2020 RESEARCH REPORT

SAGINAW VALLEY

RESEARCH & EXTENSION CENTER

MICHIGAN STATE UNIVERSITY

AgBioRESEARCH

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SAGINAW VALLEY RESEARCH AND EXTENSION CENTER REPORT

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INTRODUCTION

The Michigan sugar beet grower cooperative, Michigan Sugar Company, and the Michigan dry bean growers and industry represented by the Michigan Bean Commission and Michigan Bean Shippers Association, donated the proceeds of the 120 acre Saginaw Valley Bean and Beet Research Farm, located in Saginaw County for 38 years, to Michigan State University in 2009. Michigan Wheat Program and Michigan Corn Marketing Program also are contributing partners. The Michigan State University Office of Land Management operates a 450 acre farm near Richville Michigan in Denmark Township and is established as an AgBioResearch research center. The Education Center was completed in 2016 and in 2020 was not available for meetings due to the COVID-19 pandemic. Severty-five acres of the 150 acres purchased, previously rented was farmed in the 2020 season. An additional 50 acres was purchased in 2019 and was also farmed in 2020. Bringing the SVREC total acres to 450. The additional land will be available for research in the 2022 season. The site is located on the southeast corner of Reese and Krueger Roads, address of 3775 South Reese Road, Frankenmuth, Michigan 48734.

Field research was initiated in 2009 and the 2020 season was the 12th season of research at the SVREC location. This research report is primarily a compilation of research conducted at the site in 2020. Most of the work represents one year's results, and even though multi-season results are included, **this work should be considered as a progress report.**

Soil – The soil type on the farm is classified as a Tappan-Londo loam, these are very similar soil types separated by subsoil drainage classifications, the Tappan not being as naturally well drained as the Londo. The site was soil tested in spring 2009 at 2.5 acre increments. The soil pH averages 7.9, soil test phosphorus averages 56 pounds P/acre, soil test potassium averages 294 pounds K/acre.

Weather – The monthly rainfall for 2020 collected with the automated rain gauge is provided in Table 1. The monthly totals are given at the bottom of the table. Rainfall was near average the whole year with June being slightly drier. Maximum and minimum daily temperatures are given in Table 3. The 2020 season was warm during the three summer months of June, July, and August with 14 days above 90 degrees and 45 days above 85 degrees. The growing degree days for 2020 was 2577, which was above average. The average yields for crops grown on the farm was: corn at 170 bushels/acre, soybean at 60 bushels/acre, wheat at 90 bushels/acre, dry beans at 28 cwt/acre, and sugarbeets at 28 tons/acre.

GROWING DEGREE DAYS - SAGINAW VALLEY RESEARCH FARM

Base 50 (max + min / 2 - 50)

	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	TOTAL
1984	67.50	164.50	506.00	558.50	627.00	282.00	114.50	**2320.00**
1985	183.50	306.00	388.00	603.50	523.00	394.50	100.00	**2498.50**
1986	124.50	310.00	435.00	664.00	459.50	370.00	96.50	**2459.50**
1987	84.00	336.50	566.50	725.50	537.50	334.00	19.50	**2603.50**
1988	35.50	290.50	544.50	739.50	667.50	283.00	48.00	**2608.50**
1989	21.50	202.00	456.50	648.00	535.00	315.00	167.00	**2345.00**
1990	165.50	146.00	493.50	587.50	553.50	332.50	100.50	**2379.00**
1991	144.00	423.50	541.00	641.00	567.50	289.50	114.00	**2720.50**
1992	56.00	241.50	367.00	446.50	403.50	257.50	41.50	**1813.50**
1993	23.50	208.00	430.00	642.00	613.50	184.50	25.00	**2126.50**
1994	95.50	227.50	526.50	613.50	501.50	380.00	115.00	**2459.50**
1995	3.00	221.00	536.00	698.50	745.00	225.00	125.50	**2554.00**
1996	41.00	157.00	486.00	572.00	611.00	357.50	91.50	**2316.00**
1997	27.00	48.00	534.00	596.50	443.00	299.50	134.50	**2082.50**
1998	46.00	267.00	505.50	623.50	648.00	456.00	114.00	**2660.00**
1999	49.50	299.00	578.50	684.50	500.00	339.00	67.50	**2518.00**
2000	17.00	284.00	474.50	509.50	544.50	289.00	157.00	**2275.50**
2001	78.00	289.50	504.00	649.50	654.00	282.00	114.00	**2571.00**
2002	123.00	141.50	535.00	710.00	575.00	443.00	99.00	**2626.50**
2003	66.50	147.50	410.00	606.00	608.00	312.50	82.00	**2232.50**
2004	89.00	240.50	429.50	561.00	450.50	421.50	69.00	**2261.00**
2005	58.00	145.00	623.00	647.50	611.50	429.00	130.00	**2644.00**
2006	79.00	283.50	470.50	661.00	555.50	260.00	38.50	**2348.00**
2007	53.50	277.00	534.00	564.00	594.00	393.00	231.00	**2646.50**
2008	110.00	116.50	512.00	620.00	532.50	343.00	56.50	**2290.50**
***2009**	50.50	190.00	432.00	458.50	517.50	345.00	27.00	**2020.50**
2010	89.00	368.50	528.50	729.00	697.50	311.50	95.00	**2819.00**
2011	38.00	273.00	515.00	758.50	576.50	308.50	122.50	**2592.00**
2012	28.00	341.00	555.50	756.00	552.00	295.00	109.50	**2637.00**
2013	45.50	347.50	483.50	617.00	516.00	288.00	131.50	**2429.00**
2014	45.50	271.50	536.00	488.00	525.00	285.00	74.00	**2225.00**
2015	18.00	306.00	444.50	577.00	546.50	342.00	90.50	**2324.50**
2016	37.50	274.00	509.00	688.50	680.00	430.50	189.50	**2809.00**
2017	99.50	227.50	546.00	609.50	506.00	411.50	204.50	**2604.50**
2018	14.50	417.00	509.50	664.00	649.50	422.00	115.00	**2791.50**
2019	37.00	172.50	438.00	691.00	538.50	415.50	79.00	**2371.50**
2020	24.50	253.50	560.00	750.00	628.5	305.50	55.00	**2577.00**
AVERAGE	**64.03**	**249.05**	**498.50**	**631.35**	**565.74**	**336.01**	**101.20**	2445.88

* Station moved to from Saginaw, MI to Richville, MI

MAXIMUM-MINIMUM AIR TEMPERATURES (F)
SAGINAW VALLEY RESEARCH & EXTENSION CENTER - 2020

	JANUARY		FEBRUARY		MARCH		APRIL		MAY		JUNE	
DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1	37	19	33	29	47	21	47	36	62	42	73	44
2	45	33	42	30	48	31	61	31	74	49	86	58
3	40	33	42	28	44	26	56	29	71	43	85	63
4	34	28	33	22	41	24	55	31	55	38	85	59
5	34	26	28	17	48	24	49	33	55	29	84	56
6	39	27	27	22	35	25	60	27	60	31	79	56
7	38	28	31	17	44	17	60	43	58	39	72	53
8	30	13	23	12	61	31	66	43	42	29	83	52
9	46	14	33	20	59	45	48	33	52	28	90	61
10	46	40	34	24	51	32	44	30	51	38	90	66
11	43	24	32	21	41	31	57	28	n/a	n/a	74	55
12	25	17	31	20	51	37	63	44	57	25	67	49
13	33	23	28	-4	49	31	56	32	61	24	64	44
14	36	30	17	-10	34	24	40	26	62	44	70	42
15	36	29	31	5	39	21	38	25	70	55	76	43
16	33	19	35	16	47	17	42	22	66	46	82	51
17	26	18	32	13	48	27	40	28	60	48	84	54
18	35	20	36	25	47	25	56	27	56	51	87	55
19	30	10	25	15	51	25	58	28	64	52	89	62
20	23	6	23	8	59	26	58	23	69	48	91	64
21	27	14	32	11	32	19	45	24	75	45	84	68
22	31	17	41	25	41	14	37	19	76	53	86	62
23	38	27	49	31	39	28	45	33	76	57	76	59
24	36	32	43	30	47	29	52	33	84	60	75	55
25	36	32	35	30	56	35	58	27	88	60	80	54
26	35	32	31	20	52	32	58	36	91	66	84	56
27	35	31	23	15	53	34	62	28	87	67	85	64
28	31	27	24	17	48	38	70	44	78	68	85	58
29	29	27	32	17	61	42	65	51	70	56	87	58
30	30	26			43	37	56	43	66	49	88	58
31	32	28			40	36			63	40		

MAXIMUM-MINIMUM AIR TEMPERATURES (F)
SAGINAW VALLEY RESEARCH & EXTENSION CENTER - 2020 cont.

	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
DAY	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1	87	58	80	56	79	62	59	43	49	30	36	26
2	93	60	74	63	80	57	54	37	46	29	44	27
3	95	67	76	62	84	55	53	40	60	32	39	31
4	89	65	69	58	73	50	51	41	72	46	43	33
5	92	58	74	51	73	50	58	34	67	48	34	21
6	94	64	79	50	72	44	67	47	70	45	31	26
7	93	68	81	53	76	55	68	42	72	50	35	20
8	91	67	82	56	58	52	67	38	75	47	36	18
9	95	71	89	67	63	53	76	37	77	54	40	29
10	82	68	89	71	60	54	74	47	74	61	49	23
11	85	62	83	60	68	47	63	41	61	32	42	28
12	78	61	86	56	74	48	70	43	52	28	42	30
13	81	59	87	57	70	55	66	40	44	31	32	27
14	83	58	86	57	64	46	66	40	45	24	32	20
15	88	65	86	63	71	43	64	40	54	36	26	18
16	77	66	80	62	77	54	53	30	40	30	30	17
17	85	63	82	58	64	44	53	33	33	28	30	18
18	90	64	76	52	58	37	53	38	44	23	35	25
19	82	67	75	48	64	32	51	35	62	38	35	29
20	83	65	84	54	68	37	50	35	62	36	36	30
21	80	61	85	60	71	40	55	44	45	30	38	32
22	85	66	87	58	75	47	55	43	36	30	35	31
23	78	59	87	63	80	48	71	41	43	23	50	33
24	80	54	90	62	78	55	46	33	35	18	50	22
25	86	57	87	65	80	48	48	35	43	34	24	19
26	91	67	83	62	80	58	42	37	44	40	27	21
27	87	63	85	70	77	63	38	36	43	33	38	25
28	86	61	78	67	64	50	51	34	44	28	39	25
29	84	64	77	60	63	46	44	35	49	33	28	19
30	78	58	74	53	62	46	37	32	40	28	36	24
31	80	56	79	53			49	25			30	17

MONTHLY PRECIPITATION, SAGINAW VALLEY RESEARCH FARM

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1990	1.23	1.21	1.17	1.54	2.81	2.07	2.53	6.94	3.74	5.87	4.51	1.45	**35.12**
1991	0.85	0.60	3.68	6.61	3.71	2.66	4.53	2.61	1.50	3.52	2.04	1.24	**31.58**
1992	1.20	1.65	1.31	4.56	1.10	2.10	4.33	2.92	4.08	2.54	4.50	2.10	**32.39**
1993	2.72	0.47	0.87	4.08	2.76	3.03	2.46	4.62	4.00	3.70	1.99	0.53	**31.23**
1994	0.55	0.66	0.91	3.58	2.04	6.99	2.57	4.44	2.19	2.24	4.40	1.03	**31.60**
1995	1.67	0.35	1.38	2.72	1.44	1.96	1.29	5.00	1.33	2.39	4.05	0.79	**24.37**
1996	0.83	0.94	0.49	3.18	5.47	5.65	2.32	1.53	3.52	3.31	1.37	2.21	**30.82**
1997	1.51	4.25	1.32	1.38	3.00	0.69	2.44	3.61	3.46	1.31	1.03	0.36	**24.36**
1998	2.66	2.05	3.17	2.14	1.87	1.56	1.02	2.01	1.41	3.18	1.79	1.32	**24.18**
1999	2.75	0.41	0.62	5.01	2.33	3.07	5.02	3.01	2.52	1.12	1.04	1.90	**28.80**
2000	0.57	1.35	0.89	2.94	5.34	2.65	3.03	3.69	3.27	0.90	2.07	1.57	**28.27**
2001	0.33	3.16	0.11	2.38	4.42	2.45	0.53	3.52	4.34	4.90	1.76	1.61	**29.51**
2002	1.02	1.49	2.47	3.49	4.46	3.15	3.00	4.50	0.50	1.87	1.19	0.97	**28.11**
2003	0.27	0.21	1.66	0.36	4.19	2.04	2.49	1.33	1.99	1.09	5.35	1.20	**22.18**
2004	1.09	0.55	2.50	1.31	7.34	2.70	2.01	2.32	0.66	2.41	3.44	1.51	**27.84**
2005	2.90	0.71	0.62	1.32	1.74	4.97	3.20	0.72	0.72	1.30	3.83	1.49	**23.52**
2006	1.91	1.57	1.59	1.87	4.17	2.03	5.72	2.61	2.53	3.77	3.05	2.81	**33.63**
2007	1.11	0.35	1.27	3.02	2..20	1.06	2.59	4.80	2.64	2.86	0.89	1.93	**22.52**
2008	1.76	2.59	1.23	1.99	1.13	3.88	3.94	2.10	5.61	1.70	1.36	1.21	**28.50**
***2009**	0.01	2.12	1.84	4.69	1.23	4.81	2.73	3.48	0.82	3.61	0.47	1.88	**27.69**
2010	0.14	0.20	0.40	2.15	3.36	2.71	0.89	1.27	3.11	1.94	1.97	0.42	**18.56**
2011	0.48	0.24	1.82	4.96	3.86	1.51	1.34	2.98	2.28	2.85	2.74	1.42	**26.48**
2012	1.86	0.76	1.41	1.19	3.92	1.10	3.62	4.03	1.60	4.29	0.38	1.41	**25.57**
2013	2.77	0.84	0.36	7.38	3.43	1.73	2.03	1.85	0.58	3.26	2.34	0.74	**27.31**
2014	0.47	0.55	0.92	3.99	3.06	2.74	4.17	3.90	3.03	2.10	2.07	1.49	**28.49**
2015	0.59	0.08	0.56	1.97	2.86	2.68	2.20	3.94	2.62	1.96	1.26	2.04	**22.76**
2016	0.94	0.73	4.09	1.30	1.59	1.51	3.47	5.15	2.03	2.11	2.14	0.81	**25.87**
2017	2.80	1.98	1.90	5.79	1.97	4.83	1.10	2.26	1.54	3.52	2.08	0.33	**30.10**
2018	0.71	1.96	0.54	2.82	2.14	1.47	1.98	7.90	1.92	2.65	1.27	2.17	**27.53**
2019	0.61	0.92	1.33	2.27	5.02	6.97	2.37	1.06	3.78	6.29	1.41	2.03	**34.06**
2020	2.30	0.32	2.07	2.08	3.75	1.35	3.24	3.36	2.75	2.37	1.50	1.84	**26.93**
AVG.	**1.22**	**1.10**	**1.33**	**2.89**	**2.80**	**2.57**	**2.53**	**3.19**	**2.24**	**2.52**	**2.14**	**1.29**	**25.83**

**Station moved from Saginaw, MI to Richville, MI*

PRECIPITATION - SAGINAW VALLEY RESEARCH & EXTENSION CENTER- 2020

Day:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		0.05		0.02		0.03			0.10	0.22	0.17	
2								1.87	0.18			
3			0.01			0.10		0.05		0.06		
4				0.02				0.25		0.21		
5	0.03											
6			0.05						0.03			
7		0.05		0.60					0.15	0.09		
8				0.07					0.68			
9		0.01	0.09	0.11		1.03	0.08		0.62			
10		0.04	0.27			0.09	1.29	0.01	0.03		0.05	
11	1.42		0.01				0.10				0.13	0.02
12	0.09									0.28		1.25
13	0.16		0.01	0.05					0.22		0.06	
14	0.01				0.53						0.02	
15					0.52			0.10			0.48	
16							0.39	0.04		0.09		
17					0.45					0.02		
18	0.16	0.17			1.09					0.15		
19			0.20		0.11		0.77					
20			0.08	0.02						0.12		
21				0.04						0.22		0.10
22									0.01	0.43	0.08	
23			0.10			0.01				0.32		
24	0.34				0.09						0.16	0.05
25	0.09			0.01	0.02						0.32	
26						0.04		0.60			0.01	
27				0.02	0.02	0.05	0.22	0.11		0.08		0.09
28			0.61	0.17	0.22		0.25	0.32	0.43			0.13
29			0.58	0.63	0.70		0.14	0.01				
30			0.01	0.32					0.30	0.08	0.02	0.20
31			0.05									
TOTAL	**2.30**	**0.32**	**2.07**	**2.08**	**3.75**	**1.35**	**3.24**	**3.36**	**2.75**	**2.37**	**1.50**	**1.84**

Rainfall is measured in inches

2020 YEAR END TOTAL - 26.93 INCHES

2020 Seedless Pickling Cucumber Variety Trial

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A pickling cucumber variety trial was planted at the Saginaw Valley Research and Extension Center (43.399097, -83.694497, Frankenmuth, Michigan). Bejo (BJ), Nunhems (NU), and Rijk Zwaan (RZ) seed companies donated parthenocarpic (seedless) varieties for mechanical once-over harvest.

Materials and Methods

On 15 June 2020, 15 parthenocarpic pickling cucumber varieties were planted in a completely randomized block design with four replications. Seeds were pre-counted and distributed into four rows by a cone planter. Rows were 20 ft long, 20 inches on-center, with 10 inch in-row spacing targeting 30,000 seeds per acre. The soil type was a Tappan-Londo loam with a poor-moderate drainage class, typical of the pickling cucumber-growing region of Michigan's Saginaw Valley.

On 30 March 150 pounds 46-0-0 was preplant incorporated, resulting in ~70 lb N per acre. On 16 June, Curbit (ethalfluralin) and Command (clomazone) preemergent herbicide was applied at 2 pints per acre and 1 pint per acre, respectively. On 29 June, all plots were thinned to 29,000 plants per acre. On 15 July, Ranman (cyazofamid) and Bravo (chlorothalonil) were applied at 2.5 fl. oz. per acre and 1 pint per acre, respectively.

Four reps of all cultivars were harvested and measured between 26 July - 3 Aug (day 42-47). We harvested 29 plants from the middle two rows of the four-row plots when the fruits began reaching advanced sizes consistently across all replications. All fruit were removed from the plants and sent through a sorter that separated and weighed them by the following sizes: 2As (1 ¹⁄₁₆" – 1 ¼"), 2Bs (1 ¼" – 1 ½"), 3As (1 ½" – 1 ¾"), 3Bs (1 ¾" - 2"), and 4s (> 2" in diameter). L:D ratios, hollow center and monkeyface percentages were measured from ten cucumbers per size class, subsampled from a combination of all replications of a variety. Hollow centers were counted if a hole larger than ¹⁄₁₆" could be seen in the center of the seed cavity. A monkeyface was counted if holes larger than ¹⁄₁₆" could be seen along the outside of the seed cavity. Fruit per plant, bushels per acre of each size class and combined total bushel per acre yield calculations do not include culls. With a 29,000 plant per acre population, we multiplied the measured yields from 29 plants by 1,000 to obtain a per-acre estimate.

Results and Discussion

The season was characterized by dry spells, but the plots received two well-timed rains in weeks 4 and 5. Heavy rains in the last week of the trial resulted in muddy harvest conditions (Table 3). Half of the Rijk Zwaan varieties (RZ07, RZ10, RZ17, RZ19, RZ22), and the two Nunhems varieties, were harvested by day 43. But the latest varieties – Aristan, Gershwin, and RZ21 – were harvested on day 47 (Table 2).

The top five varieties with the highest combined yields of 2B and 3A fruit were RZ06, RZ16, RZ22, V5025, and Aristan (Table 1). Of those, RZ16 and V 5025 had L:D ratios closest to the desired 3.0 in the 3A size class. The top five varieties with the highest combined yields of 3A and 3B were Aristan, RZ22, RZ06, RZ10, and RZ16. Of these, RZ16 had the L:D ratios closest to 3.0 in both size classes. Cull rates were between 0% and 20%. The five varieties with the lowest cull percentages were RZ07, V5025, Amarok, RZ10, and RZ19. The five varieties with the highest cull percentages were Gershwin, RZ21, RZ04, RZ06, and Absolut.

The five varieties with the best brine recovery rates were Absolut, Aristan, RZ21, RZ04, and RZ16 (Table 2). The five varieties with the lowest brine recovery rates were RZ19, RZ22, V5025, V5031, and Gershwin. Nine of the varieties had large seed pips, but their presence was not associated with brine recovery rates. The varieties with large seed pips were Absolut, Amarok, RZ06, RZ07, RZ16, RZ17, RZ21, RZ22, and V5031.

Table 1. Yield data of 15 seedless picking cucumber varieties at the Saginaw Valley Research and Extension Center in 2020. Values in bold indicate the variety performed statistically similar to the variety with the highest value for that column. Plant population was 29,000 plants per acre.

Company and Variety	Bushels Per Acre							Fruit per plant
	Total	4	3B	3A	2B	2A	Cull	
BJ Aristan	434.2	37.4	157.1	**140.9**	79.9	18.9	**22.1**	2.7
RZ 06	391.8	2.4	92.0	**163.1**	97.6	36.7	**33.9**	2.8
RZ 16	387.7	13.0	88.6	**147.1**	110.6	28.2	**25.3**	2.7
RZ 22	383.3	13.2	114.8	**141.9**	94.9	18.5	8.6	2.7
BJ Amarok	377.3	48.5	113.9	**103.4**	83.1	28.4	6.1	2.6
RZ 10	352.4	23.8	121.1	**114.7**	78.0	14.8	5.8	2.3
NU V5025	337.8	4.6	74.1	**133.7**	97.8	27.6	4.5	2.6
RZ 17	322.6	16.1	138.0	99.2	54.8	14.5	13.3	1.9
BJ Absolut	288.3	19.9	56.8	89.2	83.3	39.1	**22.2**	2.2
RZ 19	287.8	33.6	107.6	77.8	47.0	21.7	4.8	1.8
RZ 07	282.4	11.6	44.6	**113.2**	82.3	30.6	0.0	2.2
RZ 21	280.9	31.6	37.4	56.0	99.4	**56.4**	**48.0**	2.3
NU V5031	275.4	2.3	45.0	**104.1**	93.4	30.7	13.5	2.6
RZ Gershwin	258.2	20.4	40.2	69.7	82.5	**45.3**	**51.6**	2.0
RZ 04	234.8	21.8	42.7	48.8	70.7	**50.8**	**30.6**	1.8
MSerror	10601.3	460.2	3467.2	1841.5	779.5	126.6	104.5	0.4
Df	42	42	42	42	42	42	42	42
Mean	326.3	20.0	84.9	106.9	83.7	30.8	19.4	2.3
CV	31.6	107.1	69.3	40.2	33.4	36.5	52.8	26.0
t.value	2.018	2.018	2.018	2.018	2.018	2.018	2.018	2.018
LSD	NS	NS	NS	61.2	NS	16.1	14.6	NS
p-value	0.238	0.136	0.072	0.009	0.169	<0.001	<0.001	0.232

Table 2. Quality data of 15 seedless picking cucumber varieties planted at the Saginaw Valley Research and Extension Center in 2020. Values are averaged across four replicates. No statistics were performed on quality data. Plant population was 29,000 plants per acre.

Company and Variety	L:D Ratios		%Hollow	%Monkey face	%Cull	Days after planting	% Recovery
	3B	3A					
BJ Aristan	2.4	2.4	0.0	0.0	5.1	47	99.0
RZ 06	2.6	2.5	0.0	0.0	8.6	46	88.0
RZ 16	2.6	2.9	0.0	0.0	6.5	45	94.0
RZ 22	2.6	2.8	0.0	0.0	2.2	42	73.0
BJ Amarok	2.4	2.5	0.0	0.0	1.6	45	89.0
RZ 10	2.8	2.6	0.0	0.0	1.6	42	91.0
NU V5025	2.6	2.9	0.0	0.0	1.3	43	74.0
RZ 17	2.7	3.0	0.0	0.0	4.1	42	94.0
BJ Absolut	2.5	2.9	0.0	10.0	7.7	46	99.0
RZ 19	2.7	3.0	0.0	0.0	1.7	43	60.0
RZ 07	2.5	2.7	0.0	0.0	0.0	42	86.0
RZ 21	2.7	2.9	0.0	0.0	17.1	47	98.0
NU V5031	2.5	2.9	0.0	0.0	4.9	43	76.0
RZ Gershwin	3.0	2.9	0.0	0.0	20.0	47	79.0
RZ 04	2.5	2.7	0.0	0.0	13.0	46	97.0
Mean	2.6	2.8	0.0	0.7	6.4	44	86.5
StDev	0.2	0.2	0.0	2.6	6.0	2.0	11.7
CV	6.06	6.14	NA	387.3	94.7	4.6	13.5

Table 3. Weather data summarized by weeks between 15 June and 3 Aug at the Saginaw Valley Research and Extension Center in 2020. Temperatures were averaged by week, and precipitation is total number of inches received for that week.

Week	Max Air Temp (F)	Min Air Temp (F)	Max Soil Temp (F)	Min Soil Temp (F)	Precipitation (inches)
1	85.1	57.1	71.5	67.1	0.0
2	82.1	58.6	72.2	68.7	0.1
3	90.7	60.9	77.8	72.9	0.0
4	88.8	66.4	78.9	75.2	1.5
5	84.3	63.6	78.0	74.0	1.2
6	83.8	61.7	78.5	74.0	0.0
7	81.7	60.5	78.2	73.9	2.5
8	76.6	62.2	74.7	70.9	0.1
Mean	84.2	61.4	76.2	72.1	0.7
StDev	4.4	2.9	3.0	2.9	0.9
CV	5.2	4.7	3.9	4.0	143.3

Acknowledgements
Thanks to Kristin Oomen, Ken McCammon, Chris Dyk, Robert Grohs, and George Pape at the seed companies; Paul Horny, and Dennis Fleischmann at the farm; Dave Brewer, Aaron, Joel, Tony, Todd, Mike, and others at Hausbeck's Pickle Company; and Pickle Packers International.

2019 MI Craft Beverage Council Final Report
Proposal Title: Variety Selection and Agronomy Practices for Soft Winter Wheat Malting
(grant# 190000002128)

Principle Investigator: Dennis Pennington (MSU Wheat Extension Specialist)
Collaborators: Dr. Eric Olson (MSU Wheat Breeder), Vince Coonce (Independent Barley and Malt), Dave Dyson (The Andersons, Inc)

Abstract: Craft brewing is a large and growing economic sector in Michigan, but the malting industry is held back by lack of a local supply of quality raw grains. Wheat beers already comprise an appreciable segment of craft beer production in Michigan and the U.S. Demand for wheat beer products is growing. Often grains with the best malting characteristics have the lowest yield potential for farmers, creating a dichotomy between maltsters and farmers. The goal of the project is to identify wheat varieties and agronomic production practices that provide acceptable quality to maltsters and high yield potential for farmers. Four wheat varieties were selected based on previous grain quality responses and planted in a split plot design with six fertility treatments (3 nitrogen plus 2 potassium). Yield, moisture and test weight data was collected at harvest. Subsamples were sent to the Center for Craft Food and Beverage Center at Hartwick College for pilot malting and full malt analysis.

Materials and Methods: Dave Dyson provided input on fertility treatments with the goal of producing the highest grain yield, while keeping protein content low. Twelve varieties from the 2019 MSU Wheat Performance Trials were pilot malted by Vince Coonce. Data from the pilot malt was used to select four varieties to include in the trial (6771 EXP, Kokosing, W 304 and Dyna-Gro 9362W). Small plots (5 foot x 12 foot) were planted at the Saginaw Valley Research and Extension Center near Frankenmuth, MI. Plots were planted with an Almaco HD grain drill equipped with a packet planter. Plots were arranged in a split plot design with fertilizer rate as the main factor and variety as the sub factor. Main factor treatments include 3 nitrogen rates (0, 40, 80 lbs. per acre) plus 2 potassium rates (0, 60 lbs. per acre). Sub factor treatments include the 4 varieties selected from the preliminary screen.
Treatments (rates are pounds of actual nutrient per acre):

1. 0 nitrogen, 0 potassium (control)
2. 40 lbs. nitrogen, 0 potassium
3. 80 lbs. nitrogen, 0 potassium
4. 40 lbs. nitrogen, 60 potassium
5. 80 lbs. nitrogen, 60 lbs. potassium
6. 0 lbs. nitrogen, 60 lbs. potassium

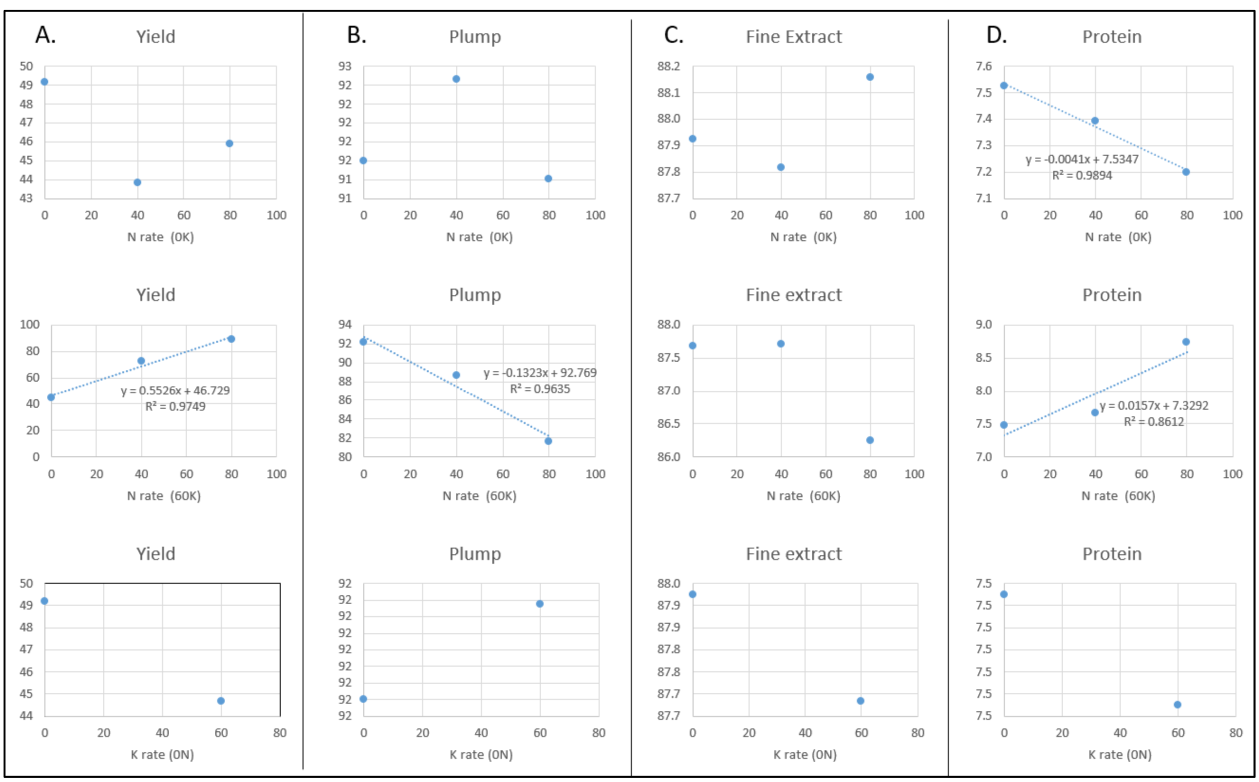
Plots were seeded at 2 million seeds per acre. Affinity broadspec (0.8 oz/a) was applied for weed control. Prosaro fungicide (8 oz/a) was applied at Feekes 10.5.1 (flowering) to control fusarium head blight. Plots were harvested by a Wintersteiger Quantum research combine equipped with an H2 HarvestMaster system to obtain yield, moisture and test weight. All plots were bagged and subsampled. Subsamples from each replication was submitted to Hartwick College Center for Craft Food & Beverage lab for full malt analysis including moisture, assortment, friability, fine extract, coarse extract, f/c difference, β-glucan, fan, soluble protein, s/t, dp, α-amylase, color, pH, filtration time, clarity, DON and protein. Statistical analysis of the data was conducted by the PI using SAS 9.4 Proc Mixed.

Results and Discussion: Farmers will be most interested in the yield response to treatment while maltsters will be more interested in malt quality parameters. Yield, plump, fine extract and grain protein are reported here. Germination, color, ßeta glucan, soluble protein, Kolbach index, FAN, diastatic power, alpha amylase, filtration time and clarity data is available, but not reported here. It is recommended not to draw conclusions from this data as this represents just one year of field trials. Year 2 of this project has been planted and will be harvested in July 2021. When drawing conclusions about what practices to use when growing winter wheat for malting purposes data from more than one year should be considered. This data should be considered to be preliminary.

Data from Figure 1 shows that there was no significant yield response to nitrogen when no potassium fertilizer was added (panel A, top chart). However, the highest yields (reported in bushels per acre) were achieved when potassium was applied at a rate of 60 pounds per acre and the yield response to nitrogen (panel A, middle chart) showed a strong positive linear relationship (r^2=0.9749). In the absence of nitrogen, yield response to potassium was not significant (panel A, bottom chart).

Plump is a measure of kernel size and is the proportion of seed that will not pass through a 6/64 screen. In barley, larger kernel size is strongly correlated with higher extract yield meaning more beer can be made from the same number of kernels. It is desirable to maximize the plump. Here we tested the effect of fertility treatments on plump. In the absence of potassium, plump was not significantly impacted by nitrogen rate (panel B, top chart). In the presence of 60 pounds of potassium per acre (panel B, middle chart), there was a strong negative relationship between plump and nitrogen rate (r2=0.9635). In the absence of nitrogen, plump was not significantly effected by potassium rate (panel B, bottom chart).

Figure 1. Data from year 1 of malting wheat project. Each panel contains a chart showing the response of yield (A), plump (B), fine extract (C) and protein (D) for three different fertility treatments. The top chart is the response to nitrogen in absence of potassium (0K), middle chart is the nitrogen response in the presence of potassium (60 pounds K/a) and the bottom chart is the response to potassium in the absence of nitrogen. Trend lines are displayed where the response was significant at α=0.05.

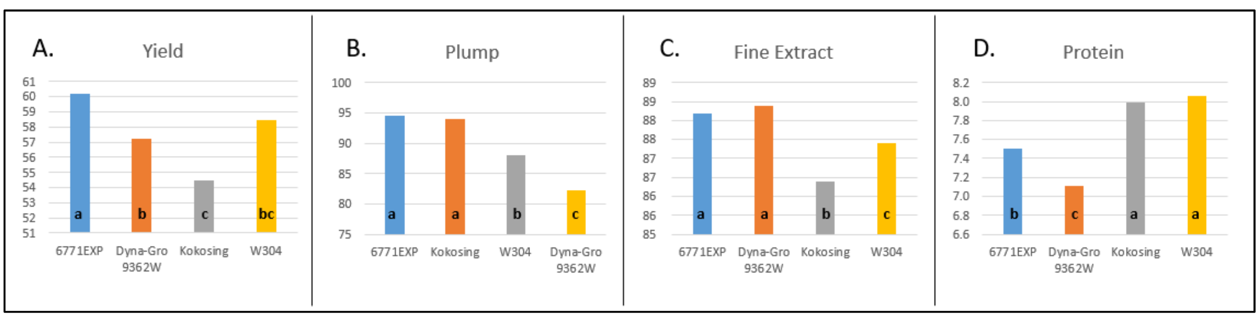


Surprisingly, fine extract was not significantly effected by nitrogen or potassium in any of the comparisons (panel C). This suggests that fine extract is related to some other aspect of production, such as variety. This can be seen in Figure 2, chart C where two varieties (6771EXP and Dyna-Gro 9362W) has significantly higher fine extract compared to Kokosing and W304 varieties.

Total protein Figure 1, panel D showed an interesting and unexpected response to nitrogen and potassium. In setting up this trial, it was discussed with collaborators that in order to grow high yielding wheat with low protein, we need to manage nitrogen very carefully. It is well known that wheat yields increase with nitrogen fertilizer, but so does total grain protein content. In the plant, potassium is involved in protein synthesis. Higher potassium levels generally relate to higher protein synthesis. In this trial, protein response to nitrogen and potassium was mixed. In the presence of potassium (panel D, middle chart) protein increased with nitrogen as expected (r^2=0.8612). However, in the absence of potassium (panel D, top chart) protein level was inversely proportional to nitrogen rate (r2=0.9894). While it makes sense that in the absence of potassium, there would be lower protein production, it was not expected that increasing nitrogen rates would decrease protein. In this case, data from year 2 will be important to verify if this relationship is in fact real or circumstantial.

As expected, there was a significant variety response to yield, plump, fine extract and protein (see Figure 2). Variety 6771EXP has higher grain yield, plump and fine extract and lower protein. These characteristics make this variety a good fit for farmers due to good yield and malsters due to high fine extract yield. In this trial, only 4 varieties have been evaluated. It is recommended that future research evaluate a wider range of varieties. About 115 varieties are tested each year in the MSU Wheat Performance Trial program. There could be additional varieties available that meet farmer and maltster needs.

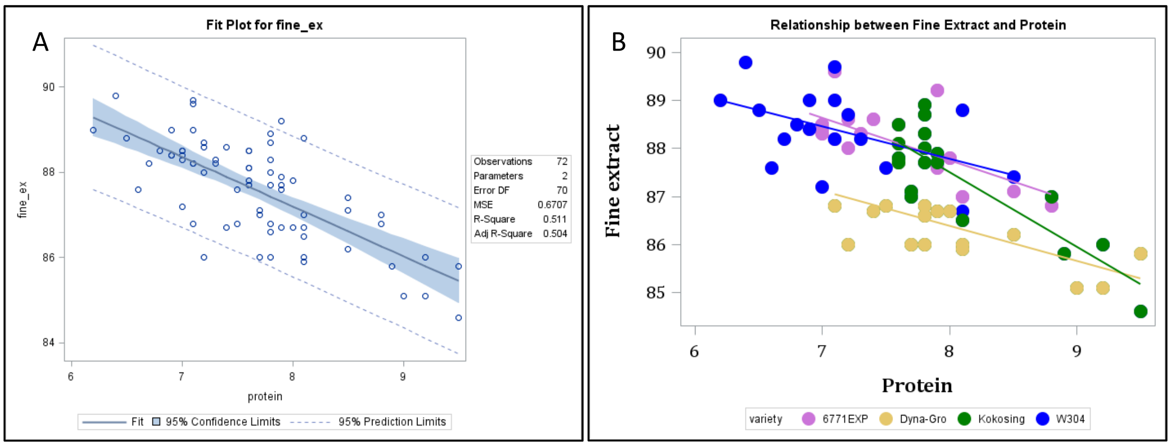
Figure 2. Variety response to yield (A), plump (B), fine extract (C) and protein (D).



One of the objectives of this work is to find out what malting characteristics are most important and which ones can be used as predictors for malt quality. Conducting the full malting and lab analysis is prohibitively expensive if we want to expand testing to include additional fertility and variety evaluations for malting quality. For barley, there have been many associations quantified and verified for grain yield and malting quality. This work is lacking for wheat and other small grains that are being increasingly considered to make unique, craft beverages. In this study, protein was evaluated to determine if its relationship with fine extract could be used to reliably predict malt quality. Assessing grain protein is relatively cheap compared to malting. This would allow many more comparisons to be made at lower cost.

There appears to be a weak relationship (r^2=0.511) between protein and fine extract across all treatments and varieties (Figure 3A). When looking at the same relationship for each variety, there are slight differences in the magnitude of the relationship (slope of each line) in Figure 3B. Variety 'W304' has the largest amount of variation and lowest relationship. This is just preliminary data as year 2 of the project is under way. Multi-year data is important to determine how different weather (growing seasons) will impact this relationship.

Figure 3. Relationship between kernel protein and fine extract in soft winter wheat.



Finally, the last objective of this study was to look at the profitability of different fertilizer treatments in terms of income potential for farmers, while delivering a product that meets the needs of maltsters. Partial budget analysis is a tool that looks at the income and expense items only for the variables included in the trial. It assumes all other expense items are the same across treatments. Results from this analysis for the '19-'20 crop year are listed in Figure 4. Data for Yield, Plump, Fine extract and Protein are reported in columns along with the calculated Income and Expense. Income is calculated as yield x $5.54/bushel (MAC Brown City, 11/13/20). Expense is calculated as (N rate x $0.41)+(K rate x $0.30). These fertilizer prices were based on a price of $375 per ton for urea and $365 per ton for potash. The Partial Budget column is calculated as Income – Expense.

Figure 4. Partial budget analysis showing the income potential of each treatment.

Trt	N rate	K rate	Yield	Plump	Fine extract	Protein	Income	Expense	Partial Budget	Diff from Max ($)	Diff from Max ($/bu)
1	0	0	49.2	91.6	87.9	7.5	$272.50	$0.00	$272.50	-$169.40	-$3.44
2	40	0	43.8	92.5	87.8	7.4	$242.85	$16.30	$226.55	-$215.35	-$4.91
3	80	0	45.9	91.4	88.2	7.2	$254.43	$32.61	$221.82	-$220.08	-$4.79
6	0	60	44.7	92.2	87.7	7.5	$247.54	$17.95	$229.59	-$212.31	-$4.75
4	40	60	72.9	88.7	87.7	7.7	$404.02	$34.26	$369.77	-$72.13	-$0.99
5	80	60	88.9	81.6	86.3	8.7	$492.46	$50.56	$441.90	$0.00	$0.00

Farmers would select the treatment that has the highest partial budget number, in this case - treatment 5 at $441.90. This treatment also produces the lowest plump, fine extract and highest protein – all of which are opposite of what a malster is looking for. If a malt company wanted to contract with a farmer to grow wheat and specify a lower fertility program, that could be done with a contract that provides market price plus a premium to offset the lower income potential. The difference from the max (last column) would be the amount of premium needed by the farmer to offset the lower income potential. Discussion of this data with malsters is needed to help determine what is fair and equitable to both parties. Again, another year of data is needed to help verify this relationship and increase confidence in the actual values.

Title: Maximizing Yield Potential in Winter Wheat through Precision Planting and Agronomic Management

MWP Tracking Number: 17-03-07-DS

Researchers:
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Date: December 31, 2020

Project goals and value for Michigan Wheat Growers

Uniform spatial distribution of plants resulting from precise placement of seed can lead to improved resource use efficiency and plant health by equally sharing plant growth resources such as water, nutrients, and sunlight. Reducing plant-to-plant competition may lead to decreased input costs and increased yield potential. Farmers are trying to utilize the precision planting technology that they already have for small grains. This project will help them determine the optimum configuration for their planter and/or if they need to invest in other planter technology. This project has helped wheat growers understand the importance of accuracy in placing seed at uniform depth and spacing. Interest in evaluation of planting technology has spurred further interest in seed placement technology and has resulted in a new project evaluating high-speed broadcast incorporation of wheat seed.

