MANAGEMENT GUIDE

Timing of Cover Crop Termination: Management Considerations for the Southeast

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Abstract

Conservation tillage combined with high-residue cover crops make up the two components that define a conservation system designed to increase productivity and improve soil quality. Cover crops are an important part of these systems that maintain and/or improve soil quality. The proper timing of cover crop termination is one important management consideration growers must consider on a site- and situation-specific basis when adopting a conservation system. Cover crops terminated too early in the season diminish associated soil quality and crop production benefits, while delaying termination until closer to cash crop planting dates maximizes soil quality and crop production benefits. However, delaying termination increases risk associated with crop emergence, particularly in dryland conditions. Management considerations that include the cover crop growing season, soil moisture, soil temperature, nitrogen (N) management, alleopathy/weed suppressive potential, and equipment each affect timing of cover crop termination. Growers that consider each of these management considerations with respect to timing of cover crop termination can successfully use cover crops to enhance crop productivity while minimizing risk to cash crop establishment.

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TYPICALLY, SOILS of the southeastern United States are highly weathered and characterized as Ultisols with coarse textures and low organic matter contents (Radcliffe et al., 1988; Shaw et al., 2002). This soil order is commonly distributed east of the Mississippi River, although it also exists in Arkansas, Louisiana, Missouri, and Texas (Soil Survey Staff, 1998). Due to the climate of the Southeast (high rainfall, high temperatures, high humidity), surface residues do not persist for long periods of time (Causarano et al., 2006; Franzluebbers, 2010). In addition, conventional tillage practices that mix crop residues with the soil create a flush of microbial activity that can rapidly decompose soil organic matter (Novak et al., 2009).

Conservation tillage combined with high-residue cover crops can help maintain and supplement existing surface residue to offset degraded soil conditions associated with low organic matter. Cover crops are one component of these

Table A. Useful conversions.

To convert Column 1 to Column 2, multiply by	Column 1 Suggested Unit	Column 2 SI Unit
25.4	inch	millimeter, mm (10^{-2} m)
1.12	pound per acre, lb/acre	kilogram per hectare, kg/ha

cropping systems designed to maintain and/or improve soil quality benefits across the Southeast. Cover crops provide additional surface residue to protect the soil from erosion during fallow periods and throughout the growing season, while promoting soil quality by enhancing organic matter near the soil surface. In general, the more surface residue present, the more soil quality benefits are enhanced, which can be attributed to increased carbon (C) inputs and subsequent soil organic matter increases (Follett, 2001; Franzluebbers et al., 1994). Warmer winters in the Southeast extend the cover crop growing season, which allows greater biomass production compared with other regions of the United States that use cover crops (e.g., Midwest). However, enhanced biomass production across the Southeast may increase risks associated with crop establishment.

Risks associated with crop establishment in cover crops can be reduced with proper timing of cover crop termination, regardless of biomass levels. This decision is affected by various management considerations that include the cover crop growing season, soil moisture, soil temperature, N management, alleopathy/weed suppressive potential, and equipment. Each of these management considerations is site and situation specific, so growers should consider them each year to make sound agronomic decisions. Due to the potential for high biomass levels in the Southeast, we will focus on management considerations for this region, although concepts are applicable for other regions. Therefore, our objective was to provide information and data regarding each of the management considerations in relation to proper timing of cover crop termination to allow growers in the Southeast to maximize benefits and minimize risk to the emergence of the subsequent cash crop.

