Cover Crop Species Comparison for Weed Suppression in Cotton Production

HIGHLIGHTS

Long-term use of cover crops benefits cotton farmers and the environment.

- → **INCREASED** DROUGHT RESILIENCE
- → **INCREASED** NUTRIENT CYCLING
- → **IMPROVED** EROSION CONTROL
- → **IMPROVED** WATER INFILTRATION
- → **INCREASED** SOIL ORGANIC CARBON
- → **IMPROVED** HABITAT FOR SOIL LIFE
- → **REDUCED** HERBICIDE RESISTANCE
- → **REDUCED** WEED DENSITIES

The Soil Health Institute, Texas A&M AgriLife Research, and The Rodale Institute conducted a literature overview of cover crop research for weed suppression in the U.S. Cotton Belt.

The overview identified 14 field trials since 2005 that evaluated cover crop performance for weed suppression in cotton.

Grass cover crops were the most evaluated cover crop species for weed suppression and were included in 12 of the 14 field trials; cereal rye was included in 11.

Cover crops aid in increasing the longevity of herbicide effectiveness in cotton systems.

Many farmers, including certified organic farmers, can benefit from the weed suppression effects of cover crops.

Overview

Any change in management practices requires time to perfect the system for an individual operation. In addition to research summarized here and from other resources, real-world experiences play a crucial role in understanding the benefits and challenges of planting different species of cover crops. The table below lists the various winter cover crop species discussed in this article, as well as some of the advantages and limitations associated with each species. It is important for farmers to keep in mind that each cover crop has specific management requirements, provides unique benefits, and can have limitations that need to be considered prior to planting. For instance, understanding the type of equipment required for a high-residue cover crop or identifying species that may not withstand cold temperatures is vital. Equally important is for growers to clarify their primary goals for using cover crops before choosing a specific species. This fact sheet summarizes relevant research about the use of cover crops as a tool for weed suppression in cotton production along with the experience of farmers who have had success with these methods. The fact sheet also highlights considerations for certified organic farmers interested in using cover crops as a tool for weed suppression in their operations.

Cover Crop Species	Cover Crop Group	Benefits	Potential Limitations
Cereal Rye	cool season grass	establishes quickly; large amounts of biomass possible; tolerant of cold temperatures; natural chemicals released by the plant may suppress weeds	large amounts of biomass can be challenging for cotton planting and nitrogen availability
Wheat	cool season grass	establishes quickly; tolerant of cold temperatures; can be grazed	produces less biomass than other cereal grains
Oat	cool season grass	can produce high biomass; can survive hot, dry weather	large amounts of biomass can be challenging for cotton planting and nitrogen availability; disease risk with some varieties
Triticale	cool season grass	cereal grain with wider leaves than cereal rye, offering improved weed suppression	seed availability can be challenging
Vetches	cool season legume	can provide nitrogen to cash crop; can be a good partner in mixes	must be planted early for winter survival; can be slow to establish; does best in mixes; will need more than a glyphosate application for termination
Clovers	cool season legume	can provide nitrogen to cash crop; can be a good partner in mixes	plant early for winter survival and best growth; can be slow to establish
Winter Pea	cool season legume	establishes quickly; can provide nitrogen to cash crop	plant early for winter survival and best growth; does best in mixes
Turnip	cool season non-legume broadleaf	winter survival; good ratings for weed suppression; produces large underground storage that breaks soil hard pan; grazers like adding this in mixes	large underground storage can be challenging to till; Brassicas tend to attract insects
Mustard	cool season non-legume broadleaf	if tilled in the soil, it can suppress pests such as nematodes	not cold tolerant; can attract non-beneficial insects

Grower Spotlight

Research in the U.S. Cotton Belt is offering farmers insights into effective cover crop use, complemented by the practical experiences of early adopters of cover crops. Through seasons of trial and error, these growers have honed the use of cover crops to enhance soil health and leverage the residue for weed control. While the choice of species, blends, seeding densities, and management strategies may vary regionally, farmers have been effective at identifying what works best for their operations, to be able to capture the benefits of cover crops.

