MICHIGAN DRY BEAN RESEARCH REPORT

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Optimization of Fertilizer Rate Recommendations for Michigan Dry Bean Growers: Strengthening Economic and Environmental Sustainability

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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: ***'Optimization of Fertilizer Rate Recommendations for Michigan Dry Bean Growers: Strengthening Economic and Environmental Sustainability.*** This work was the continuation and expansion of trials performed in 2020 under a previous Specialty Crop Block Program Grant. Objectives of this project were to: **(**1) Validate and optimize nutrient requirements of the major market classes grown in Michigan; **(**2) Provide substantiated grower guidelines for application of macro (N, P, K) and micro nutrients (Zn and Mn) based on the physiological needs of the plant with particular emphases for Phosphorous containment, carry over management, application method, and end use nutrient content; (3) Establish cover crop recommendations for use in dry bean systems based on nitrogen retention/fixation, weed control, disease management, and dry bean yield**; (**4) Provide optimum nitrogen requirements important to minimize plant canopy growth to assist with white mold proliferation, particularly in narrow row systems; **(**5) Establish continued grower education of fertilizer application rates that include knowledge of soil fertility and crop rotations and carry over management; **(**6) Publish fertility requirements and management strategies for distribution to bean growers in Michigan.

Season Summary: Planting conditions for the 2021 dry bean crop were very good. The state of Michigan received below average rainfall in the months leading up to dry bean planting in June, this resulted in low levels of soil moisture at planting compared to a 5-year average. However, moisture was sufficient for planting and germination of the 2021 dry bean crop. Into late June and July isolated heavy rainfall events caused crop injury in central and western Michigan, however the eastern production region of Michigan was largely spared from these damaging weather events.

As the dry bean crop progressed into July and August timely rainfall was conducive for pod set and seed fill. A limiting factor through midseason was periodic stretches of very hot weather that caused blossom abortion on the very uppermost branches of some dry bean plants. However, this hot weather limited yield reductions from white mold infection that could have increased in severity under cool-wet conditions. The hot weather facilitated an early harvest starting in late August and nearly complete by October 1. In general dry bean yields were average to above average with excellent quality.

We would like to thank all cooperators that hosted trials in 2021. Without their assistance this research would not be possible.

Thank you,

Scott Bales & *Joe Cramer*

2021 Michigan Dry Bean Performance Trials Canning Report

Introduction: One hundred fifty (150) lines from 12 market classes were tested across six locations (Table 1) in 2021. In each table documenting the results, you will find agronomic information such as plant maturity and disease tolerance. Plant maturity is rated visually in days after planting (DAP) across all locations. Lodging is evaluated on a scale of 1 to 5, with a 1 indicating that the entry was completely erect in the field at harvest and a 5 indicating that the entry was flat on the ground with stems and pods touching the soil surface. White mold infection was recorded in Huron County by calculating the percent of infection on each replication (number infected/total stand)*100). In 2021, white mold incidence was evaluated at the Huron County location due to adequate disease pressure. White mold was not present in either location where kidney bean testing was conducted (Montcalm or SVREC), and was not, therefore, evaluated in 2021.

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 counties. Large seeded beans were tested in Montcalm and Tuscola counties (SVREC). Yield is presented combined across all locations in 2021 unless production systems differ (irrigated vs. dry land); representing a one-year average across all locations. When possible, this combining is also done for two- and three-year averages across locations and years. For example, a three-year average of navy bean yields includes data from 2019, 2020, and 2021 at four locations per year (12 site years).

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 asterisks (**). 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 either one or two asterisks, there is **no** evidence that the entries differed for that given trait.

Field Trial 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. All trials were designed as a randomized complete block (RCB). Trials received industry standard seed treatments, fertilization, and weed control applications at labeled rates. White mold fungicides were 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 is present. Yield data is obtained by direct harvest for small- and medium-seeded beans. Large seeded beans are pulled by a two row Pickett bean puller and then mechanically thrashed to prevent harvest loss. Following harvest, samples are cleaned, weighed, and moisture tested. Questions regarding the 2021 performance trials or suggestions for 2022 should be directed to Scott Bales at 989-262-8550, ext. 2 or balessco@msu.edu.

Table 1. Trial location, grower co-operator, planting date, nitrogen application rate, nitrogen application method, total accumulated growing degree days (GDD), and total precipitation

County	Co-operator	Planting Date	Nitrogen Rate (lb/A)	Nitrogen Application	Total GDD*	Total Precipitation (inches)
Bay	Weiss Farms	31-May	53	Broadcast	2229	13.3"
Huron	Gentner-Bischer Farms	11-June	42	2x2	1967	14.2"
Sanilac	Keinath Farms	5-June	53	2x2	2243	15.9"
Tuscola (Kidney beans)	SVREC	6-June	42	Broadcast	2308	15.9"
Tuscola (Small and medium seed)	Zimmer Farms	4-June	42	2x2	2347	17.1"
Montcalm	Waldron Farms	3-June	42	2x2	2274	17.6" + Irrigation

*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

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

Location	OM (%)	Soil Type	pH	CEC
Bay	2.6	Sandy Clay Loam	6.8	10.9
Huron	2.8	Loam	7.6	12.1
Sanilac	3.3	Clay Loam	7.6	11.5
Tuscola (Kidney beans)	2.5	Clay Loam	7.7	16.8
Tuscola (Small and medium seed)	3.6	Clay Loam	7.6	16.6
Montcalm	2.3	Sandy Loam	6.3	7.6

Canning Quality: All 150 lines tested were sampled from both the Huron and Bay county locations and processed utilizing the following methods: Prior to processing dry beans were moisture tested and subsampled to create discrete samples for individual cans. Each can was filled with 115 grams of dry matter for all small and medium seeded market classes. Kidney

and Cranberry beans were filled to 100 grams of dry matter per can. Moisture levels prior to soaking ranged from 11.7-17.5% averaging at **13.8%** across all cultivars tested. Following subsampling dry beans were transferred to the Food Processing and Innovation Center (FPIC) an MSU facility in Okemos, MI. At FPIC two days of sample processing took place in 2021. Dry beans were soaked and blanched by market class according to the protocol in Table 3. All soaks also include 100ppm of calcium chloride ($CaCl_2$). Immediately following blanching, samples are transferred to individually identifiable cans (size 307x407) and filled with brine at 200ºF. Brine is a mixture of tap water, 1.5% sucrose (sugar), 1.2% sodium chloride (NaCl) (salt), and 0.005% $CaCl_2$. Cans are then seamed and individually inspected to ensure seam quality prior to thermal processing. Cans are loaded in approximately 400 can batches and transferred to an 'Allpax' retort. Thermal processing parameters are set for a 19 minute cook cycle at 250ºF with one rotation during cool down. Following cool down samples are returned to storage for approximately 4 weeks prior to opening and evaluations to allow for equilibration.

Table 3. Dry bean soaking and blanching protocol by market class.

Class	Overnight	Soak 125ºF	Blanch 200ºF
Navy	-	30 min	5 min
Black	-	-	90 sec
Great northern	-	30 min	15 min
Pinto	Yes	-	5 min
Small red	-	30 min	15 min
Pink	-	30 min	15 min
Dark red kidney	Yes	-	5 min
Light red kidney	Yes	-	5 min
White kidney	-	30 min	15 min
Cranberry	Yes	-	5 min
Yellow	-	30 min	15 min

Evaluations: In early 2022 a public meeting was held for the evaluation of all lines tested. Cans were opened and scored by a 15 member panel of trained evaluators. Trained evaluators scored all market classes visually on a scale from 1-5. This scoring system has been created and validated by USDA researchers located at MSU who are also involved in the training of evaluators, and the in-person evaluations that were done in 2022. It is also important to note that these evaluations were performed using a blind evaluation in 2022 to eliminate the possibility of any inherent bias. Table 4 documents this established scoring system based on physical characteristics of the processed sample for all market classes besides black beans. Black beans are scored using a very similar system except color is rated independently from general appearance on a 1-5 scale as this is a key trait in black beans.

Table 4. General appearance scale used for scoring all market classes except for black beans.

Category	Score	Bean Splitting	Brine Clarity	Free Starch/Clumps	Color
Excellent Appearance	**5**	None (90% intact)	Very Clear	Very Little Starch/Clumps	Excellent color (exceeds industry standard)
Very Good Appearance	**4**	Moderately Intact (70-89% intact)	Moderately Clear	Moderately little starch/clumps	Very good color (meets industry standard)
Average Appearance	**3**	Average (60-69% intact)	Neither Clear nor Cloudy	Neither Little nor Much	Average Color
Poor Appearance	**2**	Moderately Broken (badly split but holding together)	Moderately Cloudy	Moderately Many/Big Starch/clumps	Poor color (a little darker or lighter than industry standard)
Unacceptable Appearance	**1**	Severe (Seeds blown apart)	Very Cloudy	Very Big Starch/Clumps	Unacceptable color (a lot darker or lighter than industry standard)

Table 5. Navy bean agronomic, yield results, and canning results.

VARIETY	Maturity (DAP)	Lodging (1-5)	White Mold Infection (%)	1-year avg. Lb. $^{-1}$ Acre	2-year avg. Lb. $^{-1}$ Acre	3-year avg. Lb. $^{-1}$ Acre	Canning Score (1-5)		Seed Size Seeds $^{-1}$ Lb.
							Bay	Huron	
Apex	92	2.5	36*	2928	2827	2632	4.2	4.0	2111.2
Argosy	92	2.0	33*	3028*	2734	2671	3.6	4.0	1982.8
Armada	90	2.0	48	3108*	2883*	2686	3.9	3.9	2214.0
Blizzard	90	1.6	61	3120*	2936*	2742	4.0	4.1	2240.6
HMS Bounty	91	1.3	21**	3130*	3041*	2728	3.8	4.2	2471.7
HMS Medalist	92	2.0	51	3011*	2985*	2785	3.8	4.7	2416.5
Liberty	91	1.9	49	3233**	3094**	2988**	3.6	4.4	2560.7
Merlin	92	1.8	43	2560	2579	2413	3.1	3.8	2632.6
Nautica	89	2.1	39*	3052*	-	2575	4.3	4.4	2544.3
Rogue	90	3.1	60	3149*	2842	-	4.6	4.6	2400.6
Shock	90	2.4	61	2967	2705	-	3.7	2.9	2007.9
Valiant	90	1.7	55	2821	2793	2569	4.3	4.3	2575.4
Victory	89	2.0	49	3158*	3071*	2874*	3.9	4.0	2176.5
Vigilant	88	1.4	41	2804	2678	-	4.0	4.0	2064.1
12039	92	2.2	57	2943	2852	2761	3.3	3.9	2235.2
14068	91	1.8	67	2768	2837	2639	4.6	3.8	2126.3
14078	91	1.7	56	2840	-	-	3.3	3.3	2083.8
14084	90	1.8	48	2838	2838	2524	3.6	4.2	2338.6
EX1802-N	86	1.0	36*	2270	2357	-	4.6	4.1	2305.2
EX1803-N	87	1.3	41*	2298	2414	-	4.1	3.8	2118.9
EX1804-N	88	1.3	29*	2868	2555	-	3.3	3.8	2200.9
N18103	88	1.7	27*	3038*	2852	-	3.4	3.8	2369.3
N19226	89	1.9	39*	2794	-	-	2.8	3.2	2834.8
N19246	90	1.9	42	3224*	-	-	3.3	3.8	2373.7
N19253	90	1.6	44	2825	2864	-	3.9	4.2	2473.7
N19285	90	2.7	66	2685	2555	-	4.4	4.1	1911.5
N20388	90	1.3	53	2901	-	-	4.1	4.0	2059.2
N20404	88	1.1	30*	3191*	-	-	3.4	4.1	2276.4
SV1893GH	90	2.0	66	3135*	2903*	2462	3.9	4.2	2347.3
MEAN:	90	1.8	45.9	2916	2791	2671	3.8	4.0	2291.5
LSD $_{(0.05)}$:	-	-	19.2	289	221	122	-	-	-
CV:	-	-	0.4	16.5%	18.7%	13.7%	-	-	-

***Highest yielding variety within column*

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

Table 6. Black bean agronomic, yield and canning results.

VARIETY	*Maturity (DAP)*	*Lodging (1-5)*	*White Mold Infection (%)*	*1-year avg. Lb.$^{-1}$ Acre*	*2-year avg. Lb.$^{-1}$ Acre*	*3-year avg. Lb.$^{-1}$ Acre*	*Canning Score (1-5)*		*Seed Size Seeds^{-1} Lb*
							Bay	*Huron*	
Ace	88	1.4	56	2954	-	-	3.3 (2.6)[a]	2.7 (2.5)	2179.1
Adams	91	1.9	41	3256*	3318**	-	3.1 (3.0)	3.5 (2.8)	2013.7
Black Bear	93	1.9	53	2881	2837	2661	2.3 (1.8)	2.6 (2.0)	2164.9
Black Tails	91	1.8	52	2800	2846	2631	3.5 (3.3)	3.4 (2.7)	2057.0
Black Beard	91	1.7	54	3065	3025	2836*	3.7 (4.3)	3.6 (4.5)	1917.7
Eclipse	87	1.3	55	2642	2632	-	3.1 (2.7)	3.7 (3.1)	2054.6
ND Twilight	86	2.5	76	2717	2486	-	2.6 (3.1)	3.4 (2.7)	1822.2
Nimbus	91	1.8	41	3006	3294*	3091**	2.3 (2.4)	3.0 (2.5)	1967.0
Spectre	93	1.9	28*	3009	3152*	2872*	1.7 (2.7)	2.6 (2.8)	2118.6
Zenith	91	1.5	35*	3186*	3011	2736	3.3 (4.6)	3.6 (4.8)	1900.1
Zorro	91	1.4	34*	3069	2938	2705	4.1 (3.4)	3.8 (3.5)	1933.6
14531	91	1.8	47	2873	-	-	3.6 (3.3)	3.0 (3.1)	2312.8
15610	92	1.5	53	2943	2913	2774	4.4 (3.7)	3.4 (3.3)	2241.7
15619	92	1.9	67	2705	3001	2727	4.2 (4.5)	3.5 (4.0)	2329.4
16590	93	1.7	52	3175*	3092*	-	3.0 (3.2)	2.8 (3.4)	2208.2
16648	91	2.0	54	3077	2953	-	3.5 (2.7)	2.8 (2.7)	2036.4
17715	90	1.9	55	3187*	2954	-	3.8 (3.7)	3.7 (4.0)	2041.3
17751	90	1.3	40	3291*	3248*	-	3.1 (2.6)	3.3 (2.0)	1904.9
B19309	90	1.6	37*	3218*	-	-	3.5 (3.7)	3.6 (3.3)	2078.8
B19330	89	1.7	58	3085	2997	-	3.8 (4.4)	3.6 (3.6)	1949.8
B19344	90	1.5	38*	3303*	3217*	-	3.3 (5)	3.6 (4.7)	2034.0
B20547	90	1.6	19**	3375*	-	-	4.1 (4.1)	3.2 (4.7)	1878.5
B20591	89	1.7	30*	3466**	-	-	3.7 (3.6)	3.5 (3.4)	1994.1
B20597	89	1.2	26*	3090	-	-	3.2 (3.5)	2.5 (3.4)	1852.7
B3036381	91	2.2	50	2918	2894	-	3.7 (4.4)	3.6 (4.2)	2086.3
BL1726-2	88	1.2	33*	3153	-	-	4.0 (4.3)	4.0 (4.4)	1905.9
MEAN:	90	1.7	45.6	3047	2973	2782	3.4 (3.5)	3.4 (3.4)	2037.8
LSD $_{(0.05)}$:	-	-	19.5	305	267	250	-	-	-
CV:	-	-	36.0%	16.5%	21.0%	26.7%	-	-	-

***Highest yielding variety within column*

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

[a] Canning scores for black beans are notated as general appearance followed by color. Example: appearance (color)

Table 7. Small Red and Pink bean agronomic, yield, and canning results.

VARIETY	*Maturity (DAP)*	*Lodging (1-5)*	*White Mold Infection (%)*	*1-year avg. Lb.$^{-1}$ Acre*	*2-year avg. Lb.$^{-1}$ Acre*	*3-year avg. Lb.$^{-1}$ Acre*	*Canning Score (1-5)*		*Seed Size Seeds^{-1} Lb.*
							Bay	*Huron*	
Cayenne	89	2.0	50	2954	2727	2583	3.7	3.9	1294.6
Rosetta	90	1.6	40	2891	-	-	2.4	2.9	1238.5
Ruby	89	2.8	77	2495	2590	2363	2.8	3.6	1644.0
Viper	85	1.6	53	2917	2963**	2830**	2.3	3.2	1639.3
16686	89	2.3	66	3130**	2894*	2557	3.2	3.7	1272.8
17837	90	1.6	65	2922	2794	2506	2.2	2.9	1325.4
17839	91	2.0	44	2745	2764	2419	3.3	3.7	1488.6
17875	88	2.3	44	3035*	-	-	2.9	3.6	1242.5
R17604	89	1.7	30*	3037*	2765	2598	4.2	4.4	1435.0
R20627	89	1.3	22**	3075*	-	-	3.4	3.8	1353.6
R20667	87	1.3	27*	3076*	-	-	3.8	4.1	1369.1
S18904	88	1.4	42	2700	2584	-	2.1	2.4	1145.2
MEAN:	89	1.8	46.9	2915	2760	2551	3.0	3.5	-
LSD (0.05) :	-	-	13.0	172	147	169	-	-	-
CV:	-	-	23.7	17.5%	17.6%	19.7%	-	-	-

***Highest yielding variety within column*

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

Table 8. Pinto bean agronomic, yield, and canning results.

VARIETY	*Maturity (DAP)*	*Lodging (1-5)*	*White Mold Infection*	*1-year avg. Lb. -1 Acre*	*2-year avg. Lb. -1 Acre*	*3-year avg. Lb. -1 Acre*	*Canning Score (1-5)*		*Seed Size Seeds -1 Lb.*
							Bay	*Huron*	
Charro	88	2.0	57*	2910	3069*	2716**	3.0	2.9	1133.5
LaPaz	85	2.0	53*	2899	2908	2562*	2.6	3.8	1260.9
ND Falcon	90	2.0	57*	2391	2453	-	2.7	3.4	1246.4
ND Palomino	91	3.2	72*	2920	2759	-	3.7	4.0	1225.2
Windbreaker	84	3.3	79.0	2561	2430	-	2.6	2.7	1113.0
P19103	92	3.2	52**	3335**	3171**	-	3.9	3.3	1354.7
P19713	87	1.6	58*	3072*	-	-	3.3	3.0	1257.6
SV6139GR	85	1.7	67*	3177*	3000*	-	2.1	2.7	1161.1
MEAN:	88	2.4	13.9	2908	2827	2639	2.8	3.1	1219.0
LSD (0.05) :	-	-	5.0	316	202	256	-	-	-
CV:	-	-	18.8%	17.5%	16.7	28.3%	-	-	-

***Highest yielding variety within column*

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

Table 9. Great Northern bean agronomic, yield, and canning results.

VARIETY	Maturity (DAP)	Lodging (1-5)	White Mold Infection (%)	1-year avg. Lb. $^{-1}$ Acre	2-year avg. Lb. $^{-1}$ Acre	3-year avg. Lb. $^{-1}$ Acre	Canning Score (1-5)		Seed Size Seeds $^{-1}$ Lb.
							Bay	Huron	
Aries	85	2.5	69	2286	2302	2153	2.6	3.0	1371.3
Draco	85	2.2	51*	2483	-	-	2.4	3.3	1364.2
Eiger	88	2.3	44*	2953	3149*	2919**	3.2	3.6	1429.3
ND Pegasus	87	1.8	37**	3373**	3223**	-	2.8	3.4	1335.0
Powderhorn	84	1.8	48*	2659	2554	2300	3.7	4.0	1327.1
Virgo	89	2.3	49*	2945	2764	-	3.2	3.3	1309.3
14164	86	1.6	51*	2294	-	-	4.1	4.2	1133.1
G19611	90	2.3	39*	3194*	-	-	2.3	2.4	1248.6
G19613	86	1.8	44*	3180*	-	-	2.6	3.0	1211.2
MEAN:	87	2.0	47.9	2819	2798	2457	3.0	3.4	1303.2
LSD $_{(0.05)}$:	-	-	16.2	231	247	206	-	-	-
CV:	-	-	28.0%	13.9%	21.3%	24.7%	-	-	-

***Highest yielding variety within column*

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

Table 10. Cranberry bean agronomic, yield, and canning results.

VARIETY	Maturity (DAP)	Lodging (1-5)	Irrigated 2-year avg. Lb. $^{-1}$ Acre	Irrigated 3-year avg. Lb. $^{-1}$ Acre	Dry Land 2-year avg. Lb. $^{-1}$ Acre	Dry Land 3-year avg. Lb. $^{-1}$ Acre	Canning Score (1-5)		Seed Size Seeds $^{-1}$ Lb.
							Bay	Huron	
AAC Scotty	*97*	3.0	-	-	-	-	2.1	2.3	716.1
Amaranto	83	2.7	2765	3011*	1961	1664	2.1	1.1	692.7
Bellagio	83	3.0	2323	2550	2296	1918	3.6	3.2	752.2
Chianti	84	2.0	2709	2942	-	-	2.9	2.4	773.7
Etna	81	2.2	3141*	3267**	2197*	1721	1.4	1.9	734.8
Jester	85	2.2	2820	2867	2507*	2130*	1.3	1.3	724.2
Vero	85	2.7	2934*	2975	1947	-	1.8	1.6	757.4
16756	89	2.2	2768	-	1911	-	3.8	4.1	894.1
16758	83	2.2	2900	-	1948	-	3.1	2.9	894.4
16760	82	2.7	3168*	3152*	2138	1855	1.8	1.9	744.0
16764	81	4.0	2875	2842	2235*	1964*	1.4	2.1	770.4
16775	84	1.5	2520	2704	1994	1663	3.3	3.6	896.7
16776	84	1.5	-	-	-	-	4.1	3.7	843.4
16816	83	2.5	2848	-	2003	-	2.0	1.3	835.1
151093	83	2.5	3177**	2947	2519**	2166**	1.8	1.7	758.3
MEAN:	84	2.4	2842	2926	2138	1890	2.4	2.3	785.8
LSD $_{(0.05)}$:	-	-	265	260	202	237	-	-	-
CV:	-	-	11.2%	13.1%	16.3%	16.8%	-	-	-

***Highest yielding variety within column*

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

Table 11. Light Red Kidney bean agronomic, yield and canning results.

