MICHIGAN DRY BEAN RESEARCH REPORT

2024

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Production Research Advisory Board

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Sustainable Dry Bean Production Systems: Improving Production for an Evolving Market Place

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In 2023 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: *Sustainable Dry Bean Production Systems: Improving Production for an Evolving Market Place*. Results from this project will work to improve the environmental and economic sustainability of dry bean production in Michigan while reducing the reliance on synthetic crop inputs to better meet the demands of a changing marketplace. The outcome will be the improvement of sustainable management practices for dry beans in an ever-changing marketplace. Objectives of this project were to: ***(1)*** Development of dry bean cultivars and breeding lines that are resilient to environmental stress and mature uniformly across diverse production regions in Michigan. ***(2)*** Improve weed control strategies to improve weed control in Michigan dry beans with increasingly difficult environmental conditions and the development of herbicide resistant weed species. ***(3)*** Utilize multi- location testing protocols to ensure the adaptation of new dry bean varieties to Michigan's unique production locations (yield, quality, and disease resistance). ***(4)*** Implementation of grower educational activities to communicate intervention strategies and economic options for improved production practices for premium quality Michigan dry beans.

Season Summary: Planting conditions for the 2024 dry bean crop were average. High levels of soil moisture were problematic in some areas after a mild winter with little frost. Top soil moisture for the week ending in June 2 were: 3% short, 72% adequate, and 25% surplus (USDA Michigan Crop Weather). Through the month of June and Early July isolated bands of heavy rainfall caused localized waterlogging issues across the eastern half of Michigan. Production west of US-127 was largely spared from damaging rainfall. As July progressed into August, rainfall greatly slowed. Many rainfall stations across the thumb reported rainfall deficits greater than 50% when compared to 5-year averages. This early season root damage followed by a prolonged period of dry weather was the limiting factor on 2024 dry bean yields in Michigan. Given the dryness through the reproductive stages of the crop white mold was not a major issue across most of the production area apart from those in very close proximity to Lake Huron. However, anthracnose disease could also be found in quite high incidence through Huron County and should be a point of concern as we look forward to 2025 with high levels of inoculum left in the field following 2024 harvest. This is the second season with higher than normal anthracnose disease incidence and should be a caution to growers about rotations and seed sourcing decisions. Overall warm and dry conditions led to an early harvest. Most of the crop matured 3-4 days ahead of expectations. Rain was nearly absent through September and mid-October leading to a dryer than normal harvest. In general, dry bean yields were average with good quality. USDA has reported a state average yield for 2024 of 24.3 cwt./acre when averaged across all dry bean classes.

We would like to thank all the cooperators that hosted trials in 2024. Without their assistance, this research would not be possible.

Thank you,

Scott Bales & *Joe Cramer*

Introduction

In 2024, Michigan State University researchers and Michigan dry bean producers tested 155 lines from 12 market classes of dry beans. The trial plots (Table 1) were placed in six locations across five Michigan counties: Bay, Huron, Montcalm, Sanilac, and Tuscola (two sites).

Small- and medium-seeded beans were tested in Bay, Huron, Sanilac, and Tuscola counties. Black beans (Small-seeded beans) were also tested in Montcalm County based on grower feedback and interest. Large-seeded beans were tested in Montcalm and Tuscola counties.

This report summarizes the results of the trials. Please contact Scott Bales (phone 989-262-8550, extension 2; email balessco@msu.edu) with questions about the 2024 performance trials and suggestions for the 2025 trials.

Table 1. 2024 research trial conditions: locations, grower co-operators, planting dates, nitrogen application rates and methods, total accumulated growing degree days (GDD), and total precipitation.

County	Grower co-operator	Planting date	Nitrogen rate (Lbs/A)	Nitrogen application method	Total GDD [a]	Total precipitation (inches)
Bay	Meylan Farms	June 3	45	2x2	1,877	10.5"
Huron	Cedar Pond Farms	June 13	0 [b]	Clover	1,882	10.5"
Montcalm	Thorlund Brothers	June 8	85	Broadcast + 2x2	1,937	11.6" + Irrigation
Sanilac	Wadsworth Farms	June 4	45	2x2	1,975	8.8"
Tuscola	LAKKE Ewald Farms	June 4	50	Broadcast	2,078	9.7"
Tuscola	Saginaw Valley Research & Extension Center (Kidney beans)	June 12	60	Broadcast	2,027	11.7"

Note: Weather data was retrieved from the Michigan Automated Weather Network (MAWN) and MSU Enviroweather stations nearest to the performance trial. All weather data is from the day of planting to the day of harvest.

[a] Growing degree days (GDD) were calculated using the following equation: $([\mathrm{MAX} + \mathrm{MIN}] \div 2) - 50 = \mathrm{GDD}$

[b] Nitrogen was not applied at the Huron location in 2024 because a clover cover crop in 2024 and a history of biosolids application to the field provided enough nitrogen.

Field Trial Methods

Dry beans were seeded in four-row plots that measured 6.6' wide by 24' long, with 20" rows. Each entry was replicated four times (with the exception of black beans in Montcalm County, which were tested in a three-replication design). All trial plots were designed as randomized complete blocks (RCB). (RCB is a standard agricultural trial design in which entries are randomly assigned to groups or blocks, and the blocks are randomly repeated. The goal of the replication is to control for variables that might affect an entry's yield, such as soil nutrient levels [Table 2], pest loads, and variability in soil textures.)

Trials received industry standard seed treatments, fertilization, and weed control applications at labeled rates. Yield data was obtained by direct harvest for small- and medium-seeded beans. Large-seeded beans were pulled by a two-row Pickett bean puller and then mechanically threshed to prevent harvest loss. Following harvest, samples were cleaned, weighed, and moisture tested.

Table 2. Soil test information from the 2024 trial locations, including the percentage of organic matter, soil type, soil pH, and soil cation exchange capacity (CEC). All macro- and micronutrients were sufficient for dry bean production.

Location	Percentage of organic matter	Soil type	Soil pH	Soil CEC
Bay	1.7	Sandy Loam	6.9	12.2
Huron	2.3	Loam	7.6	12.3
Montcalm	1.7	Sandy Loam	5.5	6.7
Sanilac	8.0	Loam	7.7	19.5
Tuscola (LAKKE Ewald)	2.4	Sandy Clay Loam	7.6	15.4
Tuscola (SVREC)	2.0	Sandy Clay Loam	7.5	11.3

Yield Trial Results

Tables 5 through 15 provide Yield information in pounds per acre (Lbs./A) adjusted to 18% moisture.

The combined average yield for each entry across all sites in 2024 is also included. (**Note:** If an entry was grown under different production systems [irrigated versus dry land] at different sites, the combined yield was not calculated.) When possible, two- and three-year average yields were also calculated across locations. For example, the three-year average yield of a navy bean entry (Table 3) includes data from 2022, 2023, and 2024 at four locations per year (12 site-years).

The last three rows of yield results tables list the trial average (mean), least significant difference (LSD), and coefficient of variation (CV), respectively, for the data in each column.

The entry with the **highest** value in each yield column is followed by two asterisks (**). Any yields listed in the same column that are not significantly different from the highest yield are noted with one asterisk (*). This means that if two entries in the same column are followed by either one or two asterisks, the difference in values between the entries is not statistically significant.

Table 16 lists the sources of dry bean varieties tested in 2024. The entries are organized by bean market class.

