Cover crops may be considered an integral part of any cropping system that seeks to become more sustainable and supportive of conservation agriculture. Cover crops are grown in most cropping systems to provide environmental and soil productivity benefits. Thus, integrating cover crops into a crop production system should be considered a long-term investment for conserving and/or improving soil and water resources. The benefits arise from:

- Providing soil cover to prevent erosion in the off-season;
- Increasing water infiltration into the soil;
- Providing plant residues to increase soil organic matter;
- Reducing nutrient loss and leaching from the soil profile and/or lowering residual soil nitrogen (N);
- Reducing herbicide runoff in a corn–soybean rotation;
- Suppressing or reducing early-season weeds and weed biomass; and
- In the case of legumes, increasing N supply for the following summer grain crop.

For row crop producers in the Midsouth, the major categories of winter cover crops to consider are either grasses (wheat, rye, oats), legumes (vetches, peas, clovers), or a mixture of the two, and brassicas (See Table 4 at end of article). The grasses will generally require N fertilizer to produce the desired biomass. The legumes will not require any fertilization since they have the ability to “fix” N; however, they may require the appropriate N-fixing bacteria. Some of the N that is “fixed” by the legumes will be available to the following summer crop, and this makes planting a legume cover crop more economical.

A cover crop can consist of a single species or a mixture of species. Current dogma is that successful establishment of a non-volunteer cover crop is best accomplished with the seeding of a mixture of diverse species, specifically grasses and legumes. However, this approach will create potential seeding and management problems because of the diversity of species in the mixture. For example, legume species that are grown in a cover crop mix with grasses will not compete very well with the annual grasses they are mixed with. Thus, the additional N they will contribute will be very low compared to that of legumes grown alone as a cover crop (Harris, Nebraska Farmer, Apr. 2018).

The CTIC published results from a cover crops survey that was conducted during early 2016 in the Midwest. Even though the results from this survey likely are not applicable to Midsouth producers, they do give some insight into practices that can be considered by producers in the southern US.

An excellent source for cover crop information for the entire US is Managing Cover Crops Profitably--SARE. Important sections and their page numbers are listed in Table 1. The charts on pages 66-72 are especially useful.
Grass and legume species that provided a high biomass yield and legume species that provided biomass with a high N content in Louisiana are highlighted in Table 2.

Table 2. Biomass and N production from selected cover crops in Louisiana; average of four years and six locations.

<table>
<thead>
<tr>
<th>Species</th>
<th>Aboveground biomass yield</th>
<th>Average</th>
<th>Low</th>
<th>High</th>
<th>N content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hairy vetch</td>
<td></td>
<td>4347</td>
<td>2946</td>
<td>8699</td>
<td>144</td>
</tr>
<tr>
<td>Common vetch</td>
<td></td>
<td>4054</td>
<td>0*</td>
<td>4592</td>
<td>122</td>
</tr>
<tr>
<td>Crimson clover</td>
<td></td>
<td>5827</td>
<td>4286</td>
<td>8254</td>
<td>147</td>
</tr>
<tr>
<td>Burseem clover</td>
<td></td>
<td>5489</td>
<td>2843</td>
<td>9498</td>
<td>137</td>
</tr>
<tr>
<td>Sub clover</td>
<td></td>
<td>4290</td>
<td>2733</td>
<td>5567</td>
<td>122</td>
</tr>
<tr>
<td>Austrian winter pea</td>
<td></td>
<td>3866</td>
<td>1904</td>
<td>7088</td>
<td>88</td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td>4835</td>
<td>2103</td>
<td>6738</td>
<td>54</td>
</tr>
<tr>
<td>Ryegrass</td>
<td></td>
<td>3856</td>
<td>851</td>
<td>7285</td>
<td>46</td>
</tr>
</tbody>
</table>

Adapted from Boquet. *Winter killed in some years.
Cereal rye not included in above work.
Basic management information for 5 cover crop species that should be considered by Midsouth producers is shown in Table 3. The information is general and should be supplemented with the more detailed information in the linked article in Table 1 and the linked sources in the footnotes.

Table 3. Management details for five selected cover crop species for the Midsouth.

<table>
<thead>
<tr>
<th>Cover crop</th>
<th>Date of Planting</th>
<th>Seeding Rate</th>
<th>Cost of seed*</th>
<th>Fall N requirement</th>
<th>Kill stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hairy vetch</td>
<td>30-45 days before frost**</td>
<td>15-20</td>
<td>2.05-2.25</td>
<td>Inoculate#</td>
<td>Full bloom</td>
</tr>
<tr>
<td>Crimson clover</td>
<td>6-8 wks before frost**</td>
<td>15-20</td>
<td>1.50-1.70</td>
<td>Inoculate#</td>
<td>Full bloom</td>
</tr>
<tr>
<td>Berseem clover</td>
<td>Aug. 30–Oct. 15</td>
<td>10-12</td>
<td>2.15-2.20</td>
<td>Inoculate#</td>
<td>Full bloom</td>
</tr>
<tr>
<td>Wheat</td>
<td>Sept. 15–Oct. 15</td>
<td>75-90</td>
<td>0.25</td>
<td>None</td>
<td>soft dough</td>
</tr>
<tr>
<td>Cereal rye</td>
<td>late summer–early fall</td>
<td>65-80</td>
<td>0.25-0.35</td>
<td>None</td>
<td>flowering</td>
</tr>
</tbody>
</table>

*Estimated from Green Cover Seeds.
**Average frost date for a location. See article for Mississippi locations.
# Use inoculant specific for species or class.

Planting date is critical for the success of winter cover crops. Cover crops should be planted early enough to:

- Establish adequate stands, achieve ground cover, and attain some growth before the onset of low temperatures; i.e., the risk of failed cover crop establishment increases with later fall planting;
- Achieve the desired growth for biomass production; i.e., later planting will result in less biomass production (Redfearn and Elmore, UNL CropWatch, May 2018);
- Achieve adequate growth for significant nitrogen fixation (legumes); and
- Achieve growth that is sufficient to suppress winter weeds.

Cover crops may be planted preceding harvest (overseeding or interseeding) or immediately following harvest of a summer crop. It is projected that interseeding some cover crop species before harvest can result in the production of more dry matter in the fall than those planted after harvest. For instance, overseeding cereal rye into soybeans at leaf drop will result in more biomass yield than if seeding is delayed until after harvest.

Gandy has several types of seeders that attach to the head of a grain harvester so that seeding is done with the harvest operation. An article in No-Till Farmer describes other equipment that has been built or modified to spread cover crop seed.

Click here for descriptions and short videos from Great Plains Ag that discuss cover crop planting methods and cover crop seeding.
equipment that can be used to plant the various cover crop species into various seedbed conditions.

Seeding rate will vary for planting method (drilled or broadcast—see below Tables 4 and 5) and whether or not each species is planted alone or in a mixture; e.g. grass and legume mix.

Seed prices represent a major portion of the costs associated with establishing legume cover crops. However, the above-mentioned N contribution of the legume cover crop to a following grain crop will somewhat offset the high cost of the seed.

N requirement (fall-applied) of wheat and cereal rye will depend on whether or not they follow a legume (e.g. soybeans) or grain crop (e.g. corn, grain sorghum) and the desired fall growth. Also, when grass cover crop species are planted in a mix with legume species, fall-applied N may not be necessary.

Kill date or stage will vary if preceding an early-planted summer crop such as corn since the cover crop should be killed at least 2 weeks prior to planting the summer crop. Also, the kill date should match the desired N contribution with maximum growth and the manageable residue amount from the cover crop, and should be 2 weeks prior to planting the intended summer crop (See following section on timing of cover crop termination).

Cover crops usually are destroyed by tillage or herbicides prior to planting of a following summer row crop. They can also be destroyed mechanically by a crimper/roller designed for this purpose. See the video with rolling of the cover crop and planting of the summer crop in one operation and the video of a crimper/roller being used. An implement that is commonly referred to as a pulverizer or cultipacker made by Brillion may also be used. The best results are likely achieved when the crimping/rolling and planting are done in one operation as shown in the first video because this dictates that the planter drill is running parallel to the downed cover crop.

