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Use of Legumes in Pecan Orchards

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Oklahoma's approximately 40,000 acres of managed pecans contribute about $15 million each year to the state's agriculture economy. Acreage estimates of unmanaged native pecans in Oklahoma vary but are conceded to be in excess of 100,000 acres. Most of Oklahoma's pecans are from improved native groves, most of which also support livestock during part of the season.

A mature pecan orchard consists of two separate but interrelated ecosystems. The orchard floor provides a working surface for orchard operations and influences activities in the tree canopy which produces the pecan crop. Oklahoma's planted pecan orchards usually consist of native vegetation on the orchard floor with a clean strip 6' to 12' wide along the tree row. Vegetation weed-free strips are normally maintained with herbicides while the vegetation in row middles is maintained by mowing. The mowed sod middle prevents or reduces erosion, improves wet weather trafficability for spraying and other orchard operations and can provide forage for grazing livestock. Due to irregular tree spacing improved native groves often utilize sod culture throughout.

A good orchard floor cover does not compete excessively with trees for moisture or nutrients and is compatible with orchard insect populations. The importance of vegetation management in the orchard floor is documented. Weed competition with tree roots is significant throughout the tree life. Weed competition in newly planted pecan orchards decreases survival and severely retards tree growth. Weed competition even with mature trees can reduce tree growth and yield as well as contribute to alternate bearing. Pecan trees have an extensive root system including a tap root which penetrates as deep as the soil structure and water table will permit. The bulk of the pecan's nutritional needs, however, are met by small feeder roots which are located near the soil surface. It is these roots which come into direct competition with vegetation on the orchard floor. An effective orchard floor management program integrates the needs of the cover with the needs of the trees with respect to rooting depth, extent of rooting and time of year when water and nutrient demand peak.

Sod-free culture in pecan orchards is discouraged due to increased erosion, decreased wet weather accessibility in the orchard and a poor harvest surface. A vegetation-free orchard floor also loses moisture faster than a properly managed sod and is dusty during harvest. Tillage equipment is prone to inflict injury to trunks and frequently damages shallow feeder roots which provide nutrients and water to trees. A well managed orchard floor cover facilitates harvest and may provide grazing for livestock.

Nitrogen Needs of Pecans

Mature pecan trees require 100 to 150 lbs. of nitrogen (N) per acre annually to grow and produce properly. Adequate N must be available at budbreak to support vegetative growth and leaf expansion which occurs immediately and relatively rapidly after budbreak. The nutritional needs of the orchard cover crop as well as the trees must be in concert. Ideally, peak demands of each would occur at different times of the year.

Insects

Hundreds of species of arthropods, i.e. insects, mites and spiders, are present in pecan orchards. Fortunately, most are noninjurious to the pecan and many are beneficial; feeding on those which inflict damage to pecan tree leaves, twigs or nuts.

Harmful insects include various kinds of aphids, worms and true bugs as well as phylloxera, mites, spittlebugs and weevils.

Nature provides some natural pest control by the presence of insects which feed on other arthropods.

Some of the most common predators include various species of lady beetles, lacewings, assassin bugs, spiders, and others. See OSU Extension Fact Sheet 7307 for additional information on beneficial insects.

An effective orchard pest management program manages the orchard ecosystem to attract beneficial insects to the orchard and retain them in numbers sufficient to combat infestations of harmful insects. This usually involves provision of a food source, e.g. aphids. The beneficials must then follow the food source, e.g. aphids, up into the trees as the ground cover growth slows or goes dormant.

Benefits of Legumes

Legumes as the ground cover in pecan orchards offer two advantages over typical grass ground covers. First, N is fixed, i.e., removed from the air by bacteria associated with the legume roots and utilized by the legume. When the legume root and top decompose, stored N in the legume is released and available to the pecan tree. Second, certain legumes harbor large aphid densities which attract beneficial insects that feed on aphids and other insects. When the aphid densities on the legume decline or the legumes senesce, the beneficial insects associated with the legumes seek another food source such as aphids and other pests in the pecan canopy. Therefore, proper selection and management of legumes as the orchard floor cover may reduce or eliminate the need for supplemental N fertilization and may reduce the number of pesticide applications necessary for pecan production.

Characteristics of Legumes

Certain characteristics of legumes are more compatible with pecan production. First, a cool season legume is less competitive with the trees for soil moisture than a warm season legume, plus the cool season legume would stimulate an earlier increase in the beneficial insects. The legume should be tolerant to both sun and shade. Many pecan orchards are prone to flooding; therefore, flooding tolerance is desirable. Also, the legume must not cause an increase in undesirable insects, such as stink bugs, while attracting beneficial insects. The legume should also be capable of fixing large quantities of N. Additionally, the legume must be capable of withstanding the traffic associated with orchard maintenance and harvesting.

Legume Selection

Since 1990 five annual and seven perennial legumes were tested in research plots in southern Oklahoma (Noble Foundation Research and Demonstration Farm, Ardmore) central Oklahoma (Oklahoma Pecan Research Station, Sparks) and northern Oklahoma (Knight Creek Farm, Sapulpa). Legumes included are listed in Table 1.