Results of Project

The results conveyed below are high level outcomes from this project. A great deal of data and analysis is being conducted, which will yield two peer reviewed scientific journal articles as well as a couple of Extension fact sheets. These reports and outcomes are forthcoming and expected to be completed before wheat harvest 2021. Data reported below are a combination of four site years of data from the Saginaw Valley Research and Extension Center (SVREC) and Mason Research Farms in 2019 and 2020. Data was analyzed in SAS software using α=0.10, meaning 90% confidence level. All four site-years were pooled for this report for simplicity, although year had a significant interaction with treatments. We will refer to this interaction where important in results.

Both locations and both years received the same applications as the high management protocol used in the variety trials. This included 90 pounds of nitrogen applied at greenup followed by a second application of 30 pounds of nitrogen just prior to stem elongation. At greenup, ammonium sulfate was added to provide 20 pounds of sulfur per acre. Two fungicide applications were made at Feekes 9 (flag) and 10.5.1 (flowering).

The first objective of this project is to evaluate Precision Planting (PP) and conventional drill (Drill) technologies. Data collection included stand counts, yield, deoxynivalenol (DON) and yield components.

Table 1. Research results for Precision Planter and Drill comparison trials.

	Yield (bu/a)	Stand/acre	Heads/ft2	Seeds/head	TKW	DON*
7.5''PP	101.1 A	732,744 B	76.1 A	29.7 A	29.1 A	1.8 A
7.5''Drill	96.7 B	852,822 A	72.5 A	28.9 A	28.8 A	2.8 B

*Data for DON is from Mason in 2019 only. Samples from 2020 harvest are still being analyzed.

In 2019, PP outperformed the drill by 11.5 bushels, but was lower (though not statistically) in 2020 by 3.2 bushels. While there was variability in the results, the PP outperformed the drill by 4.4 bushels per acre across all four site years. Yield components are reported in the table but for this comparison, none are statistically significant. Grain samples at harvest were sent to the University of Minnesota DON Testing Lab for analysis. PP had lower DON levels by 1 ppm or 35%. We believe this is due to more uniform emergence and crop development (see objective 2 below) leading to improved efficacy of fungicide application in controlling fusarium head blight. Results from 2nd year will be analyzed once DON data is available.

The second objective of this study was to compare the seed placement accuracy of PP and conventional drill technology in terms of seed-to-seed spacing within a row and seed depth placement. Seed to seed spacing was measured by laying a ruler down in two rows and marking where each emerged plant was. The space between each plant can then be obtained. Ideally, the spacing between each plant would be identical if all seeds were precisely spaced. Coefficient of Variation (CV) is a statistical measure of how much variability there is. The lower the CV, the lower the amount of variability in plant-to-plant spacing. Planting depth was also measured in each plot each year.

Figure 1. Plant to plant coefficient of variation.

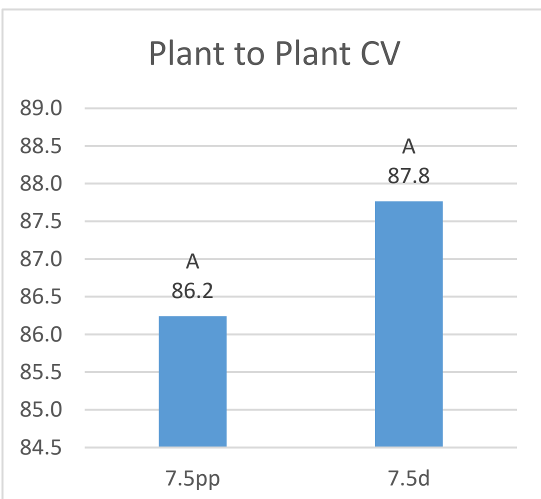
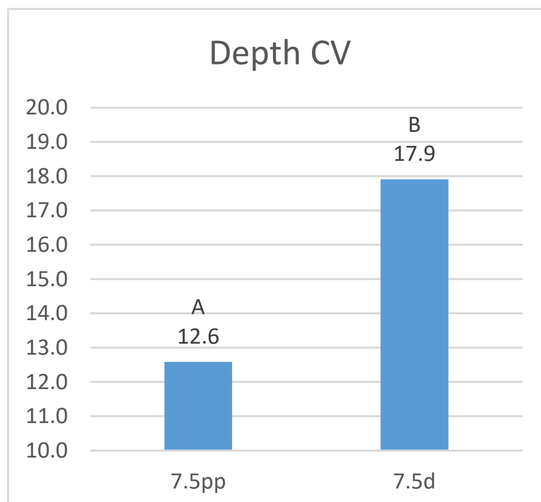


Figure 2. Planting depth coefficient of variation.



Here, we found the PP provided greater consistency in plant to plant spacing (Figure 1), although not statistically significant. Compared to a drill, PP had less variability in planting depth with a depth CV of 12.6 (29% lower than the drill). For high yield, farmers should manage their wheat crop to develop 4-5 tillers per plant and maintain them over the summer. Stress factors such as temperature, water, nutrient deficiency, disease and insect damage reduce the number of tillers that successfully produce harvestable heads. In this study, tiller were counted from 10 randomly harvested plants multiple times over the summer to understand tiller development and survival. From May 8 to July 14, both PP and drill plots suffered tiller mortality. The highest degree of variability in tiller numbers per plant occurred on July 14.

There was also a significant seeding rate effect on final tiller numbers. As expected, lower seeding rates allowed plants to produce and maintain more tillers per plant. In this study, 1.0 million seeds per acre produced the optimum number of tillers. The first five are primary tillers, meaning they produce their own root system. Tiller six and above are secondary, meaning they do not produce roots requiring them to obtain water and nutrients from the main stem.

Figure 3. Tillers per plant for PP and Drill.

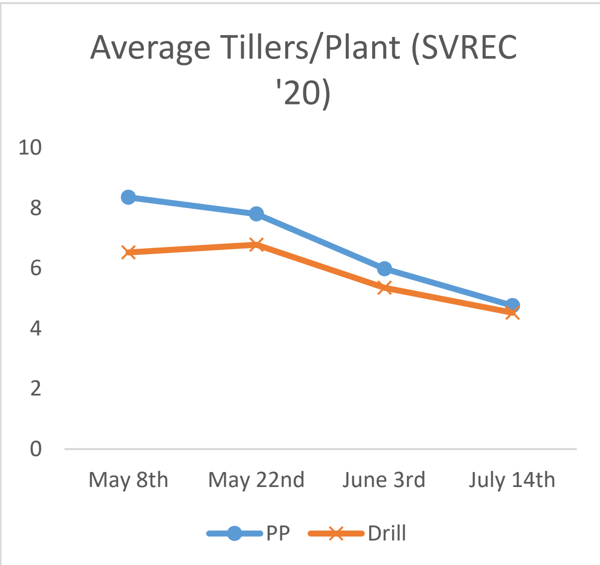


Table 2. Effect of seeding rate on the number of tillers per plant.

Seeding Rate*	Tillers per plant	
0.5	8.8	A
1.0	4.7	B
1.5	2.8	C
2.0	2.3	C

* Million seeds per acre

A third objective was to measure the impact of row spacing and plant populations on grain yield. Row spacings of 5", 7.5", 10" and 15" and populations of 0.5, 1.0, 1.5 and 2.0 million seeds per acre were evaluated. These were planted with the Monosem 4NG precision planter.

Figure 4. Precision planter yield by row spacing.

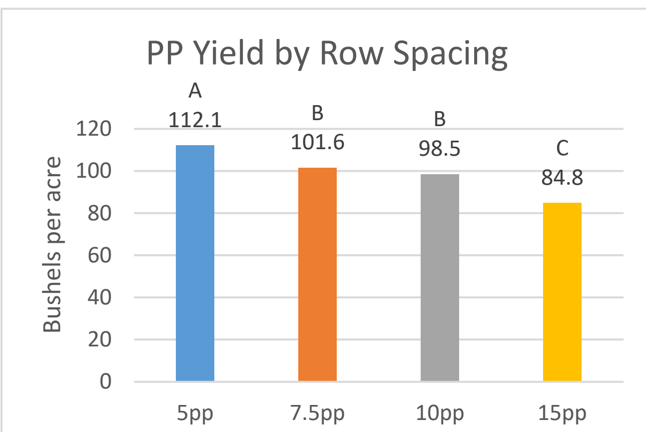
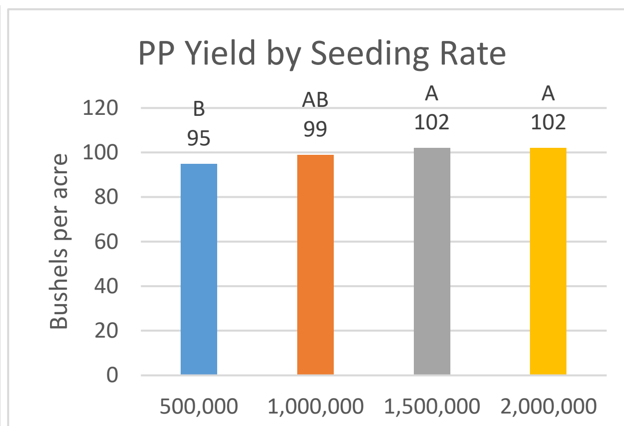


Figure 5. Precision planter yield by seeding rate.



In this study, planting in narrow rows shows real potential. The 5-inch row spacing out-performed the 7.5-inch row spacing by 10.5 bushels or 9.4% (Figure 4). Moving to wider row spacings reduce yield potential. The 15-inch row spacing produced 84.8 bushels per acre, down 16.8 bushels from the industry standard 7.5-inch row spacing. One of the reasons this research was conducted was to answer farmer questions about what kind of planter should be used to plant wheat. Several growers asked if moving to 10 or 15-inch rows would be feasible so that they could use the same planter they plant soybeans with. Moving from 7.5 to 10-inch row spacing has a small impact on yield (not significant in this trial). However going wider will reduce yield potential. When making equipment decisions, farmers should also consider that going narrower rather than wider improves yield potential. In this study, there was a 13.6 bushel per acre difference between 5 and 10-inch row spacings. Each farm should conduct an economic assessment of planting equipment to determine the best option for them.

European wheat growers plant less seed per acre than we typically do here in Michigan. In this study, across all row spacings, yield was maximized at 1.5 m seed/acre but was not statistically different from 1.0 m or 2.0 m seeds/acre (Figure 5). However, seeding rate of 0.5 m seeds/acre reduced yield. These data shows that optimum seeding rate might be closer to 1.0 m seeds/acre in Michigan. Most studies planted with a drill generally shows increasing yields with increasing seeding rates. The results presented here show that we can in fact achieve higher yields with lower seeding rates using PP technology. More research needs to be done on seeding rates.

Samples were collected prior to harvest to measure yield components, which help to explain where yield came from. Averaged across all seeding rates, narrow rows (5-inch) had higher heads per square foot but had lower thousand kernel weight (TKW) and less seeds per head compared to wider row spacings (Table 3). Since the 5-inch row spacing had the highest yield, it can be concluded that in this study the yield component showing the greatest contribution to yield was heads per unit area. When averaged across all row spacings, heads per square foot was highest at 2 million seeding rate and decreased with seeding rate (Table 4). TKW was not affected by seeding rate. Lower seeding rates had higher number of seeds per head. When looking at yield components, it appears that more heads per square foot is driving yield potential. In the future, we need to conduct research aimed at understanding how to increase TKW and seeds per head.

Table 3. Yield components of PP as affected by row spacing.

	Heads per ft^2	TKW	Seeds per head
5pp	86.4 A	28.2 B	28.0 B
7.5pp	76.0 AB	28.8 AB	29.2 AB
10pp	75.2 AB	29.2 A	30.5 AB
15pp	67.8 B	29.7 A	31.5 A

Table 4. Yield components of PP as affected by seeding rate.

	Heads per ft^2	TKW	Seeds per head
500000	71.4 B	29.3 A	30.7 AB
1000000	75.5 AB	29.2 A	31.1 AB
1500000	76.5 AB	29.0 A	29.7 AB
2000000	82.0 A	28.4 A	27.7 B

Summary

From two years of looking at precision planting wheat, we have learned that Michigan wheat growers looking to increase wheat yields should consider the use of precision planting technology on their farms. Increased singulation and uniform seeding depths leads to increased resource use efficiency and the potential for higher yields. Michigan wheat growers that are looking to reduce cost and maintain yields should consider lowering seeding rates. Data from this trial shows yield can be maximized at seeding rates below 1.5 m per acre, and increasing seeding rates >1.5m seeds/acre does not increase yield. More importantly, narrow row spacing tends to increase yield potential over wide row spacings.

Future work

This research was made possible by a collaboration between the Michigan Wheat Program and MSU Project GREEEN. Through presentations at grower meetings and field day events, there has been interest in looking at additional wheat seeding technology. A new project to evaluate high speed broadcast incorporation as compared to drill and precision planter technology has been initiated because of this work. Additional research trials evaluating planting depth and a seeding rate by seeding date trial have been initiated. More work needs to be done to understand how to manage yield components to increase yield potential. In addition, graduate student Kalvin Canfield is expected to graduate in February 2021. Two journal articles are planned from this project as well. Data from this project will continue to be presented at winter grower meetings, field days and posted on the MSU Wheat and Agronomy webpages.

Project Changes
There are no project changes to report. This project is completed.

Budget narrative
The budget for this project is on track. No major changes to the budget are needed.

Intellectual property
None.

Approach to Disseminate Research
Two journal articles are planned from this project as well. Data from this project has been presented at winter grower meetings and field days, and American Society of Agronomy's annual meetings. Research results will be posted on the MSU Wheat and Agronomy webpages. An article for the Wheat Wisdom newsletter can be submitted in any month.

Start Right to Finish Well: Wheat Grain and Straw Production
2020 Report to the Michigan Wheat Program

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Location: Lansing, MI	**Tillage**: Conventional
Planting Date: October 8, 2019	**Nitrogen Rates**: 50, 100, 150 lbs. N/A
Soil Type: Conover Loam; 7.0 pH, 9.2 meq 100g^{-1} CEC, 2.8% OM, 42 ppm P (Bray P-1), 120 ppm K, 7 ppm S, 3.8 ppm Zn	**Population**: 1.8 million seeds/A
Variety: Flipper & Red Dragon (SRWW)	**Replicated**: 4 replications

Location: Richville, MI	**Tillage**: Conventional
Planting Date: September 26, 2019	**Nitrogen Rates**: 60, 120, 180 lbs. N/A
Soil Type: Tappan-Londo Loam; 7.9 pH, 15.6 meq 100g^{-1} CEC 2.3% OM, 34 ppm P (Bray P-1 equivalent), 154 ppm K, 10 ppm S, 7.1 ppm Zn	**Population**: 1.8 million seeds/A
Variety: Jupiter & AC Mountain (SWWW)	**Replicated**: 4 replications

Introduction:

Increases in wheat (*Triticum aestivum* L.) grain and straw yield along with heightened awareness of soil spatial variability have prompted growers to focus on season-long nutrient availability for optimal yield. Michigan continues to produce some of the nation's greatest wheat yields ranking third in the 2020 growing season harvesting a total of 33,750,000 bushels with an average yield of 75 bu A^{-1} (USDA-NASS, 2020). As the demand for wheat straw increases for livestock bedding, feed, and biofuel, management strategies to optimize both grain yield and straw production are critical to the economic return for Michigan growers.

Previous studies indicate a positive correlation between yield and biomass production by manipulating a variety of nutrient inputs. For maximum production, methods of determining nitrogen (N) fertilization rates in winter wheat are based on fixed N removal rates per unit of produced grain and projected yield goals (Lukina et al., 2001). Variation in N usage and yield potential of varieties both influence fertilization practices based on estimates of early-season plant N uptake and potential yield (Lukina et al., 2001). Nitrogen deficiency during establishment may result in reduced tiller counts and growth rates setting limitations on grain yield and biomass production before initiating primary development.

Variety selection is an important management strategy to achieving high yielding grain and straw. Variations in plant height have correlated to straw production and growth in stressed environments. Taller varieties are better suited for stressed environments due to improved emergence and combing harvest (Pinthus, 1974). In addition to plant height, selecting varieties that are less susceptible to lodging and shattering is important to both grain and straw production (Klein, 2007). While short statured varieties are often overlooked for straw production, responses to input manipulation have overcome limitations specific to wheat variety and environmental conditions (Beuerlein et al., 1989; (Karlen & Gooden, 1990).

Objective and Hypothesis:

Objective 1: Evaluate soft red winter wheat (SRWW) and soft white winter wheat (SWWW) grain and straw yield response to autumn applied starter fertilizer, spring N, and varietal stature. Our *working* hypothesis is that autumn-applied starter fertilizer will increase wheat stand resilience prior to spring greenup for improved grain yield, straw production, and grower profitability.

Methods and Procedures:

A randomized complete block split-plot design with four replications was used to evaluate three 12-40-0-10S-1Zn autumn starter rates, three spring N rates, and two varietal statures (Table 1, 2). Main plots consisted of three rates of autumn starter fertilizer while sub-plots consisted of three spring N rates. The untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Variety stature was an additional component of this study. One short statured SRWW variety (i.e., 'Flipper') and one tall statured SRWW variety (i.e., 'Red Dragon') were selected to evaluate autumn starter implications on plant height and biomass production in Lansing, MI. One short statured SWWW variety (i.e., 'Jupiter') and one tall statured SWWW variety (i.e., 'AC Mountain') were selected for Richville, MI.

Table 1. Overview of split plot trial design, treatment names, and inputs applied to soft red winter wheat, Lansing, MI 2019 and 2020.

		------Autumn Starter and Spring Nitrogen (N) Applied------	
Treatment	**Treatment Name**	**Rate† 12-40-0-10S-1Zn**	**Rate‡ UAN (28%)**
1	Low Starter, Base N	125 lb A^{-1}	100 lb A^{-1}
2	Low Starter, High N	125 lb A^{-1}	150 lb A^{-1}
3	Low Starter, Low N	125 lb A^{-1}	50 lb A^{-1}
4	High Starter, Base N	250 lb A^{-1}	100 lb A^{-1}
5	High Starter, High N	250 lb A^{-1}	150 lb A^{-1}
6	High Starter, Low N	250 lb A^{-1}	50 lb A^{-1}
7	No Starter, Base N	0 lb A^{-1}	100 lb A^{-1}
8	No Starter, High N	0 lb A^{-1}	150 lb A^{-1}
9	No Starter, Low N	0 lb A^{-1}	50 lb A^{-1}
10	**Check**		

† Autumn starter (12-40-0-10S-1Zn) applied as top-dress application 15 Oct. 2019.
‡ Spring nitrogen (UAN 28%) applied at green-up 24 Mar. 2020.

Table 2. Overview of split plot trial design, treatment names, and inputs applied to soft white winter wheat, Richville, MI 2019 and 2020.

		------Autumn Starter and Spring Nitrogen (N) Applied------	
Treatment	**Treatment Name**	**Rate† 12-40-0-10S-1Zn**	**Rate‡ UAN (28%)**
1	Low Starter, Base N	125 lb A^{-1}	120 lb A^{-1}
2	Low Starter, High N	125 lb A^{-1}	180 lb A^{-1}
3	Low Starter, Low N	125 lb A^{-1}	60 lb A^{-1}
4	High Starter, Base N	250 lb A^{-1}	120 lb A^{-1}
5	High Starter, High N	250 lb A^{-1}	180 lb A^{-1}
6	High Starter, Low N	250 lb A^{-1}	60 lb A^{-1}
7	No Starter, Base N	0 lb A^{-1}	120 lb A^{-1}
8	No Starter, High N	0 lb A^{-1}	180 lb A^{-1}
9	No Starter, Low N	0 lb A^{-1}	60 lb A^{-1}
10	**Check**		

† Autumn starter (12-40-0-10S-1Zn) applied as top-dress application 15 Oct. 2019.
‡ Spring nitrogen (UAN 28%) applied at green-up 24 Mar. 2020.

Results and Discussion (2019-2020):

Soft Red Winter Wheat Yield

Autumn starter fertilizer and spring N interacted to affect both grain and straw yield in SRWW (Table 3 & 4). The low starter, high nitrogen treatment resulted in an increase of 31.4 bu A^{-1} and 21.4 bu A^{-1}, respectively, as compared to the no starter, high nitrogen treatment with varieties 'Flipper' and 'Red Dragon' (Table 3). In addition, grain yield increased in 'Red Dragon' with low autumn starter, base nitrogen treatment exceeding the yield of the no starter, high nitrogen treatment (Table 3). Straw yield increased for ‘Flipper’ with the low starter, low N treatment exceeding the yield of the no starter, high N treatment (Table 4). Straw yield increased in ‘Red Dragon’ with low autumn starter, base N exceeding the yield of no starter, base N (Table 4). Addition of autumn starter increased plant height of SRWW with both low autumn starter and high autumn starter applications as compared to no autumn starter (Table 8).

Soft White Winter Wheat Yield

The high-rate of autumn starter increased ‘Jupiter’ grain yield compared to no starter but was similar to the low starter application rate (Table 5). The base and high spring N rates were similar and increased yield 16.2 – 22.2 bu A^{-1} compared to the low N treatment. Autumn starter increased yield 8-13 bu A^{-1} for ‘AC Mountain’ compared to no starter fertilizer application. Similar to ‘Jupiter’, ‘AC Mountain’ base and high N treatments increased grain yield 16-22 bu A^{-1} as compared to the low N treatment. Straw yield increased in varieties ‘Jupiter’ and ‘AC Mountain’ with application of autumn starter (Table 6). A significant increase in straw yield occurred between the high autumn starter rate as compared to the low autumn starter rate in SWWW variety ‘AC Mountain.’ There was no significant difference between low and high autumn starter rate in ‘Jupiter.’ Both low and high autumn starter applications increased straw yield compared to no autumn starter. The low rate of spring N reduced straw yield in both ‘Jupiter’ and ‘AC Mountain’ with no differences between the base and high N application rates. Addition of autumn starter increased plant height of the short SWWW variety ‘Jupiter’ with both low autumn starter and high autumn starter applications as compared to no autumn starter (Table 8). Plant height of SWWW variety ‘AC Mountain’ was unaffected by the addition of autumn starter.

Profitability

Net profitability analysis of grain and straw yield evaluated SRWW and SWWW return on investment (Table 3,4,5,6). Local grain and straw market price, total treatment cost, and harvest cost (i.e., thrashing and baling) were assessed to determine the estimated net return based on observed yields. Net grain yield profitability was highest in SRWW variety ‘Flipper’ with the low starter, base N treatment while profitability for SRWW variety ‘Red Dragon’ was highest with the no starter, base N treatment. The preliminary differential response to starter by variety mean height (short vs tall statured) across the SRWW varieties will continue to be investigated moving forward. Autumn biomass production and tillering, spring biomass production, rooting characteristics, and nutrient dilution from greater biomass may all influence nutrient use efficiency. No significant differences in grain or straw yield profitability occurred between no, low, and high autumn starter applications in SWWW varieties ‘Jupiter’ and ‘AC Mountain.’ Grain yield profitability as affected by spring nitrogen rate was greatest with base spring N treatments in both SWWW varieties.

Straw nutrient removal is an important factor when performing a net profitability analysis for straw production. The average straw fertilizer equivalent is 16.2 lbs T^{-1} for N, 2.4 lbs T^{-1} for P_2O_5, 26.8 lbs T^{-1} for K_2O, and 0.8 lbs T^{-1} of sulfur (Reiter et al., 2015). Preliminary evaluation of straw nutrient removal for SRWW variety 'Flipper' aligns with these findings (Table 7). It was determined that nutrient removal was greatest for K_2O and S with the high starter, high nitrogen treatment and lowest with the no autumn starter treatments (Table 7). Nitrogen and P_2O_5 removal decreased with the inclusion of autumn starter but increased with the high spring N rate. Greater biomass production from the autumn starter (i.e., 12-40-0-10S-1Zn) likely caused the increased K_2O removal.

Table 3. SRWW mean grain yield and net profitability analysis**.**

Treatment	Flipper	Red Dragon	Flipper	Red Dragon
	---------------Bu A^{-1}--------------		--------------US$ A^{-1}-------------	
Low Starter, Base N	123.2 c †	105.3 ab	$484.21 ab	$399.03 a
Low Starter, High N	132.7 ab	111.1 a	$508.06 a	$405.62 a
Low Starter, Low N	105.7 d	86.9 d	$421.87 c	$332.57 bc
High Starter, Base N	129.3 bc	106.5 ab	$484.38 ab	$376.26 ab
High Starter, High N	141.7 a	111.1 a	$522.31 a	$376.90 ab
High Starter, Low N	108.3 d	92.2 dc	$405.49 cd	$329.08 c
No Starter, Base N	107.3 d	97.3 bc	$437.23 bc	$389.75 a
No Starter, High N	101.3 d	89.7 cd	$387.84 cd	$333.00 bc
No Starter, Low N	88.5 e	84.3 d	$369.29 d	$349.06 bc
Check‡	53.0	51.4	$223.98	$213.84
$P_r > F$	= 0.06	= 0.07	= 0.06	= 0.07

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Table 4. SRWW mean straw yield and net profitability analysis.

Treatment	Flipper	Red Dragon	Flipper	Red Dragon
	---------------T A^{-1}--------------		--------------US$ A^{-1}-------------	
Low Starter, Base N	1.92 c †	2.08 cd	$180.48 ab	$207.45 abc
Low Starter, High N	1.88 c	2.37 ab	$164.80 abc	$227.26 a
Low Starter, Low N	1.50 e	1.60 e	$148.22 cd	$162.03 cde
High Starter, Base N	2.10 b	2.32 bc	$182.46 a	$211.91 ab
High Starter, High N	2.32 a	2.57 a	$191.55 a	$226.36 a
High Starter, Low N	1.76 cd	1.72 de	$156.09 bcd	$149.60 de
No Starter, Base N	1.60 de	1.49 e	$170.66 abc	$154.01 cde
No Starter, High N	1.02 f	1.50 e	$66.80 e	$133.97 e
No Starter, Low N	1.16 f	1.45 e	$128.76 d	$169.89 bcd
Check‡	0.66	0.84	$79.97	$105.10
$P_r > F$	< 0.01	< 0.01	= 0.06	= 0.07

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Table 5. SWWW mean grain yield and net profitability analysis**.**

Treatment	Jupiter		Treatment	AC Mountain	
	---Bu A^{-1}---	--US $ A^{-1}--		--Bu A^{-1}--	--US $ A^{-1}--
Low Starter	115.7 ab †	$457.49	Low Starter	103.8 a	$399.39
High Starter	117.5 a	$437.37	High Starter	108.9 a	$395.39
No Starter	108.3 b	$450.01	No Starter	96.1 b	$389.98
$Pr > F$	= 0.10	NS	$Pr > F$	= 0.04	NS
Base N	117.2 a	$454.85 a	Base N	106.9 a	$414.51 a
High N	123.2 a	$469.22 a	High N	111.8 a	$413.15 a
Low N	101.0 b	$410.79 b	Low N	90.1 b	$357.10 b
$Pr > F$	< 0.01	< 0.01	$Pr > F$	< 0.01	< 0.01
Check‡	51.0	$217.45	Check‡	42.0	$176.81

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Table 6. SWWW mean straw yield and net profitability analysis.

Treatment	Jupiter		Treatment	AC Mountain	
	---T A^{-1}---	--US \$ A^{-1}--		--T A^{-1}--	--US \$ A^{-1}--
Low Starter	1.57 a †	\$127.68	Low Starter	1.73 b	\$150.71
High Starter	1.63 a	\$107.43	High Starter	1.92 a	\$148.19
No Starter	1.30 b	\$119.79	No Starter	1.51 c	\$147.85
Pr > F	= 0.06	NS	*Pr > F*	= 0.01	NS
Base N	1.45 a	\$111.17	Base N	1.78 a	\$157.57
High N	1.77 a	\$131.56	High N	1.86 a	\$145.34
Low N	1.23 b	\$112.17	Low N	1.51 b	\$143.84
Pr > F	< 0.01	NS	*Pr > F*	< 0.01	NS
Check‡	0.37	\$39.40	Check‡	0.50	\$57.72

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Table 7. SRWW variety 'Flipper' mean straw nutrient removal.

Treatment	K_2O	Sulfur	Treatment	P_2O_5	Nitrogen
	--------------------------------lbs T^{-1}---------------------------------				
Low Starter, Base N	20.59 cd †	0.70 de	Low Starter	2.53 c	8.75 b
Low Starter, High N	23.25 b	0.80 cd	High Starter	3.03 b	9.25 b
Low Starter, Low N	21.23 bcd	0.80 cd	No Starter	4.41 a	10.06 a
High Starter, Base N	21.85 bc	0.90 bc	*Pr > F*	< 0.01	= 0.04
High Starter, High N	25.96 a	1.25 a			
High Starter, Low N	20.63 cd	0.95 b	Base N	2.83 b	8.95 b
No Starter, Base N	20.95 cd	0.65 e	High N	4.08 a	11.13 a
No Starter, High N	19.86 cd	0.59 e	Low N	3.06 b	7.97 c
No Starter, Low N	19.16 d	0.60 e	*Pr > F*	< 0.01	< 0.01
Check‡	18.19	0.95			
$P_r > F$	=0.06	< 0.01	Check‡	4.03	7.21

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.

Table 8. Influence of autumn starter (12-40-0-10S-1Zn) on plant height.

Variety	Location	No Starter	Low Starter	High Starter	
		-------------------- Height cm^{-1}		------------------------	*Pr > F*
Red Dragon	Lansing	82.7 b	88.7 a	90.3 a	> 0.01
Flipper	Lansing	73.4 c	77.7 b	79.2 a	> 0.01
AC Mountain	Richville	77.1 a	80.3 a	82.8 a	= 0.29
Jupiter	Richville	77.1 b	80.3 a	82.8 a	= 0.02

† Values followed by the same lowercase letter are not significantly different at α=0.1
‡ Untreated check containing no fertilizer or additional inputs was not included in statistical analysis.
€ Heights obtained from 10 plants per plot used for this analysis.

Discussion

Results from the SRWW varieties indicate application of high (i.e., above recommended) spring N did not compensate for the lack of autumn applied starter at plant establishment. When pre-plant soil nitrate concentrations are below 5 ppm, positive yield responses to autumn N are likely. Soil nitrate concentrations were 3.5 and 3.3 ppm, respectively, at Lansing and Richville indicating a positive response to autumn N may be probable especially considering the timely planting. In addition to N, the interaction between sulfur and nitrogen has shown to have an impact on the physiological attributes to wheat biomass and grain yield (Salvagiotti & Miralles, 2008). Research has shown that nitrogen use efficiency can be increased when there is no sulfur deficiency of the current crop (Salvagiotti & Miralles, 2008). Pre-plant soil S levels were 7 ppm in Lansing, MI but soil S testing is not a reliable indicator for S response. Sulfur application is cost effective considering ~25 lbs. A^{-1} is all that is required. The critical soil test P concentration for winter wheat is 25 ppm (Warncke et al., 2009). A high pre-plant Bray P-1 phosphorous concentration of 42 ppm in Lansing, MI reduced the likelihood of a yield response to phosphorous application. The decreased response to autumn starter in the SWWW varieties may be due to the more highly buffered soils of the region, different genetics with SWWW as compared to SRWW, greater residual S from a more varied cropping rotation, or slightly altered weather conditions than Lansing.

Results from SRWW varieties ‘Flipper’ and ‘Red Dragon’ agree with previous work from Purucker and Steinke (2018-2019) who observed a grain yield decrease of 18.7 and 37.5 bu A^{-1} when autumn starter fertilizer was removed from enhanced management and a grain yield increase from 17.4 and 25.9 bu A^{-1} when autumn starter fertilizer was added to traditional management at Richville and Lansing, MI, respectively. Low pre-plant residual nitrate concentrations, inclusion of the sulfur component, and timely autumn planting likely resulted in the positive grain and straw yield response to autumn starter fertilizer observed in this study. Be sure to consider a pre-plant nitrate test as part of a proactive approach to address soil variability. Autumn starter can help winter wheat “Start Right to Finish Well” for optimal grain and straw production but response will be field- and site-specific.

References

Beuerlein, J. E., Oplinger, E. S., & Reicosky, D. (1989). Yield and Yield Components of Winter Wheat Cultivars as Influenced by Management-A Regional Study. *Journal of Production Agriculture*, *2*(3), 257–261. https://doi.org/10.2134/jpa1989.0257

Karlen, D. L., & Gooden, D. T. (1990). Intensive Management Practices for Wheat in the Southeastern Coastal Plains. *Journal of Production Agriculture*, *3*(4), 558–563. https://doi.org/10.2134/jpa1990.0558

Klein, R. N. (2007). How to Select the Winter Wheat Varieties Best for Your Operation | CropWatch | University of Nebraska–Lincoln. *Univeristy of Nebraska: Institute of Agriculture and Natural Resourcs*. https://cropwatch.unl.edu/how-select-winter-wheat-varieties-best-your-operation

Lukina, E. V., Freeman, K. W., Wynn, K. J., Thomason, W. E., Mullen, R. W., Stone, M. L., Solie, J. B., Klatt, A. R., Johnson, G. V., Elliott, R. L., & Raun, W. R. (2001). Nitrogen fertilization optimization algorithm based on in-season estimates of yield and plant nitrogen uptake. *Journal of Plant Nutrition*, *24*(6), 885–898. https://doi.org/10.1081/PLN-100103780

Pinthus, M. J. (1974). Lodging in Wheat, Barley, and Oats: The Phenomenon, its Causes, and Preventive Measures. *Advances in Agronomy*, *25*(C), 209–263. https://doi.org/10.1016/S0065-2113(08)60782-8

Reiter, M. S., Deitch, U. T., Frame, W. H., Holshouser, D. L., & Thomason, W. E. (2015). The Nutrient Value of Straw. *Virignia Cooperative Extension*.

Salvagiotti, F., & Miralles, D. J. (2008). Radiation interception, biomass production and grain yield as affected by the interaction of nitrogen and sulfur fertilization in wheat. *European Journal of Agronomy*, *28*(3), 282–290. https://doi.org/10.1016/j.eja.2007.08.002

USDA/NASS 2019 State Agriculture Overview for Michigan. (2020). Small Grains Report. Retrieved January 21, 2021, from https://www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=MICHIGAN

Warncke, D., Dahl, J., & Jacobs, L. (2009). *Nutrient Recommendations for Field Crops in Michigan*.

USDA-ARS Yellow and Black Bean Breeding Progress

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Yellow Bean Trials: Two yellow bean trials were planted at the Montcalm Research Farm in Entrican, MI on June 12, 2020. The trials were planted in 4 row plots 20 ft. long with 22 inch spacing between rows. Both trials consisted of two field replications per entry in a randomized complete block design. At maturity, the center 15 ft. of the center two rows were direct harvested with a Hege plot thresher. This is the first time that direct harvest was attempted for yellow bean yield trials at the Montcalm Research Farm. Direct harvest was also attempted on kidney and cranberry lines, and of the three, the yellow beans were best suited for direct harvest. Both trials included Mayocoba and Manteca yellow beans. The Mayocoba are the highlighter yellow market class and the Manteca are a pale yellow with a grey hilum. The Mantecas are not produced in the US but have value in Africa and South America because of fast cooking times and preferred cooked bean flavor and texture.

The advanced yield trial consisted of 20 entries, including 13 breeding lines and 7 check varieties (Table 1). Seed yields ranged from 13.2 to 33.2 CWT/acre with an average of 23.1 CWT/acre. The top three yielding lines were sibs of a Manteca by Mayocoba cross. The fourth highest yielding line, Y1702-22, is a cross between a Canadian Mayacoba, CDC-Sol and an African yellow bean, Akaryose. Y1702-22 had one of the fastest cooking times in the trial at 14 min. The preliminary yield trial consisted of 25 entries (Table 2). Seed yields ranged from 10.2 to 28.7 CWT/acre with an average of 19.5 CWT/acre. Three of the top five yielding lines in this trial have the designation RR in front of them. This indicates that they were selected for root rot resistance based on a greenhouse screening using the *Fusarium brasiliense* isolate F_14-42, as recommended by Marty Chilvers. All three of these top yielding RR lines have Patron as a parent. Patron is a Mayocoba variety from Oregon State University, and has previously been observed to have field tolerance to root rot (unpublished).

Black Bean Trials: Two black bean trials were planted at the Saginaw Valley Research Farm and Extension Center in Richville, MI on June 6, 2020. The trials were planted in 4 row plots 20 ft. long with 22 inch spacing between rows. Both trials consisted of two field replications per entry in a randomized complete block design. At maturity, the center 15 ft. of the center two rows were direct harvested with a Hege plot thresher.

The advanced yield trial consisted of 17 entries including three 3 check varieties and 14 breeding lines (Table 3). Seed yields ranged from 19.4 to 28.1 CWT/acre with an average of 24.4 CWT/acre. One of the major objectives of the black bean breeding program is to develop a low phytic acid black bean adapted to Michigan. Low phytic acid is a trait that changes the phosphorus storage in the seed and helps to make iron and zinc more bioavailable to people consuming the beans. Many of the parental lines are low phytic acid. While we have successfully developed high yielding adapted low phytic acid black bean lines, (B-LPA17-34-2, for example), these lines tend to develop hard to cook. The hard to cook can be observed such that even after prolonged cooking times, here over 60 minutes, the beans do not soften. It is unclear if it is possible to separate the low phytic acid from the hard to cook phenotype and we continue crossing and screening for the low phytic acid trait and cooking time. The preliminary yield trial consisted of 30 entries (Table 4). Seed yields ranged from 11.9 to 28.1 CWT/acre with an average of 18.6 CWT/acre. Phenotypic evaluation of phytic acid levels is currently underway with the preliminary yield trial cooked seed samples to determine which of these express the low phytic acid trait.

Table 1. USDA-ARS 2020 Yellow Bean Advanced Yield Trial at the Montcalm Research Farm in Entrican, Michigan

ID	Pedigree	Seed yield	Lodging[1]	CBB[2]	Maturity	Seed wt.	Water uptake[3]	CookTime[4]	Cooked bean rating[5]
		CTW/ACRE	1 to 5	1 to 5	days	g -100 seeds	percent	min	1-5
Y1608-07	Y11405/ADP521	33.2	3.5	2	101	39.0	117	20	5
Y1608-14	Y11405/ADP521	30.8	4	3	88	38.4	117	18.5	2.5
Y1608-09	Y11405/ADP521	28.6	2.5	3.5	86	39.9	116	21.5	4
Y1702-22	ADP0781/Akaryose	28.1	1.5	4	88	34.6	107	14	3
Y1610-01	DYB-28-1/ADP-521	27.3	3	2.5	86	40.0	111	13.5	5
YBC162	91-1	27.2	3	3.5	101	28.1	106	16	2.5
YBC129	Ervilha	26.9	2	3.5	96	51.0	113	17	3.5
YBC127	Patron	26.8	3	3	98	38.5	105	18	5
Y1703-21	ADP0781/Y11405	25.3	2	3	88	44.5	108	22.5	5
Y1701-03	ADP0781/Marafax	25.1	1.5	5	88	35.5	100	22.5	3.5
PIC86	ADP-37/Dolly (ADP-624)	23.9	3	3	102	70.9	110	17	5
YBC126	Y11405	21.3	1	5	94	42.0	108	26.5	4.5
Y1608-02	Y11405/ADP521	20.6	2.5	2.5	92	41.4	116	20.5	5
RRY1801	ADP0476 (hutterite)/patron	20.4	5	3	94	33.6	102	22	5
Saginaw Cheetah	.	19.8	1	3	88	27.6	115	18	3
Y1609-02	Y11405/ADP512	19.4	1	5	82	37.3	133	16.5	2.5

YBC196	Yellowstone	16.1	2	3	89	37.6	91	43.5	2
Y1609-14	Y11405/ADP512	14.3	1	6	84	39.8	123	17	2.5
YBC136	Canario	13.3	5	1.5	105	37.0	98	31	4
YBC176	L11YL002	13.2	1.5	5	82	37.3	113	24	3
	Average	**23.1**	**2.3**	**3.6**	**90.8**	**38.4**	**110**	**21.3**	**3.7**
	CV (%)	13.3	24.8	21	3.7	3.8	3.3	23.3	21.1
	LSD	-	-	-	-	-	-	-	-

[1]Lodging: Based on a scale of 1 to 5 where 1 is completely upright and 5 is completely prostrate.
[2]CBB: Common Bacterial Blight disease rating on a 1 to 5 scale where 1 is the absence of CBB on leaves and pods and 5 is 100% infection
[3]Water uptake: Percent water up take after seeds soaked in distilled water for 12 hr at room temperature.
[4]Cook Time: The time required to cook 80% of a 25 seed sample in distilled water following a 12 hr soak in distilled water.
[5]Cooked bean rating: The appearance rating of cooked beans on a scale of 1 to 5 where 1 is the poorest quality (i.e seed do not hold together) and 5 is the best quality (seed hold together).

Table 2. USDA-ARS 2020 Yellow Bean Preliminary Yield Trial at the Montcalm Research Farm in Entrican, Michigan

ID	Pedigree	Seed yield	Lodging[1]	CBB[2]	Maturity	Seed wt.	Water uptake[3]	CookTime[4]	Cooked bean rating[5]
		CTW/ACRE	1 to 5	1 to 5	days	g -100 seeds	percent	min	1-5
Y1803-8-1	ADP0781/mayocoba	28.7	2.5	2.5	88	37.7	95	21.5	2
RRY1803-1-2	ADP0512/Patron	26.0	2.5	3.5	96	43.7	109	22	3.5
RRY1801-1-1	ADP0476 /patron	23.6	1	3.5	86	25.4	93	27	5
Y1802-9-1	ADP0781/patron	22.4	1	3.5	88	37.8	102	20	3.5
RRY1803-1-1	ADP0512/Patron	21.6	2.5	2.5	100	39.3	102	25	3.5
Y1801-1-1	ADP0781/Snowdon	21.5	1.5	4.5	86	49.4	88	31	2
Y1802-11-1	ADP0781/patron	20.7	2.5	3.5	90	35.1	109	24.5	4.5
Y1802-2-1	ADP0781/patron	20.4	1.5	2.5	92	39.4	108	21.5	5
Y1804-1-1	ADP0781/ADP0791	20.4	1.5	3	98	32.7	103	31	2
Y1802-11-2	ADP0781/patron	20.0	1.5	3	86	35.9	108	18.5	3
Y1805-8-1	ADP0781/DBY28-1	19.9	3	3.5	86	40.1	105	18.5	3
Y1802-6-1	ADP0781/patron	19.9	2	3	98	37.3	96	31	3
Y1803-4-2	ADP0781/mayocoba	19.0	2	4	86	39.7	89	21.5	3
Y1805-3-1	ADP0781/DBY28-1	18.9	1.5	4	84	39.4	110	21.5	3.5
Y1802-5-1	ADP0781/patron	18.7	2.5	3	93	35.5	108	22.5	3.5
Y1803-6-1	ADP0781/mayocoba	18.5	1.5	2.5	84	38.1	107	24.5	2
Y1805-1-1	ADP0781/DBY28-1	18.3	2	3	88	39.2	99	23.5	3.5
Y1805-8-2	ADP0781/DBY28-1	17.9	1.5	2.5	88	44.6	107	19	3.5
Y1804-1-2	ADP0781/ADP0791	17.6	1	3	98	33.7	101	26.5	2

Y1803-1-1	ADP0781/mayocoba	16.0	1	3	88	35.9	102	18	3
Y1803-13-1	ADP0781/mayocoba	15.7	3	4	88	34.5	110	21	3
Y1805-10-1	ADP0781/DBY28-1	14.8	2	3	87	40.0	103	20	5
Y1812-4-1	.	14.6	1.5	3	94	33.3	90	31	1
Y1803-5-3	ADP0781/mayocoba	13.7	3	2	90	40.1	101	20	4
Y1803-2-2	ADP0781/mayocoba	10.2	1	4	88	38.2	106	20	4
	Average	**19.5**	**1.8**	**3.2**	**90**	**37.8**	**100**	**23.4**	**3.2**
	CV (%)	25.9	44.4	22.8	3.9	3.7	5.2	15.3	28.2
	LSD	-	-	-	-	-	-	-	-

[1]Lodging: Based on a scale of 1 to 5 where 1 is completely upright and 5 is completely prostrate.
[2]CBB: Common Bacterial Blight disease rating on a 1 to 5 scale where 1 is the absence of CBB on leaves and pods and 5 is 100% infection.
[3]Water uptake: Percent water up take after seeds soaked in distilled water for 12 hr at room temperature.
[4]Cook Time: The time required to cook 80% of a 25 seed sample in distilled water following a 12 hr soak in distilled water.
[5]Cooked bean rating: The appearance rating of cooked beans on a scale of 1 to 5 where 1 is the poorest quality (i.e seed do not hold together) and 5 is the best quality (seed hold together).