VARIETY	*Maturity (DAP)*	*Lodging (1-5)*	*Irrigated 2-year avg. Lb.$^{-1}$ Acre*	*Irrigated 3-year avg. Lb.$^{-1}$ Acre*	*Dry Land 2-year avg. Lb.$^{-1}$ Acre*	*Dry Land 3-year avg. Lb.$^{-1}$ Acre*	*Canning Score (1-5)*		*Seed Size Seeds^{-1} Lb.*
							Irrigated	*Dry Land*	
Big Red	81	2.5	2888*	2701*	2247*	1938	2.0	1.3	722.4
California Early	80	2.7	2858*	2691*	1949	1462	1.6	1.4	709.0
Clouseau	85	3.2	2848*	2687*	2381*	1713	2.4	1.3	709.1
Coho	84	2.2	2522	2525*	2512**	2203	2.4	3.2	930.6
Pink Panther	83	2.5	2981*	-	2106	-	1.6	1.6	682.9
Red Dawn	79	2.7	3030**	2781**	2295*	1985	2.2	1.3	753.0
Ronnie's Red	85	1.7	2131	2395	2498*	2188	2.2	2.6	678.4
Rosie	86	2.2	1845	-	2252*	-	2.3	2.2	789.8
11413	86	3.2	-	-	-	-	1.7	1.3	724.0
15916	84	3.5	-	-	-	-	1.8	1.1	755.0
15923	84	2.2	-	-	-	-	2.4	1.3	686.7
16998	84	2.0	-	-	-	-	1.9	1.7	666.1
161082	84	2.0	-	-	-	-	1.7	1.9	678.7
K17703	85	2.0	2568	2443	2512*	2812**	2.4	2.1	816.5
K19610	83	2.2	-	-	-	-	3.6	3.4	881.0
K20734	85	1.7	-	-	-	-	2.3	2.7	737.8
K20743	86	1.7	-	-	-	-	2.6	3.2	788.0
MEAN:	84	2.4	2629	2603	2306	2043	2.2	2.0	751.6
LSD $_{(0.05)}$:	-	-	368	322	345	342	-	-	-
CV:	-	-	16.7%	23.5%	15.4%	22.0%	-	-	-

***Highest yielding variety within column*

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

Table 12. Dark Red Kidney bean agronomic, yield and canning results.

VARIETY	*Maturity (DAP)*	*Lodging (1-5)*	*Irrigated 2-year avg. Lb.$^{-1}$ Acre*	*Irrigated 3-year avg. Lb.$^{-1}$ Acre*	*Dry Land 2-year avg. Lb.$^{-1}$ Acre*	*Dry Land 3-year avg. Lb.$^{-1}$ Acre*	*Canning Score (1-5)*		*Seed Size Seeds^{-1} Lb.*
							Irrigated	*Dry Land*	
Dynasty	85	2.2	2955*	3008**	2519**	2223*	2.4	3.0	725.3
Epic	81	2.2	2713*	2750*	2162	2019	2.4	2.8	735.7
Gallantry	84	2.5	-	-	-	-	2.6	2.7	763.7
Montcalm	86	2.5	2675*	2793*	2406*	2064	3.1	2.6	791.5
Rampart	83	2.2	2755*	2688	2361*	2070	2.8	2.3	839.5
Red Cedar	85	2.7	2721*	2592	2195	2066	2.3	2.4	853.6
Red Hawk	85	3.0	2738*	2916*	1771	1754	2.9	2.2	816.0
Red Rover	85	2.7	2565	2759*	2173	1926	3.6	3.1	736.2
15977	85	2.7	2731*	-	2359*	-	2.9	2.6	707.7
15978	86	2.0	1896	1906	2169	2278**	3.9	2.9	878.7
151011	81	3.8	3045**	2967*	2152	2008	2.8	2.2	910.8
161156	84	2.2	3006*	-	2360*	-	3.1	2.9	889.4
161164	84	2.5	2774*	-	2221	-	3.1	2.9	848.7
181017	85	2.2	2850*	-	2259*	-	4.1	3.6	779.1
181020	84	3.0	-	-	-	-	2.4	2.6	733.0
181021	84	2.5	-	-	-	-	2.1	2.1	728.4
K16136	84	2.2	2674*	2746*	2312*	2075	3.3	3.3	801.8
K20234	83	2.2	-	-	-	-	4.1	2.9	815.7
MEAN:	84	2.5	2721	2712	2244	2048	3.0	2.7	797.5
LSD $_{(0.05)}$:	-		391	291	288	225	-	-	-
CV:	-		17.3%	15.8%	13.3%	14.8%	-	-	-

***Highest yielding variety within column*

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

Table 13. White Kidney bean agronomic, yield and canning results.

VARIETY	Maturity (DAP)	Lodging (1-5)	Irrigated 2-year avg. Lb. $^{-1}$ Acre	Irrigated 3-year avg. Lb. $^{-1}$ Acre	Dry Land 2-year avg. Lb. $^{-1}$ Acre	Dry Land 3-year avg. Lb. $^{-1}$ Acre	Canning Score (1-5)		Seed Size Seeds $^{-1}$ Lb.
							Irrigated	Dry Land	
Beluga	86	2.5	2116	2388	2296	2331**	3.6	2.7	809.4
ND WhiteTail	85	3.0	2588	-	2346	-	2.1	2.7	823.9
Snowdon	82	2.5	-	-	-	-	2.0	2.0	670.6
Yeti	87	2.2	2258	2774	2362	2004	2.8	2.9	841.4
K16924	86	2.7	3113**	3476**	2403	2177*	2.3	2.7	784.7
K19830	85	2.0	2728	-	2697**	-	2.7	3.4	747.9
K19831	86	2.0	-	-	-	-	2.7	3.6	751.0
MEAN:	85	2.7	2561	2879	2421	2171	2.6	2.8	775.6
LSD $_{(0.05)}$:	-	-	280	261	176	249	-	-	-
CV:	-	-	12.8%	18.4	6.7%	19.0%	-	-	-

Table 14. Mayocoba/Yellow bean agronomic, yield, and canning results.

VARIETY	Maturity (DAP)	Lodging (1-5)	Irrigated 2-year avg. Lb. $^{-1}$ Acre	Irrigated 3-year avg. Lb. $^{-1}$ Acre	Dry Land 2-year avg. Lb. $^{-1}$ Acre	Dry Land 3-year avg. Lb. $^{-1}$ Acre	Canning Score (1-5)		Seed Size Seeds $^{-1}$ Lb.
							Irrigated	Dry Land	
Claim Jumper	85	3.7	2414*	2576	2305	2029	4.7	4.4	1129.1
Motherlode	89	2.7	-	-	-	-	4.1	4.7	976.5
Patron	80	4.0	-	-	-	-	3.8	4.3	1115.0
SVS-0863	80	4.0	2485*	2791*	2719**	2618**	4.1	4.6	1156.7
Yellowstone	86	3.5	2541**	2845**	2182	2008	-	-	-
Y1608-14	82	4.2	2354*	-	1905	-	2.7	3.0	1078.2
Y1702-22	83	2.7	2397*	-	2031	-	2.4	2.9	1149.0
MEAN:	84	3.5	2438	2737	2252	2218	3.6	3.9	1100.7
LSD $_{(0.05)}$:	-	-	265	247	274	172	-	-	-
CV:	-	-	12.7%	12.8%	13.0%	10.4	-	-	-

***Highest yielding variety within column*

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

Western Thumb Black Bean Strip Trial

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Locations:	**Planted:**
Lakke Ewald Farms (Unionville)	June 9, 2021 (22" rows)
Voelker Farms (Pigeon)	June 4, 2021 (15" rows)
Average Plot Size: 0.8 acre	

Table 1. Variety entered, white mold percent infection, lodging, and dry bean yield.

#	Variety	White Mold (% Infection)[a]	Lodging [b]	Yield [c]
1	Adams	38 a[d]	2.6 a	2988 c
2	Black Beard	76 b	3.3 a	2919 c
3	Spectre	31 a	2.3 a	3372 a
4	Nimbus	30 a	2.3 a	3236 b

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).
[b] Lodging is evaluated on a scale of 1 (completely erect in the field)- 5 (near flat with pods and stems touching the soils surface).
[c] Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.
[d] Percent infection from Lakke Ewald location only.

Summary: In 2021 two locations in the western thumb were used in the testing of four commercial black bean varieties utilizing large plot methodology. Both farmer cooperators utilized standard production practices with one key difference being row width between operations. However, there was no significant interaction between factors and locations, so data was combined across locations. Both trial locations were of high quality as the 2021 growing season was very conducive for dry bean production. White mold infection did occur in a significant severity at the Lakke Ewald location and not the Voelker location. Therefore percent infection evaluations could only be performed at the Lakke Ewald location in 2021. Both locations were treated with fungicides during flowering for white mold suppression. As in previous years, an interesting relationship between lodging and white mold was observed. It is common place for dry bean plants that have lodged to be more susceptible to white mold infection, and believe this was a compounding factor with Black Beards high level of infection in 2021. Excessive plant growth in 2021 resulted in increased lodging for Black Beard in the Lakke Ewald location, this also corresponded to a significant increase in white mold infection for Black Beard when compared to the other three varieties tested ($P \leq 0.05$). With very uniform locations yield differences separated into three statistical groups. Ranking from top to bottom: Spectre (3372 lb.), Nimbus (3236 lb.), Adams (2988 lb.), and Black Beard (2919 lb.).

The support and expertise of both Lakke Ewald Farms and Voelker Farms helped make these results possible.

Commercial Navy Bean Strip Trial

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Location: Bednarski Farms (Colling, MI)	**Plot Size:** 0.97 acre
Planted: June 3, 2021	**Row width:** 22-inch
Harvested: September 11, 2021	**Replications:** 1

Table 1. Variety entered, gross yield, moisture, test weight, pick (%), and net saleable yield.

#	Variety	Gross Yield [ab]	Moisture	Test Weight [c]	Pick	Net Yield
1	Blizzard	3660	15.4%	63.9	0.7%	3594
2	Armada	3780	15.6%	64.1	0.5%	3730
3	Medalist	3780	15.9%	63.4	0.4%	3738
4	HMS Bounty	4040	15.5%	64.3	0.5%	3991

[a] Data presented is the result of one replication and therefore cannot be analyzed for statistical differences.
[b] Yield is in pounds per acre obtained by direct harvest
[c] Test weight is presented in lb. per bushel

Summary: In 2021 one location in Tuscola County was used in the testing of four commercial navy bean varieties utilizing large plot methodology. Standard production practices were used in the management of the plot throughout the growing season. The 2021 growing season was favorable for dry bean yields, producing very uniform and above average yields. While it is important to interpret these results with caution as they are the result of one replication, due to the field uniformity and supporting results in the 'Michigan Dry Bean Performance Trials E3465' it appears there is validity and value in the results presented in Table 1 above. All varieties exceeded 3,500 lb. per acre after all deductions. White mold was present but not at a disease severity high enough to warrant evaluations, or significant yield reductions. Numerical rankings are as follows: HMS Bounty (3991 lb.), Medalist (3738 lb.), Armada (3730), and Blizzard (3594).

The support and expertise of Bednarski Farms make these results possible.

Answer Plot 2021
Dry Bean Research

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In 2021 four separate dry bean trials were planted at the Answer Plot location near Sebewaing, MI. Trials included: Dry bean response to tank-mix combination of Outlook herbicide post-emergence, Black beans varietal response to management, dry bean response to Ascend seed treatment, and dry bean response to the foliar application of plant growth regulators. Trials were established as a cooperative effort between MSU Dry Bean Specialist Scott Bales and Winfield United Agronomist Jason Roth. Ahead of planting a tank-mix of Dual (1.5 pts) + Prowl (1.5 pt) + Roundup Powermax (32 fl oz) + AMS (17lb/100 gal) was applied and incorporated for weed control. Nimbus black bean was planted on the evening of June 1, 2021 for all trials that did not test multiple varieties utilizing a 20-inch Almaco cone planter. Plot size was 4 rows by 25' in length for all trials. The plot location was in a mature stand of alfalfa ahead of the 2021 growing season so additional nitrogen fertilizer was not added at the time of planting. All trials with the exception of the low management block received two applications of fungicide (Propulse (10.3 fl. oz.)), however white mold severity remained high in all trials in this location in 2021. All trials were harvested on September 17th utilizing a two row Wintersteiger plot combine. All reported yields are in lb. per acre and adjusted to 18% moisture for uniformity of interpreting results.

Trial #1: Dry bean response to tank-mix combination of Outlook herbicide post-emergence.

In efforts of better understanding dry beans response to Outlook herbicide a 13 treatment trial was designed and implemented at the Answer Plot in 2021. All plots were kept weed free though the application of a PPI herbicide (Dual + Prowl) and spot weeding throughout the remainder of the growing season within this trial. The first POST applications (A) were made on June 23 at growth stage V2, and the second application (B) were made on July 6 for the few treatments that required a split application. All treatments were made using a backpack sprayer calibrated to 22 gallons per acre at 60 PSI utilizing water as a carrier.

Results (Table 1): Plant injury was evaluated at 7 days after treatment (DAT) on a scale of 0-100%. Using this method 20% is a general benchmark for commercial acceptability and 100% represents complete plant death. At 7 DAT all herbicides caused plant injury. The treatment of Varisto + Superb HC+ AMS caused the lowest level of injury at 5%. All other treatments caused significantly more injury ranging from 6.4-15.0%. While this is encouraging for the crop safety of Outlook applied post emergence it is important that environmental conditions are also considered prior to, and after application, as these can also affect the amount of plant injury observed. The second variable evaluated in this trial was yield. There were no statistical differences for yield across all treatments ranging from 3058-3695 lb. per acre.

Table 1. Treatments, application timings, injury 7 days after treatments (0-100%) and yield.

#	Treatment	Timing	Injury 7 d. after treatment (0-100%)	Yield (lb A^{-1})[a]
1	Untreated	A	0 c[b]	3465 a
2	Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	5.0 b	3160 a
3	Outlook (10 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	6.4 a	3557 a
4	Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	11.6 a	3695 a
5	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	11.6 a	3278 a
6	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A) + Max-In ZMB (32 fl oz)	A	11.6 a	3306 a
7	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A) + ENC (32 fl oz)	A	12.4 a	3405 a
8	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) +Superb HC (0.5%) +AMS (2.5 lb/A) + Max-In ZMB (32 fl oz) + AlphaPlus Humic (32 fl oz)	A	12.8 a	3335 a
9	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A) + Max-In ZMB (32 fl oz) +AlphaPlus Humic (32 fl oz) + Section 3 (4 fl oz)	A	11.0 a	3319 a
10	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A) + Max-In ZMB (32 fl oz) + ENC (32 fl oz) + AlphaPlus Humic (32 fl oz) + Section 3 (4 fl oz)	A	13.6 a	3058 a
11	Outlook (21 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	14.8 a	3330 a
12	Outlook (10 fl oz) + Reflex (16 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A)	A	15.0 a	3215 a
13	Outlook (10 fl oz) + Reflex (8 fl oz)+ Varisto (21 fl oz) + Superb HC (0.5%) + AMS (2.5 lb/A) Fb. Outlook (10 fl oz) + Reflex (8 fl oz)+ Superb HC (0.5%) + AMS (2.5 lb/A)	AB	14.4 a	3105 a

[a] Yield is in pounds per acre obtained by direct harvest.

[b] Means within the same column with different letters are significantly different from each other ($\alpha \leq 0.05$).

Trial # 2: Black beans varietal response to management

In recent years there has been increasing interest and understanding of how current commercial dry bean varieties may be better adapted for certain production conditions than others. A good example of this is selecting varieties with a higher tolerance for white mold for fields that have a history of mold issues. While this is a good start to the evolution of variety selection it is also important to understand how these varieties may respond differently to inputs or management. To investigate this question, four commercial black bean varieties were selected and placed into paired trials. One block was treated to a high management program (additional nutritionals and fungicides applied) and the other block was considered standard management (only post emergence herbicides were applied). Treatment components for each block can be found in Table 2. Outside of the treatment differences within Table 2 all management of the trials was standardized for planting populations, row width, etc.

Table 2. Standard and high management comparison table.

Timing	Input	Standard Management	High Management
V2	Raptor (4 fl oz) + Basagran (16 fl oz) + COC (1%) + AMS (2.5 lb)	X	X
	Max-In Ultra (32 fl oz)		X
	ENC (16 fl oz)		X
R1	Propulse (10.3 fl. oz.)		X
	Max-In Ultra (16 fl oz)		X
R1+ 14 d.	Propulse (10.3 fl. oz.)		X
	Max-In Ultra (16 fl oz)		X

Results: Overall trial quality was very good in 2021. Average yields across all varieties in the high management block were 573 lb. higher than in the standard management block (Table 3). Overall all varieties numerically responded to the additional inputs of fungicide and nutritionals. An important note is that white mold disease was severe in this location in 2021 in both high and standard blocks and a response to fungicide applications would have been expected given environmental conditions. In the standard block all varieties yielded statistically similar, ranging from 3156-3506 lb. per acre. However, in the high management block Nimbus, Adams, and Spectre significantly out yielded Black Beard ($\alpha \leq 0.05$). Trials in 2022 will look to expand this project across multiple market classes (Navy, small red, etc.) in conditions that are not as conducive for severe disease pressure.

Table 3. Variety and yield for each variety under each management program.

Variety	Standard Management** —— Lb. A^{-1} ——	High Management —— Lb. A^{-1} ——
Nimbus	3506 a*	4104 a
Adams	3440 a	3857 a
Spectre	3308 a	4004 a
Black Beard	3156 a	3750 b
Trial Mean:	3352	3929
CV:	8.5%	9.5%

*Means within the same column followed by the same letter are not significantly different ($\alpha \leq 0.05$).
**Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.

Trial #3 Dry bean response to Ascend seed treatment

Two commercial black bean varieties were tested for yield after additions of Ascend seed treatment (0.4 oz. per cwt.) were made to standard seed treatment programs. The standard seed treatment used was Cruiser Max Vibrance (3.22 fl. oz. per cwt.) for both varieties. After seed treatment dry bean seed was packed for planting in a randomized complete block design with five replications. Seedling diseases were not of high severity in 2021.

Results: No significant yield differences were observed across varieties (Table 4). Furthermore no yield differences were observed between standard seed treatments, and standard seed treatments + Ascend. While it is important to document the severity of foliar disease that set into this location in 2021, one application of Propulse (10.3 fl. oz.) was made as a blanket application across all treatments. Disease certainly limited overall yield potential, however it should not be viewed as a confounding factor on the effects of seed treatment on yield.

Table 4. Ascend Seed Treatment Trial Treatments, varieties, and yield.

Treatment	**Variety**	**Ascend Seed Treatment**	**Yield (Lb. A^{-1})***
1	Zorro	NO	3457 A
2	Zorro	YES	3447 A
3	Nimbus	NO	3712 A
4	Nimbus	YES	3596 A

*Means within the same column followed by the same letter are not significantly different ($\alpha \leq 0.05$).

Black Bean Yield Response To Planting Rate

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Locations: SVREC	**Plot Size:** 6.6' x 20'
Planting Date: June 6, 2021	**Replicated:** 4 times (RCBD)
Variety: Zenith Black Bean	**Row Spacing:** 20-inch

Figure 1. Treatments, planted populations, final plant populations at harvest, percent of planted stand, and dry bean yield

Treatment:	Planted Population	Harvested Population	Percent Stand (Planted ÷ Harvested) * 100	Yield**
1	50,000	38,565	77.1%	2849 d*
2	60,000	45,101	75.1%	3079 cd
3	70,000	49,677	70.9%	3106 c
4	80,000	49,029	61.2%	3152 c
5	90,000	54,906	61.0%	3313 c
6	100,000	50,331	50.3%	3460 bc
7	110,000	64,057	58.2%	3775 a
8	120,000	69,940	58.2%	3626 ab
9	130,000	70,594	54.3%	3786 a
10	140,000	72,555	51.8%	3745 a
11	150,000	74,516	49.6%	3546 ab

*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.

Summary: In efforts of better examining the effects of altering planting populations on Michigan black beans, a trial was established at SVREC in 2021. Zenith black beans were planted on June 6, 2021 using a 4 row Almaco cone type planter. Eleven total treatments were included ranging from 50,000 to 150,000 seeds per acre. Stand counts were conducted at eighty nine (89) days after planting to provide a final plant population at harvest corresponding to the original planting populations. An important note is through the use of a cone planter the error rate in the seeding population is very low, individual seeds are counted out into planting envelopes ahead of planting and thus determine the final seeded population/density and is considered very accurate. However, precision metered planters may provide more uniform individual seed spacing. This raises an interesting point when we analyze the differences between planted and harvested populations. Results demonstrate a numerical increase in seedling mortality throughout the growing season for higher planting populations when compared to lower (33% loss for 50,000; 51% loss for 150,000). This may be mitigated by more precise seed spacing in some commercial planters (Lower % of doubles and/or skips per row foot). Yield results indicated that optimal seeding rates for 20" rows are 110,000-150,000 seeds per acre. However, previous research has also documented the increased risk of foliar disease under increased planting populations (>130,000 seeds per acres). Therefore current planting recommendations of 110,000-130,000 seeds per acre are considered optimal for dry bean yield potential in 20" rows.