EXTEND THE COVER CROP GROWING SEASON

Planting cover crops as early as possible is essential to maximizing cover crop biomass, but timing of termination can also influence biomass production (Duiker, 2014). Figure 1 shows two cover crops (cereal rye [*Secale cereale* L.] and wheat [*Triticum aestivum* L.]) planted on identical dates (fall 2003 to fall 2009) each year at the same location in central Alabama (Balkcom et al., 2013). Covers preceding corn (*Zea mays* L.) were terminated

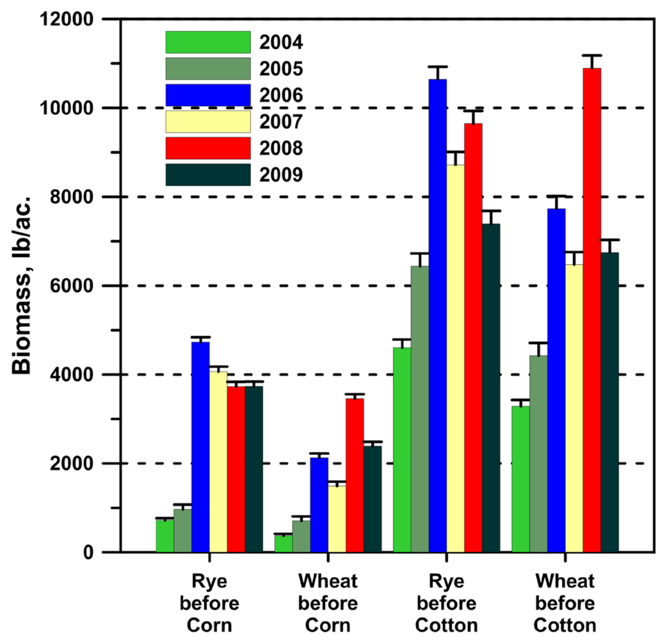

Figure 1. Biomass (lb/acre) production measured for two cover crops planted on identical dates each year at the same location and terminated on two different dates (mid-March preceding corn and mid-April preceding cotton) approximately 1 month apart. Adapted from Balkcom et al. (2013).

approximately 1 month before covers preceding cotton (*Gossypium hirsutum* L.). Termination times were dictated by the cash crop planting date (e.g., corn is usually planted before cotton in the Southeast), but Fig. 1 illustrates how terminating the cover crop prematurely by 1 month can dramatically reduce final biomass. In this example, cover crops terminated early in the season, preceding corn planting, generally failed to produce the level of biomass (4000 lb/acre) required to qualify as a high-residue cover crop (Reiter et al., 2008). Wagger (1989) also reported increased biomass levels across multiple cover crops by delaying termination by only 2 weeks.

SOIL MOISTURE

Adequate soil moisture at planting is one component needed to ensure timely, uniform crop emergence (Egli and Rucker, 2012). Krueger et al. (2011) demonstrated how delaying termination by growing a rye cover crop as a forage on a silt loam soil depleted soil moisture

