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Irrigated Warm Season Cover Crops for Western Oregon

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ABSTRACT

Cover crop use is increasing in the Pacific Northwest, but information is not readily available on the growth potential, biomass production, adaptability, and bloom period of warm season cover crop species and/or varieties for this region. A study was conducted in 2015–2016 at the United States Department of Agriculture - Natural Resources Conservation Service (USDA-NRCS) Plant Materials Center in Corvallis, Oregon to evaluate commercially available summer cover crops for the Willamette Valley of western Oregon. The replicated trial included ten warm-season species that were evaluated for emergence, canopy cover, vigor, pest and disease susceptibility, bloom period, plant height, and biomass production. Based on two years of data, buckwheat (*Fagopyrum esculentum*) and Sudangrass/sorghum-Sudangrass (*Sorghum bicolor* var. *bicolor* x *S. bicolor* var. *sudanense*) were shown to be particularly well adapted to our region and performed well for a variety of functions, including quick cover, weed suppression, biomass production, and bloom.

INTRODUCTION

Incorporating cover crops into cropping systems can improve soil quality and resiliency of agricultural lands by increasing soil organic matter and water holding capacity, serving as a nitrogen trap to improve water quality, serving as a nitrogen source for subsequent crops, and for suppression of weeds, among other benefits (Clark, 2007). Cover crops are useful in both conventional row crops and organically grown crops. However, selecting the most useful

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species or varieties to fit into a cropping system is sometimes limited by a lack of data on growth potential, biomass, adaptability, winter hardiness, and bloom time for a particular region.

The purpose of this study was to evaluate the growth characteristics and production attributes of commercially available warm-season cover crop varieties/cultivars in the Willamette Valley. Understanding the local adaptation and growth characteristics of different summer cover crop species/varieties will assist conservation planners and growers with optimizing cover crop selections. The plantings also served as a demonstration and training tool for conservation planning staff and local growers during field days at the Corvallis Plant Materials Center (PMC) in 2015 and 2016. Sudangrass, hybrid sorghum-Sudangrass, and buckwheat are currently the most commonly recommended summer cover crops in western Oregon (Sattel and Dick, 1998). The other species included in this trial are commonly grown cover crops in other regions of the U.S. that show promise as cover crops in Oregon, but for whatever reason, have not been as widely used: pearl millet, teff, phacelia, safflower, sunflower, cowpea, soybean, and sunn hemp.

MATERIALS AND METHODS

The soil type at the PMC in Corvallis, OR where the study was planted is an Amity silt loam, 0 to 3 percent slopes, somewhat poorly drained. Climate data for the study period are given in Table 1. The fields were prepared by disking and rolling to produce a firm, well-prepared seedbed. All crops were drill seeded in replicate 8 x 21-ft plots (3 replications in 2015 and 4 replications in 2016) with a Hege cone seeder (Wintersteiger Inc., Salt Lake City, UT) on 8.5-inch row spacing according to the seeding rates given in Table 2. Because we did not order sufficient quantities of seed for a few crops, different varieties were used in 2016 than 2015 (Sudangrass, safflower, and soybean). Plots were planted on June 12, 2015 and June 22, 2016. All legume seeds were inoculated with the appropriate rhizobia prior to planting.

Soil tests taken in May 2015 for first year plots (Kuo Testing Labs, Othello, WA) showed a pH of 5.0 (the field was limed in June 2015 with 2 tons/acre CaCO_3 prior to seedbed preparation to adjust the pH), high P levels (55 ppm), and medium levels of K (184-194 ppm), $\text{SO}_4\text{-S}$ (8-13 ppm), Ca (5.4 meq/100 g) and Mg (0.6 meq/100 g). Soil tests taken in June 2016 for second year plots (Kuo Testing Labs) showed a pH of 6.1, high P levels (51 ppm), and medium levels of K (181 ppm), $\text{SO}_4\text{-S}$ (13 ppm), Ca (6.9 meq/100 g) and Mg (0.5 meq/100 g). The non-legume plots were fertilized with 100 lb N/ac as urea (46-0-0) about 30 days after planting, and all plots

Table 1. Weather averages/totals from Hyslop weather station for summer cover crop trials at the Corvallis Plant Materials Center (6/12/2015 to 9/10/2015 and 6/22/2016 to 9/26/2016).