Important points to consider when using herbicides to terminate cover crops can be found here, with more detail presented in a publication from Purdue University.

The following are traits or properties associated with the 5 species in Table 3.

### Cereal rye

- Winter hardy.
- Relatively inexpensive seed.
- Excellent scavenger of unused/residual soil N to prevent N leaching.
- Can serve as an overwintering cover crop after corn or before or after soybeans.
- Can be overseeded into maturing corn and soybeans.
- Produces relatively high amount of biomass/residue.
- Taller and quicker growing than wheat.
- Rapid resumption of spring growth.
- Out-competes many weeds.
- Works well with companion legume cover crops such as hairy vetch.
- Spring weed suppression through N deprivation to weeds that lasts 5-6 weeks.
- Mineralization of N from decomposing residue very slow.
- Planted following soybean harvest can
result in as much post-planting residue cover as a crop of corn.

- Environmental benefits of a killed winter rye cover crop do not impact corn or soybean yields.

**Winter Wheat**

- Seed are less expensive than cereal rye seed.
- Slower to mature than cereal rye, and thus easier to manage.
- Excellent scavenger of unused or residual soil N to prevent N leaching.
- Works well with companion legume cover crops such as crimson clover or hairy vetch.
- Rapid spring growth aids in suppressing weeds, especially when grown with a legume.
- Produces less but easier-to-manage residue than cereal rye.
- Can use bin-run seed for planting.
- Provides the option of harvesting for grain if summer crop plans change.
- May not be as adapted to wet soils as cereal rye.
- Should be seeded in a mix with legumes on low-N soils.
- Seed at higher rate than shown in table if overseeding into soybeans.

It is important to remember that cereal cover crops such as cereal rye and wheat are used mainly to 1) maintain vegetative cover in the winter months to reduce soil erosion, 2) take up residual soil nitrate-N remaining from a summer crop that might otherwise leach into groundwater, and 3) aid in the management of HR weeds.

**Hairy vetch**

- A top producer of biomass.
- Heavy contributor of N that is readily available to the following summer crop.
- Slow fall growth and vigorous spring growth that smothers spring weeds.
- Decomposition of residue leads to ineffective weed suppression after 3-4 weeks.
- Killed vetch left on the soil surface conserves soil moisture.
- May provide enough N for low-N-requiring crops such as grain sorghum.
- Relatively drought tolerant.
- Excellent scavenger of soil P.
- Most widely used of the winter annual legumes because of its high N production, vigorous growth, tolerance of a wide range of soil conditions, low fertility needs, and winter hardiness.
- Works well in a hairy vetch/cereal rye mixture.
- Provides high N contribution even in no-till systems.
- Mechanical killing much quicker and more thorough using a roller with a chevron design.
- Better adapted to sandy soils than crimson clover.

**Crimson clover**

- Rapid fall growth.
- Provides adequate N for grain sorghum production.
- Fixes large amounts of N and produces large amounts of biomass.
- Grows well in mixtures with cereal grains.
- May not be suited for clay soils.
- Requires adequate P and K and soil pH.
above 5.5 for adequate N fixation.

- Planting too early will result in fall seed production and delayed regrowth from seed in the spring.
- May be managed to reseed for later-planted summer crops.
- Works well with no-tilling into killed residue that is left on the surface.
- Easy to kill mechanically, especially if at early to full bloom.

**Berseem clover**

- Fixes large amounts of N and produces large amounts of biomass.
- Adapted to silt and clay textured soils.
- One of most expensive legume seeds.
- May be subject to winterkill if temperatures fall below 20 deg. F for several days.
- May not be effectively killed with rolling/crimping.
- Is susceptible to root-knot nematode.

**Cover Crop Mixtures**

- Mixture of grasses and legumes provides both biomass and N production.
- May improve winter survival of a companion species.
- Mixing grass and legume species may extend weed control effects of mulches.
- Provides greater control of winter annual weeds.
- Produces longer-lasting residues.
- Provides insurance against survival failure of a particular single species planting.
- Higher seed cost than planting only grasses.
- May provide too much residue to manage effectively.
- Grass/legume cover crop mix adjusts to amount of available soil N: if there is an abundance of N, the grass dominates; if there is not much available soil N, the legume will tend to dominate.
- Adding grasses to fall-seeded legumes improves soil coverage in the fall and winter.
- May complicate killing in the spring by having to compromise on which component(s) of the mix to choose for the proper time or stage to kill.

There are other cover crop species that may be appropriate for the Midsouth. Thus, the above list is not intended to recommend the five in the list to the exclusion of others that may be suitable.

**Cover Crops in Soybean and Corn Production Systems**

Cover crops can suppress early-season weeds for the first 3 to 5 weeks after soybean planting.

Cover crops planted in the fall and killed with herbicides before soybean planting the following spring favor soybean emergence and growth over that of weeds.

A grass winter cover crop can result in lower corn yield because of the depletion of soil nitrate levels by cover crop decomposition that is not overcome by postemergence broadcast application of N to the corn crop.

The decreased N requirement from added fertilizer (and thus lower N fertilizer expense) for corn following a legume cover crop will somewhat offset the higher
estimated cost for establishment of the legume cover crop compared to that for a cereal cover crop.

The preponderance of research results indicates that using cover crops in a soybean or corn system does not result in increased yield of either soybean or corn. Thus, net returns may be lower when cover crops are part of a soybean or corn production system because their use results in an added expense with no increased return.

Using cover crops is an environmentally sustainable practice, but likely is not an economically sustainable one in traditional or non-organic soybean and corn production systems. This must be weighed against the long-term soil health improvements that are expected.

Cover crops can be used in a production system that includes corn to increase farm profits by allowing a greater amount of corn residue to be harvested for sale as a cellulosic ethanol feedstock. Click here for a summary of this concept and here for a Purdue University article that describes the concept in detail.

Results from a 12-year study conducted in southern Illinois and published in “Long-Term Effects of Cover Crops on Crop Yields, Soil Organic Carbon Stocks and Sequestration” in the August 2014 issue (online) of the Open Journal of Soil Science provide evidence to support the above claims. The results from that work are:

- Average annual corn and soybean yields were statistically the same for no-till (NT), chisel-plow (CP), and moldboard-plow (MP) tillage treatments with and without hairy vetch and cereal rye cover crops.
- At the end of the study, cover crop treatments had more soil organic carbon (SOC) than those without cover crops for the same soil layer and tillage treatment.
- All tillage treatments with cover crops sequestered SOC in the 0-30 in. root zone.
- All tillage treatments without cover crops had a 20 to 30% greater soil loss over the 12 years of the study.
- Cover crops did not reduce soil loss from the tilled treatments (CP and MP) below the tolerance level of 3.75 ton/acre.
- For the tilled treatments (CP and MP), cover crops helped reduce the rate of SOC stock loss.

**Allelopathy–Cover Crops**

Cover crops have long been recognized for their potential to provide soil cover that will curtail erosion between crop growing seasons, and to provide residue that is available to increase soil organic matter.

With the increasing occurrence of herbicide-resistant (HR) weeds, cover crops are now being evaluated for their allelopathic potential to control weeds.

Current thought is that cover crops and their residues may provide weed suppression through their physical presence on the soil surface and/or by the release of allelochemicals that may inhibit weed seed germination and/or early seedling development. Thus, allelopathic potential of cover crops for weed suppression is touted. Until this is proven, cover crop management
strategies should be directed towards practices that ensure maximum cover crop development in the fall to ensure maximum physical weed-suppression activity the following spring.

Cereal cover crops oftentimes will produce more biomass than will legume cover crops. This increased physical barrier, coupled with the slower degradation of residues from cereals compared to that of legumes, should result in more and longer-lasting weed control/suppression from using cereal cover crops.

There are four important points regarding the use of cover crops for weed control either by physical suppression or by allelopathy.