Figure 1. Cotton planted into standing cover in North Carolina.
Photo Credit: Zeb Winslow.

ZEB WINSLOW
Scotland Neck, North Carolina

Zeb Winslow's row crop farm in eastern North Carolina is in its tenth year of using cover crop mixes. If not planting into a single species (Figure 1), his go-to six-way mix of rye, triticale, oats, clover, vetch, and radish allows him to feed the soil biology, keep his soil in place, and provide a level of residue for weed suppression. By using this mix, Winslow can hedge his bets and make sure he gets a cover crop stand should one species not perform well that season. When using cover crops for the first time or changing up cover crop selection, starting small and learning from that experience has been the key to Winslow's success.

MATT ENSOR
Thorndale, Texas

Matt Ensor's cattle and row crop operation in central Texas incorporates both warm season and cool season cover crops into the rotation. Warm season species used on his farm include pearl millet, sunn hemp, and cowpeas. Winter cover crops are terminated before cotton planting (Figure 2). Ensor's winter cover crop species include oats, winter peas, radishes, and hairy vetch. These covers shade the soil surface which suppresses weeds from growing. Ensor points out that the effectiveness of the strategy is evident, as areas where the planter fails to sow the cover crop seed experience significantly higher weed pressure compared to other areas.

Figure 2. A cereal rye cover crop used in cotton to suppress weeds, protect cotton seedlings from wind erosion, and provide soil health benefits.
Photo Credit: Jodie McVane.

JEREMY BROWN
Dawson County, Texas

Jeremy Brown farms both conventional and organic cotton in Texas. When it comes to cover crops, Brown encourages growers to start small and to do their own experiments. If they have always planted wheat for cover, put a legume in the mix like hairy vetch or winter peas or some clover. Brown says growers have to see the results for themselves.

Introduction

Soil health management practices such as minimized disturbance and maximized soil cover provide numerous benefits such as reduced erosion, increased water infiltration, and increased soil productivity. Implementation of cover crops can provide an additional benefit of weed suppression, which is particularly important for cotton, a slow-growing crop that suffers from early-season weed competition. Moreover, cotton is inherently a very low residue crop, and cover crops integrated into cotton-based systems offer tremendous soil health benefits. Although many benefits are attributed to cover crop use, and cover crop adoption has increased across the U.S. in recent years, the adoption of cover crops is still less than 10% of row crop acres in the country.[1] In cotton producing states, the adoption of cover crops can vary from as low as 1% to as high as 29%.[1] While a great deal of research has been conducted to evaluate cover crops and their weed suppression potential, there are very few reports specific to cotton. In this fact sheet, we present a summary of cover crop weed suppression potential in cotton from 14 identified field trials conducted in the U.S. Cotton Belt.

APPROACH

In 2023, a search was conducted on the Web of Science and Google Scholar databases, using the keywords “cotton,” “cover crops,” and “weed suppression.” The target areas were the major cotton-producing states in the southern and southeastern U.S. Papers were selected by relevance and date of publication (from 2005 to 2023). The information included here summarizes cover crop benefits, weed suppression potential, cover crop species, and cover crop management practices reported in the 14 field research papers and review articles identified in the literature search. Field trials took place across the U.S. Cotton Belt region (Figure 3) and included grass and broadleaf (leguminous and non-leguminous) cover crop species with a range of weed suppression potential. A summary of cover crops evaluated, biomass (plant material) produced, and weed suppression potential is presented in the Appendix. The following section provides overviews of cover crop species and benefits of each species.

