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Cover Crops to Improve Soil Health and Pollinator Habitat in Nut Orchards: Part II

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Integrating cover crops into a nut orchard can have some unique benefits and problems not found when used cover crops during the fallow period between cash crops. Studies show ground covers can reduce hardwood tree growth anywhere from a few percent to more than 70 percent in the case of tall fescue (Fig. 1). This means if it takes 3 years to put on one inch of diameter growth in a weed-free planting, it will take more than 9 years if growing in a tall fescue sod. Impacts on nut production appear to be even greater.

Fig. 1-Tall fescue as a ground cover or cover crop in a slow growing walnut stand leaves little soil nitrogen for the trees.

The amount of sunlight available to the ground cover in an orchard will depend on the row orientation, size, and crown density of the trees. In a mature nut orchard less than 50% of incoming solar radiation reaches the ground cover. Some shade-tolerant cover crops like Kentucky bluegrass, sweet clover, white and red clover have better growth under moderate shade than under full sun while shade-intolerant cover crops like field peas and oats do poorly under moderate shade.

Normally, tillage in an orchard is discouraged to minimized damage to tree roots. Deep tillage to incorporate a cover crop as green manure is also discouraged as it speeds up the microbial loss of nitrogen and organic matter and slowing the gains in soil health expected from a cover crop. The trees and cover crops will both benefit from no-till practices and other weed management practices.

We have more options when using cover crops in our orchards than farmers because we can establish and maintain perennial forbs as cover crops. One suggested cover crop for orchards is a mix of moderately shade-tolerant white clover for nitrogen fixation and weed suppression and perennial ryegrass for nutrient scavenging, and soil building. Bud burst and flowering on walnut growing in a perennial grass sod can be delayed 4 to 5 days due to cooler soil temperatures lessening the risk from late spring frosts.

Perennial cool-season cover crops should be left to flower, produce seed (unless the cover crop itself can become a weed), and then go dormant over the summer to help conserve soil moisture. Summer mowing is discouraged because it will stimulate new plant growth that will again actively compete with the trees for available soil moisture and nutrients.

An added value of using forage cover crops in an orchard maybe the production of high quality forage for livestock. When grown under moderate to dense shade most plants produce less, but higher quality forage (higher crude protein and less non-digestible fiber). Care is needed when selecting cover crop species to minimize risks from bloat, nitrite poisoning, and toxic compounds that occur naturally or form if hay is not properly harvested. According to Kansas State, the plant to worry most about is hairy vetch, one of the most frequently used cover crop species.

If grazing the orchard, you should follow the UMCA's silvipastural guidelines to minimize compaction and overgrazing. Guidelines recommend creating multiple small paddocks so livestock can be rotated when forage cover is reduced by two-thirds or plants grazed early in the rotation show new growth. To minimize compaction in the orchard, maintain some open pasture paddocks, so livestock can be removed from the orchard when soil moisture is near field capacity.

When choosing which cover crop to use, consider how plant residues in the fall will impact the harvesting operation. Plants with tall woody stems will make it difficult to pick up the nuts unless mowed before harvest. Warm-season perennials are weakened if fall mowing is not delayed until after a killing frost. Most mechanical harvesters are not designed to handle large volumes of grass or legume forage. Although Daikon radish can be used to break up the plow pan found under many orchards, it is easily pulled up and jams mechanical nut harvesters in addition to leaving holes in the orchard floor into which nuts disappear.

When cover crops are planted in black walnut and to a lesser extent in pecan and hickory plantings, some consideration should be given to the susceptibility of the cover crop to juglone. Numerous lists exist on the web as to what plants are supposedly tolerant and susceptible to juglone although few cover crop species are on these lists. It is important to note that improving soil health, i.e. increasing the organic matter and the populations of soil microbes lessens the likelihood of juglone toxicity occurring even if a species is listed as susceptible.