Prior to seeding all existing vegetation was killed with Roundup® in September. At two sites the soil was disked lightly, the seed broadcast with a rotary planter then rolled. At the third site the soil was either disked or brush raked then seeded and rolled. Northern and southern plots were seeded in early October while the central Oklahoma plots were seeded the middle of January.

Poor stands were achieved with Mt. Barker subterranean clover and birdsfoot trefoil due to inability to compete with annual grasses. 'Kura' clover seed did not germinate well and Purple Prairie Clover grew too slowly initially. A better stand was achieved in all cases by disking prior to seeding and better stands were

Table 1. Legumes selected for evaluation as pecan orchard cover crops.

Legume	*Scientific name*	*Seeding rate (lb./A)*
Annuals		
'Yuchi' Arrowleaf clover	*Trifolium vesiculosum*	10
'Dixie' Crimson Clover	*T. incarnatum*	20
Rose clover	*T. hirtum*	10
'Mt. Barker' subterranean clover	*T. subterraneum*	10
Hairy vetch	*Vetch villosa*	20
Perennial		
'Kenland' red clover	*T. pratense*	10
Kura clover	*T. ambiguum*	10
'Osceola' white clover	*T. repens*	4
'Regal' white clover	*T. repens*	4
'Louisiana S-1' white clover	*T. repens*	4
Purple prairie clover	*Petalostemum purpureus*	10
'Empire' birdsfoot trefoil	*Lotus corniculatus*	4

achieved by seeding in October than January. Arrowleaf produced the most forage while 'Dixie' crimson and 'Kenland' red clovers produced the most N. Larger scale tests indicate total N production from certain legumes exceeds 100 lbs/A. Aphid densities were highest on crimson, arrowleaf, subterranean and red clovers. Lady beetle adult and larval densities were highest on crimson, red and arrowleaf clovers. Other prominent beneficials present included green lacewings, soldier beetles, predacious stink bugs, damsel bugs and hover flies. As the legumes decline with the onset of hot weather in June the beneficials move up into the trees and feed on aphids.

White clover was the most flood tolerant of the legume species tested. White clover stands were thinned after 2 weeks of flooding but recovered well after water subsided. Red clover and annual clovers were killed by 2-week flood.

Perennial legumes, e.g. red and white clover, also appear to be better adapted over a wide range of soils including relatively heavy silt loan soils than are annuals. Crimson clover and vetch performed poorly on silty clay loam soils in Rogers County but better on lighter textured soils. Perennial legumes may attract stink bugs, which can damage pecans by feeding on the nuts. To avoid damage, legumes should not be mowed between August 1 and shuck split. This should retain stink bugs in the ground cover rather than forcing them into the trees. Also, trees should be scouted carefully to determine if stink bug control becomes necessary.

Studies thus far indicate the most compatible legume mixtures for pecan orchards as shown in Table 2. Due to seed size differences between legume species, separate seeding operations for each legume are required to achieve the recommended seeding rates. Legume seed should be inoculated with the appropriate *Rhizobium spp.* prior to planting. Light disking prior to seeding followed by rolling benefits stand establishment. Growers should soil test and ensure adequate phosphorous and potassium prior to seeding. Additional information on legume establishment is contained in OSU Fact Sheet 2585, "Forage Legumes for Oklahoma."

Either the annual or perennial mixture can be used. However, each mix should include both legumes listed in the pair since each member of the pair complements the other. In the annual mix the vetch lasts longer than the clover. Reseeding of crimson clover may be needed each fall. In the perennial mix, the white clover produces more N while the red clover attracts more beneficial insects. Grower preference determines which mix, annual or perennial, to use.

Grazing livestock on orchard legumes reduces N availability to the pecans, but legumes provide a high quality forage and rapid weight gain for cattle. Growers who choose to graze should exercise due caution with respect to bloat prevention. Consult your county extension agent in this regard.

Whether or not orchards are grazed, a leaf sampling program should be followed to ensure that the legumes are meeting the N needs of the trees. Broadcast N applications on actively growing legumes tend to reduce the legume stands and decrease the amount of N fixed by the legume. If the trees require supplemental N applications, it should be broadcast in early June when legumes begin to senesce or become inactive during the summer. N should not be applied between mid-June and about October 1 to avoid stimulating late season growth that may make trees more susceptible to cold injury. Information on pecan leaf sampling is in OSU Fact Sheet 6232, "Fertilizing Pecan and Fruit Trees." Legumes must also be utilized in conjunction with a good insect scouting program to determine the need for pesticide applications.

Table 2. Recommended annual and perennial legume mixes* for use as pecan orchard cover crops.

Legume	*Habit*	*Seeding rate (lb/A)*	*Approximate seed cost ($/lb)*	*Seeding time*
'Dixie' Crimson Clover	Annual	10	1.00	early Oct.
+				
Hairy Vetch	Annual	8	.60	early Oct.
'Kenland' Red Clover	Perennial	8	1.20	early Oct.
+				
'Louisiana S-1' White Clover	Perennial	2	2.50	early Oct.

*For best results use both annuals together or both perennials together.

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