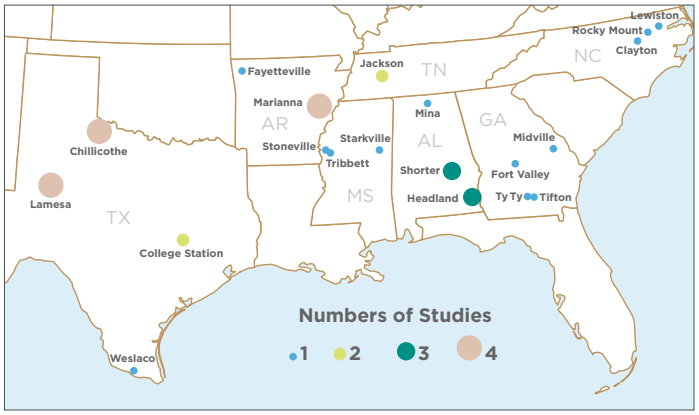

Figure 3. Distribution of the 14 field studies in this review across the southern and eastern U.S. Cotton Belt regions.

Findings

Cool Season Grasses

CEREAL RYE

Cereal rye, a cool-season grass, is the most commonly used winter cover crop species in the U.S. Its popularity is likely due to its adaptation to several environments and its ability to survive extreme winter temperatures. Cereal rye's ability to suppress weeds can be attributed to its large biomass production, and the natural compounds it produces that negatively affect weeds (Figure 4). Several studies have documented the weed-suppressive abilities of cereal rye in cotton.[2-10] When cereal rye is planted as a cover crop, it helps reduce the number and size of weeds early in the growing season.[4,6] Additionally, compared to leaving the field empty or fallow, cereal rye does a better job of suppressing weeds further into the growing season. It is better at controlling troublesome weeds such as Palmer amaranth (Figure 5).[8,9,11,12]

In an Alabama study, researchers found that using cereal rye increased profits in two out of three years compared to no cover crops.[9] However, it's important to note that all these studies emphasized the need to use an effective chemical and/or mechanical control options along with rye cover crops to ensure that weeds don't come back throughout the season.

Figure 4. Cotton seedlings in a terminated cereal rye cover crop (left) and weedy sunflower in fallow ground (right) in a study conducted in College Station, Texas.

Photo Credit: Gustavo Camargo Silva.

Figure 5. Cereal rye cover crop integrated into a cotton-based rotation can increase biomass residue, while providing weed suppression.

Photo Credit: Jessica Kelton.

WHEAT AND TRITICALE

Wheat grows shorter and produces less biomass than cereal rye, so it can be a good option in areas where too much biomass can be an issue. Even so, wheat can prevent weed emergence in the early season. Most studies agree that wheat, like other small grains, improves weed suppression and herbicide effectiveness.[4-7] Wheat has also been found to improve cotton yields compared to a fallow management system. This is mostly due to fewer weeds, better soil health, and less water loss from soils when wheat is used as a cover crop.[5]

One study reported that small grains, including wheat, can reduce Palmer amaranth emergence almost entirely during the first two weeks of cotton growth. Wheat also reduces weed emergence for up to eight weeks.[7] This is important because cotton is a slow-growing crop, which gives weeds a longer window for establishment during the early growing season. Cover crops alone, however, do not typically provide season-long weed suppression. One of the studies suggested that other forms of control, such as postemergence herbicide treatments, are still needed for prolonged control of Palmer amaranth and other weeds.[6] Herbicides aren't a tool organic farmers can fall back on, so it is critical to get high-cover crop biomass to compete with weeds and create a mulch to prevent weed emergence during crop growth. This requires high planting densities, usually 1.5 times the recommended rate.

Triticale, a cross between wheat and rye, offers the benefits of cereal rye while growing shorter like wheat. Triticale produces much biomass and decomposes slowly. This combination improves weed suppression throughout the season. However, more studies are needed to determine how triticale behaves in cotton systems as not much research has been done on triticale cover crops in cotton.[13]

OAT AND BLACK OAT

Oat is another small grain species that can produce plenty of biomass for weed suppression in warmer climates. Oats can be a good choice in the U.S. Cotton Belt region as they are adaptable to several of the unfavorable environmental conditions in the region.

