TENNESSEE STATE UNIVERSITY COOPERATIVE EXTENSION COLLEGE OF AGRICULTURE

ANR-PROD-01-2025 Beneficial Cover Crops for Tennessee Nurseries

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Introduction

Tennessee has over 23,600 acres of nursery production in the open (without a shade house or other covered structure) according to the 2022 USDA Census of Agriculture; that is the area of roughly 17,800 football fields. Much of that land is lined with field-grown plants that will be dug and sold as bareroot or balled and burlapped (B&B) stock. After a new row of crops is transplanted, the soil surface can remain bare for several months until grasses, sedges and broadleaf weeds establish. Bare soil is prone to structural decline and erosion, especially during heavy rain and/or strong wind (Figure 1). During summer, bare soil can lead to increased temperatures that can be stressful for plant roots, lethal temperatures for soil microorganisms and excessive evaporation of soil moisture. In addition to water loss, a soil surface lacking vegetation is prone to losing nitrogen (N) and other nutrients when volatilized into the atmosphere and during an irrigation or rain event when leached into groundwater or through surface water runoff. When harvesting ornamental trees and shrubs in field production, accompanying soil is lost

Figure 1. *Soil erosion from heavy rainfall in a nursery field. (Photo credit: Anthony Witcher, Tennessee State University (TSU))*

and localized soil quality is reduced. Since amending the soil with bulk organic material is not economically viable, growers can take advantage of best management practices like not tilling row middles to suppress weed pressure and using cover crops to build soil

and bolster organic material (SARE, 2012). Besides protecting soil and enhancing its overall health, cover crops strengthen nutrient cycling and reduce nutrient losses in nursery production systems. Cover crops are a versatile tool to retain soil, improve its properties and maximize the success of future crops.

What are Cover Crops

A cover crop is one or more plant species or cultivar grown to cover bare soil between or within crop rows or in seasonal rotation with main crops (i.e., in fallow plot). The main advantages of using cover crops in nurseries are to increase the soil's organic and nutrient contents, reduce erosion, conserve soil moisture, provide habitat for beneficial insects, improve water infiltration, suppress weeds and soil-borne plant pathogens, break up compact soil and improve field conditions for harvesting crops.

Types of Cover Crops

Plant species used as cover crops can be categorized as either a legume or non-legume or by their main growing season (warm or cool). Cover crops can be used throughout the year, and the species and/or cultivars selected should be based on local growing conditions and should match the needs of the site and production system.

Legumes

Legumes (or plants belonging to the Fabaceae family, such as clovers, beans and peas) have symbiotic relationships with N-fixing bacteria (*Rhizobium* spp.) that add N to the soil in amounts that depend on the plant species and environmental factors. There are guides to estimate the pounds (lbs) per acre of N that the leguminous species add to the soil per season to determine if and how much additional N fertilizer is needed (see SARE, 2012) or for more precise nutrient levels, plant tissue and/or soil samples can be submitted to a professional lab. For leguminous plants to achieve maximum N fixation, seed must be inoculated with *Rhizobium* spp. bacteria prior to sowing. The organic matter of the soil is increased by both leguminous and non-leguminous cover crops through their decomposition at the end of the growing season.