Canning Methods

All 155 lines tested were sampled for canning quality. For Mesoamerican germplasm (black, navy, s. red, etc) samples were taken from Bay and Huron Trial locations, Andean germplasm was sampled from the Montcalm and Tuscola Trial location. Samples were processed utilizing the following methods: Each can was filled with 90 grams of dry matter for all mesoamerican market classes. Andean beans were filled to 85 grams of dry matter per can. Moisture levels prior to soaking ranged from 8.5-18.0% averaging at 13.4% 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 three days of sample processing took place in 2025. Dry beans were soaked and blanched by market class according to the protocol in Table 3. Water for soaking included 125ppm of CaCl2 for Andean beans. Immediately following blanching samples were transferred to individually identifiable cans (size 307x407) and filled with 190^{o}F brine. Brine is a mixture of tap water, 1.5% sucrose (sugar), 1.2% sodium chloride (salt), and 100ppm of CaCl2. Colored beans had the additional component of disodium EDTA added at a ratio of 0.02%. Cans are then seamed and individually inspected to ensure seam quality prior to thermal processing. Cans were loaded in 552 can batches and transferred to an 'Allpax' retort. Thermal processing parameters were set for a 19 minute cook cycle at 250^{o}F. Following cool down samples were stored for approximately 4 weeks prior to opening and evaluations to allow for equilibration.

Table 3. Dry Bean Brine, Soaking, Blanching and Thermal Processing by market class

Class	Brine				Rehydration		Thermal Processing
	Salt	Sugar	$CaCl_2$	EDTA	Hot Soak	Blanch	
Navy	1.2%	1.5%	100 ppm	-	30 min (125ºF)	5 min (190ºF)	19min/250º F
Black	1.2%	1.5%	100 ppm	-	-	90 sec (190ºF)	19min/250º F
Great Northern	1.2%	1.5%	100 ppm	-	30 min (125ºF)	15 min (190ºF)	19min/250º F
Pinto	1.2%	1.5%	100 ppm	0.02%	2 Hr. (130ºF)	5 min (190ºF)	19min/250º F
Small Red	1.2%	1.5%	100 ppm	0.02%	30 min (125ºF)	15 min (190ºF)	19min/250º F
Pink	1.2%	1.5%	100 ppm	0.02%	30 min (125ºF)	15 min (190ºF)	19min/250º F
Dark Red Kidney	1.2%	1.5%	100 ppm	0.02%	2 Hr. (130ºF)	5 min (190ºF)	19min/250º F
Light Red Kidney	1.2%	1.5%	100 ppm	0.02%	2 Hr. (130ºF)	5 min (190ºF)	19min/250º F
White Kidney	1.2%	1.5%	100 ppm	-	30 min (125ºF)	15 min (190ºF)	19min/250º F
Cranberry	1.2%	1.5%	100 ppm	0.02%	2 Hr. (130ºF)	5 min (190ºF)	19min/250º F
Yellow	1.2%	1.5%	100 ppm	-	30 min (125ºF)	5 min (200ºF)	19min/250º F

Evaluations: On February 12, 2025 a public meeting was held for the evaluation of all lines tested. Cans were opened and scored by a 18-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 conducted in 2025. Table 4 documents this established scoring system based on physical characteristics of the processed sample for all market classes besides black beans. Black beans were scored similarly, but color was evaluated on a 1-5 scale independently from general appearance as this is a unique trait of economic interest in black beans.

Table 4. General appearance scale used for scorning 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 or Cloudy	Neither Little or 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)

Images from Annual Can Opening Meeting at Saginaw Valley Research and Extension Center

Table 5. Navy bean yield and quality results.

Navy bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
14084	3,221 [a]	3,052	2,871	2490	3.4	3.1	3.3	2.9	3.2
14092	3,552	NA	NA	2303	2.7	2.6	2.7	NA	NA
21102	2,689	NA	NA	2780	2.3	2.4	2.4	NA	NA
21108	2,966	NA	NA	2711	3.8	3.4	3.6	NA	NA
21127	3,275	NA	NA	2325	2.4	2.8	2.6	NA	NA
Argosy	3,592	3,146	2,890	2176	2.9	2.2	2.6	1.9	2.7
Armada	3,469	3,188	2,950*	2548	3.5	2.8	3.2	2.5	3.1
AuSable	3,104	2,823	2,379	2220	3.3	2.5	2.9	2.7	2.6
Blast	3,333	NA	NA	2376	2.9	2.4	2.7	NA	NA
Blizzard	3,400	3,256*	2,942*	2363	3.2	2.6	2.9	2.7	2.8
EX2109-N	2,859	2,616	2,434	2171	3.6	2.6	3.1	2.5	2.6
EX2111-N	3,350	2,913	NA	2621	3.5	2.1	2.8	2.3	NA
HMS Bounty	2,701	3,043	2,984*	2675	3.2	3.0	3.1	2.7	3.0
HMS Medalist	3,252	3,300	3,134*	2468	3.2	2.9	3.1	3.5	3.0
Liberty	3,244	3,166	3,173**	2379	4.1	3.3	3.7	3.4	3.5
N21510	3,014	2,859	NA	2609	3.1	2.1	2.6	2.4	NA
N22005	3,100	NA	NA	2456	2.7	3.1	2.9	NA	NA
N22616	3,442	3,087	NA	2508	2.8	2.7	2.8	2.4	NA
N22622	3,747	NA	NA	2373	2.7	2.6	2.7	NA	NA
N22623	3,357	NA	NA	2256	3.4	2.9	3.2	NA	NA
N23706	3,480	NA	NA	2529	3.3	2.8	3.1	NA	NA
N23715	2,848	NA	NA	2450	2.6	2.6	2.6	NA	NA
Nautica	3,342	3,047	2,813	2429	2.7	2.3	2.5	2.2	2.5
ND Polar	2,785	2,551	2,530	2498	3.5	3.0	3.3	3.1	3.3
OAC Charm	3,226	NA	NA	2174	3.3	2.5	2.9	NA	NA
OAC Seal	3,425	3,109	NA	2259	2.7	2.7	2.7	2.0	NA
Steam	4,255**	NA	NA	2335	3.2	2.1	2.7	NA	NA
T9905	3,204	3,079	2,762	2127	3.4	2.6	3.0	2.3	2.7
Valiant	3,047	3,116	2,951*	2603	3.8	3.6	3.7	3.5	3.8
Victory	3,256	3,454**	3,093*	2613	2.9	2.5	2.7	2.6	2.8
MEAN	3,251	3,045	2,871	2428	3.1	2.7	2.9	2.6	3.0
LSD$_{(0.05)}$	356	280	249	NA	NA	NA	NA	NA	NA
CV	16.9%	18.1%	19.5%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Due to poor trial quality this season, Bay County yield averages were not included in the one-year average.

Table 6. Black bean yield and quality results.