A study found that black oat cover crops combined with preemergence herbicides had similar weed control as high-input herbicide only treatments.[5] Cotton yields were also similar in both systems. Expenses associated with chemical weed control can be minimized with an oat cover crop plus preemergence herbicide system, like other cereal grain cover crops. Oats can also provide prolonged suppression of Palmer amaranth, given its extended residue retention potential.[7]

Small grains, like cereal rye, wheat, and oats, can be additions to any cover crop mix for weed suppression, and are widely adapted to many soils and moisture conditions across the U.S. Cotton Belt. Cereals should be planted at a low enough rate so as not to overtake the legumes in the mixture. Although these cover crop options can be beneficial for weed control, some studies have indicated reduced cotton stands or stunted growth due to cover crop residue.[14] These challenges can be overcome with nutrient management, planter selection and modification, and proper residue handling equipment.[7] Furthermore, an analysis of more than one thousand studies indicated that cover crop use resulted in a 5% increase in cotton lint yield.[15]

Broadleaves

COOL SEASON LEGUMES

The most popular cool-season legumes are clovers, peas, and vetches, but other species like lupine can also be used. Legumes are unique because they form associations with Rhizobium bacteria to fix atmospheric nitrogen. This is an asset to producers interested in providing nitrogen to the next crop, especially organic farmers who do not have the option to use fast-acting soluble fertilizers. Legume cover crops also support biodiversity and provide off-season foraging to honey bees. Legumes are typically planted in mixes with cereals because they can be expensive by themselves, and their residues decompose very fast due to a low carbon to nitrogen ratio. Legumes also take time to become established and must be planted in the early fall to develop enough biomass for winter survival and spring regrowth. Considering the low residue retention, legumes should be mixed with a cereal cover for improved weed suppression,[6,7,16,17] but in large enough proportion that cereals do not out-compete the legumes.

CLOVERS AND PEAS

Clovers do not produce as much biomass compared to winter cereals. Moreover, they decompose faster than mature small grains, which reduces their weed suppression capabilities into the summer season. One study found that clover can reduce weed competition in the first two to four weeks after planting cotton, but not much after this timeframe.[7] In another trial, clovers were able to slow down Palmer amaranth growth in the early season.[6]

Winter peas establish quicker than clovers and provide ground coverage to compete with weeds, but also decompose quickly (Figure 6). For this reason, it is recommended that pea and clovers be paired with small grains if weed suppression is an important goal.

Figure 6. Winter peas provide nitrogen additions, excellent ground cover, and weed suppression.
Photo Credit: Jodie McVane.

COOL SEASON BRASSICAS

Some of the most common brassicas used for weed suppression are mustards, turnips, and radishes (Figure 7). Mustards are known for releasing chemicals into the soil that damage weed seedlings. Some members of the group have tap root systems that assist in breaking compaction layers, scavenging nutrients, and suppressing weeds. They also have a low carbon-to-nitrogen ratio and decompose easily. Brassicas can be sensitive to freezing temperatures if they do not have enough time to harden for winter. Producers typically use this group in mixtures and it can be used in animal grazing systems.[4,13] However, not much research has been done on brassica cover crops in cotton.

Turnips alone did not improve summer weed control in a cotton system compared to fallow. In fact, it was noted that turnips may harm cotton yield in certain circumstances. Mustard performed better for weed control than turnips in an Arkansas field study.[4]

Mustard had variable weed suppression performance in the field trials identified here. It was noted that early-terminated mustard did better at suppressing weeds than late-terminated mustard in College Station, Texas.[13] This was primarily due to high insect pressures associated with late termination.

These cool-season brassica species, like legumes, also do well when planted in a mix rather than single species plantings for weed suppression in cotton.

Figure 7. Oilseed radish and collard. The large taproots in these species can help to improve compacted soils, scavenge nitrogen, and be used in grazing systems.

Photo credit: Jodie McVane.

COVER CROP MIXES

Cover crop mixes provide plant diversity, a key principle for soil health management systems. Species selection is important and can differ based on the individual goals of the farmer, and from region to region. Benefits of cover crop mixes will vary depending on the species in the mix, but studies have shown benefits may include improvements in weed suppression, erosion control, grazing, biomass production, and with legumes specifically, nitrogen availability. Additionally, cover crop mixes present a challenge to optimize benefits from all species included in the mix. Planter setup, seed size, growth habit, and termination requirements of each species should be considered when formulating a mix.