Dry Bean Response To Nitrogen

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Location: Lutz Farms LLC. (Sebewaing, MI)	**Plot Size:** 0.80 acre
Planted: June 3, 2021	**Row width:** 28-inch
Harvested: September 9, 2021	**Replications:** 2
Application Method: Broadcast	**Source:** 28-0-0 + Thiosol (13:2)

Table 1. Fertilizer target rate of actual nitrogen in pounds per acre, actual gallons applied by broadcast sprayer, and yield.

#	Rate (lb/A)	Gallons (28-0-0)	Net Yield [ab]
1	0	0	3098 b
2	20	7.5	3117 b
3	40	15.0	3254 a
4	60	22.5	3230 a
5	80	30.0	3323 a

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

Summary: In 2021 one location in Huron County was used in the testing of dry beans response to supplemental nitrogen. Nitrogen was applied by a broadcast application utilizing a self-propelled sprayer ahead of planting. 28-0-0 was used as the nitrogen source blended with Thiosol at a 13:2 ratio, thus higher nitrogen rates also received a proportional increase in sulfur. However, past work has demonstrated that dry beans demonstrate little response to additional sulfur once critical levels are met. Full strips were 84’ wide and corresponded to 36 rows (28-inch spacing). After incorporation Zenith black beans were planted at a uniform population across all treatments. Two fungicide applications (Propulse Fb. Topsin) were made to the trial as white mold risk was severe in 2021. Overall, the highest numerical yield was from the 80lb rate of nitrogen, however this yield was not statistically different from the 40 or 60 lb application rate. In conclusion these results support current recommendations of 40-60 lb. of available (fertilizer, manure, cover crops, residual, etc.) nitrogen per acre for optimized dry bean yields.

The support and expertise of Lutz Farms make these results possible.

Dry Land White Mold Fungicide Trial

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Location:	Sanilac (Planted: June 5)	**GPA:** 22	
	Huron (Planted: June 11)	**PSI:** 60	
	Tuscola (Planted: June 4)	**Nozzle:** TP8002VS	
Replicated: 4 times		**Application A** (R1):	Sanilac (July 20)
Variety: Viper Small Red			Huron (July 26)
Population: 120,000 seeds/A			Tuscola (July 20)
Row width: 20-inch		**Application B:**	Sanilac (August 3)
Treated Plot Size: 6.6' x 20'			Huron (August 11)
			Tuscola (August 3)

Table 1. On-farm white mold fungicide treatments, application timing, and dry bean yield.

#	Treatments	Application Timing	Yield [ab]			
			Huron	Sanilac	Tuscola	Average
1	Untreated	-	2901 B	3115 BC	3370 BC	3129 D
2	Propulse (10.3 fl oz)	A	3418 A	3333 B	2995 C	3249 CD
3	Propulse (10.3 fl oz)	B	3330 A	3969 A	3691 AB	3664 AB
4	Propulse (10.3 fl oz)	AB	3586 A	4088 A	3928 A	3867 A
5	Omega (8 fl oz)	A	3278 A	2942 C	3654 AB	3291 A
6	Omega (8 fl oz)	B	3449 A	3915 A	3083 C	3482 BC

[a] Means within the same column with different letters are significantly different from each other ($\alpha \leq 0.05$).
[b] Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.

Summary: One fungicide trial was established in 2021 with three on-farm locations. All locations were non-irrigated and examined multiple commercial products at various application timings. In combination with on-site weather stations the objective of these trials was to help validate predictive modeling apps (Sporecasters) reliability for dry bean systems. Overall, white mold infection in the untreated control was less than 20% at both Sanilac and Tuscola locations. The Huron county untreated plots averaged 70% infection with severity of 6.5 on a scale from 1-10. In all locations dry bean yield significantly responded to fungicide applications. This supports 2020 findings that documented dry bean yield responses even when white mold pressure was relatively low (less than 10% infection in 2020). In regards to application timing trends have indicated that later applications ('B' 7-10 d. after R1) have been more economical than applications made at early R1. However, when examining the factor of timing in 2021 the interaction with location is significant. This means that environmental factors within this three county area had a significant impact of the optimal fungicide timing in 2021. Continued analysis of weather station data and future research will focus on optimized fungicide application timings for both one and two pass application programs.

Dry Bean Response to In-Furrow Applications of Azoxystrobin Alone and In Combination With Fertilizer

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Location: SVREC	**Treated Plot Size:** 6.6' x 20'
Planting Date: June 6, 2021	**GPA:** 9.6
Replicated: 4 times	**PSI:** 10
Design: RCBD	**Application Timing:** 'A' at planting
Variety: Zenith Black Bean	**Nozzle:** T-Band
Population: 105,000 seeds/A	**Row Width:** 20-inch

Table 1. Treatments, application timing, stand counts, and dry bean yield.

#	Treatment	Application Timing	Stand Count/A		Yield [b]
			8 DAP [a]	89 DAP	
1	Untreated	-	81,662 ab	64,058 a	3626 a
2	SureCrop (3.3 gal/A)	A	78,396 ab	63,390 a	3700 a
3	Azteroid (5 fl. oz./A)	A	92,058 a	62,097 a	3403 ab
4	SureCrop (3.3 gal/A) + Azteroid (5 fl. oz./A)	A	81,009 ab	62,097 a	3239 b
5	Quadris (9.5 fl. oz./A)	A	72,516 b	60,136 a	3078 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 acre obtained by direct harvest, adjusted to 18% moisture.

Summary: A trial was established in 2021 to test dry beans tolerance to in-furrow applications of azoxystrobin (Azteroid or Quadris) alone and in combination with SureCrop (4-12-3 + Micros) fertilizer products. Trial quality was very good as a dry planting season did not interfere with dry bean planting or emergence at SVREC. All treatments were applied in a T-Band application method at 9.6 gallons per acre at planting. Eight days after planting dry bean vigor was not visually affected by any treatment and plots had reached maximum emergence. However, the treatment of Azteroid alone did have higher stand counts per acre than Quadris applied alone. This result should be interpreted with caution as the rate of azoxystrobin applied in lb. per acre was not equivalent between Azteroid and Quadris formulations and cannot be used as a reference for differing crop safety between formulations. None of the included treatments differed in stand count from the untreated at either eight days after planting, or immediately ahead of harvest at eighty nine days after planting. Significant levels of root disease were not present in the 2021 location and therefore was not evaluated. Yield was not significantly increased by any treatment in comparison to the untreated control, in contrast treatments of SureCrop + Azteroid as well as Quadris reduced dry bean yield by 387 and 548 lb. per acre, respectively.

Dry Bean Response to Alternative Seed Treatment and In-Furrow Fungicide Programs

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Location: SVREC	**Treated Plot Size:** 6.6' x 20'
Planting Date: June 6, 2021	**Variety:** Zorro black bean
Replicated: 4 times	**Population:** 105,000 seeds/A
Design: RCBD	**Row Width:** 20-inch
Application Timing: 'A' Seed Treatment	**GPA:** 10
'B' At Planting	**PSI:** 10

Table 1. Treatments, application timing, stand counts, and dry bean yield.

#	Treatment	Application Timing	Stand Count /A		Yield [a]
			8 DAP	89 DAP	
1	Untreated	-	97,395	74,093	3302
2	Propulse (6 fl. oz./A)	B	86,936	72,556	3231
3	Evergol Energy	A	101,317	73,863	3096
4	Evergol Energy + Propulse (6 fl. oz./A)	AB	94,780	74,301	3363

[a] Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.

Summary: A trial was established in 2021 to test dry beans response to seed treatments and in-furrow fungicide applications. Zorro black beans were planted with no seed treatment in treatments 1 (untreated) and 2 (Propulse). Evaluations included stand counts at 100% emergence (8 days after planting (DAP)), stand counts prior to harvest (89 DAP), and dry bean yield. Planting conditions were favorable for quick dry bean emergence into warm dry soils and did not indicate a significant benefit in plant population or yield to any treatment in the trial. Dry bean root diseases were not present in a great enough severity for the rating of product effects. Additional research should focus on inoculated trials or locations with a history of high severity of dry bean root diseases. Environmental impacts such as heavy rainfall and soil crusting may at times also impact results.

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The Effect of EndoPrime Biological on Dry Bean Production

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Location: SVREC	**Treated Plot Size:** 6.6' x 20'
Planting Date: June 6, 2021	**Variety:** Zenith black bean
Replicated: 4 times	**Population:** 105,000 seeds/A
Design: RCBD	**Row Width:** 20-inch
Application Timing: 'A' At Planting	**2X2:** 15 GPA @ 12 PSI
	In-Furrow: 10 GPA @ 10 PSI

Table 1. Treatments, application timing, application placement, stand counts, and dry bean yield.

#	Treatment	Application Timing	Application Placement	Stand Count/A	Yield *
				89 DAP	
1	Untreated	-	-	55,953	2849
2	EndoPrime (2 fl. oz./A)	A	In-Furrow	58,567	2777
3	EndoPrime (2 fl. oz./A)	A	2x2 Coulter	61,705	3135

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

Summary: A trial was established in 2021 to test dry beans response to a biological product applied in two separate methods. An untreated control was also utilized for comparison of treatment effects. All treatments received 42 lb/A of actual nitrogen from a broadcast application of 28-0-0 liquid fertilizer prior to the incorporation of PPI herbicides. For both application methods water was used as the carrier for EndoPrime biological. Evaluations included stand counts (89 days after plating (DAP)) and dry bean yield (Adjusted to 18% moisture). For either application method EndoPrime did not significantly affect dry bean plant populations or yield. Trials were of high quality and did not have significant levels of root or foliar bean diseases in any of the included treatments.

Dry Bean Response to In-Furrow Applications of Propulse In Two Michigan Locations

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Location: SVREC (June 6, 2021)	**Treated Plot Size:** 6.6' x 20'
Kawkawlin (May 31, 2021)	**GPA:** 10
Replicated: 4 times	**PSI:** 10
Design: RCBD	**Application Timing:** 'A' at planting
Variety: Zenith Black Bean	**Nozzle:** TP8002VS
Population: 105,000 seeds/A	**Row Width:** 20-inch

Table 1. Treatments, application timing, stand counts, and dry bean yield.

#	Treatment	Application Timing	Stand Count/A		Yield *
			8 DAP	89 DAP	
1	Untreated	-	72,216	66,006	3505
2	Propulse 6 fl. oz./A	A	68,295	58,164	3225
3	Propulse 8 fl. oz./A	A	77,934	53,131	3487
4	Propulse 10 fl. oz./A	A	82,999	64,537	3350

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

Summary: A trial was established in 2021 to test dry beans tolerance to in-furrow applications of multiple rates of Propulse fungicide. Applications were made from 6- 10 fl. oz. per acre directly into the seed furrow at planting. This trial was not inoculated with any specific root rot pathogens and natural disease pressure was not great enough for evaluation of root rot. Seed for all treatments was treated with a standard Cruiser Max Vibrance (3.22 fl. oz. per 100 Lb. of seed) seed treatment prior to planting. When data were combined over two locations neither evaluation of stand count nor yield were significantly impacted by fungicide application when compared to the untreated control ($P \leq 0.05$). While this trial demonstrated an acceptable level of crop safety at the rates tested, additional research is required to better understand the impact Propulse may have on dry bean root diseases.

Certis White Mold Trial

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Location: Montcalm Research Center	**Treated Plot Size:** 6.6' x 20'
Planted: June 10, 2021	**GPA:** 22
Replicated: 4 times	**PSI:** 60
Variety: Viper Small Red Beans	**Nozzle:** TP8002VS
Population: 120,000 seeds/A	**Application A:** July 22, 2021
Row width: 20-inch	**Application B:** August 5, 2021

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	Untreated	-	79 a	9.3 a	921 ab
2	Double Nickel 55 (0.5 lb)	A	85 a	8.8 ab	681 b
3	Double Nickel 55 (0.5 lb)	AB	82 a	8.8 ab	788 b
4	LifeGard (1 oz)	A	82 a	7.3 ab	976 ab
5	LifeGard (2 oz)	AB	79 a	7.8 ab	1032 ab
6	Propulse (10.3 fl oz)	B	83 a	6.5 b	1354 a

[a] Means within the same column with different letters are 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 2021. Disease pressure was very high in 2021 as a combination of excessive irrigation near flowering and favorable environmental conditions for disease. Given this combination untreated plots were documented of having near 80% infection, disease severity ratings of 9.3, and yield losses of 433 lb. per acre when compared to the best performing fungicide program. This is an important note on the interpretation of these results and understanding the limitations of current fungicide programs. No statistical difference for yield evaluations exist when compared to the untreated control even for the non-organic commercial standard (Propulse). This speaks to the overwhelming severity of disease pressure that was experienced in this location in 2021. Treatments were made at two separate timings: (A) Pre-bloom and (B) R1. The application of Propulse (10.3 fl oz) produced the highest numerical dry bean yield at 1354 lb. per acre when applied at R1 (B). However, this yield was statistically similar to the untreated control, as well as both treatments of LifeGard (Both rates and timings). Treatments of Double Nickel were considered lower than the non-organic standard (Propulse) but not the untreated control ($\alpha \leq 0.05$).

UPI White Mold Trial

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Location: Montcalm Research Center	**Treated Plot Size:** 6.6' x 20'
Planted: June 10, 2021	**GPA:** 22
Replicated: 4 times	**PSI:** 60
Variety: Viper Small Red Beans	**Nozzle:** TP8002VS
Population: 120,000 seeds/A	**Application A:** July 28, 2021
Row width: 20-inch	**Application B:** August 10, 2021

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	Untreated	-	79 a	7.5 a	927 b
2	Topsin M (40 fl oz)	A	70 a	5.8 a	2407 a
3	Topsin M (20 fl oz)	AB	76 a	7.0 a	1699 a
4	Propulse (10 .3 fl oz)	A	73 a	7.5 a	1697 a

[a] Means within the same column with different letters are 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 2021. Disease pressure was very high in 2021 as a combination of excessive irrigation near flowering and favorable environmental conditions for disease. Given this combination untreated plots were documented of having near 80% infection, disease severity ratings of 7.5, and yield losses of 1480 lb. per acre when compared to the best performing fungicide program. This is an important note on the interpretation of these results and understanding the limitations of current fungicide programs. No statistical difference for percent infection or disease severity exist within this trial even when comparing the commercial standard (Propulse) to the untreated. This speaks to the overwhelming severity of disease pressure that was experienced in this location in 2021. Treatments were made at two separate timings: (A) R1 and (B) 13 d. after R1. The application of Topsin M (40 fl oz) produced the highest numerical dry bean yield at 2407 lb. per acre when applied at R1 (A). However, this yield was statistically similar to Topsin M (20 fl oz) applied at both application timings (AB), and to Propulse (10.3 fl oz) applied at R1 (A). While the three fungicide treatments were not considered different from each other, all are statistically different from the untreated control ($\alpha \leq 0.05$).

Gowan White Mold Trial

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Location: Montcalm Research Center	**Treated Plot Size:** 6.6' x 20'
Planted: June 10, 2021	**GPA:** 22
Replicated: 4 times	**PSI:** 60
Variety: Viper Small Red Beans	**Nozzle:** TP8002VS
Population: 120,000 seeds/A	**Application A:** July 28, 2021
Row width: 20-inch	**Application B:** August 10, 2021

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	Untreated	-	84 a	8.0 a	588 b
2	Domark (6.4 fl oz)	A	82 a	8.0 a	869 ab
3	Domark (6.4 fl oz) + Badge (32 fl oz)	A	92 a	8.3 a	708 ab
4	Affiance (10 fl oz)	A	89 a	7.5 a	644 ab
5	Badge (32 fl oz) + Affiance (10 fl oz)	A	91 a	7.5 a	605 b
6	Endura (8 oz)	A	87 a	6.5 a	1057 a
7	Badge (32 fl oz)	A	83 a	7.3 a	857 ab
8	Domark (6.4 fl oz) + Badge (32 fl oz)	AB	88 a	8.0 a	815 ab

[a] Means within the same column with different letters are 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 2021. Disease pressure was very high in 2021 as a combination of excessive irrigation near flowering and favorable environmental conditions for disease. Given this combination untreated plots were documented of having greater than 80% infection, disease severity ratings of 8.0, and yield losses of 469 lb. per acre when compared to the best performing fungicide program. This is an important note on the interpretation of these results and understanding the limitations of current fungicide programs. No statistical difference for percent infection or disease severity exist within this trial even when comparing the commercial standard (Endura) to the untreated. This speaks to the overwhelming severity of disease pressure that was experienced in this location in 2021. Treatments were made at two separate timings: (A) R1 and (B) 13 d. after R1. The application of Endura (8 oz) produced the highest numerical dry bean yield at 1057 lb. per acre. This was the only treatment that was not statistically similar with the untreated control (588 lb per acre).

Bayer White Mold Trial

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Location: Montcalm Research Center	**Treated Plot Size:** 6.6' x 20'
Planted: June 10, 2021	**GPA:** 22
Replicated: 4 times	**PSI:** 60
Variety: Viper Small Red Beans	**Nozzle:** TP8002VS
Population: 120,000 seeds/A	**Application A:** July 28, 2021
Row width: 20-inch	**Application B:** August 10, 2021

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	Untreated	-	91 a	8.3 a	852 c
2	Propulse (6 fl oz)	AB	72 bc	6.8 ab	1952 ab
3	Propulse (8 fl oz)	AB	65 c	5.3 b	2315 a
4	Propulse (10.3 fl oz)	AB	68 bc	4.8 b	2414 a
5	Delaro (12 fl oz) Fb. Propulse (8 fl oz)	A+B	83 ab	7.0 ab	1513 b
6	Delaro Complete (12 fl oz) Fb. Propulse (8 fl oz)	A+B	72 bc	7.5 ab	2289 a
7	Luna Flex(13.7 fl oz) Fb. Propulse (8 fl oz)	A+B	68 bc	6.5 ab	2388 a

[a] Means within the same column with different letters are 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 2021. Disease pressure was very high in 2021 as a combination of excessive irrigation near flowering and favorable environmental conditions for disease. Given this combination untreated plots were documented of having greater than 90% infection, disease severity ratings above 8, and yield losses of 1,562 lb. per acre when compared to the best performing fungicide program. Treatments were made at two separate timings: (A) R1 and (B) 13 d. after R1. The application of Propulse (10.3 fl oz) at both application timings (AB) produced the highest numerical dry bean yield at 2414 lb. per acre adjusted to 18% moisture. All treatments were statistically similar to the application Propulse (10.3 fl oz) AB with the exception of Delaro (12 fl oz) Fb. Propulse (8 fl oz) and the untreated control. Results do also indicate the limitations of current fungicide products for the suppression of white mold. The Montcalm Research Center has a 5 year yield history of well over 3,000 lb. per acre in these trials that receive excellent fertility and additional irrigation. However, with this year's favorable environmental conditions white mold disease put limitation on dry bean yield even when multiple applications of the best available product were made on a susceptible variety (Viper small reds).

Dark Red Kidney bean seeding rate study
Collins Farm, Fayette, MI (Delta County)
Sponsored by the Michigan Bean Commission and MSU Extension

Background:
Ron Collins is interested in exploring whether he can reduce his seeding rate of Red Hawk dark red kidney beans from 70,000 seeds per acre to 60,000 seeds per acre while maintaining or increasing return per acre.

Method:
Six strips of 24 rows at 30" spacing were planted on June 14, 2021. The strips alternated between 70K/acre and 60K/acre target population, resulting in 3 replications of side-by-side treatments. Plant populations were counted on July 28, 2021 by measuring 17'5" of each of the rows in a 6-row planter pass in each strip, and again on September 16, 2021. An average of the two plant stand counts from each strip was used to estimate the actual plant stand in each strip. The surrounding dark red kidney bean field was pulled and combined before trial harvest. Final dimensions of each strip was 60' (24 rows) X 801.5', or 1.104 acres. The strips were harvested using Ron's bean puller on September 20 and combined with a Lilliston 6200 on September 22. Yield from each strip was emptied into a gravity wagon and weighed on a local gravel pit Fairbanks scale.

Results:

Stand count results (estimated plants per acre)

	Rep 1	Rep 2	Rep 3	AVG
70K/acre target	68,150	64,150	64,600	65,630
60K/acre target	59,900	57,300	57,080	58,093

Yield results (lbs per acre before milling)

	Rep 1	Rep 2	Rep 3	AVG
70K/acre target	2,301	2,210	1830	2114
60K/acre target	2,174	2,138	2101	2138

Statistical analysis of yield data:

Agricultural Statistics Analysis Program

Title: DRK planting rate study 2021

Experimental Design

(•) Completely Randomized Design (CRD) ( ) Randomized Complete Block Design (RCBD)

Level of Significance

( ) 1% (•) 5% ( ) 10% ( ) 20%

	Replication/Block 1	Replication/Block 2	Replication/Block 3	Treatment Mean
70K	2540	2440	2020	2,333
60K	2400	2360	2320	2,360
Replication/Block Mean	2,470	2,400	2,170	2,347

[Analyze] [Save File] [New Analysis] [Logout]

Source	Degree of Freedom	Sum Square	Mean Square	Observed F	P value	
Total	5	156,533	31,307			
Treatments	1	1,067	1,067	0	87.65%	Not significant
Blocks						
Error	4	155,467	38,867			
Required F	8					
Correction Factor	33,041,067					
Standard Deviation	197					
Coeff. of Variation	8%					

LSD	447	
Treatment Name	Mean	

Discussion:

This single-year, single-location study does not show any significant difference in yield between 60K/acre and 70K/acre target seeding rates. Yields were unusually high for this farm compared to previous years. The results of this study suggest that a reduced seeding rate of 60K/acre has the potential to provide similar yield to the original seeding rate of 70K/acre. Additional side-by side comparisons in future years are desirable to confirm this observation.

Following harvest, Ron Collins indicated that he observed a slightly higher yield in his 70K seeded fields versus 60K seeded fields. At his contracted price, the difference made the 70K planting rate more economical.

