ORCHARD COVER CROPS

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Orchard trees show considerable variation in the amount of annual growth made under various conditions. Young fruit trees may grow rapidly for a few years without proper soil culture, but they usually lose vigor as they become older and eventually make little growth. Under such conditions, if soil management practices are not improved, the bark frequently turns reddish-brown, the twigs are short and weak, and the leaves change from a dark, lustrous green to a pale, yellowish-green color and are smaller than those produced while the tree is making rapid growth. The blossoms produced on these weak trees are small, frequently pale in color, and only a small per cent of them set fruit. The fruits produced are small.

Growing legume cover crops improves the fertility and physical condition of the soil so that the trees respond with satisfactory growth and fruit production. Hard and compact soils may be improved by adding humus and by growing a green cover crop of alfalfa, clover, or vetch. Cover crops make such soils more mellow and improve water-holding capacities. The available plant food material, especially nitrogen, is also increased. This improved state of orchard soils has been maintained for years by using cover crops.

Poor fruit tree growth is sometimes caused by lack of water. Deep irrigation ditches, ditches spaced too far apart, improper application of water, or water shortage often make it impossible to irrigate properly. Too much water, high water table in the soil, hardpan or impervious subsoil, and coarse sand or gravel subsoil also sometimes cause poor tree growth. Proper drainage is also

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essential. Subsoil plowing and blasting to improve a hardpan subsoil frequently fail to produce the desired results.

Water relations. The water supply required by orchard cover crops is not different from that of the orchard trees. Average orchard trees with a cover crop use more water than either alone, but not as much as the two crops would use if grown separately. Most of the cover crop grows in partially shaded areas under the trees and does not give off water as rapidly as when fully exposed to the sun. In irrigated orchards, cover crops frequently improve the soil so that both orchard and cover crop make good growth with the water supply that formerly seemed hardly sufficient for the orchard while kept in clean tillage. Many orchards kept in clean tillage for several years develop a hard, compact soil, which absorbs water slowly. A large portion of the water applied to such soils instead of penetrating the soil runs off. This method of soil management frequently develops a nearly impervious strata (plow sole) beneath the tilled earth.

The densest shade in a good orchard will not prevent a medium growth of alfalfa, sweet clover or vetch. Plants grown in partial shade are more slender and do not branch and spread as do those in full sunlight, but they are, nevertheless, effective in soil improvement. The amount of tree roots is much greater near the tree trunk than at a great distance from the trunk. Because of the water requirement of this dense root area, the cover crop plants near the tree suffer quicker from lack of water than those at a greater distance from the tree. This is especially true when the cover crop plants are in their first season.

Choice of Cover Crop

The choice of a cover crop should be determined by the age and condition of the orchard, the type and condition of the soil, and the season and water supply. Crops commonly used are perennial, biennial, and annual legumes, and annual non-legumes. Alfalfa is pre-eminently the leading perennial legume. It endures more rough treatment than most other crops and by growing deep roots endures drought. When once established, it lasts for several years, making annual or biennial reseeding unnecessary. It can be cut, rolled or dragged down reducing interference with
other orchard work. The objection to alfalfa is that it requires a well-prepared seed bed and careful attention to seeding and irrigation while being established.

Hardy Northern grown Common alfalfa is giving good results and is grown most commonly. Ladak is a variety that gives promise of making a splendid cover crop. It is resistant to winter injury and is able to maintain a stand for a long time. Grimm produces less stem and leaf growth and in the orchards is no harder than the other two varieties named.

