MICHIGAN DRY BEAN RESEARCH REPORT

2020

MSU Extension

Michigan BEAN COMMISSION

2020

Scott Bales, *MSU Dry Bean Specialist*

Dr. Francisco Gomez, *MSU Dry Bean Breeding and Genetics*

Dr. Kurt Steinke, *MSU Soil Fertility and Nutrient Management Specialist*

Dr. Christy Sprague, *MSU Weed Science*

Verification of Proposed Fertilizer Recommendations for Michigan Dry Bean Growers: Enhancing Economic and Environmental Sustainability

Scott Bales, *MSU Dry Bean Specialist* &

Joe Cramer, *MBC Executive Director*

In 2020 the Michigan Bean Commission was awarded a grant from the Michigan Department of Agriculture and Rural Development through the USDA Specialty Crop Block Competitive Grant Program. This project was titled: ***'Verification of Proposed Fertilizer Recommendations for Michigan Dry Bean Growers: Enhancing Economic and Environmental Sustainability'.*** This work was the continuation and expansion of trials performed in 2019 under a separate funding source. Objectives of this project were to: (1) Assess nutrient requirements of new bean varieties for the major market classes grown in Michigan. (2) Provide grower guidelines for application of macro nutrients (N, P, K) based on physiological needs of the plant with particular needs for Phosphorous containment. (3) Provide optimum nitrogen requirements important to minimize plant canopy growth to prevent white mold proliferation, particularly in narrow row systems. (4) Provide grower guidelines for application of micro nutrients (Zn and Mn). (5) Provide innovative screening technologies (drone field flyovers and bio-based techniques) to assess nitrogen fixation potential and micro-nutrient needs (foliar applications). (6) Establish grower education of fertilizer application rates that include knowledge of soil fertility and crop rotations and carry over management; Delivery of a workshop designed to instruct growers on strategies to maximized soil nutrient residuals and to build soil fertility while reducing nutrient leaching and run-off, with focus on Phosphorus. (7) Publish fertility requirements and management strategies for distribution to bean growers in Michigan.

Season Summary: Planting conditions for the 2020 dry bean crop were very good. Adequate levels of soil moisture and few heavy rain events were noted in the month of June with one exception. On June 10, 2020 the majority of the dry bean production region received rainfall amounts greater than 1". This rain fall event was followed by dry weather and little cloud cover, these conditions resulted in widespread soil crusting that often needed rotary cultivation to allow dry bean emergence. As the dry bean crop progressed conditions remained dry through the end of June and early July. This dry weather did make for difficult environmental conditions for weed control in areas of heavy weed pressure. Rain fall frequency did increase through the month of August into September. This rainfall was very timely for late flowering and pod fill. As harvest began in September weather was very cooperative and allowed for timely field work. In general dry bean yields were average to above average with excellent quality.

We would like to thank all cooperators that hosted trials in 2020. Without their assistance this research would not be possible.

Thank you,

Scott Bales Joe Cramer

Scott Bales Joe Cramer

2020 Michigan Dry Bean Performance Trials

Scott Bales, *MSU Dry Bean Specialist*

Introduction: 148 lines from 10 separate market classes were tested across 5 locations (Table 1) in 2020. In each result table you will find information on agronomics such as flowering date, plant maturity, height, and disease tolerance. Flowering and plant maturity are rated visually in days after planting (DAP) across all locations. In 2020 plant height and lodging were recorded at the Bay and Tuscola County locations due to adequate plant growth. Lodging is evaluated on a scale of 1-5. A 1 indicates that the entry was completely erect in the field at harvest; inversely, a 5 indicated that the entry was flat on the ground with stems and pods touching the soil surface. White mold infection was recorded in Tuscola County by calculating percent infection on each replication ((number infected/ total stand)*100).

Yield results are presented in pounds per acre (lb. A^{-1}) adjusted to 18% moisture for all locations. Small and medium seeded beans were tested in Bay, Huron, Sanilac, and Tuscola County. Large seeded beans were tested in Montcalm and Tuscola County. Following individual location results, yield is presented combined over locations for 2020 unless production systems differ (irrigated vs. dry land), this represents a 1-year average across all locations. When possible this is also done for 2- and 3- year averages across locations and years. For example, a 3-year average of navy bean yield results includes data from 2018, 2019, and 2020 at 4 locations per year (12 site years). Following harvest each eligible line was also evaluated for end use quality (Canning). Black beans were scored for overall appearance (1-5) and color (1-5). All other market classes were evaluated for overall appearance (1-5). When rating canning quality for all market classes 1=poor and 5=superior, more information and examples can be found in Figure 1.

At the bottom of most columns you will find the trial average (mean), least significant difference (LSD) and coefficient of variation (CV) for the data within that column. To assist in the evaluation of these results the entry with the highest numerical yield in each column (trial and year) is followed by two asterisk (**). However, entries that are not significantly different from the highest yielding entry are followed by one asterisk(*). This means that if an entry is followed by an asterisk (one or two) there is **no** evidence that the entries differed for that given trait.

Table 1. Trial location, grower cooperator, planting date, nitrogen application method and timing, total accumulated growing degree days (GDD), and total precipitation.

County	Cooperator	Planting Date	Nitrogen application	Total GDD*	Total Precipitation (inches)
Bay	Schindler Farms	7-Jun	2x2	2081	10.72
Sanilac	Aldrich Farms	5-Jun	PPI	2127	10.89
Tuscola	Bednarski Farms	6-Jun	PPI	2049	10.42
Montcalm	Jaquays Farms	15-Jun	2x2 + side-dress	1923	9.68 + irrigation
Huron	Pawlowski Farms	5-Jun	2x2	2158	16.71

*Weather data retrieved from the nearest Michigan Automated Weather Network (MAWN) and the Enviro-weather Program station nearest to the trial. All weather data is from the day of planting to October 1. Growing degree days were calculated using the following equation: ((MAX + MIN)/2)-50

Methods: Dry beans were seeded in four row plots (20" rows) that measure 6.6' wide by 20' long. Each entry is replicated **four** times within the trial with one exception. Kidney, cranberry, and yellow beans planted in Tuscola County in 2020 had **two** replications. All trials were designed as randomized complete block (RCB). Trials received industry standard seed treatments, fertilization, and weed control applications at labeled rates. White mold fungicides are not applied to any location. The absence of fungicide allows the evaluation of a variety's natural tolerance or avoidance to white mold when the disease was present. Yield data is obtained by direct harvest for small and medium seeded beans. Large seeded beans are pulled by hand and then mechanically thrashed to prevent harvest loss. Following harvest samples are cleaned, weighed, and moisture tested. Questions regarding the 2020 variety trials, or suggestions for 2021 should be directed to Scott Bales: (989)-262-8550 ext. 2; Balessco@msu.edu**.**

Table 2. Soil test information from the 5 county locations including organic matter (%OM), pH, and cation exchange capacity (CEC). All macro and micro nutrients were sufficient for dry bean production.

Location	OM (%)	pH	CEC
Tuscola	2.3	7.3	9.6
Huron	3.0	7.4	10.8
Sanilac	2.3	7.5	9.2
Bay	2.2	6.8	10.5
Montcalm	1.1	5.8	4.3

TRIAL **PAGE**

Table 3. Navy bean agronomic, yield and canning results.

VARIETY	Maturity	Flowering	Plant Height	Lodging	White Mold Infection	Bay	Huron	Sanilac	Tuscola	1-year avg.	2-year avg.	3-year avg.	Seed Size	Appearance (after canning)		
														Bay	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*- (1-5) -*	*– % –*		*—— Lb. A^{-1} ——*				*—— Lb. A^{-1} ——*		*seeds Lb^{-1}*	*- (1-5) -*	*- (1-5) -*	*- (1-5) -*
Apex	104	38	22.5	3.0	12.7	2691	3679*	2226*	2752	2934*	2849	2886	2028	3.6	4.1	3.9
Argosy	100	44	22.5	2.8	8.4	2815	3066	1856	2880	2654	2745	2813	2241	3.6	3.8	3.7
Armada	100	45	23.0	2.5	8.4	3147*	2957	2085	3257	2861	2838	2908	1925	4.1	4.0	4.0
Blizzard	98	-	24.0	2.1	16.7	3646**	2942	2673*	3215	3119*	2922*	2848	2220	3.9	3.8	3.8
HMS Bounty	103	-	24.0	2.6	2.2	3381*	3207	2643*	3425*	3179*	2929*	3125**	2387	3.1	3.8	3.4
HMS Medalist	101	45	23.0	2.3	19.9	3368*	3389*	2273*	3808**	3191*	2806	2740	2264	3.9	3.6	3.8
Indi	95	43	23.5	2.0	4.3	2987	2517	1618	3006	2532	2488	2536	2278	3.4	2.9	3.2
Merlin	103	-	23.5	3.0	7.6	2894	3138	2346*	2340	2679	2497	2669	2193	3.1	3.3	3.2
Nautica	103	38	21.0	3.1	13.4	3033*	3089	2153	2793	2751	2573	2514	2233	3.8	3.5	3.6
Shock	98	44	22.0	2.7	14.5	3162*	2773	1639	3099	2668	-	-	2086	2.6	3.1	2.8
Valiant	101	46	23.5	2.7	13.0	3056*	3990**	2061	3135	2995*	2747	-	2178	4.1	3.9	4.0
Vigilant	96	46	25.0	1.5	6.5	2502	3615*	1961	2963	2814	2680	-	2378	3.9	2.8	3.3
12039	100	45	24.0	3.0	8.6	2517	3824*	2119	3362	2769	2942*	-	2180	3.3	2.9	3.1
14068	101	45	25.0	2.9	16.3	3151*	3624*	2060	3295	3285*	2913*	2885	2241	2.6	2.9	2.8
14080	102	45	22.5	2.9	6.9	2258	3091	2416*	2800	2605	2685	-	2207	3.6	3.2	3.4
14084	102	47	24.0	2.1	13.7	3453*	3666*	2281*	3456*	3214*	2879	2903	2392	3.5	3.1	3.3
14089	101	47	22.0	2.5	7.2	3175*	2477	2060	3020	2686	-	-	2270	3.3	3.3	3.3
15094	100	45	23.5	2.5	21.0	3492*	3442*	2227*	3423*	3146*	2987	3016*	2126	3.6	3.3	3.5
15095	104	46	21.5	2.9	14.8	3605*	3530*	2781**	3308	3306**	3152**	3097*	2344	4.2	3.3	3.7
EX1702	100	46	22.0	3.1	10.9	2183	2753	2179	2880	2499	2376	2600	2207	3.3	2.9	3.1
EX1708	102	-	23.0	2.8	18.8	3175*	2569	1751	3121	2712	2367	-	2489	3.0	2.7	2.8
EX1711	100	-	23.0	3.0	13.7	2876	2537	2217	2742	2593	2439	-	2155	3.2	3.0	3.1
EX1801	101	47	23.0	2.2	6.5	2543	3042	1802	2722	2527	-	-	2297	3.3	2.9	3.1
EX1802	96	46	21.0	1.5	11.2	2566	3480*	1418	2799	2703	-	-	2301	3.0	3.4	3.2
EX1803	101	-	22.0	2.5	26.8	2741	3198	2093	2997	2845	-	-	2631	2.8	3.2	3.0
EX1804	97	48	22.0	2.5	2.5	2870	2497	1572	2752	2311	-	-	2266	3.6	3.3	3.5
EX1914	101	47	21.0	3.0	11.9	2062	2761	1893	2922	2623	-	-	2072	3.1	3.3	3.2
N18103	97	42	22.5	2.2	12.7	2731	2906	1359	3002	2500	-	-	2029	2.9	2.8	2.8
N19253	100	-	25.0	2.2	7.9	3346*	3292	2182	3143	2966*	-	-	2237	2.7	3.3	3.0
N19285	102	44	22.0	2.9	7.2	2999	2206	2085	2968	2569	-	-	2104	3.4	3.9	3.7
SV1893GH	103	44	22.5	2.9	3.6	2889	3249	1552	3115	2701	2401	-	2129	2.9	3.3	3.1
MEAN:	100	45	22.9	2.6	11.3	2945	3112	2071	3068	2806	2725	2823	2229	3.4	3.3	3.3
LSD $_{(0.05)}$:	-	-	-	-	NS	617	621	556	399	395	257	182	-	-	-	-
CV:	-	-	-	-	-	17.8%	17.1%	22.9%	11.1%	23.8%	22.9%	19.2%	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Scott Bales; MSU Dry Bean Specialist
989-262-8550; balessco@msu.edu

Table 4. Black bean agronomic, yield and canning results.