June 17, 2021

June 30, 2021

July 28, 2021

July 28, 2021 – 1st stand counts

September 16, 2021 - 2nd stand count

September 20, 2021 - pull plots

September 22, 2021 – combine plots

September 22, 2021

September 22, 2021 – weigh and record plot yields

September 22, 2021

September 22, 2021 – weigh plot yields at Gembel & Sons Excavating, Fayette, MI

2021 DRY BEAN YIELD TRIALS

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Plant, Soil and Microbial Sciences

Expt. 2101: Standard Black Bean Yield Trial -N

This trial was planted without the application of any nitrogen (N) fertilizer. Yields ranged from 1.5 to 33.0 cwt/acre with a test mean of 28.0 cwt/acre. Variability was low in this test, (CV=9.1%) and the LSD was 3.0 cwt/acre. Eleven entries significantly out yielded the test mean which included B16504 for the sixth and B19309 for the second consecutive years. Adams was the only variety in this group. Several promising B20 breeding lines with good canning quality, high levels of CBB resistance, and upright architecture also showed excellent yield potential in their first year of testing in the absence of N fertilizer. Zenith ranked slightly above the trial mean, Zorro slightly below, while private varieties Black Bear, Eclipse, Nimbus, and Black Beard grouped at the bottom of the trial producing yields of only 22-25 cwt/a as result of low fertility and susceptibility to CBB These results suggest that MSU breeding lines can perform well under low fertility and high CBB pressure relative to private entries. 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 2102 where it did pod and dry down, similar to 2020 results. It was encouraging to see several lines continue to perform well in the absence of additional N suggesting they have improved Nitrogen use efficiency (NUE). Given environmental concerns as well as increasing fertilizer costs, there exists a need to identify lines with higher NUE and improved yield. This trait could also be advantageous to organic producers who are limited in forms of N they may apply.

Expt. 2102: Standard Black Bean Yield Trial +N

This 42-entry trial included the same standard commercial black bean varieties and advanced breeding lines as test 2101. The trial was planted with standard nitrogen (N) treatment of 63 lbs/acre. Yields ranged from 3.9 to 39.2 cwt/acre with a test mean of 32.1 cwt/acre. Variability was low in this test, (CV=9.5%) and the LSD was 3.5 cwt/acre. Six entries significantly out yielded the test mean including the recent MSU release Adams at 36.1 cwt/acre. It was encouraging to see B20599, B16504, B20591, Adams, B20590, B19309, B20597 rank in the top ten of both +/- N trials. Zenith performed near the mean at 32.9cwt, while Nimbus, Eclipse, Zorro, Black Beard and Black Bear all ranked below the test mean in contrast to 2020 results. Black Beard and Black Bear were severely infected with CBB and were therefore the lowest yielding varieties. The non- nodulating line R99 that does not fix N was the lowest yielding entry in the test yet yielded more than 160% better than in test 2101 suggesting that N-fixation was an important contributor to yield in the low N trial. The goal of these paired trials is to improve overall NUE 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 equivalent or better than Zenith are being advanced.

Comparison of Black Bean Trials 2101 and 2102

A comparison of the two 42-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 use efficiency. In general, the yields of the fertilized treatment were very similar (32.1 cwt/acre) compared to those without fertilizer (28.0 cwt/acre). One black bean line with exceptionally high seed yield, B19330, had equivalent and higher yield potential under low N conditions (Fig. 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 long lasting and beneficial impacts on the agro-environmental sustainability in the Great Lakes watershed. Given environmental concerns of the overuse of N fertilizer, there exists a need to identify lines with a higher NUE with higher yields. N application rates of over 50 lbs/acre produce ultimately increase plant biomass, which can result in greater white mold infection and 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.

Expt. 2118: National White Mold Yield Trial

This 16-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. Entries included commercial navy and pinto 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, NDSU, and University of Nebraska (UNL). 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 to maintain adequate levels of moisture for favorable disease development at the critical flowering period. Overall disease development was excellent. 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 33.3 to 96.3% with a mean value of 64.6%. The susceptible check Beryl had the highest white mold rating. The test ranged in yield from 7.8 to 24.9 cwt/acre with a mean yield of 16.1 cwt/acre. Variability was low (CV=9.2%), with an LSD value of 2.1 cwt/ acre needed for significance. The highest yield was approximately 50% compared to 2020 when the top yielding entry Charro produced 50.4cwt/acre. Seven lines significantly out-yielded the test mean and included new release Charro (19.4 cwt/a), as well as breeding lines from each of the breeding programs that entered the trial. SR9-5 was the second highest yielding line. Likewise, Beryl was the lowest yielding, while G122 ranked twelfth at 11.7 cwt. The new navy release ND Polar from NDSU ranked thirteenth at 9.6 cwt/acre. The severe WM infection and drastic yield reductions observed in this trial serve as a reminder of the continued effort needed towards further improvement of tolerance levels. This trial will continue to be part of the breeding effort to improve tolerance to white mold in future varieties in 2022.

Rhizoctonia Root Rot Screening Trial, East Lansing MI

This 48-entry trial was conducted in collaboration with the Chilvers Lab at MSU to evaluate a range of diverse dry bean varieties and breeding lines for reaction to root rot specifically when inoculated with *Rhizoctonia solani*. Entries included commercial black, navy, pinto, and red lines as well as advanced MSU breeding lines. Lines in the trial were developed by MSU and Provita and planted on May 30, 2021. Entries were planted in two row plots under inoculated and non-inoculated treatments and plots were arranged in a randomized complete block design with four replicates. Stand count was collected one, two, and three weeks after planting. To evaluate the effect of the inoculation treatment we estimated post-emergence damping-off as the difference between the first and last stand count. However, increased precipitation in late June led to significant waterlogging damage and some observations were excluded to reduce confounded stand count observations. Overall, results found that the inoculated plots had higher post-emergence damping-off than the non-inoculated plots $Prob >|t| <0.001^{*}$. Lines that were inoculated had higher post-emergence damping-off relative to non-inoculated as expected (Fig. 2). Interestingly, the commercial line Valiant and the breeding line N19246 had similar post-emergence damping-off under inoculated and non-inoculated treatments. It would be expected that any emergence or for post-emergence damping-off in the non-inoculated plots would be a result of the 'natural' pressure in this specific location. Significant differences were also found for post-emergence damping-off among genotypes ($P<0.0001^{*}$) (Fig. 3). The five lines with the highest post-emergence damping-off were Medalist, R20639, Black Bear, Viper, and Zenith. While the five lines with the lowest post-emergence damping-off were N20388, P19103, G19611, N20404, and N19226. MSU breeding lines demonstrated to be the most tolerant to post-emergence damping-off caused by *Rhizoctonia solani* demonstrating the previous efforts to improve root rot tolerance in the small and medium-seeded types. Root rot continues to be a major problem in dry bean production areas in Michigan and screening will continue to be part of the breeding effort to improve tolerance to root rot in future varieties in 2022.

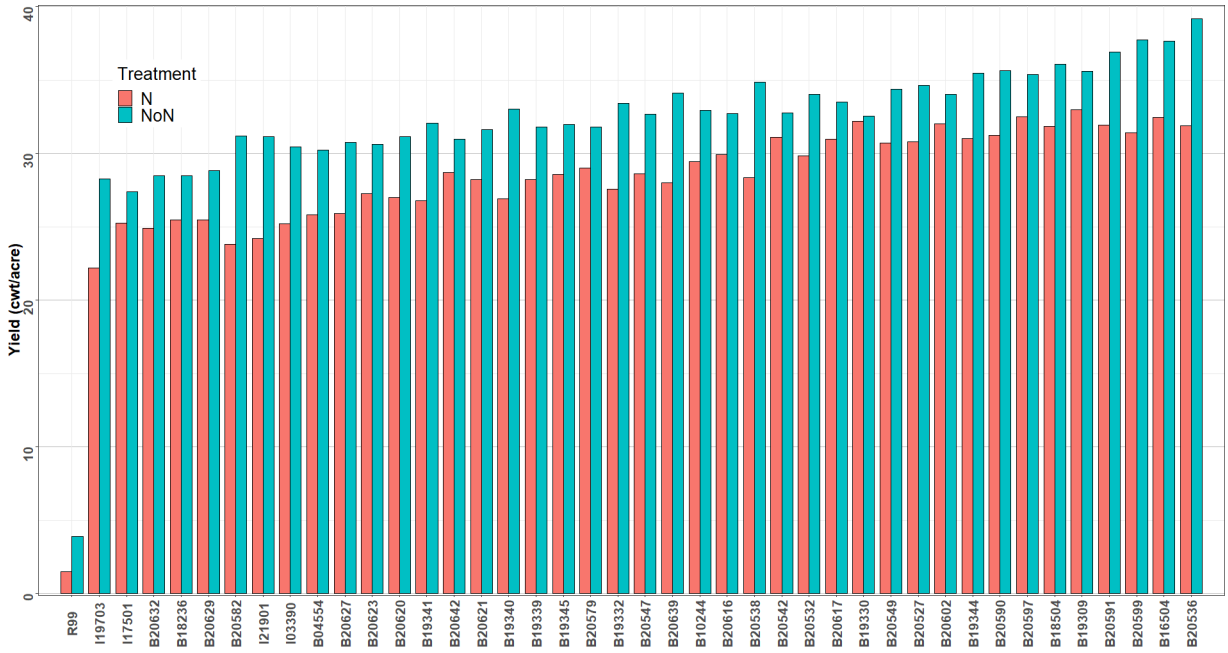

Figure 1. Comparison of yield for 42-black bean lines tested at the Saginaw Valley Research and Extension Center, near Frankenmuth, MI in 2021 under Nitrogen (N) and No Nitrogen (NoN) field conditions. R99 designates the non-nodulating bean line that does not fix N.

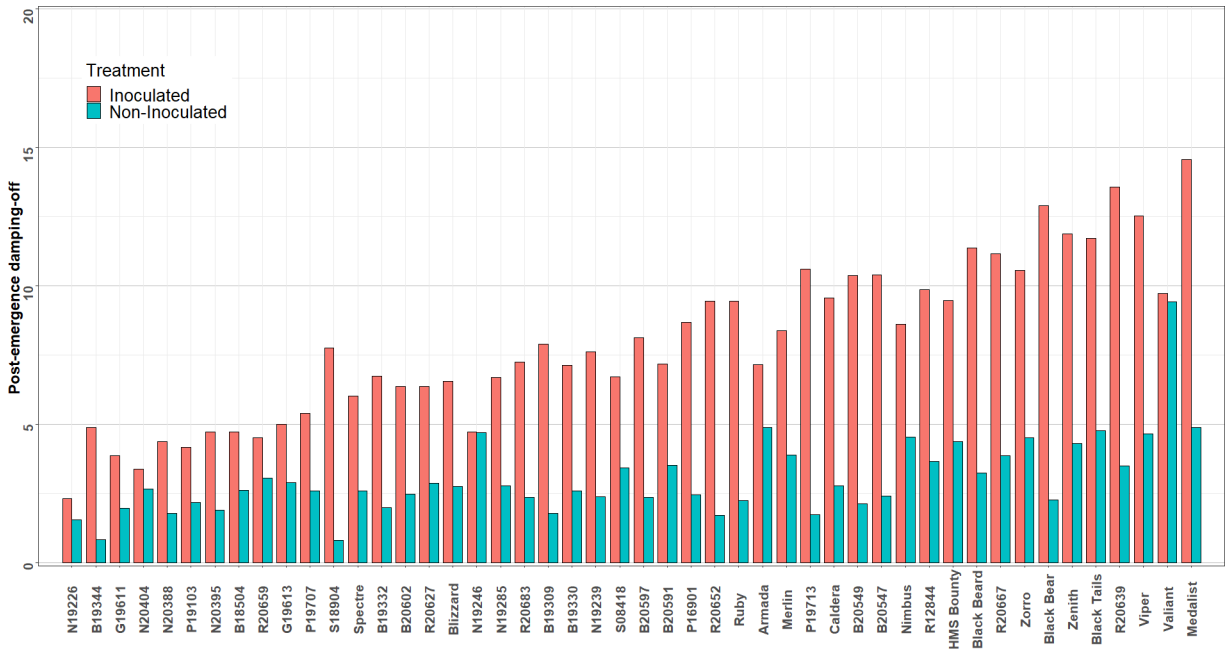

Figure 2. LSMeans for post-emergence damping-off between inoculated vs non-inoculated for 48 lines evaluated in East Lansing, MI. Inoculated plots were inoculated with *Rhizoctonia solani*.

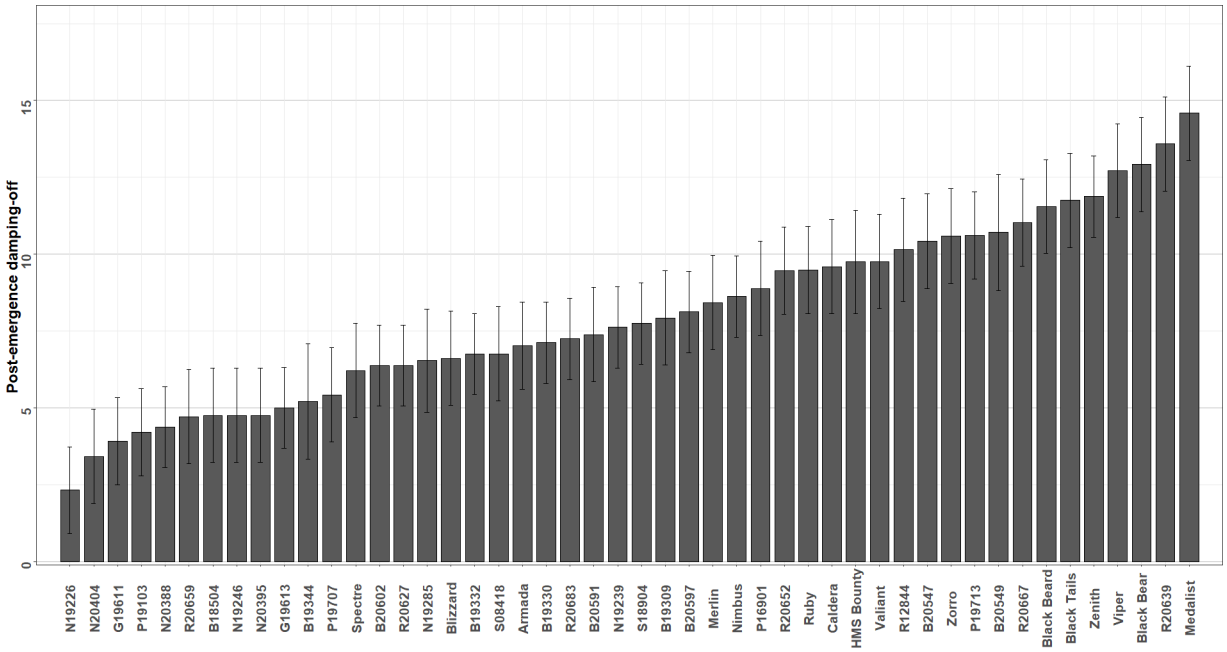

Figure 3. Root rot screening for 48 genotypes evaluated in East Lansing, MI inoculated with *Rhizoctonia solani*. Post-emergence damping-off was estimated by the difference between first and last stand count. Standard error bars label each barplot.

EXPERIMENT 2101 STANDARD BLACK BEAN YIELD TRIAL (-N) **PLANTED: 6/2/21**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B19309	B15414/B16504	1	33.0	19.7	44.0	84.0	1.0	43.5	5.0
B20597	B16506/B15430	20	32.5	23.1	44.0	83.0	1.0	42.0	4.5
B16504	Zenith//Alpena*/B09197	7	32.5	19.4	44.0	88.0	2.0	47.5	5.0
B19330	B16501/B15414	4	32.2	22.8	44.0	86.0	2.0	39.8	4.5
B20602	B16506/B16504	23	32.0	23.4	44.0	84.0	1.5	43.0	4.5
B20591	B16505/B16504	19	31.9	20.7	44.0	85.0	2.0	46.3	4.5
B20536	B15430/B16504	30	31.9	20.3	44.0	88.0	1.0	51.0	6.0
B18504	Zenith//Alpena*/B09197, **ADAMS**	2	31.9	19.3	44.0	87.0	2.0	43.8	5.0
B20599	B16506/B15430	18	31.4	18.8	44.0	87.0	1.5	48.5	4.0
B20590	B16505/B16504	34	31.3	19.4	44.0	89.0	1.5	47.8	5.0
B20542	B16501/B15430	29	31.1	20.2	44.0	83.0	1.0	43.0	4.0
B19344	B16506/B16507	3	31.0	21.4	44.0	87.0	2.0	42.5	5.5
B20617	B17106/N14218	26	31.0	18.8	44.0	85.0	1.0	40.5	4.5
B20527	B14302/B15430	31	30.8	18.5	44.0	85.0	2.0	40.5	5.5
B20549	B16501/B16504	22	30.7	19.6	44.0	82.0	1.0	43.5	4.0
B20616	B17106/B17259	41	29.9	19.0	44.0	84.0	1.0	41.8	5.0
B20532	B15430/B16504	24	29.9	19.0	44.0	85.0	1.5	43.3	6.0
B10244	B04644/ZORRO, **ZENITH**	5	29.5	19.9	44.0	87.0	1.0	44.8	5.0
B20579	B16504/B17259	40	29.0	21.9	44.0	84.0	1.5	38.8	4.5
B20642	B17730/B16504	25	28.7	18.8	44.0	89.0	1.0	51.3	4.0
B20547	B16501/B16504	21	28.6	20.4	44.0	87.0	1.5	42.0	5.0
B19345	B16506/B16507	6	28.6	19.2	43.0	84.0	1.0	42.0	4.5
B20538	B15430/B16504	36	28.4	19.9	44.0	86.0	1.0	46.3	5.5
B19339	B16507/B15453	11	28.2	21.0	44.0	87.0	1.5	45.5	5.0
B20621	B17106/N14218	35	28.2	18.5	44.0	84.0	1.0	41.5	4.5
B20639	B17730/B15430	37	28.0	19.4	44.0	86.0	1.0	47.8	5.0
B19332	B16501/B15464	15	27.6	20.0	44.0	88.0	2.0	42.3	5.0
B20623	B17523/B16504	38	27.3	18.3	44.0	88.0	1.5	41.3	4.0
B20620	B17106/N14218	27	27.0	16.5	44.0	85.0	1.5	45.8	4.5
B19340	B16507/B15453	9	26.9	22.2	45.0	88.0	1.5	46.3	4.5
B19341	B16507/B16501	13	26.8	20.0	44.0	85.0	2.0	40.8	4.0
B20627	B17540/N14218	39	25.9	18.2	44.0	85.0	1.0	42.3	4.5
B04554	B00103*/X00822, **ZORRO**	10	25.8	19.1	44.0	88.0	2.0	46.0	4.0
B20629	B17692/B16504	28	25.5	17.2	44.0	87.0	2.0	49.5	3.5
B18236	B14303/B12724	14	25.5	19.8	44.0	88.0	2.0	41.3	4.0

EXPERIMENT 2101 STANDARD BLACK BEAN YIELD TRIAL (-N) **PLANTED: 6/2/21**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
I17501	Jaguar/BL05222, **BLACK BEAR**	8	25.3	18.7	44.0	90.0	3.0	42.0	3.0
I03390	ND9902621-2, **ECLIPSE**	12	25.2	19.9	44.0	86.0	2.5	42.8	3.0
B20632	B17692/B16504	33	24.9	18.7	44.0	85.0	1.0	42.8	3.0
I21901	BL14500, **NIMBUS**	42	24.2	19.7	44.0	90.0	2.5	47.3	3.5
B20582	B16504/B17523	32	23.8	17.6	44.0	85.0	1.0	44.5	4.5
I19703	BL14506, **BLACK BEARD**	16	22.2	19.8	44.0	90.0	3.0	45.3	3.0
I07112	**R99 NO NOD**	17	1.5	16.1	44.0	95.0	1.0	30.8	1.0
MEAN (42)			28.0	19.6	44.0	86.2	1.5	43.8	4.4
LSD (.05)			3.0	0.9	0.6	2.7	0.6	4.7	0.8
CV%			9.1	3.8	1.2	1.9	24.6	9.1	11.0