Month	Air Temp Avg. Max (°F)	Air Temp Avg. Min. (°F)	Highest Daily Max (°F)	Lowest Daily Min. (°F)	Precipitation (inches)	Approx. Irrigation (inches)
Jun-2015	84	51	98	42	0.00	2.50
Jul-2015	87	53	104	45	0.00	4.50
Aug-2015	86	53	102	45	0.42	4.00
Sep-2015	76	49	86	40	0.33	0.00
Total:					0.75	11.00
Jun-2016	80	50	97	40	0.50	2.00
Jul-2016	81	53	101	46	0.50	4.00
Aug-2016	87	51	106	44	0.11	4.00
Sep-2016	76	46	94	38	0.71	0.00
Total:					1.82	10.00

Table 2. Cover crop species, varieties, and seeding rates for the 2015 and 2016 study at the Corvallis Plant Materials Center.

Species	Variety	Crop	Crop Type	Seeding Rate PLS lb/acre ¹	Seeds per pound ²	Seeding Rate PLS seeds/sq.ft.
<i>Pennisetum glaucum</i>	K Graze	pearl millet, hybrid	Grass	10	18,000	4
<i>Sorghum bicolor</i> var. <i>bicolor</i> x <i>S. bicolor</i> var. <i>sudanense</i>	VNS* (2015)	sorghum-Sudangrass, hybrid	Grass	35	18,000	14
<i>Sorghum bicolor</i> var. <i>sudanense</i>	Piper (2016)	Sudangrass	Grass	35	39,700	32
<i>Eragrostis tef</i>	Excalibur	teff	Grass	7	1,480,000	237
<i>Fagopyrum esculentum</i>	Koma	buckwheat	Broadleaf	60	15,000	21
<i>Phacelia tanacetifolia</i>	VNS	phacelia	Broadleaf	8	200,000	37
<i>Carthamus tinctorius</i>	VNS (2015)	safflower	Broadleaf	25	15,800	9
<i>Carthamus tinctorius</i>	Finch (2016)	safflower	Broadleaf	25	14,400	8
<i>Helianthus annuus</i>	VNS	sunflower, black oil	Broadleaf	4	12,700	1
<i>Vigna unguiculata</i>	Iron & Clay	cowpea	Legume	60	4,600	6
<i>Glycine max</i>	Surge (2015)	soybean	Legume	50	3,200	4
<i>Glycine max</i>	Stonewall (2016)	soybean	Legume	50	2,700	3
<i>Crotalaria juncea</i>	Tillage Sunn	sunn hemp	Legume	25	7,900	5

*VNS - Variety Not Stated, ¹PLS - Pure Live Seeding Rate, ²Seeds per pound calculated as average weight from 3 counts of 100 seeds

received about 1 inch of sprinkler irrigation per week from June through August. Plots were hand-weeded once during the growing season as needed to prevent excessive weed competition.

Germination/emergence was scored in each plot approximately every 7 days for the first four weeks after planting using the following scale: 0 = poor (<25% germination), 1 = moderate (25-65% germination), 2 = good (66-85% germination), 3 = excellent (>85% germination). Every 15 days, all plots were rated for the following: vigor (general health and growth, rated on a scale of 1–5, where 1=poor and 5=excellent); disease (visual estimate of foliar diseases, rated from 0–5, where 0=no damage and 5=severe damage); pests (visual estimate of insect damage, rated from 0–5, where 0=no damage and 5=severe damage); and canopy cover (visual estimate of the percentage of ground covered by the plant, estimated to the nearest 10%).

Bloom period was monitored and the date of 50% bloom was recorded. When plants reached 50% bloom, aboveground biomass samples were clipped at ground level from 0.5 x 1.0-m subplots in the center of each plot. Aboveground biomass samples were oven dried at 50°C to a steady weight (Undersander et al., 1993) and percent dry matter and biomass were calculated on a pound per acre basis. Plant height measurements (height of lush canopy growth, not including blooms or inflorescences) were taken from 5 random locations in each plot at the time aboveground biomass was harvested.

The experimental design was a randomized complete block (block 1 was arranged by crop type for demonstration/training purposes). Data were analyzed using the analysis of variance (AOV) procedure and the Kruskal-Wallis one-way AOV in Statistix 10 (Analytical Software, Tallahassee, FL). Mean separation was performed at $P < 0.05$ within each crop type (grass, broadleaf, and legume).