**Sweet Clover** is the most popular of the biennial legumes. It grows rapidly and produces a heavy crop of vegetation to be incorporated into the soil. It is a splendid crop for soil improvement. The amount of vegetation above ground as well as the root system in the soil greatly improves the physical condition of hard soils and the fertility of poor soils. The plants grow rapidly, often partially reseeding every other year. Although sweet clover often maintains a partial stand for several years by reseeding itself biennially, it will seldom maintain as much as a 50 per cent stand without being replanted every other year. The tall biennial white-blossom and the tall biennial yellow-blossom sweet clovers have been used with good results although the plants often become large and woody, and difficult to drag or roll down. A new variety known as Alpha 1, a biennial white, shows promise. Its height is similar to that of alfalfa. It produces a large number of small, leafy, erect stems. Common Red Clover is a good plant for soil improvement and, although occasionally planted, has not gained general favor. The roots do not go as deep as alfalfa roots and the top is often badly damaged by mildew.

**Hairy (Winter) Vetch** has been used with good results as a cover crop on light loam and sandy soils. Planted in the fall or late summer, it will usually cover the ground before winter and produce a good growth that may be turned under as green manure in the midspring before spring rains cease. This saves soil moisture for the trees in midsummer, which is important in some districts. If the fall planting of Hairy Vetch is not turned under before early summer, it will produce seed that will partially and infrequently wholly reseed, so that a volunteer crop may be grown the next year. This method of management usually results in an uneven and poor stand.
Spring vetch is not winter-hardy and is planted in the spring and may be turned under by midsummer or later. Summer plowing in irrigated orchards is objectionable. In non-irrigated orchards, the crop does not make much growth before it must be plowed under to save soil moisture for the trees.

Rye, wheat, and oats are sometimes planted as cover crops either as a pure stand or mixed with vetch. These crops may serve in preventing soil erosion, snow drifting, and increasing the humus content of the soil, but being non-legumes they do not add directly to the nitrogen supply of the soil. These crops, weeds and grass tend to check tree growth. They are sometimes effective in increasing color development in apples in over-fertilized orchards.

Preparing the Seed Bed

Young alfalfa and sweet clover plants are small and require good soil and moisture conditions in order to grow and become established. A good seed bed is essential. This is best prepared by reducing the land to clean tillage until the soil is nearly free of weeds and weed seed. In many orchards three years of clean tillage will be necessary. The weeds are usually more vigorous than the young cover crop and if permitted, will crowd out the latter.

Irrigated orchard land that has been in clean tillage for several years commonly contains little humus and is greatly improved for seeding by application of a quickly available nitrogen fertilizer such as barnyard manure, ground alfalfa or similar material.

The soil should be well cultivated and smoothed to an even surface, and then packed to a depth of about four inches. This packed soil should be worked down well so that there are no large open spaces, and at the same time be loose enough to permit root penetration. This packing can be prepared in moist cultivated ground by going over it several times with a harrow having the teeth set about 50 to 60 degrees from perpendicular.

Planting the Cover Crop

Planting should be done immediately after the seed bed is prepared, in the spring as soon as irrigation water is available. If portable spray rigs are used, seeding should be delayed until the dormant spray has been applied. Where stationary sprayers are used,
the seeding may be done earlier. Late summer or early fall seeding may be successful in young orchards. Severe winters following fall seeding, however, often kill most of the young plants.

Ten pounds of alfalfa or sweet clover seed per acre on heavy soil give a good stand if the soil is well prepared and the planting is well done. On sandy, fine, and light loam soils, as much as 15 pounds of seed per acre are sometimes required to develop a good stand. The importance of careful seeding is demonstrated by the fact that if each seed grew, one or two pounds per acre would produce a good stand.

Drilling is the best method of seeding because it places the seed at a more uniform depth and distributes it more evenly. Cross drilling gives most uniform distribution. If the seed is broadcast, the soil should be given shallow cultivation after the packing. The spring-tooth harrow is one of the best tools for this work. Immediately following this shallow cultivation, broadcast the seed as evenly as possible and then cover with a brush drag or light spiked-tooth harrow with the teeth set at an angle. Follow this with a rolling packer or go over the ground a second time with the harrow.

**Irrigation**

Irrigation furrows should be made immediately after seeding. They should be 18 to 20 inches apart and even closer in sandy soil. Deep and widely spaced ditches prevent voluntary plants from renewing the stand. When feasible, irrigation by overhead sprinklers is better than furrow irrigation although satisfactory stands are often started by the latter. The best shallow furrows are made with a ditcher that leaves the soil smooth and not ridged.