EXPERIMENT 2102 STANDARD BLACK BEAN YIELD TRIAL (+N) **PLANTED: 6/2/21**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B20536	B15430/B16504	30	39.2	21.8	44.0	85.0	2.0	50.8	6.0
B20599	B16506/B15430	18	37.7	20.8	44.0	87.0	2.5	51.5	5.0
B16504	Zenith//Alpena*/B09197	7	37.7	20.4	44.0	89.0	2.0	45.5	4.5
B20591	B16505/B16504	19	36.9	21.6	44.0	86.0	2.0	50.0	5.0
B18504	Zenith//Alpena*/B09197, **ADAMS**	2	36.1	20.5	44.0	87.0	2.0	47.5	4.5
B20590	B16505/B16504	34	35.7	20.1	44.0	88.0	1.5	53.5	5.0
B19309	B15414/B16504	1	35.6	20.1	44.0	83.0	2.0	48.0	5.0
B19344	B16506/B16507	3	35.5	22.2	44.0	83.0	1.5	50.8	5.0
B20597	B16506/B15430	20	35.4	23.5	44.0	82.0	1.0	45.3	5.5
B20538	B15430/B16504	36	34.8	21.7	44.0	85.0	1.5	49.8	5.5
B20527	B14302/B15430	31	34.6	19.9	44.0	83.0	2.5	43.8	5.0
B20549	B16501/B16504	22	34.4	23.7	44.0	83.0	2.0	50.3	4.5
B20639	B17730/B15430	37	34.1	19.6	45.0	83.0	1.0	52.3	5.5
B20602	B16506/B16504	23	34.0	24.8	44.0	83.0	1.0	42.8	4.5
B20532	B15430/B16504	24	34.0	20.3	44.0	85.0	2.0	48.0	6.0
B20617	B17106/N14218	26	33.5	20.3	44.0	85.0	1.0	46.0	4.0
B19332	B16501/B15464	15	33.4	19.7	44.0	87.0	2.0	49.5	5.0
B19340	B16507/B15453	9	33.0	22.8	45.0	87.0	2.0	52.5	5.0
B10244	B04644/ZORRO, **ZENITH**	5	32.9	20.2	44.0	83.0	1.5	47.0	5.0
B20542	B16501/B15430	29	32.7	20.9	44.0	83.0	1.0	43.0	4.0
B20616	B17106/B17259	41	32.7	19.9	44.0	86.0	1.0	46.3	5.0
B20547	B16501/B16504	21	32.7	20.7	44.0	85.0	1.0	49.8	4.0
B19330	B16501/B15414	4	32.6	22.7	44.0	86.0	2.5	43.3	3.5
B19341	B16507/B16501	13	32.1	21.0	44.0	87.0	1.0	44.5	4.5
B19345	B16506/B16507	6	32.0	20.8	44.0	82.0	1.0	42.8	4.0
B19339	B16507/B15453	11	31.8	22.1	44.0	87.0	1.5	49.5	4.0
B20579	B16504/B17259	40	31.8	22.8	44.0	86.0	1.5	42.8	4.0
B20621	B17106/N14218	35	31.6	18.1	44.0	84.0	1.5	48.3	5.0
B20582	B16504/B17523	32	31.2	18.8	44.0	86.0	1.5	49.5	5.0
I21901	BL14500, **NIMBUS**	42	31.1	21.8	44.0	89.0	2.5	48.5	3.0
B20620	B17106/N14218	27	31.1	18.2	44.0	86.0	1.5	52.3	5.0
B20642	B17730/B16504	25	31.0	20.2	44.0	84.0	1.0	55.3	4.0
B20627	B17540/N14218	39	30.8	19.3	44.0	84.0	1.5	46.3	5.0
B20623	B17523/B16504	38	30.6	18.5	44.0	86.0	1.0	44.8	4.0
I03390	ND9902621-2, **ECLIPSE**	12	30.5	20.1	44.0	86.0	2.0	40.0	3.5

EXPERIMENT 2102 STANDARD BLACK BEAN YIELD TRIAL (+N) **PLANTED: 6/2/21**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B04554	B00103*/X00822, **ZORRO**	10	30.2	20.4	44.0	87.0	2.5	43.3	4.0
B20629	B17692/B16504	28	28.8	18.7	44.0	88.0	2.0	49.8	4.5
B18236	B14303/B12724	14	28.5	21.0	44.0	85.0	2.0	42.5	4.5
B20632	B17692/B16504	33	28.5	19.2	44.0	84.0	1.0	39.3	3.5
I19703	BL14506, **BLACK BEARD**	16	28.3	21.2	44.0	90.0	3.0	48.8	3.0
I17501	Jaguar/BL05222, **BLACK BEAR**	8	27.4	19.1	44.0	90.0	3.0	42.3	3.0
I07112	**R99 NO NOD**	17	3.9	17.6	46.0	96.0	1.5	30.8	1.0
MEAN (42)			32.1	20.6	44.1	85.5	1.7	46.8	4.4
LSD (.05)			3.6	0.9	0.4	2.6	0.8	5.3	0.7
CV%			9.5	3.6	0.7	1.8	29.1	9.6	8.9

EXPERIMENT 2118 NATIONAL WHITE MOLD YIELD TRIAL **PLANTED: 6/9/21**

NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	DES. SCORE	WHITE MOLD (1-9)	WHITE MOLD (%)
G19611	G16346/G16318	13	24.9	37.9	47.0	95.0	4.3	5.7	63.0
I09203	SR9-5	6	23.0	31.1	46.0	95.0	3.0	5.0	55.6
I18606	NE1-17-36	12	22.0	39.3	43.0	90.0	3.0	5.7	63.0
B19309	B15414/B16504	9	21.5	19.7	49.0	94.0	4.0	5.3	59.3
I21902	ND172568	5	20.4	38.2	47.0	93.0	3.0	7.0	77.8
P16901	Eldorado/P11519, **CHARRO**	16	19.4	38.6	48.0	90.0	4.0	6.7	74.1
P19713	P16911/P16901	15	18.8	30.3	45.0	89.0	3.7	5.0	55.6
S18904	S14706/R13752	10	17.6	36.5	49.0	94.0	3.7	6.7	74.1
I81010	JAPON3/MAGDALENE, **BUNSI**	3	14.5	18.6	43.0	93.0	3.0	5.0	55.6
I21929	SR16-1	7	14.1	37.3	50.0	95.0	3.0	5.7	63.0
G19613	G16351/P16902	14	13.9	35.1	46.0	88.0	3.3	7.0	77.8
I96417	**G122**	1	11.7	38.2	48.0	96.0	3.0	3.0	33.3
I20816	**ND132162, ND POLAR**	4	9.6	16.6	50.0	92.0	3.7	5.3	59.3
I19719	SR16-2	8	9.1	28.7	50.0	87.0	3.0	8.0	88.9
N19246	N15331/N16405	11	9.0	17.9	48.0	94.0	3.0	3.3	37.0
I89011	**BERYL**	2	7.8	33.2	43.0	87.0	2.0	8.7	96.3
MEAN (16)			16.1	31.1	47.1	92.0	3.3	5.8	64.6
LSD (.05)			2.1	1.1	2.6	2.7	0.5	1.5	16.1
CV%			9.2	2.1	3.9	2.1	9.9	18.0	18.0

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Impact of Outlook postemergence on dry edible bean

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

Location: East Lansing	**Tillage:** Conventional
Planting Date: June 1, 2021	**Row width:** 30-inch
Replicated: 4 times	**Population:** 109,000 seeds/A
Variety: 'Zenith' black beans	**PPI:** Prowl H_2O (2 pt) + Outlook (11 fl oz)
Soil Type: clay loam **O.M.:** 2.6% **pH:** 7.2	**POST application date:** July 2, 2021

Table 1. Injury, yield, and common ragweed control from POST herbicide treatments of Outlook tank-mixtures to V2 dry beans.

POST Treatments[a]	Injury (7 DAT)	C. ragweed control (28 DAT)	Yield
	— % —	— % —	— cwt/A —
Varisto (21 fl oz)	9	77	31.6
Outlook (10 fl oz) + Varisto (21 fl oz)	3	86	27.8
Outlook (20 fl oz) + Varisto (42 fl oz) – 2X rate	9	91	32.4
Reflex (1 pt) + Varisto (21 fl oz)	18	100	33.8
Outlook (10 fl oz) + Reflex (1 pt) + Varisto (21 fl oz)	16	100	33.5
Dual II Magnum (1.33 pt) + Reflex (1 pt) + Varisto (21 fl oz)	19	100	32.3
Warrant (3 pt) + Reflex (1 pt) + Varisto (21 fl oz)	14	100	30.0
Outlook (10 fl oz) + Reflex (1 pt)	15	100	29.0
Untreated	0	0	18.8
$LSD_{0.05}$[b]	*8.3*	*5.6*	*6.0*

[a] All treatments were applied with crop oil concentrate (COC) (1% v/v) + AMS (2.5 lb).
[b] Means within a column greater than least significant difference (LSD) value are 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. Although not labeled for POST use in dry bean, Dual II Magnum and Warrant tank-mixtures were also examined. Herbicide injury to dry beans was greatest 7 DAT and was negligible by 28 DAT. At 7 DAT, the addition of 10 fl oz/A of Outlook to Varisto at the full- and 2-times the labeled rate did not increase dry bean injury compared with Varisto alone. Tank-mixing Reflex with Varisto resulted in slightly higher dry bean injury than Varisto alone. Adding Outlook (10 fl oz/A), Dual II Magnum, or Warrant to this mixture also did not significantly increase dry bean injury. Common ragweed control was also evaluated in this trial. Common ragweed control was 100% when Reflex was included in the treatment. Additionally, there were no differences in dry bean yield with any of the tank-mixtures. Dry bean yield was reduced by at least 32% if an effective POST herbicide treatment was not applied. While this trial provides some insights on potential injury from Outlook POST tank-mixtures, we will need to continue to examine additional studies under different environmental conditions. From this research it appears that if Outlook at 10 fl oz/A is added to Varisto, Varisto + Reflex, or Reflex alone there will not be an increase in dry bean injury compared with any of these herbicide treatments alone.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Overlapping residuals for waterhemp control in dry edible beans

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

Location:	Shiawassee County	**Tillage:**	Conventional
Planting Date:	May 20, 2021	**Row width:**	30-inch
Replicated:	4 times	**PRE application date:**	May 20, 2021
Variety:	'Zenith' black beans	**POST application date:**	June 16, 2021

Table 1. Waterhemp control 21, 35, and 56 d after POST treatment (DAT) from overlapping residuals alone and with Reflex.

		Waterhemp control		
Herbicide treatments		**21 DAT**	**35 DAT**	**56 DAT**
PREs	**POST[a]**	— % —	— % —	— % —
None	Reflex (1 pt)	81	79	61
None	Outlook (21 fl oz) + Reflex (1 pt)	91	88	81
None	Dual II Magnum (2 pt) + Reflex (1 pt)	97	88	86
None	Warrant (3 pt) + Reflex (1 pt)	95	84	81
Outlook (11 fl oz)	Outlook (10 fl oz) + Varisto (21 fl oz)	99	98	95
Dual Magnum (1 pt)	Dual Magnum (1 pt) + Varisto (21 fl oz)	96	93	88
Warrant (1.5 pt)	Warrant (1.5 pt) + Varisto (21 fl oz)	99	93	89
None	Reflex (1 pt) + Varisto (21 fl oz)	81	77	68
Outlook (11 fl oz)	Outlook (10 fl oz) + Reflex (1 pt) + Varisto (21 fl oz)	100	100	96
Dual Magnum (1 pt)	Dual Magnum (1 pt) + Reflex (1 pt) + Varisto (21 fl oz)	100	100	100
Warrant (1.5 pt)	Warrant (1.5 pt) + Reflex (1 pt) + Varisto (21 fl oz)	100	100	98
	Untreated	0	0	0
$LSD_{0.05}$[b]		*8.1*	*10.8*	*11.5*

[a] All treatments were applied with crop oil concentrate (COC) (1% v/v) + AMS (2.5 lb).
[b] Means within a column greater than least significant difference (LSD) value are different from each other.

Summary: Herbicide-resistant waterhemp is becoming more prevalent throughout Michigan. Even though glyphosate is not a major component for weed control in dry bean, ALS-resistant waterhemp is wide spread. Additionally, a few populations have also been found to be resistant to the Group 14 herbicides (Reflex) limiting potential options for waterhemp control in dry bean. Overlapping residual herbicide programs may be one potential way to effectively control glyphosate-resistant waterhemp. Currently, Outlook is the only residual (Group 15) herbicide labeled for early POST applications in dry bean. However, we also wanted to compare Outlook with other Group 15 herbicides that could potentially be labeled as early POST applications in the future. We compared full-rate and split-applications (PRE followed by EPOS) of the Group 15 herbicides Outlook, Dual Magnum, and Warrant with and without Reflex. Reflex was included to control any emerged waterhemp. From this trial we found that Reflex provided approximately 80% waterhemp control alone 21 DAT and was significantly lower by the end of the growing season. When a residual was added, control was higher due to the residual activity on later emerging waterhemp. The split applications of the residual herbicides generally resulted in greater control later in the season (late-August). These results show that if a grower has or is concerned about waterhemp in their dry beans a program they should consider applying is a split-application of Outlook, PRE followed by EPOS, especially if Reflex is in the POST application. This treatment provided excellent waterhemp control from this first year of research. We will be repeating this trial to confirm these results.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Fall-planted cover crop effects on horseweed and dry edible beans

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

Location: East Lansing	**Tillage:** No-till
Soil Type: clay loam **O.M.:** 2.1% **pH:** 6.9	**Variety:** 'Zenith' black beans
Replicated: 4 times	**Population:** 109,000 seeds/A
Cereal rye: 'Wheeler' at 60 lbs/A	**Cover termination:** May 21, 2021 (14 EPP)
Planting date: Oct. 16, 2020	June 2, 2021 (Roller/ Roller crimper)
Winter wheat: 'Whale' at 60 lbs/A	**Planting date:** June 2, 2021
Planting date: Oct. 16, 2020	**POST application date:** July 12, 2021

Table 1. Effect of fall-planted cereal cover crops on horseweed suppression, dry bean growth, maturity and yield.

		At POST[b]			
Cover crop	**Termination[a]**	**Dry bean stunting**	**Horseweed suppression**	**Maturity** (100 DAP)	**Yield**
		—— % ——	—— % ——	—— % ——	— cwt/A —
No cover		0	0	86	40.0
Wheat	14 EPP	4	91	73	30.7
	14 EPP + Roller	6	95	73	33.7
Cereal rye	14 EPP	5	96	69	31.0
	14 EPP + Roller	11	99	75	29.9
	Roller crimper	20	100	65	28.9
$LSD_{0.05}$[c]		*4.4*	*5.2*	*5.6*	*4.7*

[a] 14 EPP treatments consisted of Roundup PowerMax at 32 fl oz/A + AMS.
[b] All plots were treated POST with Reflex (1 pt) + Raptor (4 fl oz) + Basagran (16 fl oz) + COC (1%) + AMS (2.5 lb)
[c] Means within a column greater than least significant difference (LSD) value are different from each other.

Summary: The use of cover crops as a weed suppression tool is becoming increasingly popular amongst cropping systems in the United States due to herbicide-resistant weeds. One approach that has been shown to suppress weeds in other cropping systems is the use of cereal rye. Winter wheat and cereal rye was drilled at 60 lb/A the fall prior dry bean planting. Approximately 2 weeks prior to planting, cover crops were terminated with glyphosate. Cereal rye was at Feekes stage 10.5 and 36-inches tall and winter wheat was at Feekes stage 10 and 22-inches tall at termination. Just prior to planting half of the glyphosate terminated cover crops were rolled with a field roller. One treatment of cereal rye was not terminated with glyphosate and a roller crimper was used to terminate rye in this treatment just prior to planting. These cover crop treatments were compared with a no cover control. Dry beans that were planted into the cover treatments resulted in reduced growth, with roller crimper treatment stunting dry bean approximately 20% compared with the no cover control. This was likely the result of another 2 weeks of cover crop growth. These covers also suppressed glyphosate-resistant horseweed >90% on a low population (~3 plants/ft^2). All covers also delayed maturity of dry beans compared with the no cover control. Dry beans planted in standing glyphosate-terminated cereal rye and cereal rye that was crimped resulted in the greatest delay in emergence. All cover crop treatments resulted in reduced dry bean yield. Even though these covers were good for horseweed suppression, we need to develop strategies that would alleviate the cover crop competition with the dry bean crop. Strip-tillage, earlier termination of the covers, or reducing cover growth by planting covers in the spring could potentially be systems that would work.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Spring-planted cover crop effects on dry edible beans

Christy Sprague and Scott Bales, Michigan State University

Location: Richville (SVREC)	**Tillage:** No-till
Soil Type: clay loam **O.M.:** 2.4% **pH:** 8.0	**Variety:** 'Black Bear' black beans
Replicated: 4 times	**Population:** 109,000 seeds/A
Cover crop planting date: March 22, 2021	**Planting date:** June 2, 2021
Cover termination: May 22, 2021	**POST application date:** July 6, 2021[d]

Table 1. Effect of spring-planted cover crops on weed suppression and dry bean growth and yield.

	Cover crop[a]		Weed[a]			
	Biomass	**Height**	**Counts**	**Biomass**	**Stand[b]**	**Yield**
Treatments[c]	— lbs/A —	— inches —	— #/m^2 —	— g/m^2 —	— #/ft —	— cwt/A —
No cover	0	0	22	3.5	4.7	29.8
Oats (1 bu/A)	364	10	14	1.0	3.1	25.6
Oats (2 bu/A)	520	10	5	0.1	1.2	23.5
Cereal rye (1 bu/A)	302	5	20	4.7	3.3	26.5
Cereal rye (2 bu/A)	416	6	5	0.2	3.3	26.3
Winter wheat (1 bu/A)	217	4	13	0.9	4.0	31.9
Winter wheat (2 bu/A)	213	4	14	0.5	3.8	25.3
LSD$_{0.05}$[e]	*193*	*0.5*	*14*	*N.S.*	*0.65*	*5.6*

[a] Cover crop biomass, heights, weed counts and biomass were measured just prior to cover crop termination.
[b] Dry bean stand counts were taken 1 week after planting.
[c] Cover crops were terminated with Roundup PowerMax at 32 fl oz/A + AMS.
[d] A POST application of Raptor (4 fl oz) + Basagran (16 fl oz) + Reflex (8 fl oz) + COC + AMS was applied to the entire trial on July 6, 2021.
[e] Means within a column greater than least significant difference (LSD) value are different from each other.

Summary: Cover crops have been used to suppress weeds, as well as provide several other benefits, in many different crops. Since dry beans are planted later in the season, fall-planted cover crops may have too much growth prior to dry bean planting that could potential interfere with dry bean growth and suppress yield. This trial was conducted to determine what effects spring planted cereal cover crops may have on early-season weed suppression and dry bean growth. Oats, cereal rye, and winter wheat were all planted at two different seeding rates in late March and were allowed to grow for approximately 2 months. The cereal cover crops were terminated approximately 2 weeks prior to dry bean planting. At the time of termination, cover crop biomass, height, weed counts and biomass were measured. Oats and cereal rye provided the greatest cover crop biomass and wheat provided the least amount of biomass. Within each cover crop there was no statistical difference cover biomass due to seeding rate. Oats were the tallest cover, followed by cereal rye, and then wheat. Weed numbers were only reduced in oats and cereal rye planted at 2 bu/A compared with the no cover control, however there were no differences in weed biomass. Oats, cereal rye, and the high rate of winter wheat also slowed down dry bean emergence. At the end of the season, dry bean yield was for all cover crops was similar to the no cover control, except for dry beans planted in terminated oats at the highest seeding rate.

Carryover potential of fall application of Tiafenacil to dry bean

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

Location: East Lansing	**Tillage:** Conventional
Planting Date: June 1, 2021[a]	**Row width:** 30-inch
Replicated: 4 times	**Population:** 109,000 seeds/A
Variety: 'Zenith' black beans	**Application date:** Oct. 5, 2020 (FALL)
Soil Type: loam	**O.M.:** 2.8% **pH:** 5.8

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

	Stand	Injury			
Treatments	**21 DAP**	**21 DAP**	**42 DAP**	**66 DAP**	**Yield**
	#/100' row	— % —	— % —	— % —	*cwt/A*
Tiafenacil (1 fl oz) + MSO	224	6	0	0	30.1
Tiafenacil (2 fl oz) + MSO	211	13	3	0	30.5
Tiafenacil (3 fl oz) + MSO	193	20	2	0	26.8
Tiafenacil (4 fl oz) + MSO	215	5	0	0	35.5
Sharpen (2 fl oz) + MSO	203	9	1	0	34.0
Sharpen (4 fl oz) + MSO	187	15	1	0	32.1
Untreated	219	0	0	0	33.8
$LSD_{0.05}$[b]	*33.4*	*10.2*	*2.1*	*N.S.*[c]	*4.4*

[a] Roundup PowerMax at 32 fl oz/A + AMS was applied to the entire study prior to planting and treated to be weed-free for the remainder of the season.
[b] Means within a column greater than least significant difference (LSD) value are different from each other.
[c] N.S. = not significant.

Summary: Tiafenacil is a new herbicide being evaluated for spring and fall 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 the previous fall. Tiafenacil was compared with saflufenacil at various application rates, knowing that under certain conditions saflufenacil applications the fall prior to planting dry beans can cause substantial stand loss, injury, and yield. Initial dry bean injury from tiafenacil ranged from 5 to 20% and was similar to similar rates of saflufenacil. By 42 d after planting dry bean injury was negligible. None of the treatments resulted in significant stand loss compared with the untreated control. However, slight dry bean stand loss occurred with the highest rate of saflufenacil compared with the treatment with highest stand. Most treatments did not affect dry bean yield, with the exception of tiafenacil at 3 fl oz/A. This treatment resulted in a 20% reduction in yield compared with the untreated control. Though not observed this year, it is expected under certain conditions Sharpen could also affect dry bean yield. This is the first year out of three where we have observed some carryover from tiafenacil, even though the highest rate of 4 fl oz/A did not affect yield. It will be important to examine further the soil type and weather conditions that may have contribute to the reduced breakdown of this herbicide, particularly in the 3 fl oz/A tiafenacil treatment.