Black bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
17746	3,306 [a]	NA	NA	2221	2.7(2.8)	3.2(3.1)	2.9(2.9)	NA	NA
17751	3,315	3,350	3,291	2277	2.3(1.8)	3.1(2.0)	2.7(1.9)	3.5(1.5)	3.3(2.0)
17771	2,902	NA	NA	2542	2.5(1.7)	3.3(2.8)	2.9(2.2)	NA	NA
21650	3,115	NA	NA	2164	2.2(2.8)	3.3(3.1)	2.8(2.9)	NA	NA
21702	3,659*	NA	NA	2168	2.5(2.9)	3.3(3.2)	2.9(3.1)	NA	NA
21723	3,136	NA	NA	2154	3.3(3.5)	4.2(4.2)	3.7(3.8)	NA	NA
21727	3,395	NA	NA	2278	3.0(3.2)	2.5(3.2)	2.8(3.2)	NA	NA
22B042	2,639	NA	NA	2150	1.9(2.0)	3.5(3.0)	2.7(2.5)	NA	NA
22B127	2,932	NA	NA	2312	2.9(3.1)	3.9(3.7)	3.4(3.4)	NA	NA
B18094173	3,167	3,397	3,293	2133	2.6(3.5)	3.8(4.3)	3.2(3.9)	3.6(4.0)	3.5(4.2)
B2002-1-3	3,812*	NA	NA	2329	2.9(2.9)	3.6(3.8)	3.3(3.4)	NA	NA
B20591	3,278	3,292	3,099	2285	2.5(2.6)	3.1(3.2)	2.8(2.9)	3.4(2.8)	3.1(3.3)
B21710	3,597*	3,212	3,178	2396	2.8(2.6)	3.3(3.1)	3.0(2.8)	3.2(3)	3.1(2.9)
B22041	3,540*	3,687*	NA	2299	3.3(3.7)	3.5(4.1)	3.4(3.9)	3.8(3.4)	NA
B22042	3,906**	NA	NA	2356	3.2(3.9)	4.0(4.2)	3.6(4.1)	NA	NA
B22062	3,586*	NA	NA	2103	2.2(2.6)	3.4(3.0)	2.8(2.8)	NA	NA
B22854	3,729*	3,516*	NA	2208	2.7(2.8)	3.2(2.9)	2.9(2.8)	3.5(2.9)	NA
B23911	3,772*	NA	NA	2003	3.1(3.7)	3.7(3.8)	3.4(3.8)	NA	NA
B23949	3,733*	NA	NA	2161	2.4(2.7)	2.7(2.8)	2.6(2.7)	NA	NA
B5054313	2,878	3,202	NA	2353	3.1(2.7)	3.4(2.7)	3.2(2.7)	3.2(3.2)	NA
B7071259	3,497	3,739**	3,533**	2170	2.2(2.0)	3.4(3.1)	2.8(2.5)	3.5(2.8)	3.4(2.8)
B7072252	3,097	3,302	NA	2286	3.7(4.2)	3.5(4.3)	3.6(4.2)	3.5(3.6)	NA
B7072269	3,015	3,171	3,126	2440	2.9(3.3)	3.6(4.2)	3.2(3.7)	3.5(3.2)	3.5(3.9)
Black Bear	3,098	3,282	3,276	2456	1.7(1.4)	2.6(2.6)	2.2(2.0)	2.4(2.2)	2.4(2.4)
Black Pearl	3,349	3,148	3,094	2135	2.5(4.2)	3.2(4.1)	2.9(4.1)	3.3(2.9)	3.4(4.1)
Black Tails	3,225	2,982	2,925	2326	2.8(3.4)	3.2(3.4)	3.0(3.4)	2.8(3)	2.8(3.0)
Black Beard	3,239	3,550*	3,317*	2080	3.3(3.8)	4.1(4.2)	3.7(4.0)	3.7(3.7)	3.7(4.2)
Kona	3,770*	3,671*	3,465*	2280	3.1(3.2)	3.2(3.5)	3.1(3.3)	3.4(3.1)	3.2(3.3)
Nimbus	3,228	3,269	3,325*	2199	2.5(2.6)	2.8(2.7)	2.7(2.7)	3.1(2.7)	2.7(2.6)
Spectre	3,051	3,142	3,091	2235	2.3(2.6)	2.9(3.2)	2.6(2.9)	2.6(2.6)	2.8(2.8)
Umbra	3,689*	3,621*	NA	2116	2.4(3.0)	2.9(3.2)	2.7(3.1)	3.1(2.7)	NA
Zenith	3,508	3,212	3157	2292	3.9(4.5)	4.3(4.6)	4.1(4.6)	4.0(4.1)	4.1(4.4)
MEAN	3,354	3,356	3227	2247	2.7(3.0)	3.4(2.7)	3.1(3.2)	3.3(3.0)	3.2(3.3)
LSD$_{(0.05)}$	362	238	218	NA	NA	NA	NA	NA	NA
CV	16.9%	16.6%	17.0%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Due to poor trial quality this season, Bay County yield averages were not included in the one-year average.

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

Table 7. Small red and pink bean yield and quality results.

Small red & pink bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Coral[a]	3,146*	3,005	2,873	1267	3.2	3.4	3.3	2.6	2.8
ND Rosalind[a]	3,381*	NA	NA	1407	2.3	2.1	2.2	NA	NA
S22507[a]	2,965	NA	NA	1322	2.6	3.1	2.9	NA	NA
16686	3,265*	3,335*	3,132*	1346	2.7	3.2	2.9	2.7	3.4
17822	3,047	3,220*	3,198*	1607	2.7	3.2	2.9	3.0	2.9
17837	3,128*	3,359*	3,059	1431	2.3	2.5	2.4	2.7	2.7
17848	3,308*	NA	NA	1232	3.1	3.9	3.5	NA	NA
17851	3,038	NA	NA	1328	2.5	2.9	2.7	NA	NA
19837	3,165*	3,231*	3,105	1264	2.2	2.2	2.2	2.1	2.7
R20669	3,250*	3,329*	3,347**	1539	2.2	3.1	2.6	2.5	2.5
R22703	3,364*	NA	NA	1415	3.1	3.6	3.3	NA	NA
R22710	3,112*	NA	NA	1440	3.2	3.8	3.5	NA	NA
Viper	3,392**	3,368**	3,285*	1634	2.8	3.3	3.0	2.7	3.4
MEAN	3,197	3,264	3,143	1402	2.7	3.1	2.9	2.6	2.9
LSD(0.05)	343	294	226	NA	NA	NA	NA	NA	NA
CV	18.3%	18.2%	17.9%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Pink bean variety.

Table 9. Conventional pinto bean yield and quality results.

Pinto bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Cancun	2,964 [a]	NA	NA	1103	3.2	3.1	3.2	NA	NA
Charro	3,848**	3,671**	3,491**	1219	3.2	2.9	3.0	4.0	4.1
Cowboy	3,533	NA	NA	1293	1.9	2.6	2.3	NA	NA
EX2145-P	3,027	2,860	NA	1345	2.3	2.2	2.2	2.4	NA
EX2146-P	3,025	NA	2,716	1511	1.4	2.1	1.7	NA	2.9
ND Falcon	3,237	2,876	2,791	1280	2.2	2.7	2.4	3.2	3.2
P23311	3,710*	NA	NA	1347	2.3	2.7	2.5	NA	NA
SV6139GR	3,050	2,945	2,733	1409	1.8	3.5	2.7	3.2	3.3
USDA Rattler	3,727*	3,338	NA	1318	2.5	3.3	2.9	3.0	NA
MEAN	3,319	3,128	2,953	1314	2.3	2.8	2.5	3.2	3.4
LSD(0.05)	285	292	305	NA	NA	NA	NA	NA	NA
CV	12.6%	17.0%	17.2%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Due to poor trial quality this season, Bay County yield averages were not included in the one-year average.