Table 3. USDA-ARS 2020 Black Bean Advanced Yield Trial at the Saginaw Valley Research Farm and Extension Center in Richville, Michigan

ID	Pedigree	Seed yield	Lodging[1]	CBB[2]	Matur ity	Seed wt.	Water uptake[3]	CookTime[4]	Cooked bean rating[5]	Cooked bean color rating[6]
		CTW/ACRE	1 to 5	1 to 5	days	g -100 seeds	percent	min	1-5	1-5
BL1726-2	B1402_46_101\Lpa-02(06)	28.1	2	2.5	89	20.6	111	25.5	2	3
BL1726-1	B1402_46_101\Lpa-02(06)	28.0	2	3	88	20.1	114	24.5	2	3
Zorro	**Zorro**	27.6	2	2	89	18.3	114	28	3.5	3.5
BL1726-6	B1402_46_101\Lpa-02(06)	26.8	2.5	2.5	87	19.6	112	25.5	2.5	2.5
BL1703-2	Zenith\BEL1291d	26.3	2	3	90	18.6	113	27	3.5	2.5
B-LPA17-34-2	LPA145 \Zenith	26.0	2.5	3.5	88	15.7	114	>60	-	-
Zenith	**Zenith**	25.8	2	2	87	19.5	109	28	3	4
BL1727-2	B1402_46_101\Lpa-02(06)	25.2	1	2.5	88	18.2	111	26.5	2.5	2.5
BL1709-6	Lpa-10(09)\B1402-4-99	25.2	2	3	87	19.0	111	30	2.5	3
B-LPA17-32-3	LPA145 \Zenith	24.9	1.5	4	84	15.3	112	>60	-	-
BL1726-5	B1402_46_101\Lpa-02(06)	23.4	2	2.5	88	19.3	116	28	1.5	2
BL1717-1	Lpa-10(17)\BEL1303-10	22.3	1.5	3	85	19.0	105	35	4	3
BL1715-4	Lpa-10(17)\B1402_46_101	22.0	1	3	88	18.9	108	23	3	3.5
BL1709-4	Lpa-10(09)\B1402-4-99	21.4	3.5	4.5	90	17.0	116	25	3	1.5
BL1730-3	Zenith\Lpa-9 (16)	21.1	1.5	3	85	16.8	115	27	3.5	2
BL1730-1	Zenith\Lpa-9 (16)	20.4	1.5	2	88	18.4	115	27	3	2
Eclipse	**Eclipse**	19.9	1	2	85	18.9	110	30.5	3.5	2

	Average	**24.4**	**1.9**	**17.3**	**87**	**18.4**	**110**	**27.4**	**2.9**	**2.7**
	CV (%)	14.8	24.5	2.9	2	3.3	2.3	4.8	31.2	21.7
	LSD	7.6	1	-	4	1.3	5	3.6	1.9	1.2

[1]Lodging: Based on a scale of 1 to 5 where 1 is completely upright and 5 is completely prostrate.
[2]CBB: Common Bacterial Blight disease rating on a 1 to 5 scale where 1 is the absence of CBB on leaves and pods and 5 is 100% infection.
[3]Water uptake: Percent water up take after seeds soaked in distilled water for 12 hr at room temperature.
[4]Cook Time: The time required to cook 80% of a 25 seed sample in distilled water following a 12 hr soak in distilled water.
[5]Cooked bean rating: The appearance rating of cooked beans on a scale of 1 to 5 where 1 is the poorest quality (i.e seed do not hold together) and 5 is the best quality (seed hold together).
[6]Cooked bean color rating: The color rating of cooked beans on a scale of 1 to 5 where 1 is the lightest and 5 is the blackest.

Table 4. USDA-ARS 2020 Black Bean Preliminary Yield Trial at the Saginaw Valley Research Farm and Extension Center in Richville, Michigan

ID	Pedigree	Seed yield	Lodging[1]	CBB[2]	Maturity	Seed wt.	Water uptake[3]	CookTime[4]	Cooked bean rating[5]	Cooked bean color rating[6]
		CTW/ACRE	1 to 5	1 to 5	days	g -100 seeds	percent	min	1-5	1-5
BL1801-2-1	B1403-19\LPA9(29)M	28.1	2.5	3	88	20.4	108.5	18	4	2.5
BL1814-2-1	LPA17-08\BEL1303-9	24.5	1	2.5	85	17.4	106.0	34	3.5	2.5
BL1802-7-1	B1403-19\LPA17-08	24.4	1.5	2.5	89	19.1	109.0	19	4	4
BL1812-8-1	LPA17-08\B1402-15	22.8	1	2.5	85	17.1	112.0	27	4	1
BL1801-3-1	B1403-19\LPA9(29)M	22.1	1.5	3	85	18.6	43.0	52.5	3	4
BL1814-6-1	LPA17-08\BEL1303-9	22.1	1.5	4	85	16.6	106.5	25	3.5	2.5
BL1810-2-1	LPA17-08\B1403-19	22.1	2	3	90	18.1	110.5	17	3.5	3
BL1802-4-1	B1403-19\LPA17-08	21.1	3	3	87	21.6	79.5	28.5	3.5	2.5
BL1803-1-1	B1402-15\LPA9(29)M	20.2	1	2	88	18.2	113.0	24	4.5	3.5
BL1812-6-1	LPA17-08\B1402-15	19.9	1	2.5	85	17.8	105.0	21	3.5	4
BL1815-1-1	LPA9(29)M\BEL1291D	19.7	2	2.5	90	18.7	70.5	>60	-	-
BL1814-8-1	LPA17-08\BEL1303-9	19.6	2.5	2.5	90	17.4	111.5	20	3.5	3
BL1801-6-1	B1403-19\LPA9(29)M	19.6	1	3	91	19.4	116.0	>60	-	-
BL1814-2-2	LPA17-08\BEL1303-9	19.5	1	3	88	17.4	104.0	25	3.5	3
BL1812-7-1	LPA17-08\B1402-15	19.3	1	2.5	87	16.9	116.0	24.5	3.5	3.5
BL1812-10-2	LPA17-08\B1402-15	19.1	1.5	3	89	18.2	117.5	23	3.5	3

BL1813-4-1	LPA9(29)M\BEL1303-9	18.5	1	2.5	89	16.7	108.5	80	4	5
BL1812-10-1	LPA17-08\B1402-15	17.7	1.5	3	90	18.4	106.0	21.5	3.5	3.5
BL1810-2-2	LPA17-08\B1403-19	17.5	1.5	2	89	19.2	114.0	18	3	2.5
BL1802-6-1	B1403-19\LPA17-08	16.5	1	4	85	17.3	107.5	28	4.5	1
BL1813-5-1	LPA9(29)M\BEL1303-9	15.9	1	3.5	87	20.5	119.0	28	3.5	3
BL1806-3-1	BEL1303-9\LPA17-08	15.6	1.5	2.5	89	19.2	118.0	22.5	3	2.5
BL1814-7-1	LPA17-08\BEL1303-9	15.4	1	3	87	14.8	104.5	22.5	3	3
BL1806-5-1	BEL1303-9\LPA17-08	15.2	2		87	17.9	115.5	23	4	2
BL1806-6-1	BEL1303-9\LPA17-08	15.2	1	4	85	16.0	111.5	27	4.5	1.5
BL1812-9-1	LPA17-08\B1402-15	14.9	1.5		85	17.5	115.5	24.5	3	3
BL1814-8-2	LPA17-08\BEL1303-9	14.8	2.5	3.5	89	14.4	105.5	24	5	1
BL1813-1-2	LPA9(29)M\BEL1303-9	13.0	1	4	85	18.7	114.5	>60	-	-
BL1813-1-1	LPA9(29)M\BEL1303-9	12.1	1.5		85	18.0	114.5	>60	-	-
BL1812-2-1	LPA17-08\B1402-15	11.9	1.5	3	88	15.3	113.5	22.5	3.5	1.5
	Average	**18.6**	**1.5**	**2.9**	**87**	**17.9**	**110.0**	**27**	**3.7**	**2.8**
	CV (%)	19.7	35.9	23.5	2	4.6	5.0	17.3	21.5	28.1
	LSD	7.5	1	-	3	1.7	10	12.9	-	1.6

[1]Lodging: Based on a scale of 1 to 5 where 1 is completely upright and 5 is completely prostrate.
[2]CBB: Common Bacterial Blight disease rating on a 1 to 5 scale where 1 is the absence of CBB on leaves and pods and 5 is 100% infection.
[3]Water uptake: Percent water up take after seeds soaked in distilled water for 12 hr at room temperature.
[4]Cook Time: The time required to cook 80% of a 25 seed sample in distilled water following a 12 hr soak in distilled water.
[5]Cooked bean rating: The appearance rating of cooked beans on a scale of 1 to 5 where 1 is the poorest quality (i.e seed do not hold together) and 5 is the best quality (seed hold together).
[6]Cooked bean color rating: The color rating of cooked beans on a scale of 1 to 5 where 1 is the lightest and 5 is the blackest.

2020 DRY BEAN YIELD TRIALS

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The dry bean-breeding program initiated its twelfth season on the 450-acre Saginaw Valley Research & Extension Center (SVREC) research farm near Frankenmuth, MI in 2020. The program conducted 18 yield trials in 2020 in ten market classes and participated in the growing and evaluation of the Cooperative Dry Bean, Midwest Regional Performance, National Drought and the National Sclerotinia Nurseries in Michigan and winter nursery in Puerto Rico. The nurseries were planted over an extended two-week period (June 5-June 18) due to delays receiving seed from Puerto Rico due to the Covid-19 pandemic. Bean trials received 9.84" of rain following planting (June - mid Sept). The season was characterized by a timely rain after planting (1.12" on June 10), followed by a dry period until the next significant rain on July 10 (1.47"), and then adequate rain for the critical reproductive phase of the season resulting in overall excellent yields. Harvest conditions were good, with most trials harvested at or near ideal seed moisture. Root rot caused by Rhizoctonia strain AG2-2 caused some damage throughout the nurseries at SVREC, particularly in midsize pinto, GN and small red classes. CBB was also prevalent on some of the research plots on both research farms and notes were collected to identify those lines that showed some level of resistance. In contrast with 2019 season, yields were considerably higher in 2020 averaging 30+ cwt/acre compared to average yields of 20 cwt/acre in 2019. A total of 1736 single plant selections were made in F_2 and F_3 nurseries and these were sent to Puerto Rico for seed increase. In contrast to previous years, F_4 seed was not received from winter nursery due to covid restrictions, so remnant F_3 seed was planted. Quantities of F_6 seed for preliminary yield trials was also reduced by these restrictions such that only a single replication in augmented design could be planted.

Two 36-entry black bean trials were conducted side by side at SVREC to measure symbiotic N-fixation of elite black bean lines. One trial received no N while the other received normal fertility of 48 lbs/acre. Data was collected on a range of traits throughout the season using unmanned aerial systems (UAS). Yields in the non-fertilized trial ranged from 1.2 to 37.1 cwt/acre, mean 29.5 cwt/acre, compared to range from 8.3 to 38.7 cwt/acre, mean 29.9 cwt/acre in the fertilized trial. The no-nod check was the lowest yielding entry in both trials, but some lines produced consistent high yields in both trials in the absence of applied N.

Six nurseries were conducted at the Montcalm Research Farm (MRF) and all were irrigated. These included three kidney bean trials, two yellow bean trials and the National Sclerotinia white mold trial. Plots were planted June 12 and 16, and harvest conditions were generally favorable. All trials were pulled and windrowed, except for the white mold trial and Red Hawk/Sacramento RILs which were direct harvested. Trials were located on Comden 1 field, which has not been in bean production for 20+ years, which likely contributed to the lack of root rot infection (typically Fusarium) in these nurseries in 2020. Anthracnose Race 2 was detected again, in the preliminary yellow bean nursery resulting in only 14 of 23 entries being harvested. Two applications of Priaxor were made to limit the spread of anthracnose, but infection was still observed on a limited basis in kidney bean trials. A special emphasis will be taken in 2021 to avoid seed from the infected plots, and protective fungicide applications will be made earlier to better manage this destructive disease that has significantly impacted nurseries in 2019 and 2020. Moreover, efforts to breed for anthracnose resistance in large-seeded beans including kidney and yellow beans continued this year by continued introgression and screening.

The data for all tests are included in an attached section. Procedures and details on nursery establishment and harvest methods are outlined on the first page. Since the data collected on each test are basically the same, a brief discussion of each variable measured is presented below for clarification purposes.

1. Yield is clean seed weight reported in hundredweight per acre (cwt/acre) standardized to 18% moisture content. Dry beans are commercially marketed in units of 100 pounds (cwt).

2. Seed weight is a measure of seed size, determined by weighing in grams a pre-counted sample of 100 seeds, known as the 100-seed weight. To convert to seeds per 100g (10,000/100 seed wt); for example, 100-seed weight of 50 converts to 200 seeds per 100 g (used in marketing).

3. Days to flower are the number of days from planting to when 50% of plants in a plot have one or more open flowers.

4. Days to maturity are the actual number of days from planting until date when all the plants in a plot have reached harvest maturity.

5. Lodging is scored from 1 to 5 where 1 is erect while 5 is prostrate or 100% lodged.

6. Height is determined at physiological maturity, from soil surface to the top of plant canopy, and is recorded in centimeters (cm).

7. Desirability score is a visual score given the plot at maturity that takes into consideration such plant traits as; moderate height, lodging resistance, good pod load, favorable pod to ground distance, uniformity of maturity, and absence of disease, if present in the nursery. The higher the score (from 1 to 7) the more desirable the variety, hence DS serves as a subjective selection index.

At the bottom of each table, the mean or average of all entries in a test is given to facilitate comparisons between varieties. To better interpret data, certain statistical factors are used. The LSD value refers to the Least Significant Difference between entries in a test. The LSD value is the minimum difference by which two entries must differ before they can be considered significantly different. Two entries differing in yield by 1 cwt/acre cannot be considered as performing significantly different if the LSD value is greater than 1 cwt/ acre. Such a statement is actually a statement of "probable" difference. We could be wrong once in 20 times (p=0.05) on the average, depending on the level of probability. The other statistic, Coefficient of Variation (CV), indicates how good the test was in terms of controlling error variance due to soil or other differences within a location. Since it is impossible to control all variability, a CV value of 10% or less implies excellent error control and is reflected in lower LSD values. Under the pedigree column, all released or named varieties are **bolded** and always preceded by a comma (,); when preceded by a slash (/), the variety was used only as a parent to produce that particular breeding line.

Expt. 2001: Standard Navy Bean Yield Trial

This 36-entry trial included standard commercial navy bean varieties, and advanced lines from the MSU breeding program, which carry the N-prefix. Yields ranged from 25.6 to 40.6 cwt/acre with a mean of 32.2 cwt/acre. Variability in this trial was low (CV= 8.7%) and the LSD needed for significance was 3.3 cwt/acre. Five newer breeding lines significantly out-yielded the test mean and the overall navy yields were higher compared to those of black beans, which contrasted with 2019 results. Valiant was the top commercial variety in the trial. Common bacterial blight (CBB) was a significant factor in the underperformance of the remaining varieties, which all ranked below the test mean. This disease pressure did allow for useful screening of breeding lines, with several entries showing minimal infection across reps. AC Portage from Ontario, which has resistance to CBB, failed to exceed the yield of other varieties that all had more severe disease, and ranked near the bottom of the trial, consistent with 2019 results. Canning tests will be conducted on all new MSU breeding lines before being considered for advance.

Expt. 2002: Standard Black Bean Yield Trial +N

This 36-entry trial included the standard commercial black bean varieties and advanced breeding lines. The trial was planted with standard nitrogen (N) treatment of 48 lbs/acre. Yields ranged from 8.3 to 38.7 cwt/acre with a test mean of 29.9 cwt/acre. Variability was moderate in this test, (CV=10.2%) and the LSD was 3.6 cwt/acre. Four entries significantly out yielded the test mean including the recent MSU release Adams at 35.9 cwt/acre. Newer breeding lines with excellent canning quality similar to Zenith were also among this group. The varieties Zenith, Black Bear, Zorro, and Eclipse all exceeded the test mean. Black Beard was severely infected with CBB and was the lowest yielding variety. New release ND Twilight was similarly low yielding, despite showing less CBB severity. The non-nodulating line R99 that does not fix N was the lowest yielding entry in the test yet yielded 7.1 cwt better than in test 2013 suggesting that N-fixation was an important contributor to yield in the low N test 2013. Interestingly, this 7.1 cwt difference for R99 with/without fertilizer was consistent with results from 2019 black bean N-fixation trials. The goal of these paired trials is to improve overall nitrogen fixation ability of black beans by identifying lines that perform similar or better without the addition of nitrogen fertilizer. Canning tests will be conducted on new breeding lines to ensure only those with canning quality similar to Zenith are advanced.

Expt. 2013: Standard Black Bean Yield Trial -N

This trial was planted without the application of any nitrogen (N) fertilizer. This 36-entry trial included the same standard commercial black bean varieties and advanced breeding lines as test 2002. Yields ranged from 1.2 to 37.1 cwt/acre with a test mean of 29.5 cwt/acre. Variability was moderate in this test, (CV=10.3%) and the LSD was 3.6 cwt/acre. Ten entries significantly out yielded the test mean which included B16504 for the fifth consecutive year. Adams and Zenith were the only two varieties in this group. Several promising B19 breeding lines with excellent canning quality, high levels of CBB resistance, and excellent architecture also showed excellent yield potential in the absence of N fertilizer. Zorro matched the trial mean, followed by Black Bear, Eclipse, Black Beard, ND Twilight, and AAC Knight Rider were the lower yielding varieties. As expected, the non-nodulating line R99 that does not fix N was the lowest yielding entry in the test. It failed to set many pods and mature normally in this trial in contrast to test 2002 where it did pod and dry down. It was encouraging to see several lines performed well in the absence of additional N suggesting they have improved N-fixation capacity. Given environmental concerns, there exists a need to identify lines that naturally fix higher levels of N that partitions efficiently to yield. This trait would also be advantageous to organic producers who are limited in forms of N they may apply.

Comparison of Black Bean Trials 2002 and 2013

A comparison of the two 36-entry black bean trials was designed to compare the performance of beans produced with no N fertilizer to those with standard N fertilizer applied (broadcast at planting). The objective of this field trial was to identify black bean lines that perform well under low N conditions due to superior Nitrogen-fixation ability. In general, the yields of the fertilized treatment was very similar (29.9 cwt/acre) compared to those without fertilizer (29.5 cwt/acre). Two black bean lines with exceptionally high seed yield, B19309 and B16504, had equivalent and higher yield potential under low N conditions (Figure 1). This suggests that through selection and breeding, it would be possible to reduce the need for N fertilizer in Michigan dry bean production, which would have lasting and beneficial impacts on agro-environmental sustainability in the Great Lakes watershed. Given environmental concerns, there exists a need to identify lines that naturally fix higher levels of N that contributes to yield as N application rates of over 50 lbs/acre produce higher plant biomass, which results in greater white mold infections and resulting lower yields. Higher plant biomass does not always translate into higher seed yields, but usually results in the need for chemical desiccation prior to harvest. These issues are exacerbated in organic production systems unable to apply chemical fungicides to combat mold or chemical desiccation to harvest.

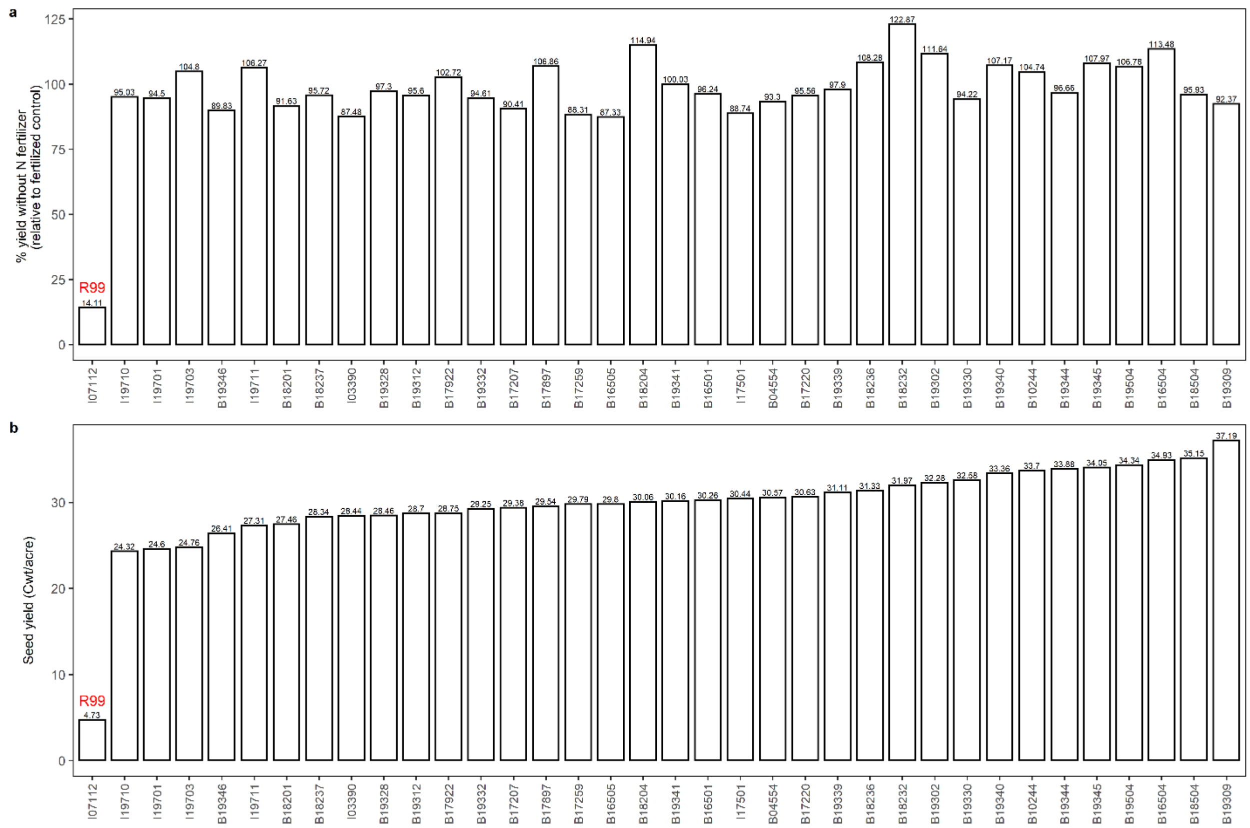

Figure 1. Comparison of % yield relative to fertilized control of 36 black bean lines tested at the Saginaw Valley Research and Extension Center, near Frankenmuth, MI in 2020. R99 designates the non-nodulating bean line that does not fix N.

Expt. 2003: Preliminary Navy Bean Yield Trial

This 84-entry trial included new navy bean lines (N20-prefix) and check varieties. Yields ranged from 1.4 to 36.8 cwt/acre with a mean of 23.1 cwt/acre. Variability among experimental entries was high in this 1-rep modified augmented design test that was planted with poor quality seed that had degraded following wet harvest conditions in Puerto Rico. Germination and stand issues were widespread, but surprisingly the replicated checks used in the augmented design were effective at controlling a portion of the variability and resulted in a CV=7.2% vs the same data analyzed as a RCBD (CV=18.2%). All yield data from this trial should be considered tentative given the exceptionally poor seed quality and un-replicated plots. In addition, the three checks were planted with more vigorous commercial seed and this led to noticeably better stand establishment, which is reflected in their rank at the top of the trial. Despite these limitations, the trial was useful to rank entries relative to each other and identify superior families of interest. Many of the lines in this trial carry anthracnose resistance. As in recent years, concerns exist over small seed size (<18g/100 seed) of several of the entries. Future advances of any new breeding lines will largely depend on acceptable seed size, desirable upright architecture, confirmation of disease reactions, and canning quality.

Expt. 2004: Preliminary Black Bean Yield Trial

This large 146-entry trial included new black bean lines (B20-prefix) and check varieties. Yields ranged from 6.9 to 40.6 cwt/acre with a mean of 30.3 cwt/acre. Variability was well controlled by the modified augmented design despite the limitations of a single-rep test (CV=5.0%). As previously discussed above, seed quality was sub-par although the black beans tolerated the wet conditions at harvest of winter nursery better than navies resulting in higher germination rate and plant stand. As with all the later planted trials, the black beans produced more vigorous vegetative growth due to more plentiful rainfall versus the standard trials that were planted almost two weeks earlier and established in drier conditions. The trial was useful for ranking families and observing seed size and upright plant architecture, with both traits generally more acceptable than in the navy trial. It was encouraging to observe new lines that matched the yield of Adams and Zenith, despite imperfect trial conditions. These high yielding lines will be advanced to properly replicated trials in 2021 based on acceptable canning quality and confirmation of disease reaction.

Expt. 2005: Standard Great Northern Yield Trial

This 24-entry trial included MSU great northern breeding lines (G-prefix) and standard commercial check varieties. The test ranged in yield from 27.9 to 41.3 cwt/acre with a mean yield of 34.2 cwt/acre. Variability was low (CV= 8.2%) resulting in a LSD value of 3.3 cwt/acre needed for significance. Only two entries significantly outperformed the test mean. Eiger, a consistent performer over the last 4-years, was the top yielding variety. The other new release tested was ND Pegasus, which yielded slightly above the mean and exhibited an attractive open canopy with high pod placement. It was encouraging to see both these new varieties exceed the yield of Taurus from Nebraska with its susceptibility to lodging and white mold, although it is interesting that Powderhorn remains competitive despite being an older variety with shorter stature and earlier maturity. There remains room for future effort to combine the efficient partitioning of Powderhorn with the larger plant height of Eiger and ND Pegasus to further increase the yield potential of this class. Seed size and canning quality will be considered prior to advancing lines to further testing.

Expt. 2006: Standard Pinto Bean Yield Trial

This 16-entry trial included MSU pinto lines (P-prefix) and standard commercial check varieties. The test ranged in yield from 22.6 to 40.6 cwt/acre with a mean yield of 33.4 cwt/acre. Variability was low (CV= 8.8%) resulting in an LSD value of 4.1 cwt/acre needed for significance. Four entries significantly outperformed the test mean and included P16902 the top entry in 2019, P19713, P19103 which is a newer slow darkening breeding line, and longtime commercial check LaPaz. New MSU release Charro was the next highest yielding variety and not significantly different than LaPaz. Other checks included Eldorado, Staybright (SDP from Colorado) and new release ND Falcon from NDSU program. As in 2019, the new ND Falcon from NDSU significantly underperformed the test mean at 25.7 cwt/acre. The future of traditional pinto bean seed types versus slow darkening types in the marketplace remains uncertain, complicating future breeding efforts in this seed class. Breeding for the slow dark trait continues to bring along negative traits such as late maturity that appear to be negatively impacting yield due to genetic linkage drag. Several early generation lines expressing the slow darkening trait with better plant type and maturity were selected in 2020 and should enter yield testing next year.

Expt. 2007: Standard Small Red and Pink Bean Yield Trial

This 18-entry trial included small red and pink breeding lines from MSU (R-small red; S-pink prefix), in addition to standard commercial check varieties. The test ranged in yield from 30.8 to 41.4 cwt/acre with a mean yield of 36.4 cwt/acre. Variability was low (CV=7.7%) resulting in a LSD value of 3.4 cwt/acre for significance. Only two lines significantly out yielded the test mean. S18904 was also the top yielding entry in 2019 and demonstrated improved upright architecture with resistance to lodging (lodging=1.0) and stem breakage and an attractive larger seed size (41.4g). It also yielded significantly higher than Rosetta. S19307 was third best entry in 2019 and was less erect (lodging=2.0) with a smaller seed size (35.1g). Small red R17604 continued to showed superiority over other sibs (R17603, R17605) as in 2019 trial. This family showed outstanding architecture, and performance in 2017, but fell below test mean in 2018. Cayenne and Viper small red varieties yielded slightly above mean, and well ahead of Merlot, lowest yielding entry for the second year in a row at 30.8 cwt/acre. Caldera ranked just above Merlot, and yield potential was limited by moderate incidence of CBB (3.0). As in past years, seed size of Viper (31.8g) is significantly smaller than that of Merlot (40.8g) and Cayenne (37.2g). Progress in pink and small red breeding programs has been limited by a lack of useful variability and inability to combine performance with upright architecture and suitable canning quality in new lines. All lines will be evaluated for canning quality and BCMV reaction prior to advancing to 2021 trials.

Expt. 2008: Preliminary Great Northern Bean Yield Trial

This 60-entry trial was planted to evaluate new great northern breeding lines. As discussed in test 2003, seed quality was adversely impacted by wet harvest conditions in winter nursery. As a result, germination and stand were extremely poor, resulting in trial abandonment. Remnant F_5 rows were grown and bulk selected in 2020 and will be evaluated in 2021.

Expt. 2009: Preliminary Small Red and Pink Bean Yield Trial

This large 159-entry trial included small red and pink breeding lines from MSU (R-small red; S-pink prefix), in addition to standard commercial check varieties. The test ranged in yield from 12.5 to 38.4 cwt/acre with a mean yield of 26.6 cwt/acre. Variability was well controlled (CV=8.9%) in this un-replicated augmented design trial. Seed quality of small reds and pinks in Puerto Rico seemed to be less affected by wet harvest weather, consistent with previous observations in Michigan. Therefore, this trial germinated in a more typical fashion and allowed for a good visual evaluation of agronomic traits despite the lack of replication that hindered separation of fine differences in yield. Three lines exceeded the yield of Viper, including top yielding pink line S18904 that also performed well elsewhere in 2020. Two new small reds R20627 and R20667 also slightly exceeded the yield of Viper with a larger seed size (~36g). Many of the families tested in this trial resulted from efforts to combine the yield potential of Viper with upright stature and larger seed size of Cayenne or R17603-05 family. As a result, larger seed size and superior canning quality equivalent to Cayenne will be an important basis for selection. While the checks Viper and Cayenne performed as expected, the newer variety Caldera narrowly matched the trial mean, suggesting several the new breeding lines possess higher yield potential. Resistance to BCMV will be confirmed prior to advancing lines to further testing in 2021.

Expt. 2011: Combined Midwest Regional Performance Nursery (MRPN) & Cooperative Dry Bean Nursery (CDBN) Yield Trial

The MRPN is conducted annually in cooperation with North Dakota (ND-prefix), Nebraska (NE-prefix) and Washington (GN, PK, PT, SR-prefix) to test new pinto, great northern and small red lines from all four programs and assess their potential in the different regions. The CDBN is a national trial and includes all classes but only medium-sized entries were included in this trial. The 40-entry trial ranged in yield from 17.6 to 41.7 cwt/acre with a mean of 33.4 cwt/acre. Variability was low (CV=6.7%) resulting in a LSD value (3.1 cwt/acre) for significance. As a result, fourteen lines were significantly higher in yield than the test mean including new GN varieties Eiger and ND Pegasus, along with pinto check LaPaz. S18904 exceeded 40 cwt/a in this trial and looked promising, as did small red R17604 (38.8 cwt/a). PT16-9 slow dark pinto from USDA-ARS-WA matched the yield of LaPaz and exhibited favorable maturity and agronomic traits as opposed to ND Palomino which yielded below the test mean. PT11-13-31 conventional pinto from WA also was among the top yielding group with favorable ratings. Other lines such as ND121315, NE1-18-28, and GN19-1 yielded well, but lacked the upright architecture, uniform dry down, or other agronomic characteristics that resulted in higher lodging and lower desirability scores which suggest they are not well adapted to local conditions. This cooperative trial continues to be a valuable opportunity to evaluate potential new lines from other breeding programs in the US prior to their release. Canning quality will also be evaluated for all entries.

Expt. 2012: National Dry Bean Drought Nursery

This 32-entry trial was conducted at the SVREC to evaluate a series of breeding lines identified through shuttle breeding between University Nebraska and USDA-TARS station in Puerto Rico as possessing improved levels of drought stress. The trial was replicated by collaborators at various locations across the US. Yields ranged from 21.3 to 41.5 cwt/acre with a mean of 33.9 cwt/acre. Variability was well controlled (CV=8.1%) and the LSD needed for significance was 3.7 cwt/acre. Nine lines significantly out yielded the test mean, including varieties Charro, Adams, Eiger, and Cayenne. Breeding lines B19330 and R17604 from MSU, as well as PT11-13-1, PT11-13-31, and PT16-9 from USDA-WA also were in this top group. This trial serves as an interesting way to screen for not only lines that are tolerant to severe drought conditions imposed by collaborators in more arid environments, but it also allows identification of those stress tolerant lines that possess high yield potential when grown in more favorable conditions. The ability to tolerate wide swings in environmental conditions may be important in developing robust new varieties that are adapted to increasing climate variability from year to year in Michigan.

Expt. 2014: Standard Kidney Bean Yield Trial

This 42-entry trial was conducted at Montcalm Research Farm (MRF) (on Comden 1 field that has not recently grown beans) to compare the performance of standard and new light red kidney (LRK), dark red kidney (DRK), white kidney (WK) varieties from MSU and CDBN under supplemental irrigation (13x, total 8.95”). As in 2019, there was a notable lack of root rot disease pressure and deer feeding was well controlled by installation of fencing. Yields ranged from 21.1

to 40.1 cwt/acre with a mean of 31.1 cwt/acre. Variability was moderate (CV=10.0%) resulting in a LSD value of 3.6 cwt/acre needed for significance. Seven entries significantly out-yielded the test mean, including breeding lines from all three kidney classes, and the variety Coho. It is worth mentioning that all had little to no common bacterial blight infection (CBB=1.0) vs the significant infection observed in lower yielding entries. This suggests efforts to breed for improved genetic resistance to CBB has been effective. LRK breeding line K17703 exhibited excellent upright plant habit and uniform dry down, but yielded 2cwt less than Coho, albeit with significantly larger seed (59.7g) than Coho (50.3g). K16924 exhibited uniform mid-season maturity with large WK seed and yielded 2.6cwt greater than Snowdon. Red Cedar (33.9cwt) was the only other kidney variety above test mean, while cranberry AAC Scotty (32.1cwt) from Ontario also was above mean despite suffering significant CBB infection. Check varieties Snowdon, Red Hawk, CELRK, and Beluga clustered just below the mean. New WK ND Whitetail yielded 2cwt less than Beluga, and equivalent to Montcalm. Clouseau was severely infected with CBB, which reduced yield to 21.9 cwt. A limited amount of anthracnose race 2 infection was observed in this trial in Montcalm, Red Cedar, Coho, ND Whitetail, and K17201. Canning trials will be conducted, and anthracnose resistance confirmed prior to advancing these lines for further testing.

Expt. 2015: Standard Yellow Bean Yield Trial

This 25-entry trial was conducted to evaluate advanced breeding lines and commercial varieties. Yields ranged from 22.6 to 33.1 cwt/acre with a mean of 26.3 cwt/acre. Variability was moderate (CV=9.6%) and the LSD needed for significance was 3.5 cwt/acre. Only two lines significantly out-yielded the test mean. Y18702 had the largest seed size (66.1g) but inferior seed color. Y19810 had similar seed size to SVS-0863, with significantly more yield potential. The two check varieties SVS-0863 and new release Yellowstone both ranked below the test mean. Yellowstone's lackluster performance may have been affected by poor seed quality planted in 2020 after most seed was lost in 2019 to anthracnose. Y19817 was identified as possessing excellent bright yellow seed color with a taller plant than Yellowstone. In general, this yellow bean trial shows the need for continued efforts to incorporate genetic diversity into the program to facilitate future gains. Compared to the adjacent kidney trials, yield potential of yellows still does not match the kidney class that has benefitted from more intensive history of breeding in Michigan. Efforts are also ongoing to incorporate anthracnose resistance.

Expt. 2016: Preliminary Dark and Light Red Kidney Bean Yield Trial

This 95-entry trial was conducted to compare the performance of new dark and light red kidney bean lines from MSU grown under supplemental irrigation. Seed supply was limited by delays in Puerto Rico winter nursery necessitating the use of the modified augmented design with a single replication. Yields ranged from 19.5 to 43.6 cwt/acre with a mean of 33.5 cwt/acre. Variability was low (CV=8.8%) in this experiment resulting in an LSD value of 6.1 cwt/acre needed for significance. Despite the high LSD that resulted from the lack of replication, thirteen lines significantly out-yielded the test mean and these included seven LRK, five DRK breeding lines as well as Coho. A striking feature of these top yielding lines was the prevalence of K17703 progeny, suggesting that line has excellent general combining ability. The remaining lines in this group were descendants of Red Cedar or Coho, underscoring the importance of combining the best recent varieties with diverse breeding lines to assemble superior genetic combinations that deliver robust performance. It was also encouraging to see more recent varieties Coho and Red Cedar rank above older variety Red Hawk. This trial will be evaluated for canning quality and anthracnose resistance and the most desirable breeding lines will advance to a fully replicated trial in 2021.

Expt. 2017: Preliminary Yellow Bean Yield Trial

This 23-entry trial was conducted to compare the performance of new yellow bean lines grown under supplemental irrigation. The trial was ravaged by an outbreak of anthracnose race 2 resulting in only 14 entries harvested. Yields were lower and ranged from 5.7 to 26.5 cwt/acre with a mean of 17.0 cwt/acre. Variability was very high (CV=24.5%) in this 1-rep augmented design experiment resulting in a LSD value of 8.2 cwt/acre needed for significance. Three entries significantly out yielded the test mean and these included SVS-0863 and Yellowstone, as well as Beluga WK that was included as a yield check. Y20917 and Y20903 that yielded less than Yellowstone but more than Patron appear to combine early maturity and acceptable seed size with favorable agronomic traits (Lodging=1, DS=5) and warrant testing in 2021. Otherwise, this trial had little breeding potential. The complete susceptibility of the yellow bean class to anthracnose may present an obstacle to increased commercial production in Michigan and has been prioritized as a breeding objective. Additionally, the class lacks diversity and continued efforts will be made to introgress germplasm from outside our program to revitalize the class. Most yellow beans are currently destined for the dry pack market where seed size and color are the critical traits, but canning trials will also be conducted to identify any lines that may be well suited to that use as well.

Expt. 2018: Red Hawk x Sacramento RILs Preliminary Yield Trial

This 101-entry trial was conducted to evaluate the yield potential of an F_6 recombinant inbred line (RIL) population developed by Dr. Ali Soltani to combine the heat tolerance traits of Sacramento with the heat sensitive dark red kidney market class. These same lines were also evaluated for heat stress under intense summer conditions in Puerto Rico by Dr. Timothy Porch. Yield ranged from 8.8 cwt/acre to 31.9 cwt/acre with a mean of 22.2 cwt/acre. Eleven lines significantly exceeded the trial mean, and Coho was the highest yielding entry. It is worth noting that this trial was direct harvested, which likely decreased measured yield due to harvest loss. The other prominent feature was uniformly severe CBB infection across the field. The exception was Coho (CBB=1.3) and Red Cedar (1.7) which highlights the improved tolerance to CBB as a result of breeding in these newer varieties. In contrast, all the older varieties were rated CBB=3-5, and yield reductions were observed. Minimal notes were taken on this trial as all entries appeared similarly average. Yield and seed size data from this trial will be compared with heat tolerance data from Puerto Rico to guide selection of a few lines each of both DRK and LRK classes that can be advanced and used as germplasm to enhance heat tolerance traits.

Expt. 2019: National White Mold Yield Trial

This 40-entry trial was conducted to evaluate a range of diverse dry bean varieties and breeding lines for reaction to white mold under natural field conditions. Genotypes included commercial navy and black bean cultivars, elite MSU lines, and new sources of white mold resistance entered as part of the National *Sclerotinia* Initiative (NSI) Nursery. Lines in the National trial were developed at MSU, USDA-WA, and NDSU. Entries were planted in two row plots with two rows of susceptible spreader variety Black Bear between plots and were direct harvested. Plots were fertilized with 120 lbs N/ acre to promote vegetative growth and supplemental overhead irrigation was applied 20 times for a total of 14.7" to maintain adequate levels of moisture for favorable disease development at the critical flowering period. Due to a change in crop rotations, the trial was planted on land that had not been planted to beans in 20+ yrs. However, natural white mold infection did occur in spreader rows, and was quite severe on some check varieties. Overall disease pressure was moderate. White mold was rated on a per plot basis on a scale of 1 to 9 based on disease incidence and severity where 9 had 90+% incidence and high severity index. White mold ranged from 18.5 to 100% with a mean value of 40.4%. The susceptible check Beryl had the highest white mold rating. The test ranged in yield from 13.8 to 51.4 cwt/acre with a mean yield of 35.1 cwt/acre. Variability was low (CV=8.9%), with a LSD value of 4.2 cwt/acre needed for significance. Twelve lines significantly out-yielded the test mean and included new release Charro (51.4 cwt/a), Zenith, Cayenne, and Eiger. Among this group, Charro produced exceptional yield, despite a rating of 48.1% for WM. G19609 ranked 2nd for yield, and lowest for mold, at 18.5%. Small red R17604 was 3rd highest yield, and showed similarly low 29.6% WM. As in previous years, it is interesting that in this high management location, the medium seeded pinto, GN, and small red lines significantly outperformed the small seeded black and navy bean lines. Standability and plant architectural avoidance remain a key trait in avoiding white mold in this trial. The trade off in erectness versus yield (pod load) is a major factor in avoidance of white mold. G122 resistant check and Beryl susceptible check were among the lowest yielding entries as in previous years yet differ in white mold infection from 22.2% to 100%. This trial will continue to be part of the breeding effort to improve tolerance to white mold in future varieties in 2021.

Early Generation Breeding Material grown in Michigan in 2020

F3 through F5 lines
Navy and Black - 924 lines
Pinto - 184 lines
GN - 197 lines
Pinks and Reds – 309 lines
Kidneys (DR, LR, White) - 328 lines
Yellow – 73 lines

F2 populations
Navy and Black -183 populations
Pinto - 44 populations
GN - 43 populations
Pinks and Reds - 14 populations
Kidneys (DR, LR, White) - 23 populations

F1 populations: 271 different crosses among ten contrasting seed types.