VARIETY	Maturity	Flowering	Plant Height	Lodging	White Mold Infection	Bay	Huron	Sanilac	Tuscola	1-year avg.	2-year avg.	3-year avg.	Seed Size	Appearance (after canning)			Color (after canning)		
														Bay	Tuscola	Avg.	Bay	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*- (1-5) -*	*– % –*	*——— Lb. A^{-1} ———*				*——— Lb. A^{-1} ———*			*seeds Lb^{-1}*	*- (1-5)*	*- (1-5)*	*- (1-5) -*	*- (1-5)*	*- (1-5)*	*- (1-5)*
Adams	101	44	22.0	2.7	7.4	3540	4663*	3099*	3300*	3521	3281*	3250	2066	3.6	3.9	3.7	2.8	2.5	2.7
Black Bear	103	47	20.5	2.9	3.9	3118	4016	2682	3078*	3223	2918	2875	2288	3.0	3.6	3.3	2.6	3.3	3.0
Black Beard	100	47	26.0	2.7	8.8	3684	4250	3156**	3142*	3558	3171*	3292*	1967	4.1	3.5	3.8	4.2	4.2	4.2
Black Tails	96	44	22.5	2.0	12.6	3398	3946	2374	2783	3125	2809	2887	2326	2.9	3.4	3.2	2.6	2.6	2.6
Eclipse	95	44	19.0	1.5	10.2	3052	3726	1721	3245*	2986	-	-	2156	3.1	2.6	2.9	2.6	2.8	2.7
ND Twilight	94	45	20.5	1.5	17.5	2508	3695	1729	2836	2522	-	-	2022	2.9	2.6	2.8	2.6	2.9	2.8
Spectre	101	45	23.5	2.6	4.6	3488	4849**	2822*	3208*	3591*	3190*	3252	2032	2.8	2.1	2.4	3.2	2.8	3.0
Zenith	101	46	22.0	2.4	7.0	3414	3795	2294	3002	3126	2832	2881	2034	3.9	3.5	3.7	4.6	4.8	4.7
Zorro	100	45	22.5	2.5	5.3	3316	4023	2195	3125*	3093	2718	2771	2388	3.7	4.1	3.9	3.3	3.5	3.4
Zorro + Heads Up	100	45	22.0	2.5	4.9	3406	3867	2131	2734	3034	-	-	2421	-	-	-	-	-	-
14500	101	46	23.5	2.7	9.1	4253**	4574*	3039*	3444*	3827**	3435**	3461**	1915	2.9	2.6	2.8	2.8	2.9	2.9
15610	102	47	21.0	2.8	14.0	3222	4189	2843*	3490**	3435	3134	3072	2311	3.4	3.1	3.2	3.2	3.8	3.5
15619	103	45	21.5	3.0	7.0	3140	4653*	2698	3239*	3471	2996	2796	2123	3.8	2.9	3.3	3.6	3.8	3.7
16590	102	46	23.0	3.0	6.7	3077	3900	2484	3095*	3138	-	-	2005	3.1	2.6	2.8	2.8	3.1	3.0
16648	103	47	22.5	3.0	7.0	3053	3940	2454	3096*	3143	-	-	2036	2.7	2.4	2.5	3	2.5	2.8
17704	101	47	25.0	2.5	1.1	3069	3679	2138	2830	2973	-	-	2744	3.7	3.0	3.3	3	2.7	2.9
17708	97	44	23.0	2.5	11.2	3215	3564	1909	2887	2987	-	-	2125	3.6	2.7	3.2	3.7	3.2	3.5
17715	96	47	21.5	2.6	5.3	2850	4376*	2500	2725	3112	-	-	2370	4.3	3.2	3.7	4.4	3.5	4.0
17724	96	44	23.0	2.5	14.0	3475*	3718	2086	2992	3067	-	-	2476	3.6	2.3	2.9	3.2	2.1	2.7
17751	97	43	21.0	2.7	12.6	3747	4291	2652	3131*	3504	-	-	2059	2.9	2.1	2.5	2.6	2.8	2.7
B13SR1-1	100	44	22.0	1.5	10.5	2636	3289	2111	2738	2693	2567	-	1982	1.9	2.1	2.0	2.4	3.3	2.9
B17220	100	45	21.5	1.5	1.8	3222	4308	2273	2942	3193	-	-	2052	4.3	3.6	3.9	4.6	4.4	4.5
B17922	99	46	20.5	1.5	7.7	2877	4523*	2069	2754	3083	2944	-	2333	3.8	3.8	3.8	4.2	4.3	4.3
B18201	98	46	22.0	2.0	6.0	2999	3820	2433	2848	3025	3163	-	1985	4.3	3.9	4.1	3.8	4.4	4.1
B18204	95	44	21.0	2.0	6.0	3116	4228	2059	2703	2958	2699	-	1982	3.4	2.8	3.1	4.1	3.7	3.9
B19330	96	45	20.0	2.0	10.9	3224	3896	2259	3126*	3170	-	-	2042	3.5	2.4	2.9	4	3.6	3.8
B19344	100	45	23.5	2.5	4.6	3286	4447*	2245	3101*	3269	-	-	1860	3.3	3.4	3.4	5	4.5	4.8
B3036368	97	46	21.0	2.8	4.6	2646	4081	1744	3056*	2993	-	-	2205	2.7	2.3	2.5	2.8	2.6	2.7
B3036381	101	45	23.5	3.0	11.6	2649	4217	2578	2793	3059	-	-	2205	4.0	3.8	3.9	4.3	4.1	4.2
BL1402-15	98	43	21.5	2.5	7.7	2914	3890	2416	2865	3124	-		1989	4.1	3.9	4.0	4.6	4.1	4.4
MEAN:	99	45	22.1	2.4	8.0	3186	4077	2369	3007	3165	2990	3052	2150	3.4	3.0	3.2	3.5	3.4	3.4
LSD $_{(0.05)}$:	-	-	-	-	NS	556	533	384	467	266	272	187	-	-	-	-	-	-	-
CV:	-	-	-	-	-	14.8%	11.1%	13.7%	13.2%	14.4%	22.1%	18.2%	-	-	-	-	-	-	-

***Highest yielding variety within column*
**Yield not statistically different than the highest yielding variety within column*

Table 5. Small Red and Pink bean agronomic, yield and canning results.

VARIETY	Maturity	Flowering	Plant Height	Lodging	White Mold Infection	Bay	Huron	Sanilac	Tuscola	1-year avg.	2-year avg.	3-year avg.	Seed Size	Appearance (after canning) Bay	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*- (1-5) -*	*– % –*	*——— Lb. A^{-1} ———*				*——— Lb. A^{-1} ———*			*seeds Lb^{-1}*	*- (1-5) -*	*- (1-5) -*	*- (1-5) -*
Caldera	99	46	26.5	2.5	23.7	1946	2615	2255	3006	2700	2685	2826	1356	3.1	3.9	3.5
Cayenne	98	43	22.5	2.1	10.3	2318	2655	2484	3063	2630	2645	2918*	1375	3.9	2.9	3.4
Ruby	99	43	23.0	3.5	35.6	2098	2638	2414	3251	2600	2496	2687	1594	1.8	1.8	1.8
Viper	100	44	23.0	2.5	26.0	2314	3357	3069**	3747**	3145**	3034**	3059**	1596	2.5	2.3	2.4
16686	97	44	25.0	2.5	40.0	1658	2675	2588	3688*	2652	2494	-	1323	2.1	2.6	2.3
17835	100	42	23.5	3.1	19.6	1428	2335	2004	2948	2085	2430	-	1259	2.5	2.2	2.3
17837	100	40	22.0	2.5	25.2	2185	2511	2619	3695*	2752	2518	-	1494	2.4	2.3	2.3
17839	99	39	24.0	2.6	16.3	2042	2617	2651*	3545*	2713	2458	-	1480	2.6	2.5	2.6
R17604	99	44	24.5	2.0	14.5	1919	2946	2162	3421	2612	2584	-	1616	3.8	3.5	3.6
S18904	100	43	21.5	2.2	17.4	2570	2190	2122	3128	2400	2545	-	1284	1.8	1.8	1.8
MEAN:	99	43	23.5	2.5	22.8	2048	2653	2464	3349	2629	2589	2872	1438	2.6	2.6	2.6
LSD $_{(0.05)}$:	-	-	-	-	NS	NS	NS	422	301	294	276	215	-	-	-	-
CV:	-	-	-	-	-	-	-	14.6 %	7.5 %	26.7%	25.0%	22.1%	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Table 6. Pinto bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Lodging	White Mold Infection	Bay	Huron	Sanilac	Tuscola	1-year avg.	2-year avg.	3-year avg.	Seed Size	Appearance (after canning)		
														Bay	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*– (1-5) –*	*– % –*	*——— Lb. A^{-1} ———*				*——— Lb. A^{-1} ———*			*seeds Lb^{-1}*	*– (1-5) –*	*– (1-5) –*	*– (1-5) –*
Charro	103	45	24.0	2.7	14.1	3087*	3765**	2879**	3777**	3377**	2942**	-	1229	4.0	2.7	3.3
LaPaz	98	46	24.0	2.9	14.5	2966*	3597*	2510	3495*	2957	2678	-	1221	3.3	2.7	3.0
ND Falcon	97	46	26.0	2.3	4.3**	2647*	2555	2295	2868	2591	-	-	1270	2.7	1.7	2.2
ND Palomino	103	44	21.0	3.0	23.9	2774*	3088*	1643	3000	2508	-	-	1230	3.6	2.8	3.2
Windbreaker	96	43	20.0	3.0	11.6	1900	2708	1855	2550	2253	-	-	1172	2.3	2.3	2.3
P19103	104	41	24.0	3.0	17.0	3088**	3290*	2659*	3308	3086*	-	-	1318	3.8	3.3	3.6
SV6139GR	92	44	21.5	2.7	11.9	2529*	3146*	2318	3238	2807	-	-	1252	2.2	1.8	2.0
MEAN:	99	44	22.9	2.8	13.9	2713	3164	2308	3176	2797	2810	-	1242	3.1	2.5	2.8
LSD $_{(0.05)}$:	-	-	-	-	5.0	670	742	352	391	358	231	-	-	-	-	-
CV:	-	-	-	-	18.8%	20.1%	18.9%	12.4%	10.0%	21.7%	19.4	-	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Scott Bales; MSU Dry Bean Specialist
989-262-8550; balessco@msu.edu

