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FINAL STUDY REPORT
James E. "Bud" Smith Plant Materials Center
Knox City, Texas

Winter Cover Crop Species Adapted to North-Central West Texas and Southwestern Oklahoma

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ABSTRACT


USDA-NRCS James E. "Bud" Smith PMC

Cover crop mixes and plant diversity is critical in farming and ranching management to improve the soil health. Many commercial seed companies sell numerous species that can add plant variety to any operation. However, all plants are not adapted to every environment. The objective of this study is to assemble, evaluate, and identify different cover crop species available to farmers and ranchers and determine their adaptability throughout north-central west Texas and southwestern Oklahoma. Thirty-five potential cool season cover crop species were submitted by commercial seed companies and plant materials centers and planted into an observation nursery at the James E. "Bud" Smith Plant Materials Center, Knox City, Texas on a Miles fine sandy loam soil and evaluated for plant growth and adaptability. Small grains produced excellent biomass ranging from 11 000 to 17 000 lb/acre and provided adequate soil cover within 50 days after planting. While the brassicas and legumes did not produce as much biomass as the small grains, many of them would provide suitable soil protection during critical erosion periods. All thirty-five species show to be adapted to the PMC service area and could add diversity to any cool season cover crop mix.

INTRODUCTION

Protecting our soils has been a goal of the NRCS for many years, but recently, improving the overall health of soils has become a central component of that goal. Cover crops have long been used in combination with cash crops to prevent soil erosion from wind and water. Years of research has shown that cover crops can also improve the health and productivity of cultivated soils. Summer and winter cover cropping provides many advantages when implemented into row crop farming and ranching operations. Some of these advantages include:

- Added organic matter
- Reduce soil erosion

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- Provide nitrogen
- Provide weed control
- Reduce disease inoculums (Roozeboom, 2013)
- Improve soil structure (aggregation, infiltration, available water capacity)
- Manage nutrients
- Furnish moisture conserving mulch and lower soil temperature
- Provide habitat for beneficial organisms (Clark, 2007)

Producers must also understand how to manage a cover crop to reap their full benefits. In addition to many of the advantages of cover cropping, there are also potential drawbacks such as:

- Cover crop residue may delay soil warming and drying in the spring, resulting in delayed planting of the cash crop.
- Heavy cover crop residue may interfere with planting operations
- Nitrogen may become tied up and not readily available to cash crop
- Some cover crop species may become weeds
- Disease inoculums may increase (Roozeboom, 2013)
- Planting dates between cash crop harvest and cover crop establishment may be difficult to manage

Sullivan (2003) states that, "cover crops could be considered the backbone of any annual cropping system that seeks to be sustainable". Taking advantage of cover crops may provide producers the opportunity to continue to produce food and fiber for a growing population while reducing input costs and maximizing precipitation while protecting the soil resources.

These benefits are only achieved if the selected cover crop species are adapted to the environmental conditions in the areas where they are used (Bodner et al., 2009). Growing conditions differ from one region to another and plant species will not perform the same under every environmental condition. For instance, species that require large amounts of water will not thrive in arid, dry regions. A basic understanding of the area's growing condition is critical when choosing cover crops.

The purpose of this study is to provide productivity and adaptability information on commercially available winter cover crop species for soil health improvement in North Central Texas and Southwestern Oklahoma.

MATERIALS AND METHODS

Thirty-five potential cool season cover crop species were obtained by the USDA-Natural Resources Conservation Service (NRCS), James E. "Bud" Smith Plant Materials Center (PMC), Knox City, TX in 2012. Plots were planted on 23 October 2012 using a Wintersteiger Plotseed XL cone plot planter (Wintersteiger Inc., Salt Lake City, UT) in a randomized complete block design with two replications. Plot size was six rows spaced eight inches apart, ten feet long and four feet wide. Seed were drilled ½-¾ inch deep on a smooth, firm seed bed. Legumes were inoculated with the specific inoculant dependent on each individual specie. Irrigation was applied immediately following planting using an overhead sprinkler system to provide adequate moisture for germination and emergence. Soil type was a Miles fine sandy loam. Weeds were controlled by hand weeding and cultivation. No commercial fertilizer was applied or soil test conducted prior to planting. Plant height was measured monthly throughout the growing season to determine maximum height. Ground cover was a visual estimate of the soil surface recorded at 30 day intervals from planting for 175 days. After the final data had been collected, biomass was collected using a Carter forage harvester (Brookston, IN). A 3-ft x 10-ft swath was harvested from the interior rows of the plot to a height of 6 inches on 26 April 2013. Grab samples were collected from each harvest plot and dried in a Shel-Lab FX14-2 (Shel-Lab, Cornelius, OR) dryer for 24 hours at 55 °C for dry matter determination. Percent ground cover, plant height, and dry matter yield were analyzed using the analysis of variance procedure for general linear models in Statistix 8 ® (Tallahassee, FL). Means were separated using the least significant difference test (LSD: $P<0.05$).