2020 DRY BEAN YIELD TRIALS

Experiment	Title	Planting Date	Location	Entries	Design	Reps	Harvest Method
2001	STANDARD NAVY BEAN YIELD TRIAL	6/5/2020	SVREC	36	ALPHA LATTICE	4	DIRECT
2002	STANDARD BLACK BEAN YIELD TRIAL +N	6/5/2020	SVREC	36	ALPHA LATTICE	4	DIRECT
2003	PRELIMINARY NAVY BEAN YIELD TRIAL	6/17/2020	SVREC	84	AUG. DESIGN	1	DIRECT
2004	PRELIMINARY BLACK BEAN YIELD TRIAL	6/17/2020	SVREC	146	AUG. DESIGN	1	DIRECT
2005	STANDARD GREAT NORTHERN BEAN YIELD TRIAL	6/5/2020	SVREC	24	ALPHA LATTICE	4	DIRECT
2006	STANDARD PINTO BEAN YIELD TRIAL	6/17/2020	SVREC	16	ALPHA LATTICE	3	DIRECT
2007	STANDARD RED AND PINK BEAN YIELD TRIAL	6/5/2020	SVREC	18	ALPHA LATTICE	4	DIRECT
2008	PRELIMINARY GREAT NORTHERN BEAN YIELD TRIAL	6/17/2020	SVREC	60	RCBD	1	ABANDONED
2009	PRELIMINARY RED AND PINK BEAN YIELD TRIAL	6/18/2020	SVREC	159	AUG. DESIGN	1	DIRECT
2011	MIDWEST AND CO-OP REGIONAL TRIAL	6/5/2020	SVREC	40	ALPHA LATTICE	3	DIRECT
2012	NATIONAL DRYBEAN DROUGHT YIELD TRIAL	6/5/2020	SVREC	32	ALPHA LATTICE	3	DIRECT
2013	STANDARD BLACK BEAN YIELD TRIAL -N	6/5/2020	SVREC	36	ALPHA LATTICE	4	DIRECT
2014	STANDARD KIDNEY BEAN YIELD TRIAL	6/12/2020	MRF	42	ALPHA LATTICE	4	ROD PULLED
2015	STANDARD YELLOW BEAN YIELD TRIAL	6/12/2020	MRF	25	ALPHA LATTICE	3	ROD PULLED
2016	PRELIMINARY LIGHT AND DARK RED KIDNEY YIELD TRIAL	6/16/2020	MRF	95	AUG. DESIGN	1	ROD PULLED
2017	PRELIMINARY YELLOW BEAN YIELD TRIAL	6/16/2020	MRF	14	AUG. DESIGN	1	ROD PULLED
2018	PRELIMINARY KIDNEY YIELD TRIAL (RED HAWK/SACRAMENTO)	6/12/2020	MRF	101	AUG. DESIGN	1	DIRECT
2019	NATIONAL WHITE MOLD YIELD TRIAL	6/12/2020	MRF	40	ALPHA LATTICE	3	DIRECT

PROCEDURE: PLANTED IN 4 ROW PLOTS, 20 FEET LONG, 20 INCH ROW WIDTH, 4 SEEDS/FOOT, 15 FOOT SECTION OF CENTER 2 ROWS WAS HARVESTED AT MATURITY.

SVREC-FRANKENMUTH: FERTILIZER BROADCAST: 650# OF 8-27-19 + S, ZN,MN PRIOR TO PLANTING.
HERBICIDES APPLIED: 1 PT DUAL + 1 QT EPTAM + 1.5 PT PROWL APPLIED PPI ON JUNE 4.
16 OZ. BASAGRAN + 8 OZ. REFLEX + 4 OZ. RAPTOR ON JULY 13.
INSECTICIDE: 4 OZ. MUSTANG MAXX ON JULY 7.

MRF-ENTRICAN: FERTILIZER BROADCAST: 200# OF 19-10-19 PRIOR TO PLANTING. 100# 46-0-0 SIDE DRESSED ON JULY 23.
HERBICIDES APPLIED: 1.0 QT DUAL + 1.25 QT EPTAM + 1.0 QT SONOLAN APPLIED PPI.
4 OZ. RAPTOR + 16 OZ. REFLEX + 16 OZ. BASAGRAN + 12 OZ. SELECT ON JULY 7.
INSECTICIDE: 4 OZ MUSTANG MAXX ON JULY 7, JULY 23, JULY 31.
FUNGICIDE: 8 OZ. PRIAXOR JULY 31 and AUGUST 7.

EXPERIMENT 2001 STANDARD NAVY BEAN YIELD TRIAL							PLANTED: 6/5/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
N19226	N14243/N15326	30	40.6	18.6	46.0	96.0	1.5	50.8	5.8	3.0
N19246	N15331/N16405	21	37.0	20.6	45.0	96.0	1.3	48.5	5.5	2.0
N19239	N15331/N16404	18	36.8	20.5	45.0	97.0	1.5	46.3	5.5	2.5
N19243	N15331/N16405	27	36.4	20.8	46.0	97.0	1.5	47.3	5.5	3.5
N19277	N14229/N14218	17	35.7	17.8	46.0	97.0	1.8	48.8	5.5	2.0
N19290	N13142/B14302	34	35.0	18.8	48.0	97.0	1.8	49.8	5.3	1.5
N19285	G14505/X16708	6	34.6	22.9	44.0	97.0	2.8	45.0	4.0	2.5
I20815	**Valiant**	36	34.4	21.3	43.0	96.0	1.8	46.8	5.0	2.5
N18105	N13131/N14201	10	34.2	20.6	45.0	96.0	1.0	57.3	6.0	2.5
N18122	N15334/N15335	9	34.0	21.4	45.0	96.0	1.0	58.0	6.5	2.5
N19240	N15331/N16404	23	33.6	20.0	45.0	96.0	1.5	47.3	5.5	3.0
N17505	N14230/N12447	4	33.5	21.5	46.0	97.0	1.0	50.3	6.0	2.0
N18103	N13120/PR00806-81	1	33.4	21.9	45.0	96.0	1.3	48.3	5.0	2.5
N19269	B15453/N14243	26	33.3	20.5	47.0	96.0	1.0	50.3	6.0	3.5
N18130	N15341/N14238	7	33.2	20.6	49.0	96.0	1.3	51.5	5.8	4.0
N17506	N14230/N12447	11	33.2	18.4	48.0	97.0	1.3	46.5	5.3	1.5
N19223	N14230/N16405	24	32.4	18.8	48.0	96.0	1.3	53.5	5.3	3.5
N19284	G14505/X16708	14	32.1	22.3	46.0	96.0	1.0	49.8	5.5	2.0
N19252	N15335/N14243	19	32.0	19.7	45.0	96.0	1.3	45.3	5.3	3.0
N18102	N13120/PR0806-81	13	31.8	20.0	46.0	96.0	1.3	47.5	5.3	4.0
N19253	N15335/N14243	22	31.7	18.2	47.0	96.0	1.3	51.8	6.0	3.5
N19281	N14243/N14218	29	31.6	20.4	48.0	96.0	1.5	48.5	5.3	3.0
N19216	N14201/N15331	28	31.4	18.9	47.0	97.0	1.5	53.3	5.5	2.5
N19283	N14243/N14218	33	31.4	19.2	48.0	97.0	1.8	50.8	5.3	2.5
N19248	N15331/N16405	20	31.2	18.9	45.0	96.0	1.3	43.5	5.3	4.0
N18104	N13131/N14201	8	30.6	20.8	46.0	96.0	1.3	49.0	6.0	1.0
N18128	N15341/N14238	5	30.4	21.7	45.0	96.0	1.3	53.0	6.0	5.0
N15306	N11230/N11298	12	30.4	19.3	48.0	97.0	1.0	47.3	5.3	4.0
N19262	N16405/B16504	25	30.1	19.4	44.0	96.0	1.0	39.3	5.0	3.0
I11264	COOP 03019, **MERLIN**	16	28.7	20.8	45.0	97.0	1.8	45.5	5.0	5.0
I19712	**AC PORTAGE**	35	28.2	20.2	43.0	97.0	1.5	48.5	5.0	1.0
N11283	MEDALIST/N08003, **ALPENA**	2	27.9	19.8	45.0	97.0	2.0	54.3	5.0	4.5
N19204	N14229/I15616	31	27.7	19.4	46.0	96.0	1.0	49.3	5.8	4.0
I08958	Mayflower/Avanti, **MEDALIST**	3	27.7	20.1	44.0	97.0	2.5	50.0	4.8	3.5
I10101	COOP 02084, **VIGILANT**	15	27.1	20.6	45.0	97.0	1.3	51.0	5.0	4.5
N19271	G14505//N13120/PR0806-81A	32	25.6	22.2	44.0	97.0	1.5	47.3	5.0	4.5
MEAN(36)			32.2	20.2	45.5	96.4	1.4	49.2	5.4	3.0
LSD(.05)			3.3	1.0	1.3	0.5	0.5	5.0	0.6	1.7
CV%			8.7	4.3	1.6	0.4	29.7	8.7	10.7	33.3

EXPERIMENT 2002 STANDARD BLACK BEAN YIELD TRIAL (+N) **PLANTED: 6/5/20**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B19309	B15414/B16504	23	38.7	21.5	47.0	96.0	1.0	51.8	6.0	1.5
B18504	Zenith//Alpena*/B09197, **ADAMS**	3	35.9	21.6	45.0	97.0	1.8	48.5	5.3	2.5
B19344	B16506/B16507	24	34.5	22.5	44.0	97.0	1.3	48.3	5.8	2.0
B19330	B16501/B15414	19	33.6	22.8	46.0	97.0	1.3	50.8	5.5	3.0
B19504	Reselection of B16504 (SS)	35	33.2	20.3	46.0	97.0	1.3	49.3	5.8	2.5
B10244	B04644/ZORRO, **ZENITH**	15	32.9	23.2	45.0	97.0	1.0	44.8	5.8	2.5
B19345	B16506/B16507	26	32.7	21.1	45.0	96.0	1.0	49.8	5.8	2.5
B16504	Zenith//Alpena*/B09197	9	32.7	21.3	46.0	97.0	1.8	50.0	5.8	2.0
I17501	Jaguar/BL05222, **BLACK BEAR**	10	32.3	24.4	46.0	98.0	1.3	52.3	6.0	3.5
B19340	B16507/B15453	30	32.2	24.7	45.0	97.0	1.0	48.8	5.8	0.5
B16505	B11363//Alpena*/B09197	6	31.8	22.8	45.0	96.0	1.3	46.5	5.3	2.0
B17259	B10244/B12724	13	31.6	21.9	45.0	96.0	1.0	46.5	5.5	3.5
B04554	B00103*/X00822, **ZORRO**	17	31.6	21.6	47.0	97.0	1.5	49.5	5.3	3.0
B19339	B16507/B15453	33	31.4	23.8	46.0	97.0	1.3	50.3	5.5	1.5
B17220	B10244/B12724	2	31.3	21.7	45.0	96.0	1.3	46.3	5.3	2.5
B17207	B10244/B12724	12	30.9	19.8	45.0	96.0	1.0	47.8	5.8	5.0
B16501	Zenith/B10215	1	30.8	21.8	46.0	97.0	1.0	42.8	5.3	4.0
B19302	N16405/B16504	28	30.5	19.4	46.0	96.0	1.0	43.3	6.0	3.5
I03390	ND9902621-2, **ECLIPSE**	18	30.3	21.5	45.0	97.0	1.3	45.3	5.5	3.5
B19341	B16507/B16501	25	30.2	22.4	46.0	97.0	1.0	38.8	4.8	2.5
B18236	B14303/B12724	4	30.1	19.6	46.0	96.0	1.3	45.0	5.5	1.5
B19332	B16501/B15464	22	30.1	20.8	46.0	97.0	1.0	46.0	5.5	1.5
B19312	B15417/B15442	20	29.3	23.8	45.0	97.0	1.0	50.8	5.8	2.5
B18237	B14303/B12724	14	29.0	20.7	46.0	97.0	1.3	43.3	5.5	1.0
B19328	B15464/B15417	27	28.9	21.6	45.0	96.0	1.0	44.3	5.5	0.5
B18232	B15430/B10244	8	28.7	22.5	45.0	96.0	1.0	43.5	5.5	2.0
B18201	B10244/B13218	16	28.7	20.7	46.0	97.0	1.0	46.5	5.0	4.0
B17897	B14302/B10244	5	28.6	19.6	46.0	96.0	1.0	47.3	5.8	2.5
B17922	B14302/B10244	11	28.4	19.5	47.0	96.0	1.5	48.5	5.3	3.5
B18204	B10244/B15430	7	28.0	22.2	45.0	96.0	1.0	42.5	5.8	2.5
B19346	B15414/B16504	21	27.8	22.0	46.0	96.0	1.0	39.0	5.0	3.0
I19711	NE14-18-4	36	26.5	25.1	43.0	97.0	2.5	39.0	4.5	1.5
I19701	NDF120287, **ND TWILIGHT**	34	25.3	20.8	45.0	96.0	1.8	41.3	5.0	2.0
I19710	**AAC Knight Rider**	32	24.9	20.3	46.0	97.0	2.0	49.8	5.3	2.0
I19703	BL14506, **BLACK BEARD**	29	24.2	22.9	46.0	98.0	1.0	52.0	6.0	5.0
I07112	**R99 NO NOD**	31	8.3	17.1	45.0	105.0	2.0	44.5	4.0	3.0
MEAN(36)			29.9	21.6	45.3	96.7	1.3	46.5	5.4	2.5
LSD(.05)			3.6	1.0	1.0	0.4	0.4	5.3	0.6	1.6
CV%			10.2	4.0	1.3	0.4	28.7	9.7	10.7	37.7

EXPERIMENT 2003 PRELIMINARY NAVY BEAN YIELD TRIAL								PLANTED: 6/17/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
N11283	MEDALIST/N08003, **ALPENA**	91	36.8	19.0	47.0	93.0	2.3	49.1	4.8	2.3
I11264	COOP 03019, **MERLIN**	93	35.1	20.1	47.0	92.0	1.7	53.0	5.0	2.0
I10101	COOP 02084, **VIGILANT**	92	34.4	19.8	47.0	94.0	2.3	44.7	4.0	2.0
N20351	N16405/G16301	46	31.0	25.2	47.0	93.0	3.0	44.0	5.0	3.0
N20388	B15430/N14229	73	30.6	20.2	48.0	93.0	2.0	50.0	5.0	5.0
N20404	B16505/N17504	89	30.1	18.8	46.0	93.0	3.0	40.0	5.0	1.0
N20352	N16405/G16301	47	29.7	26.2	47.0	94.0	3.0	57.0	4.0	3.0
N20348	N16405/N17506	43	28.7	19.3	54.0	94.0	3.0	40.0	3.0	3.0
N20395	B16504/N17504	80	28.6	18.4	47.0	94.0	2.0	47.0	5.0	3.0
N20372	N17506/N14229	60	28.3	16.1	49.0	94.0	3.0	46.0	4.0	4.0
N20336	N15306/N14218	32	27.8	18.2	52.0	95.0	3.0	30.0	4.0	4.0
N20335	N14229/G14503	31	27.8	17.2	50.0	94.0	3.0	54.0	5.0	2.0
N20347	N16405/N15337	42	27.0	17.9	48.0	94.0	3.0	42.0	3.0	3.0
N20381	N17506/B15430	66	26.7	18.9	50.0	95.0	3.0	38.0	3.0	3.0
N20342	N15337/N16405	37	26.3	17.3	52.0	94.0	3.0	45.0	5.0	5.0
N20401	B16505/N17504	86	26.3	17.7	49.0	94.0	2.0	54.0	5.0	2.0
N20371	N17506/N14229	59	26.0	17.0	48.0	93.0	2.0	36.0	5.0	5.0
N20385	N14229/N17506	70	26.0	18.4	53.0	94.0	3.0	44.0	3.0	2.0
N20391	B16504/N14218	76	25.6	18.0	53.0	94.0	2.0	50.0	5.0	2.0
N20369	N17504/B15430	57	24.7	18.8	54.0	94.0	2.0	44.0	5.0	3.0
N20405	B17523/B16504	90	24.5	18.8	49.0	96.0	3.0	44.0	4.0	2.0
N20380	N17506/B15430	65	24.2	19.8	53.0	96.0	3.0	37.0	3.0	3.0
N20337	N15306/N14218	33	24.1	17.8	53.0	96.0	4.0	55.0	2.0	1.0
N20343	N15337/N16405	38	23.9	17.4	47.0	95.0	3.0	39.0	4.0	3.0
N20362	N17504/N15337	50	23.9	19.0	49.0	96.0	4.0	45.0	4.0	1.0
N20338	N15306/N14218	34	23.9	16.7	53.0	95.0	3.0	46.0	4.0	2.0
N20349	N16405/G16301	44	23.0	27.3	48.0	96.0	4.0	47.0	2.0	4.0
N20376	N17506/N16405	62	22.3	18.5	49.0	94.0	3.0	51.0	4.0	3.0
N20346	N16405/N15337	41	22.2	19.9	52.0	95.0	3.0	47.0	4.0	2.0
N20341	N15337/N16405	36	22.0	18.7	53.0	96.0	3.0	58.0	4.0	3.0

EXPERIMENT 2003 PRELIMINARY NAVY BEAN YIELD TRIAL								PLANTED: 6/17/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
N20384	N14229/N17506	69	21.9	18.0	47.0	94.0	3.0	47.0	4.0	2.0
N20390	B16504/B14302	75	21.9	17.6	53.0	94.0	3.0	40.0	3.0	1.0
N20360	N17504/N14229	48	21.5	19.4	51.0	97.0	3.0	44.0	2.0	3.0
N20317	N14218/N17504	13	21.2	18.6	48.0	93.0	3.0	46.0	4.0	2.0
N20386	B14302/N17504	71	21.0	16.2	48.0	92.0	1.0	50.0	6.0	1.0
N20319	N14229/N15306	15	21.0	18.9	48.0	94.0	3.0	30.0	3.0	3.0
N20345	N15337/G17913	40	20.9	20.2	53.0	96.0	3.0	54.0	4.0	5.0
N20387	B14302/N17504	72	20.6	17.4	51.0	94.0	2.0	50.0	4.0	1.0
N20361	N17504/N15337	49	20.4	18.7	47.0	95.0	3.0	45.0	4.0	3.0
N20344	N15337/G17913	39	19.9	19.3	49.0	94.0	3.0	50.0	4.0	3.0
N20334	N14229/B16504	30	19.2	18.6	54.0	95.0	3.0	50.0	4.0	2.0
N20329	N14229/B16504	25	19.1	18.9	49.0	97.0	3.0	43.0	2.0	4.0
N20378	N17506/B15430	64	19.1	20.9	49.0	96.0	3.0	37.0	4.0	2.0
N20363	N17504/N16405	51	19.0	17.3	50.0	94.0	2.0	53.0	5.0	4.0
N20402	B16505/N17504	87	18.7	19.4	49.0	97.0	3.0	46.0	2.0	2.0
N20325	N14229/B14302	21	18.5	21.0	52.0	96.0	3.0	50.0	4.0	3.0
N20403	B16505/N17504	88	18.1	18.2	47.0	93.0	2.0	36.0	5.0	5.0
N20323	N14229/N17504	19	18.0	15.5	53.0	94.0	3.0	42.0	4.0	1.0
N20389	B15430/N14229	74	17.8	20.0	47.0	96.0	3.0	39.0	2.0	1.0
N20398	B16505/B11617	83	17.4	17.1	47.0	95.0	3.0	48.0	4.0	2.0
N20392	B16504/N14218	77	17.4	18.6	54.0	95.0	3.0	40.0	3.0	4.0
N20364	N17504/N16405	52	17.2	16.4	53.0	92.0	2.0	48.0	4.0	4.0
N20383	N14229/N17506	68	16.1	17.1	50.0	95.0	3.0	50.0	5.0	3.0
N20332	N14229/B16504	28	15.8	20.9	48.0	96.0	3.0	50.0	4.0	1.0
N20306	N14218/N15306	6	15.0	19.2	53.0	96.0	3.0	37.0	2.0	4.0
N20339	N15306/N14218	35	15.0	18.7	53.0	96.0	3.0	30.0	3.0	3.0
N20377	N17506/N16405	63	14.4	19.9	53.0	94.0	3.0	45.0	3.0	1.0
N20367	N17504/B15430	55	14.4	24.1	47.0	95.0	3.0	39.0	3.0	4.0
N20350	N16405/G16301	45	14.1	21.7	53.0	97.0	4.0	34.0	2.0	4.0
N20333	N14229/B16504	29	13.9	19.8	50.0	98.0	3.0	35.0	2.0	3.0

EXPERIMENT 2003 PRELIMINARY NAVY BEAN YIELD TRIAL							PLANTED: 6/17/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
N20382	N14229/N17506	67	13.8	17.8	53.0	95.0	1.0	43.0	4.0	3.0
N20316	N14218/N17504	12	13.1	19.1	53.0	96.0	4.0	46.0	4.0	3.0
N20370	N17504/B15430	58	12.6	19.9	54.0	96.0	3.0	41.0	3.0	3.0
N20396	B16504/N17504	81	12.3	17.2	49.0	95.0	2.0	40.0	4.0	1.0
N20400	B16505/N14229	85	12.1	16.2	48.0	96.0	3.0	40.0	4.0	1.0
N20321	N14229/N17504	17	11.6	18.3	53.0	97.0	3.0	30.0	4.0	3.0
N20406	B17523/N14218	20	11.3	20.9	49.0	94.0	3.0	44.0	4.0	2.0
N20303	N14218/N15306	3	10.7	16.8	53.0	96.0	4.0	33.0	3.0	1.0
N20320	N14229/N15306	16	10.1	18.6	53.0	94.0	3.0	50.0	2.0	4.0
N20366	N17504/N16405	54	10.0	19.1	47.0	96.0	3.0	48.0	3.0	2.0
N20322	N14229/N17504	18	9.2	17.3	50.0	96.0	3.0	30.0	3.0	1.0
N20368	N17504/B15430	56	9.2	23.7	49.0	96.0	4.0	40.0	4.0	2.0
N20301	N14218/N15306	1	8.6	17.5	52.0	96.0	3.0	42.0	4.0	4.0
N20331	N14229/B16504	27	8.6	18.3	48.0	96.0	3.0	29.0	4.0	2.0
N20373	N17506/N14229	61	8.3	16.4	51.0	94.0	1.0	48.0	5.0	4.0
N20308	N14218/N15306	8	8.1	19.3	55.0	97.0	4.0	37.0	2.0	1.0
N20318	N14229/N15306	14	7.4	21.2	53.0	96.0	3.0	39.0	3.0	2.0
N20310	N14218/N15306	9	6.8	17.9	53.0	96.0	3.0	40.0	4.0	2.0
N20365	N17504/N16405	53	6.1	20.5	49.0	96.0	3.0	31.0	3.0	3.0
N20394	B16504/N14229	79	6.1	19.6	53.0	97.0	4.0	30.0	3.0	3.0
N20307	N14218/N15306	7	5.9	19.2	53.0	95.0	4.0	45.0	4.0	3.0
N20393	B16504/N14229	78	2.9	20.8	52.0	96.0	2.0	40.0	3.0	2.0
N20328	N14229/B14302	24	2.0	19.4	53.0	97.0	3.0	32.0	4.0	2.0
N20304	N14218/N15306	4	1.4	21.1	54.0	96.0	3.0	29.0	4.0	2.0
MEAN(84)			23.1	19.0	50.4	95.0	2.9	43.0	3.7	2.6
LSD(.05)			-	1.5	1.2	1.5	1.3	12.3	1.0	1.9
CV%			7.2	3.8	1.2	0.8	21.9	13.7	13.2	33.9

EXPERIMENT 2004 PRELIMINARY BLACK BEAN YIELD TRIAL — PLANTED: 6/17/20

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B20599	B16506/B15430	93	40.6	21.4	47.0	92.0	3.0	49.0	5.0	1.0
B18504	Zenith//Alpena*/B09197, **ADAMS**	145	40.6	20.3	47.0	93.0	2.5	47.6	4.5	1.7
B20591	B16505/B16504	85	40.4	20.2	47.0	92.0	2.0	49.0	5.0	1.0
B20597	B16506/B15430	91	40.1	21.1	47.0	92.0	2.0	59.0	6.0	1.0
B20547	B16501/B16504	44	40.0	19.9	47.0	94.0	1.0	52.0	5.0	2.0
B19330	B16501/B15414	144	37.0	21.9	47.0	93.0	1.0	55.0	5.0	1.0
B10244	B04644/ZORRO, **ZENITH**	146	36.5	20.7	47.0	92.0	1.9	52.4	5.5	1.9
B20549	B16501/B16504	46	36.1	22.8	47.0	92.0	1.0	58.0	6.0	2.0
B20531	B15430/B16504	28	35.4	19.3	47.0	94.0	4.0	48.0	3.0	1.0
B20602	B16506/B16504	96	35.3	21.8	48.0	92.0	2.0	46.0	6.0	3.0
B20537	B15430/B16504	34	35.1	22.8	47.0	93.0	3.0	47.0	4.0	1.0
B20638	B17730/B15430	132	34.6	20.1	47.0	92.0	2.0	50.0	5.0	1.0
B20532	B15430/B16504	29	34.5	20.0	47.0	92.0	2.0	48.0	4.0	2.0
B20535	B15430/B16504	32	34.4	20.6	49.0	94.0	2.0	53.0	5.0	1.0
B20642	B17730/B16504	136	34.3	19.2	53.0	95.0	2.0	47.0	4.0	1.0
B20553	B16504/B11519	49	34.2	18.8	47.0	92.0	2.0	50.0	5.0	2.0
B20617	B17106/N14218	111	34.2	19.6	47.0	92.0	1.0	59.0	6.0	1.0
B20601	B16506/B16504	95	33.8	21.7	47.0	93.0	2.0	47.0	5.0	1.0
B20620	B17106/N14218	114	33.6	18.4	47.0	92.0	2.0	50.0	5.0	2.0
B20598	B16506/B15430	92	33.6	21.3	47.0	92.0	1.0	60.0	6.0	2.0
B20541	B16501/B15430	38	33.5	20.7	52.0	94.0	2.0	46.0	4.0	2.0
B20629	B17692/B16504	123	33.4	18.1	47.0	92.0	2.0	48.0	5.0	3.0
B20542	B16501/B15430	39	33.3	19.1	47.0	92.0	1.0	54.0	5.0	2.0
B20528	B14302/B15430	25	33.2	20.2	47.0	95.0	3.0	50.0	4.0	1.0
B20533	B15430/B16504	30	33.0	20.1	53.0	96.0	4.0	45.0	2.0	1.0
B20536	B15430/B16504	33	33.0	21.5	47.0	93.0	2.0	48.0	5.0	1.0
B20527	B14302/B15430	24	32.9	19.1	47.0	95.0	3.0	46.0	4.0	1.0
B20582	B16504/B17523	76	32.5	18.2	47.0	93.0	2.0	56.0	5.0	3.0
B20570	B16504/B17106	65	32.4	21.0	47.0	95.0	3.0	45.0	2.0	1.0
B20632	B17692/B16504	126	32.4	18.8	53.0	92.0	2.0	48.0	5.0	3.0
B20590	B16505/B16504	84	32.4	18.6	47.0	94.0	2.0	48.0	5.0	2.0
B20621	B17106/N14218	115	32.4	18.4	47.0	92.0	2.0	50.0	5.0	2.0
B20538	B15430/B16504	35	32.3	20.7	47.0	93.0	2.0	60.0	5.0	2.0
B20572	B16504/B17106	67	32.3	21.0	48.0	95.0	3.0	45.0	4.0	2.0
B20551	B16504/B11519	47	32.3	21.4	47.0	92.0	3.0	55.0	4.0	2.0

EXPERIMENT 2004 PRELIMINARY BLACK BEAN YIELD TRIAL									PLANTED: 6/17/20	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B20639	B17730/B15430	133	32.2	18.2	54.0	93.0	2.0	56.0	5.0	1.0
B20612	B17106/B16504	106	32.2	17.1	47.0	93.0	3.0	54.0	4.0	4.0
B20623	B17523/B16504	117	32.2	19.5	47.0	94.0	3.0	48.0	4.0	2.0
B20509	N17504/B15430	8	32.1	19.6	49.0	93.0	2.0	56.0	5.0	3.0
B20645	I93153/B16504	139	32.1	19.4	48.0	92.0	2.0	46.0	5.0	1.0
B20516	N17504/B17106	13	32.0	19.4	47.0	92.0	2.0	55.0	6.0	2.0
B20618	B17106/N14218	112	32.0	18.6	47.0	92.0	3.0	46.0	5.0	3.0
B20625	B17523/B16504	119	31.9	19.5	54.0	94.0	4.0	40.0	4.0	3.0
B20627	B17540/N14218	121	31.9	18.2	48.0	92.0	2.0	49.0	6.0	2.0
B20579	B16504/B17259	74	31.8	21.7	48.0	95.0	2.0	39.0	4.0	2.0
B20594	B16505/N17504	88	31.7	18.1	47.0	92.0	1.0	50.0	6.0	1.0
B20587	B16504/N17504	81	31.6	18.6	54.0	95.0	2.0	55.0	4.0	3.0
B20556	B16504/B14302	52	31.3	19.6	52.0	93.0	1.0	55.0	5.0	4.0
B20595	B16505/N17504	89	31.2	18.4	47.0	92.0	2.0	44.0	5.0	5.0
B20526	B14302/B15430	23	31.2	18.9	47.0	94.0	3.0	41.0	4.0	2.0
B20501	N14218/B16504	1	31.2	19.1	55.0	96.0	4.0	56.0	4.0	1.0
B20616	B17106/B17259	110	31.1	18.9	47.0	94.0	2.0	49.0	5.0	2.0
I19703	BL14506, **BLACK BEARD**	147	31.1	21.1	47.0	94.0	1.9	60.6	5.0	4.3
B20543	B16501/B16504	40	30.9	20.0	47.0	92.0	1.0	60.0	5.0	2.0
B20555	B16504/B14302	51	30.8	21.3	47.0	93.0	3.0	49.0	4.0	5.0
B20649	B15430/B17996	143	30.8	21.1	46.0	92.0	3.0	41.0	5.0	2.0
B20506	N16405/B15430	5	30.8	19.1	53.0	94.0	3.0	50.0	4.0	1.0
B20646	I93153/B16504	140	30.7	20.0	47.0	94.0	2.0	55.0	5.0	2.0
B20588	B16504/I17560	82	30.7	18.6	47.0	94.0	3.0	56.0	4.0	4.0
B20564	B16504/B17106	60	30.6	18.1	51.0	93.0	4.0	53.0	3.0	2.0
B20515	N17504/B17106	12	30.4	19.3	51.0	95.0	3.0	44.0	4.0	3.0
B20557	B16504/B14302	53	30.4	15.2	47.0	92.0	2.0	56.0	5.0	1.0
B20600	B16506/B15430	94	30.4	21.7	48.0	96.0	4.0	42.0	2.0	1.0
B20575	B16504/B17228	70	30.4	20.9	53.0	96.0	4.0	47.0	3.0	4.0
B20569	B16504/B17106	64	30.3	20.3	47.0	94.0	4.0	50.0	4.0	2.0
B20574	B16504/B17106	69	30.2	20.6	48.0	95.0	3.0	45.0	4.0	3.0
B20545	B16501/B16504	42	30.0	21.1	48.0	96.0	3.0	31.0	4.0	4.0
B20563	B16504/B17106	59	30.0	20.0	51.0	92.0	3.0	45.0	5.0	2.0
B20622	B17106/N14218	116	29.9	18.4	47.0	92.0	2.0	50.0	5.0	1.0
B20544	B16501/B16504	41	29.8	18.3	47.0	92.0	1.0	58.0	5.0	4.0

EXPERIMENT 2004 PRELIMINARY BLACK BEAN YIELD TRIAL								PLANTED: 6/17/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B20607	B17106/B14302	101	29.7	17.5	47.0	92.0	1.0	49.0	6.0	1.0
B20508	N17504/B15430	7	29.6	18.1	48.0	94.0	3.0	58.0	5.0	3.0
B20562	B16504/B16501	58	29.4	16.9	48.0	96.0	4.0	46.0	4.0	2.0
B20554	B16504/B11519	50	29.3	18.0	48.0	92.0	2.0	50.0	5.0	4.0
B20546	B16501/B16504	43	29.2	20.7	49.0	96.0	3.0	50.0	4.0	2.0
B20534	B15430/B16504	31	29.2	19.8	47.0	95.0	4.0	50.0	2.0	1.0
B20613	B17106/B17259	107	29.1	18.1	47.0	92.0	2.0	52.0	5.0	2.0
B20529	B15430/B16504	26	29.0	21.5	48.0	92.0	2.0	41.0	5.0	1.0
B20614	B17106/B17259	108	28.9	17.6	47.0	92.0	2.0	56.0	5.0	2.0
B20628	B17540/N14218	122	28.9	17.0	48.0	92.0	2.0	46.0	5.0	2.0
B20565	B16504/B17106	61	28.8	18.3	51.0	92.0	3.0	40.0	4.0	2.0
B20580	B16504/B17259	75	28.8	20.6	48.0	92.0	3.0	45.0	5.0	2.0
B20619	B17106/N14218	113	28.6	17.7	47.0	92.0	2.0	54.0	5.0	1.0
B20611	B17106/B14302	105	28.6	17.0	47.0	93.0	3.0	54.0	4.0	3.0
B20637	B17692/B18504	131	28.5	21.0	54.0	94.0	3.0	48.0	2.0	1.0
B20586	B16504/B17536	80	28.4	17.5	53.0	95.0	3.0	37.0	4.0	4.0
B20512	N17504/B17106	9	28.3	17.6	51.0	93.0	3.0	46.0	4.0	4.0
B20517	N17504/B17106	14	28.0	17.2	46.0	92.0	2.0	46.0	5.0	4.0
B20578	B16504/B17228	73	28.0	18.8	47.0	95.0	4.0	49.0	2.0	1.0
B20610	B17106/B14302	104	27.9	17.2	49.0	92.0	1.0	54.0	5.0	1.0
B20609	B17106/B14302	103	27.9	16.5	49.0	92.0	2.0	60.0	5.0	1.0
B20596	B16505/N17504	90	27.7	18.4	47.0	92.0	1.0	50.0	5.0	3.0
B20568	B16504/B17106	63	27.7	21.7	53.0	93.0	3.0	40.0	4.0	2.0
B20524	B14302/B15430	21	27.6	20.6	53.0	95.0	3.0	49.0	4.0	2.0
B20589	B16505/B11617	83	27.4	17.2	54.0	94.0	3.0	41.0	4.0	3.0
B20615	B17106/B17259	109	26.6	17.3	47.0	92.0	3.0	50.0	4.0	1.0
B20507	N16405/B15430	6	26.6	19.9	47.0	92.0	2.0	46.0	5.0	1.0
B20573	B16504/B17106	68	26.6	20.6	50.0	96.0	4.0	40.0	4.0	2.0
B20592	B16505/B17108	86	26.3	20.8	48.0	95.0	2.0	42.0	4.0	1.0
B20525	B14302/B15430	22	26.1	19.2	47.0	92.0	1.0	50.0	5.0	1.0
B20576	B16504/B17228	71	26.1	18.8	47.0	96.0	4.0	45.0	3.0	3.0
B20585	B16504/B17536	79	25.9	17.1	52.0	95.0	3.0	46.0	4.0	5.0
B20604	B17106/B14302	98	25.8	17.4	47.0	92.0	2.0	46.0	5.0	1.0
B20593	B16505/B17108	87	25.8	20.6	47.0	94.0	2.0	48.0	5.0	3.0
B20513	N17504/B17106	10	25.8	16.6	48.0	92.0	1.0	47.0	5.0	1.0

EXPERIMENT 2004 PRELIMINARY BLACK BEAN YIELD TRIAL								PLANTED: 6/17/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B20606	B17106/B14302	100	25.7	17.0	49.0	92.0	1.0	50.0	6.0	2.0
B20648	B15430/B17996	142	25.7	20.3	48.0	94.0	3.0	54.0	3.0	1.0
B20518	B11519/B17106	15	25.6	18.8	47.0	93.0	2.0	56.0	4.0	2.0
B20631	B17692/B16504	125	25.6	17.8	48.0	93.0	2.0	51.0	5.0	3.0
B20514	N17504/B17106	11	25.5	15.5	52.0	93.0	3.0	46.0	4.0	4.0
B20605	B17106/B14302	99	25.4	15.8	47.0	92.0	2.0	52.0	5.0	1.0
B20584	B16504/B17523	78	25.4	17.1	52.0	95.0	3.0	41.0	4.0	2.0
B20603	B17106/B14302	97	25.2	17.7	48.0	92.0	1.0	56.0	5.0	3.0
B20643	B17996/B17540	137	25.2	19.6	47.0	95.0	3.0	36.0	4.0	1.0
B20636	B17692/B16504	130	25.2	17.6	48.0	94.0	3.0	50.0	4.0	3.0
B20608	B17106/B14302	102	25.0	17.3	51.0	92.0	2.0	55.0	5.0	1.0
B20641	B17730/B16504	135	25.0	19.2	53.0	95.0	2.0	60.0	4.0	1.0
B20624	B17523/B16504	118	24.9	18.6	48.0	95.0	3.0	60.0	4.0	4.0
B20523	B11519/B17106	20	24.9	16.1	48.0	96.0	3.0	49.0	4.0	1.0
B20522	B11519/B17106	19	24.9	20.9	47.0	92.0	1.0	43.0	5.0	2.0
B20583	B16504/B17523	77	24.7	17.4	47.0	95.0	2.0	52.0	5.0	3.0
B20530	B15430/B16504	27	24.4	20.2	47.0	96.0	3.0	34.0	5.0	2.0
B20634	B17692/B16504	128	24.3	18.6	53.0	94.0	2.0	51.0	4.0	3.0
B20644	B17996/B17540	138	24.1	18.6	52.0	95.0	4.0	49.0	3.0	1.0
B20519	B11519/B17106	16	24.1	21.3	47.0	92.0	2.0	48.0	4.0	1.0
B20626	B17536/B16504	120	23.9	19.4	54.0	95.0	2.0	43.0	5.0	3.0
B20566	B16504/B17106	62	23.3	18.9	52.0	93.0	4.0	47.0	4.0	1.0
B20521	B11519/B17106	18	23.0	19.9	54.0	94.0	4.0	46.0	4.0	1.0
B20577	B16504/B17228	72	22.9	17.8	48.0	97.0	4.0	36.0	2.0	1.0
B20630	B17692/B16504	124	22.5	17.0	53.0	96.0	4.0	59.0	4.0	2.0
B20640	B17730/B15430	134	22.5	20.2	54.0	95.0	2.0	46.0	4.0	1.0
B20633	B17692/B16504	127	22.3	19.2	54.0	95.0	3.0	52.0	4.0	1.0
B20571	B16504/B17106	66	21.9	17.4	48.0	93.0	3.0	50.0	4.0	2.0
B20520	B11519/B17106	17	21.3	20.7	49.0	92.0	3.0	48.0	5.0	1.0
B20635	B17692/B16504	129	21.3	17.4	54.0	93.0	2.0	50.0	4.0	2.0
B20647	B15430/B17996	141	21.2	20.2	53.0	95.0	3.0	49.0	4.0	2.0
B20503	N16405/B14302	3	21.0	17.0	54.0	93.0	3.0	48.0	4.0	4.0
B20561	B16504/B16501	57	20.0	18.7	53.0	96.0	3.0	44.0	4.0	3.0
B20540	B15430/N14229	37	19.7	20.3	54.0	96.0	4.0	36.0	2.0	3.0
B20559	B16504/B16501	55	17.3	15.6	54.0	95.0	3.0	50.0	4.0	3.0

EXPERIMENT 2004 PRELIMINARY BLACK BEAN YIELD TRIAL **PLANTED: 6/17/20**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B20539	B15430/N14229	36	16.2	21.4	52.0	95.0	4.0	34.0	4.0	2.0
B20504	N16405/B14302	4	15.7	17.8	49.0	95.0	2.0	49.0	4.0	5.0
B20558	B16504/B16501	54	15.2	20.3	54.0	96.0	3.0	42.0	4.0	2.0
B20552	B16504/B11519	48	12.9	19.5	53.0	96.0	3.0	44.0	4.0	1.0
B20502	N16405/B14302	2	10.7	19.9	54.0	95.0	3.0	43.0	3.0	4.0
B20560	B16504/B16501	56	6.9	19.2	53.0	96.0	4.0	51.0	3.0	1.0
MEAN(146)			30.3	19.2	49.1	93.6	2.5	48.8	4.4	2.1
LSD(.05)			-	1.8	2.2	2.2	1.2	9.9	1.5	1.7
CV%			5.0	4.2	2.0	1.1	22.8	9.3	15.4	38.2

EXPERIMENT 2005 STANDARD GREAT NORTHERN BEAN YIELD TRIAL									PLANTED: 6/5/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
G17410	G13467/G13479	15	41.3	36.1	44.0	97.0	1.5	53.5	5.5	2.0
G19611	G16346/G16318	19	39.1	41.3	43.0	96.0	2.0	55.5	4.8	3.5
G16351	Eldorado/G13467, **EIGER**	7	37.5	33.7	47.0	97.0	2.5	49.0	4.3	2.5
G16305	Powderhorn/G12501	11	37.2	38.1	43.0	97.0	1.5	44.8	5.3	2.5
G16345	G12508/G13455	9	36.0	34.4	44.0	96.0	1.5	53.0	5.3	2.5
G19613	G16351/P16902	8	35.9	41.6	45.0	97.0	1.3	56.5	5.8	2.5
G18502	G13444/G14506	4	35.8	32.2	46.0	97.0	1.5	47.0	5.5	1.5
G08254	G04514/Matterhorn, **POWDERHORN**	23	35.3	41.4	39.0	96.0	2.0	36.3	4.5	2.5
G17418	G14530/G11431	3	35.3	36.7	45.0	97.0	1.5	50.0	4.5	2.5
G18512	G14525/P14815	2	35.0	39.0	46.0	97.0	2.5	44.0	3.8	2.5
G19607	G16346/G16318	5	34.6	43.5	44.0	96.0	1.3	50.5	5.3	3.5
I15652	ND121630, **ND PEGASUS**	24	34.6	41.1	43.0	96.0	2.0	52.3	4.8	3.5
G19623	G16339/G16318	10	34.5	37.5	44.0	97.0	1.5	51.0	5.0	4.5
G18506	G14525/G13444	22	34.0	39.8	42.0	97.0	3.0	41.3	4.0	3.0
G19624	G16339/G16318	12	34.0	34.2	44.0	96.0	2.3	49.0	4.8	3.5
G19626	G16339/G16346	13	33.1	35.1	44.0	97.0	2.8	46.8	4.3	3.5
G19617	G16346/G16309	14	32.9	42.8	42.0	96.0	3.0	40.0	3.5	5.0
I17509	**TAURUS**	21	32.3	38.7	44.0	98.0	3.3	44.8	3.3	4.5
G19619	X15405/G13444	16	32.0	39.9	43.0	97.0	2.8	44.3	4.3	4.0
G19622	G16339/G16301	20	32.0	33.0	44.0	98.0	2.5	48.0	4.3	3.5
G19601	G13444/COSD-44	17	31.5	37.5	45.0	97.0	2.0	51.5	4.8	2.0
G19609	G16346/G16318	6	31.1	41.7	45.0	96.0	1.8	52.0	5.0	3.0
G19628	G16339/G16351	18	29.0	35.3	46.0	97.0	2.5	51.5	4.5	3.0
G19620	X15405/G13444	1	27.9	34.9	50.0	98.0	3.5	42.0	2.3	2.5
MEAN(24)			34.2	37.9	44.1	96.6	2.2	48.1	4.5	3.1
LSD(.05)			3.3	1.3	2.0	0.8	0.8	6.2	0.7	1.7
CV%			8.2	2.9	2.6	0.7	31.3	11.0	13.6	32.3