Non-legumes

Non-leguminous cover crops include cereals (e.g.: winter wheat, cereal rye and

triticale), forage grasses (like annual ryegrass), other grasses (sorghum-sudangrass, also known as sudex) and broadleaf plants (e.g.: mustards, other brassicas and sunflowers). Non-leguminous cover crops are effective at scavenging nutrients deep in the soil and can make them available to subsequent crops, however this process is dependent on weather, time, plant species and soil microbe populations. Grasses scavenge soil N well, however, due to their high ratio of carbon to N (C: N) the soil N is not readily available to other plants until the grass is largely decomposed. When the main crop is planted too soon following the termination of a grass cover crop, foliar yellowing (chlorosis) can occur due to the lack or deficiency of available N. Alternatively, some broadleaf species, such as radish, quickly produce deep roots in the fall that scavenge N deep in the soil until freezing or near-freezing temperatures kill the plant, which allows N to be released and available for other plants. Tillage radish (*Raphanus sativus*) is also beneficial for breaking up compacted soils with its long tap root (aka bio-drilling) and promoting water infiltration (SARE, 2012; USDA, 2024). Some plants in the Brassicaceae family, particularly mustards, are used as biofumigants to reduce soilborne plant pathogens (fungi, oomycetes and bacteria) and inhibit weed seed germination (Santos et al., 2021). Biofumigants contain bioactive compounds that trigger the activity of other compounds, often containing sulfur, which are toxic to some soil organisms, notably the disease-causing pathogens *Phytophthora nicotianae* and *Rhizoctonia solani* (Baysal-Gurel, 2018; Panth et al, 2020). Some compounds resulting from this process can also support a soil environment that promotes the growth of beneficial microorganisms (Panth et al., 2020). Research conducted by Baysal-Gurel and others (2019) saw a reduced incidence of Rhizoctonia root rot disease of flowering cherry ‘Kwanzan’ in outdoor propagation beds when beds were first seeded with one of three cover crops (arugula, mustard green or turnip) and then solarized by covering with a clear polyethylene sheet. Another study found suppression of the soil pathogens *Phytophthora nicotianae* and *Rhizoctonia solani* when seed of several cover crop cultivars were first sown, allowed to grow to flowering stage and then chopped and incorporated into the topsoil layer in greenhouse containers, which were subsequently covered with clear plastic sheeting. When viburnum and hydrangea plants were transplanted to the soil formerly

containing cover crops, they had higher whole plant fresh weights (an indication of growth) than soil without cover crops (Baysal-Gurel et al., 2020). In addition to cover crop species in the mustard family (Brassicaceae), there is also research showing *Allium* species (e.g., onion, leek, garlic) suppress soil populations of *Pythium* spp., which can lead to diseases like damping off and crown rot (Arnault et al., 2013). Several studies have been published demonstrating the use of cover crops to suppress soilborne pathogens and promote the growth of agricultural crops (Baysal-Gurel et al., 2018; Panth et al., 2020; Parajuli et al., 2022; Santos et al., 2021).

Season of Growth

Tennessee climate has sufficient moisture year-round with mild winters, which supports both warm and cool season plant growth. In TN, warm season cover crop seed sown in early May to mid-June will develop vegetatively in the summer and mature in late summer to early fall. For growing cool season cover crops in TN, seed should be sown from late August through October. These seed will germinate in the fall, then grow slowly until late winter and mature in late spring (April/May). During winter months in TN, cool season cover crops can prevent erosion and provide traction and stability for both workers and equipment while digging trees and shrubs for B&B production. Cool season cover crops can also help reduce attacks to young tree trunks by the flatheaded borer (*Chrysobothris* spp.) (Addesso et al., 2022).

At the end of a growing season, plants reproduce via seed (unless they are biennial and seed set occurs in their second growing season) and the amount of seed they produce is another consideration when selecting cover crop(s). When plants are allowed to disperse or release their seed and germinate (re-seeding), the resulting seedlings might be desirable to some growers or a weed problem for others. Plants that re-seed can naturally create a dense cover. However, if wanting to reduce or avoid reseeding, mowing or other means of terminating cover crops before they set seed or selecting a plant that produces a low seed amount are options. Use caution when selecting cover crops as some species can escape cultivation and become weedy while others have developed resistance to herbicides, like annual or Italian ryegrass (*Lolium multiflorum*) (Bobadilla et al., 2021).

Below are suggested cover crops by season of growth for TN nursery growers and notable advantages and considerations for each. More in-depth information and additional cover crop species can be found in "Managing Cover Crops Profitably" (3rd edition) by the Sustainable Agriculture Research & Education (SARE), which is available at no cost on-line: https://www.sare.org/resources/managing-cover-crops-profitably-3rd-edition/.

Cool season cover crops

- Buckwheat (*Fagopyrum esculentum*) – cool season or summer annual; non-legume, broadleaf grain; quickly covers soil; suppresses weeds; helps break up topsoil; plant residue quickly decomposes and adds nutrients to soil; supports populations of beneficial insects; attracts honeybees; frost-sensitive; short growth season
- Field peas (*Pisum sativum* subsp. *arvense*) – other common names: Austrian winter peas, Canadian field peas; winter annual; legume, adds high amount of N (via fixation); suppresses weeds; reliably winter hardy (can survive 10°F)
- Tillage radish (*Raphanus sativus*) (Figure 2)– annual, usually winter or spring; in mustard family; large taproot that breaks up compacted soil and increases water infiltration; suppresses weeds; adds N to soil

Figure 2. *Tillage radish planted as part of a cool season cover crop mix at a commercial nursery in Tennessee in February. (Photo credit: Anthony Witcher, TSU)*