Although legume cover crops can provide much of the needed nitrogen, they do have a down side. Legumes, especially the clovers, aggressively take up potash and orchards may require application of K fertilizers. Clover and hairy vetch ground covers (Fig. 2) are attractive to deer and seem to increase the incidence of browsing and buck rub. Cover crops are also likely to increase the number of mice and voles followed by snakes. Pecan growers may not want to mow or harvest the cover crop after August 1 or until shuck split to lessen movement of nut-damaging stink bugs into the trees.

Fig. 2-Hairy vetch, an excellent cover crop and N-fixer, in full flower.

In *Managing Cover Crops Profitably*, Andy Clark (2007) says there is a cover crop to fit just about every situation and suggests starting by considering the top recommended cover crops species for your region. For Missouri, he recommends crimson clover, red clover, sweet clover, hairy vetch, cereal rye, annual ryegrass, spring oats, and buckwheat because of their properties as nitrogen sources, soil nutrient scavengers, soil builders, erosion fighters, subsoil looseners, and weed fighters.

Andy Clark did include an example for a sloping orchard needing a cover crop to control erosion, contribute organic matter and N, attract beneficial organisms, limit rodents and other pests, conserve soil moisture, and not tie up nutrients during key periods of fruit or nut development. He recommended selecting a cover crop that does not produce too much N causing excessive leaf growth on the trees, can be a perennial or reseeding annual, is low growing and needs minimal management, uses water efficiently, releases nutrients during the growing season, and harbors or

attracts few pests. He recommended white clover or possibly strawberry clover (although they attract pocket gophers) mixed with quick-growing reseeding soft brome or annual ryegrass (although they may require some control by periodically mowing). He suggested using reseeding winter annuals such as crimson clover, rose clover, subclover (south Missouri only), annual vetches, or an annual medic as alternatives.

Two tables were distribution at the 2017 MNGA annual meeting that rank grasses, legumes, or other broad-leaved species either for their value as a cover crop in nut orchards or for their establishment, growth characteristics, management, and utilization. Table 1 is an example of these tables that shows values for 6 of the >50 traits compiled for 20 of the >60 species. The full tables most likely will also be available in a future issue of The Nutshell published by the Northern Nut Growers Association or can be obtained by contacting Jerry Van Sambeek.

COVER CROPS AND POLLINATORS

Declining populations of the monarch butterfly and honeybees have brought national attention to the importance of pollinators and other beneficial insects. Over 100 agricultural crop species in North America and more than 75% of the food we eat depends on a pollinator to achieve full potential yield. Under the 'National Strategy to Promote the Health of Honey Bees and Other Pollinators,' almost 200,000 acres have already been signed up for planting to a mix of forbs to provide nectar, pollen, and nesting sites.

Although honey bees facilitate pollination of more than 120 crops, there are nearly 4,000 different species of bees found in the United States. Most species are solitary bees, meaning each female locates and provisions her own nest with pollen before laying eggs (Fig. 4). Most bees require undisturbed areas because they nest in the soil and excavate underground tunnels.

Fig. 3-Bees actively forage for pollen and nectar that results in movement of pollen.

Other beneficial insects that benefit from pollen and nectar sources during part of their life cycle include predatory beetles, lacewings, and parasitic wasps. These insects prey on destructive insects including aphids, slugs, caterpillars, and grasshoppers.

Trees and shrubs can provide significant forage (pollen and/or nectar) and many serve as larval hosts for butterflies and moths. Nearly all native trees, shrubs, and woody vines including walnut, pecan, oak, and chestnut are utilized by pollinators. Dumroese and Luna (2016) suggest our nut trees can support more than 120 different species of butterflies or moths. Honey bees prefer to forage on the lee side of trees and stop pollinating when it gets too windy. Some studies show increased pollination efficiencies extending 10 to 15 times the height of the trees.

Legume cover crops are excellent sources of pollen and nectar for pollinators and beneficial insects in addition to their being able to boost soil fertility. UMCA researchers found that the number and diversity of beneficial predatory and parasitic insects were higher in a walnut alley-cropping practice than in a pure alfalfa stands. McGraw and Smith also reported that planting legumes in pecan orchards was followed by a build-up of beneficial insects. Recognize that when

the cover crop goes dormant or dies, it is also likely to drive insect pests into the tree canopies such as stink bugs that feed on the immature nuts.