EXPERIMENT 2006 STANDARD PINTO BEAN YIELD TRIAL							PLANTED: 6/17/20			
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
P16902	P11519/P12610	1	40.6	35.5	44.0	92.0	1.0	53.0	5.3	2.5
P19713	P16911/P16901	11	39.5	34.4	46.0	92.0	2.3	49.7	4.7	2.5
P19103	Eldorado*/Palomino//G13444 (SDP)	9	39.4	36.7	42.0	95.0	2.7	45.3	4.0	1.0
I07113	PNE-6-94-75/Kodiak, **LAPAZ**	7	38.3	34.8	45.0	92.0	2.7	40.0	4.3	2.0
P19707	P16911/X16801	8	36.8	38.8	44.0	93.0	2.0	50.7	5.0	1.5
I18623	PT16-9, **USDA DIAMONDBACK**	16	35.7	38.0	43.0	92.0	1.7	45.3	5.0	3.0
P16901	Eldorado/P11519, **CHARRO**	5	34.7	37.4	46.0	92.0	2.3	50.0	5.0	2.0
P18608	P11522/LONG'S PEAK	2	34.6	35.3	45.0	92.0	2.0	49.0	5.0	1.5
P19708	P16913/P16901	13	33.0	36.7	43.0	91.0	1.0	53.7	5.7	2.0
P07863	AN-37/P02630, **ELDORADO**	14	32.7	38.9	43.0	93.0	1.7	49.3	5.0	1.5
P19703	I16706/P16901	6	31.8	37.3	46.0	94.0	1.7	40.3	4.7	2.0
P18603	P14815/G14525	4	31.7	39.9	46.0	95.0	3.0	44.0	4.0	3.0
P19702	P14815/I15643	3	30.0	36.6	44.0	95.0	2.7	42.3	4.0	2.0
I15644	COSD-35, **STAYBRIGHT**	10	27.5	35.5	42.0	93.0	2.0	38.3	4.7	2.5
I16705	ND121448, **ND FALCON**	15	25.7	35.1	45.0	92.0	1.0	53.3	6.0	2.0
P19701	P14815/I15643	12	22.6	36.0	47.0	96.0	2.3	47.0	4.0	1.5
MEAN(16)			33.4	36.7	44.1	93.1	2.0	47.0	4.8	2.0
LSD(.05)			4.1	1.5	1.6	0.9	0.7	7.4	0.5	1.6
CV%			8.8	2.9	2.1	0.7	25.6	11.4	7.6	45.8

EXPERIMENT 2007 STANDARD RED AND PINK BEAN YIELD TRIAL									PLANTED: 6/5/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
S18904	S14706/R13752	1	41.4	41.6	44.0	96.0	1.0	47.5	5.8	1.0
S19307	X16804/S16804	3	40.5	35.1	44.0	96.0	2.0	42.5	4.0	4.0
R17602	R12845/R12859	8	38.9	41.1	44.0	98.0	1.3	50.5	4.8	2.0
R17605	R12859/R12844	7	38.6	37.9	44.0	97.0	1.5	49.8	5.0	1.0
S18907	S14706/R13752	4	38.0	42.4	45.0	97.0	1.8	45.5	5.0	2.0
S08418	S02754/S04503, **ROSETTA**	12	37.9	36.3	44.0	96.0	1.5	45.5	4.3	2.0
R17604	R12859/R12844	2	37.2	34.1	43.0	96.0	1.5	50.3	5.5	1.0
R17603	R12859/R12844	11	37.1	35.4	44.0	96.0	1.3	53.5	5.5	1.0
I13401	SR99238/Merlot, **VIPER**	10	36.8	31.8	44.0	96.0	2.0	48.8	4.0	2.0
R12844	SR9-5/R09508, **CAYENNE**	9	36.6	37.2	43.0	97.0	2.3	46.3	4.0	2.0
R18402	R12859/R12844	6	36.6	37.8	43.0	97.0	1.5	52.5	4.8	1.0
R19502	R16519/R16518	14	36.0	33.7	44.0	97.0	1.8	47.8	5.0	3.5
S18903	S14706/R13752	18	35.9	40.4	44.0	98.0	3.5	35.0	3.0	1.0
S19305	X16803/P16809	5	35.2	37.8	44.0	96.0	1.8	53.5	5.0	2.0
I19718	PK9-15	17	33.9	40.0	43.0	96.0	3.0	39.8	2.8	3.5
I17546	PK16-1	16	31.9	37.8	42.0	96.0	3.8	37.5	2.3	4.5
I20814	SR11511, **CALDERA**	15	31.4	38.8	47.0	97.0	2.3	53.3	4.3	3.0
R98026	R94037/R94161, **MERLOT**	13	30.8	40.8	44.0	97.0	3.3	42.5	3.5	3.5
MEAN(18)			36.4	37.8	43.7	96.5	2.0	46.8	4.3	2.2
LSD(.05)			3.4	1.4	1.0	1.0	0.7	6.4	0.7	1.6
CV%			7.7	3.2	1.3	0.9	28.4	11.6	14.1	40.8

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL							PLANTED: 6/18/20			
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
S18904	S14706/R13752	154	38.4	40.2	45.0	93.0	1.0	45.0	6.0	1.0
R20627	R17605/R16503	27	36.0	35.4	45.0	93.0	2.0	45.0	2.0	1.0
R20667	I13401/R17603	67	35.6	34.6	47.0	92.0	2.0	48.0	6.0	2.0
I13401	SR99238/Merlot, **VIPER**	158	34.8	30.7	46.0	93.0	2.3	46.9	4.7	1.8
R20652	I13401/R12844	52	34.0	31.3	46.0	94.0	2.0	44.0	5.0	1.0
R20639	R17605/R16503	39	33.8	33.9	46.0	94.0	2.0	59.0	5.0	1.0
R20659	I13401/R17603	59	33.4	33.7	45.0	95.0	3.0	50.0	5.0	1.0
R20637	R17605/R16503	37	33.1	34.2	46.0	92.0	2.0	48.0	5.0	2.0
R20648	I13401/R12844	48	33.0	30.7	49.0	92.0	2.0	45.0	5.0	1.0
R20633	R17605/R16503	33	32.5	34.2	46.0	94.0	2.0	47.0	5.0	1.0
R20625	R17605/R16503	25	32.3	33.2	45.0	94.0	1.0	46.0	5.0	1.0
R20664	I13401/R17603	64	32.2	29.7	48.0	94.0	2.0	57.0	5.0	1.0
R20669	I13401/R17603	69	32.2	32.2	48.0	96.0	3.0	47.0	5.0	1.0
R20657	I13401/R17603	57	32.1	34.2	48.0	95.0	3.0	40.0	4.0	2.0
R20674	I13401/R17603	74	32.1	31.4	51.0	95.0	2.0	49.0	5.0	1.0
R20683	I13401/R17605	83	32.0	33.7	46.0	94.0	2.0	44.0	5.0	1.0
R20604	R12844/I13401	4	31.9	31.8	51.0	95.0	3.0	36.0	5.0	1.0
R20653	I13401/R17603	53	31.7	35.1	47.0	94.0	3.0	45.0	5.0	2.0
R20676	I13401/R17603	76	31.6	28.2	46.0	92.0	2.0	50.0	6.0	1.0
R20675	I13401/R17603	75	31.5	30.8	48.0	93.0	2.0	47.0	5.0	1.0
R20607	R17603/I17551	7	31.3	39.2	46.0	94.0	2.0	44.0	5.0	1.0
R20642	I13401/R12844	42	31.2	32.5	46.0	92.0	1.0	48.0	6.0	2.0
R20624	R17605/R16503	24	31.0	34.2	46.0	94.0	2.0	52.0	5.0	1.0
R20672	I13401/R17603	72	30.9	30.1	46.0	95.0	2.0	47.0	5.0	1.0
R20685	I13401/R17605	85	30.9	37.7	46.0	94.0	3.0	45.0	5.0	3.0
R20684	I13401/R17605	84	30.7	32.2	45.0	93.0	3.0	49.0	5.0	1.0
R20635	R17605/R16503	35	30.6	34.2	47.0	92.0	2.0	50.0	5.0	1.0
R12844	SR9-5/R09508, **CAYENNE**	157	30.6	35.4	45.0	93.0	1.8	49.0	5.0	1.0
R20665	I13401/R17603	65	30.0	32.7	46.0	96.0	3.0	46.0	5.0	1.0
R20612	R17603/I17551	12	29.9	37.9	45.0	95.0	2.0	42.0	4.0	1.0

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL								PLANTED: 6/18/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
R20632	R17605/R16503	32	29.7	32.2	48.0	92.0	1.0	48.0	6.0	1.0
R20658	I13401/R17603	58	29.5	36.4	52.0	95.0	4.0	40.0	4.0	2.0
R20662	I13401/R17603	62	29.5	32.4	47.0	95.0	3.0	60.0	4.0	1.0
R20629	R17605/R16503	29	29.3	34.6	45.0	93.0	2.0	47.0	6.0	1.0
R20649	I13401/R12844	49	29.2	30.2	46.0	92.0	1.0	51.0	5.0	4.0
R20650	I13401/R12844	50	29.1	34.0	46.0	95.0	3.0	43.0	4.0	1.0
R20636	R17605/R16503	36	29.0	35.1	47.0	94.0	2.0	54.0	5.0	1.0
R20614	R17604/I13401	14	29.0	34.0	45.0	94.0	2.0	49.0	5.0	1.0
S20405	S17702/R17604	131	28.7	36.6	50.0	95.0	3.0	44.0	4.0	1.0
R17604	R12859/R12844	156	28.7	32.3	46.0	92.0	2.0	51.0	6.0	1.0
R20716	S17702/R17603	116	28.7	36.3	50.0	95.0	3.0	44.0	4.0	1.0
R20655	I13401/R17603	55	28.7	36.4	51.0	97.0	4.0	34.0	4.0	1.0
R20647	I13401/R12844	47	28.7	30.4	46.0	93.0	2.0	50.0	4.0	1.0
R20622	R17605/R16503	22	28.5	37.2	46.0	92.0	2.0	48.0	5.0	2.0
R20643	I13401/R12844	43	28.3	32.4	46.0	93.0	1.0	51.0	5.0	1.0
S20420	S17702/I13427	146	28.3	34.6	53.0	94.0	2.0	36.0	4.0	3.0
R20619	R17605/R16503	19	28.2	35.9	45.0	95.0	2.0	45.0	5.0	2.0
R20686	I13401/R17605	86	28.1	34.9	46.0	94.0	2.0	45.0	5.0	1.0
R20656	I13401/R17603	56	28.0	35.3	46.0	95.0	3.0	48.0	5.0	1.0
R20654	I13401/R17603	54	28.0	29.8	46.0	94.0	3.0	51.0	5.0	2.0
R20670	I13401/R17603	70	28.0	35.3	50.0	95.0	3.0	31.0	4.0	4.0
R20606	R12844/I13401	6	28.0	31.1	48.0	94.0	3.0	44.0	4.0	1.0
R20660	I13401/R17603	60	27.9	32.1	47.0	94.0	3.0	50.0	5.0	1.0
R20702	S16804/I13401	102	27.8	31.8	53.0	97.0	3.0	45.0	5.0	1.0
R20678	I13401/R17603	78	27.8	32.4	51.0	95.0	3.0	42.0	5.0	1.0
R20645	I13401/R12844	45	27.8	36.1	47.0	94.0	3.0	49.0	4.0	1.0
R20701	R16503/I17551	101	27.8	40.2	44.0	93.0	2.0	50.0	5.0	1.0
R20644	I13401/R12844	44	27.8	28.4	47.0	92.0	1.0	45.0	5.0	1.0
R20680	I13401/R17605	80	27.8	33.4	46.0	94.0	2.0	43.0	5.0	1.0
R20663	I13401/R17603	63	27.8	32.3	45.0	92.0	2.0	51.0	5.0	1.0

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL								PLANTED: 6/18/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
R20609	R17603/I17551	9	27.7	34.9	46.0	94.0	2.0	48.0	5.0	1.0
R20704	S16804/I13401	104	27.6	31.7	46.0	95.0	3.0	33.0	4.0	2.0
R20630	R17605/R16503	30	27.4	35.4	46.0	94.0	2.0	47.0	5.0	3.0
S20401	S16804/I13401	127	27.4	30.2	41.0	92.0	2.0	38.0	5.0	1.0
R20601	R12844/I13401	1	27.3	34.6	47.0	95.0	3.0	49.0	4.0	1.0
R20705	S16804/I13401	105	27.1	33.9	52.0	96.0	3.0	47.0	4.0	1.0
R20720	R17604/G14510	120	27.1	33.5	48.0	94.0	3.0	45.0	4.0	1.0
R20679	I13401/R17603	79	27.0	30.2	47.0	94.0	2.0	59.0	5.0	1.0
R20631	R17605/R16503	31	26.9	33.0	46.0	93.0	1.0	55.0	6.0	1.0
R20626	R17605/R16503	26	26.9	33.8	46.0	94.0	2.0	50.0	5.0	1.0
R20623	R17605/R16503	23	26.9	33.1	46.0	92.0	2.0	58.0	5.0	4.0
R20646	I13401/R12844	46	26.8	31.6	47.0	94.0	2.0	43.0	5.0	1.0
I20814	SR11511, **CALDERA**	155	26.7	39.2	47.0	95.0	3.0	52.0	5.0	4.0
R20668	I13401/R17603	68	26.7	37.4	49.0	97.0	2.0	35.0	4.0	1.0
R20677	I13401/R17603	77	26.4	31.9	46.0	94.0	3.0	55.0	5.0	1.0
R20602	R12844/I13401	2	26.3	32.2	47.0	95.0	3.0	39.0	5.0	1.0
R20611	R17603/I17551	11	26.2	36.8	43.0	92.0	1.0	50.0	5.0	1.0
R20714	S17702/R17605	114	26.2	37.5	52.0	95.0	3.0	33.0	4.0	1.0
R20695	I17551/I13401	95	26.1	35.0	46.0	95.0	3.0	42.0	5.0	1.0
R20709	S17702/R17605	109	25.9	35.9	48.0	95.0	2.0	44.0	4.0	1.0
R20613	R17604/I13401	13	25.8	34.5	46.0	96.0	4.0	36.0	4.0	1.0
R20717	S17702/R17603	117	25.6	33.4	47.0	94.0	3.0	40.0	4.0	1.0
R20603	R12844/I13401	3	25.6	30.6	46.0	93.0	3.0	46.0	5.0	1.0
R20687	I13401/R17605	87	25.6	32.4	45.0	92.0	2.0	49.0	5.0	2.0
R20661	I13401/R17603	61	25.5	32.2	46.0	95.0	3.0	45.0	4.0	4.0
S20403	S17702/R17604	129	25.5	36.8	47.0	93.0	3.0	50.0	5.0	1.0
R20706	S16804/I13401	106	25.5	29.9	47.0	93.0	2.0	45.0	5.0	1.0
S08418	S02754/S04503, **ROSETTA**	159	25.5	32.3	45.0	92.0	1.1	41.4	5.1	1.2
R20713	S17702/R17605	113	25.3	37.1	46.0	94.0	3.0	43.0	4.0	2.0
R20634	R17605/R16503	34	25.3	34.8	45.0	94.0	2.0	38.0	5.0	1.0

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL								PLANTED: 6/18/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
R20681	I13401/R17605	81	25.2	35.6	48.0	94.0	2.0	50.0	5.0	2.0
R20703	S16804/I13401	103	25.1	28.5	47.0	93.0	2.0	35.0	4.0	1.0
R20726	R17604/G14510	126	25.0	34.5	46.0	95.0	2.0	46.0	4.0	1.0
R20694	I13401/R17605	94	25.0	27.6	46.0	93.0	1.0	41.0	5.0	1.0
R20615	R17604/I13401	15	24.9	30.8	52.0	95.0	2.0	47.0	5.0	1.0
R20673	I13401/R17603	73	24.8	29.4	47.0	94.0	2.0	56.0	4.0	1.0
R20690	I13401/R17605	90	24.6	30.7	46.0	94.0	1.0	58.0	5.0	2.0
R20707	S17702/R17604	107	24.5	37.3	49.0	94.0	3.0	40.0	5.0	1.0
R20712	S17702/R17605	112	24.4	37.8	46.0	96.0	3.0	29.0	3.0	1.0
R20605	R12844/I13401	5	24.4	30.0	46.0	95.0	3.0	48.0	4.0	1.0
S20422	S17702/I13427	148	24.3	32.4	47.0	92.0	4.0	25.0	3.0	1.0
R20688	I13401/R17605	88	24.3	33.2	46.0	95.0	3.0	38.0	4.0	2.0
R20682	I13401/R17605	82	24.2	35.2	46.0	93.0	3.0	40.0	5.0	3.0
S20418	S17702/R17605	144	24.2	36.4	47.0	95.0	2.0	40.0	5.0	1.0
R20692	I13401/R17605	92	24.1	29.5	46.0	93.0	1.0	45.0	5.0	3.0
R20691	I13401/R17605	91	24.1	32.1	46.0	95.0	2.0	46.0	4.0	2.0
R20689	I13401/R17605	89	24.1	30.7	48.0	95.0	2.0	46.0	5.0	1.0
S20404	S17702/R17604	130	24.0	37.7	46.0	94.0	3.0	40.0	4.0	1.0
R20725	R17604/G14510	125	23.8	33.8	46.0	94.0	2.0	45.0	5.0	1.0
R20617	R17604/I13401	17	23.6	32.9	53.0	95.0	4.0	38.0	4.0	1.0
R20638	R17605/R16503	38	23.6	34.6	47.0	92.0	2.0	50.0	5.0	1.0
R20721	R17604/G14510	121	23.5	33.1	47.0	94.0	2.0	45.0	5.0	1.0
R20710	S17702/R17605	110	23.4	34.4	46.0	95.0	2.0	44.0	5.0	1.0
R20641	I13401/R12844	41	23.2	34.5	45.0	94.0	1.0	46.0	4.0	5.0
R20708	S17702/R17604	108	22.6	40.5	46.0	95.0	3.0	38.0	4.0	1.0
S20423	S17702/I13427	149	22.6	34.3	50.0	95.0	4.0	39.0	3.0	2.0
R20616	R17604/I13401	16	22.3	31.9	46.0	96.0	4.0	54.0	4.0	1.0
S20426	S17702/R17603	152	22.1	32.9	46.0	94.0	3.0	39.0	4.0	1.0
R20666	I13401/R17603	66	22.1	35.6	46.0	97.0	3.0	47.0	4.0	2.0
S20414	I13427/S17702	140	22.1	30.6	45.0	95.0	3.0	30.0	4.0	1.0

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL								PLANTED: 6/18/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
S20417	S17702/R17605	143	22.0	32.9	47.0	94.0	2.0	36.0	5.0	1.0
R20698	I17551/I13401	98	22.0	32.8	48.0	95.0	3.0	35.0	4.0	5.0
S20424	S17702/R17603	150	21.9	32.1	44.0	93.0	4.0	33.0	4.0	1.0
R20618	R17605/R16503	18	21.8	33.1	47.0	92.0	2.0	45.0	4.0	3.0
S20412	I13427/S17702	138	21.8	37.3	47.0	93.0	3.0	45.0	4.0	1.0
R20640	I13401/R12844	40	21.8	30.5	46.0	92.0	1.0	49.0	5.0	1.0
R20724	R17604/G14510	124	21.8	31.7	47.0	94.0	2.0	55.0	5.0	1.0
R20608	R17603/I17551	8	21.5	39.6	41.0	92.0	2.0	38.0	4.0	1.0
S20410	S17702/R17604	136	21.3	35.7	53.0	95.0	3.0	25.0	4.0	1.0
R20621	R17605/R16503	21	21.1	34.4	46.0	94.0	2.0	37.0	5.0	1.0
S20411	S17702/R17604	137	21.0	38.0	53.0	96.0	3.0	27.0	4.0	1.0
R20722	R17604/G14510	122	20.6	34.0	47.0	93.0	2.0	50.0	5.0	1.0
S20408	S17702/R17604	134	20.6	36.2	46.0	94.0	4.0	37.0	3.0	1.0
R20697	I17551/I13401	97	20.3	34.1	47.0	94.0	2.0	37.0	4.0	3.0
R20696	I17551/I13401	96	20.3	32.0	46.0	94.0	2.0	52.0	4.0	5.0
R20610	R17603/I17551	10	20.3	36.9	46.0	96.0	2.0	46.0	5.0	1.0
R20628	R17605/R16503	28	20.2	34.4	47.0	92.0	2.0	47.0	5.0	2.0
R20715	S17702/R17603	115	20.1	31.6	46.0	94.0	4.0	40.0	4.0	1.0
S20427	S17702/R17603	153	19.9	34.1	54.0	96.0	3.0	36.0	5.0	1.0
R20719	S17702/R17603	119	19.7	32.1	46.0	94.0	4.0	44.0	4.0	1.0
S20409	S17702/R17604	135	19.6	34.0	47.0	94.0	3.0	50.0	4.0	1.0
R20723	R17604/G14510	123	19.5	34.9	46.0	93.0	3.0	51.0	5.0	1.0
S20419	S17702/I13427	145	19.4	35.0	46.0	95.0	4.0	30.0	2.0	2.0
S20406	S17702/R17604	132	19.2	35.8	54.0	95.0	4.0	39.0	4.0	1.0
S20416	S17702/R17605	142	19.0	30.9	47.0	95.0	3.0	44.0	3.0	1.0
S20407	S17702/R17604	133	18.9	36.4	49.0	95.0	3.0	38.0	4.0	1.0
S20413	I13427/S17702	139	18.8	32.8	51.0	94.0	1.0	37.0	4.0	1.0
R20620	R17605/R16503	20	18.6	38.1	46.0	94.0	2.0	49.0	5.0	1.0
R20651	I13401/R12844	51	18.5	33.3	54.0	97.0	2.0	49.0	5.0	1.0
R20700	R16503/I17551	100	17.6	40.2	47.0	95.0	2.0	42.0	5.0	1.0

EXPERIMENT 2009 PRELIMINARY RED AND PINK BEAN YIELD TRIAL							PLANTED: 6/18/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
S20415	I13427/S17702	141	17.5	30.7	46.0	95.0	4.0	37.0	2.0	1.0
R20718	S17702/R17603	118	17.5	36.7	46.0	95.0	3.0	40.0	4.0	1.0
S20421	S17702/I13427	147	17.3	30.8	45.0	92.0	2.0	36.0	3.0	1.0
R20693	I13401/R17605	93	17.0	29.6	52.0	94.0	2.0	0.0	4.0	2.0
S20402	S17702/R17604	128	15.5	39.0	47.0	94.0	3.0	50.0	4.0	1.0
R20711	S17702/R17605	111	15.4	33.9	46.0	94.0	2.0	45.0	4.0	1.0
R20699	R16503/I17551	99	14.2	40.2	46.0	94.0	2.0	35.0	4.0	2.0
S20425	S17702/R17603	151	13.8	38.9	49.0	95.0	3.0	39.0	4.0	1.0
R20671	I13401/R17603	71	12.5	34.9	54.0	97.0	2.0	39.0	3.0	1.0
MEAN(159)			26.6	33.9	47.1	94.1	2.4	44.3	4.5	1.4
LSD(.05)			-	2.4	2.3	1.2	0.9	10.5	1.1	1.0
CV%			8.9	3.3	2.3	0.6	17.3	11.1	11.7	34.6

EXPERIMENT 2011 MRPN/CDBN YIELD TRIAL									PLANTED: 6/5/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
G16351	Eldorado/G13467, **EIGER**	39	41.7	34.3	44.0	96.0	2.7	42.0	4.7	1.5
G18512	G14525/P14815	6	41.2	41.9	46.0	98.0	2.7	43.0	3.7	2.5
I15652	ND121630, **ND PEGASUS**	24	40.7	41.9	43.0	96.0	1.3	50.0	4.3	1.5
S18904	S14706/R13752	10	40.7	40.4	44.0	96.0	1.0	47.0	5.3	2.0
I07113	PNE-6-94-75/Kodiak, **LAPAZ**	19	39.6	40.0	43.0	97.0	3.0	38.3	4.0	2.0
I18623	PT16-9, **USDA DIAMONDBACK**	32	39.2	42.5	44.0	96.0	2.3	53.3	5.0	3.0
I16707	ND121315	20	39.0	40.7	42.0	96.0	2.7	36.7	3.7	4.0
R17604	R12859/R12844	12	38.8	34.5	43.0	96.0	2.0	52.3	5.0	1.5
I20808	NE1-18-28	4	38.4	43.3	42.0	96.0	2.7	38.3	3.0	3.0
G17418	G14530/G11431	5	37.6	36.6	45.0	96.0	2.3	49.7	5.0	2.5
I20801	PT11-13-31, **USDA RATTLER**	34	37.4	45.7	43.0	96.0	1.7	47.0	5.0	2.5
I19720	PT11-13-1	33	37.3	44.8	43.0	96.0	2.3	46.7	4.3	2.5
I20809	GN19-1	7	37.2	43.5	42.0	97.0	3.0	44.0	3.0	2.0
P18603	P14815/G14525	17	36.7	45.0	49.0	98.0	2.7	43.0	3.3	2.0
I18606	NE1-17-36	25	36.2	43.8	42.0	97.0	2.3	40.0	3.7	2.0
I19721	NE4-17-6	30	35.1	44.5	42.0	98.0	3.3	32.0	2.3	1.5
R98026	R94037/R94161, **MERLOT**	13	35.0	42.0	43.0	98.0	3.0	41.0	3.0	3.0
I20811	PK19-1	11	34.7	39.1	42.0	96.0	3.3	41.0	2.0	4.5
I19716	NDF141506	22	34.6	41.5	45.0	98.0	2.3	55.3	4.3	3.5
I19717	GN16-7-3	23	33.9	42.2	42.0	97.0	2.3	46.3	4.7	2.5
I19739	NE4-18-23	15	32.6	42.4	42.0	98.0	3.0	43.3	3.3	2.5
I19719	SR16-2	28	32.4	36.8	42.0	96.0	2.3	47.7	4.3	3.0
G12901	G07321/Fuji, **SAMURAI**	38	31.8	28.7	43.0	96.0	1.7	42.3	4.7	5.0
P19103	Eldorado*/Palomino//G13444 (SDP)	40	31.6	38.1	43.0	98.0	3.0	42.3	3.3	3.0
I20807	NE1-18-18	3	31.3	46.4	43.0	98.0	3.0	35.7	2.0	2.5
I20810	GN19-2	8	31.3	42.1	42.0	96.0	2.7	39.0	3.3	4.5
I19741	NE2-18-3	16	31.1	50.6	42.0	98.0	3.3	42.3	2.0	2.0
I20812	NE4-18-55	14	30.9	51.6	42.0	100.0	2.7	44.3	3.0	2.0
I18601	Matterhorn/NE94-75, **ARIES**	9	30.9	39.3	43.0	95.0	3.0	35.3	2.7	4.0
I17546	PK16-1	27	30.3	38.5	42.0	96.0	3.3	33.3	2.0	1.5
I14520	Santa Fe/PS08-108, **ND PALOMINO**	36	29.9	39.8	41.0	98.0	3.3	35.7	2.7	2.0
I17520	NDF140813	1	29.4	45.1	43.0	97.0	3.0	43.3	3.0	2.5
I19715	ND131406	21	29.2	39.9	42.0	96.0	2.0	45.7	4.3	3.0
I16705	ND121448, **ND FALCON**	35	29.0	38.0	45.0	96.0	1.7	52.7	4.7	2.0
I18608	NE2-17-37	29	29.0	39.8	43.0	99.0	3.3	37.0	2.7	1.0

EXPERIMENT 2011 MRPN/CDBN YIELD TRIAL									PLANTED: 6/5/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
I20806	NE1-18-15	2	27.9	41.1	43.0	100.0	4.0	36.7	2.3	2.0
I20813	PT16-7	18	25.4	43.5	42.0	96.0	2.3	37.3	3.3	2.5
I19722	NE4-17-10	31	25.2	43.5	42.0	97.0	3.0	33.0	2.7	1.5
I18605	NE1-17-19	26	24.3	41.6	43.0	101.0	4.3	33.7	2.0	2.0
I84002	NW410//VICTOR/AURORA, **OTHELLO**	37	17.6	42.9	39.0	94.0	5.0	26.0	2.0	4.5
MEAN(40)			33.4	41.4	42.6	97.0	2.7	41.8	3.5	2.6
LSD(.05)			3.1	1.8	1.5	2.0	0.8	7.8	1.0	1.2
CV%			6.7	3.3	2.2	1.5	22.0	13.8	22.0	27.4

EXPERIMENT 2012 DBDN BEAN YIELD TRIAL								PLANTED: 6/5/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B19330	B16501/B15414	32	41.5	23.8	46.0	97.0	1.7	48.7	5.3	1.5
P16901	Eldorado/P11519, **CHARRO**	22	41.4	40.2	46.0	97.0	2.3	55.0	4.0	2.0
B18504	Zenith//Alpena*/B09197, **ADAMS**	20	41.2	21.6	45.0	96.0	1.0	51.0	5.7	1.5
G16351	Eldorado/G13467, **EIGER**	21	39.4	35.3	45.0	97.0	2.3	56.7	4.3	3.0
I19720	PT11-13-1	8	38.6	42.1	43.0	96.0	2.0	44.3	3.7	1.5
R17604	R12859/R12844	19	38.5	34.5	43.0	96.0	2.0	53.7	4.7	1.0
R12844	SR9-5/R09508, **CAYENNE**	26	37.8	38.0	43.0	98.0	3.0	50.7	3.3	1.0
I18623	PT16-9, **USDA DIAMONDBACK**	6	37.7	42.6	43.0	96.0	2.7	43.0	4.0	3.0
I20801	PT11-13-31, **USDA RATTLER**	9	37.7	45.2	43.0	96.0	2.0	40.7	5.0	2.5
B10244	B04644/ZORRO, **ZENITH**	28	37.6	23.5	44.0	96.0	1.3	48.0	5.3	1.5
I20803	NE28-15-55/NE28-15-1, SB4-204	5	37.2	23.4	45.0	96.0	2.3	46.7	4.0	1.5
I19718	PK9-15	12	36.6	42.6	43.0	96.0	3.3	46.0	3.7	2.0
I18606	NE1-17-36	18	36.4	41.6	43.0	96.0	2.7	43.3	3.3	2.5
P18603	P14815/G14525	31	36.1	44.1	49.0	98.0	2.7	39.7	3.0	2.5
I20804	PT16-12-1	7	36.0	40.5	44.0	97.0	2.7	45.7	4.0	1.5
S08418	S02754/S04503, **ROSETTA**	27	35.6	35.8	43.0	97.0	2.7	42.0	3.3	1.5
I19741	NE2-18-3	16	35.0	50.2	42.0	99.0	3.7	37.0	2.0	2.0
R11806	X07714/X07710, **GYPSY ROSE**	30	34.2	31.0	46.0	97.0	3.3	38.0	2.7	2.5
I20805	GN16-7-2	10	34.0	39.6	42.0	96.0	2.7	42.3	4.0	3.0
I19717	GN16-7-3	11	33.7	41.8	43.0	96.0	2.3	49.3	3.3	4.0
R98026	R94037/R94161, **MERLOT**	24	33.6	39.5	43.0	99.0	3.0	49.3	2.7	3.5
I19742	NE4-18-63	17	33.4	41.9	43.0	95.0	3.3	42.7	3.0	3.0
I20802	NE28-15-54/NE28-15-1, SB4-171	4	31.7	25.8	44.0	98.0	3.3	43.3	3.3	1.0
G93414	**MATTERHORN**	23	31.6	35.6	42.0	96.0	3.3	38.7	2.3	5.0
I19739	NE4-18-23	14	30.3	43.1	43.0	101.0	3.0	35.3	2.7	2.5
I05834	ND020351, **STAMPEDE**	25	27.8	38.1	42.0	98.0	2.3	49.3	3.3	3.5
I19740	NE2-18-2	15	27.6	49.5	42.0	95.0	4.0	31.7	2.0	2.5
I19734	MIB 780/Matterhorn, SB3_0347	1	27.1	42.3	43.0	97.0	2.7	39.0	2.7	2.0
I16708	XRAV-40-4, **SANKARA**	13	26.2	22.8	43.0	96.0	1.7	41.0	4.3	3.5
I19736	MIB 780/Matterhorn, SB3_0314	2	26.2	39.5	42.0	96.0	3.0	37.3	3.3	2.5
R11801	X07712/X07721, **DESERT SONG**	29	21.9	37.2	42.0	98.0	3.7	37.7	2.0	2.5
I19738	Matterhorn/PT7-2, SB3_0143	3	21.3	33.7	42.0	95.0	3.7	32.0	2.0	5.0
MEAN(32)			33.9	37.1	43.3	96.8	2.7	43.7	3.5	2.4
LSD(.05)			3.7	1.7	2.0	1.2	0.8	6.5	1.0	1.2
CV%			8.1	3.4	2.7	0.9	21.3	10.9	21.4	29.5

EXPERIMENT 2013 STANDARD BLACK BEAN YIELD TRIAL (-N)							PLANTED: 6/5/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
B16504	Zenith//Alpena*/B09197	9	37.1	20.3	46.0	97.0	1.0	55.3	5.5	3.0
B19309	B15414/B16504	23	35.7	22.1	46.0	96.0	1.0	55.8	7.0	2.0
B19504	Reselection of B16504 (SS)	35	35.5	20.3	47.0	96.0	1.0	55.5	6.5	2.5
B19345	B16506/B16507	26	35.4	21.7	46.0	97.0	1.0	48.8	5.5	2.5
B18232	B15430/B10244	8	35.3	24.0	46.0	96.0	1.0	51.5	6.0	1.0
B19340	B16507/B15453	30	34.5	24.9	46.0	97.0	1.0	61.0	5.5	1.5
B10244	B04644/ZORRO, **ZENITH**	15	34.5	23.4	45.0	97.0	1.0	53.5	5.5	2.5
B18504	Zenith//Alpena*/B09197, **ADAMS**	3	34.4	21.1	46.0	97.0	1.0	51.8	6.0	2.0
B19302	N16405/B16504	28	34.1	20.8	47.0	96.0	1.0	55.5	6.5	2.5
B19344	B16506/B16507	24	33.3	23.7	45.0	96.0	1.0	53.5	5.0	2.0
B18236	B14303/B12724	4	32.6	19.9	46.0	96.0	1.5	49.3	5.5	0.5
B18204	B10244/B15430	7	32.2	23.1	46.0	96.0	1.0	54.0	5.0	1.0
B19330	B16501/B15414	19	31.6	23.6	46.0	97.0	1.0	58.3	6.0	3.0
B19339	B16507/B15453	33	30.8	23.4	46.0	97.0	1.0	59.3	5.0	1.5
B17897	B14302/B10244	5	30.5	20.2	46.0	98.0	1.0	48.3	5.0	3.5
B19341	B16507/B16501	25	30.2	23.4	45.0	96.0	1.0	53.3	6.0	2.0
B17220	B10244/B12724	2	29.9	21.3	45.0	96.0	1.0	54.0	5.0	3.5
B16501	Zenith/B10215	1	29.7	22.9	46.0	97.0	1.0	54.3	6.0	3.0
B04554	B00103*/X00822, **ZORRO**	17	29.5	22.2	45.0	98.0	1.0	52.3	6.0	2.0
B17922	B14302/B10244	11	29.1	20.8	47.0	98.0	1.0	55.8	6.0	3.5
I17501	Jaguar/BL05222, **BLACK BEAR**	10	28.6	24.3	47.0	99.0	2.0	59.8	6.0	3.0
B19332	B16501/B15464	22	28.4	21.6	46.0	98.0	1.0	54.0	5.5	3.0
I19711	NE14-18-4	36	28.1	27.8	43.0	98.0	3.0	40.5	4.0	2.5
B19328	B15464/B15417	27	28.1	22.6	45.0	96.0	1.0	48.0	5.5	1.0
B19312	B15417/B15442	20	28.1	24.2	46.0	96.0	1.0	51.0	5.5	2.0
B17259	B10244/B12724	13	27.9	22.1	47.0	98.0	1.0	49.8	5.5	2.0
B17207	B10244/B12724	12	27.9	19.2	46.0	96.0	1.0	53.0	5.5	4.0
B16505	B11363//Alpena*/B09197	6	27.8	21.4	46.0	97.0	1.0	45.5	5.0	3.0
B18237	B14303/B12724	14	27.7	20.8	48.0	98.0	1.5	50.5	5.5	1.0
I03390	ND9902621-2, **ECLIPSE**	18	26.5	20.9	44.0	97.0	1.0	53.0	5.5	2.5
B18201	B10244/B13218	16	26.3	21.8	46.0	97.0	1.0	52.8	5.0	3.5
I19703	BL14506, **BLACK BEARD**	29	25.3	22.9	46.0	98.0	1.0	58.3	5.0	5.0
B19346	B15414/B16504	21	25.0	23.0	46.0	96.0	1.0	42.3	6.0	3.5
I19701	NDF120287, **ND TWILIGHT**	34	23.9	21.7	46.0	97.0	2.0	50.5	5.0	2.0
I19710	**AAC Knight Rider**	32	23.7	19.6	46.0	99.0	1.0	52.0	5.5	2.0
I07112	**R99 NO NOD**	31	1.2	15.7	45.0	107.0	2.5	46.5	4.0	2.5
MEAN(36)			29.5	22.0	45.6	97.1	1.2	52.4	5.5	2.4
LSD(.05)			3.6	0.9	1.3	1.2	0.3	6.4	0.8	1.4
CV%			10.3	3.5	1.7	0.7	16.8	10.5	8.9	33.6

EXPERIMENT 2014 STANDARD KIDNEY BEAN YIELD TRIAL								PLANTED: 6/12/20		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
K19610	K16126/K11306	36	40.1	54.5	45.0	106.0	3.5	44.5	4.0	1.0
K19831	K16638/K16980	27	39.6	64.2	44.0	107.0	2.8	54.5	5.0	1.0
K19817	K15901/K16980	24	38.3	54.1	46.0	107.0	3.5	50.0	4.0	1.0
K17702	K11714*/ISABELLA	10	38.1	60.0	45.0	106.0	2.8	45.8	4.5	1.0
K15601	RED CEDAR/K11916, **COHO**	13	37.8	50.3	44.0	106.0	3.3	44.5	4.0	1.0
K17703	K11714*/K13902	3	35.8	59.7	45.0	105.0	1.8	50.5	6.0	1.0
K19111	K16119/K16109	37	35.0	50.3	45.0	105.0	1.5	48.8	5.0	1.0
K19830	K16638/K16980	26	34.6	63.6	44.0	106.0	2.3	51.8	5.0	1.0
K11306	K06621/USDK-CBB-15, **RED CEDAR**	12	33.9	53.7	44.0	105.0	3.0	43.3	4.0	3.0
K19832	K16981/K16962	23	33.8	66.4	45.0	107.0	3.5	44.8	4.0	1.0
K18907	SNOWDON/UYOLE 98	2	33.2	57.2	40.0	101.0	2.5	42.8	4.0	2.5
K19811	K16136/K16980	28	33.2	54.0	45.0	107.0	3.5	46.8	3.5	1.0
K16136	K12206/ND02-385-14	11	33.0	55.1	44.0	105.0	1.5	47.8	5.5	2.0
K16924	K11917/SNOWDON	4	32.8	59.7	38.0	99.0	1.0	45.5	6.0	2.5
K16911	SNOWDON/K12214	5	32.8	63.7	39.0	99.0	1.0	48.0	6.0	3.0
K16640	K11914/K12209	7	32.6	62.1	43.0	105.0	3.5	45.8	4.0	2.0
K17704	K11714*/K13902	1	32.6	61.6	43.0	105.0	2.0	49.8	5.0	1.0
K18312	RED CEDAR/K14104	8	32.5	55.1	45.0	103.0	2.5	42.3	5.0	3.5
K19120	K16109/K16119	41	32.5	53.7	44.0	105.0	1.8	52.5	4.5	1.0
K19124	K11306/K16126	39	32.3	50.4	44.0	104.0	2.8	46.8	5.0	3.5
K19114	K16119/K16109	40	32.3	52.8	46.0	105.0	3.3	52.3	4.0	1.0
K19605	K16638/K16647	35	32.2	66.4	42.0	106.0	1.8	48.8	5.0	3.0
I19723	**AAC Scotty**	42	32.1	64.0	39.0	103.0	2.5	51.8	4.0	3.5
K19812	K16136/K16980	30	31.9	54.6	47.0	107.0	3.5	38.3	3.5	1.0
K17201	RED CEDAR//DRAKE/K12205	6	31.5	56.8	45.0	104.0	1.5	42.5	4.5	1.5
K18314	TALON/RED CEDAR	15	31.0	55.8	44.0	104.0	3.5	44.3	4.0	2.5
K08961	K04604/USDK-CBB-15, **SNOWDON**	9	30.2	63.0	36.0	95.0	1.0	46.3	5.5	3.5
K90101	CHAR/2*MONT, **RED HAWK**	20	29.8	54.9	40.0	96.0	1.5	46.6	5.1	2.4
I90013	**CELRK**	22	29.3	63.1	37.0	96.0	1.3	49.8	5.5	5.0
K19604	K16638/K16640	34	29.1	58.9	48.0	107.0	3.8	49.3	4.0	3.0
K16957	K12206/SNOWDON	17	28.6	56.9	46.0	106.0	3.3	44.3	4.0	2.0
K90902	BEA/50B1807//LASSEN, **BELUGA**	21	27.9	59.2	43.0	106.0	2.8	50.0	5.0	3.5
K19608	K16640/K16638	33	26.9	55.7	45.0	101.0	2.0	52.0	6.0	3.5
K19825	K16980/K15901	25	26.4	57.9	48.0	107.0	3.5	46.5	4.0	2.5
K19827	K16638/K16980	31	26.1	57.7	47.0	107.0	3.5	46.3	4.0	3.0