RESULTS AND DISCUSSION

The thirty-five varieties in the observational nursery had satisfactory survival and winter hardiness throughout the evaluation. The total biomass was harvested 175 days after planting and is shown in Table 1. Small grains, such as the barley, cereal rye, and wheat produced biomass ranging from 11 000 to 17 000 pounds per acre. These small grains have the potential to add substantial amounts of carbon into the soil for soil microbes (Clark, 2007). Clovers, vetches, winter peas, and other legumes produced a broad range of biomass significantly less than the top producing grasses. White and rose clover and hairy vetch produced the highest biomass ranging from 7 000 to 9 000 pounds per acre. Although they do not produce near the amount of carbon as the small grains, the legume species provide other benefits such as nitrogen for the subsequent commodity crop. The forbs in the observation nursery including plantain and *Brassica* spp. also ranged dramatically in biomass production. Rape and forage collards produced 10 000 to 11 000 pounds of biomass per acre, while the radish only produced 2 000 to 4 000 pounds per acre. These forbs are beneficial for scavenging excess nutrients and preventing soil compaction. Additionally, flowering forbs and legumes provide a nectar source and cover for various beneficial pollinators.

A seventy-five percent stand was observed within sixteen days after planting following a post planting irrigation application (Table 2). Small grains germinated and emerged within eight to ten days. The forbs and legumes where slightly slower at twelve to sixteen days with the exception of the crimson clover and Nitro radish, which reached seventy-five percent in eight days.

Plant height measurements are shown in Table 3. Plant height is the maximum height reported at harvest. ‘Elbon’ rye and triticale were significantly taller than the rest of the entries reaching 42 and 40 inches, respectively. The other entries ranged from ten to thirty-five inches. Tall, fast growing cover crops can be an effective tool to control problematic weeds by competing for sunlight, water, and nutrients.

Percent of ground covered was recorded approximately 30 days after planting until harvest, 175 days later. Maximum ground cover is important for regulating soil temperature and protecting soil surface from water and wind erosion (Clark, 2007). Several small grain, legume and brassica species reached 70% ground cover within 50 days after planting. The clover species and alfalfa grew slower and did not reach 70% cover until 150-175 days after planting. Flax failed to reach 70% ground cover during the duration of the study. It remained a 43% for the final 75 days. Most of the species have the ability to provide ground cover in the fall and maintain sufficient cover throughout the winter and early spring. Small grains and brassicas provide the quickest ground cover which aids in winter weed management.

Table 1. Biomass produced in the winter cover crop adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City, Texas in April 26, 2013.

Variety	Common Name	Scientific Name	Yield (lb/ac)
Tambar	Barley	*Hordeum vulgare*	17 325 A[1]
	Elbon Rye	*Secale cereale*	16 752 AB
A & A	Wheat	*Triticum aestivum*	15 592 ABC
Fridge	Triticale	*Triticale hexaploide*	15 391 ABCD
Tam 113	Wheat	*Triticum aestivum*	14 923 ABCD
Sturdy 2K	Wheat	*Triticum aestivum*	13 708 ABCDE
Tamo 606	Oats	*Avena sativa*	13 657 BCDE
Nomini	Barley	*Hordeum vulgare*	13 423 BCDE
	Black Oats	*Avena strigosa*	12 145 CDEF
Walken	Oats	*Avena sativa*	11 930 DEF
Dwarf	Rape	*Brassica napus*	11 132 EF
	Ethiopian Cabbage	*Brassica* spp.	11 097 EFG
	Forage Collards	*Brassica oleracea*	10 351 EFGH
Hubam	White Clover	*Trifolium repens*	9062 FGHI
	Winfred Hybrid	*Brassica* spp.	8948 FGHIJ
Overton R-18	Rose Clover	*Trifolium hirtum*	7448 GHIJK
	Hairy Vetch	*Vicia villosa*	7192 HIJKL
	Purpletop Turnip	*Brassica rapa*	6518 JKLM
	Crimson Clover	*Trifolium incarnatum*	6429 IJKLM
Specter	Winter Pea	*Pisum sativum*	5526 IJKLMN
Austrian	Winter Pea	*Pisum sativum*	5488 IJKLMN
Yuchi	Arrowleaf Clover	*Trifolium vesiculosum*	5360 JKLMNO
	Common Vetch	*Lathyrus sativus*	5135 KLMNO
	Cahaba vetch	*Vicia* spp.	4658 KLMNOP
Bigbee	Berseemn Clover	*Trifolium alexandrium*	4449 KLMNOP
Nitro	Radish	*Raphanus sativus*	4389 KLMNOP
	Winter Pea	*Pisum sativum*	4181 KLMNOPQ
	Sainfoin	*Onobrychis viciifolia*	3612 LMNOPQR
	Chickling Vetch	*Lathyrus sativus*	3512 MNOPQR
	Faba Bean	*Vicia faba*	3360 MNOPQR
Driller	Radish	*Raphanus sativus*	2413 NOPQR
	Plantain	*Musa paradisiaca*	1827 OPQR
Madrid Blossom	Yellow Clover	*Trifolium aureum*	1407 PQR
	Flax	*Linum* spp.	621 QR
	Alfalfa	*Medicago sativa*	509 R