RESULTS AND DISCUSSION

Quick canopy cover is important for protecting the soil surface and for suppressing weed growth (Clark, 2007). Buckwheat and sorghum-Sudangrass provided the quickest emergence and canopy cover of the crops in our trial, both reaching over 65% emergence in about a week and 70% cover in about a month (Table 3). It should be noted, however, that in a number of western states, including Oregon and Washington, NRCS does not recommend planting buckwheat in rotation with or adjacent to commodity wheat production for two prior growing seasons because of the potential for buckwheat seed to contaminate the wheat crop, and the human allergen health risks that buckwheat poses (USDA-NRCS, 2016).

Sudangrass, hybrid pearl millet, phacelia, teff, and safflower also had good establishment within two weeks after planting, and quick cover, reaching 70% cover by about 45 days after planting (DAP) (Table 3). The legumes tended to have lower vigor than the grass and broadleaf varieties included in this trial, and generally took longer to reach 70% cover. By 70 DAP in late August, all the plots had reached at least 70% cover except the Stonewall soybeans (largely due to poor establishment) and the sunn hemp.

For aboveground biomass production, the sorghum-Sudangrass was the hands-down winner at over 6 feet tall and more than 7 tons dry matter (DM)/acre at 50% anthesis (Table 3). General recommendations are to mow or graze sorghum-Sudangrass to about 6-inch stubble height when it reaches 3 to 4 ft tall to increase the plants' root biomass and encourage the roots to penetrate compaction layers in the soil (Clark, 2007). When we tried this on half of each plot in 2015, we harvested 6,700 lb DM/ac in the first cutting at 49 DAP, and regrowth was rapid and vigorous. In 2016 we tried the same thing with the Piper Sudangrass, and harvested 2,900 lb DM/ac from the first cutting at 42 DAP and 6,400 lb DM/ac from the second cutting at 96 DAP, for a total of 9,300 lb DM/ac compared to only 6,700 lb DM/ac for the single cutting. Mowing or grazing the sorghum-Sudangrass when it is shorter, and still vegetative, also keeps the residue manageable, as it tends to get extremely tough when allowed to flower and mature seed, wrapping itself around and bogging down mowing equipment. Sorghum-Sudangrass plants and residue have been reported to secrete or contain allelopathic weed-suppressing compounds, and have also been reported to suppress nematodes and certain diseases (Clark, 2007). We observed few weeds in the sorghum-Sudangrass plots in our trial, but it's not clear whether this was due to allelopathy or simply competition.

Biomass production in the other grasses and broadleaf crops included in our trial ranged from 2.4 to 4.5 tons DM/ac (Table 3). The cowpea and 'Stonewall' soybean, however, produced less than 1.5 tons DM/ac, likely due to disease in the cowpea (apparently from contaminated seed stock) and poor establishment from bad seed and/or maladaptation of the Stonewall soybean. While we didn't actually quantify residue longevity or C:N ratio, based on visual observations there were substantial differences in the quality of the residue produced by different crops. When left unincorporated on the surface, cowpea and soybean residue were the quickest to break down, followed by phacelia and buckwheat; sunflower and sunn hemp stalks took longer to break down, but didn't provide much cover for the soil. Safflower, pearl millet, Sudangrass, and teff all had lasting residue that continued to protect the soil surface after winter killing.

Flowering cover crops provide important resources of pollen and/or nectar for bees and other pollinators and beneficial insects. In our trial, buckwheat and phacelia provided the longest and most abundant bloom period, with buckwheat starting to flower approximately 30 DAP and continuing for 8 weeks, especially when it was mowed and allowed to regrow. Phacelia began to

bloom at 45 DAP and continued for 6 weeks. Honey bees were particularly attracted to the buckwheat flowers, while the phacelia, originally a native of California, was favored by our native bumble bees. The safflowers and sunflowers were also popular with both honey bees and native bees, and provided bloom over a period of about 4 weeks from late August through late September, when many other floral resources are unavailable. The soybeans bloomed early, but their small flowers did not attract many bees or other visitors; the sunn hemp had few flowers; and the ‘Iron and Clay’ cowpeas hadn’t bloomed by the time they were terminated over 90 days after planting, though this may be remedied by selection of a more appropriate cultivar for our region.

Appendix 1 contains photos and individual descriptions of each cover crop variety.

