Ground Covers To Maximize Ease Of Management, Tree Vigor, And Ease Of Harvest

J. W. Van Sambeek, H. Gene Garrett and James E. Jones

Van Sambeek: Research Plant Physiologist, USDA Forest Service, North Central Forest Experiment Station, 1-26 Agriculture Building, University of Missouri, Columbia, MO 65211-0001
Garrett: Professor, School of Natural Resources, 1-30 Agriculture Building, University of Missouri, Columbia, MO 65211-001
Jones: Director of Forestry and Land Management, Hammons Products Company, 105 Hammons Drive, Stockton, MO 65785.

Orchard floor management planning needs to be begin before the walnut trees are planted – long before the trees mature and start producing nuts. Decisions such as number of trees per acre, spacing between and within row, and ground cover management between and within the row are needed before the trees are planted in order to accommodate equipment, future cultural practices, and planning for a sustainable forest operation. Important objectives for whatever system is chosen are to provide the walnut trees with a uniform amount of water and nutrients through the growing season at the acceptable cost, to provide for frost and pest control without significant environmental damage, and to provide the necessary space to efficiently operate equipment for ground cover maintenance and nut collection.

On a deep, well-drained site suited for acceptable growth of eastern black walnut, the orchard management system should provide many of the following benefits through the growing cycle: a) provide a cover to decrease soil erosion and nutrient leaching below the root zone, b) keep soils cool to delay spring budburst and reduce damage by late killing frosts, c) allow air movement through the orchard to minimize frost pockets, d) remove excess soil moisture that has accumulated during the dormant season, e) reduce dispersal of airborne disease spores that affect walnut leaves, f) minimal competition for soil moisture and nutrients during the growing season, g) improve soil organic matter and nutrient cycling, and h) facilitate mechanical harvesting of nuts in the fall.

The ideal orchard management system provides an effective ground cover during the dormant season to minimize soil erosion and delay walnut budburst and flowering, abundant spring growth to remove excess soil moisture to enhance walnut root growth and increase soil organic matter when incorporated, sufficient root growth to firm the soil for operating equipment when spraying or performing other cultural activities, minimal competition for soil nutrients and water during the summer when nuts are developing, and minimal above ground biomass in the fall to impede mechanical harvesting of fallen nuts. Mechanical harvesting is likely to use equipment to sweep fallen nuts into windrows followed by some type of cleaner to separate the nuts from leaves, twigs, and other trash raked into the windrows. As with most things, no one ideal orchard management system meeting all the above criteria exists; however, systems do exist that meet many of the above criteria.

Orchard floor management systems can include 1) complete cultivation, 2) complete chemical weed control, 3) sod culture, and 4) sod culture with strip weed control. The following section describes each management system and some advantages and disadvantages of each system.

Complete cultivation. This system involves periodic cultivation of the entire orchard floor from late spring through nut harvesting. The major advantage is minimal competition from other plants for soil moisture and nutrients during the growing season. Periodic tillage also reduces surface evaporation of soil moisture by disrupting the capillary rise of soil moisture to the surface. However, it should be noted that potential evaporation rates from bare ground, even when periodically tilled, can still be almost as great as from orchard floors covered with lowing growing vegetation. A major disadvantage with complete cultivation is that the shallow feeder roots in the upper soil layers are repeatedly cut or injured. Another major disadvantage is that complete cultivation should be limited to level ground unless other conservation practices are used to minimize soil erosion.

Complete cultivation is usually the most expensive management system because it must be periodically repeated during the year, requires more time, and uses larger tractors than other systems. Complete cultivation normally requires square planting designs to facilitate cultivation in both directions where wide equipment can limit the number of walnut trees planted per acre and reduce selection gains from thinning. The larger tractors needed for cultivation can also lead to more soil compaction and reduce water infiltration. In addition, during periods of heavy rainfall, cultivation on a timely basis may not always be possible. This can be especially critical in the fall when the soil surface needs to be tilled and leveled to facilitate sweeping fallen nuts into rows for mechanical harvesting. A cultivated orchard may require harrowing and floating to make it level along with rolling with a cultipacker or other equipment to firm the soil surface.