- Cereal rye (*Secale cereale*) – additional common names: winter rye, grain rye; cool season annual, non-legume; prevents erosion; aggressively scavenges soil N and reduces nutrient loss; adds organic matter; can reduce soilborne diseases and root knot nematodes; suppresses weeds by producing allelopathic compounds
- Crimson clover (*Trifolium incarnatum*) – annual; grows quickly after germination; ideal for early spring or fall or short-rotation use; legume, conducts N fixation; reseeds; builds soil; prevents erosion; suppresses weeds and may need reseeding every few years
- Red clover (*Trifolium pratense*) – short-lived perennial or winter annual; legume, conducts N fixation; suppresses weeds; supports beneficial insect populations; dormant in extreme heat and occasionally needs reseeding
- White clover (*Trifolium repens*) – long-lived perennial; adapted to wide geographical range and varied environmental conditions; legume, conducts N fixation; suppresses weeds; prevents erosion and reseeds. Common cultivars are categorized by size: 'Dutch White' – an intermediate size, blooms more profusely than larger cultivars, more heat-tolerant than some other cultivars; 'Ladino White' – taller and larger leaves than other cultivars, produces most N per area but less heat-tolerant and may need to be reseeded some years
- Winter wheat (*Triticum aestivum*) – winter annual but can be spring planted; non-legume; deep roots stabilize the soil and prevent erosion; increase organic matter; scavenge deep in soil for nutrients; suppress weeds; typically senesces in May in TN
- Triticale (hybrid of wheat and cereal rye) – winter annual; reduces erosion (deep roots); increases organic matter; roots scavenge for nutrients deep in soil and suppress weeds

<u>Warm season cover crops</u>

- Sudex or sorghum-sudangrass (*Sorghum bicolor* × *S. bicolor* var. *sudanese* hybrids) (Figure 3) – summer annual; quickly increases soil organic matter; loosens subsoil; suppresses weeds via allelopathic compounds; can tolerate pH 5.0-9.0; height: 5-12' tall; mowing when 3-4' tall can increase root mass and depth.

- Cowpeas (*Vigna unguiculata*) – additional common names: southern peas, black-eye peas, crowder peas; summer annual legume (thrives in hot, moist areas); suppresses weeds; conducts N fixation; prevents erosion; builds soil through biomass; drought tolerant; upright (not vining) varieties are more suitable for use in nursery crops

Figure 3. *Sudex growing as a cover crop in a fallow commercial nursery field. (Photo credit: Anthony Witcher, TSU)*

Planting a mix of cover crop species with complementing characteristics can efficiently improve soil properties (Figure 4). Research at Tennessee State University's Otis L. Floyd Nursery Research Center (NRC) identified compatible cover crop mixes for field production in commercial nurseries (Table 1).

How to Implement Cover Crops

Sowing seed of cover crop species efficiently establishes coverage between nursery rows (nursery middles) during the growing cycle or in fallow plots. Before sowing seed, any pre-existing plants should be mowed very low to the soil surface. If possible, plant clippings should be removed to minimize plant residue prior to sowing.

Figure 4. *Cool season cover crop mix (crimson clover and triticale) in row middles of field production at a Tennessee commercial nursery. (Photo credit: Anthony Witcher, TSU)*

Having more bare ground increases the opportunity for germinating seed roots to penetrate the soil and successfully establish. Another way to increase germination success is to sow seed prior to a rain event or, if possible, irrigate soil following sowing seed.

Machinery for sowing seed is not one-size fits all and the best tool will depend on the plant species being sown and the

nursery row width. A broadcast seeder is a cost-effective machine for sowing small-seeded species such as clover, but for large-seeded species, like cereal grasses (cereal rye, wheat and hybrids) and tillage radish, it is not ideal due to insufficient soil contact. Another caveat to a broadcast seeder is the risk of seed landing in the rows of the main crop (nursery trees or shrubs), which can lead to competition for water and nutrients. Another cost-effective option is an all-purpose overseeder (Figure 5).