CONCLUSIONS

Based on two years of data, a couple of “tried and true” cover crops, buckwheat and Sudangrass/sorghum-Sudangrass, appeared to be well adapted to our region and performed well for a variety of functions, including quick cover, weed suppression, biomass production, and bloom. Other “non-traditional” cover crops that performed well and that warrant further attention included phacelia, pearl millet, teff, safflower, and sunflower. Although not a strong performer on its own, sunn hemp may also serve a role as a nitrogen-fixing legume in a mix with other cover crop species that are quicker to establish.

Starting in 2017, we are planning a non-irrigated warm season cover crop trial of these and other species/varieties at the Corvallis PMC to evaluate their performance during our dry western Oregon summers without supplemental irrigation. Data from this and future PMC studies will be used to inform cover crop seeding recommendations in the NRCS *Pacific Northwest Cover Crop Selection Tool* and the *Seeding and Planting Guide for Western Oregon and Washington* in the electronic NRCS Field Office Technical Guide (eFOTG).

REFERENCES

- Clark, A. (ed). 2007. Managing cover crops profitably, 3rd edition. Handbook 9. Sustainable Agriculture Research & Education (SARE) program, College Park, MD.
<http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition/Text-Version>
- Green Cover Seed. 2017. Cover crop and forage species. Green Cover Seed, Bladen, NE.
<https://greencoverseed.com/species/list>
- Liebig, M., and H. Johnson (eds.). 2016. Cover crop chart (v. 2.1). USDA-ARS, Northern Great Plains Research Laboratory, Mandan, ND. <https://www.ars.usda.gov/plains-area/mandan-nd/ngprl/docs/cover-crop-chart/>
- Sattell, R., and R. Dick (eds.). 1998. Using cover crops in Oregon. EM 8704. Oregon State Univ. Ext. Service, Corvallis, OR.
<http://extension.oregonstate.edu/crook/sites/default/files/oregoncovercrops.pdf>
- Statistix 10. 2013. Analytical software, Tallahassee, FL.
- Undersander, D., D.R. Mertens, and N. Thiex. 1993. Forage analysis procedure. National Forage Testing Association, Omaha, NE.
- USDA-NRCS. 2016. National Bulletin 190-16-8 ECS – Exclusion of Buckwheat in Conservation Plantings in or Near Commodity Wheat Fields in Selected West and Central States. <https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=39272>

Table 3. Average summer cover crop emergence, cover, bloom, pest and disease susceptibility, vigor, height, and aboveground biomass from 2015 and 2016 trials at the USDA-NRCS Corvallis Plant Materials Center.

	Crop	Variety	Days to >65% emergence	Days to 70% cover	Days to full bloom	Cover at 28 DAP (mid- July)* ¹	Cover at 70 DAP (late Aug.)* ¹	Pests ²	Disease ³	Vigor ⁴	Mature height (ft)	Above- ground biomass DM lb/ac
Grasses	hybrid pearl millet	K Graze	12	40	83	5.6 ab	9.3 a	1.2 b	0.4 ab	4.7 a	3.4 c	9,138 b
	sorghum-Sudangrass	VNS (2015)	7	33	70	7.7 a	10 a	2.1 a	0.5 a	5.0 a	6.7 a	14,168 a
	Sudangrass	Piper (2016)	13	42	61	6.5 ab	10 a	1.8 a	1.1 a	4.9 a	4.8 b	6,692 b
	teff	Excalibur	14	44	65	3.9 b	9.7 a	1.2 b	0.1 b	4.7 a	2.2 d	7,623 b
Broadleaf	buckwheat	Koma	8	28	54	8.7 a	9.7 a	1.5 b	0.3 ab	5.0 a	2.0 b	5,460 a
	phacelia	VNS	11	41	63	6.3 ab	9.3 ab	0.3 c	0.0 b	4.8 a	2.3 b	4,795 a
	safflower	VNS (2015) & Finch (2016)	11	47	75	4.6 bc	9.1 ab	1.0 b	0.4 a	4.9 a	2.0 b	7,028 a
	sunflower, black oil	VNS	21	67	70	1.9 c	7.9 b	2.3 a	0.3 ab	4.3 b	3.9 a	6,644 a
Legumes	cowpea	Iron & Clay	11	63	no bloom	2.9 ab	8.0 a	1.4 c	3.3 a	3.2 a	1.8 b	2,715 a
	soybean	Surge (2015)	20	59	70	3.3 a	8.3 ab	2.5 ab	0.1 b	3.5 a	2.4 ab	4,875 a
	soybean	Stonewall (2016)	NA ⁵	96	96	2.0 b	6.3 ab	1.8 bc	0.1 b	3.2 a	1.4 b	2,795 a
	sunh hemp	Tillage Sunn	14	70	93	2.4 ab	6.4 b	2.7 a	0.6 b	3.4 a	3.9 a	5,403 a

*Means within each crop category (Grass, Broadleaf, or Legume) followed by the same letter are not statistically different at $\alpha=0.05$.