TABLE 5A – Weed Response to Herbicides in Dry Edible Beans*

			ANNUAL BROADLEAVES									ANNUAL GRASSES								PERENNIALS				
	SITE OF ACTION	CROP TOLERANCE**	COCKLEBUR	JIMSONWEED	LAMBSQUARTERS	NIGHTSHADE (E. BLACK)	PIGWEED	RAGWEED (COMMON)	SMARTWEED	VELVETLEAF	WILD MUSTARD	BARNYARDGRASS	CRABGRASS	GIANT FOXTAIL	GREEN FOXTAIL	YELLOW FOXTAIL	FALL PANICUM	WITCHGRASS	SANDBUR	BINDWEED (FIELD)	BINDWEED (HEDGE)	CANADA THISTLE	QUACKGRASS
Preplant Incorporated																								
DUAL MAGNUM/PARALLEL	15	2	N	N	P	F	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**G**	**G**	F	N	N	N	N	**G**
EPTAM	15	2	P	P	**G**	F	F	F	F	F	F	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	F	F
OUTLOOK	15	3[a]	N	N	P	**G**	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**G**	**G**	P	N	N	N	N	F
PROWL H_2O/PROWL	3	1	N	N	**G**	P	F	P	P	F	P	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N
PURSUIT	2	3	F	F	P	**E**	**E**	P	F	F	**G**	P	P	F	F	F	P	P	P	N	N	N	N	F
SONALAN	3	1	N	N	**G**	F	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N
TRIFLURALIN	3	1	N	N	**G**	N	**G**	N	P	N	P	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**G**	N	N	N	N	N
Preemergence																								
DUAL MAGNUM/PARALLEL	15	2	N	N	P	F	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**G**	**G**	F	N	N	N	N	F
PERMIT/SANDEA	2	3	F	F	F	P	**E**	**G**	P	**G**	**E**	N	N	N	N	N	N	N	N	N	N	N	N	F
PURSUIT	2	3	P	P	P	**E**	**E**	P	F	P	**G**	P	P	F	F	F	P	P	P	N	N	P	N	F
REFLEX	14	2	P	P	**G**	**E**	**E**	**G**	**G**	P	**E**	N	N	N	N	N	N	N	N	N	N	N	N	N
SEQUENCE[b]	9/15	2	N	N	P	F	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**G**	**G**	F	N	N	N	N	F
Postemergence																								
ASSURE II/TARGA	1	1	N	N	N	N	N	N	N	N	N	**G**	**G**	**E**	**E**	**G**	**E**	**E**	**E**	N	N	N	**E**	N
BASAGRAN	6	2	**E**	**G**	F	P	P	F	**E**	**G**	**E**	N	N	N	N	N	N	N	N	N	N	**G**	N	**G**
FUSILADE DX	1	1	N	N	N	N	N	N	N	N	N	**E**	**G**	**E**	**E**	**E**	**E**	**E**	**E**	N	N	N	**G**	N
OUTLOOK[d]	15	2	N	N	P	**G**	**G**	P	P	N	P	**E**	**E**	**E**	**E**	**E**	**G**	**G**	P	N	N	N	N	F
PERMIT	2	3	**E**	**G**	N	P	**E**	**G**	F	**G**	**E**	N	N	N	N	N	N	N	N	P	P	P	N	**E**
POAST	1	1	N	N	N	N	N	N	N	N	N	**E**	**G**	**E**	**E**	**E**	**E**	**E**	**E**	N	N	N	F	N
PURSUIT[e]	2	3	F	P	P	**E**	**E**	P	F	F	**E**	P	P	F	P	P	P	P	P	N	N	P	N	F
PURSUIT[e] + BASAGRAN	2/6	2	**E**	**G**	F	**E**	**E**	F	**G**	**G**	**E**	P	P	F	P	P	P	P	P	N	N	**G**	N	**G**
RAPTOR[e]	2	3	F	F	F	**E**	**E**	P	F	**G**	**E**	F	P	F	P	P	P	P	P	N	N	P	N	P
RAPTOR[e] + BASAGRAN 8 oz (4L)	2/6	2	**G**	F	F/**G**	**E**	**E**	F	**G**	**G**	**E**	F	P	F	P	P	P	P	P	N	N	F	N	F
or 6 .4 oz (5L)																								
RAPTOR[ef] + BASAGRAN 16 oz (4L)	2/6	2	**E**	**G**	**G**	**E**	**E**	F	**E**	**G**	**E**	P	P	F	P	P	P	P	P	N	N	**G**	N	F
or 12 .8 oz (5L)																								
REFLEX	14	2	P	F	P	**G**	**G**	**E**	P	P	**E**	N	N	N	N	N	N	N	N	N	N	N	N	N
REFLEX + BASAGRAN	6/14	2	**E**	**G**	F/**G**	**G**	**G**	**E**	**E**	**G**	**E**	N	N	N	N	N	N	N	N	N	N	F	N	**G**
REFLEX + RAPTOR[f]	2/14	3	F	F	F	**E**	**E**	**E**	F	**G**	**E**	F	P	F	P	P	P	N	N	N	N	P	N	P
SELECT/SELECT MAX/ARROW	1	1	N	N	N	N	N	N	N	N	N	**E**	**G**	**E**	**E**	**E**	**E**	**E**	**E**	N	N	N	**G**	N
VARISTO	2/6	2	**E**	**G**	**G**	**E**	**E**	F	**E**	**G**	**E**	P	P	F	P	P	P	P	P	N	N	**G**	N	F

Herbicide Site of Action: The site of action key is located on pages 15-16 .

Herbicide Effectiveness: P = Poor; F = Fair; **G** = Good; **E** = Excellent; N = None

* The above ratings are a relative comparison of herbicide effectiveness . Weather conditions greatly influence the herbicide's effectiveness, and weed control may be better under favorable conditions or poorer under unfavorable conditions .

** Crop Tolerance: 1 = Minimal risk of crop injury; 2 = Crop injury can occur under certain conditions (soil applied — cold, wet; foliar applied — hot, humid); 3 = Severe crop injury can occur. Follow precautions under Remarks and Limitations and on the label; 4 = Risk of severe crop injury is high.

[a] Crop tolerance for navy and black beans = 3. For other bean classes, crop tolerance = 2. Preplant incorporation will increase tolerance of navy and black beans to *Outlook* .

[b] Sequence is a premixture of *Dual Magnum* and glyphosate and should be used to control existing vegetation prior to planting dry beans. See Remarks and Limitations section.

[c] Control of **hairy nightshade** is good.

[d] *Outlook* will not control emerged weeds but will provide residual control of the above listed species including waterhemp.

TABLE 5B – Dry Edible Bean Herbicides – Remarks and Limitations

Dry Edible Beans — Preplant Incorporated Only

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual grasses	EPTC *(Eptam)*	2 .25	1 .25 qt 7EC	• **Apply preplant incorporated only**. • Refer to Table 5A for weed control and crop tolerance ratings . • Incorporate immediately after application. • *Eptam* suppresses common ragweed and wild mustard. • ***Prowl* (pendimethalin)**, ***trifluralin***, or ***Sonalan*** should be **tank mixed** with ***Eptam*** for additional broadleaf control, including lambsquarters. • *Pursuit* (2 oz) can be added to tank mixes with *Prowl*, *trifluralin*, or *Sonalan* for nightshade control. • *Pursuit* (2 oz) may also be applied preemergence after preplant incorporated applications of *Eptam* tank mixed with *Prowl, trifluralin*, or *Sonalan*. See remarks for *Pursuit*. • A postemergence application of *Basagran, Pursuit* or *Raptor* may be necessary for additional broadleaf control . • DO NOT use on adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.
	dimethenamid-P *(Outlook)*	0.66	14 oz 6L	• **Apply preplant incorporated only.** • Refer to Table 5A for weed control and crop tolerance ratings. • *Outlook* may be applied early postemergence. Refer to the postemergence section for more information. • Reduce the *Outlook* rate to 12 oz/A on coarse-textured soil with low organic matter. • Navy and black beans are more sensitive to *Outlook* applications than *Dual Magnum.* • *Outlook* provides better pigweed and nightshade control than Dual Magnum. • *Prowl*, *trifluralin*, or *Sonalan* can be tank mixed preplant incorporated for lambsquarters control. • *Pursuit* (2 oz) can be tank mixed for nightshade and additional broadleaf weed control. • A postemergence application of *Basagran*, *Pursuit*, or *Raptor* may be necessary for additional broadleaf control. • DO NOT apply *Outlook* within 70 days of harvest. • DO NOT use on adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.
Annual grasses **Annual broadleaves**	pendimethalin *(Prowl)* OR *(Prowl H_2O)*	0.75	1.8 pt 3.3EC OR 1.6 pt 3.8CS	• **Apply preplant incorporated only**. • Refer to Table 5A for weed control and crop tolerance ratings. • Incorporate immediately after application. • *Prowl* provides better velvetleaf control than *trifluralin* or *Sonalan* . • ***Prowl*** should be **tank mixed** with ***Eptam***. Other measures may need to be taken for additional broadleaf control. • Refer to label and Table 12 for crop rotation restrictions.
	ethalfluralin (Sonalan)	0.75	2 pt 3EC	• **Apply preplant incorporated only.** • Refer to Table 5A for weed control and crop tolerance ratings. • Incorporate immediately after application. • ***Sonalan*** should be **tank mixed** with ***Eptam*** . Other measures may need to be taken for additional broadleaf control. • Refer to label and Table 12 for crop rotation restrictions.

(Continued on next page)

Dry Edible Beans — Preplant Incorporated Only *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual grasses **Annual broadleaves**	trifluralin *(many)*	0 .5	1 pt 4EC	• **Apply preplant incorporated only.** • Refer to Table 5A for weed control and crop tolerance ratings . • Incorporate immediately after application. • *Trifluralin* provides better pigweed control than *Prowl* or *Sonalan* . • ***Trifluralin*** should be **tank mixed** with ***Eptam***. Other measures may need to be taken for additional broadleaf control . • Refer to label and Table 12 for crop rotation restrictions.

Dry Edible Beans — Soil Applied

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual grasses	s-metolachlor *(Dual Magnum, EverpreX)* OR *(Dual II Magnum, Cinch)*	1 .27	1 .33 pt 7 .62EC OR 1 .33 pt 7 .64EC	• **May be applied preplant incorporated or preemergence.** • Refer to Table 5A for weed control and crop tolerance ratings . • PREPLANT INCORPORATED *Dual Magnum* minimizes the danger of bean injury . • DO NOT apply if soil is cracking and beans are in the crook stage . • Reduce *Dual Magnum* rate to 1 pt/A on coarse-textured soils with low organic matter . • Preemergence applications require rainfall for incorporation . Rotary hoe if no rainfall occurs within 7 days . • *Dual Magnum* provides better yellow nutsedge control than *Outlook* . • *Prowl, trifluralin* or *Sonalan* can be tank mixed preplant incorporated for lambsquarters control . • *Pursuit* (2 oz) can be tank mixed for nightshade and additional broadleaf control . • A postemergence application of *Basagran, Pursuit* or *Raptor* may be necessary for additional broadleaf control . • DO NOT apply *Dual Magnum* within 60 days of harvest . • DO NOT use on adzuki beans . • Refer to label and Table 12 for crop rotation restrictions .
	metolachlor *(Parallel PCS)*	1 .3	1 .33 pt 8EC	• **May be applied preplant incorporated or preemergence.** • *Parallel PCS* is a mix of the R and S-isomers of metolachlor. Limited research has shown that 1 .33 pt/A of these products provide similar activity to s-metolachlor products at 1 .33 pt/A. However, *Parallel PCS* may not provide the consistency, length of control or performance on more difficult to control weeds. Rates would need to be increased to 2 .0 pt/A to provide the same amount of s-metolachlor (the more active isomer) in the 1 .33 pt/A rate of *Dual Magnum/ Dual II Magnum/Cinch* (s-metolachlor). • Refer to Table 5A for weed control and crop tolerance ratings . • See remarks and limitations for *Dual Magnum* . • DO NOT use on adzuki beans . • Refer to label and Table 12 for crop rotation restrictions .

(Continued on next page)

Dry Edible Beans — Soil Applied *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual grasses	glyphosate + s-m etolachlor *(Sequence)* + ammonium sulfate	1.64	3 pt 2.25L + 17 lb/100 gal	• **May be applied preplant or preemergence.** • Sequence contains 0.9 lb a.e./A of glyphosate and 1.2 pt/A of *Dual Magnum*. • *Sequence* is best used to control existing vegetation prior to planting no-till dry beans with the residual control of *Dual Magnum*. • Refer to Table 5A for residual weed control and crop tolerance ratings. • DO NOT apply to emerged dry bean – severe injury will occur. • DO NOT apply more than 3.5 pt/A on coarse textured soils or 4 pt/A on medium and fine textured soils. • Apply only one application per crop year. • Refer to label and Table 12 for crop rotation restrictions.
Annual broadleaves	halosulfuron *(Permit/Sandea)*	0.023	0.67 oz 75DG	• **May be applied preplant incorporated or preemergence.** • Refer to Table 5A for weed control and crop tolerance ratings. • Reduce the rate of *Permit/Sandea* to 0.5 oz/A on lighter textured soils with low organic matter. • *Permit/Sandea* can cause injury under cool and wet growing conditions. • Delayed maturity may result from applications of *Permit/Sandea*. • Dry bean varieties and classes vary in their tolerance to *Permit/Sandea*. From MSU research, CAUTION should be taken when applying *Permit/Sandea* to kidney and black beans. • *Permit/Sandea* can be tank mixed with *Eptam* for grass and additional lambsquarters control. • *Permit/Sandea* can be tank mixed with metolachlor products or *Outlook* for annual grass control. • *Permit/Sandea* will not control ALS-resistant weed species. • DO NOT plant SUGAR BEETS within 21 months of a *Permit/Sandea* application. • Refer to label and Table 12 for crop rotation restrictions.
	imazethapyr *(Pursuit)*	0.031	2 oz 2L	• **May be applied preplant incorporated or preemergence.** • Refer to Table 5A for weed control and crop tolerance ratings. • DO NOT use on sands or loamy sand soils. • DO NOT apply *Pursuit* if cold and/or wet conditions are present or predicted to occur within 1 week of application. • Delayed maturity may result from applications of *Pursuit*. DO NOT apply if planting is delayed and frost is likely to occur prior to maturity. • On heavy soils with greater than 2% organic matter and heavy weed pressure, 3 oz of *Pursuit* may be applied. • *Pursuit* can be tank mixed and applied preplant incorporated with *Eptam* plus *trifluralin*; *Prowl* or *Sonalan*; or *Dual Magnum* or *Outlook*; or preemergence with *Dual Magnum* or *Outlook*. *Pursuit* in these mixes will control eastern black nightshade. • Preemergence applications require rainfall for incorporation. Rotary hoe if no rainfall occurs within 7 days. • *Pursuit* will NOT control common ragweed. • Dry bean varieties vary in their sensitivity to *Pursuit*. Use ONLY on navy, black turtle, pinto, kidney, and cranberry beans. DO NOT use on DOMINO black or OLATHE pinto beans. • DO NOT apply within 60 days of harvest. • DO NOT use if SUGAR BEETS, CUCUMBERS, CANOLA or TOMATOES are in the rotation; requires 40 months and a soil bioassay. • Refer to label and Table 12 for crop rotation restrictions.

(Continued on next page)

Dry Edible Beans — Soil Applied *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual broadleaves	fomesafen *(Reflex)*	0.25	1 pt 2L	• **May be applied preplant surface or preemergence.** • Refer to Table 5C for weed control and crop tolerance ratings. • *Reflex* will provide 4-5 weeks of control and/or suppression of broadleaf weeds. • Rainfall that splashes treated soil onto newly emerged seedlings can cause temporary crop injury. • Tank mixtures or sequential herbicide applications are needed to broaden the spectrum of weed control. • *Reflex* can be applied only in the Lower Peninsula of Michigan. • DO NOT apply *Reflex* or other fomesafen products to the same field in CONSECUTIVE years. • The maximum use rate of *Reflex* per field is 1 pint per acre. • Refer to Table 12 for crop rotation restrictions.

Dry Edible Beans — Postemergence

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Grasses	quizalofop-P-ethyl *(Assure II/Targa)* + crop oil concentrate OR surfactant	0.044	7 oz 0.88L + 1% OR 0.25%	• Refer to Table 5A for weed control and crop tolerance ratings. • Treat actively growing grasses (annual grasses up to 4 inches). • DO NOT apply to grasses under stress — poor weed control will result. • DO NOT cultivate within 5 days prior to and 7 days following application. • Allow 30 days between *Assure II/Targa* application and dry bean harvest. • *Assure II/Targa* can be tank mixed with *Basagran* for foxtails and barnyardgrass. Increase the *Assure II/Targa* rate by 2 oz. • Tank mixes with *Pursuit* and *Raptor* are not recommended — grass antagonism will occur. • *Assure II/Targa* (10 oz/A) plus crop oil concentrate (1% v/v) or nonionic surfactant (0.25% v/v) will control quackgrass 6-10 inches tall. A sequential application of 7 oz/A may be needed 14-21 days later. • Refer to label and Table 12 for crop rotation restrictions.
	fluazifop-P-butyl *(Fusilade DX)* + crop oil concentrate	0.188	12 oz 2L + 1%	• Refer to Table 5A for weed control and crop tolerance ratings. • Apply 6 oz/A of *Fusilade DX* to control volunteer corn. • Allow 60 days between *Fusilade DX* application and dry bean harvest. • Two applications 7-14 days apart are usually needed for control of perennial grasses. • Tank mixes with *Pursuit* and *Raptor* are not recommended – grass antagonism will occur. • DO NOT apply more than 48 oz/A of *Fusilade DX* per season. • Refer to label and Table 12 for crop rotation restrictions.

(Continued on next page)

Dry Edible Beans — Postemergence *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Grasses	sethoxydim *(Poast)* + crop oil concentrate + ammonium sulfate	0 .19	1 pt 1 .5SC + 1 qt + 2 .5 lb	• Refer to Table 5A for weed control and crop tolerance ratings. • Reduced rates of *Poast* (12 oz/A) may be used when barnyardgrass, green and giant foxtail, and fall panicum l are ess than 4 inches tall and the target species. • DO NOT apply to grasses under stress — poor weed control will result . • DO NOT cultivate within 5 days prior to and 7 days following application. • Allow 30 days between *Poast* application and dry bean harvest. • *Poast* is generally less effective than other postemergence grass herbicides for perennial grass control. • Tank mixes with *Pursuit* and *Raptor* are not recommended— grass antagonism will occur. • Refer to label and Table 12 for crop rotation restrictions.
	clethodim *(Select/Arrow)* + crop oil concentrate OR *(Select Max)* + surfactant + ammonium sulfate	0.094 0.068	6 oz 2EC + 1% OR 9 oz 0.97EC + 0 .25% + 2.5 lb	• Refer to Table 5A for weed control and crop tolerance ratings. • Reduced rates of *Select/Arrow* (4-5 oz/A) or *Select Max* (6-8 oz/A) may be used when some grass species are small. • The addition of ammonium sulfate at 2 .5 to 4 lb/A has been shown to improve control of difficult to control weeds, e .g., quackgrass, rhizome Johnsongrass, volunteer cereals, and volunteer corn. • DO NOT apply to grasses under stress — poor weed control will result. • DO NOT cultivate within 7 days prior to and 7 days following application. • Allow 30 days between application and dry bean harvest. • *Select/Arrow* or *Select Max* can be tank mixed with *Basagran*. Increase the *Select/Arrow* rate to 8-10 oz/A and the *Select Max* rate to 12 oz/A and apply with crop oil concentrate (1% v/v). • Tank mixes with *Pursuit* and *Raptor* are not recommended— grass antagonism will occur. • *Select/Arrow* (8-16 oz/A) plus crop oil concentrate (1% v/v) plus ammonium sulfate (2 .5 lb/A) will control quackgrass 4-12 inches tall. A sequential application of 8 oz/A may be needed 14-21 days later. Sequential applications of *Select Max* (12 + 12 oz/A) are needed to control 4 to 12 inch quackgrass. • Refer to label and Table 12 for crop rotation restrictions.
Residual annual grass control	dimethenamid-P *(Outlook)*	0.47	10 oz 6L	• Refer to Table 5A for weed control and crop tolerance ratings. • *Outlook* may be applied from the first to the third trifoliate stage. • *Outlook* will not control emerged weeds but will provide residual control of annual grasses and some broadleaf weeds, including waterhemp. • Postemergence applications may result in temporary spotting or browning of dry bean leaves and stunting. • Tank mixtures with other postemergence herbicides may result in increased dry bean injury. • DO NOT exceed a total of 21 oz/A of *Outlook* per season. • DO NOT apply *Outlook* within 70 days of harvest. • DO NOT use on adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.

Dry Edible Beans — Postemergence *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Annual broadleaves	bentazon *(Basagran)* OR *Basagran 5L* + crop oil concentrate	0 .75	1 .5 pt 4L OR 1 .2 pt 5L + 1 qt	• Refer to Table 5A for weed control and crop tolerance ratings. • Most effective on small weeds. Check dry bean label for specific rate and proper weed growth stage . • Beans MUST HAVE one fully expanded trifoliate before application . • Use a minimum of 20 gal. water/A for adequate coverage. • DO NOT apply if dry beans are under stress from herbicide injury, cold or dry weather, or hail damage . • For improved velvetleaf control 28% liquid nitrogen (2-4 qt/A) or ammonium sulfate (2.5 lb/A) can be used INSTEAD OF crop oil concentrate. However, if common ragweed and common lambsquarters are present, a crop oil concentrate must also be included. • Split applications of 1 pt + 1 pt (4L) or 0.8 pt + 0.8 pt (5L) plus crop oil concentrate (1 pt + 1 pt) can be used for more consistent common ragweed and lambsquarters control. Make the first application when weeds are less than 1 inch tall, and make second application 10-14 days later. • For CANADA THISTLE and YELLOW NUTSEDGE control, apply sequential applications of 1.5 pt + 1.5 pt (4L) or 1.2 pt + 1.2 pt (5L) plus crop oil concentrate (1 qt + 1 qt) when Canada thistle is 6-8 inches tall and yellow nutsedge is 4-6 inches. Make second application 7-10 days later. • Allow 30 days between application and dry bean harvest. • DO NOT use on adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.
	halosulfuron *(Permit)* + surfactant	0.023	0.67 oz 75WG + 0.25%	• Refer to Table 5A for weed control and crop tolerance ratings. • Most effective on small weeds (less than 2 inches). • Apply when beans have 1-3 trifoliate leaves . • DO NOT apply if dry beans have begun to flower. • *Permit* can be tank-mixed with other herbicides for additional broadleaf and grass control. • Dry bean varieties and classes vary in their tolerance to *Permit*. From MSU research, CAUTION should be taken when applying to kidney and black beans. Under adverse conditions maturity of the treated crop can be delayed which can affect harvest date, yield, and quality. • DO NOT use on adzuki beans. • DO NOT plant SUGARBEETS within 21 months of *Permit* application . • Refer to Table 12 for crop rotation restrictions.