A modification of the complete cultivation system adaptable to eastern black walnut orchards is the late fall planting of cool-season annuals to establish a ground cover during the winter. Diseased walnut leaves can be incorporated during cultivation or covered by the ground cover to restrict dispersal of fungal spores in the spring. Establishing a winter ground cover has the added advantage that it can be incorporated the following spring to improve soil tilth and water infiltration rates. Use of annuals legumes such as hairy vetch or crimson clover have the added advantage that they are efficient nitrogen fixing plants that can be expected to provide as much at 100 pounds of nitrogen per acre when incorporated as a green manure crop. If the legume top growth is not harvested, it could provide up to nearly half the annual estimated 200 pounds of nitrogen per acre need to sustainable nut production in walnut orchards. Most winter annuals can be seeded in the fall as part of an operation to prepare the orchard floor for mechanical harvesting of the fallen nuts. It is generally recommended that winter legumes be planted about one month prior to the first frost date. Winter annuals such as hairy vetch, subterraneum clover, and crimson clover are good choices because they do not produce abundant height growth until the following spring.

The use of climbing winter annuals like hairy vetch could significantly reduce the number of cultivations needed the following year. In the spring, hairy vetch will climb, overtop, and kill most weeds in the spring before it produces seed and dies. If not incorporated, the dead hairy vetch vines form a dense mulch across the planting. The mulch layer effectively shades the soil preventing new weed seeds from germinating and reduces the amount of soil moisture normally lost through evaporation from bare ground. Because hairy vetch is an efficient nitrogen fixing legume, the summer decomposition of the roots and mulch slowly provides a rich source of nitrogen and other nutrients to the walnut trees. In some areas, a foliar disease kills the vines before seed pods are formed. In these areas, the hairy vetch mulch needs to be incorporated by cultivation in late summer to prepare the seedbed for reseeding and mechanical harvesting of fallen nuts.

Complete chemical control. This system uses various chemicals to control weeds during the growing season and harvesting period rather than cultivation. This system causes less compaction because it can use small tractors and other equipment with floatation tires to spread the weight of equipment over a larger surface than equipment for complete cultivation. Under complete chemical control, walnut roots are left undisturbed and can grow into the more fertile upper zone of the soil. Major disadvantages include the limited number of herbicides currently registered for use in walnut orchards, their expense, and their persistence in the environment. In addition, during periods of heavy rainfall, it is not always possible to apply herbicides when weeds are at their most susceptible life stage. Surface runoff can also be a problem in orchards where weeds are continually controlled with herbicides, especially if the orchard is also irrigated with sprinklers.

With complete chemical control it may be advisable to establish a cool-season annual in the fall to protect the site from soil erosion during the winter. In addition, the ground cover would hold or recycle nutrients in the upper soil layers especially leachable nutrients like nitrate nitrogen. The advantages of using annual legumes over annual grasses for complete chemical control are not as great as when the ground cover can be incorporated. For annual legumes more than three-fourth of the fixed nitrogen is found in the above ground parts. After herbicide application in the spring it is unclear how much of this nitrogen will enter the soil and how much will be lost as volatile ammonia during decomposition. The dead vegetation from either annual legumes or grasses following herbicide application would effectively mulch the soil surface and should reduce the emergence of other weeds that may not be more susceptible to herbicides.

Sod culture. Under this system, the orchard floor is maintained with existing weeds or a planted cover crop. The covercrop maybe planted grasses, legumes, or weeds. Sod culture offers several advantages over both complete cultivation and complete chemical control. The permanent cover allows nearly year-long access to the orchard for cultural practices such as pruning, thinning, and spraying. Because sods can be maintained with small tractors and inexpensive mowers, sod culture is less costly than discing or use of herbicides for weed control. The system is well designed for use on rolling terrain typical of cover sites where some of the best walnut growth occurs. Rolling terrain provides for better air movement through the walnut orchard thus reducing the incidence of frost damage to the new spring growth and developing flowers.

The major disadvantages to sod culture are that additional water and nutrients that must be applied to maintain both the walnut trees and the covercrop. This is especially true if the covercrop is harvested as in alley cropping situations. Although the information is limited, we know some perennial ground covers like tall fescue or smooth bromegrass produce toxic exudates that can slow the growth of walnut. In addition, many of the grasses are bunch grasses and do not form a tight sod, thus making it more difficult to sweep nuts into windrows for mechanical harvesting of fall nuts. Conversely, we also know that black walnut produces toxic root exudates that could limit the growth of groundcovers. Most plants have been shown to be sensitive to juglone at high concentrations in laboratory studies. High juglone concentrations could be expected to occur during summer dry periods under conditions of low available soil moisture. Evidence suggests that there are a limited number of soil microorganisms capable of breaking down juglone. Orchard soils with good aeration and high levels of decomposing plant residues favor growth of these microorganisms; thus, juglone should not be a problem when selecting groundcovers for nut orchards on deep, well drained walnut sites.

