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# Cover Crops to Improve Soil Health and Pollinator Habitat in Nut Orchards

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Recently several national programs have been initiated calling for improving soil health and creating pollinator habitat using cover crops. Opportunities exist for nut growers to do both with the use of cover crops in our nut orchards. Because we can include perennial ground covers as cover crops, we have even more choices than landowners managing cover crops during the fallow period between agronomic crops. In addition, it's easy to see how adding some native trees and shrubs along with cover crops that we can create suitable habitats supporting bees and other pollinators.

The top five reasons farmers give for planting cover crops include increasing soil organic matter, reducing soil erosion, reducing soil compaction, managing weeds, and providing an alternative source of nitrogen. These all sound like good reasons to include cover crops in our nut orchards as well. Other reasons for including cover crops include cutting fertilizer costs, increasing water infiltration and retention, capturing and holding nutrients that otherwise would leach into the subsoil, and providing an additional source of income.

At a recent meeting of the Missouri Forest Resource Advisory Committee, we were told the five rules for improving or maintaining soil health are (1) minimize soil erosion, (2) maximize organic matter production, (3) maximize soil microbial populations and diversity, (4) maximize water infiltration, percolation, and retention in the soil, and (5) minimize compaction. With deep tillage for growing agronomic crops, organic matter in many soils has gradually declined from 4 to 6 percent to less than 2 percent. Use of cover crops is one of the more practical approaches to increasing organic matter content although it will take many years.

Cover crop residues left on the soil surface serve as a mulch or protective cover. Residues reduce the impact of raindrops minimizing soil crusting and loss of soil by wind and/or water erosion. Plant cover and residues also reduce surface water evaporation. In addition, covered soils have lower temperatures than exposed bare soil during the summer which slows the microbial decomposition rate of residues and soil organic matter. Slowly decomposing cover crop residues also provide a long-lasting mulch to control weeds and potentially act as a slow release fertilizer for the trees.

Cover crops can also be efficient nutrient scavengers. The fibrous root systems of cereal grains and other grasses are good at scavenging excess fertilizer and nutrients especially nitrate nitrogen, calcium, and potassium that might otherwise leach during a fallow period into the subsoil. Grains like winter wheat, rye, and even oats, seeded in the fall can absorb more than 70 pounds of N per acre with a three month growing season. This N is made available the following spring if the cover crop winter kills, i.e., oats, or is terminated with cultivation or herbicides, i.e., cereal rye.

Legume cover crops go a step further than grasses. While legumes will use soil nitrogen if available, rhizoidal bacteria inside root nodules can take sugars from the plant and nitrogen from the air and fix them into N forms that the plant can use. Some of that nitrogen can escape from the plant or be released when the plant dies and can be taken up by your trees and other plants (Fig. 1). Grasslands interplanted with legumes frequently need little if any added nitrogen fertilizers. Our trees, if not in competition with grasses, will also use any released nitrogen.

Fig. 1-Walnut seedlings in second year of growth with only chemical weed control (left) or living mulch of hairy vetch without herbicides (right).

With legume cover crops, maximum nitrogen fixation has occurred when plants begin to flower through mid-bloom. Fixation rates can range from 50 to over 200 pounds of N per acre depending on the species. As a general rule, legumes fix 60 to 75% of the nitrogen needed for their growth with approximately 60 to 70% of their nitrogen in the aboveground forage. Thus, if legumes are grazed or harvested as forages, there should be little net loss or gain of available soil nitrogen in the orchard from using legume cover crops. If not harvested, legumes should provide a net gain in available soil nitrogen when used in an orchard.

Cover crops also provide other soil-related benefits. As plant roots and shoots decompose, they add organic matter which provides food for microorganisms. More than 80 percent of our plants have beneficial mycorrhizal fungi attached to their roots. In addition to helping plant roots take up soil nutrients, mycorrhizae produce glomalin, a sticky water-insoluble glycoprotein. Glomalin binds soil particles together to form the stable soil aggregates needed to improve soil tilth. The resulting air spaces between aggregates allows for improved soil gas exchange, water holding capacity, and root penetration. Cover crops with deep taproots can also penetrate compacted soil layers returning nutrients to the topsoil and improving soil permeability by producing channels that can be utilized by the trees.

The root systems of cover crops can also physically hold soil particles in place during storm events reducing sheet, rill, and gully erosion. Planting cover crops following tillage may reduce soil erosion by as much as 50 percent while no-till seeding of cover crops sometimes reduces erosion by 90 percent.

Cover crops suppress weeds by out competing, shading, and/or producing phytotoxic compounds. Erect cover crops typically need to produce more than 3 tons per acre of biomass to suppress weeds while prostrate (white clover), semi-erect (cowpeas), and climbing (hairy vetch) legumes require less biomass to be effective. This reduces the amount of precipitation needed for the ground cover, making more water available to the trees. On average, 4 to 4.5 inches of rainfall are needed for each ton of biomass produced. Evaporation from bare soil during the growing season averages 2 to 3 inches. Some covers like cowpeas, millet, and medics use less water per ton of biomass than other heavy user of water like alfalfa and rye.

Cover crops, especially those with very rapid growth like buckwheat, quickly shade the soil and keep other seeds from germinating. A few cover crops produce phytotoxic chemicals that can inhibit seed germination and seedling growth of other plants. Winter rye and to a lesser extent the other cereal grains release toxic compounds as plant residues decompose. Decomposing residues of canola (rapeseed), mustards, radishes, and other Brassica species act as biofumigants when tilled into the soil.

Nationally, the USDA NRCS has a program evaluating the benefits of using cover crops to improve soil health during fallow periods between cash crops. The Plant Materials Center in Elsberry, MO is currently evaluating how fall planting date (late July to late September) affects biomass production of more than 30 cover crop species alone or in mixtures. In general, cover crops seeded in August in Missouri produced the greatest above ground biomass by November. Penn State just published the results of a two-year study comparing single species versus multi-

species cover cropping systems. Results suggest the more species of different types (grass vs legume, annual vs perennial, winter annual vs cool-season vs warm-season, fibrous vs taproot, etc.) in mixtures, the more rapidly changes in soil health occur.

COVER CROPS AND NUT ORCHARDS

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. 2). 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. 2-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.

***NOW THAT YOU'VE HAD A TASTE...***This is the introduction to the presentation Jerry will be giving at the Annual Meeting. The remainder of the article will appear in the Spring issue of the MNGA news so you don't have to worry about taking notes!