Table 7. Great Northern bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Lodging	White Mold Infection	Bay	Huron	Sanilac	Tuscola	1-year avg.	2-year avg.	3-year avg.	Seed Size	Appearance (after canning) Bay	Tuscola	Avg.
	dap	*dap*	*inch*	*(1-5)*	*%*	*Lb. A^{-1}*				*Lb. A^{-1}*			*seeds Lb^{-1}*	*(1-5)*	*(1-5)*	*(1-5)*
Aries	99	37	18.0	2.5	18.3	2117*	2744	1545	2969	2344	2118	-	1290	2.8	3.3	3.1
Eiger	104	44	26.0	2.5	22.3	2622**	3119*	3163**	3662**	3141**	2927**	-	1230	3.3	3.0	3.2
ND Pegasus	96	38	26.0	2.9	26.8	2270*	3831**	2557	3640*	3007*	-	-	1336	2.7	3.0	2.8
Powderhorn	93	38	19.0	2.6	9.7	2066	2921	1731	2920	2409	2071	-	1286	4.0	4.0	4.0
Virgo	103	37	23.0	2.9	26.4	1898	2129	1884	3132	2192	-	-	1260	3.5	4.0	3.8
G18512	102	44	23.0	2.2	18.3	1806	3431*	2107	3052	2599	-	-	1202	2.8	3.3	3.1
MEAN:	100	40	22.5	2.6	20.3	2130	3029	2164	3229	2615	2372	-	1267	3.2	3.4	3.3
LSD $_{(0.05)}$:	-	-	-	-	NS	530	728	343	339	210	269	-	-	-	-	-
CV:	-	-	-	-	-	19.9 %	14.4 %	12.8 %	8.5 %	16.6 %	27.3%	-	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Table 8. Cranberry bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Montcalm	Tuscola	Irrigated 2-year avg.	Irrigated 3-year avg.	Dry Land 2-year avg.	Dry Land 3-year avg.	Seed Size	Appearance (after canning)		
											Montcalm	Tuscola	Avg.
	dap	*dap*	*inch*	*Lb. A^{-1}*		*Lb. A^{-1}*		*Lb. A^{-1}*		*seeds Lb^{-1}*	*(1-5)*	*(1-5)*	*(1-5)*
Amaranto	92	34	16.0	2881*	2340*	3425*	-	1701*	-	926	3.2	2.0	2.6
Bellagio	100	38	21.0	2356	2146*	2880	3086	1805*	2495*	819	3.8	3.8	3.8
Chianti	100	37	18.0	2353	1839	3307*	3363*	962	2085	992	4.0	-	-
Etna	92	35	14.0	3202*	2694*	3655**	3412*	1369	2003	881	2.3	2.7	2.5
Red Cran 172	95	35	20.0	1865	1919	2293	-	1819*	-	831	1.7	2.2	1.9
Red Cran Up	96	35	14.0	2240	1752	-	-	-	-	858	1.5	2.0	1.8
Vero	90	35	18.0	2642	2436*	3209	3165*	-	-	935	2.3	2.3	2.3
16758	90	35	14.0	2967*	2185*	-	-	-	-	1158	4.0	3.8	3.9
16759	95	34	18.0	3182*	-	-		-	-	790	2.2	-	-
16760	98	34	16.0	3414**	2041*	3467*	3446*	1762*	2459*	931	2.2	2.8	2.5
16761	91	34	15.0	2703	2021*	3135	3277*	1434	2109	897	1.7	1.7	1.7
16764	96	35	18.0	3184*	2613*	3163	2866	1771*	2403*	863	2.8	2.0	2.4
16775	100	38	16.0	2690	2725*	3086	-	1677*	-	915	4.2	3.7	3.9
16816	90	33	16.0	2948*	2834**	-	-	-	-	955	2.7	2.5	2.6
151085	98	36	16.0	2942*	2756*	3271*	3506**	2101**	2522*	796	1.5	2.3	1.9
151093	87	35	20.0	2934*	2867*	3081	3038	1794*	2741**	887	1.7	2.2	1.9
14L1203B	95	33	18.0	2788	-	-	-	-	-	829	3.2	-	-
16756	98	36	20.0	2428	2269*	-	-	-	-	947	4.5	3.8	4.2
CR1704-2	95	34	16.0	2398	1626	-	-	-	-	849	3.3	3.0	3.2
MEAN:	95	35	17.1	2748	2290	3244	3229	1651	2352	898	2.8	2.7	2.7
LSD $_{(0.05)}$:	-	-	-	590	901	402	375	544	347	-	-	-	-
CV:	-	-	-	18.2 %	22.5	14.8%	17.1%	29.7%	19.7%	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Table 9. Light Red Kidney bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Montcalm	Tuscola	Irrigated 2-year avg.	Irrigated 3-year avg.	Dry Land 2-year avg.	Dry Land 3-year avg.	Seed Size	Appearance (after canning) Montcalm	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*— Lb. A^{-1} —*		*— Lb. A^{-1} —*		*— Lb. A^{-1} —*		*seeds Lb^{-1}*	*– (1-5) –*	*– (1-5) –*	*– (1-5) –*
Big Red	92	37	14.0	2799	2224	2974	2932	1968	2041	782	2.6	3.4	3.0
California Early	91	35	16.0	3355*	2022	3500*	3184*	1575	1851	835	2.4	1.5	2.0
Clouseau	98	36	18.0	2805	2138	3280*	3322*	1565	1982	793	2.8	3.4	3.1
Coho	101	37	16.0	3026*	2274	2861	3297*	2409*	2409*	1030	2.6	2.8	2.7
Pink Panther	98	36	16.0	3268*	2427	-	-	-	-	802	2.4	2.0	2.2
Red Dawn	89	35	16.0	3565**	2242	3612**	3517*	1712	1945	881	2.6	2.8	2.7
Ronnie's Red	104	35	24.0	2538	2318	2676	3275*	2461**	2603**	752	2.6	3.5	3.1
Rosie	104	37	20.0	1795	2363	-	-	-	-	859	2.2	2.5	2.4
15907	105	39	18.0	1881	2017	2148	2595	2387*	2514*	786	2.8	2.8	2.8
15926	107	38	20.0	1620	1900	2077	2634	2014	2230	719	2.8	2.8	2.8
K17703	103	37	16.0	2786	2291	3072*	3581**	1991	2338*	816	2.0	2.5	2.3
K17704	103	35	20.0	2400	2214	-	-	-	-	844	2.0	2.3	2.2
K19605	103	35	18.0	2164	2517	-	-	-	-	768	2.6	3.5	3.1
MEAN:	100	36	17.8	2637	2235	2911	3148	2002	2212	820	2.5	2.8	2.6
LSD $_{(0.05)}$:	-	-	-	572	NS	541	529	413	318	-	-	-	-
CV:	-	-	-	18.3 %	-	22.2%	24.7%	22.9%	19.3%	-	-	-	-

***Highest yielding variety within column*
**Yield not statistically different than the highest yielding variety within column*

Scott Bales; MSU Dry Bean Specialist
989-262-8550; balessco@msu.edu

Table 10. Dark Red Kidney bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Montcalm	Tuscola	Irrigated 2-year avg.	Irrigated 3-year avg.	Dry Land 2-year avg.	Dry Land 3-year avg.	Seed Size	Appearance (after canning) Montcalm	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*— Lb. A^{-1} —*		*— Lb. A^{-1} —*		*— Lb. A^{-1} —*		*seeds Lb^{-1}*	*– (1-5) –*	*– (1-5) –*	*– (1-5) –*
Chaparral	105	35	18.0	2193	2296*	2415	3044	1803	1989	912	2.7	2.2	2.4
Dynasty	105	37	18.0	2855*	2583*	3224*	3596**	2205	2428*	783	1.5	2.3	1.9
Epic	102	37	20.0	2728	2379*	2963	2179	2156	2303	776	2.7	2.3	2.5
Montcalm	103	36	18.0	2732	2345*	3082*	3368*	1864	1968	815	3.5	-	-
Rampart	97	35	18.0	2640	2445*	2766	3079	2114	2281	924	2.7	2.3	2.5
Red Cedar	96	37	16.0	3050*	1032	2799	3004	1652	1855	896	1.8	2.2	2.0
Red Rover	96	34	20.0	2934*	2278*	3250**	3292*	2158	2201	876	2.3	2.8	2.6
Spire	106	36	20.0	1745	2102*	2023	2827	1952	2177	838	2.3	2.8	2.6
Talon	100	38	20.0	2664	2368*	-	-	-	-	914	1.5	2.6	2.1
15977	98	35	18.0	2957*	2340*	-	-	-	-	829	1.5	1.8	1.7
15978	103	38	20.0	2686	2589*	2433	3027	2631**	2619**	848	2.7	3.3	3.0
15981	103	38	20.0	1773	1196	1936	-	1508	-	1124	3.2	3.2	3.2
18991	104	38	18.0	1400	2058	-	-	-	-	789	3.6	4.0	3.8
151011	100	35	18.0	3190**	2196*	3220*	3410*	2084	2343	986	2.0	2.2	2.1
161156	96	35	16.0	3083*	2734*	-	-	-	-	1017	1.7	3.0	2.3
161164	103	37	18.0	2786*	2745**	-	-	-	-	913	3.2	2.7	2.9
181017	103	36	18.0	2596	1874	-	-	-	-	830	2.8	2.7	2.8
K16136	101	36	16.0	3066*	2270*	3171	3399*	2042	2301	908	3.0	3.2	3.1
K19111	102	40	20.0	2762*	2103*	-	-	-	-	928	2.0	2.8	2.4
MEAN:	101	36	18.4	2631	2271	2758	3202	2048	2224	890	2.5	2.7	2.6
LSD $_{(0.05)}$:	-	-	-	445	650	390	357	354	261	-	-	-	-
CV:	-	-	-	14.2 %	17.0%	17.0%	16.5%	17.8%	15.7%	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Scott Bales; MSU Dry Bean Specialist
989-262-8550; balessco@msu.edu

Table 11. White Kidney bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Montcalm	Tuscola	Irrigated 2-year avg.	Irrigated 3-year avg.	Dry Land 2-year avg.	Dry Land 3-year avg.	Seed Size	Appearance (after canning) Montcalm	Tuscola	Avg.
	dap	*dap*	*inch*	*Lb. A^{-1}*		*Lb. A^{-1}*		*Lb. A^{-1}*		*seeds Lb^{-1}*	*(1-5)*	*(1-5)*	*(1-5)*
Beluga	104	41	20.0	2346	2201	2803	2760	2171	2343**	841	2.8	2.8	2.8
ND White Tail	104	40	20.0	2849	2109	-	-	-	-	922	2.8	3.0	2.9
Yeti	106	39	18.0	1796	2394	2790	3145	1970	2224	841	3.0	2.8	2.9
K16924	97	34	16.0	3546**	2531	3638**	3871**	1950	2201	902	3.1	3.8	3.5
K19830	106	40	20.0	2942	2336	-	-	-	-	795	2.3	3.5	2.9
MEAN:	103	39	18.8	2695	2272	3077	3258	2030	2256	860	2.8	3.2	3.0
LSD $_{(0.05)}$:	-	-	-	339	NS	491	418	NS	296	-	-	-	-
CV:	-	-	-	9.3 %	-	18.1%	18.3%	-	16.9%	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Scott Bales; MSU Dry Bean Specialist
989-262-8550; balessco@msu.edu

Table 12. Mayocoba/Yellow bean agronomic and yield results.

VARIETY	Maturity	Flowering	Plant Height	Montcalm	Tuscola	Irrigated 2-year avg.	Irrigated 3-year avg.	Dry Land 2-year avg.	Dry Land 3-year avg.	Seed Size	Appearance (after canning) Montcalm	Tuscola	Avg.
	– dap –	*– dap –*	*– inch –*	*—— Lb. A^{-1} ——*		*—— Lb. A^{-1} ——*		*—— Lb. A^{-1} ——*		*seeds Lb^{-1}*	*– (1-5) –*	*–*	*– (1-5) –*
Claim Jumper	100	40	20.0	2356*	2469*	2821	-	1952	-	1260	4.8	3.8	4.3
SVS-0863	97	42	16.0	2635*	2425*	3118	-	2334	-	1019	4.2	4.2	4.2
Yellowstone	89	38	16.0	2843**	2149	3378	-	1993	-	1269	4.3	4.2	4.3
Y1608-14	96	35	16.0	2609*	2334*	-	-	-	-	1226	3.0	3.3	3.2
Y1609-14	87	34	16.0	2755*	2584**	-	-	-	-	1117	2.3	2.5	2.4
Y1702-22	95	35	16.0	2490	2562*	-	-	-	-	1335	3.2	2.2	2.7
MEAN:	94	37	16.7	2614	2420	3105	-	2166	-	1204	3.6	3.4	3.5
LSD $_{(0.05)}$:	-	-	-	260	339	NS	-	NS	-	-	-	-	-
CV:	-	-	-	7.5 %	5.9 %	-	-	-	-	-	-	-	-

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

Table 13. Irrigated Navy bean lodging, white mold and yield results.

VARIETY	**Lodging**	**White Mold Infection**	**Montcalm**
	- (1-5) -	*— % —*	*- Lb. A $^{-1}$ -*
HMS Medalist	2.3	17.1**	3461**
Merlin	1.9	20.6*	2285
Valiant	2.1	54.3	2981*
MEAN:	2.1	30.6	2909
LSD $_{(0.05)}$:	-	6.3	851
CV:	-	31.2%	21.3%

Table 14. Irrigated Black bean lodging, white mold and yield results.

VARIETY	**Lodging**	**White Mold Infection**	**Montcalm**
	- (1-5) -	*— % —*	*- Lb. A $^{-1}$ -*
Adams	2.3	30.8**	3632*
Black Bear	2.6	52.9	3783**
Black Beard	2.7	59.5	3472*
Spectre	2.3	32.5*	3408*
Zenith	2.4	39.3*	2739
MEAN:	2.4	43.1	3407
LSD $_{(0.05)}$:		22.0	912
CV:		35.9%	20.0%

Table 13. Irrigated Small Red bean lodging, white mold and yield results.