Table 8. Slow darkening pinto bean yield and quality results.

Pinto bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Bronco	2,714 [a]	NA	NA	1173	2.4	2.8	2.6	NA	NA
Eternal	3,069	NA	NA	1335	3.3	3.5	3.4	NA	NA
Gleam	2,938	3,037	NA	1371	2.5	2.7	2.6	3.2	NA
Mystic	3,066	3,066	NA	1173	1.2	1.4	1.3	1.3	NA
ND Palomino	3,068	3,274*	2,865	1249	3.2	3.4	3.3	3.7	3.4
ND Rodeo	3,633**	3,536**	NA	1179	2.4	2.1	2.2	3.0	NA
Shine	3,311	NA	NA	1257	1.7	2.3	2.0	NA	NA
USDA Diamondback	3,077	2,800	NA	1224	2.1	2.5	2.3	3.2	NA
Vibrant	3,279	3,220	NA	1335	1.3	1.3	1.3	2.2	NA
MEAN	3,136	3,120	NA	1255	2.2	2.4	2.3	2.8	3.4
LSD(0.05)	310	262	NA	NA	NA	NA	NA	NA	NA
CV	16.8%	16.5%	NA	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Due to poor trial quality this season, Bay County yield averages were not included in the one-year average.

Table 10. Great northern bean yield and quality results.

Great northern bean entry	1-year avg. (Lbs./A)	2-year avg. (Lbs./A)	3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Bay (1-5)	Huron (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Eiger	3,043 [a]	3116**	3021**	1460	2.8	2.7	2.8	2.3	2.8
G22004	3,422**	NA	NA	1278	2.5	2.4	2.4	NA	NA
ND Pegasus	2,833	2912*	2928*	1359	2.8	2.6	2.7	2.4	2.9
Powderhorn	2,309	2235	2281	1416	2.3	3.3	2.8	3.2	3.0
MEAN	2,907	2754	2744	1378	2.5	2.7	2.7	2.6	2.9
LSD(0.05)	337	294	236	NA	NA	NA	NA	NA	NA
CV	16.6%	21.4%	21.2%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a] Due to poor trial quality this season, Bay County yield averages were not included in the one-year average.

Table 11. Cranberry bean yield and quality results.

Cranberry bean entry	Montcalm (Lbs./A)	Tuscola (Lbs./A)	Irrigated 2-year avg. (Lbs./A)	Irrigated 3-year avg. (Lbs./A)	Dry land 2-year avg. (Lbs./A)	Dry land 3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Tuscola (1-5)	Montcalm (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
16756	3,370	2,610	3,421	3,000	2,443	2,137	1273	3.9	2.0[a]	3.0	4.1	4.2
16758	2,872	2,097	2,828	2,653	2,158	1,750	1155	3.5	2.1	2.8	3.6	3.9
16775	3,500	2,507	2,906	2,703	2,667*	2,156	1180	3.6	2.5	3.1	3.2	3.2
16816	3,495	2,245	3,233	2,940	2,240	1,948	1113	2.8	1.1	1.9	3.0	2.9
151093	4,197**	3,081**	4,024**	3,633**	3,337**	2,737**	1088	2.6	1.3	1.9	3.0	2.7
Amaranto	3,181	2,421	3,078	2,975	2,199	2,108	937	2.6	1.1	1.8	2.2	2.4
CR2007-3-1	3,459	2,262	NA	NA	NA	NA	931	3.4	1.2	2.3	NA	NA
Etna	3,115	2,344	3,161	2,992	2,170	1,896	988	2.4	1.1	1.7	1.9	2.2
IG-VN	3,255	2,600	NA	NA	NA	NA	989	3.8	3.5	3.7	NA	NA
Jester	4,156*	2,713	3,218	2,979	2,984*	2,615*	914	2.5	1.1	1.8	2.1	2.0
OAC Firestripe	3,590	2,444	2,462	3,280	2,903*	2,395*	871	3.2	1.1	2.2	2.6	2.5
OAC Navabi	3,107	2,551	2,840	2,857	2,073	2,035	1065	2.8	1.2	2.0	1.6	1.6
MEAN	3,441	2,490	3,217	3,001	2,512	2,181	1042	3.1	1.6	2.3	2.7	2.8
LSD(0.05)	466	363	443	334	670	489	NA	NA	NA	NA	NA	NA
CV	11.3%	12.1%	13.8%	13.7%	26.6%	27.6%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a]Montcalm county canning scores are artificially low f due to poor harvest conditions (excessive dryness) and should not be used for decision making out of context of this 2024 growing season.

Table 12. Light red kidney bean yield and quality results.

Light red kidney bean entry	Montcalm (Lbs./A)	Tuscola (Lbs./A)	Irrigated 2-year avg. (Lbs./A)	Irrigated 3-year avg. (Lbs./A)	Dry land 2-year avg. (Lbs./A)	Dry land 3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Tuscola (1-5)	Montcalm (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
15916	3,631*	2,689	3,221	3,161*	3,051*	2,543**	1021	2.9	1.5 [a]	2.2	2.4	2.5
15923	3,630*	2,496	3,545*	3,490**	2,210	1,962	893	3.4	1.5	2.4	2.9	2.8
20870	3,199	3,463**	NA	NA	NA	NA	916	3.7	1.7	2.7	NA	NA
20909	3,393	2,881	NA	NA	NA	NA	996	3.1	1.8	2.5	NA	NA
161055	3,475	3,017	NA	NA	NA	NA	903	3.2	1.7	2.4	NA	NA
161082	3,503	2,341	3,296	3,362*	2,982*	2,484	923	3.3	1.2	2.3	2.4	2.8
Big Red	3,985*	2,336	3,406*	3,225*	2,386*	2,029	1006	2.7	1.3	2.0	2.1	2.5
Cal Early	3,555	2,143	3,060	3,108*	2,298	2,038	943	3.0	1.1	2.0	2.0	2.7
K2007-3-2	3,164	2,510	NA	NA	NA	NA	967	3.8	1.2	2.5	NA	NA
K22601	3,417	2,944	NA	NA	NA	NA	972	3.3	1.1	2.2	NA	NA
K22604	4,371**	3,057*	3,960**	NA	3,185**	NA	1015	2.7	1.4	2.1	2.2	NA
Pink Panther	3,512	2,642	3,277	3,137*	2,520	2,140	912	3.2	1.5	2.3	2.3	2.3
Ronnies Red	3,406	2,701	3,056	3,096*	2,510	2,323	929	3.1	1.9	2.5	2.1	2.7
Rosie	3,095	2,218	NA	NA	NA	NA	1016	3.3	1.3	2.3	NA	NA
Spitfire	3,285	2,124	NA	NA	NA	NA	967	3.3	1.4	2.3	NA	NA
MEAN	3,508	2,637	3,356	3,226	2,656	2,229	959	3.2	1.4	2.3	2.3	2.6
LSD$_{(0.05)}$	800	430	576	411	703	431	NA	NA	NA	NA	NA	NA
CV	19.1%	13.7%	17.0%	15.6%	26.2%	23.6%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a]Montcalm county canning scores are artificially low f due to poor harvest conditions (excessive dryness) and should not be used for decision making out of context of this 2024 growing season.

Table 13. Dark red kidney bean yield and quality results.