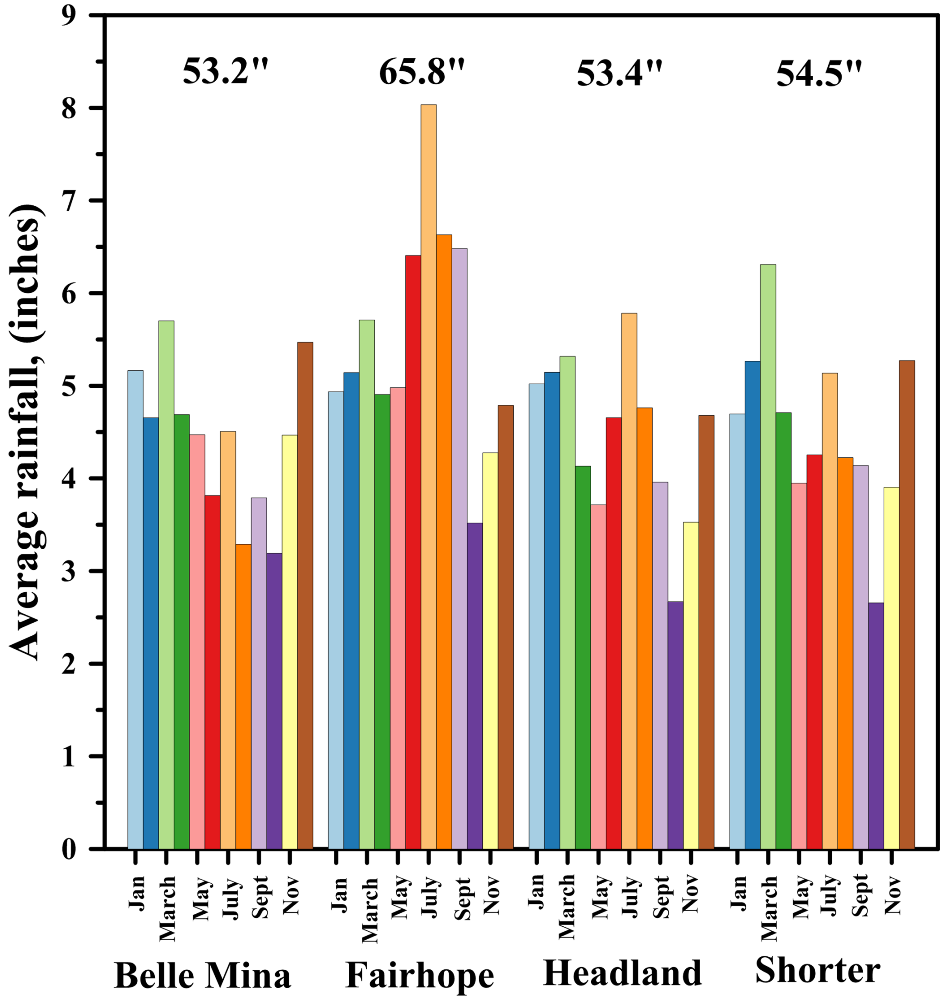

Figure 2. Rainfall distributions by month across four locations in Alabama averaged over 64 years (1950–2014). Belle Mina represents north Alabama, Shorter represents central Alabama, Fairhope represents southwest Alabama, and Headland represents southeast Alabama, respectively. Values above each location represent average yearly rainfall totals (in inches).

compared with rye terminated 3 to 4 weeks prior. This would be analogous to how an actively growing cash crop depletes soil moisture during the summer growing season without rainfall and/or irrigation. Nonirrigated soils with low water holding capacities should be given careful consideration, in regard to timing of cover crop termination. In the Southeast, Causarano et al. (2006) reported yearly rainfall totals exceeding 39 inches. However, rainfall distribution can vary drastically by year and month, which corresponds to droughts, adequate rainfall, or excessive amounts associated with tropical storms and hurricanes (Balkcom et al., 2007b). For example, across four locations in Alabama that represent north, central, southeast, and southwest Alabama, average cumulative rainfall amounts recorded for the last 64 years (1950–2014) ranged from 53 to 66 inches, but rainfall by month varied from 2.6 to 8.0 inches (Fig. 2).

During the spring months (March, April, May) when crops are typically planted in the region, monthly rainfall totals decline from March to May (Fig. 2). Growers should be aware that rainfall amounts may decline as the spring planting season progresses and consider this when making the decision to terminate a cover crop. The goal is to terminate the cover crop late enough to achieve adequate biomass production but early enough to allow for a rain event to occur, before planting. If the cover crop is still actively growing and not terminated, it will continue to deplete soil moisture following a rain event. If the cover crop has been terminated, cover crop residue will preserve soil moisture for longer time periods by reducing soil water evaporation (Munawar et al., 1990; Unger and Vigil, 1998). These aspects are qualitatively illustrated in Fig. 3. The benefits continue through the growing season by increasing soil water infiltration from rainfall and/or irrigation events and reducing soil water evaporation to potentially increase plant-available water (Balkcom et al., 2007b; Truman et al., 2003; Unger and Vigil, 1998).

