetch (at right) grown side by side under identical conditions in the Lambert cherry orchard in Marion County returned widely varying growth and cover crop yields.

**Cover Crop Aids**

**Commercial fertilizers increase cover crop growth**

The growth of cover crops in western Oregon nonirrigated orchards can be increased materially by the application of commercial fertilizers high in nitrogen in late January and early February. Nitrogen is often lacking in orchard soils. Phosphorus may be needed, especially in some of the hill soils. A complete fertilizer may be necessary in a few soils, although the use of potash has not shown much response.
Commercial fertilizers used on cover crops bring a double return. The increased cover crop growth will provide better protection and more good quality organic material. Then, as this organic material breaks down in the soil the plant foods again become available for the trees.

**Amounts of fertilizers to apply**

Nitrogen fertilizers should be used universally on cover crops in Oregon orchards. The yearly application will range from 40 pounds of actual nitrogen (200 pounds of ammonium sulphate) on annual cover crops in young orchards to an extreme of 200 pounds actual nitrogen on permanent cover crops in some of the older irrigated orchards.

With annual cover crops, part of the nitrogen up to 40 pounds should be applied in the fall at seeding time to assure a good stand and adequate protection during the winter months. The remainder should be applied in the spring, late February or March, to further increase the yield of green material and to aid in the decomposition of the crop after it is plowed down. On run-down soils it may be necessary to use 40 pounds of nitrogen in the fall and another similar application in the spring. As the soil is built up with good cover crops it may be possible to cut down the rate.

Heavy applications of nitrogen are necessary where permanent cover crops are grown, even though these covers are made up largely of legumes. Where the extra nitrogen is necessary to overcome the competition between the growing cover crop and the tree during the early part of the growing season, it is necessary that applications be made before growth gets underway in the spring. Many operators split the application between spring and fall applications. To minimize the risk of winter damage to the trees, fall applications should be held down to no more than 40 pounds of nitrogen per acre.

In addition to nitrogen, phosphorus is needed on many orchard soils, particularly in western Oregon. Phosphorus applications should be made in the fall at the time annual cover crops are seeded or as a top dressing on permanent cover crops. The minimum application for phosphorus fertilizers should provide 60 pounds of actual phosphorus per acre (330 pounds of 18 per cent superphosphate). The use of ammonium phosphate is a convenient and economical means of providing phosphorus since both the nitrogen and phosphorus can be applied at one time.

Sulphur is low in most Oregon soils and since many crops, particularly legumes, have a high sulphur requirement it is advisable to provide some sulphur in the fertilizer program. On acid soils lime should be added to grow legume crops.
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. Because manure is low in phosphorus, the addition of 300 to 400 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

Fertilizers Increase Cover-Crop Tonnage

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

Plot 1 received sulphate of ammonia alone in 1929, 1930, and 1931.
Plot 2 was unfertilized for 3 years.
Plot 3 received sulphate of ammonia and sulphate of potash for 3 years.
Plot 4 received sulphate of ammonia and superphosphate for 3 years.
Plot 5 received nitrogen, phosphorus, and potash for 3 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.

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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.

In irrigated orchards where the supply of organic matter is low, 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.

**Straw or other organic materials aid**

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

Melbourne Soil Responds to Fertilizers

![Image of 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.*

**Cover Crop:** Winter barley and common vetch.

**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.
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.

Grain straw is effective for controlling erosion and if enough nitrogen fertilizer is added (100 pounds ammonium sulphate or equivalent to each ton) it will be as good as legume straw or manure as a source of organic matter.

Straw will do double duty if disked in lightly, just enough to hold it in place. Straw on the surface will effectively replenish the

**Fertilizers Increased Walnut Orchard Cover Crops**

![Image of cover crops with fertilizer treatments](image)

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

* Rates of application of nitrogen, phosphorus, and potash annually in combination or alone 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.*
supply of organic matter. At the same time it gives extra protection from erosion.

**Lime helps legumes on acid soils**

In western Oregon some 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 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 1 to 2 tons per acre, based on results of a soil test that may be obtained at the office of the county extension 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.