- Differentiating between allelopathy and the mulching effect of cover crops is difficult. As stated above, it is accepted that increased cover crop biomass on the soil surface can suppress weeds, but to what extent and with what resulting value in a soybean production system is not known.
- The variability in allelopathic effects from plant residues presently negates their consideration as a stand-alone weed control option in large-scale crop production systems.
- A likely system will be using cover crops that are proven to physically or allelopathically suppress weeds to offset some herbicide use.
- The additional cost associated with using cover crops in a crop production system must be considered. In other words, the additional cost of using cover crops for potential weed control must be compensated for by increased soybean yield and/or reduced herbicide usage/cost. Otherwise, producers will be reluctant to insert cover crops into soybean production systems for any reason.

**Terminating Cover Crops**

A Jan. 2016 article published in Crop, Forage, & Turfgrass Management (PMN) authored by Balkcom, Duzy, Kornecki, and Price at the USDA-ARS National Soil Dynamics Lab at Auburn, AL and entitled “Timing of Cover Crop Termination: Management Considerations for the Southeast”, gives a concise summary of points that should be considered for the timing of cover crop termination in the Southeastern US.

Warmer winters in the Southeast extend the cover crop growing season, thus allowing greater biomass production compared to more northerly regions of the US. This results in potential risks associated with increased biomass production that can be reduced with proper timing of cover crop termination.

Planting a cover crop as early as practical in relation to the summer crop’s maturity is essential to maximize cover crop biomass production. This in turn will affect its resulting growth and the decision of when to terminate in the spring.

- Planting cover crops on a particular date and then terminating them preceding an early-planted crop such as corn will result in less biomass than will result from their termination at a later date preceding a later-planted crop such as soybeans or cotton. In fact, terminating a cover crop
preceding an early-planted corn crop may result in a level of biomass that fails to meet the standard for a high-residue cover crop.

For nonirrigated summer crop production, a cover crop should be terminated early enough to allow soil moisture replenishment before the intended planting date of the summer crop. If the cover crop is still actively growing or has been terminated just prior to planting the summer crop, rainfall before planting may not be sufficient to ensure optimum germination and early growing conditions for the summer crop. Also, residue remaining from a cover crop that is terminated sufficiently ahead of summer crop planting will improve infiltration and storage of rain water that is received after its termination and before planting the summer crop.

The climate of the Southeast shortens the persistence of surface residues remaining after cover crop termination. This is especially so for residues of leguminous cover crop species vs. residues of cereal cover crops. Thus, termination of the cover crop ahead of summer crop planting should consider whether or not the cover crops are predominately legumes or cereals. In essence, termination of legume cover crops can occur later than termination of cereal cover crops in relation to an intended planting date of the summer crop.

Nitrogen (N) management should be considered when timing cover crop termination.

- Residues from legume cover crops that have a low C:N ratio (<24:1) release or “mineralize” N quickly as they decompose and thus limit the time that these residues remain on the soil surface. This results in reduced benefits from the rapidly decomposing surface residue. If the summer crop is not actively growing to capture the mineralized N, then this N will be lost.

- Delaying termination of legume cover crops as long as possible will result in increased biomass production, and will improve the likelihood that cover crop N release and uptake of N by the summer crop will coincide.

- Residue from high-biomass cereal cover crops have a high C:N ratio (>24:1), and the small amount of N that is mineralized during their slower decomposition likely will be immobilized or consumed during the decomposition process. However, these residues with a high C:N ratio will persist longer than those with a low C:N ratio, and thus surface residue benefits will be enhanced.

- Delaying termination of cereal cover crops will result in increased biomass production, and increase the likelihood that resulting residues will be sufficient to provide the soil quality benefits derived from their persistence. However, the immobilization of N during cereal cover crop decomposition may necessitate that additional early-season N be applied to a following non-legume summer crop.

Cover crop residues act as a mulch, and this mulch and the possible allelopathic compounds that are released during their decomposition may inhibit weed seed germination and subsequent weed growth. In general, the more the cover crop biomass/residue, the more likely its negative...
effect against weeds. To realize the optimum benefit from the potential allelopathic effect of cover crops against weeds, their termination should be timed to allow for maximum production of biomass while also allowing sufficient time for rainfall to occur before planting the summer crop.

Cover crop termination should occur sufficiently ahead of planting the summer crop to allow for the residue to become completely dry and brittle. This will allow planting equipment to cut through the residue and prevent “hairpinning” that can result in insufficient seed-soil contact for optimum emergence of the summer crop.

Final Thoughts

Additional information about cover crops has been produced by Pioneer. The USDA-ARS Conservation Systems Research Team at Auburn, AL has produced fact sheets, publications, slide presentations, and videos that provide complete details on most aspects of cover crop use and management specifically for the southeastern US.

The USDA-ARS laboratory in Mandan ND has produced a Cover Crop Chart that is designed to assist producers with decisions on the use of cover crops in cropping systems. The chart can be used as a guide to select individual cover crop species and as a source of information on how they will mesh with a particular crop production system.

Dr. Trenton Roberts and colleagues at the Univ. of Arkansas have compiled “2018 Recommended Seeding Rates and Establishment Practices for Winter Cover Crops in Arkansas” (see below Table 5) that provides planting date and seeding rate guidance for various cover crop species that are commonly used in the Midsouth.

Drs. Delaney, Iversen, Balkcom, and Caylor of Auburn University and USDA-ARS compiled an article entitled “Cover Crops for Alabama—ANR-2139” that was published in Feb. 2014. Table 4 below from that publication provides details about and traits attributed to several cover crop species.

Their section on “Choosing the Right Cover Crops” provides suggestions for selecting cover crop species depending on the preceding crop and the desired benefit from the cover crop. A brief summary of selected topics in that section follow.

- Choose a cover crop that is the opposite type of the subsequent summer crop; i.e. soybeans should be preceded by a winter small grain such as cereal rye or wheat.
- If the desired benefit from the cover crop is adding nitrogen to the soil, then choose a legume. Conversely, if the desire is for the cover crop to scavenge unused nitrogen from a preceding crop such as corn, then choose a cereal such as rye.
- If the desire is for the cover crop to aid in weed control, then choose a cover crop that produces a lot of biomass.
- To break up soil compaction, crops such as tillage radish or canola that have a deep taproot can penetrate a compacted layer. Crops such as cereal rye that have a dense root system will add organic matter to the soil and thus improve soil structure, which can reduce compaction over the long term.
A 2015 Ph.D. Dissertation entitled “Effect of fall-seeded cereal cover crops for use in soybeans for control of Palmer amaranth in Mississippi” by Dr. Ryan Edwards (MSPB Bufkin Fellow—Project No. 51-2014) provides the following results that essentially confirm above points and results from previous cover crops research.

- Cereal rye cover provided the most effective impediment to weed emergence.
- Cover crops alone did not provide sufficient control of emerging summer weeds in soybeans.
- Cover crops did not improve weed control in soybeans above that of herbicides alone.
- High costs associated with using cover crops may prevent widespread adoption of their use in conjunction with residual herbicides.
- The presence of cover crops had no effect on soybean yield.

The information in this article is composited from many sources. It is meant to serve as a general guide to the major components of cover crop use and management in the Midsouth. The linked references will provide more detail on subject matter areas that will address a specific producer’s production system and environment.

New information about using cover crops in row crop production systems is constantly forthcoming. As this new information comes available, it is summarized in chronological order below.

