



## 2019 MSU Cover Crop Variety Test Report

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Cover crops have great value for improving soil and controlling weeds in many types of cropping systems. This variety test aims to provide information on suitability of cover crops in Michigan.

### Results

The test was planted in 2018 and concluded in 2019. Conditions before and after planting were overall dry, but a single good rain right after planting led to excellent establishment (**Table 1**). Winter had little snow and abnormally cold conditions in Jan, March, and April. Unusually cool temperatures and frequent rain in the spring delayed termination to approximately three weeks later than desirable, resulting in most ryegrass entries being taller than the recommended 8 inches at termination.

Entries are ranked by descending order of fall biomass in **Table 2**. Depending on goals for using a cover crop, other measurements may be of more value than biomass. High coefficient of variation (CV) values within seeding depth groups for most measurements other than biomass reflect the high degree of variation

among species. The greatest fall biomass was recorded for 'Pratext' black oats (2.71 ton/acre) and the least for 'Viper' balansa clover (0.54 ton/acre). However, Pratext winterkilled while Viper did not. Viper also provides nitrogen fixation, so it might be a feasible choice over Pratext even though absolute biomass production is less.

All the cool-season grass (CSG) entries at ¼-inch seeding depth were annual ryegrasses. Fall biomass averaged 1.24 (range 0.72 – 1.41) tons/acre and spring biomass averaged 0.72 (range 0.51 – 0.93) tons/acre. Fall biomass of 'Fria' and 'Lowboy' ryegrass was less than the other ryegrasses, but Lowboy had one of the greatest biomasses in spring. At 33 days after planting (9/17/18), ground cover averaged 69%. 'Marshall' (check) and 'Koga' exhibited more rapid ground cover than other ryegrasses, exceeding 80% ground cover within 30 days after planting. However, all ryegrasses had statistically similar ground cover percentages averaging 90% by 63 days after planting (10/18/18). Spring ground cover averaged 63%, where 'Koga' and 'Lowboy' had the greatest ground cover (81-82%) and 'Marshall' and 'Frostproof' (51-63%) had the least. In

general, termination was less effective for ryegrasses than other cover crops (average 88 versus 100 % kill, respectively) and Lowboy was more difficult to terminate than the other ryegrasses (48% kill vs. 95%).

Fall biomass of brassicas averaged 1.13 (range 1.02 – 1.66) tons/acre with ‘Barsica’ rape and ‘Control’ radish producing more biomass than other brassicas. Biomass measurement after frost probably missed peak biomass for collard, mustard and turnips because the canopies had already begun to die back as shown by ground cover data. Brassica ground cover 33 days after planting averaged 89%, with radishes generally having the fastest ground cover and rape the slowest. By 63 days after planting, brassicas had split into two groups—one which maintained ground cover averaging 86% (‘Tapper,’ ‘Ecotill,’ ‘CCS-779,’ and ‘Control’ radishes; ‘Barsica’ rape; and ‘T-Raptor’ turnip x rape hybrid) and one which decreased ground cover averaging 59% (‘Impact’ collard, ‘Master’ mustard, ‘Barkant’ turnip, and ‘Purple Top’ turnip check). ‘Impact’ collard was the only brassica entry with significant winter survival, producing 0.34 ton/acre and 36% ground cover in April, but it proved easy to terminate with 100% kill. Many brassica entries were notable in having negligible green ground cover in spring, which in a winterkilled cover crop indicates that there are not many weeds emerging.

Fall biomass of shallow-seeded (¼-inch) clovers was low (average 0.76, range 0.52 – 1.38 tons/acre). Spring biomass of overwintered clover averaged 0.46 (range 0.44 – 0.66) tons/acre. The crimson clover check had greatest biomass among entries in this group in both fall and spring. Crimson clover had the greatest ground cover 33 days after planting (average 30%, range 21-50%), and both crimson and berseem clovers had greater ground cover than balansa clover at 63 days (average 80%, range 69-96%). Berseem clover winterkilled as expected—all “green” spring ground cover for berseem was weeds. Overwintered crimson and balansa clover were easy to terminate. While overall weed pressure was low, low biomass of clovers was correlated with greater weed scores and weed percentage in biomass than other entries.

