United States Department of Agriculture

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

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

Brandon Carr and Gary Rea

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. Fifty-two potential 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. Many grasses, especially the sudan-grasses and forage and grain sorghums, produced excellent biomass ranging from 12 000 to 20 000 lb/acre and providing adequate soil cover within 60 days after planting. While the forbs and legumes did not produce as much biomass as the grasses, many of them would provide suitable soil protection during critical erosion periods. All fifty-two species show to be adapted to the PMC service area and could add diversity to any warm 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
- Provide nitrogen

Brandon Carr is a Soil Conservationist and Gary Rea is manager at the James E. “Bud” Smith Plant Materials Center, 3950 Farm Rd. 1292, Suite 100, Knox City, TX 79529; brandon.carr@tx.usda.gov, or gary.rea@tx.usda.gov

- 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 cover crop species for soil health improvement in North Central Texas and Southwestern Oklahoma.

MATERIALS AND METHODS

Fifty-two potential 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 2013. Plots were planted on 12 June 2013 using a Wintersteiger Plotseed XL cone plot planter (Austria) in a randomized complete block design with four 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 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 90 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 11 September 2013. Grab samples were collected from each harvest plot and dried in a Shel-Lab FX14-2 (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

Forty-nine of the varieties in the observational nursery had satisfactory germination and emergence following the post planting irrigation application. An eighty-five percent stand was observed within two weeks after planting. The Kobe and Korean lespedeza and wild reseeding soybeans had very thin stands throughout the observation period. This could be due to poor seed quality. As the summer progressed and the onset of higher temperatures and dryer conditions, mortality was observed in the cool season species such as the rapeseed and collards, which is expected because their typical growth pattern is October to early May (Clark, 2014). The total biomass ninety days after planting is shown in Table 1. Many of the grasses, mainly the sorghum and sudan-grasses produced the most biomass ranging from 12,000-20,000 lb/acre. These grasses have the potential to add substantial amounts of carbon into the soil for soil microbes (Clark, 2007). Cowpeas, mungbeans, partridge pea, and other legumes produced biomass quantities of 4,000 to 6,000 lb/acre. Although they do not produce near the amount of carbon as the grasses, the legume species provide other benefits including the nitrogen fixation in the soil. The forbs in the observation nursery including the buckwheat, sunflowers, and *brassica* sp. produced the least amount of biomass. Although they do not produce as much biomass as the grasses and legumes, these forbs benefit the soil health by scavenging for nutrients and preventing soil compaction. Additionally, flowering forbs and legumes attract various beneficial pollinators by providing food and cover.

Plant height measurements are shown in Table 2. Plant height is the maximum growth reported for each species. The sudan-grasses and sorghum entries reached heights of 52-61 inches, while the sunn hemp and partridge pea reached 27-29 inches. The *brassica* spp. grew to about seven inches before succumbing to the hot, dry summer conditions. 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 at 30 days after planting to 90 days (Table 3). Maximum ground cover is important in soil health because it helps moderate the soil temperature and protect soil surface from water and wind runoff (Clark, 2007). Most entries produced over 50% ground cover within 30 days after planting with many grasses and legumes exceeding 75% by 60 days. The lespedeza and wild reseeding soybeans produced limited ground cover due to the thin plant population. Cover remained high 90 days after planting with most entries exceeding 75%. Most of the species in the evaluation nursery have the ability to quickly provide ground cover and keep it throughout the growing season. Ground cover also helps control weed populations by shading out sunlight for emerging weed seedlings.

Figure 1. Biomass (lbs per acre) produced in the summer cover crop adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City in September 2013.