EXPERIMENT 2014 STANDARD KIDNEY BEAN YIELD TRIAL								PLANTED: 6/12/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
I17507	ND122386, **ND WHITETAIL**	32	25.8	57.0	44.0	105.0	3.0	45.0	4.0	2.0
K19119	K16109/K16119	38	25.7	50.8	47.0	106.0	2.0	49.8	4.5	1.0
K74002	MDRK/CN(3)-HBR(NEB#1), **MONTCALM**	14	25.4	57.9	43.0	105.0	1.5	48.5	5.0	2.5
K16934	CBB-15/SNOWDON	19	25.3	57.4	45.0	102.0	2.5	49.0	4.5	2.5
K19809	K15901/X16735	29	22.9	60.8	48.0	108.0	4.0	54.8	2.5	1.0
I11201	Pink Panther//ZAA/Montcalm, **CLOUSEAU**	18	21.9	60.7	37.0	97.0	1.5	41.8	5.0	5.0
K18912	SNOWDON/UYOLE 98	16	21.1	49.6	38.0	96.0	1.0	39.8	4.5	5.0
MEAN(42)			31.1	57.6	43.3	103.7	2.5	47.2	4.6	2.2
LSD(.05)			3.6	2.4	1.8	2.1	0.8	5.5	0.8	0.9
CV%			10.0	3.5	2.5	1.7	29.3	9.9	10.4	22.6

EXPERIMENT 2015 STANDARD YELLOW BEAN YIELD TRIAL								PLANTED: 6/12/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
Y18702	K08961/UYOLE 98	4	33.1	66.1	43.0	105.0	4.0	46.7	4.0	2.7
Y19810	Y16507/Y16503	17	30.4	38.7	45.0	107.0	2.7	49.0	4.3	2.7
Y19802	Y16503/Y16507	9	29.6	47.3	45.0	106.0	3.3	44.0	4.0	2.0
Y17604	Y11405*/UC Canario707	6	29.0	42.9	41.0	100.0	2.3	43.3	4.3	2.7
Y19801	Y16503/Y16507	8	28.7	49.7	42.0	105.0	2.7	44.3	4.0	3.0
Y19803	Y16503/Y16507	10	28.3	41.1	45.0	106.0	3.3	42.3	3.7	2.7
Y18703	X15305/X15302	2	26.9	41.9	43.0	97.0	1.3	44.0	4.7	3.0
Y19811	Y16507/Y16503	18	26.8	41.3	44.0	105.0	4.0	50.7	4.0	3.0
Y17502	Y11405/PR1146-123 (round)	7	26.4	45.5	42.0	99.0	1.0	45.3	5.7	2.7
Y19817	X16908/Y16507	24	26.3	44.8	44.0	97.0	1.3	48.0	6.3	3.7
Y19815	X16908/Y16507	22	26.3	44.9	44.0	97.0	1.7	48.0	5.3	3.3
Y19804	Y16503/Y16507	11	26.1	40.7	43.0	101.0	1.3	50.0	4.7	2.3
Y19808	Y16503/X16908	15	25.9	45.4	44.0	103.0	1.3	46.7	5.7	3.3
Y19807	Y16503/X16905	14	25.3	49.3	43.0	106.0	3.7	42.7	4.0	2.0
I17506	**SVS-0863**	3	25.2	38.2	46.0	101.0	3.7	42.7	4.0	3.0
Y19812	X16902/Y16503	19	25.0	42.6	45.0	103.0	2.3	48.7	5.0	3.7
Y19813	X16902/Y16503	20	24.9	42.3	45.0	106.0	3.0	49.7	4.3	3.0
Y19809	Y16507/Y16503	16	24.7	42.0	44.0	101.0	2.7	48.3	4.7	3.7
Y19814	X16902/Y16503	21	24.6	43.8	44.0	105.0	2.7	47.0	4.7	2.7
Y19805	Y16503/X16905	12	24.6	47.4	43.0	105.0	3.3	44.0	4.3	2.3
Y19816	X16908/Y16507	23	24.5	42.6	44.0	99.0	2.0	46.0	4.7	3.0
Y16507	PR1146-123/Y11405, **YELLOWSTONE**	1	24.4	40.9	41.0	97.0	2.0	39.0	4.7	2.7
Y17605	Y11405*/UC Canario707	5	23.8	43.7	41.0	102.0	2.0	42.7	4.7	3.3
Y19818	Y16507/X16902	25	23.1	48.5	44.0	100.0	3.3	47.3	4.3	2.0
Y19806	Y16503/X16905	13	22.6	43.6	45.0	107.0	3.0	48.0	4.3	2.0
MEAN(25)			26.3	44.6	43.5	102.4	2.6	45.9	4.6	2.8
LSD(.05)			3.5	2.1	1.8	2.4	1.0	5.9	0.7	0.6
CV%			9.6	3.5	2.9	1.7	29.3	9.4	11.1	16.5

EXPERIMENT 2016 PRELIMINARY KIDNEY BEAN YIELD TRIAL								PLANTED: 6/16/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
K20743	K17703/K17816	82	43.6	56.1	40.0	94.0	2.0	45.0	6.0	1.0
K20745	K17703/K17816	84	42.8	55.0	40.0	98.0	2.0	50.0	6.0	1.0
K20730	K17703/K17702	53	42.6	62.3	44.0	102.0	3.0	40.0	3.0	1.0
K20744	K17703/K17816	83	41.4	59.9	39.0	98.0	1.0	43.0	6.0	1.0
K20212	K16131/K11306	33	40.9	59.3	41.0	100.0	3.0	50.0	4.0	1.0
K20734	K15601/K16131	60	40.8	58.5	43.0	102.0	2.0	54.0	5.0	1.0
K20234	K16136/K11306	71	40.7	51.4	38.0	95.0	1.0	45.0	6.0	1.0
K20214	K17209/K17703	40	40.7	67.3	45.0	102.0	3.0	50.0	4.0	1.0
K20217	K17209/K17703	43	40.1	61.7	46.0	98.0	2.0	50.0	5.0	1.0
K20721	K16640/K17702	24	39.9	57.0	45.0	102.0	4.0	47.0	4.0	1.0
K15601	RED CEDAR/K11916, **COHO**	99	39.8	50.8	44.0	100.0	2.3	47.3	4.3	1.0
K20727	K17703/K15901	50	39.7	51.8	43.0	102.0	3.0	52.0	5.0	1.0
K20210	K16131/K11306	31	39.7	57.7	39.0	100.0	3.0	39.0	4.0	2.0
K20225	K15601/K16131	58	39.4	55.8	41.0	101.0	3.0	50.0	4.0	1.0
K20732	K17703/K17702	55	39.4	62.1	43.0	102.0	3.0	51.0	4.0	1.0
K20224	K15601/K16131	57	38.9	54.9	42.0	102.0	3.0	53.0	4.0	1.0
K20742	K17703/K17816	81	38.7	61.3	41.0	101.0	3.0	54.0	5.0	1.0
K20211	K16131/K11306	32	38.7	60.3	43.0	102.0	3.0	52.0	4.0	1.0
K20715	K16136/K16640	18	38.3	58.7	42.0	99.0	3.0	50.0	5.0	1.0
K20720	K16640/K17702	23	38.2	53.5	43.0	98.0	3.0	54.0	5.0	1.0
K20728	K17703/K15901	51	38.0	53.9	46.0	103.0	2.0	48.0	6.0	1.0
K20749	K16640/K17703	88	37.8	53.8	40.0	97.0	2.0	51.0	6.0	1.0
K20230	K15601/K16131	65	37.5	47.9	46.0	102.0	4.0	55.0	3.0	1.0
K20219	K17209/K17703	45	37.5	62.2	46.0	103.0	3.0	49.0	4.0	1.0
K20719	K16640/K17702	22	37.3	57.0	46.0	102.0	4.0	50.0	4.0	1.0
K20236	K16136/K11306	73	37.2	49.9	45.0	94.0	3.0	56.0	6.0	1.0
K20226	K15601/K16131	59	37.1	53.7	42.0	102.0	3.0	46.0	4.0	1.0
K20711	K16136/K16640	12	37.0	54.6	39.0	98.0	4.0	50.0	4.0	1.0
K20215	K17209/K17703	41	36.9	65.5	42.0	100.0	2.0	55.0	5.0	1.0
K20239	K16957/K17703	76	36.7	54.8	38.0	99.0	1.0	50.0	6.0	1.0
K20754	K16640/K17703	93	36.7	57.2	44.0	103.0	4.0	45.0	3.0	1.0
K20746	K17703/K17816	85	36.5	49.6	46.0	102.0	2.0	49.0	5.0	1.0
K20221	K17206/K16136	47	36.5	55.4	43.0	101.0	3.0	49.0	4.0	1.0
K20208	K16131/K11306	29	36.2	51.0	40.0	101.0	4.0	34.0	4.0	2.0
K20235	K16136/K11306	72	36.0	54.1	40.0	100.0	3.0	38.0	5.0	1.0

EXPERIMENT 2016 PRELIMINARY KIDNEY BEAN YIELD TRIAL								PLANTED: 6/16/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
K17703	K11714*/K13902	96	35.8	57.4	41.0	98.0	1.0	54.0	6.0	1.0
K20213	K17209/K17703	39	35.8	59.6	45.0	102.0	3.0	50.0	4.0	1.0
K20209	K16131/K11306	30	35.6	52.3	40.0	95.0	4.0	54.0	4.0	1.0
K20729	K17703/K15901	52	35.4	55.7	46.0	103.0	2.0	60.0	5.0	1.0
K20237	K16136/K11306	74	35.3	54.3	46.0	100.0	3.0	50.0	4.0	1.0
K20733	K17703/K17702	56	35.2	58.7	43.0	102.0	1.0	46.0	5.0	1.0
K20229	K15601/K16131	64	35.2	45.1	44.0	93.0	2.0	55.0	6.0	1.0
K20712	K16136/K16640	14	35.1	62.7	43.0	99.0	3.0	54.0	5.0	1.0
K11306	K06621/USDK-CBB-15, **RED CEDAR**	98	34.9	52.9	43.0	99.0	2.0	45.0	5.0	1.3
K20717	K16640/K17702	20	34.9	54.6	44.0	102.0	1.0	50.0	6.0	1.0
K20753	K16640/K17703	92	34.5	60.1	42.0	102.0	4.0	48.0	4.0	1.0
K20223	K17206/K16136	49	34.1	54.9	43.0	98.0	3.0	50.0	5.0	1.0
K20228	K15601/K16131	63	33.7	56.9	44.0	101.0	1.0	51.0	7.0	1.0
K20220	K17206/K16136	46	33.7	55.4	44.0	96.0	2.0	40.0	5.0	1.0
K16136	K12206/ND02-385-14	95	33.7	56.4	40.0	100.0	4.0	47.0	4.0	2.0
K20731	K17703/K17702	54	33.1	56.3	38.0	100.0	1.0	54.0	6.0	1.0
K20202	K16136/K16640	13	32.9	59.0	43.0	101.0	3.0	45.0	5.0	2.0
K20718	K16640/K17702	21	32.9	57.4	46.0	102.0	4.0	50.0	4.0	1.0
K20713	K16136/K16640	16	32.9	56.6	40.0	100.0	2.0	58.0	6.0	1.0
K20232	K17206/K17209	67	32.7	54.6	44.0	101.0	1.0	52.0	5.0	1.0
K20204	K16131/K11306	25	32.6	57.9	41.0	100.0	3.0	46.0	5.0	1.0
K20750	K16640/K17703	89	32.5	55.2	40.0	99.0	3.0	54.0	5.0	1.0
K20714	K16136/K16640	17	32.5	58.6	40.0	101.0	1.0	44.0	5.0	1.0
K20218	K17209/K17703	44	32.3	64.3	41.0	102.0	2.0	45.0	4.0	1.0
K20222	K17206/K16136	48	32.1	56.1	46.0	101.0	4.0	49.0	4.0	1.0
K20735	K15601/K16131	62	31.6	59.7	45.0	100.0	1.0	50.0	6.0	1.0
K20740	K16957/K17703	79	31.5	51.4	39.0	94.0	1.0	52.0	7.0	3.0
K20741	K16957/K17703	80	31.5	53.6	44.0	102.0	1.0	44.0	6.0	3.0
K20227	K15601/K16131	61	31.0	57.1	43.0	91.0	3.0	37.0	5.0	1.0
K20705	K15601/K17703	6	30.9	54.4	43.0	95.0	2.0	43.0	4.0	2.0
K20738	K16957/K17703	77	30.7	51.6	44.0	95.0	3.0	49.0	5.0	2.0
K20216	K17209/K17703	42	30.4	67.6	42.0	100.0	1.0	49.0	6.0	1.0
K20201	K15601/K17703	5	30.3	52.5	42.0	94.0	3.0	41.0	4.0	1.0
K20702	K15601/K17703	2	30.2	50.3	44.0	95.0	3.0	52.0	4.0	2.0
K90101	CHAR/2*MONT, **RED HAWK**	97	30.0	54.9	40.0	96.0	1.5	46.6	5.1	2.4

EXPERIMENT 2016 PRELIMINARY KIDNEY BEAN YIELD TRIAL									PLANTED: 6/16/20	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
K20704	K15601/K17703	4	29.6	55.8	45.0	101.0	2.0	50.0	4.0	2.0
K20708	K16131/K15601	9	29.6	51.6	45.0	101.0	3.0	41.0	4.0	3.0
K20233	K17206/K17209	68	29.5	61.4	44.0	102.0	3.0	54.0	4.0	2.0
K20231	K17206/K17209	66	29.3	59.7	45.0	102.0	3.0	47.0	5.0	1.0
K20716	K16136/K16640	19	29.1	59.9	45.0	102.0	3.0	46.0	4.0	1.0
K20703	K15601/K17703	3	28.9	58.6	43.0	101.0	1.0	45.0	4.0	2.0
K20203	K16136/K16640	15	28.7	59.4	39.0	100.0	2.0	40.0	5.0	1.0
K20706	K16131/K15601	7	28.5	55.4	45.0	101.0	3.0	48.0	4.0	3.0
K20748	K16640/K17703	87	28.3	56.4	40.0	102.0	3.0	44.0	4.0	1.0
K20238	K16136/K11306	75	28.2	53.8	41.0	101.0	1.0	45.0	5.0	1.0
K20739	K16957/K17703	78	28.2	50.4	44.0	95.0	1.0	54.0	6.0	3.0
K20751	K16640/K17703	90	28.1	56.8	41.0	101.0	2.0	47.0	5.0	1.0
K20723	K16136/K17805	35	27.9	61.1	43.0	96.0	2.0	52.0	6.0	3.0
K20710	K16131/K15601	11	27.7	52.8	46.0	100.0	1.0	39.0	5.0	3.0
K20737	K16131/K17305	70	27.0	63.0	37.0	101.0	1.0	43.0	5.0	2.0
K20722	K16136/K17805	34	26.4	60.7	46.0	98.0	2.0	46.0	5.0	3.0
K20709	K16131/K15601	10	26.3	64.4	43.0	100.0	2.0	47.0	5.0	2.0
K20736	K16131/K17305	69	25.9	61.6	37.0	96.0	3.0	49.0	4.0	2.0
K20701	K15601/K17703	1	25.3	48.8	46.0	101.0	3.0	44.0	4.0	2.0
K20205	K16131/K11306	26	24.2	63.0	41.0	102.0	3.0	45.0	4.0	1.0
K20725	K16136/K17805	37	23.9	48.5	37.0	93.0	1.0	50.0	5.0	3.0
K20707	K16131/K15601	8	21.2	55.3	43.0	94.0	3.0	49.0	3.0	3.0
K20724	K16136/K17805	36	21.0	55.5	42.0	95.0	1.0	48.0	6.0	3.0
K20752	K16640/K17703	91	20.3	54.2	43.0	102.0	1.0	49.0	4.0	1.0
K20207	K16131/K11306	28	19.5	57.2	45.0	102.0	1.0	45.0	5.0	1.0
MEAN(95)			33.5	56.5	42.6	98.4	2.3	47.6	4.8	1.4
LSD(.05)			6.1	3.0	2.1	5.8	1.6	7.8	1.3	1.3
CV%			8.8	2.6	2.4	2.8	31.9	7.8	13.4	46.2

EXPERIMENT 2017 PRELIMINARY YELLOW BEAN YIELD TRIAL									PLANTED: 6/16/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
I17506	**SVS-0863**	22	26.5	40.0	43.0	96.0	2.8	40.4	4.0	2.2
K90902	BEA/50B1807//LASSEN, **BELUGA**	13	26.3	58.2	42.0	101.0	2.0	59.0	5.0	3.0
Y16507	PR1146-123/Y11405, **YELLOWSTONE**	21	25.5	39.9	40.0	93.0	1.0	37.2	5.2	2.2
Y20917	K16957/I14515	17	22.2	39.4	39.0	92.0	1.0	35.0	5.0	3.0
Y20903	Y16507/I17504	3	21.2	40.5	39.0	94.0	1.0	40.0	5.0	3.0
I14515	DBY-60-1, **PATRON**	23	20.3	40.8	42.0	94.0	3.0	37.0	4.0	1.3
Y20909	I17504/Y17502	9	16.9	38.4	40.0	95.0	1.0	41.0	5.0	2.0
Y20904	Y16507/I17504	4	15.3	42.0	40.0	101.0	4.0	29.0	3.0	3.0
Y20916	K16957/I14515	16	14.3	37.3	40.0	94.0	1.0	40.0	4.0	3.0
Y20914	K16957/I14515	14	12.8	44.4	42.0	95.0	1.0	35.0	4.0	2.0
Y20906	Y16507/I17504	6	12.2	41.9	42.0	95.0	1.0	35.0	4.0	3.0
Y20908	I17504/Y17502	8	10.1	43.6	42.0	102.0	1.0	32.0	4.0	3.0
Y20902	Y16507/I17504	2	9.3	39.8	41.0	93.0	1.0	33.0	4.0	3.0
Y20915	K16957/I14515	15	5.7	44.6	41.0	93.0	1.0	48.0	4.0	3.0
MEAN(14)			17.0	42.2	41.0	95.6	1.6	38.7	4.3	2.6
LSD(.05)			8.2	2.6	3.2	4.5	1.4	10.2	0.6	1.3
CV%			24.5	3.1	4.0	2.4	44.5	13.5	6.6	24.9

EXPERIMENT 2018 PRELIMINARY KIDNEY BEAN YIELD TRIAL (RED HAWK/SACRAMENTO RILS)							PLANTED: 6/12/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
K15601	RED CEDAR/K11916, **COHO**	100	31.9	50.9	43.0					1.3
K20621	Red Hawk/Sacramento	44	31.5	58.3	42.0					3.0
K20635	Red Hawk/Sacramento	58	31.5	55.0	38.0					3.0
K20644	Red Hawk/Sacramento	67	31.1	62.5	44.0					3.0
K20320	Red Hawk/Sacramento	20	29.9	58.1	40.0					3.0
K20667	Red Hawk/Sacramento	90	29.7	58.5	45.0					3.0
K20650	Red Hawk/Sacramento	73	29.2	62.2	39.0					3.0
K20614	Red Hawk/Sacramento	37	28.8	56.1	44.0					3.0
K20603	Red Hawk/Sacramento	26	28.8	62.1	36.0					4.0
K20628	Red Hawk/Sacramento	51	28.8	55.1	37.0					3.0
K20636	Red Hawk/Sacramento	59	28.7	54.9	39.0					3.0
K20602	Red Hawk/Sacramento	25	28.0	53.9	44.0					3.0
K20666	Red Hawk/Sacramento	89	27.9	58.5	38.0					3.0
K20658	Red Hawk/Sacramento	81	27.8	56.6	34.0					4.0
K20664	Red Hawk/Sacramento	87	27.8	66.2	42.0					3.0
K20663	Red Hawk/Sacramento	86	27.6	61.4	43.0					3.0
K20317	Red Hawk/Sacramento	17	27.6	57.4	39.0					3.0
K20662	Red Hawk/Sacramento	85	27.3	54.0	42.0					3.0
K20641	Red Hawk/Sacramento	64	27.0	57.6	38.0					3.0
K20634	Red Hawk/Sacramento	57	27.0	53.2	35.0					3.0
K20632	Red Hawk/Sacramento	55	26.7	57.1	40.0					3.0
K20657	Red Hawk/Sacramento	80	26.4	60.3	37.0					3.0
K20616	Red Hawk/Sacramento	39	26.3	57.3	44.0					3.0
K20613	Red Hawk/Sacramento	36	26.0	55.7	36.0					4.0
K20610	Red Hawk/Sacramento	33	26.0	61.1	39.0					3.0
K20631	Red Hawk/Sacramento	54	25.9	58.7	41.0					3.0
K20623	Red Hawk/Sacramento	46	25.8	57.5	35.0					4.0
K11306	K06621/USDK-CBB-15, **RED CEDAR**	101	25.4	56.5	44.0					1.7
K20308	Red Hawk/Sacramento	8	25.2	61.3	40.0					3.0
K20309	Red Hawk/Sacramento	9	24.5	60.9	38.0					3.0
K20611	Red Hawk/Sacramento	34	24.4	57.5	36.0					4.0
K20629	Red Hawk/Sacramento	52	24.3	59.0	36.0					4.0
K20640	Red Hawk/Sacramento	63	23.8	53.0	35.0					4.0
K20645	Red Hawk/Sacramento	68	23.8	56.9	36.0					4.0
K20626	Red Hawk/Sacramento	49	23.5	63.0	35.0					5.0

EXPERIMENT 2018 PRELIMINARY KIDNEY BEAN YIELD TRIAL (RED HAWK/SACRAMENTO RILS)										PLANTED: 6/12/20	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
K20318	Red Hawk/Sacramento	18	23.4	59.4	36.0					3.0
K20619	Red Hawk/Sacramento	42	23.2	52.0	38.0					3.0
K20625	Red Hawk/Sacramento	48	23.2	59.9	35.0					4.0
K20660	Red Hawk/Sacramento	83	23.2	62.2	48.0					3.0
K20620	Red Hawk/Sacramento	43	23.1	55.8	37.0					3.0
K20303	Red Hawk/Sacramento	3	23.0	54.0	35.0					3.0
K20316	Red Hawk/Sacramento	16	22.9	50.8	38.0					3.0
K20651	Red Hawk/Sacramento	74	22.8	58.1	38.0					3.0
K20630	Red Hawk/Sacramento	53	22.7	56.0	42.0					3.0
I11201	Pink Panther//ZAA/Montcalm, **CLOUSEAU**	97	22.6	60.2	36.0					4.0
K20604	Red Hawk/Sacramento	27	22.4	55.8	36.0					4.0
K20668	Red Hawk/Sacramento	91	22.4	55.5	43.0					3.0
K20649	Red Hawk/Sacramento	72	22.4	59.0	37.0					4.0
K20653	Red Hawk/Sacramento	76	22.3	59.5	42.0					3.0
K20311	Red Hawk/Sacramento	11	22.1	55.2	36.0					5.0
K20319	Red Hawk/Sacramento	19	21.9	57.1	39.0					4.0
K20638	Red Hawk/Sacramento	61	21.8	55.4	38.0					4.0
K20615	Red Hawk/Sacramento	38	21.8	56.1	38.0					4.0
K20639	Red Hawk/Sacramento	62	21.7	59.3	40.0					4.0
K20606	Red Hawk/Sacramento	29	21.6	57.2	43.0					3.0
K20643	Red Hawk/Sacramento	66	21.6	61.8	38.0					4.0
K20323	Red Hawk/Sacramento	23	21.5	60.2	40.0					3.0
K90101	CHAR/2*MONT, **RED HAWK**	99	21.3	55.9	39.0					3.0
K20642	Red Hawk/Sacramento	65	21.1	64.4	35.0					4.0
K20612	Red Hawk/Sacramento	35	21.1	63.8	35.0					5.0
K20652	Red Hawk/Sacramento	75	21.0	58.0	39.0					3.0
K20656	Red Hawk/Sacramento	79	20.9	61.0	36.0					3.0
K20310	Red Hawk/Sacramento	10	20.8	60.5	39.0					4.0
K20647	Red Hawk/Sacramento	70	20.6	61.8	37.0					3.0
K20648	Red Hawk/Sacramento	71	20.6	59.1	38.0					3.0
K20637	Red Hawk/Sacramento	60	20.5	60.6	39.0					4.0
K20301	Red Hawk/Sacramento	1	20.4	51.6	41.0					3.0
K20665	Red Hawk/Sacramento	88	20.3	57.0	41.0					3.0
K20322	Red Hawk/Sacramento	22	20.2	59.8	41.0					4.0
K20607	Red Hawk/Sacramento	30	20.1	51.7	38.0					4.0

EXPERIMENT 2018 PRELIMINARY KIDNEY BEAN YIELD TRIAL (RED HAWK/SACRAMENTO RILS)									PLANTED: 6/12/20		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
K20601	Red Hawk/Sacramento	24	20.0	53.6	41.0					3.0
K20669	Red Hawk/Sacramento	92	19.6	53.8	42.0					4.0
K20624	Red Hawk/Sacramento	47	19.3	54.0	37.0					3.0
K20646	Red Hawk/Sacramento	69	19.2	53.5	41.0					4.0
K20618	Red Hawk/Sacramento	41	19.1	52.9	37.0					4.0
K20313	Red Hawk/Sacramento	13	19.0	52.1	36.0					4.0
K20633	Red Hawk/Sacramento	56	18.9	61.8	36.0					5.0
K20617	Red Hawk/Sacramento	40	18.9	55.2	37.0					4.0
K20307	Red Hawk/Sacramento	7	18.9	58.1	38.0					5.0
K20670	Red Hawk/Sacramento	93	18.9	66.1	37.0					3.0
I81061	SEL-CLRK, **SACRAMENTO**	96	18.6	62.0	35.0					5.0
K20608	Red Hawk/Sacramento	31	18.4	65.2	35.0					5.0
K20609	Red Hawk/Sacramento	32	18.2	58.2	35.0					5.0
K20321	Red Hawk/Sacramento	21	18.2	56.1	40.0					4.0
K20655	Red Hawk/Sacramento	78	18.1	59.9	35.0					5.0
K20661	Red Hawk/Sacramento	84	17.5	56.3	42.0					3.0
K20659	Red Hawk/Sacramento	82	17.4	58.5	38.0					4.0
K20312	Red Hawk/Sacramento	12	17.4	55.6	36.0					5.0
K90101	CHAR/2*MONT, **RED HAWK**	95	17.1	54.8	39.0					3.0
K20654	Red Hawk/Sacramento	77	16.8	59.0	44.0					3.0
K20627	Red Hawk/Sacramento	50	16.7	57.5	37.0					5.0
K20314	Red Hawk/Sacramento	14	16.6	50.7	35.0					5.0
K20605	Red Hawk/Sacramento	28	16.6	56.3	35.0					5.0
K20671	Red Hawk/Sacramento	94	16.6	62.3	36.0					5.0
K20306	Red Hawk/Sacramento	6	14.5	48.8	35.0					5.0
K20315	Red Hawk/Sacramento	15	14.4	54.9	38.0					5.0
I90013	**CELRK**	98	13.8	59.9	37.0					5.0
K20302	Red Hawk/Sacramento	2	12.6	56.2	38.0					3.0
K20304	Red Hawk/Sacramento	4	12.4	53.2	39.0					4.0
K20622	Red Hawk/Sacramento	45	11.5	52.1	35.0					5.0
K20305	Red Hawk/Sacramento	5	8.8	52.1	38.0					5.0
MEAN(101)			22.2	57.5	38.5					3.6
LSD(.05)			5.8	3.0	3.2					1.0
CV%			12.4	2.5	4.0					12.8

EXPERIMENT 2019 NATIONAL WHITE MOLD YIELD TRIAL									PLANTED: 6/12/20			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)	WM (1-9)	WM %
P16901	Eldorado/P11519, **CHARRO**	3	51.4	40.8	45.0	103.0	3.3	48.7	4.7	2.0	4.3	48.1
G19609	G16346/G16318	34	48.3	45.7	46.0	105.0	3.0	48.3	3.7	1.5	1.7	18.5
R17604	R12859/R12844	40	46.3	37.7	46.0	102.0	2.0	52.0	5.0	1.0	2.7	29.6
P18603	P14815/G14525	35	45.6	45.9	49.0	103.0	3.7	46.7	4.0	2.0	2.7	29.6
G17418	G14530/G11431	32	45.1	35.3	47.0	105.0	3.0	52.7	4.3	2.5	2.7	29.6
B10244	B04644/ZORRO, **ZENITH**	20	44.5	22.9	44.0	101.0	1.3	49.3	5.7	2.0	2.3	25.9
G18512	G14525/P14815	33	44.5	44.1	45.0	103.0	3.7	45.3	4.0	3.0	2.7	29.6
R12844	SR9-5/R09508, **CAYENNE**	38	44.3	37.8	45.0	102.0	2.7	54.7	5.0	1.0	2.3	25.9
P19703	I16706/P16901	37	42.3	40.9	48.0	103.0	3.3	46.3	4.3	3.0	3.7	40.7
S18904	S14706/R13752	39	42.0	42.2	48.0	103.0	2.0	61.7	5.0	1.0	3.3	37.0
G16351	Eldorado/G13467, **EIGER**	2	40.6	37.7	47.0	104.0	2.7	55.3	4.3	1.5	3.7	40.7
B19332	B16501/B15464	28	39.4	21.7	45.0	102.0	1.7	47.3	5.3	1.0	3.7	40.7
B19345	B16506/B16507	30	39.4	22.4	45.0	101.0	1.0	50.3	6.3	1.5	2.0	22.2
B18204	B10244/B15430	25	38.9	23.2	44.0	101.0	1.3	53.7	6.0	1.0	3.0	33.3
N17505	N14230/N12447	14	38.0	21.8	48.0	102.0	2.3	52.7	5.3	1.0	3.3	37.0
N18103	N13120/PR00806-81	18	37.6	23.5	43.0	101.0	1.7	53.3	5.7	2.0	3.3	37.0
N19285	G14505/X16708	19	37.2	24.2	44.0	101.0	3.3	46.3	4.0	1.5	3.3	37.0
I20818	PT16-23-6-B	9	37.0	38.2	45.0	101.0	3.3	47.7	4.0	3.0	6.7	74.1
B18504	Zenith//Alpena*/B09197, **ADAMS**	1	36.8	21.9	44.0	101.0	2.0	47.3	5.0	2.0	2.3	25.9
I09203	SR9-5	7	36.7	35.5	47.0	103.0	2.3	57.7	4.7	1.5	2.3	25.9
N18130	N15341/N14238	15	36.1	20.5	48.0	102.0	1.7	53.3	5.0	3.5	3.3	37.0
N19248	N15331/N16405	17	35.6	20.1	45.0	101.0	3.0	48.7	4.3	2.5	3.7	40.7
B19346	B15414/B16504	31	35.3	22.4	46.0	101.0	2.0	50.0	4.7	1.5	5.3	59.3
I19716	NDF141506	6	34.6	37.0	47.0	103.0	2.7	52.0	4.7	3.0	4.3	48.1
P19702	P14815/I15643	36	34.4	37.8	47.0	103.0	3.0	50.0	4.0	3.5	4.0	44.4
B19330	B16501/B15414	27	33.9	22.3	45.0	102.0	2.0	48.3	4.7	1.5	3.7	40.7
B17922	B14302/B10244	23	33.3	20.3	45.0	101.0	2.0	50.3	5.0	2.0	3.0	33.3
B16501	Zenith/B10215	21	33.3	21.4	45.0	101.0	1.3	51.7	5.3	2.0	3.3	37.0
B18201	B10244/B13218	24	32.7	21.7	46.0	101.0	1.0	49.0	5.7	2.0	2.0	22.2
I19719	SR16-2	8	30.3	34.2	44.0	101.0	3.0	50.3	4.0	4.0	3.3	37.0
N19239	N15331/N16404	16	30.1	20.1	45.0	101.0	2.7	50.7	4.7	1.5	6.0	66.7
B19344	B16506/B16507	29	28.6	23.7	45.0	102.0	2.0	49.0	5.0	1.0	3.7	40.7
B17220	B10244/B12724	22	28.0	22.6	44.0	101.0	1.7	51.3	5.3	2.0	3.7	40.7
I11264	COOP 03019, **MERLIN**	13	26.5	20.3	43.0	102.0	2.0	50.0	4.7	3.5	4.0	44.4
I20817	ND122454(2131)	5	26.1	59.5	45.0	104.0	3.3	31.7	4.3	1.0	2.7	29.6
B18236	B14303/B12724	26	22.8	21.4	44.0	102.0	3.0	46.3	5.0	1.0	4.0	44.4
I96417	**G122**	12	19.8	38.2	45.0	103.0	3.7	43.3	4.0	3.5	2.0	22.2
I81010	JAPON3/MAGDALENE, **BUNSI**	10	17.0	20.8	43.0	102.0	4.3	40.7	3.3	3.0	7.7	85.2
I20816	ND132162	4	16.3	18.3	50.0	103.0	3.7	42.7	4.0	1.0	4.7	51.8
I89011	RB, **BERYL**	11	13.8	34.7	40.0	101.0	5.0	30.7	2.0	2.0	9.0	100.0
MEAN(40)			35.1	30.0	45.2	102.2	2.6	48.9	4.7	2.0	3.6	40.4
LSD(.05)			4.2	1.5	1.8	1.4	0.9	8.6	0.7	1.1	1.7	19.1
CV%			8.9	3.7	2.4	1.0	27.1	12.9	11.7	33.7	34.8	34.8

Manganese and Zinc Application in Dry Bean

Kurt Steinke and Andrew Chomas, Michigan State University

See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conv., 20-in. row
Planting Date: June 04, 2020 (Harvest: 9/17/20)	**Mn, Zn Rates**: See below
Soil Type: Clay Loam; 2.3% OM; 7.8 pH; 33 ppm P; 146 ppm K; 55 ppm Mn; 5.7 ppm Zn	**Population**: 5 ½ in. seed spacing
Variety: Zorro (black bean)	**Replicated**: 4 replications

Mn Trt. (Total lb. Mn/A)	Yield[b] (cwt/A)
0	40
1 (25 DAE)	41
1 (25 DAE) 1 (35 DAE)	35
$LSD_{(0.10)}$[a]	**3.1**

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$).
[b] Yield adjusted to 18% moisture.

Zn Trt. (Total lb. Zn/A)	Yield[b] (cwt/A)
0	45
5	44
10	43
$LSD_{(0.10)}$[a]	**NS**

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$).
[b] Yield adjusted to 18% moisture.

Summary: Trial quality was good. Manganese was foliar applied using a 5% soluble Mn solution at rates of 1 lb Mn/A at 25 days after emergence and another treatment as 1 lb Mn/A at 25 and 35 days after emergence (2 lb Mn/A total). Zinc was pre-plant incorporated using zinc sulfate at 5 and 10 lb Zn/A. All treatments received 60 lbs. N/A total as urea applied pre-plant incorporated.

Critical soil test Mn concentrations for dry bean on mineral soils are near 6 ppm at a 6.3 soil pH and 12 ppm at a 6.7 soil pH. At the current soil test level of 55 ppm, a yield response to

Mn was not expected. No visual confirmation of Mn tissue deficiency was noticed at this location. Although dry bean is classified as highly responsive to Mn application, soil test Mn concentrations were sufficient thus making a foliar Mn response less likely.

Critical soil test Zn concentrations for dry bean are near 2 ppm at 6.6 soil pH and 7 ppm at 7.0 soil pH. At the current soil test level of 5.7 ppm, a yield response to Zn application was probable but not realized during the 2020 growing season. Although dry bean is classified as highly responsive to Zn application, no visible Zn deficiency symptoms were observed at this location. Due to the diffusive movement of Zn in the soil, banded Zn applications at planting are often preferred as compared to broadcast pre-plant applications. Growers should also be aware that dry bean grown after sugarbeet can result in Zn deficiencies. Dry beans rely on mycorrhizal fungi to assist with nutrient uptake but sugarbeets do not host these fungi thus often dry bean will not be able to uptake enough Zn in these situations.

Response of Dry Bean to Nitrogen Application

Christian Terwillegar, Andrew Chomas, and Kurt Steinke, Michigan State University
See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conventional
Planting Date: June 04, 2020 (Harvest: 9/17/20)	**Row Width**: 20-inch
Soil Type: Clay Loam; 2.4% OM; 7.0 pH; 43 ppm P; 162 ppm K	**N Rates**: See below
Varieties: Zenith (black bean), Black Bear (black bean)	**Population**: 5 ½ in. seed spacing
Viper (small red bean), Merlin (navy bean)	**Replicated**: 4 replications

Treatment	Yield[b] (cwt/A)	Biomass[c] (lb./A)	Nodule Count[d] (nodules/plant)	White Mold (% infected)
Variety				
Zenith	35	5,445	7.0	13
Black Bear	38	5,900	9.1	15
Viper	42	5,688	4.2	48
Merlin	37	6,326	3.5	23
$LSD_{(0.10)}$[a]	**2.0**	**NS**	**2.8**	**5.0**
N rate (lb. N/A)				
0 N	36	4,355	7.7	22
30 N	38	5,330	10.0	20
60 N	39	6,687	5.0	29
90 N	38	6,443	3.7	21
120 N	39	6,434	4.2	29
150 N	40	5,314	5.3	29
$LSD_{(0.10)}$[a]	**NS**	**1054**	**3.1**	**6.0**

[a] LSD, least significant difference ($\alpha \leq 0.10$). NS = not significant.
[b] Yield obtained by direct harvest and adjusted to 18% moisture.
[c] Biomass collected at growth stage R5.
[d] Nodules counted 6 weeks after emergence.

Summary: Trial quality was good with greater grain yield and white mold infection compared to 2019. The objective of this trial was to determine whether changes in both agricultural management practices and genetics have affected dry bean response to nitrogen fertilizer application. Treatments consisted of four dry bean varieties: Zenith (black bean), Black Bear (black bean), Viper (small red bean), and Merlin (navy bean). Urea was pre-plant incorporated at nitrogen rates of 0, 30, 60, 90, 120, and 150 lb. N/A.

Cumulative June through September precipitation was 21% less than the 30-year mean. However, July and August precipitation during pod and seed-fill was 3 and 6% greater than the 30-year mean, respectively. Near to slightly above normal mid-summer precipitation was likely the reason for a near doubling of yield potential from 2019 which endured an extremely dry late-summer period. Mid- to late-season growing conditions did not limit aboveground biomass

production as was also the case in 2019. Variety did not impact dry bean response to N rate; therefore data pertaining to variety and N rate are presented independently.

In 2020, grain yield was significantly influenced by variety but not N rate. This would appear to indicate that a combination of pre-plant residual soil N, N mineralization from soil organic matter, and biological nitrogen fixation may have fulfilled plant and seed N requirements. Nitrogen rate influenced biomass production, but results did not correspond to grain yield. Thus additional biomass was not a reliable indicator for 2020 grain yield. Biomass significantly increased up to 60 lb. N/A with no significant increases at N rates > 60 lb. N/A. Nodulation scores per plant and white mold infection were significantly impacted by variety and N rate. Nodulation was not affected at N rates up to 30 lb N/A with significant decreases at rates > 30 lb N/A. White mold infection did not directly correlate (data not shown) with biomass production. However, growers should be aware of and consider the risks for developing and spreading white mold when above optimal N rates may favor aboveground biomass production and denser canopies thus leading to potentially more favorable disease conditions. In the environments tested during 2019 and 2020, data suggest that current recommendations of 40 to 60 lb. N/A should be sufficient for row spacings < 23 inches and to accommodate both modern dry bean varieties and improved agricultural management practices. Growers should continue to consider fertilizer placement options during planting as a method that may help account for some of the early- to mid-season climate variability recently encountered and potentially improve nutrient efficiencies.

Dry Bean Response to Phosphorus Application

Kurt Steinke and Andrew Chomas, Michigan State University

See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conventional
Planting Date: June 04, 2020 (Harvest: 9/17/20)	**Row Width**: 20-inch
Soil Type: Clay Loam; 2.3% OM; 7.8 pH; 33 ppm P (Bray-P1); 146 ppm K	**P Rates**: See below
Varieties: Zenith (black bean), Black Bear (black bean)	**Population**: 5 ½ in. seed spacing
Viper (small red bean), Merlin (navy bean)	**Replicated**: 4 replications

Variety	**P Trt. (Total lb. P_2O_5/A)**					
	0	25	50	100	150	200
	(cwt/A) [b]					
Zenith	39	37	41	36	34	32
Black Bear	39	37	36	37	35	37
Viper	38	38	44	38	45	43
Merlin	41	41	39	39	39	38
$LSD_{(0.10)}$ [a]	**3.7**					

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$).

[b] Yield adjusted to 18% moisture.

Summary: Trial quality was good. Phosphorus source was monoammonium phosphate (MAP, 11-52-0) applied pre-plant incorporated with N contributions from the MAP accounted for in overall total N application rates. All treatments received 60 lbs. N/A total. 'Viper' appeared to be the only variety to respond to P_2O_5 applications up to the 50 lb P_2O_5/A rate. 'Viper' was also the variety with the greatest yield in the N response studies thus this could be an example of N promoting additional biomass and subsequent uptake of other nutrients. Further studies on root morphology, root density, or mycorrhizal fungi relationships of this variety may be warranted.

Critical Bray-P soil test concentration for dry bean is 15 ppm with a maintenance range of 15-40 ppm. The current soil test P concentration of 33 ppm (Olsen P values averaged 17-20 ppm) places this field in the maintenance range and thus a yield response was not probable. No visible P deficiency symptoms were observed at this location. 'Zenith', 'Black Bear', and 'Merlin' did not significantly respond to P_2O_5 applications in the current study. Remember that as soil test P values decline closer to critical, P fixation tends to increase thus resulting in greater rates of fertilizer to increase soil test levels.

Dry Bean Response to Potassium Application

Kurt Steinke and Andrew Chomas, Michigan State University

See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conventional
Planting Date: June 04, 2020 (Harvest: 9/17/20)	**Row Width:** 20-inch
Soil Type: Clay Loam; 2.3% OM; 7.8 pH; 33 ppm P; 146 ppm K	**K Rates:** See below
Varieties: Zenith (black bean), Black Bear (black bean)	**Population**: 5 ½ in. seed spacing
Viper (small red bean), Merlin (navy bean)	**Replicated**: 4 replications

K Trt. (Total lb. K_2O/A)	Yield[b] (cwt/A)
0	40
25	42
50	41
100	41
150	41
200	40
$LSD_{(0.10)}$[a]	**NS**

[a] LSD, least significant difference between means within a column at ($\alpha = 0.10$).

[b] Yield adjusted to 18% moisture.

Summary: Trial quality was good. Potassium source was potassium chloride (MOP, 0-0-60) applied pre-plant incorporated. All treatments received 60 lbs. N/A total as urea applied pre-plant incorporated. Variety did not affect response to K applications thus data were combined across varieties. Critical soil test K concentration for dry bean at this location was 120 ppm with a maintenance K range of 120-170 ppm.