VARIETY	**Lodging**	**White Mold Infection**	**Montcalm**
	- (1-5) -	*— % —*	*- Lb. A $^{-1}$ -*
Caldera	3.4	66.5	2814
Cayenne	2.8	43.6**	2848
Viper	2.8	54.7*	3822**
MEAN:	2.9	54.9	3161
LSD $_{(0.05)}$:	-	21.9	715
CV:	-	30.3	16.4%

***Highest yielding variety within column*

**Yield not statistically different than the highest yielding variety within column*

2020 Sourcing information:

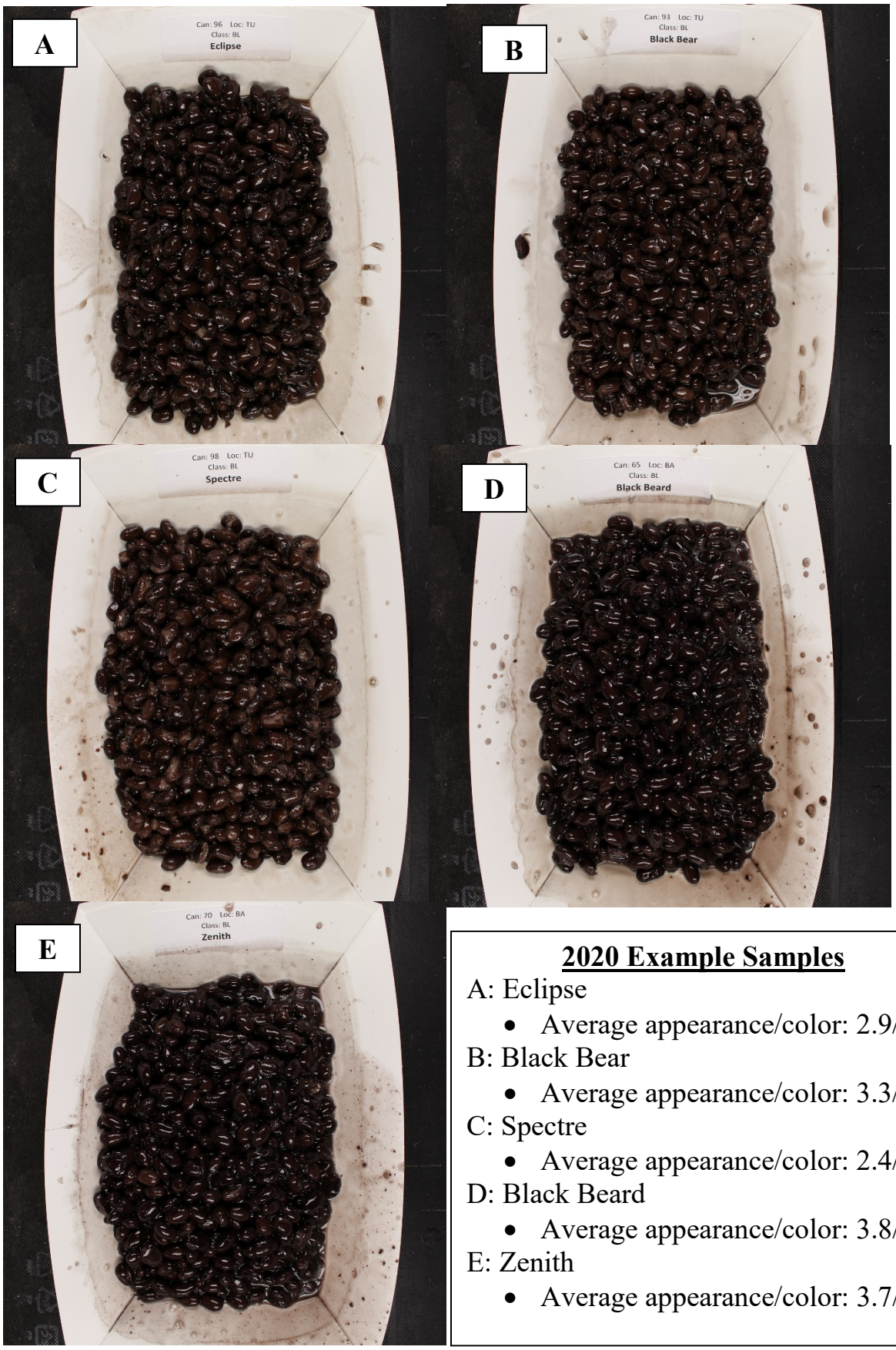
Entry	Market Class	Source
12039	NA	ProVita
14068	NA	ProVita
14080	NA	ProVita
14084	NA	ProVita
14089	NA	ProVita
14500	BL	ProVita
15094	NA	ProVita
15095	NA	ProVita
15610	BL	ProVita
15619	BL	ProVita
15907	LRK	ProVita
15926	LRK	ProVita
15977	DRK	ProVita
15978	DRK	ProVita
15981	DRK	ProVita
16590	BL	ProVita
16648	BL	ProVita
16686	SR	ProVita
16756	CR	ProVita
16758	CR	ProVita
16759	CR	ProVita
16760	CR	ProVita
16761	CR	ProVita
16764	CR	ProVita
16775	CR	ProVita
16816	CR	ProVita
17704	BL	ProVita
17708	BL	ProVita
17715	BL	ProVita
17724	BL	ProVita
17751	BL	ProVita
17835	SR	ProVita
17837	SR	ProVita
17839	SR	ProVita
18991	DRK	ProVita
151011	DRK	ProVita
151085	CR	ProVita
151093	CR	ProVita
161156	DRK	ProVita
161164	DRK	ProVita
181017	DRK	ProVita

Entry	Market Class	Source
14L1203B	CR	USDA-ARS
Adams (B18504)	BL	Michigan State University
Aires	GN	ProVita
Amaranto (SV3709GC)	CR	Seminis Seeds
Apex	NA	Treasure Valley Seeds
Argosy	NA	Canada-Hensall District Coop
Armada (13068)	NA	ProVita
B13SR1-1	BL	GenTec Seeds LTD
B17220	BL	Michigan State University
B17922	BL	Michigan State University
B18201	BL	Michigan State University
B18204	BL	Michigan State University
B19330	BL	Michigan State University
B19344	BL	Michigan State University
B3036368	BL	Archer Daniels Midland (ADM)
B3036381	BL	Archer Daniels Midland (ADM)
Bellagio	CR	Michigan State University
Beluga	WK	Michigan State University
Big Red	LRK	ProVita
BL1402-15	BL	USDA-ARS
Black Bear	BL	ProVita
Black Tails	BL	ProVita
BlackBeard (14506)	BL	ProVita
Blizzard	NA	ProVita
Caldera (11511)	SR	ProVita
California Early	LRK	University of California
Cayenne	SR	Michigan State University
Chaparral	DRK	ProVita
Charro (P16901)	P	Michigan State University
Chianti	CR	Seminis Seeds
Claim Jumper	MY	ProVita
Clouseau	LRK	Seminis Seeds
Coho (K15601)	LRK	Michigan State University
CR1704-2	CR	USDA-ARS
Dynasty	DRK	Canada-Hensall District Coop
Eclipse	BL	North Dakota State University
Eiger (G16351)	GN	Michigan State University
Epic	DRK	ProVita
Etna	CR	Seminis Seeds
EX1702	NA	Treasure Valley Seeds
EX1708	NA	Treasure Valley Seeds
EX1711	NA	Treasure Valley Seeds

Entry	Market Class	Source
EX1801	NA	Treasure Valley Seeds
EX1802	NA	Treasure Valley Seeds
EX1803	NA	Treasure Valley Seeds
EX1804	NA	Treasure Valley Seeds
EX1914	NA	Treasure Valley Seeds
G18512	GN	Michigan State University
HMS Bounty	NA	ProVita
HMS Medalist	NA	ProVita
Indi	NA	Archer Daniels Midland (ADM)
K16136	DRK	Michigan State University
K16924	WK	Michigan State University
K17703	LRK	Michigan State University
K17704	LRK	Michigan State University
K19111	DRK	Michigan State University
K19605	LRK	Michigan State University
K19830	WK	Michigan State University
LaPaz	P	ProVita
Merlin	NA	ProVita
Montcalm	DRK	Michigan State University
N18103	NA	Michigan State University
N19253	NA	Michigan State University
N19285	NA	Michigan State University
Nautica	NA	Canada-Hensall District Coop
ND Falcon	P	North Dakota State University
ND Palomino	P	North Dakota State University
ND Pegasus	GN	North Dakota State University
ND Twilight	BL	North Dakota State University
ND White Tail	WK	North Dakota State University
P19103	P	Michigan State University
Pink Panther	LRK	Seminis Seeds
Powderhorn	GN	Michigan State University
R17604	SR	Michigan State University
Rampart (09434)	DRK	ProVita
Red Cedar	DRK	Michigan State University
Red Cran 172	CR	GenTec Seeds LTD
Red Cran Up	CR	GenTec Seeds LTD
Red Dawn (09363)	LRK	ProVita
Red Hawk	DRK	Michigan State University
Red Rover	DRK	Seminis Seeds
Ronnie's Red (09360)	LRK	ProVita
Rosie	LRK	North Dakota State University
Ruby	SR	ProVita
S18904	PINK	Michigan State University

Entry	Market Class	Source
Shock	NA	Canada-Hensall District Coop
Snowdon	WK	Michigan State University
Spectre (14497)	BL	ProVita
Spire(09431)	DRK	ProVita
SV1893GH	NA	Seminis Seeds
SV6139GR	P	Seminis Seeds
SVS-0863	MY	Treasure Valley Seeds
Talon	DRK	North Dakota State University
Valiant (08077)	NA	ProVita
Vero	CR	Archer Daniels Midland (ADM)
Vigilant	NA	ProVita
Viper	SR	ProVita
Virgo (13172)	GN	Archer Daniels Midland (ADM)
Windbreaker	P	Seminis Seeds
Y1608-14	MY	USDA-ARS
Y1609-14	MY	USDA-ARS
Y1702-22	MY	USDA-ARS
Yellowstone (Y16507)	MY	Michigan State University
Yeti	WK	Canada-Hensall District Coop
Zenith	BL	Michigan State University
Zorro	BL	Michigan State University

Figure 1. Example Black Bean samples from 2020 Dry Bean Performance Trials.



2020 Example Samples

A: Eclipse
- Average appearance/color: 2.9/2.7

B: Black Bear
- Average appearance/color: 3.3/3.0

C: Spectre
- Average appearance/color: 2.4/3.0

D: Black Beard
- Average appearance/color: 3.8/4.2

E: Zenith
- Average appearance/color: 3.7/4.7

Figure 2. Example Navy Bean samples from 2020 Dry Bean Performance Trials.

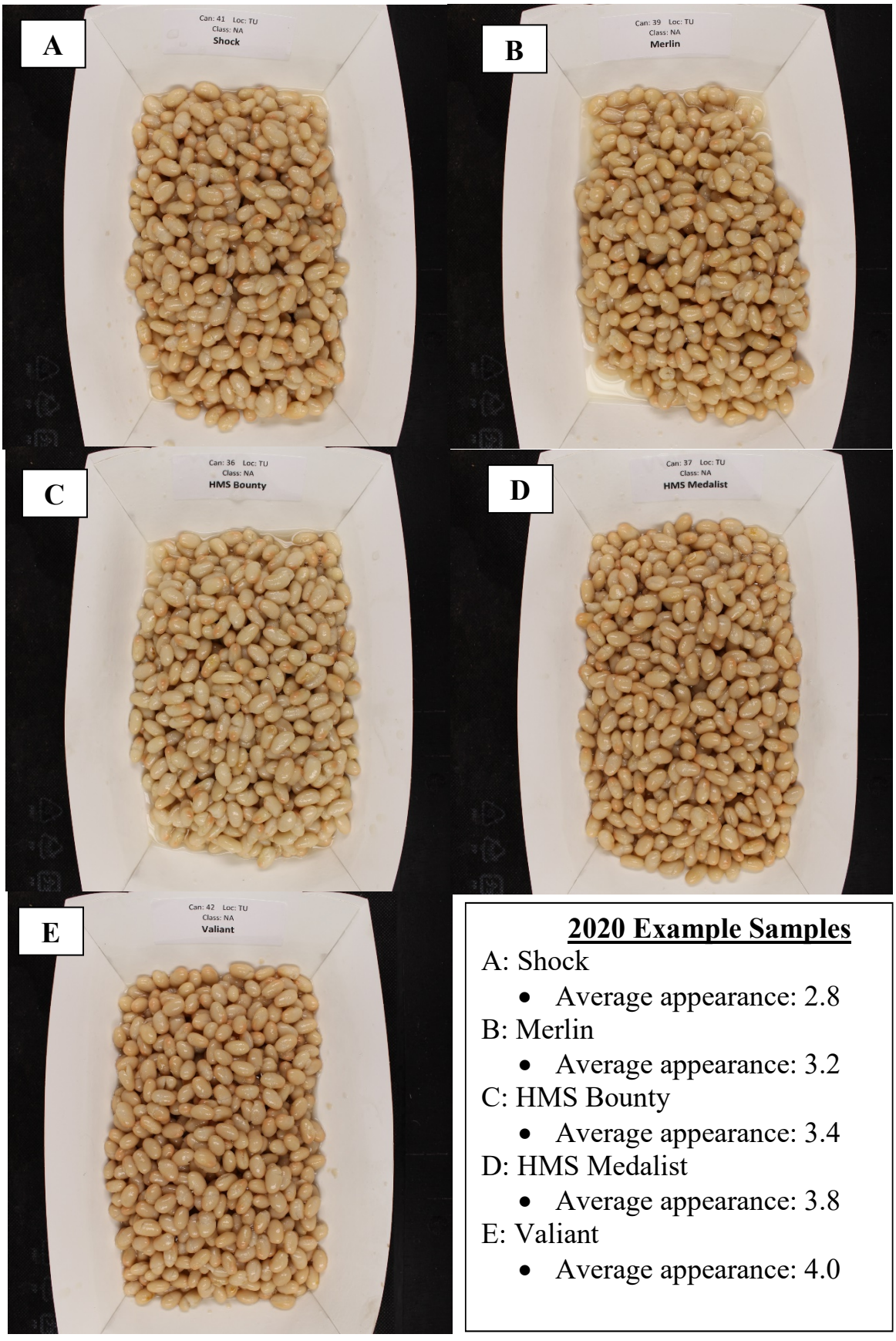
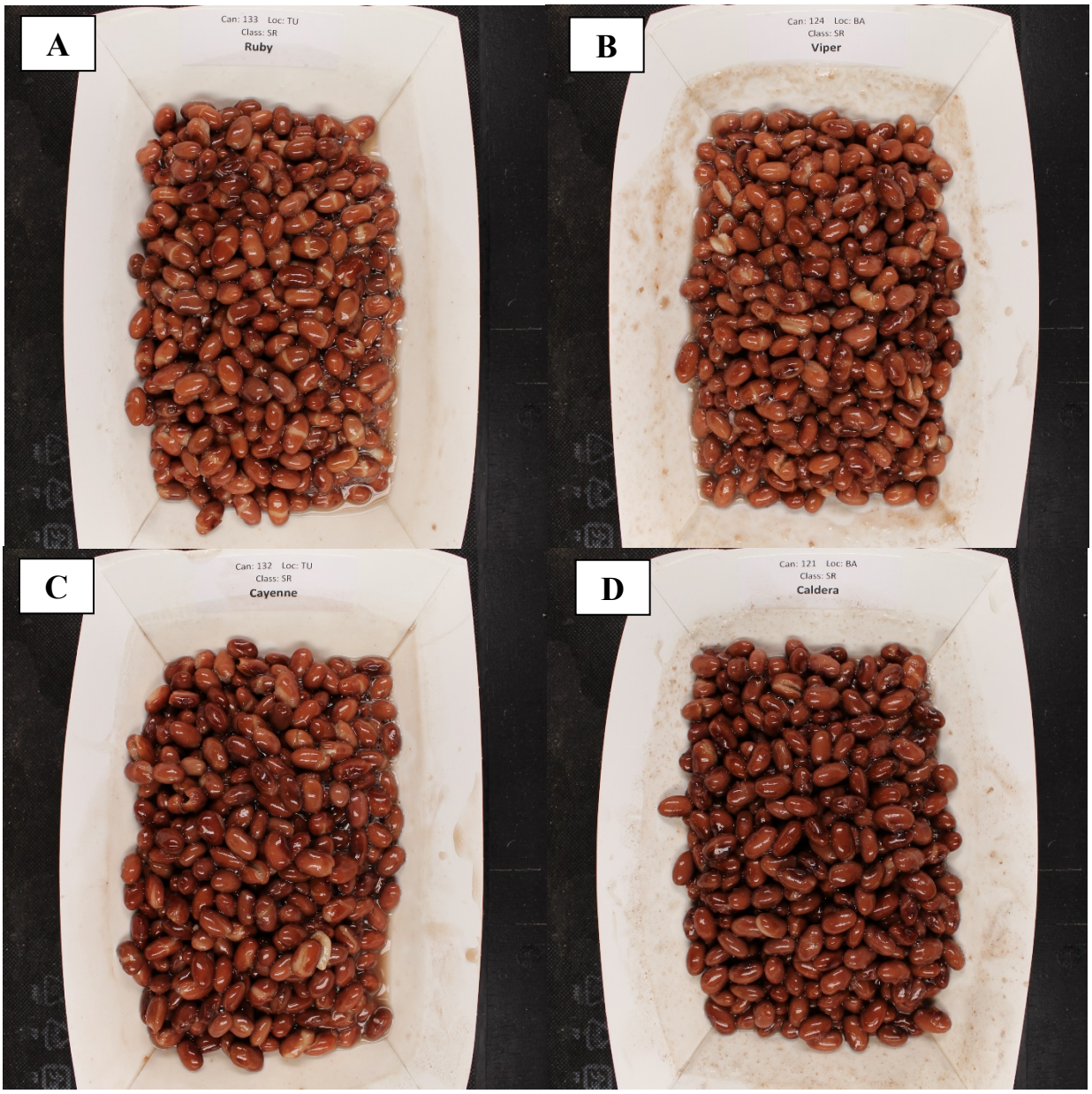