Although grass cover crops do not provide nectar, they can provide pollen. Grass pollen usually has a lower protein content than the pollen of broad-leaved plants making grass pollen marginally attractive to bees.

Cover crops of high value to honey, native, and bumble bees, butterflies and moths, and other beneficial insects include annuals such as buckwheat, canola, crimson clover, phacelia, sunn hemp, and hairy vetch; biennials such as partridge pea, sweet clover, forage radish, and turnips; and perennials such as alfalfa, kura clover, white clover, red clover, sainfoin, and the perennial vetches. Many of these same plants also provide positive benefits for improving soil health.

Buckwheat is one of the best cover crops for attracting bees and beneficial insects. It grows rapidly smothering other weeds and is easily killed by mowing before the seed matures (it can be invasive otherwise). Flowering vines and plants with weak stems are usually better cover crops than plants with erect stems because they can smother and suppress growth of other plants with less above ground biomass. Last summer, Steve Kirk observed six different species of bumblebees working our hairy vetch plots on the same day.

It is important when managing for pollinators to use a mix of species to assure flowers are present throughout most of the growing season. In a nut-producing orchard, cover crops should be chosen that are not blooming when insecticides need to be applied to control insects such as the pecan weevil. If that's not possible, plan to mow the cover crop just before spraying insecticides or spray late in the day when bees are least active. Avoid the use of systemic insecticides, especially the neonicotinoids, as these chemicals move through a plant making most parts toxic to pests as well as pollinators and beneficial insects. They can also persist in the soil and absorbed later by the next crop.

Fig. 4-Five-year-old native wildflower border seeded without native grasses.

An easy option for restoration for pollinator habitat in your orchard is to establish permanent narrow strips of native wildflowers within the tree rows or along fence rows and wider strips along orchard boundaries (Fig. 4). If you want strips to also include grasses, use bunch grasses like orchard grass, timothy, or our native little bluestem or prairie dropseed. These strips can provide undisturbed areas for solitary bees to dig underground tunnels for nesting. Mixes with eight or more native wildflowers usually provide a sequential source of pollen and nectar.

Consider including milkweeds in native wildflower strips as milkweeds are the sole

Fig. 5-Blackberries growing and producing fruit under a row of hickory trees.

source of food for the monarch butterfly. Missouri has 18 species of milkweed, half of which have seed commercially available. They are adapted to a wide range of soil conditions, so one or more species should be adapted to our orchard soils.

A third option for improving pollinator habitat is planting flowering shrubs and small trees within the tree rows. If pruned to remove lower lateral branches, we should be able to harvest nuts from under these trees and shrubs. If soils are not well drained and are low in organic matter, shrubs will need to be selected that tolerate the accumulation of juglone in black walnut orchards. If you use other nut or fruit trees, they can also be a source of additional revenue from the orchard. Pollinator-friendly species tolerant of juglone and their bloom time include witchhazel (Jan-Mar), redbud (Mar-Apr), plums (Mar-May), service berry (Mar-May), pecan (Apr-May), black raspberries (Apr-Jun), peaches, cherries, pawpaw (Apr-May), sassafras, elderberry (Jun-Jul), and willow (Apr-May), but not apples, blueberries, grapes, or blackberries (Apr-June).

Under the Conservation Reserve Program, the USDA Farm Service Agency plans to enroll nearly 270,000 acres of private lands in a special pollinator-specific initiative. In addition, the USDA NRCS plans to fund up to $4 million in cost-share programs to establish and improve habitat under the Monarch Butterfly Habitat Development Project.