Due to residual soil test K concentrations, no yield differences occurred across the spectrum of K application rates in this study nor was a yield response to be expected. Differences in aboveground biomass were observed in response to K application. No visual K tissue deficiencies were observed during this study. Given the relative short growing season for dry bean production, producers should obtain a current soil test report and consider current soil test K concentrations in relation to critical soil test K values. Critical soil test K values are 100 ppm on soils with a CEC < 5 and 120 ppm for soils with a CEC > 5. As soil test values decline closer to critical, K fixation tends to increase resulting in greater rates of fertilizer to increase the soil test level.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Sulfur Rate and Source Response for Dry Bean

Christian Terwillegar, Andrew Chomas, and Kurt Steinke, Michigan State University
See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conventional
Planting Date: June 04, 2020 (Harvest: 9/17/20)	**Row Width**: 20-inch
Soil Type: Clay Loam; 2.3% OM; 7.8 pH; 33 ppm P; 146 ppm K; 8 ppm S	**Treatments**: See below
Varieties: Zenith (black bean), Black Bear (black bean)	**Population**: 5 ½ in. seed spacing
Viper (small red bean), Merlin (navy bean)	**Replicated**: 4 replications

Treatment	Yield[b] (cwt/A)	NDVI[c]	Nodule Count[d] (nodules/plant)
Variety			
Zenith	38	0.87	3.8
Black Bear	44	0.89	2.5
Viper	40	0.88	2.2
Merlin	42	0.88	1.3
$LSD_{(0.10)}$[a]	**3.0**	**NS**	**1.3**
S Rate (lb. S/A)			
0 S	40	0.88	2.5
25 S	41	0.88	2.0
50 S	41	0.88	2.3
100 S	41	0.88	3.0
$LSD_{(0.10)}$[a]	**NS**	**NS**	**NS**

[a] LSD, least significant difference ($\alpha \leq 0.10$). NS = not significant.
[b] Yield obtained by direct harvest and adjusted to 18% moisture.
[c] NDVI data collection occurred at R1 growth stage.
[d] Nodules counted 6 weeks after emergence.

Treatment	Yield[b] (cwt/A)	NDVI[c]	Nodule Count[d] (nodules/plant)
Variety			
Zenith	39	0.87	4.8
Black Bear	43	0.89	3.2
Viper	41	0.87	2.3
Merlin	40	0.89	1.1
$LSD_{(0.10)}$[a]	**NS**	**NS**	**1.6**
S Source (25 lb. S/A)			
Gypsum	41	0.88	2.0
AMS	41	0.88	3.4
MESZ	40	0.88	3.2
$LSD_{(0.10)}$[a]	**NS**	**NS**	**NS**

[a] LSD, least significant difference ($\alpha \leq 0.10$). NS = not significant.
[b] Yield obtained by direct harvest and adjusted to 18% moisture.
[c] NDVI data collection occurred at R1 growth stage.
[d] Nodules counted 6 weeks after emergence.

Summary: Trial quality was good with above average grain yields. The objective of this trial was to determine whether decreased sulfur (S) inputs coupled with increased S removal from greater crop grain yields (e.g. corn, soybean, wheat, etc.) has impacted dry bean response to S fertilizer application. Treatments consisted of four dry bean varieties: Zenith (black bean), Black Bear (black bean), Viper (small red bean), and Merlin (navy bean). Gypsum was utilized as the S source within the S rate study which was pre-plant incorporated at 0, 25, 50, and 100 lb. S/A. For the S source study, gypsum, AMS (21-0-0-24S), and MESZ (12-40-0-10S-1Zn) were utilized as S sources and pre-plant incorporated at 25 lb. S/A. Nitrogen was balanced to 60 lb. N/A for all treatments utilizing pre-plant incorporated urea.

In the S rate study, yield and nodule counts were significantly influenced by variety, but S rate did not affect yield, NDVI, or nodulation. In the S source study, variety and S source did not significantly impact grain yield or NDVI. Previous research has demonstrated coarse sandy soils with low (< 2%) soil organic matter may not supply sufficient S. However, at both study locations, the soil type consisted of a clay loam with OM greater than 2%. Although greater grain yields may support greater S uptake, above average temperatures and timely precipitation in July and August likely promoted S mineralization and availability from soil organic matter (SOM). Furthermore, as sulfur application in more N-responsive field crops (e.g., corn and winter wheat) increases, carryover sulfur may satisfy dry bean plant and grain S requirements. Data from 2019 and 2020 suggests sulfur application was not warranted in the environments tested due to adequate soil S from mineralization and possibly carryover S from other field cropping systems.

Official Variety Trial

SVREC, Richville - 2020

PIONEER • BIG CHIEF
MICHIGAN SUGAR

Trial Quality: Fair/Poor
Plant/Harv: Apr 24/Sep 22
Plots: 2 rows X 38 ft., 8 reps
Row Spacing: 22 inches
Seeding Rate: 3.75 inches

Soil Type: Clay Loam
% OM: 2.8 **pH:** 7.4 **CEC**: 17.5
Nutrients: **P:** Opt **K:** Opt
Mn: High **B:** Low
Added N: 35 lbs. 2x2, 120 lbs. PPI
Prev Crop: Corn

****Cerc Control:** Very Good
7 applications**
Rhizoc Control: Fair
Quadris IF, 6-8 lf
Rainfall: 18.74 inches

Variety	$/A	RWSA	RWST		Yield		Sugar		CJP		Emerge	
			Lb/T	Rank	T/A	Rank	%	Rank	%	Rank	%	Rank
BTS-1065	**$1,949**	**8332**	266	12	**31.3**	**2**	18.0	12	**95.0**	**10**	**50.1**	**11**
C-G675	**$1,902**	**8131**	255	26	**31.8**	**1**	17.4	26	94.8	24	**51.6**	**7**
SX-2294	**$1,881**	**8038**	**274**	**4**	**29.3**	**8**	**18.5**	**4**	**95.0**	**9**	49.0	14
C-G943	**$1,853**	**7922**	257	24	**30.8**	**3**	17.5	23	94.9	20	**52.5**	**5**
BTS-1703	**$1,839**	**7863**	258	22	**30.4**	**5**	17.6	21	94.7	29	**58.3**	**2**
HIL-2238NT	**$1,838**	**7857**	257	23	**30.5**	**4**	17.5	24	94.9	15	**50.9**	**8**
C-G932NT	**$1,835**	**7842**	261	17	**30.1**	**6**	17.7	18	94.9	18	**52.4**	**6**
SX-2295	**$1,830**	**7824**	**273**	**6**	**28.6**	**10**	**18.4**	**6**	**95.1**	**2**	44.1	24
BTS-1941	**$1,797**	**7682**	255	25	**30.0**	**7**	17.4	25	94.8	25	49.1	13
HIL-2332NT	**$1,774**	**7583**	271	8	28.0	12	18.3	9	**95.1**	**3**	36.0	31
SX-RR1264	**$1,761**	**7528**	271	9	27.8	13	18.3	8	**95.0**	**11**	46.1	20
C-G021	**$1,752**	**7491**	265	13	28.3	11	17.9	13	**95.1**	**5**	**56.4**	**3**
HIL-9865	$1,683	7192	**274**	**3**	26.2	17	**18.6**	**3**	94.9	17	47.0	16
MA-709	$1,676	7165	264	14	27.2	14	17.8	16	**95.1**	**4**	41.9	27
SX-2296N	$1,676	7163	**279**	**1**	25.7	23	**18.8**	**1**	94.9	13	46.2	19
BTS-1399	$1,666	7122	248	29	**28.7**	**9**	17.0	29	94.8	27	**50.8**	**10**
C-G752NT	$1,598	6832	260	19	26.3	15	17.6	20	**95.0**	**8**	**50.9**	**9**
SX-2297	$1,594	6813	**277**	**2**	24.6	25	**18.6**	**2**	**95.1**	**6**	44.9	22
SX-RR1275N	$1,579	6750	259	20	26.0	18	17.6	19	94.9	16	47.1	15
C-G919	$1,568	6702	260	18	25.7	22	17.7	17	94.8	26	**60.9**	**1**
BTS-188N	$1,544	6600	255	27	25.9	21	17.3	27	94.8	23	40.8	29
HIL-9879NT	$1,541	6588	268	11	24.6	26	18.1	10	94.9	19	**53.9**	**4**
SX-RR1278N	$1,536	6566	253	28	25.9	20	17.3	28	94.7	30	46.4	18
C-G855	$1,527	6526	248	30	26.3	16	16.9	30	94.9	21	43.2	25
BTS-197N	$1,521	6503	259	21	25.2	24	17.5	22	95.0	12	46.8	17
MA-814	$1,509	6449	263	15	24.6	27	17.8	15	94.9	22	**49.9**	**12**
SX-2283	$1,499	6408	**273**	**5**	23.4	29	**18.4**	**7**	**95.2**	**1**	44.6	23
HIL-2240	$1,492	6378	263	16	24.3	28	17.9	14	94.8	28	45.3	21
BTS-1606N	$1,481	6331	245	31	26.0	19	16.8	31	94.6	31	40.3	30
MA-813NT	$1,413	6039	268	10	22.5	30	18.1	11	**95.0**	**7**	42.2	26
HIL-9908	$1,367	5845	**272**	**7**	21.5	31	**18.4**	**5**	94.9	14	40.8	28
Average	$1,660.8	7098.9	262.9		27.02		17.83		94.92		47.76	
LSD 5%	203.1	868.0	6.8		3.2		0.4		0.2		11.7	
CV%	12.4	12.4	2.6		12.2		2.3		0.2		24.8	

**** See Cercospora Fungicide Application Page**

$/A: Payment calculated using early delivery adjustment where necessary, and a per pound payment of $.165.

Bold: Results are not statistically different from top-ranking variety in each column.

Comments: Trial experienced some variability in emergence. Stands ranged from 115-195 beets/100' of row. Dry weather in June slowed growth. Pockets of Rhizoctonia and Fusarium impacted root quality and stands. This trial was not used for variety approval due to stand and root disease issues that impacted trial quality.

Rhizoctonia Nursery

Average of 2 years, 2019 & 2020

Trial Quality: Good
Location: 2019 - Blumfield East, SVREC, 2020 - SVREC
Plot Size: 2 rows X 25 ft., 6 reps
Inoculation: Inoculated with Rhizoctonia Solani AG 2-2 IIIB

Variety	Root Rating* 0-7	Estimated Root Rot %
C-G919	**4.3**	**35.4**
C-G855	**4.3**	**33.8**
SX-2297	**4.3**	**37.6**
C-G932NT	**4.4**	**36.8**
BTS-1399	**4.5**	**38.2**
C-G752NT	**4.5**	**38.0**
HIL-2332NT	**4.5**	**39.5**
HIL-9908	**4.6**	**40.0**
SX-2295	**4.6**	**41.1**
C-G675	**4.6**	**41.8**
SX-RR1264	**4.6**	**41.1**
BTS-188N	**4.7**	**42.4**
C-G943	**4.7**	**42.3**
BTS-1703	**4.7**	**42.9**
BTS-1941	**4.7**	**43.3**
BTS-1606N	**4.7**	**42.9**
MA-814	**4.7**	**43.6**
SX-2296N	**4.8**	**45.0**
Resistant Check	**4.8**	**45.5**
MA-709	**4.8**	**45.9**
HIL-9879NT	**4.8**	**46.7**
BTS-197N	**4.8**	**46.8**
HIL-2240	**4.8**	**46.1**
SX-2294	**4.9**	**46.4**
HIL-2238NT	**4.9**	**47.3**
MA-813NT	5.0	**49.6**
SX-RR1278N	5.0	50.0
SX-RR1275N	5.0	50.5
HIL-9865	5.0	50.7
Susceptible Check	5.1	51.5
SX-2283	5.1	51.8
**C-G021	5.4	60.0
**BTS-1065	5.8	69.5
Average	4.77	44.95
LSD 5%	0.7	14.5
CV %	6.9	16.2

Bold: Results are not significantly different from the top ranking variety in each column
****C-G021 and BTS-1065** - First year varieties only used 2020 data.
***Rating System:**

0 = No Infection
1 = less than 2% rotted roots
2 = less than 5% rotted roots
3 = 5 to 25% rotted roots
4 = 26 to 50% rotted roots
5 = 51 to 75% rotted roots
6 = 76 to 95% rotted roots
7 = 100% rotted roots

During evaluations, roots were dug and assigned values from 0 to 7. Each plot contained approximately 50 roots and each root was rated.

Cercospora Nursery

Average of 2 years, 2019 & 2020

Trial Quality: Good

Locations: 2019 - Blumfield East, SVREC
2020 - Gilford, SVREC

Plot Size: MSC - 2 Rows X 17.5 ft., 5 reps
SVREC - 2 Rows X 20 ft., 5 reps
Gilford - 2 rows X 17.5 ft., 5 reps

Inoculation: Trials were Inoculated

Variety	Avg of 2 Years CLS Rate 0-9	2019 CLS Rate 0-9	2020 CLS Rate 0-9
**C-G021	N.A	N.A	2.0
BTS-1941	2.2	2.5	1.8
**BTS-1065	N.A	N.A	2.2
C-G943	2.5	2.8	2.2
C-G919	3.8	4.4	3.3
HIL-9908	3.8	4.2	3.5
BTS-1399	4.1	4.7	3.6
C-G855	4.3	5.0	3.5
BTS-1703	4.3	5.1	3.5
HIL-2240	4.5	5.0	3.9
MA-709	4.6	5.2	4.0
MA-813NT	4.6	5.6	3.6
HIL-9879NT	4.6	5.4	3.8
MA-814	4.7	5.3	4.1
HIL-2238NT	4.7	5.4	4.1
C-G675	4.8	5.5	4.2
Resistant Check	4.8	5.5	4.1
SX-2295	4.9	5.8	4.0
SX-2294	4.9	5.7	4.0
SX-2297	4.9	5.9	3.9
SX-RR1264	4.9	5.8	4.1
SX-2283	5.1	6.0	4.2
HIL-9865	5.2	6.0	4.3
C-G752NT	5.2	5.8	4.6
BTS-1606N	5.3	6.2	4.4
SX-RR1275	5.4	6.1	4.6
HIL-2332NT	5.4	6.3	4.6
C-G932NT	5.5	6.3	4.8
BTS-197N	5.6	6.2	5.0
BTS-188N	5.7	6.2	5.1
SX-2296N	5.8	6.9	4.6
Susceptible Check	5.8	6.7	4.9
SX-RR1278N	5.8	6.7	4.9
Average	4.77	5.50	3.93

Cercospora Rating (0-9 Scale): 0 = no spots, 1 = very few spots, 2 = up to 10 spots/leaf, 2.5 = up to 50 spots/leaf, 3 = 100 to 200 spots/leaf (approx 3% leaf injury), 4 = up to 10 % injury, 5 = up to 25 % injury, 6 = up to 50% injury, 7 = up to 75% injury, 8 = up to 90% injury, 9 = leaves completely dead.

****C-G021 and BTS-1065** - First year varieties only used 2020 data.

Comments: Disease pressure was late to develop and less severe in the 2020 Nursery trials. New varieties with the CR+ trait were able to stay below economic injury level during the rating period. Many more varieties are now available with Good to Excellent tolerence compared to past years.

Sugar beet activities of the USDA-ARS East Lansing conducted in cooperation with Saginaw Research & Extension Center during 2020

Linda Hanson, Tom Goodwill, and Holly Corder
USDA – Agricultural Research Service, East Lansing, MI

Evaluation and rating plots were planted at the Saginaw Valley Research & Extension Center (SVREC) in Frankenmuth, MI in 2020 that focused on Cercospora leaf spot (CLS) and Rhizoctonia root and crown rot (RRCR) disease performance of a wide range of *Beta vulgaris* materials. CLS and RRCR trials were conducted in conjunction with the Beet Sugar Development Foundation (BSDF) and CLS trials included USDA-ARS cooperator germplasm as well as germplasm screening for the National Plant Germplasm System. All trials were planted following normal fall and spring tillage operations with a USDA-ARS modified John Deere / Almaco research plot planter. The BSDF CLS nursery was planted on May 22 and the BSDF RRCR nursery was planted on May 23 (delayed due to Covid restrictions),. All plots were 15 ft long planted on 20 in rows. BSDF entries were commercial or near-commercial varieties, and weeds were controlled with glyphosate at the recommended rates. For non-commercial entries, as in previous years, weeds were controlled by a pre-plant application of ethofumesate, followed by intervals of post-plant mixtures of phenmedipham, desmedipham, triflusulfuron methyl, and clopyralid (4 times), and finally with S-metolachlor. Hand weeding was done as needed to control larger weeds. The BSDF trials were thinned by hand with the generous help of Michigan Sugar Cooperative. Bolting beets were removed throughout the season. In the CLS nurseries, Quadris 2.08SC (azoxystrobin) was broadcast on May 26 at 32 oz/A to help control Rhizoctonia damping-off.

Cercospora / Agronomic Nurseries:

The BSDF cooperative CLS evaluation nursery had entries from two companies, with a total of 144 entries evaluated. This nursery was 2-row with 4 replications. The nursery was inoculated on July 9 with a liquid spore suspension (approximately 1 x 10^3 spores/ml) of *Cercospora beticola*. Inoculum was produced from a mixture of leaves collected from the 2019 inoculated leaf spot nursery at the SVREC. A second inoculation was performed July 23 as a rain event occurred shortly after the initial inoculation and disease development was very slow. Visual evaluations of the plot were conducted with a disease index (DI) on a scale from 0-10 where 0=no symptoms, 1=a few scattered spots, 2=spots coalescing or in large numbers on lower leaves only, 3= some dieback on lower leaves, but leaves not entirely dead, 4-8 are increasing amounts of dead and diseased tissue, 9= mostly dead with few remaining living leaves with large dead patches, and 10=all leaves dead. Disease severity peaked in late September, with commercial entries averaging severity between 3 and 6 on this scale. After this, regrowth started to outpace new disease development. In addition to commercial entries, 30 Plant Introductions and USDA-ARS breeding lines and checks from a USDA cooperator (Ft. Collins, CO, 54 entries) were evaluated in randomized replicated trials and rated for disease reaction on two dates.

In addition to testing for Cercospora leaf spot, five germplasm were planted in a non-inoculated control plot. This plot was adjacent to the Cercospora leaf spot nursery but was not inoculated and was sprayed with fungicides using standard recommendations for Cercospora leaf spot management. Germplasm was collected using a plot lifter and hand harvest for a storage rot trial being conducted during the winter of 2020/2021. Plant roots that appeared healthy were placed in bags with sawdust to absorb excess moisture and stored at 7 C.

Rhizoctonia nurseries:

The BSDF cooperative RRCR Eastern Evaluation Nursery had entries from five companies, with a total of 297 entries plus two control varieties evaluated. This nursery was 1-row with 5 replications conducted in a double-blind fashion. In addition, susceptible or moderately resistant varieties were planted to collect sacrificial samples through the season and assess root rot development. The nursery was inoculated on July 5 with a dry ground barley inoculum of *Rhizoctonia solani*, Anastomosis Group 2-2 (highly virulent isolate) at 0.9 g per foot of row using a Gandy applicator to apply inoculum directly to the rows. The nursery was sprayed with water following inoculum application to ensure sufficient moisture for infection. Roots were dug with a modified single row harvester on August 11-13. Each root was rated for disease severity using a 0-7 scale where 0=no visible lesions and 7=root completely rotted. A weighted disease index was calculated for each replicate. Variety disease index means for the entire nursery ranged from 4.5 to 6.5 with the percent of roots classified as "harvestable" (less than 25% of the root rotted) ranging from 2.7 to 33.4% for the different varieties. For the susceptible and moderately resistant control varieties, the disease index averaged 5.8 and 4.9 respectively across the entire nursery, with the percent of roots classified as "harvestable" averaging 9.3 and 27% respectively.

Finally, 30 Plant Introductions (PIs) from the USDA-ARS National Plant Germplasm System (NPGS) *Beta* Collection [includes garden beet, sugarbeet, leaf beet, fodder beet (*Beta vulgaris* L.), and wild beet (*Beta* spp.)] (2011-2014) along with two controls were evaluated for resistance to *Cercospora beticola* in an artificially produced epiphytotic environment (based generally on Ruppel, E.G. and J.O. Gaskill. 1971. J. Am. Soc. Sugar Beet Technol. 16:384). A randomized complete-block design with 1-row and 3-replications was used to evaluate germplasm at the Michigan State University Saginaw Valley Research and Extension Center (SVREC) near Frankenmuth, MI. Internal controls included a susceptible check, F1042 (PI 674103), and a resistant check, EL50/2 (PI 664912). The nursery was spray-inoculated with a liquid spore suspension (approximately 1 x 10^3 spores/ml as determined with a hemacytometer) of *C. beticola*. Inoculum was produced from a mixture of leaves collected from the 2019 inoculated leaf spot nursery at SVREC and naturally infected beets grown at SVREC and on the Michigan State University campus farms in East Lansing, MI. Visual evaluations of the plot with a disease index (DI) on a scale from 0-10 where 0=no symptoms, 1=a few scattered spots, 2=spots coalescing or in large numbers on lower leaves only, 3= some dieback on lower leaves, but leaves not entirely dead, 4-8 are increasing amounts of dead and diseased tissue, 9= mostly dead with few remaining living leaves with large dead patches, and 10=all leaves dead. Bolting beets were removed throughout the season.

We extend our gratitude to Paul Horny and Dennis Fleischmann for their help with nursery and farm operations.

We thank Michigan Sugar for their generous assistance in thinning and recording for Rhizoctonia ratings

We also thank the Michigan State University students who assisted with aspects of conducting the nursery: Malini Jayawardana and Doug Minier.

Ongoing effort on developing a consistent and efficient inoculation method for Alternaria leaf spot on sugar beet in field

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Alternaria leaf spot (ALS), caused by strains of *Alternaria alternata* species complex, is a foliar disease on sugar beet. ALS caused minor issues on sugar beet before 2015 in the United States. Recently it has been reported as an increasing issue in Michigan. Identification and breeding varieties for host resistance is important to manage this disease. Identification of resistant varieties using natural infection in the field is a convenient way but can have issues such as inconsistency or lack of data in years when natural infection is low. Therefore, a reliable and consistent inoculation method is important for screening sugar beet varieties for resistance. As an effort to develop a consistent inoculation method in the field, we started field trials in 2018 and the report here is a continuation of adjusting the conditions for inoculation in the field.

Two varieties of sugar beets, one susceptible and one with partial resistance were planted in plots at the Saginaw Valley Research and Extension Center, Frankenmuth, MI in 2020. Two sections were used for this trail where fungicide applications to control Cercospora leaf spot were used in section 1 whereas section 2 had no fungicide applications to control Cercospora leaf spot. Inoculation was done in September to provide favorable environmental conditions (cool temperature) for Alternaria leaf spot (Franc 2009) and to avoid the peak of Cercospora leaf spot in the field. The pathogen (isolate P23) was grown on half strength V8 medium and incubated in the dark for 10 days to enhance the sporulation. Five treatments were used in each section where treatment 1- water control, 2- 0.2% malt extract broth (MEB) control, 3-0.5% MEB control, 4- 0.2% MEB + inoculum and 5- 0.5% MEB + inoculum. The inoculum was prepared for treatments 4 and 5 by suspending the pathogen spores (approximately $1x10^3$ spores/ml as determined with a hemacytometer) in MEB (Becton Dickinson and Company, Sparks, MD, USA). Each treatment had 4 replicates for each variety. Spray inoculation was done using a backpack sprayer with a rate of 20 ml per plant. Disease rating was started 1 week after inoculation and continued weekly up to 5 weeks. A 0-10 rating scale was used where 0 – no spots, 1: 1-2 spots throughout the plot, 2: few spots on <3 plants, 3: spots on <5 plants, 4: spots on 6-10 plants, 5: spots on >10 plants, 6: spots enlarging on at least 10 plants, 7: coalescing spots, 8: 1-2 dead leaves; 9: >2 dead leaves, 10: total defoliation. Statistical analysis was done using SAS software (version 9.4).

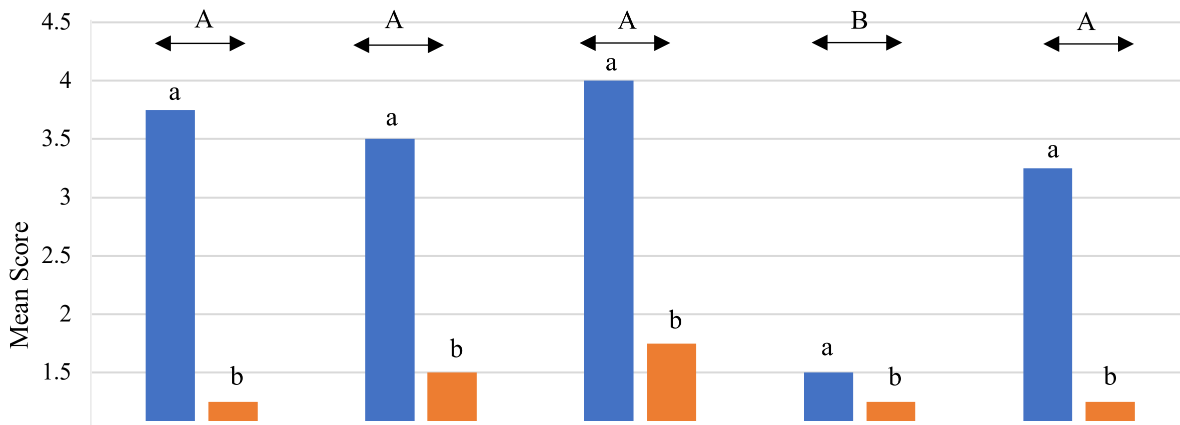

Figure 1: A histogram showing the mean score of Alternaria leaf spot (ALS) in two sugar beet varieties (variety 1: susceptible, variety 2: partial resistant) with different treatments (1: water control, 2: 0.2% MEB, 3: 0.5% MEB, 4: inoculum in 0.2% MEB and 5: Inoculum in 0.5% MEB) at 2 weeks in section 1. The lowercase and uppercase letters above each bar indicate significant difference among varieties and treatments, respectively. Bars with same letters were not significantly different by Fisher's protected LSD at alpha = 0.05.

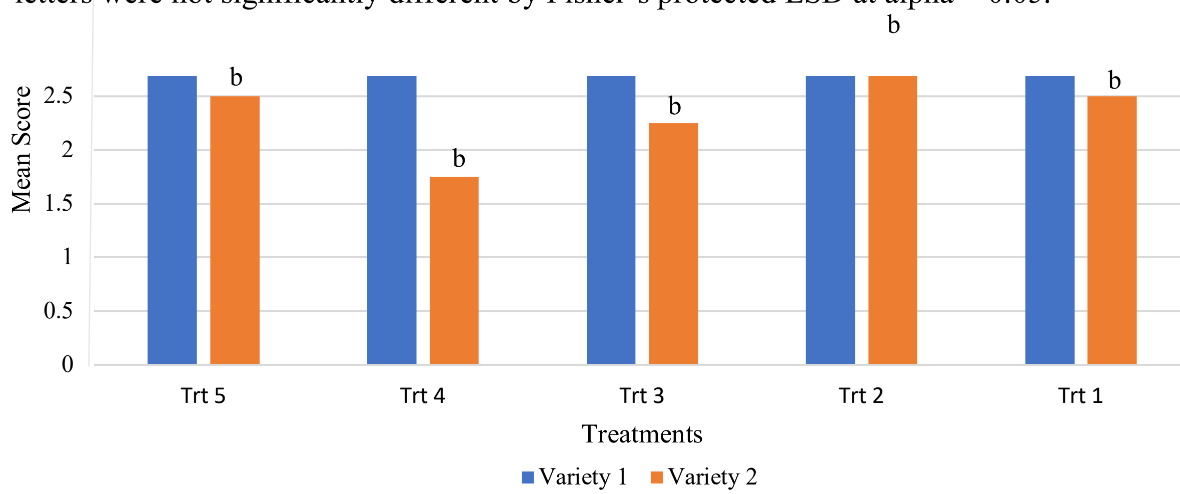

Figure 2: A histogram showing the mean score of Alternaria leaf spot (ALS) in two sugar beet varieties (variety 1: susceptible, variety 2: partial resistant) with different treatments (1: water control, 2: 0.2% MEB, 3: 0.5% MEB l, 4: inoculum in 0.2% MEB and 5: Inoculum in 0.5% MEB) at 2 weeks in section 2. The lowercase letters above each bar show the significant difference among varieties. Bars with same letters are not significantly different by Fisher's protected LSD at alpha = 0.05. No significant difference among treatments were observed

section 1 (Figure 1 and Figure 2). Treatment 2 (0.2% MEB control) was significantly lower than treatment 4 which was inoculated with the pathogen spores in 0.2% MEB (Figure 1). This may indicate that 0.2% MEB concentration works if it is sprayed with the pathogen inoculum. There was no significant difference between 0.5% MEB control (treatment 3) and inoculum in 0.5% MEB (treatment 5). We hypothesize the MEB might have stimulated natural infection.

The same experiment was done in both sections. The difference between section 1 and 2 is the application of fungicides to control Cercospora leaf spot in section 1. There was no significant difference among treatments observed in section 2. The interference with ALS rating by Cercospora leaf spot in section 2 might be one of the reasons for not getting a significant difference among treatments. To overcome this problem, we conducted the experiments in late summer where the temperature is not good for Cercospora leaf spot (Jacobsen and Franc 2009). We are planning to conduct the same experiment next year in a different location where Cercospora leaf spot is less abundant in the field.

Summary and future work:

The inoculation of Alternaria strain (P23) with MEB gave a significant difference in disease between susceptible and resistant varieties. No significant difference between 0.5% MEB control and inoculum in 0.5% MEB indicates that 0.5% MEB may not require outside pathogen inoculum but still showed a difference in disease among varieties with natural infection. This is an indication that similar methods might be used in future to develop a consistent inoculation method using the natural infection. To check the consistency of these results, the same experiment will be performed next year with the same varieties and treatments. In addition, this will be performed in another location which gets less Cercospora leaf spot.

References:

- Franc, G. D. 2009. Alternaria leaf spot. Pages 12-13 in: Compendium of Beet Diseases and Pests. R. M. Haveson, L. E. Hanson, and G. L. Heil. eds. APS Press, St. Paul, MN.
- Jacobsen, B., and Franc, G. 2009. Cercospora leaf spot. Pages 7-9 in: Compendium of Beet Diseases and Pests. R. M. Haveson, L. E. Hanson, and G. L. Hein. eds. APS Press, St. Paul, MN.

Evaluation of in-furrow fungicides to manage Rhizoctonia root and crown rot of sugar beet

Chris Bloomingdale and Jaime Willbur, Michigan State University

Location: Frankenmuth (SVREC)	**Treatment Timings:** In-Furrow & Banded (6-8 leaf stage)
Planting Dates: May 5, 2020	**Pesticides:** see table
Soil Type: Loam	**O.M.:** 5.0 **pH:** 7.5
Replicates: 4	**Variety:** HIL-9879NT

Summary: No differences were observed in the percent stand loss of treatments (P > 0.05), which had mean values ranging between 1.6-14.7%. Mean yield values ranged between 15.4-19.7 t/A but were not significantly different among treatment programs (P > 0.05). Significant differences were observed in Rhizoctonia root rot index ratings at harvest (P = 0.05). DX values ranged from 3.9 to 9.8%, and though differences were detected among fungicide programs, no program differed from the controls.

Table 1. End of season stand loss, Rhizoctonia root rot index, and yield from the tested fungicide programs.

No.	Treatment, Rate[a]	Application Type[b]	Stand Loss (%)	Yield (t/A)	Disease Index (%)[c, d]
3	Quadris, 9.2 fl oz Proline, 5.7 fl oz	In-Furrow Banded	1.6	18.6	3.9 c
9	Actinovate AG, 6 oz Excalia, 2 fl oz	In-Furrow Banded	4.4	19.2	3.9 c
11	Elatus, 7 oz Elatus, 7 oz	In-Furrow Banded	8.4	17.9	3.9 c
8	Excalia, 4 oz	Banded	6.5	19.7	4.3 bc
10	Quadris, 13.9 fl oz Quadris, 13.9 fl oz	In-Furrow Banded	4.6	15.4	4.3 bc
6	Quadris, 12 fl oz	Banded	5.4	17.4	4.4 bc
7	Excalia, 2 fl oz	Banded	11.6	18.7	4.9 bc
2	Non-Inoculated Control[e]	-	5.2	19.0	6.1 abc
4	Experimental, 12.8 fl oz Quadris, 9.2 fl oz Proline, 5.7 fl oz	In-Furrow In-Furrow Banded	11.9	18.2	7.5 abc
1	Inoculated Control[e]	-	13.1	17.1	7.6 abc
12	Quadris, 13.9 fl oz Elatus, 7 oz	In-Furrow Banded	14.7	17.6	8.4 ab
5	Quadris, 12 fl oz	In-Furrow	7.6	17.5	9.8 a

[a] All rates are listed as measure of a product per acre.
[b] In-furrow treatments were applied at planting, banded applications were applied at the 6-8 leaf stage.
[c] Disease index was calculated by multiplying the Rhizoctonia root rot incidence (0-100%) by the mean symptomatic root severity (1-7) and dividing by 7.
[d] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05).
[e] Non-treated.

Azoxystrobin sensitivity of *Rhizoctonia solani* AG2-2 populations affecting Michigan sugar beet

Jaime F. Willbur[1], Chris Bloomingdale[1], Cameron Pincumbe[1], Douglas H. Minier[1], Linda E. Hanson[2]; [1]Michigan State University, [2]USDA-ARS

Summary: From 2018-2019, *Rhizoctonia solani* primarily AG 2-2 isolates were tested for sensitivity to azoxystrobin. In Michigan, azoxystrobin (Quadris) is widely applied one to two times per season to manage Rhizoctonia root and crown rot. Azoxystrobin, a quinone outside inhibitor, targets a single site to inhibit fungal respiration and so possesses a high risk of fungicide resistance development. Continued reliance on this product has justified recent investigations of azoxystrobin sensitivity in Michigan *R. solani* populations. Isolates were collected from research and commercial fields in Michigan (10 counties). Two additional baseline isolates (R1 and R9), collected prior to azoxystrobin use in sugar beet, were included for comparison. Isolates were screened in half-strength clarified V8 broth amended with salicylhydroxamic acid at 10 µg ml^{-1} and azoxystrobin at concentrations: 0, 0.01, 0.1, 1, 10, and 100 µg ml^{-1}. The effective concentrations for 50% inhibition of colony mass (EC_{50}) were determined using three-parameter logistic regression. The majority of tested isolates (more than 95%) were comparable to baseline isolates with EC50 values less than 0.3 ug ml^{-1} (Lunos 2016). Azoxystrobin insensitivity was observed (*N* = 3 isolates), however, pathogen fitness may have been impacted as minimal growth was observed even at low concentrations. No trends in year of collection, host of origin, or county of origin were observed.

Table 1. Mean, standard deviation, minimum, and maximum azoxystrobin EC_{50} values (µg ml^{-1}) for baseline and nonbaseline *Rhizoctonia solani* AG 2-2 isolates tested in 2018 and 2019.

Tested	Collected	Isolate Group	*N*	Mean	St. Dev.	Min.	Max.
2018	Pre-1999	Baseline	2	0.025	0.001	0.025	0.026
	2015-2018	Nonbaseline	37	0.050	0.095	0.012	0.606
2019	Pre-1999	Baseline	2	0.014	0.003	0.012	0.016
	2019	Nonbaseline	49	0.228	0.983	0.005	4.956

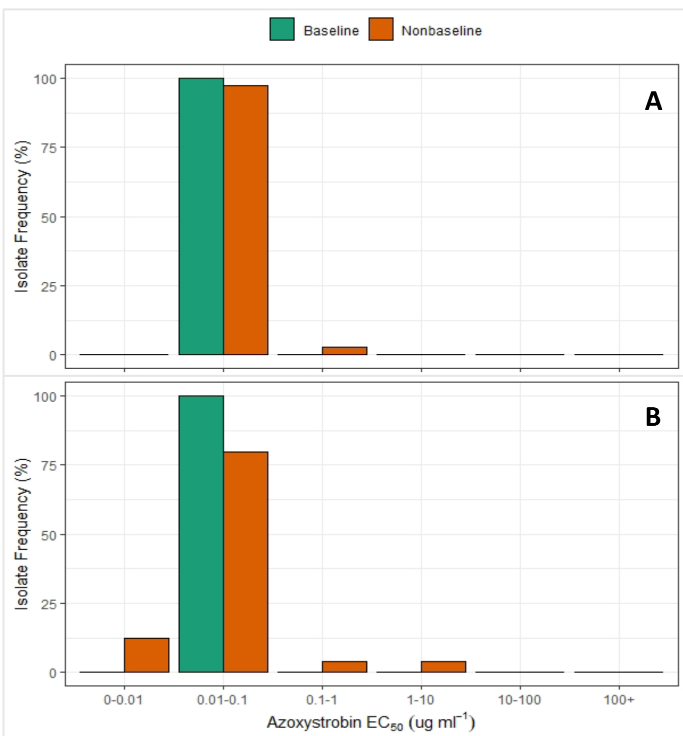

Figure 1 (left). Frequencies of *Rhizoctonia solani* primarily AG 2-2 EC_{50} values (µg ml^{-1}) for baseline isolates collected pre-1999 and nonbaseline isolates collected **A**, between 2015 and 2018 (*N* = 37), and **B**, in 2019 (*N* = 49).

Acknowledgments: This work was supported by Michigan Sugar Company, MSU Extension, and MSU AgBioResearch. We also thank Dennis Bischer, Corey Guza, and Michigan Sugar Company agronomists for their assistance in obtaining beet root samples.

Epidemiological studies of Cercospora leaf spot of sugar beet for improved management

Alexandra Hernandez[1], Daniel Bublitz[1], Tom Wenzel[1], Chris Bloomingdale[1], Cameron Pincumbe[1], Cheryl Trueman[2], Linda E. Hanson[1,3], and Jaime F. Willbur[1]; [1]Michigan State University; [2]University of Guelph – Ridgetown; [3]United States Department of Agriculture – Agricultural Research Service

Background:

Cercospora leaf spot (CLS)is the most important foliar disease of sugar beet in Michigan and several other sugar beet growing regions (Harveson et al. 2009; Lartey et al. 2010). This research aims to identify, develop, and deploy novel short-term and long-term CLS management strategies. Observations made of the disease, including early-season inoculum presence, changes in *Cercospora beticola* fungicide resistance, and performance of CLS prediction models have helped us to identify opportunities for further improvement in CLS management. Strategies which were investigated to aid in CLS management include creating improved disease prediction tools through an innovative spore abundance model, identifying alternative strategies to reduce inoculum survival for long-term management, and evaluating fungicide resistance management tactics in Michigan *C. beticola* populations. Continued population monitoring, model development and refinement, and multi-year and -location validation is ongoing.

Methods:

Objective 1. Monitor *C. beticola* spore presence and abundance using spore traps and sentinel beets to refine existing predictive modeling tools. Aerial spores were captured using Burkard spore traps and highly susceptible sentinel beet traps at the MSU Crop and Soils Farm, Frankentrost, MI, and Ontario, Canada in 2019 and the Saginaw Valley Research and Extension Center (SVREC) in 2020. Environmental factors were monitored using on-site or local MSU Enviroweather stations and evaluated for correlations to spore abundance. Stepwise regression analyses were conducted to assess the accuracy of the model variables separately and together.

Objective 2. Assess potential end-of-season management strategies to reduce inoculum levels and disease. Treatments included a nontreated control, plowing immediately post-harvest, applying heat with a burner at 1 mph prior to defoliation at-harvest, and applying a desiccant (saflufenacil, Sharpen) 7 days pre-harvest. Leaf samples were collected from each plot at harvest before topping and evaluated 0-, 45-, 90-, and 135-days post-harvest to assess *C. beticola* survival over the winter. Survival was determined by observing the percentage of lesion sporulation and viability. In 2020, highly susceptible sentinel beets and bi-weekly CLS ratings in re-planted plots were used to assess the long-term efficacy of inoculum reduction strategies. Yield and sugar data were also collected to assess the long-term efficacy of inoculum reduction strategies. A repeated trial was initiated in 2020 with the addition of a second burner treatment applied at 3 mph.

Objective 3. Determine fungicide sensitivity of *C. beticola* populations recovered from resistance management trials. Treatment programs evaluated at the SVREC included: a nontreated control; a mixed application, where both high-risk (pyraclostrobin) and low-risk (mancozeb) fungicides were applied at each spray timing; high-low, where alternate sprays of pyraclostrobin and mancozeb were applied, with pyraclostrobin sprayed first; and low-high, which is similar to the previous treatment but with low-risk applied first. Symptomatic leaves were sampled from field trials in July (after three treatments) and September (after all six treatments). Mono-conidial *C. beticola* isolates were then tested for in vitro pyraclostrobin sensitivity. A spiral gradient dilution method was used to find the effective concentration inhibiting growth by 50% (EC50). Resistance management trials were conducted in 2019 and 2020.

For all objectives, statistical analyses (analysis of variance and simple and linear mixed model regression) were conducted in SAS v. 9.4 and evaluated at the α=0.05 significance level. Fisher's protected Least Significance Difference was used for mean comparisons.

Results & Conclusions:

Objective 1. In 2019, a preliminary model to predict spore number was developed using significantly correlated weather predictors ($R^2 = 0.23$, $P < 0.0001$). The initial model predicted daily spore abundance based on daily total precipitation, minimum daily relative humidity, maximum daily soil temperature, and maximum daily wind speed. With additional observations from Ontario in 2019 and Michigan in 2020, significant correlations were observed between spore abundance and maximum air temperature ($r = 0.35$, $P < 0.0001$) and maximum soil moisture ($r = 0.22$, $P < 0.05$), though precipitation ($r = 0.12$, $P = 0.11$) and maximum wind speed ($r = 0.17$, $P = 0.06$) were also noted. Additional locations and years will be added to the spore abundance and initial disease observations for further model refinement and validation. A preliminary model will be used in field validations conducted in 2021. Initial detections and general trends of abundance suggest a spore presence or abundance model will complement existing tools to better predict early-season risk and improve subsequent CLS management.

Objective 2. In 2019, significant treatment differences were detected in percentages of lesion sporulation ($P < 0.0001$) and lesion viability ($P < 0.05$) in at harvest samples (N=133 leaves and 240 lesions). In 2020, reduced numbers of CLS lesions were observed on sentinel beets collected in 2019 burner treated plots from May 26-June 1 ($P < 0.05$, Fig. 1A) and June 2-9 ($P < 0.01$, Fig. 1B). The heat treatment also significantly reduced the area under the disease progress curve (AUDPC), calculated from ratings in re-planted plots ($P < 0.01$, Fig. 1C). In the repeated trial initiated in 2020, lesion sporulation was reduced in at harvest ($P < 0.0001$, Fig. 2) and 45-days post-harvest samples ($P < 0.01$). Continued monitoring will occur until harvest in 2021. Novel management strategies, particularly the use of a foliar burner at-harvest, have the potential to reduce inoculum overwintering and aid in long-term CLS control.

Remaining leaf samples from inoculum overwintering studies will continue to be evaluated for the repeated trial initiated in 2020. In 2021, early-season spore presence and abundance, weekly disease ratings, and final yield and sugar data will be collected to validate the long-term efficacy of inoculum reduction strategies.

Objective 3. In 2019, no significant differences were found in mean pyraclostrobin EC_{50} values for isolates collected from the fungicide treatment programs in July (N=145 isolates) or September (N=75 isolates, *in progress*). All programs resulted in similar yields ($P < 0.001$), relative area under the disease progress curves (RAUDPC; $P < 0.01$) and performed better than the non-treated control. So far, 43% of isolates from July and 20% of isolates from September are considered highly resistant ($EC_{50} \geq 25$ ppm). All isolates tested were sensitive to pyraclostrobin concentrations below label rates (1,200-1,500 $\mu g\ ml^{-1}$). In 2019, resistance management tactics were found to have little effect on mid-season populations of *C. beticola*.

Testing of the remaining end-of-season *C. beticola* populations from 2019 and 2020 is in-progress and will continue. These samples received the full-season treatments. Isolate pyraclostrobin sensitivity will be tested and results will be evaluated by treatment. In 2021, *C. beticola* populations will be monitored for sensitivity to critical fungicide groups.