[1]Means within column followed by the same letters are not significantly different as determined by least significant difference test at P<0.05.

Table 2. Days after planting (23 October 2012) to 75% emergence in the winter cover crop adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City, Texas.

Variety	Common Name	Scientific Name	Days to 75% Emergence
Walken	Oats	*Avena sativa*	8 A[1]
Tambar	Barley	*Hordeum vulgare*	8 A
Tam 113	Wheat	*Triticum aestivum*	8 A
Nomini	Barley	*Hordeum vulgare*	8 A
	Crimson Clover	*Trifolium incarnatum*	8 A
	Elbon Rye	*Secale cereale*	8 A
Nitro	Radish	*Raphanus sativus*	10 AB
Fridge	Triticale	*Triticale hexaploide*	10 AB
	Flax	*Linum* spp.	10 AB
A & A	Wheat	*Triticum aestivum*	10 AB
	Purpletop Turnip	*Brassica rapa*	11 BC
Dwarf	Rape	*Brassica napus*	12 BCD
	Hairy Vetch	*Vicia villosa*	12 BCD
	Ethiopian Cabbage	*Brassica* spp.	12 BCD
Driller	Radish	*Raphanus sativus*	12 BCD
	Winfred Hybrid	*Brassica* spp.	13 CDE
Tamo 606	Oats	*Avena sativa*	13 CDE
Sturdy 2K	Wheat	*Triticum aestivum*	14 DEF
Specter	Winter Pea	*Pisum sativum*	14 DEF
	Forage Collards	*Brassica oleracea*	14 DEF
	Common Vetch	*Lathyrus sativus*	14 DEF
	Cahaba vetch	*Vicia* spp.	14 DEF
	Black Oats	*Avena strigosa*	14 DEF
Hubam	White Clover	*Trifolium repens*	15 EF
	Chickling Vetch	*Lathyrus sativus*	15 EF
Austrian	Winter Pea	*Pisum sativum*	15 EF
Madrid Blossom	Yellow Clover	*Trifolium aureum*	16 F
	Winter Pea	*Pisum sativum*	16 F
	Sainfoin	*Onobrychis viciifolia*	16 F
Overton R-18	Rose Clover	*Trifolium hirtum*	16 F
	Plantain	*Musa paradisiaca*	16 F
	Faba Bean	*Vicia faba*	16 F
	Alfalfa	*Medicago sativa*	16 F
Bigbee	Berseem Clover	*Trifolium alexandrium*	16 F
Yuchi	Arrowleaf Clover	*Trifolium vesiculosum*	16 F

[1]Means within column followed by the same letters are not significantly different as determined by least significant difference test at $P<0.05$.

Table 3. Plant height in the winter cover crop adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City, Texas taken April 26, 2013.