All the CSG entries at the ¾-inch seeding depth were oats. ‘Pratext’ black oats produced more fall biomass than the ‘Jerry’ oats check (2.71 versus 1.08 ton/acre)

and had greater ground cover both 33 and 63 days after planting. Moreover, ‘Pratext’ maintained ground cover from 33 to 63 days (79 and 82%, respectively), while ‘Jerry’ declined (from 67 to 49%). All oats winterkilled but had greater dead residue cover (0.55 – 1.32 tons/acre) in spring than most other entries.

Deep-seeded (¾ inch) legumes included hairy vetch and winter pea. Fall biomass averaged 1.03 (range 0.84 – 1.28) tons/acre with differences among entries. On average, hairy vetch had greater spring biomass (0.96 ton/acre) than Austrian winter pea (0.16 ton/acre). ‘AU Merit’ hairy vetch had less spring biomass than ‘Winter King’ and the VNS check, but spring ground cover of the three entries was comparable. These legumes were overall slow to cover ground at 33 days (average 47%, range 28 – 63%), but all exceeded 80% ground cover by 63 days after planting (average 90%, range 85 – 96%).

Performance of mixtures was dependent on the specific cover crop species included (**Table 3**). When evaluating mixtures, bear in mind that seeding proportion greatly affects results and is not necessarily constant among lots of seed. Always check seed tags to be sure the proportions and specific varieties are comparable to this test. Fall biomass of mixtures averaged 1.18 (range 0.91 – 1.52) tons/acre and spring biomass averaged 0.41 (0.03 – 1.00) tons/acre. Mixtures with greater spring biomass generally contained annual ryegrass or hairy vetch. Mixtures differed in speed of ground cover, averaging 77% cover at 33 days, and 81 % at 63 days.

Weed pressure was low across all plots, including the fallow check plots which received no weed control. Therefore, this particular test provides limited information regarding weed control potential of the entries.

## Methods

The test was conducted at the Kellogg Biological Station in Hickory Corners, MI, on a Kalamazoo loam. The test used four replications and two planting depths (¼ inch and ¾ inch) in a split plot arrangement. Plots measured 5 x 20 feet with a 7.5-inch row spacing. A fallow plot was included at each seeding depth to allow

weed control comparisons with fallow. Check plots were included within each cover crop type to allow a comparison with a typical cover within each type. Species entered included berseem and balansa clovers (check: 'Dixie' crimson clover), Austrian winter peas (check: VNS), hairy vetch (Check: VNS), annual ryegrass (check: 'Marshall'), brassicas (check: 'Purple Top' turnip), small grains (check: 'Jerry' oats), and mixtures (check: Jerry + Purple Top). Seeding rates for most entries were selected based on recommendations in the *Midwest Cover Crops Field Guide, 2<sup>nd</sup> Edition* (2014). Seeding rates for monocultures were: annual ryegrass 20 lb/acre, balansa clover 6 lb/acre, berseem clover 15 lb/acre, crimson clover and hairy vetch 20 lb/acre, Austrian winter pea 80 lb/acre, oats and black oats 32 lb/acre, radish 10 lb/acre, rape and turnip 3 lb/acre, and collard 8 lb/acre. Biofumigant mustard was seeded at 20 lb/acre and biofumigant radish at 25 lb/acre at the request of the participating marketer. Seeding rates and proportions for mixtures were determined by the participating marketer (Table 2). The test was planted November 15, 2018, into a disked field using a grain drill equipped with a cone planter. The prior crop was forage soybeans harvested as silage in July 2018. Thirty pounds per acre of starter N (urea) was incorporated preplanting. Ground cover and weeds were scored on Sept. 17 and Oct. 17, 2018, and biomass was measured on Nov. 8, 2018 after a killing frost. In spring 2019, winterkill, ground cover, weed scores, and biomass were measured on April 26. Plots were terminated on May 6, 2019, using a tank mix of Roundup PowerMax (1 qt/acre), Rifle (1.25 pt/acre dicamba + 2,4-D), Choice (2 qt/acre adjuvant), and LI-700 (1 qt/acre adjuvant). A final rating for percentage kill was obtained two weeks later, on May 21, 2019.