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Dry Edible Beans — Postemergence *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual broadleaves	imazethapyr *(Pursuit)* + surfactant	0 .031	2 oz 2L + 0 .25%	• Refer to Table 5A for weed control and crop tolerance ratings. • Most effective on small weeds (less than 2 inches). • Beans MUST HAVE one fully expanded trifoliate before application . • DO NOT apply if dry beans have begun to flower. • Apply *Pursuit* with non-ionic surfactant (0 .25% v/v). • DO NOT add 28% liquid nitrogen (2 .5% v/v) or ammonium sulfate (2 .5 lb/A) unless at least 8 oz of *Basagran* 4L is added to "safen" this application. • Increase the rate of *Basagran* 4L to 16 fl oz (4L) or 12 .8 fl oz (5L) when tank mixed with *Pursuit* to control common cocklebur and jimsonweed. • Delayed maturity may result from applications of *Pursuit*. DO NOT apply if planting is delayed and frost is likely to occur prior to maturity. • DO NOT tank mix with postemergence grass herbicides — grass antagonism will occur. • Dry bean varieties vary in their sensitivity to *Pursuit*. Use ONLY on navy, black turtle, pinto, kidney, and cranberry beans. DO NOT use on DOMINO black or OLATHE pinto beans. • DO NOT apply within 60 days of harvest. • DO NOT use if sugar beets, cucumbers, canola or tomatoes are in the rotation; requires 40 months and a soil bioassay. • DO NOT use on adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.
	imazamox *(Raptor)* + bentazon *(Basagran)* + crop oil concentrate + ammonium sulfate	0.032 0.25	4 oz 1L + 8 oz 4L OR 6.4 oz 5L + 1% + 2.5 lb	• Refer to Table 5A for weed control and crop tolerance ratings. • Most effective on small weeds (less than 2 inches). • Beans MUST HAVE one fully expanded trifoliate before application. • DO NOT apply if dry beans have begun to flower. • DO NOT apply if planting is delayed and frost is likely to occur prior to maturity. • Apply *Raptor* with crop oil concentrate (1% v/v) or a non-ionic surfactant (0 .25% v/v). • At least 8 fl oz of *Basagran* 4L or 6 .4 fl oz (5L) **must** be tank mixed with *Raptor*, if ammonium sulfate (12-15 lb/100 gal) or 28% liquid nitrogen (2.5% v/v) are added. *Basagran* "safens" this application. • Increase the rate of *Basagran* to the 16 fl oz (4L) or 12.8 fl oz (5L) when tank mixed with *Raptor* to control common cocklebur and jimsonweed, and to provide good control of common lambsquarters (less than 2 inch tall). • DO NOT tank mix with postemergence grass herbicides — grass antagonism will occur. • DO NOT apply within 60 days of harvest. • DO NOT use the combination of *Raptor* + *Basagran* on adzuki beans. *Basagran* causes significant injury to adzuki beans. • Refer to label and Table 12 for crop rotation restrictions.

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Dry Edible Beans — Postemergence *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual broadleaves	fomesafen *(Reflex)* + surfactant	0 .25	1 pt 2L + 0 .25%	• Refer to Table 5A for weed control and crop tolerance ratings . • Most effective on small weeds; common ragweed 4-inches or less and eastern black nightshade 2-inches or less . • Common ragweed less than 4-inches will be controlled with 0 .5 pt/A of *Reflex* . • Beans MUST HAVE one fully expanded trifoliate before application . • A non-ionic surfactant at 0 .25-0 .5% v/v or a crop oil concentrate at 0 .5-1 .0% v/v must be included for effective control . • *Reflex* can be tank-mixed with *Basagran*, *Raptor*, or *Pursuit*. Include a COC when tank-mixing *Reflex* + *Basagran*. ONLY include a non-ionic surfactant when tank-mixing with *Raptor* or *Pursuit*. DO NOT add AMS or 28%N . • *Reflex* can be applied only in the Lower Peninsula of Michigan . • DO NOT apply *Reflex* or other fomesafen containing products to the same field in CONSECUTIVE years . • DO NOT apply within 45 days of harvest . • Refer to Table 12 for crop rotation restrictions .
	basagran + imazamox (*Varisto*) + crop oil concentrate + ammonium sulfate	0 .68	21 oz 4 .18L + 1% + 2 .5 lb	• Refer to Table 5A for weed control and crop tolerance ratings . • *Varisto* at 21 fl oz/A is equivalent to 21 fl oz (4L) or 16 .8 fl oz (5L) of *Basagran* and 4 fl oz/A of *Raptor* . • Most effective on small weeds (less than 2 inches). • Beans must have one fully expanded trifoliate before application . • DO NOT apply if dry beans have begun to flower . • DO NOT tank-mix with postemergence grass herbicides – grass antagonism will occur. • DO NOT apply within 30 days of harvest . • DO NOT use on adzuki beans . • Refer to label and Table 12 for crop rotation restrictions .

Table 5C – Preharvest Treatments in Dry Edible Beans

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
Preharvest	glyphosate *(many)* + ammonium sulfate	0 .75 lb a .e .	See Table 10 + 17 lb/100gal	• Glyphosate should ONLY be used to control weeds that hinder harvest . • Not all glyphosate products are labeled for **Preharvest** application in dry edible beans . Consult product labels for legal applications . Roundup branded products, *Duramax, Durango DMA, Touchdown Total* and *Traxion* are some glyphosate products that are currently labeled . • ***DO NOT*** use glyphosate for **vine desiccation** — residues of glyphosate have been found in harvested beans if applications are made too early . • Glyphosate should be applied when beans are in the ***hard dough stage*** **(30% moisture or less)** . • Some buyers will not purchase beans treated with glyphosate, consult your buyer prior to using glyphosate as a preharvest herbicide treatment . • Glyphosate applications should be made at least 7 days before harvest . • ONLY one application should be made per year . • DO NOT apply glyphosate to beans grown for seed . • DO NOT feed treated vines and hay from these crops to livestock .
	paraquat *(Gramoxone SL 2.0)* OR *(Gramoxone SL 3.0)* + surfactant	0 .3-0 .5	1 .2–2 pt 2SL OR 0 .8-1 .33 pt 3SL + 0 .25%	• ***Gramoxone*** **is a restricted-use pesticide.** Certified applicators are now required to complete a paraquat specific training prior to use of *Gramoxone.* The paraquat training course can be found online at: **www.epa.gov/pesticide-worker-safety/paraquat-dichloride-training-certified-applicators** . • Apply when crop is mature, at least 80% of the pods are yellowing and mostly ripe and no more than 40% (bush-type beans) or 30% (vine-type beans) of the leaves are still green. • Always add a non-ionic surfactant at 0 .25% v/v or a crop oil concentrate at 1% v/v • Apply by air in 5 gal water/A or by ground in 20-40 gal of water/A • If growth is lush and vigorous, make either a single application of the higher rate of *Gramoxone SL*; or split applications at the lower rates. Split applications may improve vine coverage. DO NOT exceed 2 .0 pt/A of *Gramoxone SL 2.0* or 1 .33 pt/A of *Gramoxone SL 3.0.* • Do not harvest within 7 days of application .
	paraquat *(Parazone)* + surfactant	0 .5	1 .33 pt 3SL + 0.25%	• ***Parazone*** **is a restricted-use pesticide.** Certified applicators are now required to complete a paraquat specific training prior to use of *Parazone.* The paraquat training course can be found online at: **www.epa.gov/pesticide-worker-safety/paraquat-dichloride-training-certified-applicators** . • *Parazone* contains the same active ingredient as *Gramoxone SL* (paraquat) . • See the Remarks and Limitation section for *Gramoxone SL 3.0* .

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Preharvest Treatments in Dry Edible Beans *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Preharvest	saflufenacil *(Sharpen)* + methylated seed oil + ammonium sulfate	0 .023	1 oz 2 .85L + 1% + 17 lb/100 gal	• Apply when crop is mature – at least 80% of the pods are yellowing and mostly ripe and no more than 40% (bush-type beans) or 30% (vine-type) beans of the leaves are still green. • *Sharpen* can be applied at rates up to 2 oz/A. • Dry beans can be harvested 2 days after application. However, it generally takes 7 days to reach maximum desiccation activity. • *Sharpen* is an effective desiccant. • DO NOT apply to beans grown for seed. • DO NOT graze or feed desiccation-treated hay or straw to livestock. • Refer to label and Table 12 for crop rotation restrictions. DO NOT include time in the rotation interval when the ground is frozen.
	flumioxazin *(Valor)* OR (*Valor EZ)* + methylated seed oil	0 .05	1 .5 oz 51WG OR 1 .5 oz 4L + 1 qt	• Apply when crop is mature – at least 80% of the pods are yellowing and mostly ripe and no more than 40% (bush-type beans) or 30% (vine-type beans) of the leaves are still green . • *Valor/Valor EZ* can be applied at rates up to 2 oz/A. • Dry beans can be harvested 5 days after *Valor* application. However, it generally takes 7 to 14 days to reach maximum desiccation activity . • Dry bean desiccation is similar to that from *Gramoxone* and glyphosate; however, the spectrum of weed control is not as broad. • *Valor* provides residual activity that may reduce winter annual growth. • Follow sprayer clean-up instructions — residues of *Valor* can be trapped in poly-tanks and hoses if not adequately cleaned. • Crop rotation restrictions are dependent on rainfall, *Valor* use rate and tillage. • Rotation restrictions for 2 oz or less of *Valor/Valor EZ* are 1 month with 1 inch of rain for corn and winter wheat. Dry bean and barley may be planted after 3 months, and alfalfa, oats and sugar beets may be planted after 4 months if the ground is tilled prior to planting or 8 months if no tillage is performed. Note: In Michigan research trials, planting sugar beet no-till the spring following a *Valor* preharvest treatment resulted in major sugar beet stand reduction. Tillage reduced the effect of *Valor* on sugar beet; however, slight injury may occur on sandier soils. • Refer to label and Table 12 for crop rotation restrictions.
	carfentrazone *(Aim)* + methylated seed oil	0.03	2 oz 2EC + 1% v/v	• Apply when crop is mature – at least 80% of the pods are yellowing and most ripe and no more than 40% (bush-type beans) or 30% (vine-type beans) of the leaves are still green. • *Aim* alone is not as effective as *Sharpen*, glyphosate, *Gramoxone*, or *Valor* for dry bean desiccation . • Tank mixtures with *Gramoxone* or glyphosate will improve dry bean desiccation and is needed to improve the spectrum of weed desiccation. • Thorough spray coverage is required – sequential applications may be needed. • The preharvest interval is 0 days for *Aim* alone.

MSU Field Crops Insect Guide: Management of Insects and Spider Mites in Dry Beans
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How to Use this Guide

This publication is set up as a series of stand-alone tables with information on insect biology, damage, management recommendations, and insecticides registered in Michigan on **dry beans**. Pesticide names and rates are current as of the date at the top of the page.

- ✓ **Table 1** shows the timing of common insect pests in the crop, from early to late season.

- ✓ **Table 2** is a checklist of damage symptoms from these insects to aid in field scouting.

- ✓ **Table 3** has information on the life cycle of each insect, plus a detailed description of its damage and the conditions that may lead to or favor infestations. A rating of pest status (and thus damage potential) is given based on experience in the state. Most insect pests are uncommon or do not increase to damaging levels in a typical year.

- ✓ **Table 4** has information on management of each pest. Most insects are kept in check by natural enemies (biological control) or by adverse environmental conditions. Some pest problems can be reduced by simply changing or avoiding certain agronomic practices. Table 4 also gives scouting and threshold recommendations. Note that these recommendations vary in quality. Key pests tend to have research-based scouting methods and thresholds. But many insects are not at damaging levels often enough to generate good information; sampling recommendations and thresholds for these species are based on observations, experience, or a best guess. This is noted in the table.

- ✓ Insecticides registered in Michigan on the crop are listed in **Table 5** (at planting) and **Table 6** (foliar sprays)**.** Active ingredients (AI) are listed alphabetically in column 1. All products with the same active ingredient are grouped together under each AI for easy comparison or substitution of one product for another. Label rates and pests are listed in columns 2 and 3. A letter under a pest indicates that a particular insect is on the label (i.e., the label claims control of that insect). The letter corresponds to an application rate in column 2. Some insecticides are applied at a single rate for all insects (‘a’), while others vary (‘a’, ‘b’, ‘c’). The final columns in the table list the preharvest interval (PHI) in days and notes on application - for example bee toxicity warnings, minimum recommended spray volumes, or other restrictions.

Dry beans Table 1. Timing of damage from common insects and related pests in Michigan
Pests are listed from early to late-season. Key species are highlighted in bold text.

Common name	Overwintering stage, location	May	June	July	August	September
seedcorn maggot	pupae, in soil	larvae (maggots) feed on seeds and scar cotyledons				
slugs & snails	both eggs and adults, in field	juveniles and adults feed on seedlings				
white grubs	larvae (grubs), underground	larvae (grubs) feed on roots				
aphids (usually black bean & cotton aphids)				nymphs and adults pierce leaves, feed on plant sap		
grasshoppers (multiple species)	egg clusters, underground			nymphs and adults feed on leaves		
green cloverworm	Southern USA, migrate north			larvae (caterpillars) feed on leaves and pods		
Mexican bean beetle	adults, in protected areas			larvae and adults skeletonize leaves		
potato leafhopper	Southern USA, migrate north			nymphs and adults suck plant sap		
spider mite	adult females, at base of hosts			nymphs and adults pierce plant cells, suck plant sap		
Lygus / tarnished plant bug	adults, in protected areas			nymphs and adults suck plant sap		
thrips	depends on species			nymphs and adults 'punch' individual cells, suck plant sap		
western bean cutworm	prepupae, underground			larvae (caterpillars) feed on blossoms and developing pods, then chew into beans		
European corn borer	larvae, in corn residue				second generation larvae bore stems & chew into pods, beans	
stink bug	adults, in & around fields				nymphs and adults suck plant sap, pierce developing pods	

Dry Beans Table 2: Damage checklist to aid in scouting for insects and related pests.

Plant part or timing Type of damage or injury	aphids	European corn borer	grasshoppers	green cloverworm	Mexican bean beetle	plant bug	potato leafhopper	seedcorn maggot	slugs & snails	spider mite	stink bugs	thrips	western bean cutworm	white grubs
Stand (emergence)														
seeds fed-on								x	x					x
gaps in row								x	x					x
wilted or cut plants														x
Leaves														
slimy or shiny trails									x					
scraping of leaf surface					x				x					
skeletonizing between veins					x									
irregular leaf feeding			x	x										
severe defoliation			x	x	x									
generalized leaf yellowing	x					x				x				
yellow leaf margins (hopperburn)							x							
tiny yellow spots (stippling)										x		x		
leaves cupped, crinkled	x					x	x			x		x		
sticky leaves or sooty mold	x													
fine webbing										x				
leaf drop, death							x			x		x		
Stems														
boring into stem		x												
powdery frass		x												
Roots														
root hairs missing														x
pruning of whole roots														x
Pods and beans														
large holes chewed into pod		x	x										x	
small holes chewed into pod		x		x									x	
beans fed-on in pod		x	x										x	
shriveled, aborted beans						x					x			
Other														
virus transmission	x													

Dry Bean Table 3: Life cycle, damage, and pest status of insects in dry beans

Pest status is rated as follows. Rating applies to Michigan.

- Rare: Insect is *unusual, not found in most fields*
- Uncommon: Insect is present in many fields, but *typically not in damaging numbers*
- Occasional: Insect is present in most fields, *sometimes increasing to damaging levels*.
- Important: Insect is present in most fields, *often increasing to damaging levels*; often a target of integrated management or insecticide use by growers.

- Sporadic: Economic outbreaks may occur in certain fields or seasons after *extreme weather* or *mass movement* from south to north early in the season
- Localized: Economic outbreaks may occur in specific locations under *specific agronomic conditions*, for example, in no-till or in late plantings.

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
aphids	Summer population is all female. Females give birth to live young and do not mate to reproduce (parthenogenesis). Multiple overlapping generations	• All stages suck plant sap from leaves • Heavy infestation may lead to stunting, curling of leaves, weakening of plants • Aphids also transmit plant viruses	• Drought stress may be made worse by aphids removing plant sap	Uncommon Usually present, but numbers not enough to cause damage
bean leaf beetle	Adults overwinter in leaf litter and wooded field margins. Become active in spring; move into alfalfa, then migrate into beans after first alfalfa cutting. Larvae feed underground on roots. 1-2 generations per year	• Adults defoliate younger plants, leaving small round holes between major leaf veins • Adults feed on and scar developing pods, reducing yield and seed quality	• Adults may move into dry beans if nearby soybean fields were infested in the previous or current season	Uncommon Usually present, but numbers rarely high enough to cause damage
European corn borer (ECB)	Mature larvae overwinter in corn residue and pupate in late spring. Moths emerge in late May-early June and lay eggs in corn and other crops. Two generations in south & central Michigan, the first in June & the second in late July/ early August. One generation in the UP and northern Michigan.	• Older larvae bore into stem, disrupt water flow, weaken stem • Larvae also bore into pods, consume seeds, and contaminate harvested beans	• Nearby non-Bt corn production probably increases local ECB risk	Uncommon Populations suppressed by widespread use of Bt GMO corn
grasshoppers *multiple species*	Eggs overwinter in soil. Nymphs emerge in June. Amount of feeding increases with size. Females lay groups of eggs in the undisturbed soil in late summer. 1 generation per year	• All stages chew on leaves; feeding has a ragged appearance	• Fallow areas and pasture are preferred egg-laying sites • A hot dry summer & fall can lead to a high population the next year	Uncommon Outbreaks rare, usually after a dry season
green cloverworm	Adults lay eggs singly on underside of leaves; larvae feed on foliage	• Small caterpillars scrape leaf tissue while older larvae defoliate plants		Uncommon Usually present, but numbers rarely high enough to cause damage

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
Mexican bean beetle	Adults overwinter in crop debris, woodlots, etc. Adults move into dry beans in early summer and lay eggs. Larvae mature in 3-4 weeks, pupating on leaf surface. Adults emerge in late July into August, lay eggs for a second generation. Second generation larvae feed, pupate in late August, and new adults overwinter.	• Larvae and adults strip the leaf surface between the veins on the underside of leaves, resulting in windowpane damage or a skeletonized (lacy) appearance. Time frame: mid-July into August. • Pod feeding is rare	• A mild winter increases survival • Planting adjacent to fields with high populations the previous year • Early-planting (adults attracted to these fields)	Uncommon and Localized
potato leafhopper (PLH)	Adults are carried into Michigan from the south on weather fronts in May/early June. Females lay eggs inside stems. Nymphs hatch in 7-10 days, begin feeding immediately, and reach adult stage in 2-3 weeks. Multiple overlapping generations	• Adults and nymphs lacerate and suck on leaves and stems, damaging cells and blocking vascular tissue; the classic symptom of feeding is tip yellowing or 'hopper burn' • Other symptoms include stunting and curling of leaves and poor pod fill	• PLH damage is worse under dry conditions, and leafhopper survival is probably better too	Sporadic *later in season*: Important, if populations become well-established
seedcorn maggot (SCM)	SCM overwinters as pupae in the soil. Adult flies emerge in early spring and are attracted to lay eggs in disturbed soil with decaying organic matter. Multiple generations	• Tiny larvae (maggots) feed on germinating seed; may cause variable emergence, stand loss, and delayed development	• Cool wet conditions which delay germination • Tillage of fields with high organic matter from a decaying green cover crop, or weeds, or fresh manure	Sporadic and Localized Depends on presence of fresh organic matter and cool, wet conditions
slugs & snails	Slugs overwinter as both eggs & adults; females deposit eggs in soil; these hatch in about one month. Multiple overlapping generations	• Feeding on cotyledons & lower leaves; feeding usually occurs at night • Substantial defoliation can be tolerated in pre-bloom dry beans, but if the growing point is killed, stands can be significantly reduced	• Planting into heavy crop residue • Cool, wet soils which delay germination • Poorly closed furrows (slug highways)	Localized Depends on residue and cool conditions. Dry beans are usually planted after slug risk is past.
spider mite	Adult females overwinter in field borders and sheltered areas. In spring, they move to new growth, and lay eggs. Mites spread from field to field by crawling or blowing in the wind. Multiple overlapping generations	• Adults & nymphs pierce individual plant cells, resulting in tiny yellow spots called stippling • Webbing is a sign of a heavy infestation • Severe damage results in leaf yellowing, death, water loss	• Prolonged hot, dry weather favors outbreaks and enhances the impact of feeding • Infestations often start on dusty edges of fields	Sporadic Outbreaks occur in hot, dry seasons
stink bug *several species including green, onespotted, & the brown marmorated*	Adults overwinter in protected areas. Weeds and early crops like wheat are fed on and colonized first. Stink bug eggs, laid in small clusters, often sport a small 'crown'. Nymphs and adults live and feed in the crop together. Note - some stink bug species are beneficial predators of other insects like caterpillars	• Adults and nymphs feed by injecting salivary enzymes into plants and sucking up plant juices • Feeding on pods can result in aborted or shriveled beans	• May move into dry beans as adjacent wheat fields dry down	Uncommon Numbers rarely high enough to cause damage
tarnished plant bug (TPB)	Adults overwinter in residue and on field edges. Weeds and early crops like alfalfa are fed on and colonized first.	• Adults and nymphs suck plant sap. Tarnished plant bug injects a toxic saliva during feeding. • Feeding on pods can result in aborted or shriveled beans	• May move into dry beans from adjacent alfalfa fields that were recently cut	Uncommon Numbers rarely high enough to cause damage

Pest (abbreviation)	Life cycle and Number of generations	Description of Damage	Conditions which favor infestation or damage	Pest Status in Michigan
thrips	Adults and nymphs overwinter in residue. Populations initially build on grasses and in wheat. Note that thrips are an important food source for some of the beneficial insects, such as pirate bugs, that control other pests.	• Nymphs and adults feed with a single mandible, using it to puncture plant cells and slurp up the liquid inside • Punctured cells dry up, resulting in areas of dead cells; under heavy infestation, leaves dry up, curl, or die	• Dry conditions in early summer • May move into dry beans from adjacent wheat fields or grassy borders that are drying down	Uncommon Usually present, but numbers rarely high enough to cause damage
western bean cutworm (WBC)	Overwinter in pre-pupal stage. Adults emerge in mid-late July; females lay eggs in pre-tassel corn and switch to dry beans as corn matures. Larvae feed on pods at night. In early-September, they drop & burrow into soil to over-winter. Areas with sandy soil appear to have deeper and better overwintering. 1 generation per year	• Tiny larvae feed on leaves and then inside blossoms • Larger larvae drop to the ground & stay under residue or in cracks during the day. They climb into the canopy to feed on pods at night	• Areas with sandy soils, where over-wintering survival is higher • Adjacent corn which is no longer attractive for egg laying (ie. past the pretassel stage)	Occasional - Important Montcalm and surrounding counties + the UP are historic hot spots for WBC
white grubs *multiple species*	Mature grubs overwinter under-ground. Adults emerge May-July, depending on species. Eggs laid in soil in the summer. Grubs feed on roots, then move down in soil profile in late fall to overwinter. In spring, grubs feed for a period, then pupate. 1 generation per year except June beetle, which has a 2-3 year life cycle	• Larvae (grubs) prune root hairs and sometimes whole roots, causing wilting, water and nutrient deficiency, or plant death	• planting into fallow fields or pasture • fields near pasture, home lawns • Fields or parts of fields with sandy soil type	Uncommon

Dry Beans Table 4: Management notes, scouting recommendations, and thresholds.