Dark red kidney bean entry	Montcalm (Lbs./A)	Tuscola (Lbs./A)	Irrigated 2-year avg. (Lbs./A)	Irrigated 3-year avg. (Lbs./A)	Dry land 2-year avg. (Lbs./A)	Dry land 3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Tuscola (1-5)	Montcalm (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
15977	3,604	2,889*	2,675	2,612	2,386	2,063	921	2.7	1.3 [a]	2.0	2.8	2.3
161156	4,622*	2,789	3,666*	3,360*	2,742*	2,389*	1180	2.9	1.5	2.2	2.7	3.0
161165	4,103*	2,985*	3,395*	NA	3,223**	NA	1008	3.1	2.1	2.6	2.8	NA
181017	4,612*	3,099*	3,648*	3,510*	3,221*	2,670**	943	2.4	2.2	2.3	3.3	3.1
181020	4,153*	2,821*	3,308*	3,218*	2,174	1,892	956	2.2	2.1	2.1	2.1	3.1
181021	4,253*	2,295	3,526*	3,368*	1,973	1,826	959	2.8	1.6	2.2	2.8	2.8
Cinder	2,916	2,361	NA	NA	NA	NA	1050	2.9	1.6	2.3	NA	NA
Dynasty	4,677**	3,172**	3,505*	3,374*	2,844*	2,633*	990	2.2	1.5	1.9	2.2	2.0
Epic	4,401*	2,925*	3,723**	3,520**	2,646*	2,421*	1008	2.6	1.5	2.1	2.3	2.5
Gallantry	4,214*	3,014*	3,554*	3,313*	2,522	2,271*	993	3.7	1.6	2.7	3.6	3.2
K1920-2-3	3,952*	2,006	NA	NA	NA	NA	1215	3.2	2.5	2.8	NA	NA
K23212	4,428*	2,861*	NA	NA	NA	NA	993	2.5	1.8	2.2	NA	NA
Montcalm	4,095*	2,214	3,505*	3,235*	2,252	2,087	1028	2.7	1.8	2.2	3.0	3.3
ND Redbarn	3,368	2,140	NA	NA	NA	NA	1044	3.1	1.3	2.2	NA	NA
Rampart	4,277*	2,553	3,536*	3,288*	2,546*	2,187*	1089	3.2	1.6	2.4	3.2	2.7
Red Hawk	3,785	2,124	3,008	2,968	1,918	1,769	1089	3.9	2.2	3.1	3.4	3.2
Seattle	3,964*	2,540	3,260*	3,001	2,707*	2,370*	1129	4.1	1.7	2.9	3.1	2.8
MEAN	4,084	2,635	3,408	3,208	2,550	2,203	1035	3.0	1.8	2.4	2.9	2.8
LSD(0.05)	779	418	612	432	681	514	NA	NA	NA	NA	NA	NA
CV	16.1%	13.3%	18.0%	15.4%	26.9%	26.8%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a]Montcalm county canning scores are artificially low f due to poor harvest conditions (excessive dryness) and should not be used for decision making out of context of this 2024 growing season.

Table 14. White kidney bean yield and quality results.

White kidney bean entry	Montcalm (Lbs./A)	Tuscola (Lbs./A)	Irrigated 2-year avg. (Lbs./A)	Irrigated 3-year avg. (Lbs./A)	Dry land 2-year avg. (Lbs./A)	Dry land 3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Tuscola (1-5)	Montcalm (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Beluga	3,618*	2,770	2,970	2,631	2,959	2,414*	960	2.6	2.3[a]	2.5	2.8	2.4
Denali	4,005*	2,900**	3,534*	3,401*	2,847	2,390*	950	2.8	2.0	2.4	2.2	2.2
K22801	3,936*	2,798	NA	NA	NA	NA	990	2.7	1.6	2.2	NA	NA
ND Whitetail	3,846*	2,613	3,056	3,172*	2,839	2,523*	1024	2.6	1.5	2.1	2.2	2.0
OAC Snowshoe	2,840	2,598	2,817	3,030*	2,897	2,704**	916	2.9	2.3	2.6	2.0	2.1
Snowdon	3,624*	2,722	2,935	2,929	2,526	2,175	858	2.4	1.4	1.9	1.8	1.8
WK1601-1	4,215**	2,732	3,759**	3,507**	3,108	2,544*	1024	3.2	1.9	2.5	3.4	3.1
MEAN	3,726	2,733	3,178	3,145	2,864	2,462	960	2.8	1.9	2.3	2.4	2.3
LSD(0.05)	601	NS	518	503	NS	491	NA	NA	NA	NA	NA	NA
CV	13.1%	9.2%	16.0%	19.5%	20.1%	24.6%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a]Montcalm county canning scores are artificially low f due to poor harvest conditions (excessive dryness) and should not be used for decision making out of context of this 2024 growing season.

Table 15. Mayocoba/yellow bean yield and quality results.

Mayocoba/ yellow bean entry	Montcalm (Lbs./A)	Tuscola (Lbs./A)	Irrigated 2-year avg. (Lbs./A)	Irrigated 3-year avg. (Lbs./A)	Dry land 2-year avg. (Lbs./A)	Dry land 3-year avg. (Lbs./A)	Seed Size (Seeds/lb.)	Tuscola (1-5)	Montcalm (1-5)	1-year avg. (1-5)	2-year avg. (1-5)	3-year avg. (1-5)
Claim Jumper	4,419**	2,744*	3,432**	2,993*	3,014*	2,688**	1400	3.6	3.1[a]	3.3	3.5	3.6
Motherlode	3,198	2,214	2,709	2,362	2,529	2,213	1259	3.9	2.8	3.4	4.0	3.9
USDA Yellowjacket	3,385	2,326	2,681	2,524	2,117	1,970	1398	2.6	1.8	2.2	2.6	2.4
Honeycomb	3,957*	2,446	3,245*	3,139**	2,499	2,112	1311	2.2	1.4	1.8	1.8	2.0
Y1803-5-3	3,352	2,843**	NA	NA	NA	NA	1316	3.4	3.0	3.2	NA	NA
Yellowstone	3,334	2,175	3,095*	2,802*	2.288	1,989	1408	3.2	2.8	3.0	3.3	3.5
Yukon Gold	3,983*	2,106	3,417*	NA	3,211**	NA	1436	3.4	2.7	3.1	2.9	NA
MEAN	3,707	2,411	3,042	2,768	2,556	2,196	1361	3.3	2.5	2.9	3.0	3.1
LSD(0.05)	560	275	490	345	564	367	NA	NA	NA	NA	NA	NA
CV	12.2%	9.3%	15.7%	15.1%	20.0%	20.3%	NA	NA	NA	NA	NA	NA

Note. The **highest** yield in each column is marked with two asterisks. Any values in a column that are not statistically different from the column's two-asterisk entry are marked with one asterisk. NA = Not available. Lbs./A = Pounds per acre. Canning is Scored from 1 (Poor) to 5 (Excellent).

[a]Montcalm county canning scores are artificially low f due to poor harvest conditions (excessive dryness) and should not be used for decision making out of context of this 2024 growing season.