**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. Whenever one is not certain what the effect of a commercial fertilizer will be on the cover crop, 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, and the supply in Oregon soils is low. 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 2 or 3 years. Often ample sulphur is supplied by other fertilizers such as ammonium sulphate, ordinary superphosphate and 16-20-0 ammonium phosphate. 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 orchards 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. Where orchards are failing and unprofitable because of overcrowding, a tree-thinning program is worthwhile.

**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.

**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.
The orchardist is then assured cover-crop protection during the winter months.

The orchardist who has ample irrigation water 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 of tree fruits can adopt permanent cover-crop practices similar to those in the irrigated parts of eastern Oregon, thus eliminating the necessity for cultivation. As in other irrigated sections, this type of culture requires heavy application of nitrogen fertilizer annually.

**Sod Covers**

**Sod mulches require ample water and nitrogen**

Sod mulches have been used successfully in irrigated apple and pear orchards, notably in the Hood River district. Such is the practice also in certain eastern states where there is sufficient summer rainfall. In these areas it has been found that the grass is a heavy feeder on the nitrogen of the soil. For that reason fertilizer applications containing nitrogen are the rule. Ample soil moisture and nitrogen fertilizer are two essentials to be kept in mind when considering sod mulches for orchards. Apples are more tolerant of sods than the shallow rooting peach. In general the other fruits react in a similar manner depending upon the extent of their root systems and water requirements. Irrigated sod orchards usually need to be mowed or have the weed and brush growth kept down with some type of cover crop beater. Girdling of trees by field mice can be a real problem in sod orchards unless proper precautions are taken to control them.

**Sod covers not proved for nonirrigated areas**

Sod mulches for nonirrigated orchards have received in the past and are still receiving consideration. Sod mulches have their limitations, but they may be advisable for fast-eroding hillside orchards where saving the soil may be more important than production. Mature orchards planted to sod without irrigation often become nonproductive in a short time. The growth of young trees is severely retarded.

Orchard sod covers have not been used in Oregon nonirrigated orchards except in a very limited way, and their use is questionable. Orchards in areas where summer rainfall is light and without irrigation show poor growth and are not productive when growing in
sod. This adverse experience has been with sod covers that continued to grow during the summer. The interest at present is in the use of covers that stop active growth during that time of the year and, therefore, draw less water from the soil. Since subclover is inactive in growth during the summer it is one of the sods being tried.

For those orchardists who wish to try out the sod covers, 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 mixtures for trials**

Any sod mulch maintained in our nonirrigated orchards should be that which makes a minimum amount of growth during the dry summer season. The Oregon Agricultural Experiment Station suggests the following crops that may be worth a trial in orchards where it appears advisable to establish or try out sod:

1. Bulbous or winter bluegrass (Poa bulbosa) at the rate of 10 pounds per acre and subclover, 5 pounds per acre. This crop should be seeded in the fall.
2. Rat-tail fescue and subclover. Seeding rates for this crop are: rat-tail fescue, 15 pounds per acre, and subclover, 4 pounds per acre. Seed in the fall.
3. Subterranean clover, seeded at the rate of 6 pounds per acre, either in the late spring or early 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 disked and cultivated.

Annual applications of commercial nitrogen fertilizers in liberal amounts, or barnyard manures, usually are necessary, with a probable occasional application of phosphorus, or phosphorus and potash. Bulbous or winter bluegrass 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 sod.

**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

Legumes or grasses have very little soil-improving action if the entire top growth is removed each season. To get the best results the cover crop should be neither pastured nor cut for hay.

When sod orchards are pastured closely, 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 provision of humus for soil building.

With trees such as walnuts, filberts, and prunes, where the fruit or nuts are picked from the ground, permanent cover crops have serious disadvantages.

Irrigated legumes sometimes not plowed or disked

The use of sod mulches in nonirrigated orchards should not be confused with the well-established practice in the Northwest of growing alfalfa, sweetclover, red clover, and other plants as a permanent cover crop in irrigated orchards.

Many cover crops in irrigated orchards are not being plowed or disked. They are sometimes rolled or dragged to flatten them, or shredded with a cover-crop beater. The legume growth is allowed to accumulate as a residue for soil building.

Fertility Values in Organic Matter

Trees need 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 in each 100 pounds it carries 10 pounds of nitrogen, 4 pounds of phosphoric acid, and 2 pounds of potash. These are for convenience labeled N, P₂O₅, and K₂O. Analyses of some of the common materials used for soil-building purposes are shown in the following table.