.

A promising sod culture system current being tried in the central part of the eastern black walnut range is a mixture of Kentucky bluegrass and Dutch white clover. Bluegrass can be found invading many plantings and can be expected to form a thick sod from which fallen nuts can be sweep into windrows. Dutch white clover is also a low creeping legume that spreads by stolons which grow along the surface of the soil. White clover is an excellent nitrogen fixing legume and during decomposition of roots and aerial parts will release nitrogen to the grass and walnut trees. Estimates of nitrogen-fixing ability of white clover in grass pastures are reported as high as 225 pounds of nitrogen per acre. Both Kentucky bluegrass and Dutch white clover flower early in the spring and if left undisturbed should remain relatively dormant through the summer minimizing competition with the walnut trees for moisture and nutrients. Because the growing points of both species are close to the ground, a bluegrass-white clover sod can be mowed close to the ground with a flail mower in the fall. Flail mowers are more efficient than rotary mowers for scalping the groundcover close to the ground to prepare the orchard for sweeping mechanical harvesting of fallen nuts.

Most perennial legumes such as birdsfoot trefoil, red clover, alsike clover, and alfalfa lack shade-tolerance and are poorly adapted to mowing with flail mowers. In addition, they may produce too much above ground biomass on the orchard floor if fallen nuts are to be sweep into windrows for mechanical harvestings. Warm-season legumes like serecia lespedeza and perennial soybeans should not be used because their most vigorous period of growth is during the summer when soil moisture is likely to be limited.

Sod culture with strip weed control. This orchard management system combines sod culture between the tree rows with use of a weed-free zone within tree rows. The weed-free zone is usually a 6 to 8 foot wide strip in the tree row maintained with herbicides. Sod culture with strip weed control takes advantage of many of the benefits of the three previous systems. Sod culture with strip weed control is adaptable to rolling terrain if tree rows are planted on the contour. Sod culture with strip weed control is easily adapted as an agroforestry practice for orchard establishment. In the past, winter wheat, soybeans, and sorghum have been successfully grown between the rows of trees planted 22.5 to 40 feet apart. With the latter spacing, agricultural crops have been grown between the tree rows for six to twelve years before plantings were converted to a permanent sod. Strip weed control is usually done in the spring or the fall using a combination of pre-emergent and post-emergent herbicides. Recent studies have shown that herbicide applications in combination with liquid fertilizers will increase nut production while similar applications in the spring are no more effective than using herbicide mixtures only.

Sod culture with strip weed control may allow walnut growers to use grasses such as tall fescue and smooth bromegrass. Grasses sods have been shown to significantly reduce elongation of tree roots in response to toxic chemicals and/or low nitrate nitrogen availability. Several demonstration plantings have shown that periodic cultivation to remove a tall fescue sod between alternate rows of walnut trees was as effective as complete removal of the tall fescue sod to rejuvenate tree growth. Strip weed control using herbicides within the tree rows maybe equally effective, but remains to be tested. It is important to emphasis that most studies show walnut trees in grass sods grow slower than trees with sods from native plant populations (weeds). Conversely, trees in sods of planted legumes frequently grow faster than trees with sods with a mix of native grasses and forbs.

Several more environmentally friendly alternatives using herbicides for strip weed control exist; however, their effectiveness in walnut orchards has not been evaluated. Cultivators with rotating tines have been developed that mount to the side of a tractor for cultivating around trees. With

these cultivators, the weed free zone is rather narrow and they are not very effective on weeds more than 6 to 10" tall. Mulching with a 3 to 4" deep layer of compost, yard wastes, or wood chips will effectively suppress most weeds. These materials can provide a slow, steady supply of nutrients into the root zone under the trees. The major disadvantages to mulching are the amounts of labor required to apply and maintain the strips and fallen nuts cannot be harvested by sweeping into windrows. Recently, woven plastic or polypropylene fabrics have been developed that have functional life expectancies of 10 years or more. Although rainfall and liquid fertilizers can penetrate these woven fabrics, they also act as a mulch reducing surface evaporation of limited soil moisture during the growing season. The major disadvantage to woven fabrics is the high initial cost and lack of mechanical equipment for installing fabric in established nut orchards.

.