**Biomass Measurement.** Biomass is an indicator of vigor, growth potential, ability to capture carbon, and overall suitability for the region. Biomass above ground level was measured by hand clipping after a killing frost to indicate maximum potential growth in the first season. Biomass was measured again right before spring termination to give an indicator of spring biomass and weed control potential.

**Ground Cover and Winterkill Measurements.** Post-planting ground cover indicates speed of growth to cover the ground and provide protection from soil erosion. Pre-termination ground cover provides a

quantitative estimate of winterkill when used in conjunction with winterkill rating and spring weed proportion. Ground cover was estimated using the Canopeo app that measured the percentage of green pixels in photos taken approximately three feet above ground level from each plot. Cover was measured 33 (9/17/18) and 63 (10/18/18) days after planting, and again before spring termination.

**Weed Control Measurement.** Weed control is an important function of cover crops. Visual weed ratings were obtained approximately 30 and 60 days after planting, and before spring termination. Ratings are reported as an index comparing entries to fallow control plots with no cover crop. With this method, the fallow control is assigned an index value of 100. Cover crop plots that contain less weeds than the fallow control will have index values between 0 (no weeds) and 100 (the same mass of weeds as the fallow control). Index values greater than 100 are possible and indicate that cover crop plots contained more weeds than the fallow plot. In addition, a visual estimate of the proportion of weeds in the biomass at the two harvests is provided. Taken together, these two values provide a comparison of weed control potential among entries.

**Ease of Termination Measurement.** For cover crops that overwintered, ease of termination was visually rated as percentage kill of surviving cover crops and weeds two weeks after herbicide application. A rating of zero indicates no kill, while 100 indicates complete kill.

**Statistics.** Comparison of yields among varieties should only be made within a seeding depth. Under controlled conditions, statistical tests allow accurate separation of true genetic effects from random variation attributed to field or weather conditions. Least significant difference (LSD) is an indicator of statistical differences between entries. When the difference between two entries is greater than the LSD value for the seeding depth, the entries can be reliably declared different in this environment.

## About Functional Groups

Variety test entries are categorized by functional groups. Plant species within a functional group typically have similar physiological characteristics and can be managed similarly. For example, they may have similar requirements for preferred soil temperature at planting and provide similar ecosystem services. Details about specific cover crop species can be obtained from the online [Midwest Cover Crop Council – Cover Crop Decision Tool](#).

**Cool-Season Grasses** include the small grains and ryegrasses. These cover crops grow best in cooler weather with ample rainfall and are poor choices for mid-summer planting. Rye, triticale, and wheat will reliably survive Michigan winters and grow vigorously in spring. Winter survival of ryegrasses and barley is dependent on location within the state and variety. Oats will winterkill in Michigan.

**Warm-Season Grasses** include sorghum, sudangrass, sorghum-sudangrass hybrids, all millets, and teff. These grasses are drought tolerant and have high biomass potential under ideal conditions but require a warm soil at planting, hot conditions during growth, and are killed by frost.

**Legumes** include clovers, alfalfa, peas, vetches, and sunn hemp. These are broadleaf non-woody plants that can fix nitrogen from air and thus provide nitrogen inputs to a crop system. Legume species vary in preference for cool or warm growing conditions, and degree of frost tolerance. Frost tolerance may also vary by variety within a species.