Figure 5. *An all-purpose overseeder for sowing cover crop seed. (Photo credit: Anthony Witcher, TSU)*

Overseeders operate by first creating divots or perforations in the soil with disc blades or a spike drum, then dropping the seed at a specified rate and finishing with a cultipacker to press the seed into the loosened soil. The width of overseeders varies but a 4-5’ wide machine is typically ideal for sowing in the space between B&B production rows (row middles). Using an overseeder when the soil is severely dry is not recommended due to the difficulty in effectively breaking up the soil surface prior to sowing seed. Another machine evaluated for nursery use was a seed drill, which is widely used for sowing cover crop seed in other cropping systems. However, seed drills were found to be too wide for nursery row middles and not cost effective.

How to End or Transition Cover Crops

At the end of the cool or warm season plants start to naturally die (annuals) or become dormant and the above-ground material dies (perennials). The above-ground material can be managed in different ways depending on plans for the plot.

For cover crops growing in row middles, plants can be left to naturally die as temperatures warm up in the spring (cool season species) or cool down as summer ends (warm season species). To avoid reseeding, the cover crops should be flattened with a roller-crimper or mowed when plants are flowering but prior to seed set to get the most cover crop growth. Mowing plant material can help start decomposition of plant residue to add

nutrients to the soil. A roller crimper is a tractor attachment that presses the above-ground growth down onto the soil surface. Several benefits to doing this include the promotion of plant residue decomposition, short-term control of spring weeds, soil moisture conservation and surface cooling. If planning to sow seed of a cover crop for the following growing season, the best approach would be to use a rotary tiller, chisel plow or disc plow to incorporate plant material into the soil, so the surface is more open and available for germinating seed roots to penetrate the soil. This should be done 2-3 weeks prior to sowing or planting depending on environmental conditions.

Cover crops on fallow land would follow a similar schedule to those grown in row middles. A best management practice for soil health includes rotating what is planted in a location every few years and incorporating cover crop biomass into the soil. This helps add nutrients and organic material back into the soil that are removed when plants are harvested and land erodes; it also supports beneficial soil microbes and can reduce soilborne pathogen populations. In TN, field-grown ornamental trees are typically dug in the fall through early spring and replanted in spring or fall. An ideal time to implement rotation with a cover crop would be after harvesting trees at the end of winter/early spring. Leveling the soil to eliminate holes from harvested trees would need to be done prior to sowing warm season cover crop seed. Research at the NRC found sudex or sudangrass is a useful warm season cover crop for increasing soil organic content relatively quickly and performs well in TN. Sowing sudex seed May-June at 50 lb/acre, followed by mowing when plants reach 3-4' tall and mowing and tilling in September of the same year resulted in acceptable soil retention, weed suppression and soil building. After the sudex, sowing a cool season cover crop mix to protect the soil through the winter and early spring is recommended before planting a new nursery tree crop in spring.

Recommended Tool and Seed Sources

Equipment (all-purpose overseeder and roller crimper) can be rented through the Warren County Soil and Water Conservation District (931-668-4383) and may also be available at a similar office near you. There are also cost-share programs available through the Tennessee Department of Agriculture's Agricultural Enhancement Program (TAEP) and the USDA National

Resource Conservation Service (NRCS) to help offset the cost of seeders and cover crop seed.

Table 1. Cool season cover crop mixes for Tennessee nurseries developed by research at Otis L. Floyd Nursery Research Center (Witcher and DeLay, 2023).

Cover Crop Species	Seed Planting Rate (lb/acre)	Comments
Mix #1		General use mix for adding N, stabilizing soil and weed suppression
Cereal Grass (cereal rye, winter wheat or triticale)	75	
Crimson Clover	15	
	Total = 90	
Mix #2		General use mix for adding N, stabilizing soil and reducing soil compaction
Cereal Grass (cereal rye, winter wheat or triticale)	40	
Crimson Clover	9	
Tillage Radish	5	
Buckwheat	15	
	Total = 68	
Mix #3		Mix for maximum benefits such as adding N, stabilizing soil, suppressing weeds and reducing compaction; provides early summer cover
Cereal Grass (cereal rye, winter wheat or triticale)	40	
Crimson Clover	9	
Tillage Radish	4	
White Clover	3	
Red Clover	3	
	Total = 59	

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Additional Resources

Southern Cover Crops Council. https://southerncovercrops.org/

Cover Crops. Appropriate Technology Transfer for Rural Areas Sustainable Agriculture Program. https://attra.ncat.org/topics/cover-crops/

For additional information, contact your local nursery specialist at:

Tennessee State University, Otis L. Floyd Nursery Research Center

472 Cadillac Lane McMinnville, TN 37110
http://www.tnstate.edu/agriculture/nrc/
931-668-3023

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