Acknowledgements: This work is supported by the Michigan Sugar Company, USDA-ARS, Project GREEEN, Sugarbeet Advancement, and the USDA National Institute of Food and Agriculture, Hatch project 1020281.

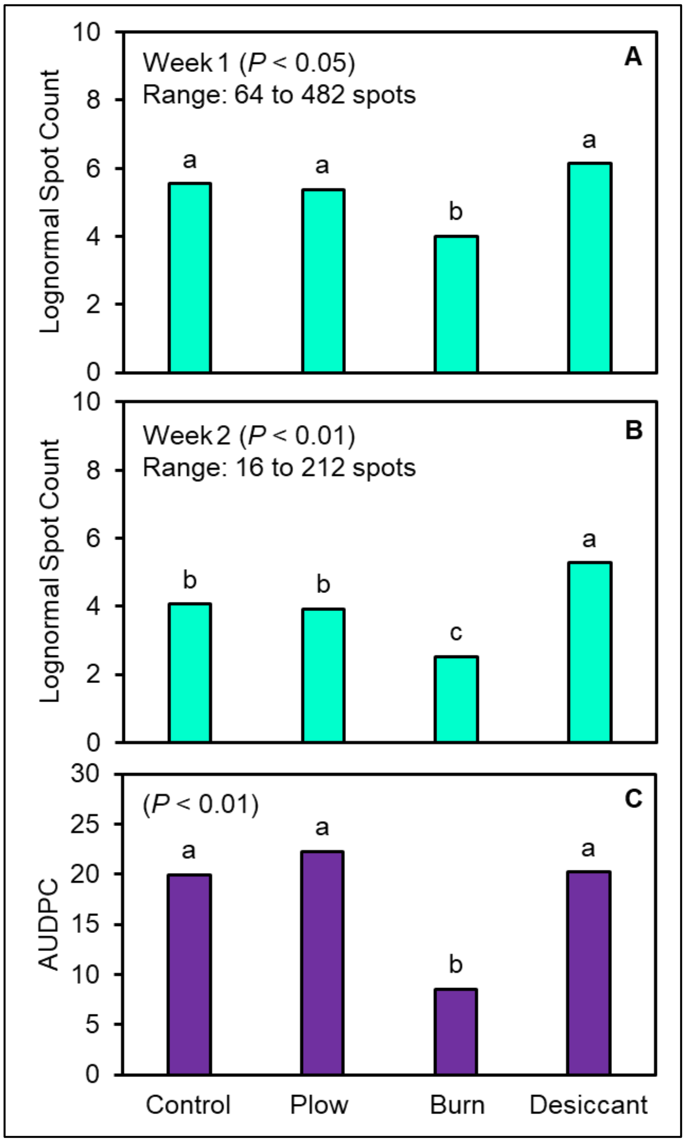

Figure 1. *Early-season inoculum and subsequent CLS observations in 2020 following end-of-season treatments applied in 2019. Leaf spot counts were collected from sentinel beets placed in plots between* ***A,*** *May 26-June 1 and* ***B,*** *June 2-9. Subsequent bi-weekly CLS ratings were used to calculate* ***C,*** *the area under the disease progress curve (AUDPC). Means of bars with the same letters were not different based on Fisher's protected LSD at α=0.05.*

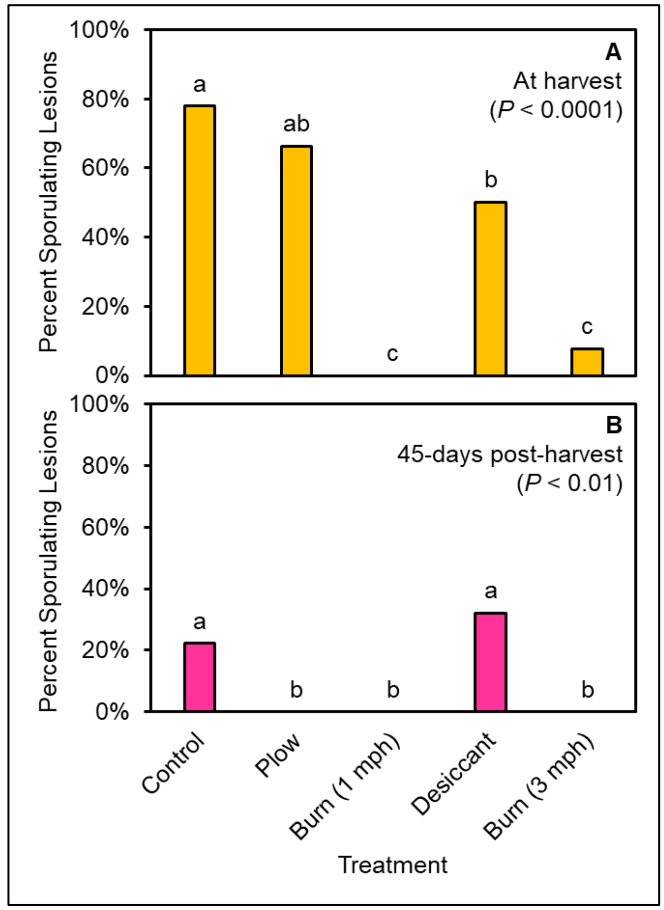

Figure 2. A, *At-harvest and* ***B,*** *45-days post-harvest lesion sporulation in repeated trial initiated in 2020, following desiccant application 7-days pre-harvest, heat treatment immediately prior to defoliation, and plowing immediately following harvest. Means of bars with the same letters were not different based on Fisher's protected LSD at α=0.05.*

Evaluation of foliar fungicide treatments to manage Cercospora leaf spot of sugar beet

Chris Bloomingdale and Jaime Willbur, Michigan State University

Location: Frankenmuth (SVREC)	**Treatment Timings:** 14-day interval starting at 35 DSV
Planting Dates: April 7, 2020	**Pesticides:** see table
Soil Type: Loam	**O.M.:** 5.0 **pH:** 7.5
Replicates: 4	**Variety:** C-G333NT

Summary: Differences in area under the disease progress curve (AUDPC) were observed in this trial. All fungicide programs had significantly lower CLS severities than the non-treated control (*P* < 0.0001). The lowest AUDPC value was observed in program 11, however, it did not perform differently than over half of the other tested programs. Estimated mean yield values ranged between 13.9 and 20.5 t/A, but no differences were observed among treatments (*P* > 0.05). Additionally, percent sugar and RWST were not different among treatments (*P* > 0.05).

Table 1. Area under the disease progress curve (AUDPC) and yield parameters from the tested fungicide programs.

No.	Treatment, Rate[a], and Timing[b]	AUDPC[c, d]	Yield (t/A)	Sugar (%)	RWST[e]
11	Manzate Max (1.6 qt) ABCD + Provysol (5 fl oz) B + Super Tin (8 fl oz) C + Priaxor (8 fl oz) D + Topsin (20 fl oz) D	22.3 k	17.5	17.9	229.7
25	Exp[f] 3 (58 fl oz) A + Manzate Max (1.6 qt) ABCD + Super Tin (8 fl oz) BCD	24.0 g-k	16.5	17.5	223.9
26	Inspire XT (7 fl oz) A + Manzate Max (1.6 qt) ABCD + Super Tin (8 fl oz) BC + Exp 3 (58 fl oz) D	25.8 jk	18.6	17.8	226.6
24	Inspire XT (7 fl oz) A + Manzate Max (1.6 qt) ACD + Super Tin (8 fl oz) BCD + Dexter Max (2.1 lb) B	26.8 ijk	15.4	18.0	231.1
12	Manzate Max (1.6 qt) ABCD + Proline (5.7 fl oz) B + Super Tin (8 fl oz) C + Flint Extra (3.6 fl oz) D Topsin (20 fl oz) D	28.5 h-k	19.3	18.1	232.1
10	Manzate Max (1.6 qt) ABD + Provysol (5 fl oz) B + Serifel (4 oz) C + Super Tin (8 fl oz) C + Priaxor (8 fl oz) D + Topsin (20 fl oz) D	30.3 h-k	15.7	17.5	224.5
27	Exp 3 (58 fl oz) A + Topsin (20 fl oz) A + Super Tin (8 fl oz) BCD + Dexter Max (2.1 lb) B + Manzate Max (1.6 qt) CD	32.0 f-k	19.3	17.8	227.1
2	Manzate Max (1.6 qt) ABCD + Inspire XT (7 fl oz) BD + Super Tin (8 fl oz) C	32.1 f-k	18.7	17.6	225.8
21	Minerva Duo (16 fl oz) ACD + Exp 2 (8 fl oz) AD + Super Tin (8 fl oz) B + Koverall (1.5 lb) B	32.1 f-k	15.1	17.6	224.9
23	Manzate Max (1.6 qt) ABCD + Inspire XT (7 fl oz) A + Super Tin (8 fl oz) BCD	33.8 f-k	17.9	17.8	229.2
7	Propulse (13.6 fl oz) ABCD	34.6 e-k	19.9	18.3	236.6
17	Minerva Duo (16 fl oz) AD + Super Tin (8 fl oz) BC + Koverall (1.5 lb) B + Brixen (21 fl oz) C	34.6 e-k	17.4	17.6	225.9
20	Minerva Duo (16 fl oz) ACD + Super Tin (8 fl oz) B + Koverall (1.5 lb) B	35.5 e-k	14.9	17.3	220.7
18	Exp 1 (32 fl oz) AD + Super Tin (8 fl oz) B + Koverall (1.5 lb) B + Minerva Duo (16 fl oz) C	35.6 e-k	17.4	18.3	236.4
6	Manzate Max (1.6 qt) ABCD + Aqueus (1.28 fl oz/gal) ABCD + Inspire XT (7 fl oz) BD	40.0 e-j	18.6	18.0	229.9
14	Manzate Max (1.6 qt) ABCD + Eminent (13 fl oz) B + Super Tin (8 fl oz) C + Provysol (5 fl oz) D	41.0 d-j	18.3	17.7	226.1

Table 1. Continued from previous page.

No.	Treatment, Rate[a], and Timing[b]	AUDPC[c, d]	Yield (t/A)	Sugar (%)	RWST[e]
22	Brixen (21 fl oz) AD + Spinnaker (1.5 lb) AD + Super Tin (8 fl oz) B + Koverall (1.5 lb) B + Minerva Duo (16 fl oz) C	41.9 d-j	18.8	18.3	235.9
16	Koverall (1.5 lb) ABD + Minerva (13 fl oz) AD + Super Tin (8 fl oz) B + Minerva Duo (16 fl oz) C	43.8 d-i	20.5	17.6	226.0
8	Proline (5.7 fl oz) ABCD	44.6 d-h	19.2	17.8	227.6
15	Brixen (21 fl oz) AD + Super Tin (8 fl oz) B + Koverall (1.5 lb) B + Minerva Duo (16 fl oz) C	48.9 def	16.3	17.7	225.9
5	Headline (12 fl oz) AC + Manzate Max (1.6 qt) ABCD	49.3 def	19.1	17.7	226.5
19	Koverall (1.5 lb) AD + Super Tin (8 fl oz) AD + Exp 1 (32 fl oz) B + Minerva Duo (16 fl oz) C	49.3 def	13.9	17.8	230.1
9	Delaro (11 fl oz) ABCD + Proline (1.71 fl oz) ABCD	51.9 de	18.2	17.9	230.0
13	Badge (2 pt) ABCD + Eminent (13 fl oz) B + Super Tin (8 fl oz) C + Provysol (5 fl oz) D	58.0 cd	15.5	17.6	225.8
4	Manzate Max (1.6 qt) ABD + Headline (12 fl oz) C	69.8 bc	16.7	17.7	226.6
3	Headline (12 fl oz) AC + Manzate Max (1.6 qt) BD	85.9 b	16.3	17.6	224.8
1	Non-Treated Control	141.1 a	16.6	17.9	229.7

[a] All rates, unless otherwise specified, are listed as a measure of product per acre. MasterLock was added to all tank mixes at a rate of 0.25 % v/v.

[b] Application letters code for the following dates: A=29 Jun, B=13 Jul, C=21 Jul, D=20 Aug.

[c] Area under the disease progress curve was calculated using CLS severity (0-10 scale).

[d] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05).

[e] Pounds of recoverable white sugar per ton of beets.

[f] Exp=experimental compound.

Evaluation of LifeGard and ManKocide fungicides to manage Cercospora leaf spot of sugar beet

Chris Bloomingdale and Jaime Willbur, Michigan State University

Location: Frankenmuth (SVREC)	**Treatment Timings:** 14-day interval starting at 35 DSV
Planting Dates: April 7, 2020	**Pesticides:** see table
Soil Type: Loam	**O.M.:** 5.0 **pH:** 7.5
Replicates: 4	**Variety:** C-G675

Summary: Despite late disease onset, significant differences were observed among treatment area under the disease progress curve (AUDPC) values (*P* = 0.001). All ManKocide treatments and LifeGard WG in a standard fungicide program (treatments 5, 6, and 7) had significantly lower CLS severities than the non-treated control and were comparable to the grower standard (treatment 2). AUDPC values in best performing programs ranged from 32.0 to 41.1; these programs did not differ from one another. LifeGard WG and LifeGard LC programs did not differ in AUDPC from the non-treated control. Differences were not observed among collected mean yield or sugar parameters ($P > 0.05$). Yield values in this trial ranged between 10.4 and 18.0 t/A, which is well below typical sugar beet yield in Michigan. Percent sugar and RWST values were comparable to state averages.

Table 1. Area under the disease progress curve (AUDPC) and yield parameters from the tested fungicide programs.

No.	Treatment, Rate[a], and Timing[b]	AUDPC[c,d]	Yield (t/A)	Sugar (%)	RWST[e]
2	Manzate Max (1.6 qt) ABCD + Inspire XT (7 fl oz) BD + Super Tin (8 fl oz) C	32.0 b	14.6	18.3	235.6
5	Manzate Max (1.6 qt) ABCD + LifeGard WG (4.5 oz/100 gal) ABD + Super Tin (8 fl oz) C	33.8 b	16.2	18.2	235.5
6	ManKocide (4.3 lb) ABCD	36.5 b	18.0	18.7	241.0
7	ManKocide (4.3 lb) ABCD + Inspire XT (7 fl oz) BD + Super Tin (8 fl oz) C	41.1 b	17.4	18.1	232.7
3	LifeGard WG (4.5 oz/100 gal) ABCD	83.6 a	16.9	18.4	236.9
4	LifeGard LC (1 gal/ 100 gal) ABCD	95.1 a	17.2	18.3	234.6
1	Non-treated Control	96.1 a	10.4	17.7	226.0

[a] All rates, unless otherwise specified, are listed as a measure of product per acre. MasterLock was added to all tank mixes at a rate of 0.25 % v/v.
[b] Application letters code for the following dates: A=29 Jun, B=13 Jul, C=21 Jul, D=20 Aug.
[c] Area under the disease progress curve was calculated using disease severity (0-10 scale).
[d] Column values followed by the same letter were not significantly different based on Fisher's Protected LSD (α=0.05).
[e] Pounds of recoverable white sugar per ton of beets.

Evaluation of Cercospora leaf spot and postharvest rot pathogen impacts on sugarbeet storage

Carly Hendershot[1], Chris Bloomingdale[1], Holly Corder[1], Tom Goodwill[2], Cameron Pincumbe[1], Randy Beaudry[1], Linda E. Hanson[1,2], and Jaime F. Willbur[1]; [1]Michigan State University; [2]USDA-ARS

Background: In 2020, storage studies were initiated to investigate: (1) the impacts of variety and Cercospora leaf spot (CLS) field infection on rate of storage rot symptom development, (2) the effect of CLS infection on beet respiration rate in storage, and (3) monitor and characterize storage pathogens affecting sugarbeets postharvest. In the following trials, sugarbeet varieties C-G333NT and F1042 [1] were selected as CLS-susceptible materials and HIL-9865 and EL50/2 [2] were selected as CLS-resistant materials. Both C-G333NT and HIL-9865 have been evaluated in Michigan Sugar Company storage trials for the past 3 years; C-G333NT consistently resulted in lower storage rot ratings than HIL-9865. High and low CLS levels were established using combinations of fungicide treatments and field inoculation. After 60 days of storage at 42°F, beet slices were inoculated with *Botrytis cinerea, Penicillium vulpinum, Fusarium graminearum* and *Geotrichum* sp. Fungal growth was measured one-week post-inoculation. At least three timepoints are planned.

Trial 1: CLS infection impact on susceptibility of sugarbeet to four postharvest diseases

Location: Saginaw (SVREC)	**Treatments:** Non-treated (high CLS), grower standard (low CLS)
Planting Date: April 7, 2020	**Variety:** C-G333NT (Inoculated July 9 and July 23, 2020)
Harvest: September 18, 2020	**Replicates:** 4 plots/treatment in field, 3 roots/plot in storage
Storage Trial Timepoint 1: November 24, 2020	**Days Postharvest Timepoint 1:** 67

Trial 2: CLS inoculation and variety impacts on susceptibility of sugarbeet to four postharvest diseases

Location: Saginaw (SVREC)	**Treatments:** Inoculated (high CLS), non-inoculated (low CLS)
Planting Date: May 22, 2020	**Varieties:** F1042, EL50/2, C-G333NT, HIL-9865
Harvest: October 15, 2020	**Inoculated:** July 9 and July 23, 2020
Storage Trial Timepoint 1: December 15, 2020	**Days Postharvest Timepoint 1:** 61

Summary (1): Results from Trial 1 showed no significant differences between storage rot susceptibility in beets with high or low CLS levels in the field ($P > 0.05$; Fig. 1). Both length and depth of lesions caused by *P. vulpinum* and *B. cinerea* were similar, *F. graminearum* caused slightly less severe symptoms, and *Geotrichum* sp. did not cause symptoms statistically different from the control. In Trial 2, however, our results suggest that the interaction between CLS level, pathogen, and variety may have an effect on sugarbeet rot depth ($P < 0.05$; Table 1). There will be another timepoint at the end of the storage season, as well as a minimum of one mid-winter sample.

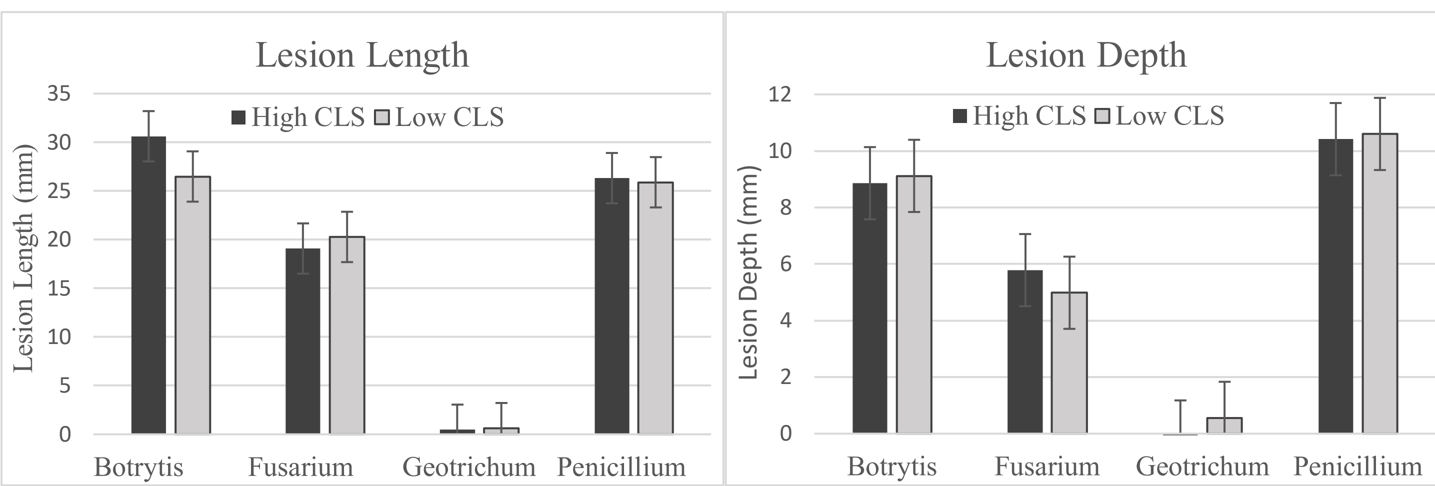

Figure 1. Mean lesion lengths and depths measured from sugarbeet roots inoculated with postharvest pathogens. Beet roots originated from plots with high or low levels of CLS in field studies, achieved from either a non-treated or grower standard treated check. Least Squares Difference showed difference of 6.6 mm is considered significant for length, and 3.5 mm for depth at α = 0.05.

Table 1. Mean lesion lengths and depths measured from sugarbeet roots inoculated postharvest pathogens. C-G333NT and F1042 were selected as CLS-susceptible and HIL-9865 and EL50/2 were selected as CLS-resistant varieties. These varieties were subjected to high and low CLS pressure following inoculation or no inoculation. Statistics indicate that the interaction between CLS level, pathogen, and variety influences rot depth.

Type III Tests of Fixed Effects						
			Lesion Length		**Lesion Depth**	
Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**	**F Value**	**Pr > F**
CLS Level	1	2	3.52	0.2015	4.37	0.1717
Pathogen	3	48	24.49	<.0001	50.20	<.0001
CLS*Pathogen	3	48	0.05	0.9832	0.53	0.6654
Variety	3	12	0.77	0.5350	0.36	0.7809
CLS*Variety	3	12	0.19	0.9008	0.51	0.6836
Pathogen*Variety	9	48	2.09	0.0492	0.90	0.5351
CLS*Pathogen*Variety	9	48	2.02	0.0569	2.17	0.0415

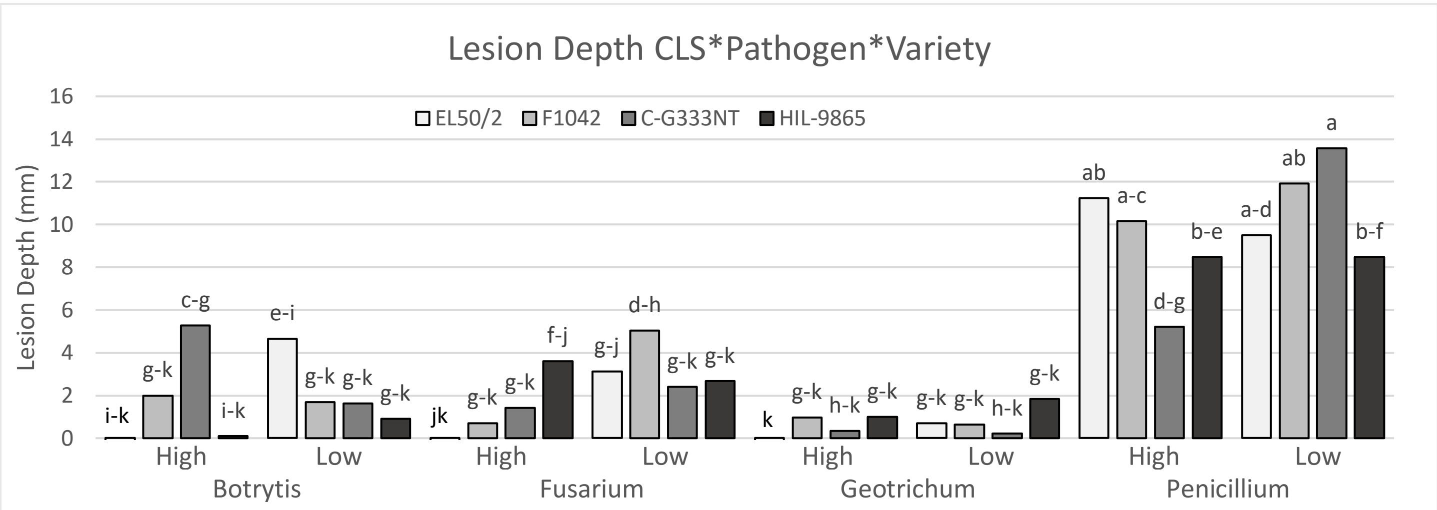

Figure 2. Mean lesion depths measured from sugarbeet roots inoculated with postharvest pathogens. Beet roots originated from plots with high or low levels of CLS in field studies, achieved from either inoculation or no inoculation. Least Squares Difference showed difference of 4.87 mm is considered significant at α = 0.05.

Summary (2): Roots of C-G333NT and HIL-9865 with high and low CLS ratings from Trial 2 are being stored in vented respirometry chambers at 42 °F. These beets will not be inoculated with storage pathogens. Samples will be taken periodically throughout the storage season to measure the beet respiration rate/lb. The effect of CLS infection in the field on the respiration rate of beets in storage will be determined.

Summary (3): 2019-20 samples show different pathogens are colonizing the beets in storage compared to the field. The main organisms isolated from SVREC field were *Fusarium* spp., *Geotrichum* spp., *Rhizoctonia solani,* and *Trichoderma* spp. *Trichoderma* spp. have been used for biocontrol control and are commonly found in the environment. *Geotrichum* spp. were not previously reported on sugarbeet in Michigan but were detected in fall of 2019 (REACh, 2020). Prominent organisms isolated from a Michigan Sugar Co. piling facility in spring 2019 include *Botrytis cinerea, Penicillium* spp., and *Fusarium* spp. In addition to the pathogens found in the spring, December 2020 samples from Michigan Sugar Co. storage piles were also infected with *Geotrichum* spp. Future goals include determining the pathogenicity, virulence, and spore dispersal mechanisms of storage pathogens to help reduce infection.

Acknowledgements: This work is supported by the Michigan Sugar Company, USDA-ARS, Beet Sugar Development Foundation, and Project GREEEN. We also thank Dennis Bischer, Corey Guza, and Michigan Sugar Company agronomists for their assistance in obtaining beet root samples.

[1] Campbell, L. G. 2015. PI 674103, *Beta vulgaris* L. subsp. *vulgaris*. U.S. National Plant Germplasm System. https://npgsweb.ars-grin.gov/gringlobal/accessiondetail?id=1923721 ; [2] McGrath, J.M. 2012. Germplasm releases: EL50/2; EL58 through EL66; SR99 through SR101 [CD-ROM]. 2012 Annual Beet Sugar Development Foundation Research Report. Denver, Colorado: Beet Sugar Development Foundation

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Utilizing Boron to Improve *Cercospora beticola* Resistance

Lacie Thomas, Jaime Willbur, Daniel Bublitz, and Kurt Steinke, Michigan State University

See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conv., 30-in. row
Planting Date: April 7, 2020 (Harvest 10/14/20)	**N Rates**: See below
Soil Type: Clay loam; 2.2% OM; 7.2 pH; 24 ppm P (Bray-P1); 138 ppm K	**Population**: 4 in. spacing
Variety: C-G333NT	**Replicated**: 4 replications

Treatment	Product Rate† and Timing‡
Grower Standard Fungicide	Manzate Max (1.6 qt) ABCDEF + Inspire XT (7 fl oz) ADF + Super Tin (8 fl oz) BE + Priaxor (8 fl oz), Topsin (20 fl oz) C + Badge (2 pt) G
Foliar Boron – Low No Fungicide	SprayBor (0.1 lb) ABCDEFG
Foliar Boron – Medium No Fungicide	SprayBor (0.25 lb) ABCDEFG
Foliar Boron – High No Fungicide	SprayBor (0.5 lb) ABCDEFG
Grower Standard + Foliar Boron Low	SprayBor (0.1 lb) ABCDEFG +Manzate Max (1.6 qt) ABCDEF + Inspire XT (7 fl oz) ADF + Super Tin (8 fl oz) BE + Priaxor (8 fl oz), Topsin (20 fl oz) C + Badge (2 pt) G
Grower Standard + Foliar Boron Medium	SprayBor (0.25 lb) ABCDEFG +Manzate Max (1.6 qt) ABCDEF + Inspire XT (7 fl oz) ADF + Super Tin (8 fl oz) BE + Priaxor (8 fl oz), Topsin (20 fl oz) C + Badge (2 pt) G
Grower Standard + Foliar Boron High	SprayBor (0.5 lb) ABCDEFG +Manzate Max (1.6 qt) ABCDEF + Inspire XT (7 fl oz) ADF + Super Tin (8 fl oz) BE + Priaxor (8 fl oz), Topsin (20 fl oz) C + Badge (2 pt) G
Check	No Fungicide, No Foliar Boron

†All rates, unless otherwise specified, are listed as a measure of product per acre.
‡Application letters code for the following dates: A=6 Jul, B=16 Jul, C=27 Jul, D=11 Aug E= 24 Aug F= 4 Sept G= 14 Sept.

Treatment	Tons/A	RWSA	RWST	% Sugar	% CJP
Grower Standard Fungicide	24.6 ab	6365 a	268 a	17.9 a	95.9
Foliar Boron – Low (FBL), No Fungicide	26.4 a	3013 c	252 b	17.1 b	95.5
Foliar Boron – Medium (FBM), No Fungicide	20.8 bc	3464 c	252 b	16.9 b	95.6
Foliar Boron – High (FBH), No Fungicide	17.9 c	3035 c	253 b	17.0 b	95.7
Grower Standard + FBL	23.4 ab	5477 ab	270 a	18.0 a	95.9
Grower Standard + FBM	24.5 ab	6091 ab	265 a	17.7 a	95.8
Grower Standard + FBH	27.2 a	5265 b	267 a	17.9 a	95.8
Check - No Fungicide, No Boron	21.1 bc	3287 c	248 b	16.7 b	95.7
Pr > F	0.07	< 0.01	< 0.01	< 0.01	NS

†Values followed by the same lowercase letter are not significantly different at (α=0.1).

Treatment	Gross Grower Payment ($/A)	Net Economic Return Minus Trucking‡ ($/A)
Grower Standard Fungicide	1088 ab	995 ab
Foliar Boron – Low (FBL), No Fungicide	1106 ab	1007 ab
Foliar Boron – Medium (FBM), No Fungicide	869 bc	791 bc
Foliar Boron – High (FBH), No Fungicide	752 c	685 c
Grower Standard + FBL	1047 ab	959 ab
Grower Standard + FBM	1084 ab	992 ab
Grower Standard + FBH	1203 a	1101 a
Check - No Fungicide, No Boron	865 bc	786 bc
Pr > F	0.05	0.03

†Values followed by the same lowercase letter are not significantly different at (α=0.1).
‡Gross grower payment and net economic returns based upon harvest date adjustment factor for tonnage and RWST and trucking costs of $3.75/T.

Treatment	NDVI Sept. 14	NDVI Oct. 6	FGCC‡ % Sept. 14	FGCC‡ % Oct. 6
Grower Standard Fungicide	0.80	0.72	75.4 a	77.3 a
Foliar Boron – Low (FBL), No Fungicide	0.80	0.58	49.7 b	37.4 c
Foliar Boron – Medium (FBM), No Fungicide	0.82	0.75	54.5 b	39.5 c
Foliar Boron – High (FBH), No Fungicide	0.71	0.57	48.7 b	37.0 c
Grower Standard + FBL	0.83	0.74	70.9 a	67.5 b
Grower Standard + FBM	0.82	0.79	72.2 a	68.5 ab
Grower Standard + FBH	0.76	0.64	70.9 a	71.9 ab
Check - No Fungicide, No Boron	0.80	0.66	55.3 b	38.7 c
Pr > F	NS	NS	< 0.01	< 0.01

†Values followed by the same lowercase letter are not significantly different at (α=0.1).
‡Fractional green canopy cover (FGCC) used to estimate canopy development and light interception.

Treatment	Disease Incidence (%) Sept. 14	Disease Incidence (%) Oct. 6
Grower Standard Fungicide	7.5 c	11.3 b
Foliar Boron – Low (FBL), No Fungicide	95.0 ab	97.5 a
Foliar Boron – Medium (FBM), No Fungicide	88.8 b	97.5 a
Foliar Boron – High (FBH), No Fungicide	95.0 ab	100.0 a
Grower Standard + FBL	13.8 c	12.5 b
Grower Standard + FBM	10.0 c	10.0 b
Grower Standard + FBH	12.5 c	15.0 b
Check - No Fungicide, No Boron	100.0 a	97.5 a
Pr > F	<0.01	<0.01

[†]Values followed by the same lowercase letter are not significantly different at (α=0.1).

Treatment	12-14 Leaf Tissue B Analysis (ppm)
Grower Standard Fungicide	65
Foliar Boron – Low (FBL), No Fungicide	63
Foliar Boron – Medium (FBM), No Fungicide	69
Foliar Boron – High (FBH), No Fungicide	62
Grower Standard + FBL	62
Grower Standard + FBM	63
Grower Standard + FBH	65
Check - No Fungicide, No Boron	63
Pr > F	NS

Summary: A field trial was established to evaluate the efficacy of foliar-applied boron for managing Cercospora leaf spot (CLS) in sugarbeet. Boron-containing compounds may have fungistatic properties as recent work has found reduced *in vitro* fungal growth and decreased disease severity in the field. Trial quality was fair. All treatments received 90 lbs. N/A as pre-plant urea. Sidedress 60 lbs N/A as UAN applied at the 4-6 leaf stage on June 9. Cool April soil temperatures followed by 3.8 inches of rainfall from May 14 – May 29 resulted in variable beet emergence. Treatments initiated on July 6 and continued every 10-14 days through September 14. Applications were made using a CO_2 powered backpack sprayer equipped with four TJ 8002XR nozzles (30-in spacing), calibrated at 15 gal/A. Inoculation of *C. beticola* (100 spores/mL) was applied at 15 gal/A using a tractor mounted sprayer on July 9 and July 23. Disease ratings were collected bi-weekly starting July 9 and continued until October 6. Plots were assigned a severity rating using the following scale based on infected leaf area: 1=0.1% (1-5 spots/leaf), 2=0.35% (6-12 spots/leaf), 3=0.75% (13-25 spots/leaf), 4=1.5% (26-50 spots/leaf), 5=2.5% (51-75 spots/leaf), 6=3%, 7=6%, 8=12% 9=25%, 10=50%. Disease incidence was recorded to represent the frequency of new lesion activity. Reduced humidity and lack of prolonged leaf wetness delayed disease incidence and severity. First CLS observation was documented August 20. Preliminary data indicate the grower standard fungicide program, FBL without fungicide, and all combinations of fungicide with boron maximized tonnage with the standard fungicide program also driving differences in RWSA and RWST. No differences were observed in canopy reflectance (NDVI) but both FBL and FBM resulted in numerically greater values. Foliar applications of boron did not appear to enhance the FGCC values nor affect disease incidence in the 2020 growing season. Study will be repeated in 2021.

Quicker, Faster, Better: Evaluating Sugarbeet Nitrogen Application Strategies

Kurt Steinke and Andrew Chomas, Michigan State University
See soil.msu.edu for more information

Location: Saginaw Valley Research and Extension Center	**Tillage**: Conv., 30-in. row
Planting Date: May 4, 2020 (Harvest 10/14/20)	**Trt's**: See below
Soil Type: Clay loam; 2.1% OM; 7.8 pH; 27 ppm P; 91 ppm K	**Population**: 4 in. spacing
Variety: C-675	**Replicated**: 4 replications

N Strategy	RWSA	RWST	Tons/A	% Sugar
Non-treated-0N	6236	288	21.6	18.4
PPI[a]-160N	7586	288	26.4	18.4
PPI-100N 2x2-60N	8631	289	29.8	18.5
2x2-60N Streamjet w/ UI[b] 2-4 lf-100N	5962	286	20.9	18.3
2x2-60N Streamjet 2-4 lf-100N	9307	289	32.2	18.5
2x2-60N PPI-50/50 blend of PCU and urea-100N	6596	286	23.1	18.3
2x2-60N Coulter-inject 2-4 lf-100N	7220	269	26.9	17.4
Y-drop-160N	8969	289	31.0	18.5
LSD$_{(0.10)}$[c]	**NS**	**NS**	**NS**	**NS**

[a] PPI, Pre-plant incorporated
[b] UI, Urease inhibitor
[c] LSD, least significant difference between means within a column at (α = 0.10).

Summary: Trial was highly variable due to mid-to late-season Rhizoctonia pressure. All treatments received 160N other than non-treated. Late-season plant losses contributed to treatment variability. Soil moisture and precipitation greatly affect sugarbeet response to N timing and sidedress placement strategies. There is no one size fits all approach to sugarbeet N management but understanding how moisture patterns affect N losses may allow greater flexibility when deciding between N strategies.

Sugarbeet tolerance to postemergence applications of Ultra Blazer

Christy Sprague, Gary Powell and Brian Stiles, Michigan State University

Location: Richville (SVREC)	**Application timings**: 2-lf beets (May 21), 6-lf beets (June 4), 12-lf beets (June 18)
Planting Date: April 20, 2020	**Herbicides:** see treatments
Soil Type: Clay loam	**O.M.:** 2.8 **pH:** 7.4
Replicated: 4 times	**Variety:** Crystal G675

Table 1. Sugarbeet tolerance to POST applications of Ultra Blazer (aciflurofen) applied at various sugarbeet stages and with various mixtures, 7 d after the 6- and 12-lf application and in September.

Herbicide treatments[a]	Timing	Injury (June 11)	Injury (June 25)	Injury (Sept. 17)	Yield	RWSA
		— % —	— % —	— % —	– ton/A –	– lb/A –
Roundup PowerMax (32/22/22 fl oz)		0	0	0	29.3	8483
Ultra Blazer (8/8 fl oz)	6, 12 lf	19*[b]	18*	1	30.2	8242
Ultra Blazer (16/16 fl oz)	6, 12 lf	29*	20*	0	26.8	7330
Ultra Blazer (16 fl oz)	6 lf	18*	12*	0	30.0	8628
Ultra Blazer (16 fl oz)	12 lf	0	25*	2*	28.8	8022
Ultra Blazer (16 fl oz) + Moccasin II Plus (1.33 pt)	6 lf	33*	25*	0	26.0	7450
Ultra Blazer (16 fl oz) + Warrant (3 pt)	6 lf	10*	11*	0	31.8	8734
Ultra Blazer (16 fl oz) + Outlook (16 fl oz)	6 lf	35*	22*	0	27.3	7422
Ultra Blazer (16 fl oz) + Ethofumesate (32 pt)	6 lf	24*	15*	1	26.0	7378
Stinger (2 fl oz) fb. Ultra Blazer (16 fl oz) + Stinger (4 fl oz)	2, 6 lf	24*	12*	1	28.0	7810
Stinger (2 fl oz) fb. Stinger (4 fl oz)	2, 6 lf	3	3	1	30.3	8602
$LSD_{0.05}$[c]		*8.9*	*9.0*	*1.6*	*5.68*	*1677*

[a] Roundup PowerMax was included in all postemergence treatments at the rates listed in the first treatment. These treatments also included AMS at 17 lb/100 gal.
[b] Injury, yield and RWSA data with asterisks (*) are significantly different than the Roundup PowerMax alone control.
[c] Means within a column greater than least significant difference (LSD) value are different from each other.

Summary: Options are extremely limited for POST control of glyphosate-resistant pigweed (waterhemp and Palmer) in sugarbeet. Ultra Blazer (aciflurofen) is a Group 14 herbicide that has activity on pigweed species. Over the last three years we have conducted field research evaluating sugarbeet safety to POST applications of Ultra Blazer. All applications of Ultra Blazer injured sugarbeet. Symptoms consist of leaf speckling/bronzing of the sugarbeet leaves. In 2019, we observed severe injury from applications to 2-leaf sugarbeet that reduced stand and yield. In all three years, Ultra Blazer applications to 6- and 12- leaf sugarbeet have also resulted in injury, however sugarbeet was able to recover and sugarbeet yield and recoverable white sugar were not affected. Examining our research and that of it of colleagues in North Dakota, it appears if an Ultra Blazer is label is granted, applications should be on larger beets (>6-leaf) at a 16 fl oz/A rate. Caution should be taken with making late season applications, two applications, or tank-mixing Ultra Blazer with other herbicides (except Roundup) or additional adjuvants.

Sugarbeet tolerance to overlapping residual herbicide programs

Christy Sprague, Gary Powell and Brian Stiles, Michigan State University

Location: Richville (SVREC)	**Application timings**: PRE (April 22), 2-lf beets (May 21), 6-8 lf beets (June 4)
Planting Date: April 20, 2020	**Herbicides:** see treatments
Soil Type: Clay loam	**O.M.:** 2.8 **pH:** 7.4
Replicated: 4 times	**Variety:** Crystal G675

Table 1. Comparison of sugarbeet tolerance of two-passes of overlapping residual herbicide programs applied POST alone and with ethofumesate (PRE) or a low rate of Dual II Magnum (PRE).

Herbicide treatments[a]		**Injury**[b] **(14 DA-6-lf)**	**Harvest Stand**	**Yield**	**RWSA**
PREs	***POST at 2- and 6-lf beets***	— % —	- #/100' row -	- ton/A -	— lb/A —
None	Roundup PowerMax (32/22 fl oz)	0	220	27.1	7716
None	Dual II Magnum (1.3/1.3 pt)	7	193	21.1	6081
None	Warrant (3/3 pt)	7	197	23.4	6672
None	Outlook (12/12 fl oz)	6	199	22.7	6432
None	Ethofumesate[a] (2/2 pt)	1	190	24.1	7015
Ethofumesate (2 pt)	Dual II Magnum (1/1 pt)	8*[b]	189	26.4	7525
Etho. (2 pt)	Warrant (3/3 pt)	9*	185	26.4	7562
Etho. (2 pt)	Outlook (12/12 fl oz)	0	212	29.6	8287
Etho. (2 pt)	Ethofumesate[a] (2/2 pt)	1	215	28.7	8261
Dual II Magnum (0.5 pt)	Dual II Magnum (1/1 pt)	6	193	22.0	6080
Dual II Magnum (0.5 pt)	Warrant (3/3 pt)	13*	190	23.3	6557
Dual II Magnum (0.5 pt)	Outlook (12/12 fl oz)	2	218	25.3	7165
Dual II Magnum (0.5 pt)	Ethofumesate[a] (2/2 pt)	4	193	26.3	7450
LSD$_{0.05}$[c]		*7.1*[c]	*-NS-*	*6.52*	*1858*

[a] Roundup PowerMax was included in all postemergence treatments at the rates listed in the first treatment. These treatments also included AMS at 17 lb/100 gal. All POST applications of ethofumesate was applied with 1.5 pt/A of Destiny HC.
[b] Injury, stand, yield and RWSA data with asterisks (*) are significantly different than the Roundup PowerMax alone control.
[c] Means within a column greater than least significant difference (LSD) value are different from each other.

Summary: Overlapping residual herbicide programs may be the only way to effectively control glyphosate-resistant pigweed (waterhemp and Palmer) in sugarbeet. This is the third year, where a field trial was conducted at the Saginaw Valley Research and Extension Center to determine what effect multiple applications of residual herbicides have on sugarbeet injury, stand, yield and recoverable white sugar per acre (RWSA). The Group 15 herbicides, Dual II Magnum, Outlook and Warrant were all evaluated at maximum rates allowed per season. These treatments were also evaluated after a preemergence application of ethofumesate or Dual II Magnum at a low rate (currently not labeled). Postemergence ethofumesate was also evaluated. In general, sugarbeet injury was less than 15% at all evaluations and none of the treatments resulted in a loss of yield or RWSA compared with the Roundup PowerMax only control. These treatments were also examined for waterhemp control and should continue to be examined over more environments.