Variety	Common Name	Scientific Name	Yield (lbs/ac)
W-615	Grain Sorghum	*Sorghum bicolor*	21 453 a[1]
Bird Magnet	Forage Sorghum	*Sorghum bicolor*	21 124 ab
Sugar Queen	Sudangrass	*Sorghum sudanense*	20 790 ab
HS II	Forage Sorghum	*Sorghum bicolor*	20 552 ab
Super Graze Ultra	Sudangrass	*Sorghum sudanense*	20 452 ab
WAC-610	Grain Sorghum	*Sorghum bicolor*	19 555 abc
Surpass BMR	Forage Sorghum	*Sorghum bicolor*	18 694 abcde
Cow Lick	Forage Sorghum	*Sorghum bicolor*	17 972 abcde
Zacate	Sudangrass	*Sorghum sudanense*	17 611 bcde
Maxi Gain BMR-6	Sudangrass	*Sorghum sudanense*	16 526 cdef
Early Sumac	Grain Sorghum	*Sorghum bicolor*	16 219 cdef
Egyptain Wheat	Forage Sorghum	*Sorghum bicolor*	15 734 def
Piper	Sudangrass	*Sorghum sudanense*	14 731 efg
Wild Game Food	Grain Sorghum	*Sorghum bicolor*	13 195 fgh
White-9200Y	Grain Sorghum	*Sorghum bicolor*	11 859 ghi
Sorghum Almum	Grain Sorghum	*Sorghum bicolor*	11 789 ghij
BMR 84	Grazing Corn	*Zea* sp.	11 607 ghijk
ML 401 BMR	Pearl Millet	*Pennisetum glaucum*	11 032 ghijk
Hybrid Pearl	Pearl Millet	*Pennisetum glaucum*	9937 hijkl
OrganicNatural	Sesame	*Sesamum indicum*	8777 ijklm
Comanche	Partridge Pea	*Chamaecrista fasciculate*	8072 jklmn
	Dove Proso Millet	*Panicum miliaceum*	8039 klmn
	Browntop Millet	*Panicum ramosum*	7956 klmno
	Mungbean	*Vigna radiata*	6293 lmnop
	Japanese Millet	*Echinochloa frumentacea*	6255 lmnop
	German Foxtail Millet	*Sertaria italica*	6008 mnopq
V.N.S.	Sesbania	*Sesbania exaltata*	5987 mnopq
	Kenaf	*Hibiscus cannabinus*	5937 mnopq
Iron & Clay	Cowpeas	*Vigna sinensis*	5765 mnopq
Tamrun OLII	Peanut	*Archis hypogea*	5496 mnopq
	Catjang Pea	*Vigna sinensis*	5301 mnopq
Red Ripper	Cowpeas	*Vigna unguiculata*	5181 mnopq
	Sunn Hemp	*Crotalaria juncea L.*	5164 mnopq
	Guar	*Cyamopsis tetragonolobe*	5083 mnopq
California Black Eyec	Cowpeas	*Vigna sinensis*	4968 nopq
Laredo	Soybeans	*Glycine max*	4351 opqr
Peredovik Type	Sunflower	*Helianthus spp.*	4284 opqr
Ronaai	Lab Lab Bean	*Lablab purpureus*	4270 opqr
Rio Verde	Lab Lab Bean	*Lablab purpureus*	4001 pqr
Quail Haven	Wild Reseeding Soybeans	*Glycine soja*	3294 pqr
Kobe	Lespedeza	*Lespedeza striata*	3043 pqr
Bengal	Rice	*Oryza sativa*	2808 pqr
Buckwheat	Buckwheat	*Fagopyrum sagittatum*	2800 pqr
Korean	Lespedeza	*Lespedeza stipulacea*	2734 pqr
VNS	Buckwheat	*Fagopyrum sagittatum*	2392 qr
Dwarf	Rape	*Brassica napus*	1227 r
Impact	Collards	*Brassica oleracea*	827 r

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

Figure 2. Plant height (inches) of summer cover crop speicies in the adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City in August 2013.