Entry ID	Market class	Source
17746	Black	ProVita
17751	Black	ProVita
17771	Black	ProVita
21650	Black	ProVita
21702	Black	ProVita
21723	Black	ProVita
21727	Black	ProVita
22B042	Black	ADM [a]
22B127	Black	ADM
B18094173	Black	ADM
B2002-1-3	Black	USDA-ARS [b]
B20591	Black	MSU [c]
B21710	Black	MSU
B22041	Black	MSU
B22042	Black	MSU
B22062	Black	MSU
B22854	Black	MSU
B23911	Black	MSU
B23949	Black	MSU
B5054313	Black	ADM
B7071259	Black	ADM
B7072252	Black	ADM
B7072269	Black	ADM
Black Bear	Black	ProVita
Black Beard	Black	ProVita
Black Pearl	Black	MSU
Black Tails	Black	ProVita
Kona	Black	MSU
Nimbus	Black	ProVita
Spectre	Black	ProVita
Umbra	Black	Gentec
Zenith	Black	MSU
16756	Cranberry	ProVita
16758	Cranberry	ProVita
16760	Cranberry	ProVita
16775	Cranberry	ProVita
16816	Cranberry	ProVita
151093	Cranberry	ProVita
Amaranto	Cranberry	Seminis
CR2007-3-1	Cranberry	USDA-ARS
Etna	Cranberry	Seminis
IG-VN	Cranberry	Gentec
Jester	Cranberry	ProVita
OAC Firestripe	Cranberry	TVS [d]
OAC Navabi	Cranberry	TVS
15977	Dark Red Kidney	ProVita
161156	Dark Red Kidney	ProVita
161165	Dark Red Kidney	ProVita
181017	Dark Red Kidney	ProVita
181020	Dark Red Kidney	ProVita
181021	Dark Red Kidney	ProVita
Cinder	Dark Red Kidney	ADM
Dynasty	Dark Red Kidney	Gentec
Epic	Dark Red Kidney	ProVita
Gallantry	Dark Red Kidney	Gentec
K1920-2-3	Dark Red Kidney	USDA-ARS
K23212	Dark Red Kidney	MSU
Montcalm	Dark Red Kidney	MSU
ND Redbarn	Dark Red Kidney	NDSU [e]
Rampart	Dark Red Kidney	ProVita
Red Hawk	Dark Red Kidney	MSU
Seattle	Dark Red Kidney	ProVita
Eiger	Great Northern	MSU
G22004	Great Northern	MSU
ND Pegasus	Great Northern	NDSU
Powderhorn	Great Northern	MSU
15916	Light Red Kidney	ProVita
15923	Light Red Kidney	ProVita
20870	Light Red Kidney	ProVita
20909	Light Red Kidney	ProVita
161055	Light Red Kidney	ProVita
161082	Light Red Kidney	ProVita
Big Red	Light Red Kidney	ProVita
Cal Early	Light Red Kidney	TVS
K2007-3-2	Light Red Kidney	USDA-ARS
K22601	Light Red Kidney	MSU
K22604	Light Red Kidney	MSU
Pink Panther	Light Red Kidney	Seminis
Ronnies Red	Light Red Kidney	ProVita
Rosie	Light Red Kidney	NDSU
Spitfire	Light Red Kidney	ADM
14084	Navy	ProVita

Entry ID	Market class	Source
14092	Navy	ProVita
21102	Navy	ProVita
21108	Navy	ProVita
21127	Navy	ProVita
Argosy	Navy	Gentec
Armada	Navy	ProVita
AuSable	Navy	MSU
Blast	Navy	Gentec
Blizzard	Navy	ProVita
EX2109-N	Navy	TVS
EX2111-N	Navy	TVS
HMS Bounty	Navy	ProVita
HMS Medalist	Navy	ProVita
Liberty	Navy	ProVita
N21510	Navy	MSU
N22005	Navy	MSU
N22616	Navy	MSU
N22622	Navy	MSU
N22623	Navy	MSU
N23706	Navy	MSU
N23715	Navy	MSU
Nautica	Navy	Gentec
ND Polar	Navy	NDSU
OAC Charm	Navy	TVS
OAC Seal	Navy	Jefferies Seeds
Steam	Navy	Gentec
T9905	Navy	TVS
Valiant	Navy	ProVita
Victory	Navy	ProVita
Coral	Pink	MSU
ND Rosalind	Pink	NDSU
S22507	Pink	MSU
Cancun	Pinto	ProVita
Charro	Pinto	MSU
Cowboy	Pinto	ProVita
EX2145-P	Pinto	TVS
EX2146-P	Pinto	TVS
ND Falcon	Pinto	NDSU
P23311	Pinto	MSU
SV6139GR	Pinto	Seminis
USDA Rattler	Pinto	Kelley Bean
Bronco	SDP [f] Pinto	TVS
Eternal	SDP Pinto	Gentec
Gleam	SDP Pinto	ProVita
Mystic	SDP Pinto	ProVita
ND Palomino	SDP Pinto	NDSU
ND Rodeo	SDP Pinto	NDSU
Shine	SDP Pinto	ProVita
USDA Diamondback	SDP Pinto	Kelley Bean
Vibrant	SDP Pinto	ProVita
16686	Small Red	ProVita
17822	Small Red	ProVita
17837	Small Red	ProVita
17848	Small Red	ProVita
17851	Small Red	ProVita
19837	Small Red	ProVita
R20669	Small Red	MSU
R22703	Small Red	MSU
R22710	Small Red	MSU
Viper	Small Red	ProVita
Denali	White Kidney	MSU
K22801	White Kidney	MSU
ND Whitetail	White Kidney	NDSU
OAC Snowshoe	White Kidney	TVS
Snowdon	White Kidney	MSU
WK1601-1	White Kidney	USDA-ARS
Beluga	White Kidney	MSU
Claim Jumper	Yellow	ProVita
Motherlode	Yellow	ProVita
Honeycomb	Yellow	USDA-ARS
USDA Yellowjacket	Yellow	USDA-ARS
Y1803-5-3	Yellow	USDA-ARS
Yellowstone	Yellow	MSU
Yukon Gold	Yellow	MSU

[a] ADM = Archer-Daniels-Midland

[b] USDA-ARS = U.S. Dept. of Agriculture—Agricultural Research Service

[c] MSU = Michigan State University

[d] TVS = Treasure Valley Seed

[e] NDSU = North Dakota State University

[f] SDP = Slow darkening pinto

Multi-Year Trialing Of Heads Up Seed Treatment

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Locations: Bay, Huron, Sanilac, and Tuscola County	**Population:** 105,000 seeds/A
Years: 2022, 2023, & 2024	**Row width:** 20-inch
Replicated: 4 times per location per year	**Treated Plot Size:** 6.6' x 17'
Design: RCBD across locations and years	**Seed Treater:** Seedburo Batch Lab Seed Treater
Variety: Black Beard and Spectre (2023-2024), Black Bear (2022)	

Table 1. 2022-2024 combined analysis for the main effect of treatment rate, all results are combined over the factor of variety as interactions were not significant.

Factor 1: Seed Treatment	3-year avg. *(Lbs./A)*[ab]
Cruiser Seed Treatment	3185 a
Cruiser Seed Treatment + HeadsUp (0.5oz cwt^{-1})	3280 a
Cruiser Seed Treatment Fb. HeadsUp (1oz cwt^{-1})	3279 a
MEAN:	3248
LSD$_{(0.05)}$:	236
CV:	22%

[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.

Table 2. 2023-2024 combined analysis for the main effect of variety tested, all results combined over the factor of seed treatment as interactions were not significant.