Irrigation should be frequent to keep the soil moist. It is not necessary to water a long time for each irrigation during the early part of the season as the subsoil is usually moist. The soil should not be allowed to dry to a depth of more than one-half inch before the plants are up. After this, the soil should never be dry below one-fourth the depth of the roots of the young plants. The young cover crop is sensitive to drought because its roots are in the surface soil. If the young plants are to grow normally and produce nitrogen efficiently, the soil must be kept moist to a considerable depth. Trees will not suffer for lack or excess of water if the needs
of the young alfalfa or clover plants are met. Light loam and sandy soils require more frequent irrigation than do the heavier soil. No chart of dates or frequency of irrigation can be given. The condition of the soil and the crop is the best guide to follow.

Nitrogen added by the alfalfa, clover or vetch depends upon nodule development on the roots. These nodules are caused by bacteria and are the organs through which the plants gather the nitrogen from the air. They are formed only on young, tender roots that are close enough to the surface of the soil to obtain air. They are found on roots farther below the soil surface in sandy and sandy loam land than in the heavy loams. In cover crops examined, 85 to 95 per cent of the nodules were found in the first foot of soil, and in only a few orchards were nodules found on roots at a greater depth than 15 inches.

Clipping

On land free of weeds, cover crops should grow through the season uncut. In orchards where weeds are numerous, the cover crop should be clipped to a height of about four inches. When the plants are eight to 12 inches high, cutting back to four inches does not seriously hinder the growth of the cover crop but is a serious setback to the weeds. The soil should be well watered immediately after the cutting. This will often necessitate an irrigation immediately following mowing. In such cases the alfalfa and sweet clover plants will renew growth with an increased number of stems and many weeds will be killed. Data collected in orchards in the Yakima Valley in 1934 show that after the first clipping, the alfalfa plants averaged 5½ stems per plant. Broad-leaf pigweeds averaged 1½ stems per plant and narrow-leaf pigweed, 2½ stems per plant. Yellow foxtail plants in the uncut area developed three good heads per plant, while in the clipped areas they developed only 1½ heads per plant. The first clipping did not kill all the plants of any one kind of annual weed, but none of them made as good growth after this clipping as the alfalfa and sweet clover. After the second clipping, the cover crop gained the advantage and a good stand resulted. Cutting or mowing did not to any appreciable extent check or kill the perennial weeds.

The most rapid soil improvement can be made if all the cover crop is permitted to decay on the ground, but cutting and removing
one or two crops a year in young orchards is not always a harmful practice. Cutting seems to increase the amount of water used by the cover crop. As the stems grow older, many of the leaves drop and the stems lie flat on the ground, using less water than do the young rapidly growing shoots.

Cultivating

Cultivation in a good stand of alfalfa is unnecessary. Sometimes cultivating with a spring-tooth harrow while the weeds are small will destroy most of them, but it is better not to disturb the cover crop. Many orchardists disk the orchard in order to incorporate the cover crop growth into the soil. The damage done to the stand of cover crop and the tree roots make this practice undesirable.

In a few irrigated orchards, a good stand of alfalfa cover crop has been maintained for 18 or more years without reseeding. This is uncommon as the average perennial cover crop has been reduced to less than 50 percent of a stand before it is 12 years old. The prevalent practice of disking has reduced many cover crops to less than 25 percent of a stand in less than 12 years. The cover crop growth in such orchards consists largely of weeds. In a good cover crop the alfalfa or clover should cover the ground as well as in a hay field.

Disking is the most destructive cultural operation to cover crops that has been generally practiced. It splits and destroys the crown of many plants and also cuts the entire crown of others. The few young plants that start as volunteers are killed by the first disking.