Figure 3. Example Small Red Bean samples from 2020 Dry Bean Performance Trials.



2020 Example Samples

A: Ruby
- Average appearance: 1.8

B: Viper
- Average appearance: 2.4

C: Cayenne
- Average appearance: 3.4

D: Caldera
- Average appearance: 3.5

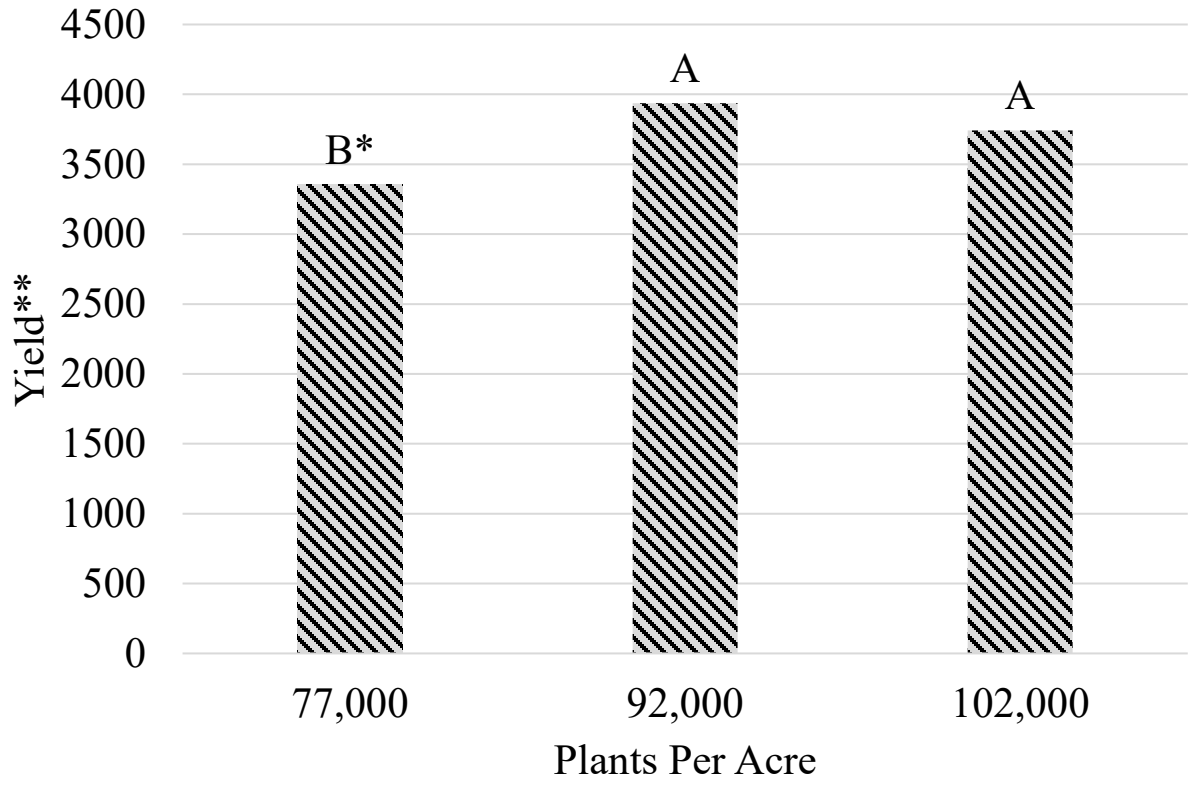
Black Bean Response to Nitrogen and Planting Rate

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location:	Huron (Planted: June 5)	**Treated Plot Size:** 6.6’ x 20’
	Sanilac (Planted: June 5)	**Replicated:** 4 times
	Tuscola (Planted: June 6)	**Row Spacing:** 20-inch
	Bay (Planted: June 7)	**Variety:** Black Bear Black Bean
Population:	100,000- 154,000 seeds^{-1} acre	**Nitrogen Rate:** 0-100 lb.$^{-1}$ acre

Introduction: a 12 treatment trial was designed and established at four locations in the dry bean production region of Michigan. Each location consisted of black bear black beans planted at three separate planting populations (100,000; 130,000; and 154,000 seeds per acre) and four rates of nitrogen. Due to differing grower practices at each location nitrogen rates tested were not the same at all locations. However, the trend remained the same with nitrogen rates increasing from the base rate by the addition of 28-0-0 at planting in a 2x2 system.

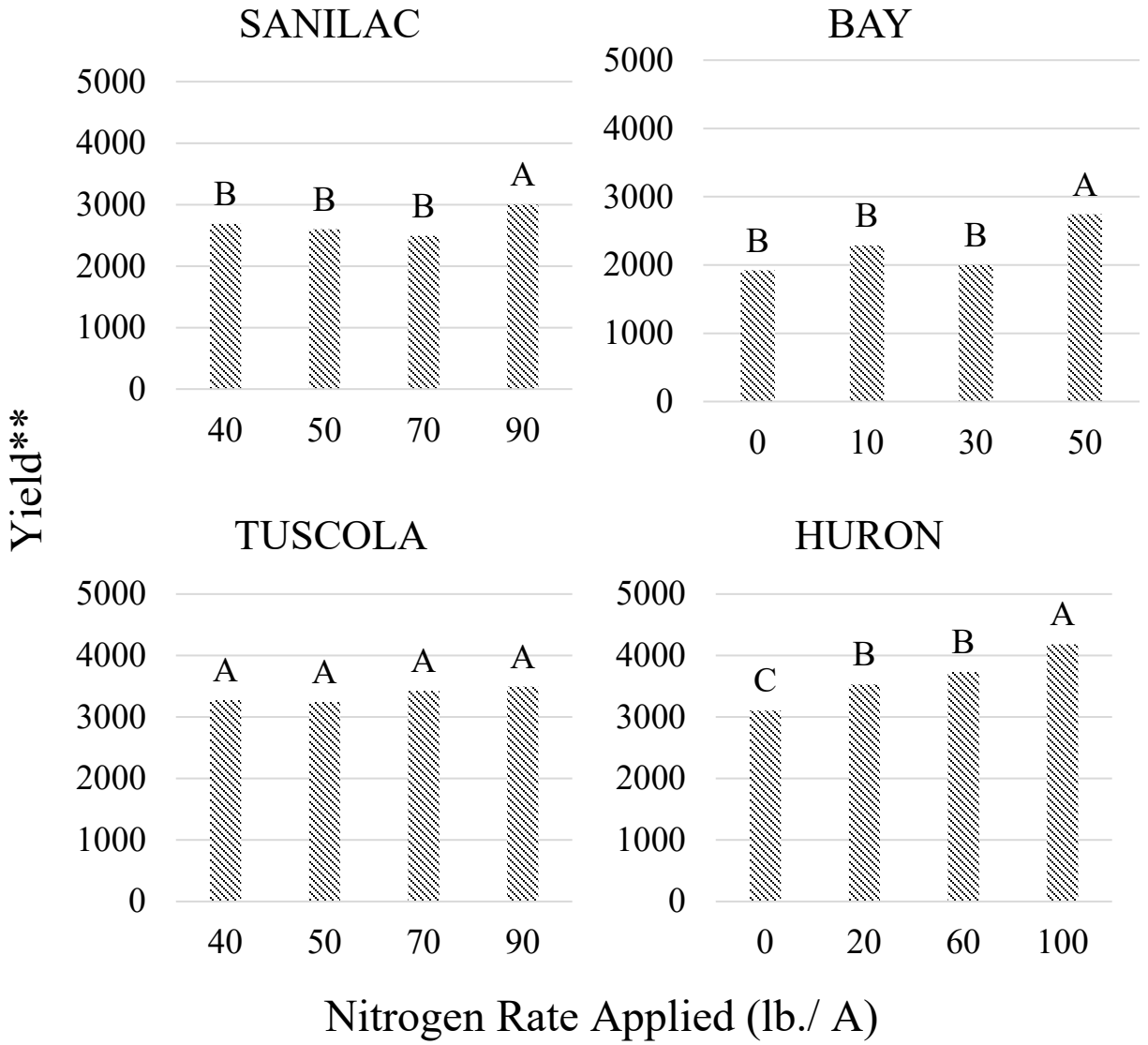
Figure 1. Dry bean yield by population at the Huron County location in 2020. Yield was not significantly different for plant population at Bay, Tuscola, or Sanilac County locations.



*Yields followed by the same letter are not significantly different from each other ($\alpha \leq 0.05$).
**Yield is in pounds per acres obtained by direct harvest and adjusted to 18% moisture.