¹Visual estimate of the percent canopy cover provided by the plant, rated on a scale from 1 to 10, where 1=1-10% cover and 10=91-100% cover.

²Pest pressure rated on a scale of 0 to 5, where 0=no pests and 5=severe pest damage (average ratings from 28-70 DAP in 2015 and 2016).

³Disease susceptibility rated on a scale of 0 to 5, where 0=no disease and 5=severe disease infestation (average ratings from 28-70 DAP in 2015 and 2016).

⁴Vigor rated on a scale of 1 to 5, where 1=poor vigor and 5=excellent vigor (average ratings from 28-70 DAP in 2015 and 2016).

⁵Stonewall soybean emergence never exceeded 'good' rating (25-65%).

Appendix 1. Warm-season cover crop variety descriptions based on observations from the 2015-2016 trials at the Corvallis PMC, as well as published sources (Clark, 2016; Green Cover Seed, 2017; Liebig and Johnson, 2016; Sattell and Dick, 1998).

‘K Graze’ Hybrid Pearl Millet



Pearl millet plot on 8/3/16, six weeks after planting.



General Description: Vigorous grass with wide leaves, extensive fibrous root system, and low incidence of pests and disease.

Uses: Quick cover for weed suppression, organic matter, forage production (longer season than other grasses since it blooms later); seeds attractive to birds.

Residue: Considerable residue, relatively slow to break down.

‘Excalibur’ Teff



Teff plot on 8/3/16, six weeks after planting.



General Description: Vigorous low-growing grass (2-3 ft tall) with fine leaves, shallow fibrous root system, and very low incidence of pests and disease.

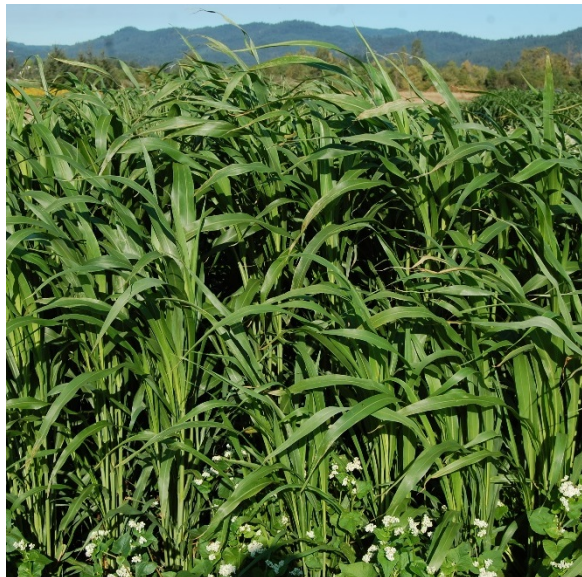
Uses: Organic matter, relatively good weed suppression and forage production.

Residue: Fine residue quicker to break down than other grasses.

Notes: Very small seeds require shallow planting for good emergence.

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VNS Sorghum-Sudangrass



Sorghum-Sudangrass plot on 7/30/15, 7 weeks after planting.



General Description: Extremely vigorous, quick-growing, tall grass (6-7 ft tall) with wide leaves, extensive, deep fibrous root system (especially when mowed), low disease susceptibility, and low/moderate pest pressure.

Uses: Extremely productive biomass/organic matter, quick cover for weed suppression, forage production; seeds attractive to birds.

Residue: Very large amounts of residue, slow to break down.

Notes: Stress can increase prussic acid levels to dangerous levels for livestock forage.

‘Piper’ Sudangrass



Sudangrass plot on 8/12/16, 7 weeks after planting.



General Description: Quick-growing, vigorous, tall grass (4-5 ft tall) with wide leaves, extensive, deep fibrous root system (especially when mowed), and low/moderate disease and pest pressure.

Uses: Quick cover for weed suppression, organic matter, forage production; seeds attractive to birds.

Residue: Considerable residue, slow to break down.

Notes: Stress can increase prussic acid levels to dangerous levels for livestock forage.

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‘Koma’ Buckwheat



Buckwheat plot on 7/20/16, 4 weeks after planting.