If erosion control is a concern, a mix with grasses as the main component is beneficial because of their fibrous roots, which can hold soil in place, create micropores for water infiltration, and reduce water erosion runoff.[18,19]

One trial found that cereal rye produced the most biomass when planted alone compared to mixing with legume.[17] However, cover crop mixes suppressed weeds effectively due to different plants growing vertically and horizontally, covering the gaps left by cereal rye, in addition to offering nitrogen benefits.

Summary

Cover crops have a high potential for reducing weed densities over diverse soil and climatic conditions in both conventional and certified organic cotton production. There is a general agreement that using a combination of cover crops and other weed suppression tools, such as herbicides or tillage, will have more positive results for weed suppression in cotton systems compared to either strategy alone. Cover crops can also be an important tool against herbicide-resistant weeds in cotton. Additionally, crop rotation and diversity are needed in cotton systems, and cover crops can serve that role.

Currently, cover crops are not used widely in U.S. cotton. Although weed suppression by some of the most popular winter cover crop species like cereal rye, wheat, and vetch was thoroughly studied and proven to work in cotton production, other less common species like lupine, turnips, triticale, and mixes have little representation in the current literature. This overview is intended to be a useful resource for cotton farmers considering using cover crops for weed suppression and soil health benefits.

Appendix

Various cover crops species were evaluated for weed suppression in 14 field trials from 2005 to present across the U.S. Cotton Belt. Most studies evaluated more than one species.

Cover Crop Species	Location	Biomass (kg/ha)	Weed Supp. %	Reference
Cereal Rye	Shorter, AL College Station, TX Marianna, AR Various Locations, GA Ty, GA Marianna, AR Marianna, AR Fayetteville, AR Bella Mina, AL Headland, AL Jackson, TN	4047 5000 6310 6900 6019 6400 8460 4860 8629 5320 2870	75 80 68 88 59 37 85 83 91 71 57	Aulakh et al., 2012 Camargo Silva and Bagavathiannan, 2023 DeVore et al., 2012 Hand et al., 2019 Hand et al., 2021 Korres and Norsworthy, 2015 Norsworthy et al., 2011 Palhano et al., 2018 Price et al., 2021 Reeves et al., 2005 Wiggins et al., 2017
Wheat	Marianna, AR Fayetteville, AR Headland, AL Jackson, TN	7500 4040 5320 3320	85 78 59 47	Norsworthy et al., 2011 Palhano et al., 2018 Reeves et al., 2005 Wiggins et al., 2017
Oat	Fayetteville, AR Headland, AL College Station, TX	3450 5320 10000	66 63 22	Palhano et al., 2018 Reeves et al., 2005 Samuelson, 2020
Triticale	College Station, TX	13000	96	Samuelson, 2020
Vetch (Hairy; Cahaba)	Marianna, AR Fayetteville, AR Ideal, GA Jackson, TN	4265 3140 2810 2660	62 42 46 40	Norsworthy et al., 2010 Palhano et al., 2018 Webster et al., 2013 Wiggins et al., 2017
Clover (Crimson)	Shorter, AL Fayetteville, AR Ideal, GA Jackson, TN	3570 3110 3250 2210	80 33 40 38	Aulakh et al., 2012 Palhano et al., 2018 Webster et al., 2013 Wiggins et al., 2017
Winter Pea	Marianna, AR Fayetteville, AR College Station, TX Ideal, GA	4630 3120 7000 4610	67 27 0 71	Norsworthy et al., 2010 Palhano et al., 2018 Samuelson, 2020 Webster et al., 2013
Lupine (Narrow-leaf)	Ideal, GA	6750	53	Webster et al., 2013
Turnip	Marianna, AR	7470	82	Norsworthy et al., 2011
Mustard	Marianna, AR College Station, TX	6770 9500	78 47	Norsworthy et al., 2011 Samuelson, 2020

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