Black Bean Response to Nitrogen and Planting Rate

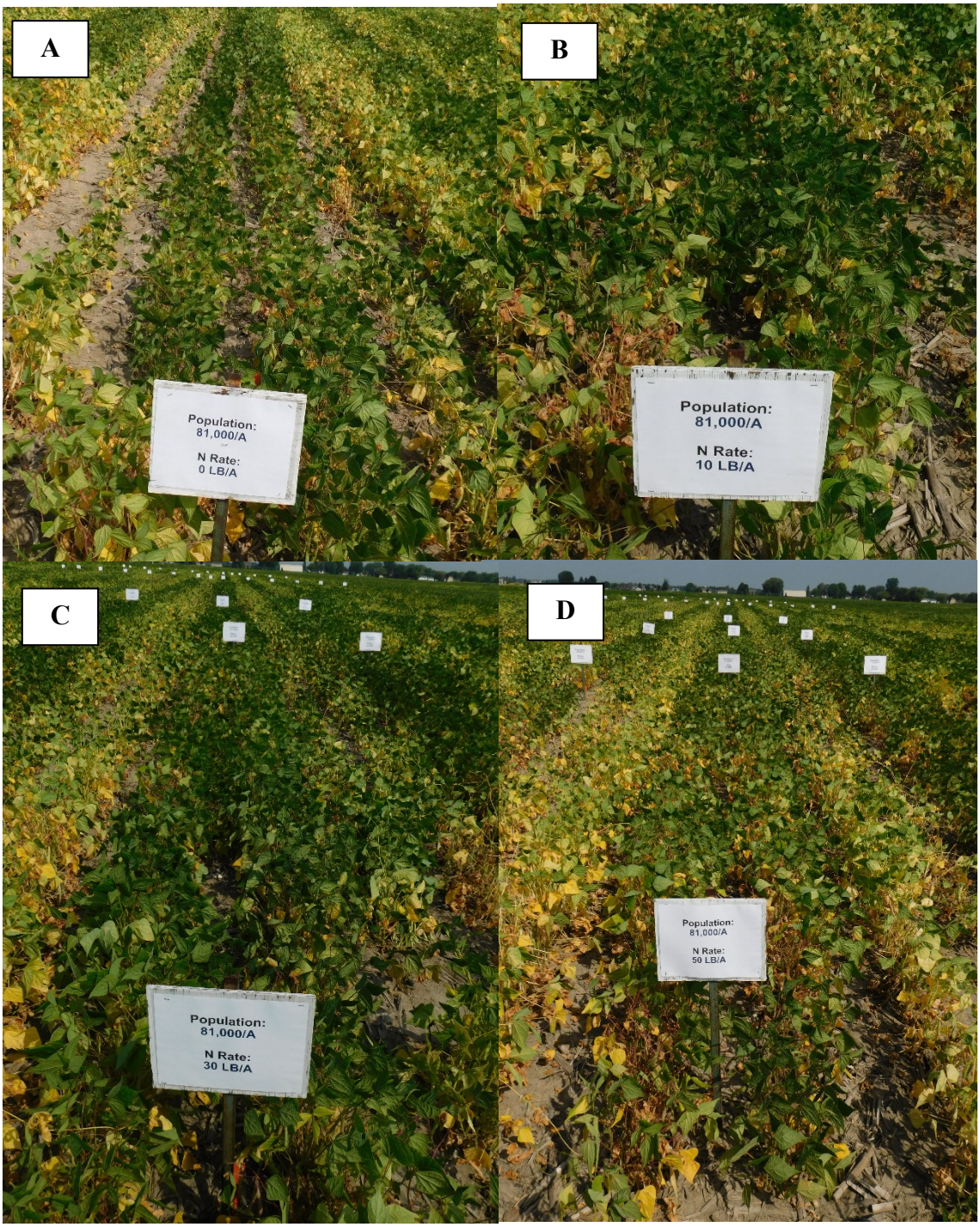
Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu



Summary: In all locations except Pawlowski Farms (Huron County) the factor of plant population was not significant at the rates tested (Figure 1). At this Huron County location yields were significantly higher than the other locations tested, here final plant stands of 92,000 and 102,000 yielded significantly more than 77,000 plants per acre. The second factor of nitrogen rate was significant at all locations except for Bednarski Farms (Tuscola). As a trend dry bean yield responded to increasing rates of nitrogen. However, an important factor was the near absence of white mold in trial locations. It is hypothesized that increasing rates of nitrogen would also increase the severity of white mold due to the increased foliar growth, this could have negative implications for the application of higher rates of nitrogen. When developing nutrient management plans for a dry bean crop it is also important to consider pre-plant residual nitrogen levels in the soil from previous crops (or cover crops). For example a farm with a history of manure use

and clover inter-seeding we would expect less of a response to nitrogen than a farm without these factors. Moving forward we will continue to focus on nitrogen use, biological nitrogen fixation, and interactions with plant diseases.

Figure 2. Increased plant size and canopy density from increased rates of nitrogen fertilizer. (A) 0 lb., (B) 10 lb., (C) 30 lb., (D) 50 lb.



Reduced Black Bean Plant Populations

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Locations: SVREC (Richville, MI)	**Plot Size:** 6.6' x 20'
Planting Date: June 16, 2020	**Replicated:** 4 times
Variety: Zorro Black Bean	**Row Spacing:** 20-inch

Table 1. Treatments, final plant populations at harvest, corresponding percent stand reduction, yield, and net yield change from stand loss.

Treatment:	Plant Population	Percent Stand Reduction	Yield**	Net Yield Change*
1	117,000	0%	3204 A	0%
2	78,000	34%	3452 A	8%
3	65,000	45%	2958 AB	(8%)
4	39,000	66%	2663 B	(17%)

*Yields followed by the same letter are not significantly different from each other ($\alpha \leq 0.05$).
**Yield is in pounds per acres obtained by direct harvest and adjusted to 18% moisture.

Summary: To examine the effects of severe stand loss on dry bean yield a trial was established at SVREC (Richville, MI) in 2020. Zorro black beans were planted in 20-inch rows at a standard population of 125,000 seeds per acre. Seven days after emergence dry beans were mechanically thinned to create three separate levels of stand loss. When compared to the treatment 1 plant populations for the remaining treatments were reduced by approximately 1/3, 1/2, and 2/3. This was done to simulate emergence issues that could be caused numerous issues in commercial production (soil crusting, flooding, poor germination, etc.). On the day of harvest (September 24) stand counts were retaken to produce a final plant populations of 117k, 78k, 65k, and 39k. From these four levels of plant population dry bean yield was not significantly affected until the lowest plant population was reached (39k). At this 66% level of stand loss dry bean yield was reduced by 17%. However, when applying this information to replant decisions in commercial production it is important to know that this stand loss was considered even down the row. This uniform plant spacing at low populations allowed dry beans to branch with the reduced competition. Additional weed control measures may also need to be taken with very low plant populations due to delayed canopy closure. In conclusion, given adequate weed control, acceptable growing conditions, and uniform stands dry bean yield can remain competitive at low populations.

2020 Black Bean Response to Nitrogen Strip Trial

Scott Bales, MSU Dry Bean Specialist

Location: LAKKE Ewald Farms (Unionville, MI)	**Treated Plot Size:** 1.45 Acres
Planting Date: June 9, 2020	**N Source:** UAN (28-0-0)
Replicated: 1 time	
Variety: Black Beard	**Fungicide App. A:** July 30 (Topsin)
Population: 120,000 seeds/A	**Fungicide App. B :** August 7 (Propulse)
Row width: 22-inch	**Field Average:** 2460 lb./A

Table 1. Fertilizer treatments, gross yield, percent pick, final clean yield per acre.

Treatments (lb. N/acre)	Gross (lb./acre)	Pick (%)	Yield (lb./acre)
0	2731	4.2%	2616
20	2863	4.6%	2732
40	2829	4.9%	2691
60	2939	6.4%	2751

**Yield is in pounds per acres obtained by direct harvest and adjusted to 18% moisture.

Summary: This trial was established in 2020 to investigate black beans response to multiple rates of nitrogen. A similar trial was established on LAKKE Ewald Farms in 2019. Due to field uniformity and other limiting factors only one replication of this study was planted and harvested. However, due to very uniform soil and field conditions we believe the data still provides valuable insight into dry beans response to nitrogen. In this trial dry beans did not show a large response to nitrogen. We hypothesize this lack of response in clean yield can be due to multiple factors including the use of legume cover crops (clover) inter-seeded into the previous crop (wheat). This combined with white mold infection in the trial possibly mitigated any yield response from increased rates of nitrogen fertilizer. A supporting point of interest is the numerical increase in gross yield. However this was accompanied by a steady rise in pick at delivery. This somewhat subtracted the yield advantage. The interaction between nitrogen fertility and white mold will be the focus of future research projects in how crop rotation, soil biotic nitrogen fixation and fungicide use interact.

Micronutrient Application Method to Navy Beans

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

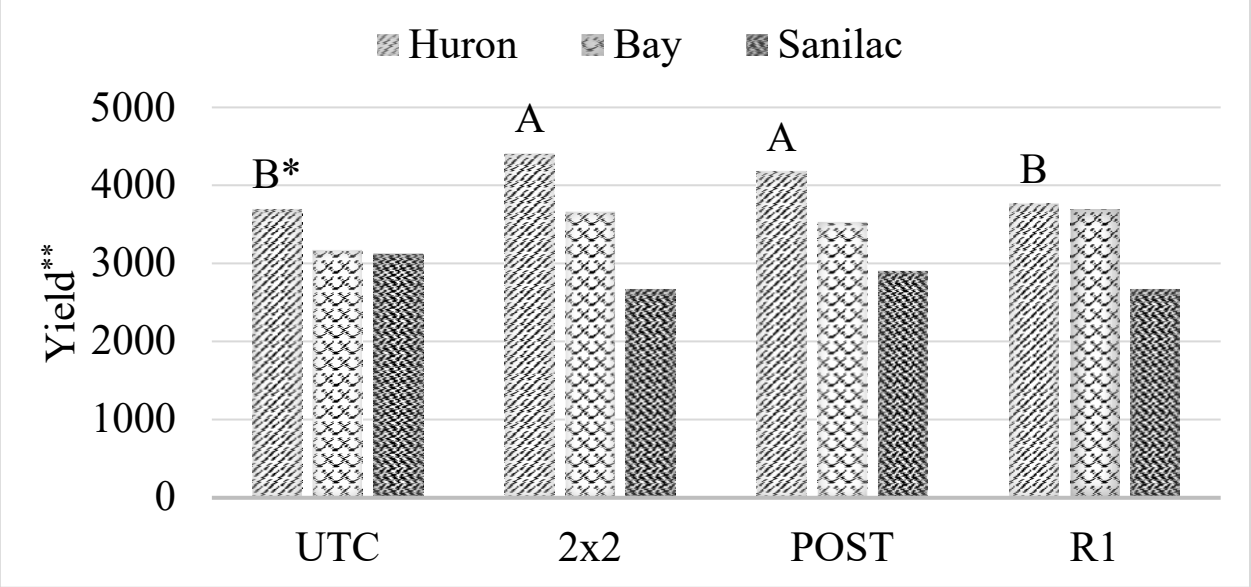
Location:	Huron (Planted: June 5)	**Treated Plot Size:** 6.6' x 20'
	Sanilac (Planted: June 5)	**Replicated:** 4 times
	Bay (Planted: June 7)	**Row Spacing:** 20-inch
		Variety: Merlin Navy Bean
Population:	130,000 seeds^{-1} acre	**Nitrogen Rate:** 40 lb.$^{-1}$ acre
Application A:	2x2 (Yield 360 'band-it'): 12 PSI; 15 GPA	
Application B:	Spray (TP8002VS): 60 PSI; 22 GPA	
Application C:	Spray (TP8002VS): 60 PSI; 22 GPA	

Table 1. Treatments, growth stage at application, equipment, and fertilizer rate.

Treatment:	Application:	Fertilizer Rate[a]:
1	Untreated	-
2	'A' (At Planting)	32 oz. Zn (6%) + 32 oz. Mn (5%)
3	'B' (V2)	32 oz. Zn (6%) + 32 oz. Mn (5%)
4	'C' (R1)	32 oz. Zn (6%) + 32 oz. Mn (5%)

[a] Sources: MAX-IN ® ZINC, MAX-IN ® MANGANESE

Figure 1. Dry bean yield at each location by fertilizer treatment.



*Columns within the same location with different letters are significantly different from each other ($\alpha \leq 0.05$).
**Yield is in pounds per acre obtained by direct harvest and adjusted to 18% moisture.

Micronutrient Application Method to Navy Beans

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Summary: This study was conducted to investigate multiple research questions: (A) navy beans response to zinc (Zn) and manganese (Mn) fertilizer; (B) response based on application method and timing. Dry beans are categorized as highly responsive to both Mn and Zn. During the growing season symptoms of deficiency are often observed in commercial fields (intravenous chlorosis) (Figure 2). In periods of little rainfall this symptomology can also be more common place due to zinc moving by mass flow (water). Zinc and Manganese availability is also limited when our soil pH moves above 7.0. Soil pH values were 7.4 (Huron), 7.5 (Sanilac), and 6.8 (Bay). Across all locations soil test levels for manganese were all >32 ppm (critical level near 12 ppm at 6.7 pH) and zinc soil test levels of >3.5 ppm (critical level near 7 at 7.0 pH). Due to the lower levels of Zinc concentrations and relatively dry conditions a response to fertilization could have been expected at one or all locations. We do find that the Huron county location had the greatest response to the addition of Zn and Mn (Figure 1). Here the addition of 32 fl oz. Zn (6%) and 32 fl. oz. Mn (5%) resulted in 11-16% increase in yield when applied at planting, or foliar early in the growing season (V2/POST). However when foliar applications were delayed until R1 in Huron county no significant yield response was documented. A similar numerical response (10-14% yield increase) was documented from applications of Zn and Mn at the Bay county location. However these differences were not considered significant ($\alpha \leq 0.05$) due to high levels of trial variation from heavy rain fall after planting. Continued research will focus on the hypothesized benefit of Zn and Mn fertilization early in the growing season as well as the possible benefits in the nutritional content of the end use product (beans) from applied nutrients (Zinc, Iron, Calcium).