Variety	CommonName	ScientificName	Plant Height (in.)
Sorghum Almum	Grain Sorghum	*Sorghum bicolor*	61 a[1]
Piper	Sudangrass	*Sorghum sudanense*	59 ab
Zacate	Sudangrass	*Sorghum sudanense*	56 abc
Egyptain Wheat	Forage Sorghum	*Sorghum bicolor*	54 bcd
Early Sumac	Grain Sorghum	*Sorghum bicolor*	52 cde
V.N.S.	Sesbania	*Sesbania exaltata*	51 de
Sugar Queen	Sudangrass	*Sorghum sudanense*	50 de
Super Graze Ultra	Sudangrass	*Sorghum sudanense*	47 ef
Cow Lick	Forage Sorghum	*Sorghum bicolor*	44 efg
HS II	Forage Sorghum	*Sorghum bicolor*	42 gh
Surpass BMR	Forage Sorghum	*Sorghum bicolor*	42 gh
Maxi Gain BMR-6	Sudangrass	*Sorghum sudanense*	38 hi
Dove Proso	Dove Proso Millet	*Panicum miliaceum*	37 hij
ML 401 BMR	Pearl Millet	*Pennisetum glaucum*	34 ijk
OrganicNatural	Sesame	*Sesamum indicum*	34 ijkl
	German Foxtail Millet	*Sertaria italica*	34 ijkl
	Kenaf	*Hibiscus cannabinus*	33 jklm
White-9200Y	Grain Sorghum	*Sorghum bicolor*	32 jklm
Hybrid Pearl	Pearl Millet	*Pennisetum glaucum*	31 klmn
	Browntop Millet	*Panicum ramosum*	30 klmno
	Japanese Millet	*Echinochloa frumentace*	30 klmnop
Wild Game Food	Grain Sorghum	*Sorghum bicolor*	29 klmnop
Bird Magnet	Forage Sorghum	*Sorghum bicolor*	29 lmnopq
	Sunn Hemp	*Crotalaria juncea L.*	29 lmnopq
W-615	Grain Sorghum	*Sorghum bicolor*	28 mnopq
Comanche	Partridge Pea	*Chamaecrista fasciculate*	27 nopqr
WAC-610	Grain Sorghum	*Sorghum bicolor*	26 opqrs
Iron & Clay	Cowpeas	*Vigna sinensis*	25 opqrst
BMR 84	Grazing Corn	*Zea* sp.	25 opqrst
Peredovik Type	Sunflower	*Helianthus spp.*	25 pqrstu
	Catjang Pea	*Vigna sinensis*	24 qrstu
VNS	Buckwheat	*Fagopyrum sagittatum*	22 rstuv
	Mungbean	*Vigna radiata*	21 stuvw
	Buckwheat	*Fagopyrum sagittatum*	20 tuvw
California Black Eyed	Cowpeas	*Vigna sinensis*	20 tuvw
Rio Verde	Lab Lab Bean	*Lablab purpureus*	20 uvw
Bengal	Rice	*Oryza sativa*	19 vw
Laredo	Soybeans	*Glycine max*	19 vw
Red Ripper	Cowpeas	*Vigna unguiculata*	18 vw
	Guar	*Cyamopsis tetragonolobe*	18 vw
Ronaai	Lab Lab Bean	*Lablab purpureus*	18 vw
Korean	Lespedeza	*Lespedeza stipulacea*	17 w
Kobe	Lespedeza	*Lespedeza striata*	11 x
Tamrun OLII	Peanut	*Archis hypogea*	10 x
Quail Haven	Wild Reseeding Soybeans	*Glycine soja*	8 x
Dwarf	Rape	*Brassica napus*	7 x
Impact	Collards	*Brassica oleracea*	7 x

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

Figure 3. Percent of ground covered at 30-day intervals from June 12, 2013 planting to termination of summer cover crop speicies in the adaptability trial at the James E. "Bud" Smith Plant Materials Center in Knox City in 2013.