Value of organic matter varies

It is impossible to put a definite value on organic matter when added to the soil. On many well managed orchard soils where good cover crops are grown every year, additional organic matter in the form of straw, manure, or other crop residues might not increase cover crop yields. On other run-down soils, the addition of some organic material may be absolutely necessary to make the soil produce even a mediocre cover crop. Organic matter is necessary in the
soil to make the natural soil minerals available to the growing crop and to utilize effectively any commercial fertilizers applied.

Organic material ordinarily available for application to orchards certainly does have a value as measured by the amount of plant food carried. The additional value for organic matter is substantial. On run-down soils it can exceed the commercial fertilizer value.

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.

<table>
<thead>
<tr>
<th>Material</th>
<th>Value per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa hay</td>
<td>$9.80</td>
</tr>
<tr>
<td>Clover straw</td>
<td>5.48</td>
</tr>
<tr>
<td>Apple leaves</td>
<td>3.36</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>2.21</td>
</tr>
<tr>
<td>Manure</td>
<td>2.35</td>
</tr>
<tr>
<td>Red-clover hay</td>
<td>8.68</td>
</tr>
</tbody>
</table>

*Fertilizers and Crops, Vanslyke, unless otherwise stated.*
These values are only a small part of the total worth of these materials in orchards. The organic matter they impart is worth more than the elements that have a market price. *Spoiled clover and alfalfa hay* or clover and alfalfa chaff, pea vines and straw are valuable soil builders when incorporated with 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 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, such as Chewings fescue in western Oregon and Fairway crested wheatgrass in eastern Oregon. Temporary control is possible in these draws through the use of straw or brush check dams. These dams should be spaced closely enough 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. They should be constructed so that the water can spill over them rather than being built so high in midstream that the water is rerouted by the end of the dam, starting a new gully. 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 with 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.

**Sawdust, chaff, and straw mulches**

There has been some use of sawdust, wood chips, spoiled hay, chaff, and straw to make deep litter mulches under fruit trees. These materials replace cultivation to keep down weeds when applied in heavy enough amounts. Litter mulches should be spread under the
tree out as far as the ends of the branches or even better, beyond the tips. Such mulches hold water and conserve soil moisture.

One of the main reasons for mulches is to keep down weeds. In general, the more compact the mulch material the better it will prevent weed growth through it.

During the first three or four seasons after application some of these materials, especially sawdust, depress the amount of available nitrogen for tree growth. For that reason nitrogen fertilizer usually needs to be applied liberally to maintain good tree growth. The amount of nitrogen to use depends largely upon the kind of litter used. Sawdust is very low in nitrogen; therefore, heavy nitrogen treatments are required. If sawdust is worked into the soil then the amount of nitrogen to maintain tree growth is even greater.

On the other hand, if the mulch material rots readily and contains considerable nitrogen, for example spoiled legume hay or barn bedding, less commercial nitrogen fertilizer needs to be applied in any one year. Because of the variability of the nitrogen content in different litters, no attempt is made here to state the quantities of nitrogen to use with these mulches. Tree growth and foliage color will need to be used as a guide. For example, mature apple trees should show about a foot of new growth each year and maintain a good green leaf color.

The time to apply nitrogen is early spring before applying mulch, then on top of the mulch in subsequent years.

Field mice harbor under most litter mulches. Poison baits are prepared especially for these mice under the supervision of the U. S. Fish and Wild Life Service, Branch of Predator and Rodent Control. The county extension agent can advise how to obtain the poisoned bait. A few baits laid in the mouse runways at two or three locations per tree under the mulch is usually recommended. Be sure to replace the mulch over the bait. The risk of tree girdling by mice is reduced if the mulch is kept back one to two feet from the tree trunks.

Experience with litter mulch materials in Oregon orchards is still limited. Most of the trials have been made with pears, apples, sweet cherries, and berries on small acreages. Present harvest methods do not lend encouragement to this system for prunes in western Oregon or for walnuts and filberts. In concentrated fruit districts of large acreages the problem would arise of obtaining enough material to adopt this practice extensively. At present this method appears restricted to home plantings, small acreages or young trees in areas where materials are cheap and plentiful. The most needful places for its trial appear to be on nonirrigated shallow soils, where land is rough or equipment lacking.