Composed by Larry G. Heatherly, Revised July 2021, larryh91746@gmail.com
### TABLE 4

<table>
<thead>
<tr>
<th>Cover Crop</th>
<th>Seeding Rate (lb/A)</th>
<th>Drilled</th>
<th>Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legumes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austrian Winter Pea (W)</td>
<td>60–90</td>
<td>90–100</td>
<td>F F VG G G VG F F VG</td>
</tr>
<tr>
<td>Crimson Clover (W)</td>
<td>15–18</td>
<td>22–30</td>
<td>F G VG VG F VG G G E</td>
</tr>
<tr>
<td>Red Clover (P)</td>
<td>10</td>
<td>10</td>
<td>VG F G VG F VG G G G</td>
</tr>
<tr>
<td>White Clover (P)</td>
<td>5–9</td>
<td>7–14</td>
<td>F F VG VG P G F F E</td>
</tr>
<tr>
<td>Hairy Vetch (W)</td>
<td>15–20</td>
<td>25–40</td>
<td>F F G G F E F G G</td>
</tr>
<tr>
<td>Iron Clay Cowpea (S)</td>
<td>40–50</td>
<td>80–100</td>
<td>G F E E G VG F G G</td>
</tr>
<tr>
<td>Lupin (W)</td>
<td>70–120</td>
<td>—</td>
<td>G F G G E E F G F</td>
</tr>
<tr>
<td>Sunn Hemp (S)</td>
<td>20–40</td>
<td>—</td>
<td>E G VG E E F F F G</td>
</tr>
<tr>
<td>Velvet Bean (S)</td>
<td>20–40</td>
<td>—</td>
<td>G G VG VG E F G G G</td>
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<tr>
<td><strong>Cereals</strong></td>
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<tr>
<td>Black Oat (W)</td>
<td>50–70</td>
<td>—</td>
<td>F G VG E E P VG F G</td>
</tr>
<tr>
<td>Rye (W)</td>
<td>60–120</td>
<td>90–160</td>
<td>G E E E G F E VG G</td>
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<tr>
<td>Sorghum-sudangrass (S)</td>
<td>30–40</td>
<td>40–50</td>
<td>E VG E VG VG G E G VG</td>
</tr>
<tr>
<td>Winter Wheat (W)</td>
<td>60–120</td>
<td>60–150</td>
<td>G VG VG VG F F VG VG VG</td>
</tr>
<tr>
<td><strong>Brassicas</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canola/Rapeseed (W)</td>
<td>5–10</td>
<td>8–14</td>
<td>G G VG VG VG G VG F G</td>
</tr>
<tr>
<td>Mustards (W)</td>
<td>5–12</td>
<td>10–15</td>
<td>G F VG VG VG G G VG G</td>
</tr>
<tr>
<td>Radish (W)</td>
<td>8–10</td>
<td>12–14</td>
<td>VG F VG E VG F E VG G</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buckwheat (S)</td>
<td>50–60</td>
<td>90–100</td>
<td>F P F E F E P E P</td>
</tr>
</tbody>
</table>

E = Excellent; VG = Very Good; G = Good; F = Fair; P = Poor/None  
(W) = Winter annual; (S) = Summer annual; (P) = Perennial.
**These recommended seeding rates and depths are for single-seeded, pure stands. If planting these crops in blends or mixed species planting depths should be adjusted to optimize seeding depth for all species included in the blend (i.e. mean planting depth for all species included).**

**Species included within this list have been tested under Arkansas production and environmental conditions over multiple years. Species not included in this list are either currently being tested or are not recommended for Arkansas crop rotations.**

### 2018 Recommended Seeding Rates and Establishment Practices for Winter Cover Crops in Arkansas

_Trenton L. Roberts, Associate Professor, Soil Fertility_  

<table>
<thead>
<tr>
<th>Cover Crop Species</th>
<th>Ideal Planting Window</th>
<th>Ideal Planting Depth (in)</th>
<th>Seeding Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Drilled</td>
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<td>---------------</td>
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<tr>
<td><strong>Winter Cereals</strong></td>
<td></td>
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<td>---------------</td>
</tr>
<tr>
<td>Barley</td>
<td>Sept-Nov</td>
<td>¾ - 2</td>
<td>35-50</td>
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<tr>
<td>Cereal Rye</td>
<td>Sept-Nov</td>
<td>¾ - 2</td>
<td>35-50</td>
</tr>
<tr>
<td>Oats</td>
<td>Sept-Nov</td>
<td>½ - 1 ½</td>
<td>35-50</td>
</tr>
<tr>
<td>Triticale</td>
<td>Sept-Nov</td>
<td>½ - 2</td>
<td>35-50</td>
</tr>
<tr>
<td>Wheat</td>
<td>Sept-Nov</td>
<td>½ - 1 ½</td>
<td>35-50</td>
</tr>
<tr>
<td><strong>Winter Legumes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Austrian Winter Pea</td>
<td>Sept-Nov</td>
<td>1 ½ - 3</td>
<td>30-50</td>
</tr>
<tr>
<td>Clover</td>
<td>Sept-Mid Oct</td>
<td>¼ - ½</td>
<td>10-15</td>
</tr>
<tr>
<td><strong>Winter Broadleaves</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bayou Kale</td>
<td>Aug-Mid Oct</td>
<td>¼ - ¾</td>
<td>8-15</td>
</tr>
<tr>
<td>Radish</td>
<td>Aug-Mid Oct</td>
<td>¼ - ¾</td>
<td>8-15</td>
</tr>
<tr>
<td>Turnip</td>
<td>Aug-Mid Oct</td>
<td>¼ - ¾</td>
<td>8-15</td>
</tr>
</tbody>
</table>
The premise supporting the use of cover crops is that they should become an integral part of any cropping system that seeks to become more sustainable and supportive of conservation agriculture. They are incorporated into most cropping systems to provide environmental and soil productivity benefits. Recently, they have been touted as an effective tool to aid in the management of herbicide-resistant (HR) weeds.

The integration of cover crops into a crop production system should be considered a long-term investment for conserving and/or improving soil and water resources. Their use as a tool against HR weeds should become a part of this broader use.

For row crop producers in the Midsouth, the major categories of winter cover crops to consider are either grasses (wheat, cereal rye, oats), legumes (vetches, peas, clovers), or a mixture of the two.

There are several cover crops articles posted on this website. Click the following links to view these supplemental articles.

- **Cover Crops and Corn Stover Removal**–posted Oct. 2015
- **Timing of Cover Crop Termination for the Southeast**–posted Feb. 2016
- **Cover Crop Termination with Herbicides**–posted Oct. 2015
- **Cover Crops**–posted Aug. 2015

In the below narrative, recent resources that pertain to cover crops are cited, and a brief summary of the content of each linked article is provided.

- **Unfertilized Cover Crop May Reduce Nutrient Losses from Tennessee Fields**–UTIA. Univ. of Tenn. scientists Hawkins and McClellan used a Soil and Water Assessment Tool (SWAT) or model to determine that farmers can significantly reduce the amount of nitrogen and phosphorus lost from row crop fields by incorporating an unfertilized winter wheat cover crop into their crop rotations.

- **Increasing Water Use Efficiency/Drought Tolerance and Yields with Cover Crops**–uterops.com. Author Tyson Raper, Univ. of Tenn. Cotton and Small Grains Specialist, found that soil moisture measurements suggest that a wheat cover crop increased water infiltration into the soil, and water retention by soil. This suggests that cover crops may aid in the prevention of yield penalties that result from slight to moderate soil water deficits.

- **A Few Thoughts on Incorporating/Managing Cover Crops**–uterops.com. Author Tyson Raper presents a summary of available information on advantages of single-species monocot covers vs. species mixtures, and timing of cover crop termination.

- **Cover Crops before Soybean Improve Soil Health**–Iowa State Univ. Drs. Castellano, Archontoulis, Helmers, Mueller, and Leandro present a summary of the results of their USB-funded project. They found that cover crops before soybean produce significantly more biomass than cover crops before corn, which in turn increased soil nitrogen retention by 100% without affecting soybean yield.

- **Functional Diversity in Cover Crop Polycultures Increases Multifunctionality of an Agricultural System**–J. of Appl. Ecology 2016. Authors Finney and Kaye present results from a unique study that was designed to determine how increasing species richness of a cover crop (cover crop with multiple species) may or may not impact the resulting ecosystem (weed suppression, N retention, cover crop biomass N, N supply during subsequent summer crop season) and yield of the following summer crop.