SOIL TEMPERATURE

Soil temperature should be used as a guide to determine cash crop planting dates. State Extension recommendations provide critical soil temperatures at planting for various crops to ensure adequate germination. Soils with

Figure 3. Visual comparison of soil moisture contents from terminated cover crop (Plot 142) and an actively growing cover crop (Plot 141). Photos courtesy of Wayne Reeves, USDA–ARS (retired).

surface residue will warm more slowly than soils without residue and remain cooler, assuming all other variables are equal by reducing daily maximum soil temperatures and the amplitude of diurnal fluctuations (Dabney et al., 2001). It is possible that planting into surface residue may need to be delayed compared with planting into no residue, particularly for crops planted earlier in the spring. However, using soil temperature, as opposed to calendar date, to help guide planting decisions will ensure adequate crop emergence, regardless of amounts of surface residue present. Benefits associated with cooler soil temperatures are similar to previously discussed soil moisture benefits associated with surface residues. For example, lower soil temperatures observed early in the season that could delay planting will also persist into the summer growing season. This early-season concern translates into a benefit by reducing soil temperatures during the hot summer months (Munawar et al., 1990; NeSmith et al., 1987) that can improve plant performance. Soil temperature, as well as soil moisture, also increases N mineralization from cover crop residues as these parameters increase (Cook et al., 2010; Quemada and Cabrera, 1997).

NITROGEN MANAGEMENT

Timing of cover crop termination can influence N management of the subsequent crop. The C/N ratio and the amount of biomass produced under a given set of environmental conditions are two important factors that determine how much N may become available or unavailable for the cash crop (Reeves, 1994). Cover crop biomass with a low C/N ratio includes legumes or low-biomass grass crops that result from being terminated when they are small (Reeves, 1994). These residues release or "mineralize" N as they decompose. This process occurs quickly and limits the time these residues remain on the soil surface, which diminishes benefits associated with surface residue (Reeves, 1994). If the cash crop is not present and actively growing to capture this N, then this "free" N will be subject to typical N loss pathways.

High-biomass cover crops such as winter cereals tend to have high C/N ratios (Huntington et al., 1985; Reeves, 1994). As they decompose, any N present is consumed or "immobilized." This is the reason that typical N recommendations for crops following high-residue cereals are increased up to 30 lb/acre in the form of additional N or used as a starter fertilizer application to promote early-season growth (Brown et al., 1985; Reeves, 1994; Reeves et al., 1990). Typical termination times for these covers correspond to flowering or later (Ashford and Reeves, 2003). As a result, these residues tend to persist for much longer periods, enhancing surface residue benefits.

Figure 4 summarizes how the C/N ratio relates to cover crops and serves as a quick reference for growers to estimate how cover crops could affect N availability. Growers should also consider how delaying termination, if possible, particularly for legumes can be beneficial (Cook et al., 2010). Delaying termination of legumes as long as possible increases biomass and N concentration, increases the potential for the legumes to reseed, and improves synchronization between cover crop N release and cash crop uptake. Delaying termination of winter cereals enhances biomass production, allowing the residues to persist for more time while providing soil quality benefits.

ALLEOPATHY/WEED SUPPRESSION

Cover crop residues act as mulch, and most cover crop residues leach allelopathic compounds that also inhibit weed germination and/or growth (Barnes and Putnam, 1983). Previous research shows that cover crop residue is very effective for controlling many small-seeded weeds in different summer crops grown across the Southeast (Price et al., 2006, 2007; Reeves et al., 2005). Cover crop residues also serve as an essential component of integrated strategies designed to control glyphosate-resistant *Amaranthus* species that endanger further use and adoption of conservation systems (Price et al., 2011, 2012). In general, more cover crop biomass results in reduced weed biomass through fewer and smaller weeds (Fig. 5). A reduction in weed density is also helpful in combating