			% Ground Covered		
Variety	**CommonName**	**ScientificName**	**30 Days**	**60 days**	**90 days**
WAC-610	Grain Sorghum	Sorghum bicolor	71 a[1]	100 a	100 a
Super Graze Ultra	Sudangrass	Sorghum sudanense	70 ab	100 a	100 a
Sugar Queen	Sudangrass	Sorghum sudanense	70 ab	100 a	100 a
Egyptain Wheat	Forage Sorghum	Sorghum bicolor	68 abc	100 a	100 a
Surpass BMR	Forage Sorghum	Sorghum bicolor	66 abc	100 a	100 a
Wild Game Food	Grain Sorghum	Sorghum bicolor	64 abcd	100 a	100 a
Zacate	Sudangrass	Sorghum sudanense	64 abcd	100 a	100 a
	Browntop Millet	Panicum ramosum	61 abcde	100 a	100 a
Bird Magnet	Forage Sorghum	Sorghum bicolor	61 abcde	100 a	100 a
Cow Lick	Forage Sorghum	Sorghum bicolor	60 abcde	100 a	100 a
HS II	Forage Sorghum	Sorghum bicolor	60 abcde	100 a	100 a
Maxi Gain BMR-6	Sudangrass	Sorghum sudanense	60 abcde	100 a	100 a
Sorghum Almum	Grain Sorghum	Sorghum bicolor	59 abcde	100 a	100 a
Red Ripper	Cowpeas	Vigna unguiculata	56 abcdef	100 a	100 a
Iron & Clay	Cowpeas	Vigna sinensis	54 bcdefg	100 a	100 a
Early Sumac	Grain Sorghum	Sorghum bicolor	54 bcdefg	100 a	100 a
Piper	Sudangrass	Sorghum sudanense	54 bcdefg	100 a	100 a
W-615	Grain Sorghum	Sorghum bicolor	53 cdefgh	100 a	100 a
White-9200Y	Grain Sorghum	Sorghum bicolor	53 cdefgh	100 a	100 a
Comanche	Partridge Pea	Chamaecrista fasciculate	40 fghijkl	100 a	100 a
	Catjang Pea	Vigna sinensis	60 abcde	99 ab	99 ab
	Mungbean	Vigna radiata	60 abcde	99 ab	99 ab
	Kenaf	Hibiscus cannabinus	65 abcd	98 abc	98 ab
BMR 84	Grazing Corn	Zea sp.	60 abcde	96 abcd	96 ab
ML 401 BMR	Pearl Millet	Pennisetum glaucum	68 abc	94 abcde	96 ab
Hybrid Pearl	Pearl Millet	Pennisetum glaucum	53 cdefgh	90 abcdef	90 abc
California Black Eyed	Cowpeas	Vigna sinensis	29 lm	90 abcdef	91 abc
OrganicNatural	Sesame	Sesamum indicum	61 abcde	89 abcdefg	89 abc
Rio Verde	Lab Lab Bean	Lablab purpureus	18 mno	89 abcdefg	89 abc
	Japanese Millet	Echinochloa frumentacea	35 ijkl	85 bcdefg	88 abcd
	Guar	Cyamopsis tetragonolobe	25 lmn	84 cdefg	84 bcde
	Sunn Hemp	Crotalaria juncea L.	39 ghijkl	83 defg	84 bcde
Ronaai	Lab Lab Bean	Lablab purpureus	36 hijkl	81 efgh	91 ab
	German Foxtail Millet	Sertaria italica	29 lm	81 efgh	69 efg
	Dove Proso Millet	Panicum miliaceum	18 mno	80 efghi	88 abcd
Laredo	Soybeans	Glycine max	30 klm	79 fghi	84 bcde
Dwarf	Rape	Brassica napus	49 defghij	78 fghi	58 gh
Impact	Collards	Brassica oleracea	51 cdefghi	76 fghij	60 fgh
VNS	Buckwheat	Fagopyrum sagittatum	33 jklm	75 ghij	73 defg
Tamrun OLII	Peanut	Archis hypogea	26 lmn	75 ghij	88 abcd
V.N.S.	Sesbania	Sesbania exaltata	46 efghijk	69 hij	75 cdef
Bengal	Rice	Oryza sativa	11 no	68 hij	65 fgh
Peredovik Type	Sunflower	Helianthus spp.	34 jklm	66 ij	65 fgh
	Buckwheat	Fagopyrum sagittatum	46 efghijk	63 j	53 h
Quail Haven	Wild Reseeding Soybeans	Glycine soja	8 o	19 k	28 i
Kobe	Lespedeza	Lespedeza striata	6 o	15 k	20 i
Korean	Lespedeza	Lespedeza stipulacea	5 o	9 k	18 i

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

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. Grain and forage sorghum and sudan-grass has the capability to produce up to 20,000 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

Bodner, G.M. Himmelbauer, W. Loiskandl, and H. Kaul. 2010. Improved evaluation of cover crop species by growth and root factors. Agronomy for Sustainable Development 30:455-464.

Clark, A., editor. 2007. Managing Cover Crop Profitability, 3rd ed. National SARE Outreach Handbook Series Book 9. National Agric. Laboratory, Beltsville, MD Beltsville, MD. http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition. (Accessed January 2014).

Clark. S. (n.d.). A Comprehensive Guide to Cover Crop Species Used in the Northeast United States. Available on-line: http://www.nrcs.usda.gov/Internet/FSE_PLANT MATERIALS/publications/nypmcpu10645.pdf. (Accessed January 2014).

Roozeboom, K. Cover Crop Species and Mixtures. Available on-line: http://www.agronomy.k-state.edu/doc2594.ashx. (Accessed January 2014).

Sullivan, P. 2003. Overview of Cover Crops and Green Manures. Available on-line: http://www.clemson.edu/sustainableag/IP024_covercrop.pdf. (Accessed January 2014).