**Non-Legume Broadleaves** include all the brassica species (radish, rape, turnip, collard, mustard, kale, camelina), buckwheat, flax, phacelia, and sunflower. These are broadleaf non-woody plants that do *not* fix nitrogen. Most cover crop forbs used in Michigan prefer cool growing conditions. Most will winterkill, except for rape and collard.

Table 1. Actual and 30-yr average (1981-2010) precipitation and average air temperature at Hickory Corners, MI.

Month	Actual precipitation (inches)	30-yr normal precipitation (inches)	Actual avg air temperature (°F)	30-yr normal avg air temperature (°F)
Aug 2018	4.38	4.03	68.8	71.8
Sept 2018	2.29	4.63	65.8	64.1
Oct 2018	4.06	3.64	50.4	52.6
Nov 2018	1.56	3.24	33.8	41.1
Dec 2018	1.27	2.70	31.8	29.4
Jan 2019	0.66	2.01	21.2	25.1
Feb 2019	1.19	1.87	27.0	27.8
Mar 2019	2.31	2.51	33.5	37.3
Apr 2020	3.40	3.49	48.6	49.7
May 2020	4.33	3.83	58.4	60.2
	<b>Sum 17.72</b>	<b>Sum 24.63</b>	<b>Avg 41.5</b>	<b>Avg 43.6</b>

**Table 2. Green and residue ground cover, weed index, cover crop and weed aboveground biomass, and herbicide kill percentage of cover crop varieties drilled at two seeding depths on 8/15/18 in Hickory Corners, Michigan.**