Possible fire hazards developed by the heavy mulch of alfalfa or sweet clover stems are reduced by removal with a hay or brush rake. It is better to remove this material in the winter after the leaves have fallen and burn it than to destroy the cover crop by disking.

Shade, minimum winter temperatures, diseases, insects and rodents damage perennial orchard cover crops. Shade is not as destructive as is commonly believed. In tests made at the Irrigation Branch Experiment Station at Prosser and at Pullman, the perennial cover crops made a good growth under lattice sheds so built as to permit one-third of the sun’s rays to strike the plants at noonday
and a smaller proportion in the early afternoon and late afternoon. The shaded plants were more slender than the exposed plants but they were nearly as tall and survived the winter equally well.

The use of hardy strains reduces the hazard of winter injury.

In only a few cases have insects and diseases destroyed cover crops. While gophers and field mice are more common and more destructive in orchards with cover crops than in those kept in clean tillage, these pests can be held in check by poisoning or trapping.

**Non-Irrigated Cover Crops**

In many non-irrigated orchards, autumn, winter and spring rainfall is abundant. In the summer, the rainfall is so light that the orchard will use all of the stored water of the preceding rains. In such orchards an annual cover crop can be used to great advantage in developing or maintaining a satisfactory soil fertility.

In non-irrigated districts, vetch used as an annual cover crop is more satisfactory than alfalfa and sweet clover. The young vetch plants are larger, stronger and more able to make growth in less favorable conditions than are alfalfa or sweet clover. A well-prepared seed bed and careful planting are necessary to obtain a good stand.

Planting is best done with a drill and cross seeding is advisable. Thirty to 40 pounds of seed per acre will give a good stand. Broadcasting the seed requires a little heavier planting per acre than drill planting. A spring-tooth harrow is the best tool to use just prior to broadcast seeding. The seeding should be followed by harrowing or smoothing down with a brush drag. The seed should be planted in late summer or early fall or in the late winter, and the crop of growing plants should be turned under while the ground still contains a good supply of water, which usually limits this operation to not later than midspring. Only in very rare cases is it safe to depend upon volunteer seeding for the second crop. Continuous clean culture in summer and early fall planting are necessary for the best results.
Weeds

Weeds in orchards reduce crop growth. They use great quantities of soil moisture and plant food material and hinder the work of spraying, irrigating, and harvesting equally as much as do cover crops. They do not improve the fertility of the soil as does a cover crop of alfalfa, clover or vetch.

Weeds find favorable conditions for growth and reproduction in the orchards that have been planted to alfalfa and sweet clover cover crops. The cultural practices that have been followed, although destructive to the cover crop, have not prevented weed growth. The weed crop has usually increased as the cover crop decreased. A survey of the orchard cover crops made in the Yakima, Wenatchee, and Spokane valleys in the summer of 1934 indicated that few orchards had a good stand of alfalfa or sweet clover. Weeds were more prevalent than cover crop plants and were increasing in
number and in the amount of land occupied. In many orchards, seeded 10 or more years before, the so-called "cover crop" was composed almost entirely of weeds. The tree growth had gradually decreased each year for two to five years, indicating a decline in the soil fertility.

Weed seedlings once started are almost certain to produce seed unless killed by cultural operations. Even if the young plants of many weeds, as pigweeds and foxtail, are checked in growth by soil conditions, they produce seed as shown in Fig. 1. The alfalfa, sweet clover, and weeds shown in Figs. 2 and 3 are the same age and grew at the same time in the same soil. When the soil became

Fig. 2. Shows alfalfa and Yellow Foxtail 45 days after the seeds were planted. Their growth was checked by drought.
too dry for good growth, the weeds blossomed and produced seed but the cover crop plants simply stopped growing. The picture shows plants 60 days old. The weeds in the same bed matured seed without more water. Three and four generations of some weeds are produced each year in the orchards by letting the surface soil become dry between irrigations. The cover crop plants make a poor growth or die under such conditions. Keeping the land moist by frequent irrigation gives the cover crop plants the advantage and they thrive and become well established.