Factor 2: Variety	2-year avg. *(Lbs./A)*[ab]
Black Beard	3337 a
Spectre	3474 a
MEAN:	3405
LSD$_{(0.05)}$:	231
CV:	22%

[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.

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Summary: Over the 2022, 2023 and 2024 growing seasons Heads Up seed treatment was tested on farm in four locations in Michigan. Heads Up seed treatment is a preplant seed treatment intended to suppress fungal pathogens. Each year testing methods were similar, testing an untreated control against two different rates/methods of application of the Heads Up seed treatment. It is important to note that the 'untreated' was an industry standard application of Cruiser seed treatment with no Heads Up added. Not to be confused with completely untreated bare seed. This was done because this testing was targeted at testing the effects of the biological seed treatment, and not the effects of Cruiser. The testing in 2022 focused on one variety of black bean, 'Black Bear'. This is considered a white mold susceptible line. Adjustments were made in 2023 and 2024 to also include a white mold tolerant line, in these years both 'Black Beard' (mold susceptible) and 'Spectre' (mold tolerant) were tested. Seed treatments remained the same over the three years of testing. The first treatment containing Heads Up was the combination of Cruiser and Heads Up added at a rate of 0.5 oz per cwt of seed applied in a slurry mixture at the same time. The second treatment containing heads up each year was a standard treatment of Cruiser that was allowed to dry, then followed by a 1 oz rate per cwt of Heads Up applied overtop of the cruiser. Over the three years and 4 locations per year (12 total site-years) white mold pressure was variable as expected. When mold pressure was sufficient for evaluation, results of testing indicate that white mold infection rates and levels of severity were not impacted by seed treatment.

In 2023 and 2024 when multiple black bean varieties were tested differences did not exist on a variety basis, or from seed treatment effects. Preliminary results in 2023 suggested that the variety Black Beard significant yielded more when treated with heads up regardless of rate than when not treated ($P \leq 0.05$). However, when 2024 was added to the data set this interaction was proven to not be significant over locations and years. In the combined analysis, neither Spectre (2023-2024), Black beard (2023-2024), or Black Bear (2022) had statistically different yield results from the effect of seed treatment, nor did differences in yield exist between Black Beard and Spectre when averaged over the effects of seed treatment (Table 2).

While it appears that the positive effects of Heads Up may be variable, there is no evidence to suggest any negative or phytotoxic effects exist when label guidelines are used in the treatment of dry bean seed. We would like to thank Heads Up and the Michigan Bean Commission for supporting this work.

Dry Bean Varietal Response to Fungicide

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Introduction:

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. Otherwise known as: genetics * environment * management= yield. To research this question twenty-six commercial dry bean varieties (9 black, 9 navy, 1 small red, 2 great northern, 5 pinto) were selected and placed into testing.

Methods:

Dry beans were seeded in four-row plots that measured 6.6′ wide by 25′ long, with 20″ rows on the evening of June 11, 2024. Planting population was 105,000 seeds per acre for all entries. 50 lb. of nitrogen was applied at planting utilizing 2x2 placement of 28-0-0 fertilizer. Each entry was replicated **four times** in a split plot design. Trials received industry standard seed treatments, fertilization, and weed control applications at labeled rates. Fungicide was applied to half of the replications for each entry. The product used was Propulse at 10.3 fl oz. per acre at R1 (timing "A"). Only one application was made in 2024 due to poor overall trial quality from excessive rainfall early in the growing season. Yield data was obtained by direct harvest. Following harvest, samples were cleaned, weighed, and moisture tested. All yield data is adjusted to a standard 18% moisture for standardization.

Results:

Trial quality was poor in 2024. Early season rain followed by a relatively dry reproductive period lead to areas of waterlogging and average dry bean yields where not damaged. White mold infection was very low in both plots that received fungicide, and plots that did not. Main plot effects (Fungicide) were not significant. The subplot (variety) effects were significant in this testing. **Fungicide:** When averaged across all entries the plots that were sprayed with fungicide yielded 162 lb./A less than the untreated which is not statistically considered different ($P \leq 0.05$) (25.8 cwt vs. 27.4 cwt.). **Variety:** When average across fungicide treatments (sprayed and not sprayed) 7 of 26 lines entered yielded in the 90th percentile (top 10%) of the trial: Charro (33.2 cwt), Nimbus (32.7 cwt), Black Beard (30.9 cwt), Shine (30.9 cwt), Umbra (30.4 cwt), Blizzard (30.2 cwt), and ND Pegasus (29.9 cwt) **(Table 1)**. Results in 2024 did not indicate that a significant interaction between factors.

Discussion:

As previously stated no significant interactions between factors existed in 2024. This was not the case in 2023 where a highly significant interaction took place between Variety and Fungicide. The main difference between seasons was trial quality and overall yield potential, in 2023 trial average yield was 34.8 cwt where in 2024 average yields were 26.7 cwt. With the added yield potential was the higher incidence of white mold (>60% in 2023). A preliminary hypothesis would be that this interaction is driven by disease and variety susceptibility rather than a plant health response. This is supported by 2023 findings in Figure 1. When plotting yield response (the difference between treated and untreated

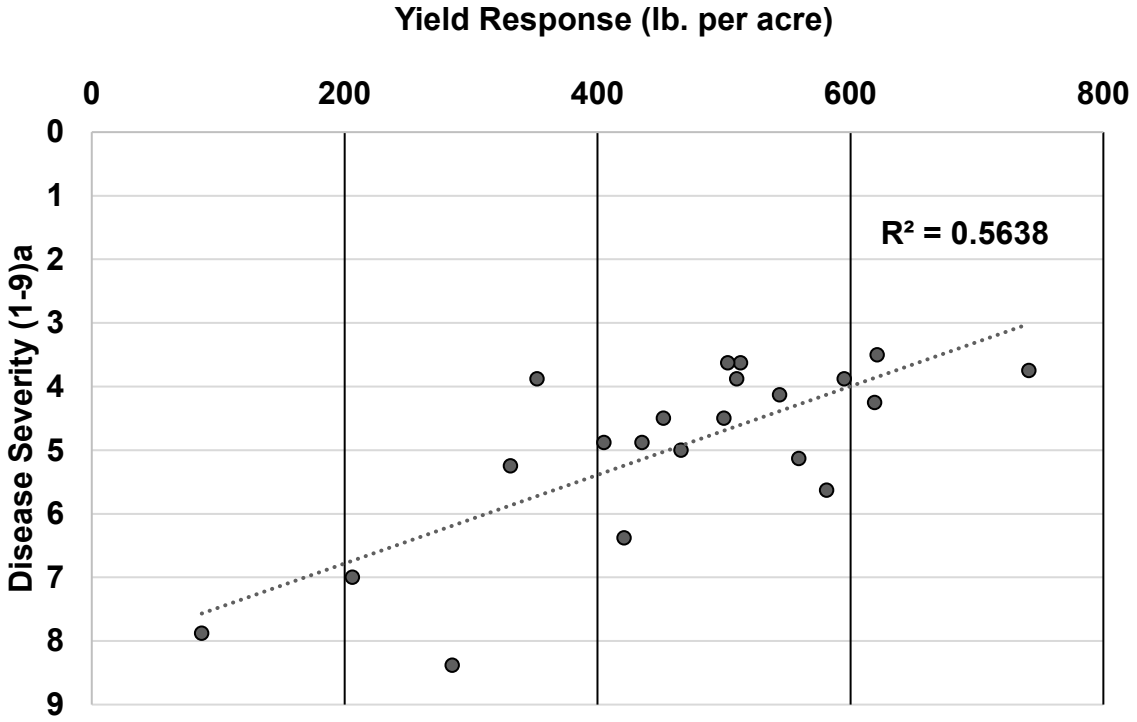
yield) for each variety against the disease severity score (visual score from 1-9 of how severe disease symptoms were in the untreated) a correlation/positive trend exists between variables. As a disease severity scores in the untreated decrease, the yield response increases. In other words as a general trend, the more tolerant a variety was to white mold genetically the higher its response to fungicide was. The development of a viable data set on a complex trait such as response to fungicide will take years of continued trialing to grasp the scale of which genetics * environment * management= yield.