Variety	Group <sup>a</sup>	Species	Ground Cover (%)				Weed Index <sup>b</sup>			Biomass (ton DM/acre)				Kill (%) 5/21/19	Marketer
			9/17/18	10/18/18	4/26/19		9/17/18	10/18/18	4/26/19	11/9/18		4/26/19			
			green	green	green	residue				cover	weed	cover	weed		
<b>1/4 inch seeding depth</b>															
Marshall	CSG	annual ryegrass	89	88	54	63	16	1	1	1.41	0	0.74	0.01	96	Check <sup>c</sup>
McKinley	CSG	annual ryegrass	75	89	69	46	43	1	0	1.36	0.02	0.85	0	95	DLF
Koga	CSG	annual ryegrass	84	89	82	81	23	6	1	1.30	0.01	0.92	0	93	Smith Seed
Frost Proof	CSG	annual ryegrass	73	89	55	51	49	1	2	1.29	0.01	0.65	0	94	Smith Seed
Ribeye	CSG	annual ryegrass	63	91	61	78	53	3	0	1.26	0.01	0.62	0	96	Barenbrug
Fria	CSG	annual ryegrass	29	92	56	26	85	17	4	0.76	0.02	0.50	0.01	97	Allied
Lowboy	CSG	annual ryegrass	46	92	81	41	55	8	3	0.69	0.03	0.84	0.02	48	Smith Seed
Control	NLB	radish (fumigant)	96	84	0	6	5	1	2	1.66	0	0.01	0	100	Allied
Barsica	NLB	rape	80	91	9	7	26	1	2	1.49	0	0.04	0	100	Barenbrug
T-Raptor	NLB	turnip x rape	85	78	10	5	18	1	3	1.19	0	0.05	0	100	Barenbrug
Master	NLB	mustard (fumigant)	78	47	9	10	13	1	28	1.12	0	0	0.01	100	Allied
Impact	NLB	collards	89	65	36	5	6	1	1	1.09	0	0.35	0	100	Allied
Tapper	NLB	radish	97	85	0	4	5	1	1	1.08	0	0	0	100	DLF
Ecotill	NLB	radish	91	90	0	4	6	1	1	0.87	0.21	0	0	100	Allied
CCS-779	NLB	radish	96	86	0	5	6	1	1	1.02	0	0	0	100	Smith Seed
Barkant	NLB	turnip	92	64	1	5	5	1	2	0.99	0	0	0	100	Barenbrug
Purple Top	NLB	turnip	89	59	3	9	6	1	8	0.54	0	0	0.01	100	Check <sup>c</sup>
Dixie	Legume	crimson clover	50	96	64	13	30	4	5	1.35	0.03	0.62	0.04	100	Check <sup>c</sup>
CW9092	Legume	berseem clover	21	81	13	4	63	13	63	0.59	0.03	0	0.26	100	Barenbrug
Taipan	Legume	balansa clover	25	73	54	3	95	63	75	0.46	0.08	0.25	0.19	100	Smith Seed
Viper	Legume	balansa clover	24	69	53	5	95	98	78	0.35	0.16	0.25	0.23	100	Smith Seed
fallow	Fallow	fallow	17	43	21	4	100	100	100	0	0.47	0	0.31	100	Check <sup>c</sup>
<b>AVERAGE</b>			<b>68</b>	<b>78</b>	<b>33</b>	<b>22</b>	<b>37</b>	<b>15</b>	<b>18</b>	<b>0.99</b>	<b>0.05</b>	<b>0.30</b>	<b>0.05</b>	<b>96</b>	
<b>LSD</b>			<b>10***</b>	<b>17***</b>	<b>8***</b>	<b>14***</b>	<b>17***</b>	<b>19***</b>	<b>18***</b>	<b>0.34***</b>	<b>0.10***</b>	<b>0.15***</b>	<b>0.06***</b>	<b>5***</b>	
<b>CV</b>			<b>18.2</b>	<b>15.9</b>	<b>39.8</b>	<b>44.2</b>	<b>18.2</b>	<b>15.9</b>	<b>39.8</b>	<b>27.6</b>	<b>104.5</b>	<b>54.8</b>	<b>102.0</b>	<b>3.4</b>	
<b>3/4 inch seeding depth</b>															
Pratext	CSG	oats, black	79	82	4	68	49	1	2	2.59	0.00	0.00	0.00	100	Allied
Jerry	CSG	oats	67	49	6	16	63	1	8	1.07	0.01	0.00	0.01	100	Check <sup>c</sup>
WyoWinter	Legume	Austrian winter pea	49	85	27	9	83	7	20	0.81	0.03	0.15	0.07	100	Smith Seed
VNS	Legume	Austrian winter pea	63	91	21	14	65	13	8	1.01	0.02	0.08	0.03	100	Check
Winter King	Legume	hairy vetch	28	86	91	2	110	70	29	0.83	0.07	0.88	0.16	100	Smith Seed
VNS	Legume	hairy vetch	33	93	95	1	93	18	2	1.08	0.03	1.21	0.03	100	Check <sup>c</sup>
AU Merit	Legume	hairy vetch	60	96	52	24	90	16	7	1.27	0.01	0.55	0.04	100	Smith Seed
KBD3	Mix	mixture <sup>d</sup>	90	80	2	16	6	1	3	1.52	0.00	0.00	0.03	100	Byron/DSV
KBD5	Mix	mixture	63	93	39	30	95	1	5	1.34	0.00	0.30	0.02	100	Byron/DSV
KBD6	Mix	mixture	69	80	57	9	73	1	4	1.22	0.00	0.49	0.02	100	Byron/DSV
KBD2	Mix	mixture	85	75	2	9	5	1	3	1.16	0.00	0.00	0.00	100	Byron/DSV
KBD4	Mix	mixture	86	90	83	64	40	3	0	1.14	0.01	1.00	0.00	97	Byron/DSV
Turnip/oats	Mix	mixture	86	60	6	9	5	1	3	0.91	0.00	0.04	0.01	100	Check <sup>c</sup>
KBD1	Mix	mixture	62	90	91	2	88	8	5	0.91	0.01	0.89	0.05	100	Byron/DSV
fallow	Fallow	fallow	13	40	18	3	100	100	100	0.00	0.24	0.00	0.30	99	Check <sup>c</sup>
<b>AVERAGE</b>			<b>63</b>	<b>79</b>	<b>40</b>	<b>18</b>	<b>64</b>	<b>16</b>	<b>12</b>	<b>1.12</b>	<b>0.03</b>	<b>0.37</b>	<b>0.05</b>	<b>99</b>	
<b>LSD</b>			<b>12***</b>	<b>12***</b>	<b>7***</b>	<b>12***</b>	<b>21***</b>	<b>18***</b>	<b>12***</b>	<b>0.20***</b>	<b>0.03***</b>	<b>0.16***</b>	<b>0.05***</b>	<b>2***</b>	
<b>CV</b>			<b>19.6</b>	<b>13.7</b>	<b>30.0</b>	<b>40.8</b>	<b>27.7</b>	<b>58.3</b>	<b>89.7</b>	<b>15.5</b>	<b>100.5</b>	<b>37.1</b>	<b>115.7</b>	<b>0.2</b>	