SOURCES FOR COVER CROP SEED

Agronomic crops that can be used as cover crops like wheat, rye, oats, soybeans, and clovers can usually be purchased from a local farm supplier. New seed companies have started that specialize in seed bred for use as soil-improving cover crops like the Daikon radish and sunn hemp or as cover crops that can also be grazed like grazing corn. These companies have prepared mixes or can do custom mixes designed to address your specific soil or grazing needs. If mixes include legumes, use the correct rhizobial inoculum at the same time to maximize nitrogen benefits. Several companies have developed their own inoculum with a broad mix of rhizobial strains that are likely to nodulate both seeded forage legumes and native legumes. Look for inoculums that also contain beneficial mycorrhizal fungi to boost growth of most cover crops. Valuable sources of information I found on the web include Center Seeds (Minster, OH; http://www.centerseeds.com) which is a network of dealers with seven locations in Missouri, Green Cover Seed (Bladen, NE; http://greencoverseed.com), and Walnut Creek Seeds (Carroll, OH; http://walnutcreekseed.com).

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Table 1. Compatibility, shade tolerance, and nitrogen source for some common cover crop species.

Cover crop	Compatibility	Shade tolerance	Nitrogen source	Soil builder	Value to bees	Grazing value
Alfalfa	D	D	A	A	A	A
Annual ryegrass	C	C	F	A	F	B
Bluegrass	B	B	F	B	D	A
Buckwheat	--	D	D	C	A	F
Cereal rye	B	B	F	A	F	C
Cowpeas	--	C	A	D	A	C
Crimson clover	B	B	B	B	A	A
Crownvetch	A	A	A	--	B	D
Field (winter) peas	--	D	B	C	C	B
Hairy vetch	B	B	A	B	B	F
Oats	B	D	F	C	F	A
Orchard grass	C	B	F	B	F	B
Radish	--	D	D	A	A	C
Red clover	B	B	B	C	B	A
Redtop	B	C	F	B	F	B
Soybeans	A	--	C	D	C	--
Sweet clover	B	B	A	A	A	C
Tall fescue	F	C	F	B	F	B
White clover	C	B	A	C	A	A
Winter wheat	A	C	F	C	F	B
A=excellent, B=very good, C=good, D=fair, F=poor, and an – means data not available.						

New Threat to Our Nut Orchards

(Jerry Van Sambeek and Michele Warmund collaborated on this article)

In 2017, we can expect to see increasing planting of soybeans (Roundup Ready 2 Xtends) and cotton (Bollgard II XtendFlex) resistant to glyphosate (Roundup) and dicamba (Banvel, Diablo, or Vanquish) in Missouri. Heavy reliance on glyphosate-resistant soybeans, corn, and cotton (some estimates as high as 90% of cropland) has led to selection for glyphosate-resistant weeds and the need to develop of crops resistant to multiple herbicides. If herbicide applications are not done correctly, volatilization and drift from these plantings pose significant risk to adjacent nut orchards and other crops.

The new concern is use of Dicamba, a benzoic acid that is readily absorbed by both foliage and roots of broad-leaved plants with a half-life of about 14 days in the soil. It quickly translocates throughout a plant where it acts as an auxin-like growth regulator. It has been used to control broadleaf weeds in corn, sorghum, pastures, and turf as well as woody plants in non-crop areas. Unlike glyphosate, dicamba is easily volatilized from leaf surfaces on hot days. We understand more than 100 complaints have been filed against Monsanto Company because of volatility and drift issues of dicamba to non-target plants.

Monsanto Company has denied any liability because of off-label use of dicamba by growers and applicators. One case involves more than 270 pecan trees that were injured or killed following spraying of an adjacent cotton field. Missouri's largest peach grower, Bader Farms, Inc. in the Missouri Bootheel, claims more than 7,000 peach trees showed damage in 2015. The number grew to 30,000 trees in 2016. The University of Missouri is developing plans to determine susceptibility and characterize symptomology on a wide range of landscape plants including apple, walnut, pecan, and oak. As Bill Reid suggested a few years ago, know what your neighbors are planting and, if their plans include Roundup and dicamba-ready soybeans and cotton, let them know our nut orchards are highly susceptible to dicamba drift and that they need to be using the newer, more-expensive non-volatile formulations and nozzle technology (XtendiMax VaporGrip). These formulations minimize the formation of small droplets readily carried by the wind. They were not

available in 2016 but should be available in 2017.