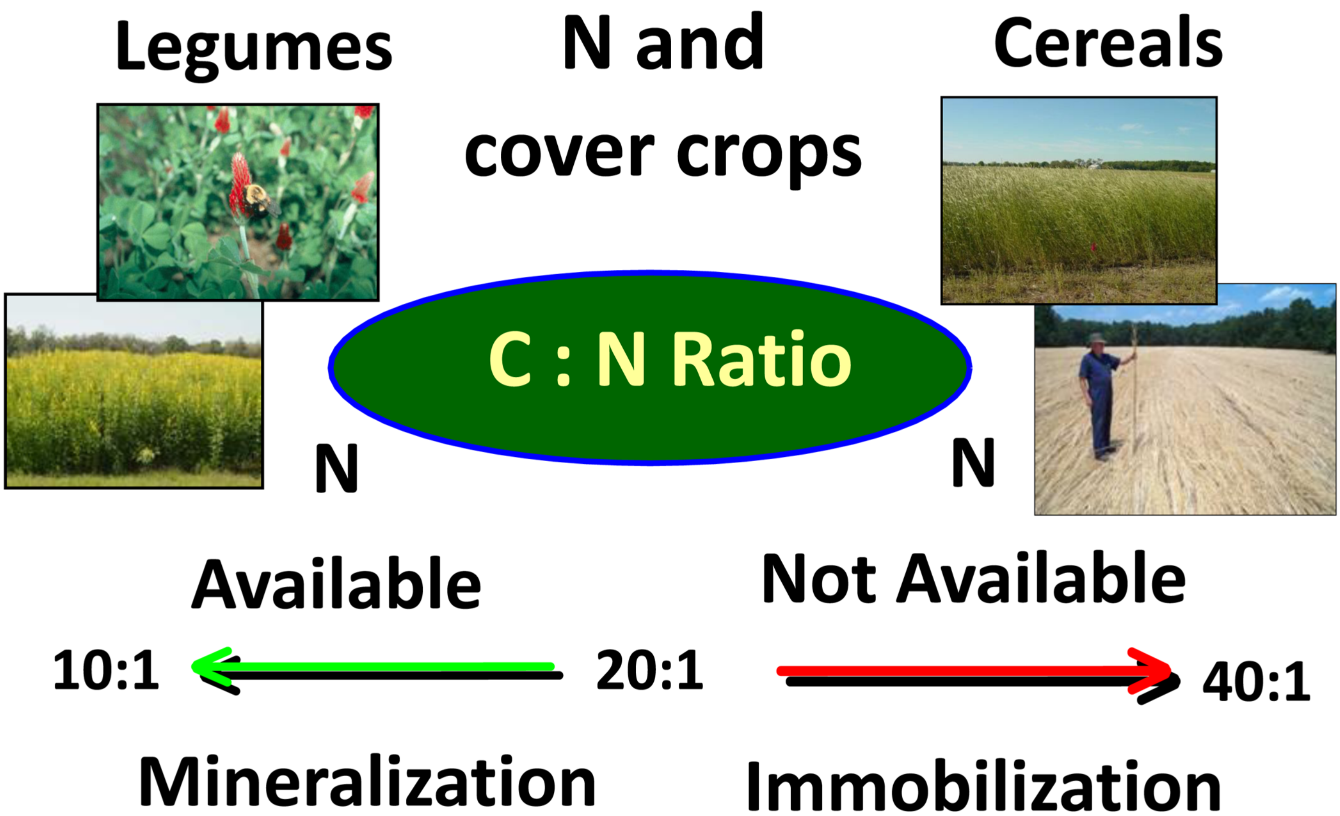

Figure 4. The carbon/nitrogen (C/N) ratio relates to mineralization–immobilization of N contained in the cover crop residue.

herbicide resistance because selection pressure is reduced due to fewer weeds being present.

However, allelopathic compounds leached from residue are nonselective and also can inhibit germination and growth of some cash crop seeds, including cotton, depending on residue attributes and residue proximity to the row after planting (Bauer and Reeves, 1999; Price et al., 2008). The longer the interval between cover crop termination and cash crop planting, the less likely allelopathic compounds will affect crop emergence and growth. Conversely, as allelopathic compounds leach away and residue biomass decays, subsequent weed-suppressive qualities decrease. Ideal timing for termination maximizes cover crop biomass while allowing for a rainfall event between termination and planting, thus leaching some of the allelopathic potential from the cover crop residue that prevents seedling injury.