<sup>a</sup>CSG=cool-season grass, NLB=non-legume broadleaf.

<sup>b</sup>Weed index is defined relative to fallow plots, where fallow is assigned a weed index of 100 and entries can rank higher or lower than fallow.

<sup>c</sup>One or two check varieties are included within each functional group/seeding depth combination.

<sup>d</sup>Mixture species and proportions are defined in Table 2.

\*\*\* Significant difference at P<0.001.



Table 3. Species components of experimental mixtures by seed weight percentage.

Species	Group*	Check	KBD1	KBD2	KBD3	KBD4	KBD5	KBD6	
Seeding rate (lb/acre)			35	20	25	45	25	20	
			----- % of mixed seed weight -----						
Italian ryegrass	CSG	-	-	-	-	50	-	-	
Oats	CSG	50	-	18	18	-	-	45	
Rye	CSG	-	-	-	-	-	30	-	
Sorghum	WSG	-	-	-	-	-	10	-	
Alsike clover	LEG	-	-	-	-	-	2	-	
Berseem clover	LEG	-	4	10	8	-	-	-	
Crimson clover	LEG	-	-	-	-	30	4	-	
Persian clover	LEG	-	1	4	-	-	2	-	
Common vetch	LEG	-	-	-	28	-	-	-	
Hairy vetch	LEG	-	39	-	-	20	30	-	
Field pea	LEG	-	49	-	30	-	16	-	
Brassica -Radish	FORB	-	-	15	-	-	1	6	
Brassica -Turnip	FORB	50	-	-	-	-	-	-	
Brassica-White mustard	FORB	-	-	-	-	-	-	6	
Brassica -Abyssinian mustard	FORB	-	-	2	-	-	-	4	
Buckwheat	FORB	-	-	14	-	-	-	18	
Flax	FORB	-	-	20	6	-	4	12	
Phacelia	FORB	-	4	5	10	-	-	7	
Sunflower	FORB	-	3	12	-	-	1	2	

\*CSG=cool-season grass, WSG=warm-season grass, LEG=legume.



Table 4. Seed marketer information.

Marketer	Phone	Web Address
Smith Seed Services	888-550-2930	<a href="http://www.smithseed.com">www.smithseed.com</a>
Byron Seeds	608-516-0101	<a href="http://www.byronseeds.com">www.byronseeds.com</a>
Barenbrug USA	800-547-4101	<a href="http://www.barusa.com">www.barusa.com</a>
DLF International Seeds	800-445-2251	<a href="http://www.dlfis.com">www.dlfis.com</a>
Allied Seed	866-325-6671	<a href="http://www.alliedseed.com">www.alliedseed.com</a>

For more information about MSU cover crop and forage variety testing, including entry applications for upcoming tests and an archive of past results, visit the variety test page at MSU Forage Connection, <https://forage.msu.edu/publications/>

## References and Other Resources

Kladivko, E.J., et al. 2014. *Midwest Cover Crops Field Guide, Second Edition*. The Education Store, Purdue University. ID-433.

*Midwest Cover Crop Council – Cover Crop Decision Tool*. 2020.  
<http://mccc.msu.edu/covercroptool/covercroptool.php>.

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