- **Legume Proportion, Poultry Litter, and Tillage Effects on Cover Crop Decomposition**–Agron. J. 107:2015. Authors Poffenbarger et al reported the following results from a 2-year study conducted at Beltsville, Maryland. 1) Rates of cover crop mass loss and rate of N release increased with increasing hairy...
vetch/cereal rye biomass proportion; 2) subsurface banded application of poultry litter did not affect the decomposition patterns of cover crop residues, which suggests that this method of litter application may conserve surface cover crop residues; 3) incorporation of cover crop residues and poultry litter with tillage increased the loss of residue mass and increased the N release from the hairy vetch residue; and 4) mixtures of hairy vetch and cereal rye provided intermediate mass loss and N release, suggesting that a mixture of the two in a cover crop can provide moderate persistence of both residue and N supply.

**Biomass and Nitrogen Content of Hairy Vetch–Cereal Rye Cover Crop Mixtures as Influenced by Species Proportion--Agron. J. 107:2015.** A study conducted at Beltsville, Maryland during two years provided the following results. 1) Cereal rye monocultures produced approximately twice the above-ground biomass as hairy vetch monocultures; 2) cereal rye was usually the dominant species in all mixtures of the two, likely due to it’s greater competitiveness and the incorporation of soybean residues prior to cover crop establishment; 3) cover crop biomass levels were similar between cereal rye monocultures and all mixtures, suggesting that all sown proportions except monoculture hairy vetch could achieve desired weed suppression following termination in a no-till system; and 4) achieving maximum cover crop N content required at least 50% hairy vetch biomass component in the cover crop residue, which was usually produced at the 80:20 hairy vetch/cereal rye sown proportion.

**Evaluating Cover Crops and Herbicides for Glyphosate-Resistant (GR) Palmer Amaranth Control in Cotton—Weed Tech 30:2016.** Authors Wiggins, Hayes, and Steckel report results from this West Tenn. study that was designed to evaluate Palmer amaranth control when integrating cover crops with PRE residual herbicides. Cereal rye and winter wheat cover treatments provided the best Palmer amaranth control, while treatments with crimson clover and hairy vetch covers had the greatest number of Palmer amaranth plants. Their conclusions were that high-residue cover crops in combination with the PRE herbicides used in the study did not adequately control Palmer amaranth, but these inputs can be a part of an effective GR Palmer amaranth management strategy when combined with additional late-season weed control inputs.

**Long-Term Corn Yield Impacted by Cropping Rotations and Bio-Covers under No-Tillage—Agron. J. 108:2016.** In a long-term Tennessee study, authors Ashworth, Allen, Saxton, and Tyler found that legume cover crops resulted in increased yield of corn that was grown in a rotation with soybean. Their results also indicated that winter wheat as a cover crop prior to corn in this rotation is detrimental to corn yield.

**Costs and Benefits of Cover Crops: An Example with Cereal Rye from the Univ. of Illinois and Adding Cover Crops to a Corn-Soybean Rotation from Missouri NRCS** provide estimates of the costs associated with inserting cover crops into a cropping system. These estimates have quite different costs assigned for seed and seeding, thus resulting in disparate cost estimates for similar cover crop systems. A Midsouth budget based on costs from MSPB-funded projects is needed (and should be forthcoming) to ensure that Midsouth producers have accurate estimates for the costs associated with adding cover crops to cropping systems commonly used in the region.

**Rolling Rye to Control Tough Weeds.** This Univ. of Georgia video provides an in-depth presentation on rolling tall cereal rye, including equipment needs.

**When Should I Terminate My Cover Crop—utcrops.com.** Author Garret Montgomery of the Univ. of Tenn. gives the pros and cons of early vs. late termination of both single species and mixed species cover crops in relation to soybean or corn planting.

**Terminating Cover Crops—What’s Your Plan—Iowa State Univ.** Authors Anderson, Vittetoe, and Hartzler present details about plus pros and cons for using herbicides, rolling/crimping, and tillage to terminate cover crops. They also provide links to other articles about cover crop termination.
A Jan. 24, 2017 article by Steve Groff in American Agriculturist lists important mindsets for cover cropping. 1) Identify the goal or what is intended by adding cover crops to a production system; e.g., erosion control, nutrient recycling, increased organic matter. This will be important for deciding cover crop species/types to use. 2) One of the most important points is to identify the proper planting window for the selected cover crop species so that emergence and stand establishment are optimized. 3) Successful cover cropping requires that cover crops be thought of and managed as an integral part of the overall cropping system. 4) Continue to adapt to/adopt new techniques to improve results from cover cropping.

Here are some points gleaned from all of the above.

- The first step when deciding to use cover crops is to define the purpose for their inclusion so that subsequent input and management decisions support that purpose; i.e., is the purpose to control HR weeds, remedy soil compaction, protect highly erodible soil, scavenge soil nutrients left from a preceding crop, increase soil organic matter, provide N to a following crop, etc.?
- A one-cover-crop-fits-all approach likely will not result in the intended result. This is supported by the research of Finney and Kaye (cited above). An example follows.

In a corn-soybean rotation, using winter wheat or cereal rye after the corn crop will scavenge soil N that may not have been used by the corn crop, thus preventing it from leaving the site. The cereal rye may also provide some weed control prior to planting the following soybean crop. Using a legume such as hairy vetch after the soybean crop likely will provide some N for the next year’s corn crop, thus reducing the amount of N fertilizer that will be required.

- The choice of seeding rates for a legume–cereal cover crop mixture should depend on the desired functions of the cover crop. If maximum biomass production is the goal, then the most cost effective proportion would be 0:100 legume/cereal, whereas achieving maximum cover crop N content likely will require a seeding rate proportion that is at least 80:20 legume/cereal.
- Cereal rye appears to be the best cover crop species for suppressing HR weeds, especially Palmer amaranth.
- A roller with the chevron design is likely the roller of choice to use when terminating a cover crop with the rolling method.
- If cereal rye is allowed to grow tall before terminating with a roller, a planter with a trash removing/handling attachment will likely be required to clean a space for the planted row of the following crop.
- With any cover crop, establishment of a suitable cover is paramount. This requires the proper species selection for the latitude, as well as suitable environmental conditions for emergence and subsequent growth of the selected cover crop species.
- No cover crop will result in complete control of problem weeds such as HR Palmer amaranth.
- Some of the above articles mention the potential allelopathic effect from a terminated cereal rye cover crop. However, there is little if any research evidence that this does in fact occur. Click here for a detailed article on allelopathy.
- Planting a row crop into a terminated cover crop likely will require a planter that is equipped with special attachments to handle or plant through cover crop residue.
- It is likely that a cover crop will be used on a limited acreage within an individual producer’s total operation to perform a specific function such as controlling HR weeds,remedying soil compaction, protecting highly erodible soil, scavenging soil nutrients left from a preceding crop, or increasing soil organic matter.
- Costs attributed to cover crops used in a row-crop production system should be determined by using the proper inputs, and rates and costs of those inputs. These costs will vary considerably based on the tillage system used, the crop rotation, the cover crop species, and the method of cover crop termination. This is the information that is most urgently needed so that the cost/benefit of cover crop incorporation into a crop production system
can be determined.

May 2017 Update

A growing concern when cover crops precede soybean is the potential change in insect infestations/problems that may adversely affect emerging soybean seedlings or young plants.

Dr. Scott Stewart with Univ. of Tenn. Extension presents video evidence of damage that a pea leaf weevil infestation can do to young soybean seedlings that emerge in a killed legume cover crop.

At this time, results from research designed to study the effect of cover crops on insect pests that may adversely affect soybean following cover crops are scarce. Thus, there is not enough information to definitively outline the need and/or tools for management of an insect occurrence that may damage soybean following cover crops.

Recently conducted research in this area was funded by the MSPB. Preliminary results (this research is continuing) from two of these projects are summarized below.

Results from MSPB Project No. 01-2018 that was designed to evaluate management tactics for early-season insect pests of soybeans following a legume cover crop revealed the following.

- The unpredictability of early season/soil insect infestations when soybeans are planted following a cover crop.
- The value of at-planting insecticide treatments as risk management tools when planting soybeans following a legume cover crop.
- Strategies to avoid replanting soybeans following a cover crop may be the best management practice.

Results from the conduct of MSPB Project No. 13-2018 revealed the following.