Figure 2. Characteristic deficiency symptoms from zinc and manganese in dry bean

Propulse For Plant Health and White Mold

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location:	Bay (planted: June 7)	**Treated Plot Size:** 6.6' x 20'
	Tuscola (planted: June 6)	**GPA:** 22
Replicated: 4 times		**PSI:** 60
Variety: Viper Small Red		**Nozzle:** TP8002VS
Population: 120,000 seeds/A		**Application A (R1):** July 27
Row width: 20-inch		**Application B:** August 5

Table 1. White mold fungicide treatments, application timing, white mold percent infection, and dry bean yield.

#	Treatments	Application Timing	White Mold (% Infection)[ab]	Yield [c]
1	Untreated	AB	28.5 a	3248 c
2	Propulse (6 fl oz)	AB	17.8 bc	3766 a
3	Propulse (8 fl oz)	AB	16.1 bc	3555 ab
4	Propulse (10.3 fl oz)	AB	13 c	3719 a
5	Delaro([d])	A	23 ab	3580 ab
5	Propulse (8 fl oz)	B		
6	Delaro ([d])	AB	10.4 c	3116 c

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] White mold percent infection was only evaluated at Tuscola location due to very low levels of infection at Bay location.
[c] Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.
[d] Delaro was applied at 12 fl oz at Tuscola and 5.7 fl oz at Bay, due to insignificance of rate as factor, data were combined over fungicide rate.

Summary: A fungicide trial with two non-irrigated locations was established in 2020. The purpose of this trial was to evaluate multiple rates of Propulse and sequential applications with Delaro in commercial production conditions. The majority of dry bean fungicide trials in recent years available for study are under irrigation. Irrigation is then utilized to ensure plant disease pressure is high. This is done by irrigating 1-2" per week through the flowering period. While this is very beneficial for the testing and screening of new and commercial fungicide products, it does not provide insight on the potential return on investment from fungicide use when disease pressure is not high. In 2020 disease pressure was relatively low, 28.5% infection in the untreated at Bednarski Farms (Tuscola) (Table 1) and less than 10% at Schindler Farms (Bay) (not published). Results indicated that both white mold infection and yield were significantly affected by Propulse rate (6-10.3 fl oz) when applied twice (R1 and 7 d. after R1). When Delaro was applied at R1 and followed with 8 fl oz of Propulse 7 d. after R1 statistically similar results were also observed. All fungicide treatments with the exception of Delaro applied twice out yielded the untreated control even under very low levels of white mold infection. Dry beans response to Delaro will continue to be investigated in future years.

Propulse In-Furrow at Planting

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location: Tuscola Co.	**Treated Plot Size:** 6.6' x 20'
Planting Date: June 6	**GPA:** 12.7
Replicated: 4 times	**PSI:** 12
Variety: Merlin Navy Bean	**Nozzle:** T-Band
Population: 120,000 seeds/A	**Application A:** Seed Treatment
Row width: 20-inch	**Application B:** In-Furrow (June 6)

Table 1. Fungicide treatments, application timing, final plant population and dry bean yield.

#	Treatments	Application Timing	Plant Population [a]	Yield [b]
1	Untreated	-	97,358 b	2745
2	Propulse (6 fl oz)	B	86,903 b	2734
3 3	Propulse (6 fl oz) EverGol Energy	B A	91,477 b	3343
4	EverGol Energy	A	113,040 a	2801

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Yield is in pounds per acres obtained by direct harvest, adjusted to 18% moisture.

Summary: A in-furrow fungicide trial was established in Tuscola County in 2020. The goal of this trial was to test the efficacy and crop safety of Propulse in-furrow at planting using a 6 fl oz use rate. Propulse was also tested in-furrow in combination with EverGol seed treatment. All treatments were made on 'Merlin' navy beans. Very little root disease was observed in the trial location regardless of treatment. This indicates low overall disease pressure. Stand counts were conducted prior to harvest and indicate that Propulse in-furrow numerically reduced dry bean stands, however these differences were not significantly different than the untreated control. When EverGol seed treatment was used without Propulse stand counts were significantly greater than all other treatments. In fields with a history of root disease combinations of seed treatments and in-furrow applications may have viability in reducing stand loss from disease. Dry bean yield was not significantly affected by any treatment. Further research should be done to verify crop safety and disease efficacy of fungicide use in furrow in combination with seed treatments.

Dry Land White Mold Fungicide Trial

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location:	Sanilac (Planted: June 5)	**Treated Plot Size:** 6.6' x 20'
	Huron (Planted: June 5)	**GPA:** 22
Replicated: 4 times		**PSI:** 60
Variety: Viper Small Red		**Nozzle:** TP8002VS
Population: 120,000 seeds/A		**Application A (R1):** July 28
Row width: 20-inch		**Application B:** August 6

Table 1. Sanilac County white mold fungicide treatments, application timing, and dry bean yield.

#	Treatments	Application Timing	Yield [ab]
1	Untreated	-	3023 b
2	Propulse (10.3 fl oz)	AB	3405 a
3	Propulse (10.3 fl oz)	B	3044 b
4	Propulse (10.3 fl oz)	A	3420 a
4	Endura (8 oz)	B	
5	Endura (8 oz)	AB	3394 a
6	Omega (8 fl oz)	AB	3089 ab

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Yield is in pounds per acres obtained by direct harvest, adjusted to 18% moisture.

Table 2. Huron County white mold fungicide treatments, application timing, and dry bean yield.

#	Treatments	Application Timing	Yield [ab]
1	Untreated	-	3543 bc
2	Propulse (10.3 fl oz)	A	4281 a
3	Propulse (10.3 fl oz)	B	4100 ab
4	Propulse (10.3 fl oz)	A	4208 a
4	Endura (8 oz)	B	

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Yield is in pounds per acres obtained by direct harvest, adjusted to 18% moisture.

Summary: Two fungicide trials were established in the eastern thumb in 2020. Both locations were non-irrigated and examined multiple commercial products at various application timings. Overall, white mold infection in the untreated control was less than 10% at both locations. Dry bean yield significantly responded to yield from fungicide applications at both locations. In Sanilac county treatments that combined a R1 (A) timing and a second application 7 d. later (B) provided a yield benefit as were one application at the B timing alone did not. In the Huron county location dry bean yield responded to statistically similar to: Single applications at R1, single applications at B, and sequential applications at both timings. These results along with 2019 results indicate that environmental differences can affect the optimum timing for fungicide application.

Irrigated White Mold Trial

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location: Montcalm Research Center	**Treated Plot Size:** 6.6' x 20'
Planted: June 12	**GPA:** 22
Replicated: 4 times	**PSI:** 60
Variety: Black Bear Black	**Nozzle:** TP8002VS
Population: 120,000 seeds/A	**Application A (PPI):** June 12
Row width: 20-inch	**Application B (R1):** July 29
	Application C: August 6

Table 1. White mold fungicide treatments, application timing, white mold percent infection, and dry bean yield.

#	Treatments	Application Timing	White Mold (% Infection)[a]	White Mold Severity (1-9)[b]	Yield [c]
1	Propulse (10.3 fl oz)	B	34.6 a	2.1 a	5475 a
2	Propulse (10.3 fl oz)	B	45.4 ab	2.7 ab	4971 b
2	Endura (8 oz)	C			
3	Endura (8 oz)	B	51.3 bc	2.7 ab	4876 b
4	Propulse (10.3 fl oz)	C	56.3 bc	3.1 bc	4732 bc
5	Froghorn (20 fl oz)	B	71.2 d	4.1 c	4665 bc
6	Untreated	-	87.5 e	5.6 d	4320 cd
7	Contans (2 lb)	A	62.9 cd	3.7 bc	4311cd
8	Zolera ODX (6 fl oz)	B	73.8 de	4.2 c	4017 d

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Severity is evaluated 1 (very little infection in upper stems) – 9 (pods and stems on the soil surface)
[c] Yield is in pounds per acres obtained by direct harvest, adjusted to 18% moisture.

Summary: An irrigated white mold trial was established at the Montcalm Research Center (MRC) near Entrican, MI in 2020. Disease pressure was lower than the 5 year average due to environmental conditions, however sufficient disease pressure was achieved (87% infection). Treatments were made at three separate application timings: (A) PPI, (B) R1, and (C) 8 d. after R1. The application of Propulse (10.3 fl oz) at R1 produced the highest dry bean yield at 5475 lb. per acre adjusted to 18% moisture. Other treatments performing better than the untreated control were Propulse fb. Endura, and Endura alone. 'Contans', a soil applied biological was tested for the second time in 2020, similar to 2019 no yield response was documented. However, in both years Contans did reduce the overall percent infection and disease severity. Repeated use of Contans in a crop rotation may have beneficial long term effects in areas of very severe white mold pressure.

Cranberry Bean Response to Nitrogen Rate and Timing

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

Location: Montcalm Co.	**Treated Plot Size:** 6.6’ x 20’
Planting Date: June 15	**GPA:** 16
Replicated: 4 times	**PSI:** 10
Variety: Etna Cranberry Bean	**Nozzle:** 2x2
Population: 100,000 seeds/A	**Row width:** 20-inch

Table 1. Fertilizer treatments, application timing, total nitrogen rate, and dry bean yield.

#	Nitrogen at Planting (lb./acre)	Nitrogen Applied at Side-dress (lb./acre)	Total Nitrogen Rate (lb./acre)	Yield [ab]
1	0	0	0	2084 b
2	0	20	20	2488 b
3	45	20	65	3226 a
4	45	60	105	3567 a

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Yield is in pounds per acres obtained by pull and harvest, adjusted to 18% moisture.

Summary: A nitrogen rate and application timing trial was established in Montcalm County under irrigation in 2020. Treatments one and two did not have any nitrogen applied at planting. Treatments three and four utilized a base rate of 45 lb. per acre applied at planting, and then 20 or 60 lb. per acre applied at side- dress (urea) that was cultivated in. Results indicated that total nitrogen rates of 65 total lb. or greater yielded significantly more than treatments of 20 lb. or less. As nitrogen rates increased canopy closure in the 20-inch rows became denser (Figure 1). An important observation to make is the increase in foliar disease as biomass also increased limiting airflow in the canopy. Diseases present in low levels of severity included white mold, anthracnose and common bacterial blight (CBB). Fungicides were not applied for management of these diseases and could be used to help mitigate the effects of a dense plant canopy.

Figure 1. Etna Cranberry bean biomass and plant disease response from increased rates of nitrogen: (A) 20 lb./A, (B) 65 lb./A, (C) 105 lb./A

Cranberry Bean Response to Micronutrients and Application Method

Scott Bales, MSU Dry Bean Specialist
(989)- 262-8550; balessco@msu.edu

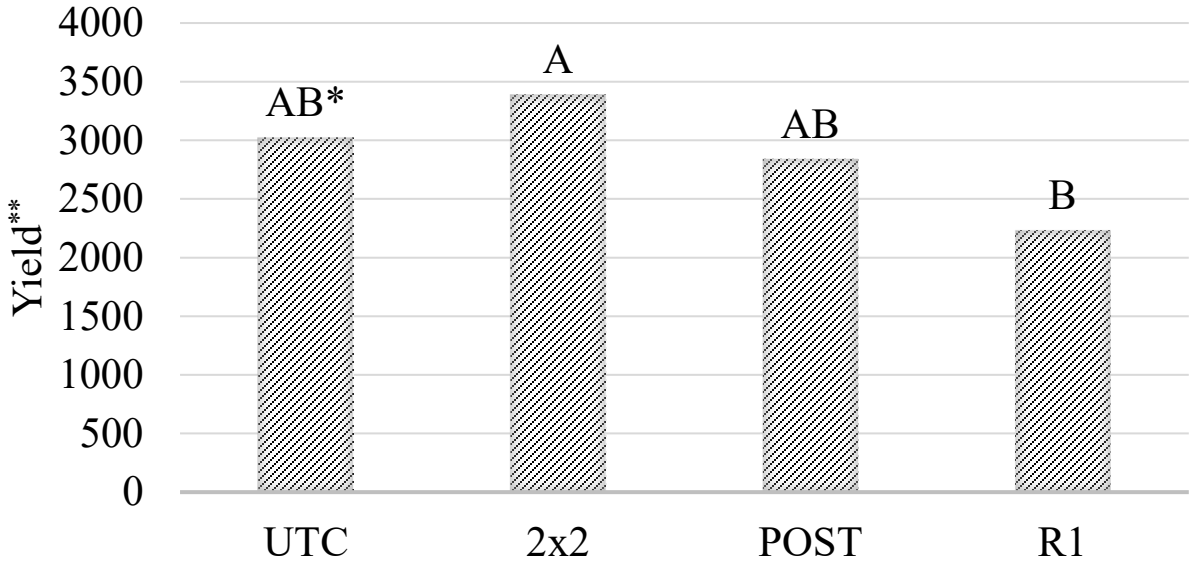
Location: Montcalm Co.	**Treated Plot Size:** 6.6' x 20'
Planting Date: June 15	**Replicated:** 4 times
Variety: Etna Cranberry Bean	**Row width:** 20-inch
	Population: 100,000 seeds/A
Application A: 2x2 (Yield 360 'band-it'): 12 PSI; 15 GPA	
Application B: Spray (TP8002VS): 60 PSI; 22 GPA	
Application C: Spray (TP8002VS): 60 PSI; 22 GPA	

Table 1. Treatments, growth stage at application, equipment, and fertilizer rate.