Variety	Common Name	Scientific Name	Height (in.)
	Elbon Rye	*Secale cereale*	42 A[1]
Fridge	Triticale	*Triticale hexaploide*	40 A
	Purpletop Turnip	*Brassica rapa*	35 B
	Forage Collards	*Brassica oleracea*	31 BC
	Black Oats	*Avena strigosa*	30 BCD
Sturdy 2K	Wheat	*Triticum aestivum*	27 CDE
Tambar	Barley	*Hordeum vulgare*	27 CDE
A & A	Wheat	*Triticum aestivum*	26 CDE
Dwarf	Rape	*Brassica napus*	26 DEF
Tam 113	Wheat	*Triticum aestivum*	25 DEFG
Nomini	Barley	*Hordeum vulgare*	25 EFGH
Tamo 606	Oats	*Avena sativa*	25 EFGH
Walken	Oats	*Avena sativa*	22 EFGH
	Ethiopian Cabbage	*Brassica* spp.	21 FGHI
	Flax	*Linum* spp.	20 GHIJ
Hubam	White Clover	*Trifolium repens*	20 GHIJ
Nitro	Radish	*Raphanus sativus*	20 HIJK
	Crimson Clover	*Trifolium incarnatum*	17 IJKL
Austrian	Winter Pea	*Pisum sativum*	15 JKLM
	Hairy Vetch	*Vicia villosa*	15 KLMN
Specter	Winter Pea	*Pisum sativum*	15 KLMN
	Winfred Hybrid	*Brassica* spp.	15 KLMN
	Faba Bean	*Vicia faba*	13 LMNO
Yuchi	Arrowleaf Clover	*Trifolium vesiculosum*	12 LMNO
	Sainfoin	*Onobrychis viciifolia*	12 LMNO
	Chickling Vetch	*Lathyrus sativus*	11 MNO
Driller	Radish	*Raphanus sativus*	11 MNO
	Cahaba vetch	*Vicia* spp.	11 MNO
Overton R-18	Rose Clover	*Trifolium hirtum*	11 MNO
Bigbee	Berseem Clover	*Trifolium alexandrium*	10 MNOP
	Common Vetch	*Lathyrus sativus*	10 NOPQ
	Plantain	*Musa paradisiaca*	10 NOPQ
	Winter Pea	*Pisum sativum*	8 OPQ
	Alfalfa	*Medicago sativa*	5 PQ
Madrid Blossom	Yellow Clover	*Trifolium aureum*	5 Q

[1]Means within column followed by the same letters are not significantly different as determined by least significant difference test at P<0.05.

Table 4. Days after planting (23 October 2012) to 70% ground cover winter cover crop adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City, Texas.

Variety	Common Name	Scientific Name	Days to 70% Ground Cover
	Winfred Hybrid	*Brassica* spp.	50 A[1]
Tambar	Barley	*Hordeum vulgare*	50 A
Tam 113	Wheat	*Triticum aestivum*	50 A
Sturdy 2K	Wheat	*Triticum aestivum*	50 A
Specter	Winter Pea	*Pisum sativum*	50 A
Dwarf	Rape	*Brassica napus*	50 A
	Purpletop Turnip	*Brassica rapa*	50 A
Nomini	Barley	*Hordeum vulgare*	50 A
Nitro	Radish	*Raphanus sativus*	50 A
Fridge	Triticale	*Triticale hexaploide*	50 A
	Forage Collards	*Brassica oleracea*	50 A
	Ethiopian Cabbage	*Brassica* spp.	50 A
Driller	Radish	*Raphanus sativus*	50 A
	Cahaba vetch	*Vicia* spp.	50 A
	Black Oats	*Avena strigosa*	50 A
Austrian	Winter Pea	*Pisum sativum*	50 A
	Elbon Rye	*Secale cereale*	50 A
A & A	Wheat	*Triticum aestivum*	50 A
	Winter Pea	*Pisum sativum*	75 AB
	Common Vetch	*Lathyrus sativus*	75 AB
	Chickling Vetch	*Lathyrus sativus*	75 AB
Walken	Oats	*Avena sativa*	88 BC
Tamo 606	Oats	*Avena sativa*	88 BC
	Hairy Vetch	*Vicia villosa*	113 C
Hubam	White Clover	*Trifolium repens*	150 D
	Sainfoin	*Onobrychis viciifolia*	150 D
	Crimson Clover	*Trifolium incarnatum*	150 D
Yuchi	Arrowleaf Clover	*Trifolium vesiculosum*	163 D
Madrid Blossom	Yellow Clover	*Trifolium aureum*	175 D
Overton R-18	Rose Clover	*Trifolium hirtum*	175 D
	Plantain	*Musa paradisiaca*	175 D
	Faba Bean	*Vicia faba*	175 D
	Alfalfa	*Medicago sativa*	175 D
Bigbee	Berseem Clover	*Trifolium alexandrium*	175 D
	Flax	*Linum* spp.	E[2]

[1]Means within column followed by the same letters are not significantly different as determined by least significant difference test at P<0.05.

[2]Flax never grew to a point where 70% ground cover was obtained.

CONCLUSION

Plant diversity is critical in developing mixtures for cover crop systems in order to maximize the individual benefits of grasses, legumes and forbs used to improve soil health. Grasses provide carbon residue for soil microbes, scavenge nutrients, and control weeds. Rye, barley, and wheat have the capability to produce up to 17 000 pounds of biomass per acre, adding carbon back into the soil profile to support microbial activity. Legumes convert nitrogen into plant usable forms in the soil profile. Forbs scavenge nutrients, suppress disease, and attract pollinators. These grasses, legumes and forbs also have the ability to provide ground cover quickly to bare soil to protect it from wind and water erosion. The cover also helps regulate extreme temperatures that can be fatal to soil microbes. Cover crop mixtures should always include diverse plant populations.

LITERATURE CITED

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