- There were no detectable levels of pea leaf weevil or any other foliar insect pests on soybean plants following a cover crop mix that included a legume. However, a neonicotinoid insecticide applied to soybean seed did result in a significant 2.2 bu/acre soybean yield increase compared to an untreated control.
- Results support the premise that insecticide seed treatments have value as an at-planting risk management tool when planting soybeans following a legume cover crop.

Aug. 2017 Update—Redbanded Stink Bug and Cover Crops

At the Aug. 2017 Emergency Forum on Redbanded Stink Bug [RBSB], Dr. Jeff Davis, LSU Assoc. Professor, made a point about the RBSB only feeding on legumes. Also, he stated that the RBSB, unlike many other insect species common to the Midsouth, does not go through diapause; i.e., this insect does not go through a dormant or arrested development period. In other words, this insect maintains activity year-round and therefore must have a food source during the winter months in the Midsouth if it is not killed by cold temperatures [generally several hours at \( \leq 23 \) deg. F].

Since the RBSB feeds only on legumes, this means that any legume such as clovers, peas, and vetches that are often used as components of a winter cover crop will provide an alternate food source during the winter months when soybeans are not available. Thus, the touted use of cover crops in a soybean production system (either monocropped or rotated) will provide a habitat for the overwintering RBSB if the cover crop contains a legume.

So here are some guidelines for using cover crops in a soybean production system when RBSB has been or may be present.

- Monitor soybean fields for the presence of RBSB, and make/keep a record of infested fields.
- In infested soybean fields, control/eradicate adult RBSB populations up to harvest to prevent their movement out of the infested field and to reduce overwintering populations.
- If cover crops are to be planted following soybean
harvest in monocropped soybean fields, do not include legume species in the cover crop mix if the fields have a history of RBSB presence.

• In a biennial corn-soybean rotation system, plant a cover crop that contains a legume species only after the soybean crop since corn, which is a non-host, will follow the cover crop. It also will be a good idea to control/eradicate an overwintering RBSB population in this cover crop to prevent RBSB infestations in soybean fields that may be in close proximity the following summer.

• When a cover crop mix does contain a legume species, monitor the stand for RBSB so that the overwintering population can be controlled or eradicated if necessary.

There is no doubt that cover crops can provide benefit in agricultural settings, but their species makeup must take into account how they will affect/promote damaging insect populations such as the RBSB.

Oct. 2017 Update


• Crop residue removal for livestock or biofuel production is common, but excessive residue removal will likely reduce soil organic carbon [SOC].
• Their review found that ≥50% residue removal reduced SOC stocks by 0.87 Mg/ha/yr and <50% removal by 0.31 Mg/ha/yr. However, cover crops [CC] increased SOC by 0.49 Mg/ha/yr, which suggests that CC could partially offset the SOC lost by residue removal.
• Reviewed studies indicated that CC following residue removal may not offset SOC losses in the short term [<6 yr].
• Opportunities to improve this short-term performance could include planting species mixtures of CC that are known to produce the most biomass, and late termination of CC since early termination of most CC does not allow for their significant biomass accumulation.
• The bottom line is this: The amount of crop residue that is removed should be determined beforehand to ensure that SOC is minimally affected, and/or the species mixture and termination time of a CC that follows residue removal should be selected to ensure maximum biomass production that will ensure SOC stabilization following residue removal.

An article titled “Influence of Cover Crops on Management of Amaranthus Species in Glyphosate- and Glufosinate-Resistant Soybean” by Loux et al. [Weed Tech., Vol. 31:487-495, 2017] provides results from a fall 2013 through fall 2015 multi-state field study that was conducted at 13 sites in Arkansas, Indiana, Illinois, Missouri, Ohio, and Tennessee. The study was designed to determine the effect of cereal rye and either oats, radish, or annual ryegrass cover crops [CC] on the control of Amaranthus spp. when integrated into comprehensive herbicide programs for soybean. Study details and results follow.

• Amaranthus species [includes Palmer pigweed] have become the major problematic HR weeds in southern crops, including soybean.
• The study was conducted with known infestations of redroot pigweed, common waterhemp, and Palmer amaranth. The Palmer populations were resistant to glyphosate. Only results from the 6 sites that contained Palmer pigweed will be presented here.
• Two cover crops were used—either cereal rye or a second cover crop that varied by site and included Italian ryegrass, spring oat, and forage radish, along with a no-cover crop treatment.
• Herbicide treatments within each combination of cover crop and HR soybean trait [glyphosate-resistant (GR) and glufosinate-resistant (GLR) soybean varieties] were designed to provide a comprehensive approach for Palmer amaranth control. They were 1] PRE/POST that consisted of PRE flumioxazin [e.g. Valor, Panther SC] followed [fb] POST application of foliar and residual herbicides applied 21 days after planting [DAP], and 2] PRE/POST/POST that consisted of the same
PRE herbicide fb by the same POST application of foliar and residual herbicides applied at 21 DAP and a POST foliar herbicide application at 42 DAP. A nontreated control was also included.

- The first POST treatment consisted of glyphosate, fomesafen [e.g. Reflex, Flexstar], and metolachlor [e.g. Dual] applied to GR soybean, and glufosinate and metolachlor applied to GLR soybean. The second POST treatment in both the GR and GLR systems was acetochlor [e.g. Warrant].
- Both herbicide programs effectively controlled (>92%) Palmer pigweed throughout the season regardless of whether or not a cover crop was present. In the absence of herbicides, cereal rye provided significantly more control [34 to 49%] of Palmer amaranth than the other cover crop species [<22%].
- Palmer amaranth density was uniformly and equally low in both herbicide programs throughout the season regardless of cover crop presence or absence. Without herbicides, the cereal rye cover crop resulted in over 50% more weed density reduction than the other cover crops and a no cover treatment.
- Soybean seed yield was highest from the herbicide treatments; there was no difference in yield between the herbicide programs or between cover crop treatments when herbicides were used. In the absence of herbicides, 24% greater soybean yield was obtained following the cereal rye cover crop vs. the other cover crops.

All of the above results indicate that cereal rye has a greater potential for controlling Palmer pigweed than the other cover crops used in this study.

Although cover crops did not affect Palmer amaranth control in the herbicide programs used in this study, the increased control potential of the cereal rye when used as a cover crop could result in improved control in high weed density situations or where adverse environmental conditions following herbicide application may reduce their effectiveness.

**May 2018 Update**

In an article titled “Effect of Multispecies Cover Crop Mixture on Soil Properties and Crop Yield” (Agric. Environ. Lett. 2:170030, 2017) published in Dec. 2017, authors Chu et al. report results from a 3-year study conducted in West Tenn. They evaluated soybean yield and soil properties following single-, double-, and multi-species cover crops that were grown for 3 years.

The cover crops treatments were: 1) wheat; 2) cereal rye; 3) cereal rye and hairy vetch; 4) cereal rye and crimson clover; 5) a multi-species mix of cereal rye, oats, daikon radish, purple top turnips, and crimson clover; and 6) no cover crop(s). Cover crops were drill-seeded soon after harvest of either corn (2013, 2015) or soybeans (2014, 2016). Soybean yield and all soil properties were measured in Oct. 2016. Major findings from the study follow.

- Gravimetric soil moisture content was significantly higher for the multi-species cover crop mix compared to the no-cover control. Soil moisture content in all other cover crops treatments was not different from the control.
- Soil inorganic N was highest in the cereal rye/hairy vetch treatment. The no-cover control and cereal rye treatments had the lowest inorganic N at the time of sampling.
- The multi-species cover crop mix and the cereal rye/crimson clover treatments had the highest potentially mineralizable N (PMN) and the control treatment had the lowest PMN.
- Soil organic carbon (SOC) did not differ among treatments, and SOC values after 3 years were comparable to those at the beginning of the study in 2013. The authors attributed this lack of a favorable response of SOC to cover cropping to the study’s short duration and climatic conditions that favor accelerated SOC mineralization at this southern US location.
- Soybean yield of 67.7 bu/acre following the multi-species cover crop mix was greater than yield from all other treatments. Yields of soybean following all other cover crops treatments were similar to each other and to the no-cover control, which was about 59 bu/acre. Soybean yield following the cereal rye treatment was 58.0 bu/acre.
- The authors concluded that their findings indicate...
that beyond the first few years, cover cropping with a mixture of diverse species could positively affect crop productivity.