Treatment:	Application:	Fertilizer Rate[a]:
1	Untreated	-
2	'A' (At Planting)	32 oz. Zn (6%) + 32 oz. Mn (5%)
3	'B' (V2)	32 oz. Zn (6%) + 32 oz. Mn (5%)
4	'C' (R1)	32 oz. Zn (6%) + 32 oz. Mn (5%)

[a] Sources: MAX-IN ® ZINC, MAX-IN ® MANGANESE

Figure 1. Dry bean yield by fertilizer treatment in Montcalm County.



*Columns with different letters are significantly different from each other ($\alpha \leq 0.05$).
**Yield is in pounds per acre obtained by pull and harvest adjusted to 18% moisture.

Summary: A micronutrient application method trial was established in Montcalm County under irrigation in 2020. As dry bean is classified as highly responsive to zinc and manganese, and often displays deficiencies, these two micronutrients were targeted. Utilizing 32 fl. oz. rates of both Zn and Mn products yields numerically declined from foliar applications. These application timings in 2020 were characterized by high heat and humidity. In future years lower rates will be tested on determinate bush type beans.

2020 MSU DRY BEAN YIELD TRIALS

F. E. Gomez and E. M. Wright

Plant, Soil and Microbial Sciences

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. 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.

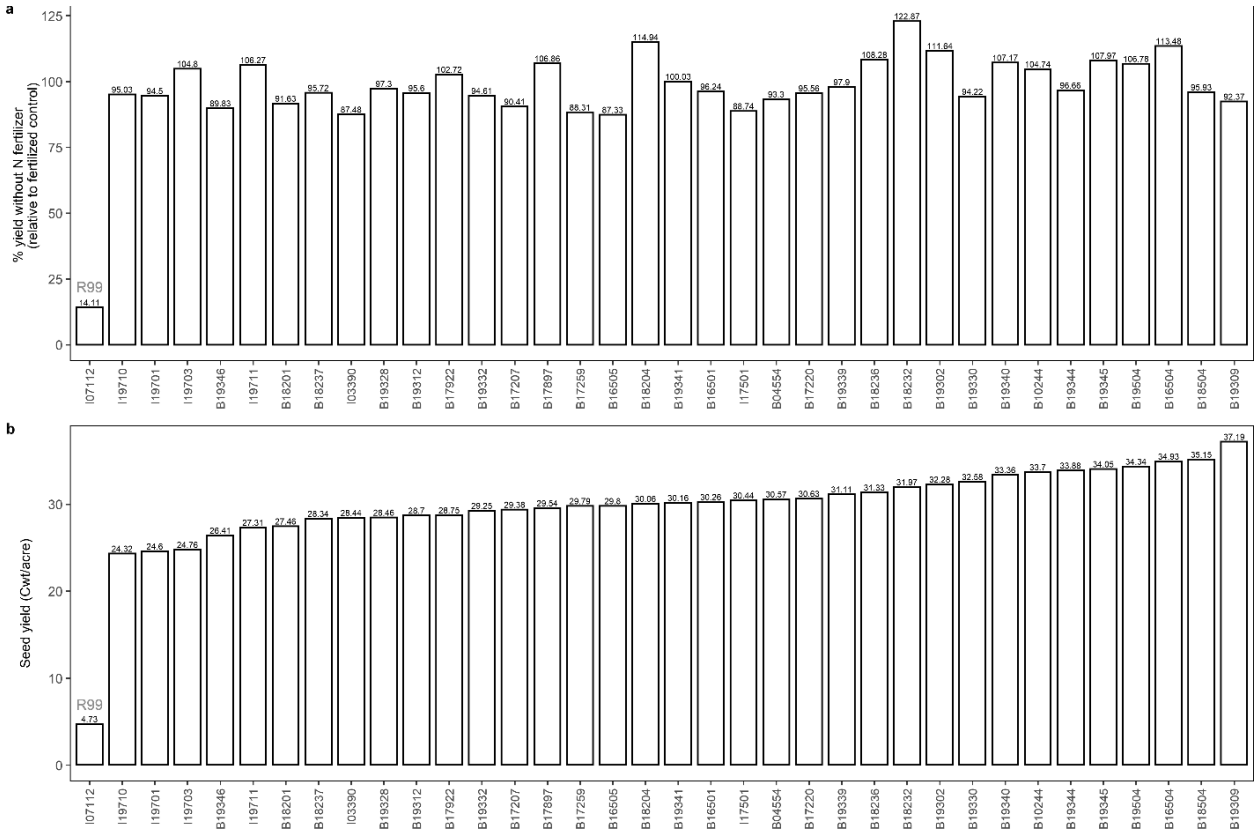


Figure 1. Comparison of % yield relative to fertilized control of 36 black bean lines tested at the Saginaw Valley Research and Extension Center, near Frankenmuth, MI in 2020. R99 designates the non-nodulating bean line that does not fix N.

Expt. 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.

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 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 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

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

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.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

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.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

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.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

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.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Crop safety of Outlook postemergence in dry edible beans

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

Location:	East Lansing	**Tillage:**	Conventional
Planting Date:	August 31, 2020	**Row width:**	30-inch
Replicated:	4 times	**Population:**	120,000 seeds/A
Variety:	'Zorro' black beans	**Application date:**	Oct. 10, 2020

Table 1. Injury from POST herbicide treatments of Outlook tank-mixtures to V2 dry beans 3 days after treatment (DAT).

	Injury (%)
Treatments	*(3 DAT)*
Varisto (21 fl oz) + COC (1% v/v) + AMS (2.5 lb)	13 d[a]
Outlook (10 fl oz) + Varisto (21 fl oz) + COC (1% v/v) + AMS (2.5 lb)	13 d
Outlook (20 fl oz) + Varisto (42 fl oz) + COC (1% v/v) + AMS (2.5 lb) – 2X rate	38 a
Reflex (1 pt) + Varisto (21 fl oz) + COC (1% v/v) + AMS (2.5 lb)	13 d
Outlook (10 fl oz) + Reflex (1 pt) + Varisto (21 fl oz) + COC (1% v/v) + AMS (2.5 lb)	28 b
Outlook (10 fl oz) + Reflex (1 pt) + Varisto (21 fl oz) + COC (0.5% v/v) + AMS (2.5 lb)	19 c
Untreated	0 a

[a] Means within a column with different letters are significantly different from each other.

Summary: Outlook is currently labeled for early-postemergence applications in dry edible beans. POST Outlook applications could provide residual control of late-emerging grasses, waterhemp and other pigweed species. The objective of this research was to examine dry bean injury from postemergence tank-mixtures of Outlook with Varisto and Reflex. This trial was established in late summer, so the magnitude of the results may not be directly related to what may be observed during normal planting time. However, increases in injury from various tank-mixtures would likely be similar. Due to an early frost dry bean injury could only be evaluated 3 DAT. The addition of 10 fl oz/A of Outlook to the full rate of Varisto did not increase dry bean injury compared with Varisto alone. However, if this mixture was applied at 2-times the rate, dry bean injury was doubled. Adding Outlook to the Reflex + Varisto tank-mixture also increased injury. By reducing the crop oil concentrate (COC) rate from 1% v/v to 0.5% v/v dry bean injury was reduced. However, it was still greater that the Reflex + Varisto tank-mixture alone. While this trial provides some insights on potential injury from Outlook POST tank-mixtures, we will need to follow-up with additional studies. From this research it will be important to keep in mind that Outlook tank-mixtures with Reflex resulted in increased injury and currently should be avoided unless the adjuvant rate is reduced.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Carryover potential from fall applications of tiafenacil to dry beans

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

Location: East Lansing (2 locations)	**Tillage:** Conventional
Planting Dates: June 17, 2020	**Row width:** 30-inch
Replicated: 4 times	**Dates treated:** Oct. 15, 2019 (LOC 1)
Varieties: 'Zorro' black beans	Dec. 17, 2019 (LOC 2)

Table 1. Effect of fall applications of tiafenacil and Sharpen on dry beans planted the following spring.

	Location 1			Location 2		
	Injury (%)	**Stand**	**Yield**	**Injury (%)**	**Stand**	**Yield**
Treatments	*(30 DAP)*	*#/100' row*	*cwt/A*	*(30 DAP)*	*#/100' row*	*cwt/A*
Tiafenacil (0.5 fl oz) + MSO	0	256	23.0 ab[a]	0 b	250 ab	23.4
Tiafenacil (1 fl oz) + MSO	0	253	21.3 b	0 b	228 b	24.8
Tiafenacil (2 fl oz) + MSO	0	242	26.4 a	0 b	246 ab	26.3
Tiafenacil (3 fl oz) + MSO	0	244	20.5 b	7 a	246 ab	23.9
Tiafenacil (4 fl oz) + MSO	0	245	26.9 a	1 b	243 ab	23.8
Sharpen (2 fl oz) + MSO	0	244	24.1 ab	0 b	255 a	26.5
Sharpen (4 fl oz) + MSO	0	239	25.2 a	0 b	252 ab	26.1
Untreated	0	240	21.4 b	0 b	251 ab	23.0

[a] Means within a column with different letters are significantly different from each other.

Summary: Tiafenacil is a new herbicide being evaluated for burndown weed control in various crops. Tiafenacil has similar characteristics to the herbicide saflufenacil (Sharpen). The objective of this research was to determine if there were any issues with carryover from tiafenacil to dry beans if it was applied in the fall. Since Sharpen (saflufenacil), can lead to carryover to dry beans planted in the spring if it is applied in the fall, tiafenacil was compared to saflufenacil at various application rates. This year at two locations that were conducted in East Lansing, there was very little effect from tiafenacil from rates ranging from 0.5 to 4 fl oz/A. Additionally, there was very little effect from fall applications of Sharpen which under dry cold winters can result in substantial stand loss to dry beans if applied the previous fall. Weather conditions between fall herbicide applications and dry bean planting must have been conducive for herbicide breakdown.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Dry bean safety from early preplant applications of tiafenacil

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

Location: East Lansing	**Tillage:** Conventional
Planting Date: June 17, 2020	**Row width:** 30-inch
Replicated: 4 times	**Population:** 109,000 seeds/A
Variety: 'Zorro' black beans	**Application date:** June 4, 2020 (EPP)

Table 1. Effect of early preplant (14 d) applications of tiafenacil and Sharpen on dry beans.

	Injury (%)	Stand	Injury (%)	Injury (%)	Yield
Treatments	*(14 DAP)*	*#/100' row*	*(21 DAP)*	*(35 DAP)*	*cwt/A*
Tiafenacil (1 fl oz) + MSO	0 e[a]	232 a	0 d	0 d	26.7 a
Tiafenacil (2 fl oz) + MSO	5 d	234 a	2 d	0 d	25.9 a
Tiafenacil (3 fl oz) + MSO	14 c	184 b	6 cd	1 d	25.0 a
Tiafenacil (4 fl oz) + MSO	19 c	169 b	13 c	13 c	29.4 a
Sharpen (2 fl oz) + MSO	74 b	43 c	75 b	78 b	10.4 b
Sharpen (4 fl oz) + MSO	98 a	3 d	98 a	96 a	0.5 c
Untreated	0	239 a	0 d	0 d	30.1 a

[a] Means within a column with different letters are significantly different from each other.

Summary: Tiafenacil is a new herbicide being evaluated for burndown weed control in various crops. Tiafenacil has similar characteristics to the herbicide saflufenacil (Sharpen). The objective of this research was to determine the crop safety of tiafenacil if applied as a burndown treatment prior to planting dry beans, 14 days early preplant. Tiafenacil was compared to saflufenacil at various application rates, knowing that saflufenacil applications prior to planting dry beans would cause substantial stand loss and injury. Dry bean injury from tiafenacil ranged from 0 to 19% and was dependent on application rate. A slight dry bean stand loss occurred when tiafenacil was applied 3 of 4 fl oz/A. However, this reduction did not affect dry bean yield compared with the untreated control. As expected, Sharpen (saflufenacil) applied at 2 or 4 fl oz/A lead to 80 to 99% reduction in dry bean stand and 65 to 98% reduction in yield. This research shows that tiafenacil may have some utility as a preplant herbicide in dry bean and also shows the importance of not applying Sharpen prior to dry bean planting.

PRAB Production Practices Survey

1. **Open the camera on your smartphone**
2. **Hold it over the QR code below**
3. **Click on the link that appears at the top of the screen**
4. **Complete the survey on dry bean production practices and help direct future research!**

Thank you!

Michigan Dry Edible Bean Production Research Advisory Board

2020