General Description: Extremely vigorous, quick-growing broadleaf with moderately deep taproot system, low disease susceptibility, and low/moderate pest pressure.

Uses: Extremely quick cover for weed suppression and organic matter production in short rotation; flowers attractive to bees and other beneficial insects over long bloom period.

Residue: Quick to break down.

Notes: Plants will regrow and bloom again if mowed high (6”) when they first start to bloom.

VNS Phacelia



Phacelia plot on 8/3/16, 6 weeks after planting.



General Description: Vigorous, relatively quick-growing broadleaf with lacy foliage, a shallow fibrous root system, and extremely low disease and pest pressure.

Uses: Decent organic matter production and weed suppression; flowers attractive to bees and other beneficial insects.

Residue: Quick to break down.

Notes: Seeding rate could likely be lowered to 4-6 lb/ac with good seedbed prep.

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VNS & ‘Finch’ Safflower



Safflower plot on 8/31/16, 10 weeks after planting.



General Description: Vigorous broadleaf with spiny leaves, a deep taproot system (reported to be a good nutrient scavenger), and relatively low disease and pest pressure.

Uses: Organic matter production and forage (when young); late blooming flowers attractive to bees and other beneficial insects; seeds attractive to birds.

Residue: Moderately fibrous residue with intermediate break down time.

VNS Black Oil Sunflower



Sunflower plot on 8/12/16, 7 weeks after planting.



General Description: Slower-growing broadleaf, about 4 ft tall at maturity, with a deep taproot system (reported to be a good nutrient scavenger), low disease susceptibility, and moderate pest pressure (mostly cucumber beetles in our plots).

Uses: Organic matter production and forage (when young); flowers attractive to bees and other beneficial insects; seeds attractive to birds.

Residue: Fibrous residue, slow to break down.

Appendix 1. Warm-season cover crop variety descriptions based on observations from the 2015-2016 trials at the Corvallis PMC, as well as published sources (Clark, 2016; Green Cover Seed, 2017; Liebig and Johnson, 2016; Sattell and Dick, 1998).

‘Iron & Clay’ Cowpea



Cowpea plot on 8/31/16, 10 weeks after planting.



General Description: Slow-growing legume (poor weed competitor) with a shallow taproot system (reported to have deep taproot on other sites), low/moderate pest pressure, and moderate/high disease incidence (likely due to infected seed).

Uses: No bloom in 3-month growing season; variety does not appear well adapted to our region.

Residue: Quick to break down.

‘Tillage Sunn’ Sunn Hemp



Sunn hemp plot on 8/28/15, 11 weeks after planting.



General Description: Slow-growing legume (poor weed competitor), about 4 ft tall at maturity, with a moderately deep taproot system, low disease susceptibility, and moderate pest pressure (mostly cucumber beetles in our plots).

Uses: Organic matter production, N fixation, and forage (though some cultivars reported to contain poisonous alkaloids).

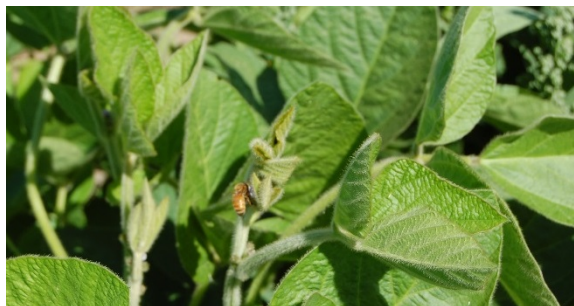
Residue: Fibrous residue, moderately slow to break down.

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‘Surge’ Soybean



‘Surge’ soybean plot on 8/10/15, 8 weeks after planting.



General Description Slow-growing legume (relatively poor weed competitor) to about 2½ ft tall, with a moderately deep taproot system, low disease susceptibility, and moderate pest pressure.

Uses: Organic matter production and N-fixation; small flowers may provide some forage for bees.

Residue: Relatively quick to break down.

‘Stonewall’ Soybean



‘Stonewall’ soybean plot on 8/22/16, 9 weeks after planting.



General Description: Slow-growing legume (poor weed competitor) to about 1½ ft tall, with a moderately deep taproot system, low disease susceptibility, and low/moderate pest pressure.

Uses: Moderate organic matter production and N-fixation (low in our study due to poor establishment); small flowers may provide some forage for bees.

Residue: Relatively quick to break down.

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