These results provide support for the following general conclusions regarding use of cover crops in Midsouth soybean production systems.

- Short-term cover cropping may not provide significant soil or crop benefits; i.e., many of the positive effects that will result from inserting cover crops into a production system likely will only be realized when cover crops have been used continually for a period longer than 3-5 years.
- Increased soil N following legume cover crops or cereal/legume mixes may only be important for a following crop such as corn. It is not likely that this is an important attribute for a following soybean crop.
- The positive attributes realized following legume cover crops or cereal/legume mixes may not be compatible with situations where HR weeds are present and a cover crop such as cereal rye is needed to manage those weeds. The increased biomass from such a cover crop is a major reason it is used on sites that have HR weeds.
- Results from cover crops studies must be evaluated with regard to the properties of the study site. For example, in the above-cited study, HR weeds were apparently not a problem, so the positive effects of legume cover crops or mixes that contain legume species that were realized in that study can be transferred to similar sites without concern for management of HR weeds.
- If HR weeds are present, then a more likely cover cropping plan for a corn-soybean system will be to use a cereal cover crop such as rye prior to the soybean crop, and a legume or legume/cereal mix prior to the corn crop. This plan assumes that an every-other-year cereal rye crop will be sufficient to provide significant management of HR weeds that may be present. This is a facet of cover cropping that should be investigated further.

Refer to the list in the second paragraph of this update. It is imperative that producers first decide their goal/expected outcome from using cover crops, and then select the species or species mix that most likely will meet that goal or achieve the intended outcome.

Sullivan and Andrews of Oregon State Univ. published an article titled “Estimating plant-available nitrogen release from cover crops” that provides details about how to estimate PAN contributions from cover crops and how to sample to obtain that estimate. Main points from that article follow.

A key benefit of some cover crops is their ability to supply PAN to a following crop such as corn. To take advantage of this benefit, one must know 1) how to predict PAN value of a cover crop, 2) how much PAN is provided by a cover crop, 3) when is this PAN available and/or when does it become negative through immobilization by cereals, and 4) what is the best way to predict how much PAN will be supplied by various cover crops/cover crop mixes.

- To maximize PAN contribution from legumes, kill the cover crop at bud stage.
- Cereal cover crops can immobilize up to 50 lb PAN/acre. To minimize this immobilization, kill the cover crop during early stem elongation (jointing) growth stage.
- When cover crop dry matter is 75% from cereals and 25% from legumes, PAN is nearly zero.
- When a cover crop is mostly legumes, e.g. 75%, its PAN contribution is similar to that of a pure legume stand.
- When cover crops contain a low percentage of N (<1.5%), they provide little or no PAN.
- When cover crops contain a high percentage of N (>3.5% in the dry matter), they provide approximately 35 lb PAN/ton of dry matter.
- PAN release increases linearly as cover crop N percentage in the dry matter increases from 1.5 to 3.5%.
- Cover crops can decompose rapidly and thus release or immobilize PAN rapidly. Most PAN release or immobilization occurs 4 to 6 weeks after the cover crop is killed.
- PAN from any cover crop is minimal when the cover crop is killed when it is very small. Much of this article is devoted to detailing the required methodology for sampling cover crops to...
estimate PAN. This methodology is based on a whole-plant, aboveground samples from specified areas in a field that are used for determination of cover crop biomass (dry weight) and total percentage N in the dry matter.

Dr. Angela McClure, Ext. Corn and Soybean Specialist at the Univ. of Tenn.–Jackson, posted a blog titled “Use full nitrogen rate behind mixed cover crops” on Mar. 29, 2018. Highlights of that article follow.

- Recent research suggests that many cover crop mixtures are quite limited in their ability to contribute enough N to warrant cutting fertilizer rates for corn.
- Growers who plant a single species legume cover crop (e.g. crimson clover, hairy vetch) can reduce the N fertilizer applied to corn by 60-80 lb/acre if cover stands are uniform and robust, and termination is delayed to early bloom.
- Results from 2017 research at six on-farm sites in Tenn. revealed the following: 1) Estimated plant available nitrogen (PAN) was greatest (43 lb/acre) at 1 site where the cover crop mix contained 25-30% legume species and biomass exceeded 3 tons dry matter/acre; 2) Three of six sites with mixed covers that contained 15-20% legume species with only modest biomass production of 1.5 ton/acre resulted in only 12 to 20 lb/acre PAN; and 3) Two of six sites resulted in 0 PAN to the following cash crop of corn because the cover crop was only a cereal or a late-planted cover mixture with a very thin legume stand.
- Legume stand fluctuated depending on how early the cover crop was planted, the seeding rate, and whether or not the legume seeds in the mix were inoculated prior to planting.

Thus, a significant percentage of legume species in the cover crop mix was required to supply a significant amount of PAN to a following corn crop. It is risky to assume a PAN contribution from a cover crop mix that contains a legume without actually sampling the field for percentage legume in the mix and the tonnage of dry biomass actually present at termination of the cover crop. Therefore, Dr. McClure recommends that growers should use the full recommended N rates for corn that follows a mixed cover crop; i.e., PAN from a mixed cover crop should not be relied on as a substitute for the addition of N fertilizer to corn.

An article titled “Aboveground and root decomposition of cereal rye and hairy vetch cover crops” by Sievers and Cook provides insight into how the decomposition of above- and below-ground components of cereal (rye) and legume (hairy vetch) cover crops affects nutrient release. Major points from the article follow.

- Hairy vetch shoots and roots decomposed faster than those of cereal rye, presumably because of vetch’s higher N content.
- Hairy vetch released a large amount of N shortly after its termination, whereas cereal rye released very little. This quick burst of N release by vetch could be lost if its termination occurs too early or planting of the subsequent crop is delayed.
- Below-ground biomass decomposed quicker than aboveground biomass.
- The lower initial C:N ratio of aboveground hairy vetch biomass (10:1) compared to that of cereal rye biomass (35:1) may have been the driver of vetch’s quicker decomposition rate.
- Their results suggest that 1) if growers choose a legume cover crop such as hairy vetch, they should delay its termination until just prior to planting of the following cash crop such as corn to ensure utilization of its quickly released N following termination, and 2) a cover crop such as cereal rye that decomposes and releases N slowly would be more beneficial when used before a cash crop such as soybean that has low N needs.

Oct. 2018 Update

A Sept. 2018 Univ. of Arkansas publication titled “Understanding Cover Crops” (FS2156) by Roberts et al. provides the following points about using cover crops in the Midsouth.

- The success of cover crops is most often tied to their biomass production.
- Biomass production of most cover crop species is
strongly influenced by planting date, with early October plantings of most species generally resulting in the greatest biomass.

- Suppression of weeds by cover crops is directly related to biomass production of the cover crop(s).
- Proper selection of the cover crop species or species mixture and regular scouting are strongly recommended to reduce the risk of promoting populations of problematic insect pests.
- Terminating a cover crop 2-4 weeks before planting a summer cash crop is recommended to eliminate the “green bridge” that will increase the risk of promoting harmful insect pests.
- When selecting a cover crop to follow/precede a summer cash crop, producers must determine the desired benefits from the cover crop that follows or precedes a specific cash crop.
- Producers should manage cover crops with the same level of intensity that they use on their cash crops.

The authors also provide 1) a list of cover crop species (winter cereals, winter broadleafs, and winter legumes) that are commonly grown in Arkansas, along with some of their major attributes when following either soybean or corn in the Midsouth, and 2) a list of “Keys to Success” that will lead to the desired benefit when inserting cover crops into a summer cash crop production system.

Dr. Roberts has also compiled “Recommended Seeding Rates and Establishment Practices for Winter Cover Crops in Arkansas” that appeared in an Arkansas Row Crops blog post on Oct. 14, 2018. This information is in Table 5 above.