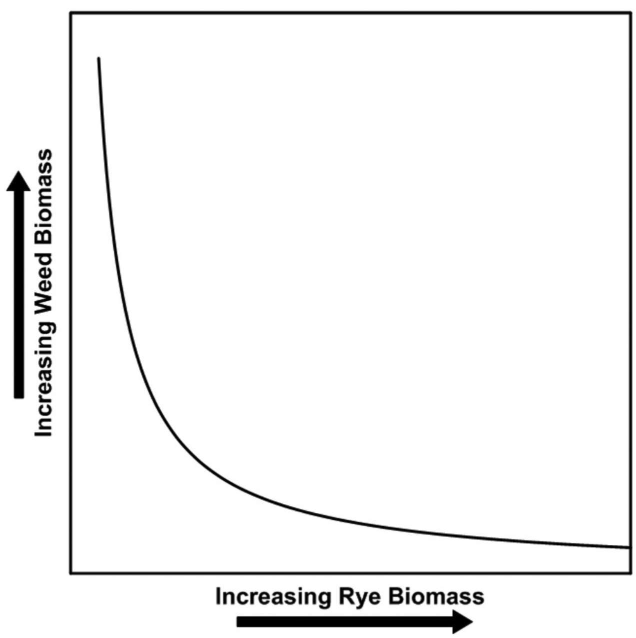

Figure 5. A qualitative relationship between rye biomass and weed biomass that illustrates how increasing rye biomass can decrease weed biomass measured in the cash crop.

EQUIPMENT

Equipment used to terminate cover crops is outside the scope of this guide, but equipment considerations to ensure successful cash crop emergence relate to surface biomass levels and can be influenced by timing of termination. Adequate seed-to-soil contact in a warm seedbed with adequate soil moisture is necessary for rapid emergence and successful stand establishment of cash crops (Schneider and Gupta, 1985). For high-residue systems, tillage and planting equipment may require special designs and/or modifications like row cleaners to operate in residue and may be used in conjunction with cover crop rollers. Numerous combinations of equipment and attachments are currently used by growers to successfully

Figure 6. Removing residue that becomes entangled in equipment can waste considerable time, leading to grower frustration with cover crops. Photo courtesy of Ted Kornecki, USDA–ARS.

Figure 7. Typical example of poor seed-to-soil contact caused by "hairpinning" that reduces crop emergence. Photo courtesy of Ted Kornecki, USDA–ARS.

operate in high-residue systems. Growers should allow sufficient time for residue to become completely dry and brittle following the cover crop termination process. Dry, brittle cover crop residue on the soil surface allows tillage and planting equipment to cut through the residue more easily compared with semi-dry, green residue that can be tough and hard to cut (Balkcom et al., 2007a). As equipment traverses the field without cutting the residue, it may become entangled in the equipment (Fig. 6). This can result in significant time delays to remove the residue and prevent it from being dragged across the field (Kornecki et al., 2009). Residues that are not cut can also be pushed into the soil and become trapped in the seed furrow, creating a condition known as "hairpinning" (Fig. 7) (Kornecki et al., 2009). "Hairpinning" can reduce seed-to-soil contact that reduces crop emergence. Dry residues that become moist from precipitation or "morning dew" can also be difficult to cut and can contribute to "hairpinning." Allowing residue to dry more thoroughly can potentially solve this problem.

SUMMARY

Proper timing of cover crop termination is an important decision that growers in the Southeast face every spring. This decision is a balancing act between ensuring adequate biomass production to enhance soil quality benefits and minimizing risk to cash crop emergence that typically changes each year to accommodate different climatic patterns and/or crop rotations. Producers need to consider the growing season of the cover crop, soil moisture, soil temperature, N management, alleopathy/weed suppression, and equipment. All production decisions, whether related to the cover crop or cash crop, impact profitability, and the potential for economic gains or losses should be considered during the decision-making process. Growers should be cautioned that the decision of when to terminate cover crops varies each year based on interactions between previously described management considerations. While there are termination guidelines available, termination decisions are farm specific, field specific, and year specific. The timing of cover crop termination is not one size fits all; growers who evaluate these management considerations with respect to their farming operations can successfully terminate cover crops to maximize the agronomic and economic benefits of adopting a conservation system with minimal risk.

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