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
aphids	• Biological: Predators (such as ladybugs, lacewings, parasitoids) keep populations in check. Under humid conditions, entomopathogenic fungi infect aphids. • Environmental: Heavy rainfall and irrigation can wash off aphids. Adequate moisture reduces feeding stress and increases humidity for infection by pathogens.	Check 100 plants (20 plants x 5 sets)	General guideline: One or more aphid colony (a group of about 30) per plant Rarely justified
bean leaf beetle	• Environment: Extended periods of cold winter temperatures may increase kill of overwintering beetles	Check 100 plants (20 plants x 5 sets)	General guideline: More than 10% of the pods damaged Rarely justified
European corn borer (ECB)	• Biological: Numerous natural enemies kill ECB eggs and larvae. Predators, egg and larval parasitoids, and pathogens are common. • Agronomic: The widespread planting of Bt corn has greatly reduced the European corn borer population in the landscape.	No specific recommendation Note: Trapping can detect large corn borer flights. Michigan moths respond to Z (Iowa) strain pheromone	None
grasshoppers	• Biological: blister beetle larvae and other insects prey on eggs, and insects, birds, and mammals eat nymphs & adults. Fungal pathogens kill eggs and nymphs under wet spring conditions. • Agronomic: Tillage reduces survival of eggs and newly hatched nymphs • Insecticide: May be able to limit sprayed area if hoppers invade from a neighboring field or grassy border	No specific recommendation Have never seen populations high enough to treat in Michigan	General guideline: During flowering & pod fill, 15% overall defoliation by leaf-feeding insects, including hoppers
green cloverworm	• Biological: many natural enemies keep it in check	No specific recommendation Cloverworm can be detected by sweeping or beating plants over a cloth laid between rows	General guideline: During flowering & pod fill, 15% overall defoliation by leaf-feeding insects, including cloverworm
Mexican bean beetle (MBB)	• Biological: natural enemies feed on eggs and larvae • Agronomic: avoid early planting, as overwintered adults colonize these fields first • Environmental: Hot, dry weather and heavy rainfall are both cited as reducing populations	Early-mid July: Scout for # egg masses per meter. Take multiple samples across the field During flowering & pod fill: estimate defoliation	General guideline – 0.5 egg masses per meter/yard or 15% overall defoliation by leaf-feeding insects, including MBB
potato leafhopper (PLH)	• Biological - a naturally occurring fungal pathogen reduces PLH numbers under favorable conditions, usually later in the year • Insecticides: resistance is not an issue with PLH	Check 100 trifoliates from different plants (20 leaves x 5 sets) Count both adults and nymphs	Unifoliate stage: > 0.5 leafhopper per plant Otherwise: > 1 leafhopper per trifoliate leaf
seedcorn maggot (SCM)	• Agronomic: Potential for injury increases in wet, cool springs when seed germinates slower, or when seed is planted into tilled fields where fresh green material (cover crops or weeds) have been worked in. Risk drops after organic matter decomposes. Risk is very low in no-till fields. • Insecticide: Management is preventative, using a seed treatment in tilled fields where weeds and cover crop were recently killed or manure applied.	No specific recommendation	No rescue treatment is available. Consider replanting fields or areas with significant stand loss

Pest (abbreviation)	Notes on non-chemical and chemical management	Scouting recommendation	Spray threshold
slugs & snails	• Biological: Some ground beetle species consume slugs • Agronomic: Tillage and crop rotation reduce corn residue (slug habitat). Avoid planting in wet conditions, as open furrows act as slug highways. • Insecticide: Slugs are not insects, thus soil insecticides and seed treatments have no impact on them. Some studies suggest that seed treatments actually exacerbate slug populations by killing their ground beetle predators.	No specific recommendation Walk fields at night or early morning, turning over residue and looking for slime trials	None established A guess: Consider applying a molluscicide (slug bait) if stand is reduced by 5%
spider mite	• Biological: Under humid conditions, a natural fungal pathogen can infect and wipe out mite populations in a matter of days. Some natural enemies eat mites. • Agronomic: Irrigation mitigates the impact of spider mite feeding and increases humidity for fungal biocontrol, but during a drought, even irrigation isn't enough. • Environmental: Rainfall has a similar effect as irrigation • Insecticide: Insecticide resistance is common in mites. Some insecticides (including most pyrethroids) flare mite populations by killing off natural enemies. Likewise, fungicide applications may disrupt fungal pathogens of mites. Insurance applications of both are discouraged; be cautious about pesticide applications in dry years.	Infestations often start on field edges Look for mites on undersides of leaves using hand lens, or tap leaves over a black piece of paper Webbing is present when populations are high	A guess: Treat when mites appear on >25% of the plants and yellowing is first seen Mites are difficult to control; spraying is often a losing proposition
stink bugs	• Biological: Several parasitoids attack egg masses or bugs	No specific recommendation	None established
tarnished plant bug	• Agronomic: Good weed control reduces alternate hosts for plant bugs	No specific recommendation	General guideline: One bug or more per plant at first flower to green pod stage
thrips	• Biological: Generally kept in check by predators. • Environmental: Rainfall or irrigation reduces populations. • Insecticides: Onion thrips are killed better by pyrethroids than OPs/ carbamates. A caution about spraying: Thrips can be viewed as semi-beneficial, because they are predators of spider mite eggs. Spraying for thrips may contribute to a spider mite outbreak in the future, especially under dry conditions.	Infestations often start on field edges Look for thrips on undersides of leaves using hand lens. Or tap leaves over a white piece of paper or a paper plate	Threshold used in the High Plains (not tested in Michigan): >15 thrips per plant and leaf cupping is present
western bean cutworm	• Biological: many predators consume eggs and larvae; tiny Trichogramma wasps have been seen in the field in Michigan parasitizing egg masses	Sampling beans directly for WBC eggs of larvae is difficult Use bucket-type pheromone traps to detect flight, starting at the end of June. At a cumulative catch of 100-120 moths, scout fields for pod feeding	Action threshold developed In the Great Lakes Region: Treat when >10% of pods are fed-on by WBC larvae
white grubs	• Biological: Some species are attacked by pathogens • Agronomic: If practical, fall plowing of long-standing fallow fields & pasture prior to planting is recommended. Tillage also exposes grubs to mammals and birds. Note: It is important to identify grubs to distinguish annual species from multi-year species of June beetles.	No specific recommendation Grubs tend to be patchy, and in sandy parts of fields Grubs are sometimes detected when plowing in the fall or spring	None established

Dry Beans Table 5: Insecticides registered on dry beans in Michigan for use at planting, with preharvest intervals and precautions

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- Note that insecticide rates per 1000 feet of row are based on a **30-inch row spacing**. See label for specific per-acre rate and gauge-setting charts for narrower row spacing.

Active ingredient Trade Names	**Labelled rate(s)** per 1000 feet of row or per acre	**seedcorn maggot**	**slugs & snails**	**white grubs**	**Precautions and Remarks**
bifenthrin Xpedient Plus V	(a) 0.15 – 0.30 oz per 1000 ft (= 2.56 - 5.12 oz per acre)	a		a	• Apply T-band or in-furrow; see label for PRE and PPI instructions Note: Many of these products can be broadcast soil surface to control black cutworm and armyworm.
Bifender FC	(a) 0.17 - 0.34 oz per 1000 ft (= 3.0 - 5.9 oz per acre)				
Capture 3RIVE3D	(a) 0.19 – 0.46 oz per 1000 ft (= 3.2 - 8 oz per acre)				
Bifenture LFC Capture LFR Sniper LFR	(a) 0.2 - 0.39 oz per 1000 ft (= 3.4 - 6.8 oz per acre)				
bifenthrin + biofungicide *(Bacillus amyloliquefaciens)* Ethos XB	(a) 0.2 - 0.49 oz per 1000 ft (= 3.4 - 8.5 oz per acre)	a		a	• contains a biological fungicide strain for suppression of early season root diseases. • Apply T-band or in-furrow; see label for PRE and PPI instructions
cypermethrin (zeta) Mustang	(a) 0.247 oz per 1000 ft (= 4.3 oz per acre)			a	• Apply T band or in-furrow in a minimum of 2-7 gal per acre
Mustang Maxx	(a) 0.23 oz per 1000 ft (= 4 oz per acre)				
iron phosphate Sluggo	(a) 0.5 – 1.0 lb per 1000 ft (= 20 - 44 lbs per acre)		a		• Broadcast using a spreader • Apply bait in evening when slugs feed; product works best when the soil is moist

Dry Beans Table 6: Foliar insecticides registered on dry beans in Michigan, with preharvest intervals and precautions.

- Insecticides are grouped by active ingredient(s), which are listed alphabetically, allowing for easy comparison of products with the same chemistry.
- Application rates are listed for pests which appear on the manufacturer label; If a column is blank, the pest is not on the label. The letters in the pest columns refer to the label use rate from column two.
- Acronyms: BLB-bean leaf beetle; ECB-European corn borer; GCW-green cloverworm; MBB-Mexican bean beetle; PLH-potato leafhopper; TPB-tarnished plant bug; WBC-western bean cutworm

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
abamectin															
Abba Ultra	(a) 4 - 8 oz								a					7	• Ground application recommended (instead of by air), at minimum 10 gal per acre • To avoid the chance of illegal residue, product must be applied with a "non-ionic activator type wetting, spreading or penetrating spray adjuvant" that is approved on dry beans. See label for details
Agri-Mek SC	(a) 1.75 - 3.5 oz														
acephate															
Acephate 90WDG Acephate 90WSP	(a) 4 - 8 oz (b) 8 - 17.6 oz (c) 12.8 - 17.6 oz	b	b	c	a	b	b	b			b	b		14	• Minimum 20 gal per acre (ground) or 2 gal per acre (air) • Do not feed treated vines to livestock • WSP formulation is in water soluble packets
Acephate 90 Prill	(a) 4.4 - 8.9 oz (b) 8.9 - 17.6 oz (c) 13.3 - 17.6 oz														
Acephate 97UP Acephate 97 WDG Orthene 97	(a) 4 - 8 oz (b) 8 - 16 oz (c) 12 - 16 oz														
Bacillus thuringiensis (Bt)															
Agree Biobit HP Dipel ES Javelin Xentari DF	(a) 0.5 - 2.0 lbs (a) 0.5 - 1 lb (a) 1 - 2 pints (a) 0.25 - 1.5 lbs (a) 0.5 - 1.5 lb					a								0	• Larvae must eat treated foliage to be killed, so good coverage is needed • Bt sprays are most effective on small caterpillars • Biobit, Dipel DF, and Xentari can be used on organic beans
bifenazate															
Acramite 4SC	(a) 16-24 oz								a					7	• Apply in minimum of 20 gal per acre (ground) or 7 gal per acre (air) • Max 2 applications per year; 14 days between sprays

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
bifenthrin Bifen 2AgGold Bifenthrin 2EC Bifenture EC Brigade 2EC Fanfare EC, 2EC, and ES Sniper & Sniper Helios Tundra EC	(a) 1.6 - 6.4 oz (b) 2.1 - 6.4 oz (c) 5.12 - 6.4 oz	b	b	b	b	a b	b	a	c	b	b	b	b	14	• Maximum 0.3 lb/ acre of active ingredient per season • Do not make applications less than 7 days apart • Extremely toxic to bees; See labels for details
bifenthrin + a biofungicide *(Bac. amyloliquefaciens)* Ethos XB	(a) 2.8 - 8.5 oz	a	a	a	a	a	a	a	a	a	a	a	a	14	• Contains a biological fungicide strain - otherwise similar to bifenthrin
bifenthrin + cypermethrin (zeta) Hero Hero EW Steed	(a) 4.0 - 10.3 oz (b) 10.3 oz (a) 4.5 - 11.2 (b) 11.2 oz (c) 3.5 - 4.7 oz	a c	a c	a c	a c	a c	a c	a c	b	a c	b	b c	a c	21	• Do not make applications less than 7 days apart • Max 27.39 oz (Hero), 29.86 (Hero EW) of product per season
bifenthrin + imidacloprid (1:1 ratio) Brigadier Swagger	(a) 3.8 - 5.6 oz (b) 5.6 oz (a) 7.6 - 11.2 oz (b) 11.2 oz	a	b	b	a	b	b	a			a	a		14	• Do not make applications less than 7 days apart • Extremely toxic to bees; See label for details
bifenthrin + imidacloprid (2:1 ratio) Skyraider	(a) 2.1 - 5.6 oz (b) 5.12 - 5.6 oz	a	a	a	a	a	a	a	b	a	a	a	a	14	• Do not make applications less than 7 days apart • Extremely toxic to bees; See label for details
carbaryl Carbaryl 4L Sevin 4F Sevin XLR Plus	(a) 0.5 - 1.0 qt (b) 1.0 qt (c) 1.0 - 1.5 qt		a	c		a	a	b		c	c	b	b	21 beans 14 forage	• Applications interval minimum of 7 days • Application to wet foliage or in periods of high humidity may cause plant injury • "May kill honey bees and other bees in substantial numbers"; do not apply when crop or weeds are in bloom. See labels for additional details
chlorantraniliprole Coragen Prevathon	(a) 2 - 5 oz (b) 3.5 - 7.5 oz (a) 8 - 20 oz (b) 14 - 20 oz			b	a								b	1	• Thorough coverage is important; insects must eat treated foliage for optimum control • See label for specific directions for grasshopper control

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
chlorantraniliprole + cyhalothrin (lambda) Besiege	(a) 5 - 8 oz (b) 6 - 10 oz (c) 10 oz	b	b	b	b	a	a	b	c	b	b	b	b	21	• Do not graze or harvest vines for forage • For mites, suppression only
cyantraniliprole Exirel	(a) 10.0- 20.5 oz			a										7	• Label lists suppression of potato leafhopper and thrips • See label statement about 'adverse crop response'
cyantraniliprole + abamectin Minecto Pro	(a) 7.5 - 10 oz			a						a				7	• Apply in minimum of 10 gal per acre ground or 5 gal per acre air; ground application recommended for coverage • Label lists suppression of potato leafhopper and thrips • See label statement about 'adverse crop response'
cyfluthrin Baythroid XL Tombstone Tombstone Helios	(a) 0.8 - 1.6 oz (b) 1.6 - 2.4 oz (c) 2.4 - 3.2 oz		c	c	c	c	c	a		b	b		*	7	• Do not feed treated vines or hay to livestock * Western bean cutworm is not on the current labels, but cyfluthrin is labeled for WBC in corn
cyfluthrin + imidacloprid Leverage 360	(a) 2.4 - 2.8 oz	a	a	a	a	a	a	a			a			7	• Label lists suppression of stink bugs at high rate • Do not feed treated vines or hay to livestock
cyhalothrin (gamma) Declare Proaxis	(a) 0.77 - 1.28 oz (b) 1.28 - 1.54 oz (a) 1.92 - 3.30 oz (b) 2.56 - 3.84 oz	b	b	b	b	a	a	b		b	b	b	b	21	• Do not graze or harvest vines for forage
cyhalothrin (lambda) Grizzly Too Lamcap II Province II Warrior w/Zeon Kendo Lambda-Cy Lambda-Cy Ag Lambda Cyhalothrin 1EC LambdaStar Lambda-T Paradigm VC Silencer Willowood Lambda-Cy1EC	(a) 0.96 - 1.60 (b) 1.28 - 1.92 (a) 1.92 - 3.2 (b) 2.56 - 3.84	b	b	b	b	a	a	b		b	b	b	b	21	• Max 7.68 oz / acre per season • Do not graze or harvest vines as forage or hay
cypermethrin (alpha) Fastac EC or CS	(a) 2.7 -3.8 (b) 3.2 - 3.9 oz	b	a	a	b	a	a	a		b	a	b	*	21	• CS formulation is microencapsulated * Western bean cutworm is not on the current labels, but cypermethrin is labeled for WBC in corn

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
cypermethrin (zeta) Mustang Mustang Maxx	(a) 3.0 - 4.3 oz (b) 3.4 - 4.3 oz (a) 2.72- 4.0 oz (b) 3.2 - 4.0 oz	b	a	a	b	a	a	a		b	a	b	*	21	• Extremely toxic to bees. Do not apply to blooming crops if bees are visiting the field * Western bean cutworm is not on the current labels, but cypermethrin is labeled for WBC in corn
dimethoate Dimate 4E Dimethoate 400 and 4EC	(a) 0.5 - 1.0 pt	a	a		a		a	a	a		a			0	• Max 2 pints/ acre per year; 14-day retreatment interval • Do not feed treated vines • Highly toxic to bees
esfenvalerate Asana XL S-FenvaloStar Zyrate	(a) 2.9 - 5.8 oz (b) 5.8 - 9.6 oz				b	b	a	b					b	21	• Do not feed or graze livestock on treated vines • See label language about grasshopper control • Highly toxic to bees; See label for details
flupyradifurone Sivanto HL Sivanto 200 SL Sivanto Prime	(a) 3.5 - 7.0 oz (a) 7 - 10.5 oz (a) 7 - 14 oz	a						a						7	• Foliar applications have systemic properties; product moves from deposition point to leaf tips and controls insects on underside of leaves
imidacloprid Admire Pro Advise Four Alias 4F Montana 4F Nuprid 4F Max Wrangler Nuprid 2SC Prey 1.6F and Sherpa	(a) 1.2 oz (a) 1.4 oz (a) 2.8 oz (a) 3.5 oz	a						a						7	• Highly toxic to bees; See label for details
indoxacarb Steward	(a) 6.7 - 11.3 oz			a										7	• For ground application use minimum 20 gal per acre
methomyl Annihilate LV Corrida 29SL Lannate LV Nudrin LV	(a) 0.75 - 3 oz (b) 1.5 - 3 oz	b		b			a	a		*	b	b		14	• Kills both eggs and larvae of corn borer. See label for specific on timing • Highly toxic to bees. See label for details * The labels for Lannate list brown marmorated stink bug as a target

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
methomyl continued Annihilate SP Corrida 90WSP Lannate SP Nudrin SP	 (a) 0.25- 1 oz (b) 0.5 - 1 oz														
methoxyfenozide Intrepid 2F	(a) 8 - 16 oz			a										7	• Apply in minimum of 20 gal per acre (ground) in a full canopy or 10 gal per acre (air) • See label for information on application timing • Endangered species warning on label for applications made in these Michigan counties: Allegan, Monroe, Montcalm, Muskegon, Newaygo, Oceana
naled Dibrom 8E	(a) 1 pint (b) 1.5 pint	a				a		a	a	b	a			1	
pyrethrins Evergreen EC 60-6 PyGanic EC 1.4 II PyGanic Specialty	(a) 2.0 - 12.6 oz (a) 16 - 64 oz (a) 4.5 - 15.6 oz	a	a	a	a	a	a	a		a	a	a	a	0 when sprays dry	• Plant-derived insecticides that knock down insects quickly but have very short residual control. Coverage is critical • Max 10 applications per season, min 3-day spray interval • PyGanic is OMRI listed for use on organic crops; Evergreen does not have OMRI certification because it contains PBO (piperonyl butoxide), a synergist which improves kill • Highly toxic to bees exposed to direct treatment; do not apply on or drift onto blooming crops or weeds
spinosyns **(spinetoram & spinosad)** Entrust Blackhawk Radiant SC Entrust SC Spintor 2SC	 (a) 1 - 2 oz (b) 1.5 - 2 oz (a) 1.7-3.3 oz (b) 2.5 - 3.3 oz (a) 3 - 8 oz (b) 5 - 8 oz (a) 3 - 6 oz (b) 4.5 - 6 oz			a								b		28	• Maximum 12 oz / acre per year • Do not make more than two consecutive applications of products with spinetoram or spinosad • For European corn borer, sprays must target eggs and small larvae; see label for information on application timing • For thrips, control improved by adding an adjuvant; see label for details • Do not feed forage to meat or dairy animals

Active ingredient Trade Names	**Labelled rate per acre** (unless stated)	**aphids**	**BLB**	**ECB**	**grasshopper**	**GCW**	**MBB**	**PLH**	**spider mite**	**stink bug**	**TPB**	**thrips**	**WBC**	**Pre harvest interval (PHI) in days**	**Precautions and Remark**
spirotetramat Movento Movento HL	(a) 4 - 5 oz (a) 2 - 2.5 oz	a												7	• Movento label also lists 'suppression' of spider mites and some species of thrips
sulfoxaflor Transform WG	(a) 0.75-1.0 oz (b) 1.5 - 2.25 oz	a									b			7	• Translaminar product, which moves within the leaf to target sucking pests • Label also lists 'suppression' of thrips and some species of stink bug

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

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