Mar. 2020 Update

A Mar. 2020 Agronomy Journal article titled “Short-run net returns to a cereal rye cover crop mix in a midwest corn-soybean rotation” by Thompson et al sheds light on the short-term downside of cover crop insertion into a corn-soybean rotation in the Midwest. Specific details of and results from the research follow.

- Unsubstantiated economic returns are a major contributor to producer reluctance in adopting cover crops.
- The objective of the study was to evaluate the short-run (4-year) net returns from inserting a predominantly cereal rye cover crop mix into a Midwest (Illinois) corn-soybean rotation.
- Results from this study showed that short-run expected net returns to the cover crop, including current cost-share payments, were routinely negative.
- In their simulations, the impact of cover crops on the subsequent cash crop yield, especially of corn, is currently the biggest influencer of cover crop returns. At best, cover crops did not significantly affect cash crop yields, with actual yield changes around zero.
- Their conclusions are that in the short-run, incentivizing producers to adopt cover crops will likely require 1) improved cover crop best management practices that will eliminate downside risk from their adoption, and 2) higher cost-share payments to encourage widespread adoption of cover crop insertion into a corn-soybean cropping system.

Apr. 2020 Update

A Jan. 2020 article titled “Do cover crops benefit soil microbiome? A meta-analysis of current research” by Kim et al. presents results compiled by Univ. of Ill. scientists and an Argentine cooperator. Pertinent points of conduct and conclusions from their analyses of results from over 60 global studies follow.

Sidebar: the soil microbiome is the collection or community of all microorganisms (such as bacteria, fungi, and viruses, both symbiotic and pathogenic) and their collective genetic material present in the soil.

- The soil microbiome is assumed to respond to
altered environmental circumstances such as cropping system, climate, tillage, etc.

• The authors conducted a meta-analysis by compiling results from 60 relevant studies that reported cover cropping effects on 48 soil microbial properties, which were categorized into soil microbial abundance, activity, and diversity.

• The analysis included results from studies that had cover crops that were neither harvested nor removed.

• Agricultural factors or “moderators” were climate, soil order, cover crop type and duration, cover crop termination method, tillage type, annual N fertilization, soil pH, and soil sampling timing and sample depth.

• Average values for measured soil microbiome parameters were greater with cover cropping than with bare fallow.

• Effects of climate and soil order were significant for microbial abundance and activity with cover crops, and these two parameters should be considered when managing cover crops for maximum benefit.

• Soil microbial abundance and activity increased with cover cropping.

• Results indicated that cover cropping can improve the soil microbiome especially on sites with a less robust soil microbiome vs. more productive soils.

• Conservation tillage had a smaller effect on the soil microbiome than did conventional tillage.

• Cover crop termination with herbicides resulted in a smaller effect on soil microbiome than did mechanical termination methods. Thus, the authors suggest that mechanical cover crop termination will maximize soil microbiome benefits derived from using cover crops.

• Soil sampling timing (either during the cash crop phase or during the cover crop phase) must be accounted for when soil microbial properties are measured.

• The authors concluded that this first meta-analysis of the effect of cover crops on soil microbiome shows that cover cropping does in fact increase soil microbial abundance (27%), activity (22%), and diversity (2.5%) compared to the same parameters measured under bare fallow. These measured effects should always consider termination method, climate, soil order, and tillage type.

A July 2019 article titled “Impacts of Single- and Multiple-Species Cover Crop on Soybean Relative to the Wheat-Soybean Double Crop System” by Raper et al. presents results from three years of research conducted in West Tenn. Pertinent points of conduct and results and conclusions from this research follow.

• Wheat-soybean doublecrop studies were conducted in 2014-2016 using several winter cover crop treatments following soybean harvest. The studies were comprised of five site-years.

• Winter treatments included fallow, a cover crop of cereal rye, wheat, wheat for grain, and crimson clover alone, and a cover crop consisting of a mixture of cereal rye, oats, oilseed radish, crimson clover, and hairy vetch (mix treatment). The mixture cover crop treatment represents a common mix of species used by producers.

• All cover crop treatments were terminated with herbicides about 4 weeks prior to planting full-season soybeans from early May to early June.

• Soybeans following the wheat-for-grain treatment were planted from mid-June to early July. These plantings were 3-6 weeks later than the full-season soybean plantings, depending on year.

• The wheat for grain and the cereal rye cover crops created the greatest quantities of biomass in all site years.

• Dominant species in the mix treatment were
typically cereal rye and vetch.

• The crimson clover cover treatment consistently produced one of the lowest quantities of biomass.
• Winter weeds in the winter fallow treatment generated considerable levels of biomass in each site-year.
• Weed control was greatest in the cereal rye, wheat for cover, and mix treatments, but no treatment provided consistent weed control that negated application of residual herbicides before soybean planting.
• Soybean yields were not affected by any cover crop treatment—i.e., all treatments resulted in similar soybean yields.
• The most significant finding of the study is that delaying soybean planting until after wheat harvest in the wheat-for-grain doublecrop treatment resulted in significantly large reductions in soybean yields in four of the five site years. Across the five site years, soybean yields in the doublecrop treatment averaged almost 17 bu/acre less than yields from the full-season soybean plantings behind the other cover crop treatments.
• Overall, these results indicate that inclusion of a cover crop will not likely increase soybean yields in the short term or eliminate the need for pre-emergence residual herbicides in soybean plantings that follow any cover crop.

A Feb. 2020 article titled “Impact of cover crop on corn–soybean productivity and soil water dynamics under different seasonal rainfall patterns” by Yang et al. presents results from MSPB Project 62-2019. Pertinent points of conduct and results and conclusions from this project follow.

• An 80-year seasonal soil water balance was simulated using the Root Zone Water Quality Model RZWQM2 (Ma et al., 2012) that was calibrated and validated with 4 years of field measurements.
• The objectives of the study were to: 1) quantify differences in deep drainage and ET with and without a wheat cover crop (CC) in a no-till, rainfed corn-soybean rotation under different seasonal rainfall amounts; 2) determine wheat CC effects on water storage under different seasonal rainfall patterns; and 3) ID the mechanisms associated with a winter wheat CC that lead to enhanced grain water use efficiency (WUE) of the following crop (either corn or soybean) under different seasonal rainfall patterns.
• Rainfall patterns were classified into dry, normal, and wet years using frequency analysis of 80 consecutive years, which resulted in 20 wet, 40 normal, and 20 dry years for wheat, 10 wet, 20 normal, and 10 dry years for corn (27.2, 19.4, 11.2 in. average rainfall, respectively), and 10 wet, 20 normal, and 10 dry years for soybean (26.7, 18.2, and 13.0 in. average rainfall, respectively).
• During autumn and spring (early Oct. to early April), the wheat CC reduced deep drainage by 11%, 15%, and 21% in wet, normal, and dry years, respectively.
• Averaged across 40 years, the wheat CC decreased surface evaporation by 32% and 24% for the corn and soybean growth periods, respectively.
• Regardless of rainfall pattern, an increase in crop WUE was attributed to a decrease in ET during the corn/soybean periods without sacrificing crop yield in the CC system.
• These simulation studies indicated that introducing a winter wheat CC into a corn-soybean rotation system may lead to improved rainfall storage, reduced surface evaporation, and increased transpiration during the cash crop growing season.
• Regardless of the simulated rainfall pattern, including the wheat CC did not improve yield of either corn or soybean, but did enhance crop
WUE.

SEPT. 2021 UPDATE

Cover Crop Variety Trial Results

Producers who plan to use cover crops between summer crops need to know which type (cereal, legume, brassica, or a mixture) and species of the chosen type(s) to plant to accomplish the intended result. This will be an important decision since it likely will determine the amount of canopy cover and biomass that will be produced during the cover crop growing period. Results from Cover Crops Variety Trials can help with this decision. Click here for a White Paper on this website that summarizes results from such trials that were conducted in Miss. And Tenn., and for links to results from those trials.

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