Table 1. Significant effect for Factor 2 Variety combined over fungicide treatment

Variety	Market Class	Yield Cwt./A	Grouping
Charro	Pinto	33.2	a
Nimbus	Black	32.7	ab
Black Beard	Black	30.9	ac
Shine	Slow Darkening Pinto	30.9	ac
Umbra	Black	30.4	ac
Blizzard	Navy	30.2	ac
ND Pegasus	Great Northern	29.9	ac
Eiger	Great Northern	29.9	ac
Black Bear	Black	29.7	ac
Liberty	Navy	27.9	ad
Mystic	Slow Darkening Pinto	27.8	ad
Black Pearl	Black	27.6	ad
Black Tails	Black	27.2	ae
AuSable	Navy	26.7	ae
Argosy	Navy	26.5	ae
Victory	Navy	26.5	ae
Spectre	Black	26.2	be
Viper	Small Red	25.9	be
Kona	Black	24.9	be
Gleam	Slow Darkening Pinto	23.6	ce
HMS Bounty	Navy	22.1	de
HMS Medalist	Navy	21.9	de
Valiant	Navy	21.8	de
Armada	Navy	20.6	de
Vibrant	Slow Darkening Pinto	20.2	de
Zenith	Black	19.3	e

[a] Note. Yields followed by the same letter are not considered to be different P<0.05.
[b] Yield is in hundred weights per acre obtained by direct harvest, adjusted to 18% moisture.

Figure 1. Severity (1-9) and yield response to fungicide treatment in 2023 season



[a] Severity is scored on a scale from 1-9 where 1 is the lowest severity and 9 is the most severe.

Dry Planter Box Treatments of Rhizobium, Azospirillum, and Harpin Proteins in Small Red Beans

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Locations: Tuscola County, MI	**Population:** 105,000 seeds/A
Year: 2024	**Row width:** 20-inch
Replicated: 4 times	**Treated Plot Size:** 6.6' x 17'
Design: RCBD	**Seed Treater:** Seedburo Batch Lab Seed Treater
Variety: Viper Small Red Beans	

Table 1. 2024 Analysis of final plant stands and yield when applications of two dry planter box treatments were made compared to an untreated control.

Dry Planter Box Treatment	Final Stand (Plants/A)	Yield *(Lbs./A)*[ab]
Untreated	78,966 a	3,201 a
MicroSURGE (9.6 oz/cwt)	75,123 a	2,880 a
MicroSURGE + Inceptive (9.6 oz/cwt)	78,616 a	3,282 a
MEAN:	77,556	3,121
LSD(0.05):	7,290	255
CV:	9.2%	8.0%

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

Summary: In 2024 two dry planted box treatments were sourced from Talc USA and trialed in comparison to an untreated control. Two components were included. #1: 'MicroSURGE', a biological treatment containing: rhizobium etli, rhizobium tropici and azospirillum brasilense. #2 'Inceptive': dry based harpin protein produced commercially. Harpin proteins were originally documented as a biproduct of Erwinia amylovora (Fire Blight in fruit crops) and known to stimulate systemic acquired resistance (SAR) in host plants. Documentation of nematode root rot suppression is found in the literature but can be pest and host plant specific, as well as dependent on ambient temperatures (Navarro-Acevedo 2016).

In 2024 field testing no significant results were documented in stand or harvestable yield. Further research should be done in dry beans analyzing the potential benefits from harpin proteins in inoculated testing focusing in both soil-borne pathogens and potential nematode suppression. This research question would benefit from testing in a controlled environment. We would like to thank Talc USA and the Michigan Bean Commission for supporting this work.

Fungicide Trials in Dry Edible Beans: Performance in Low Disease Environments

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Locations: LAKKE Ewald Farms	**GPA:** 20
Planting Date: June 4, 2024	**PSI:** 30
Replicated: 4 times	**Nozzle:** XR8002
Design: RCBD	**Timing:** R1 (A)
Variety: Viper Small Red Beans	**Row width:** 20-inch
Population: 105,000 seeds/A	**Treated Plot Size:** 6.6' x 20'
Harvest Date: September 11, 2024	**Application date**: July 22 (A)
PPI June 3, 2024 Outlook 14 (fl oz) + Prowl H2O (1.6 pt) + Eptam (3 pt)	
POST A *June 24, 2024*: Basagran 5L (20 fl oz) + Outlook (7 fl oz) + COC (1% v/v) + AMS (2.5 Lb.) **POST B** *July 2, 2024:* Basagran 5L (30 fl oz) + COC (1% v/v) + AMS (2.5 Lb.)	

Table 1. Dry bean fungicide treatments, application timing, and dry bean yield.

#	Treatments	Application Timing	Yield [ab]
1	Propulse (8 fl oz)	A	3413 a
2	Topsin M (30 fl oz)	A	3386 a-b
3	Endura (8 oz)	A	3328 a-c
4	Proline (5.7 fl oz)	A	3252 a-d
5	Endura (6 oz) + Priaxor (6 fl oz)	A	3094 a-e
6	Topsin M (40 fl oz)	A	3070 a-e
7	Priaxor (6 fl oz)	A	3046 b-f
8	Endura (6 oz)	A	3042 b-f
9	Headline (6 fl oz)	A	2994 c-f
10	Propulse (6 fl oz)	A	2948 d-f
11	Miravis Neo (13.7 fl oz)	A	2927 d-f
12	Propulse (10 fl oz)	A	2912 d-f
13	Omega (8 fl oz)	A	2899 e-f
14	Miravis Neo (13.7 fl oz) + Omega (8 fl oz)	A	2763 e-f
15	Untreated	-	2712 f
		Mean:	3053
		LSD:	345
		Cv:	12.2%

[a] Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).

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

Summary: In 2024 a trial was established on LAKKE Ewald Farms in Unionville Michigan. This specific field has experienced white mold disease in the past, but it was not a major concern for the 2024 growing season unless environmental conditions were very conducive for disease development. For this reason, it was chosen to be the location of a fungicide trial targeting low-mild disease conditions and one pass fungicide programs. Survey data suggest that around 50% of Michigan growers utilize a one pass program (opposed to a two-pass program). Despite good vegetative growth in 2024 white mold was not a significant factor in the trial and was not rated. All treatments were made at a late R1 stage, or know as ½" pin pod. We would like to thank the Michigan Bean Commission for supporting this research.

Fungicide Evaluation for White Mold Control of Bayer Products in Small Red Beans

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Locations: Gentner-Bischer Farms (Harbor Beach, MI)	**GPA:** 20
Planting Date: May 31, 2024	**PSI:** 30
Replicated: 8 times	**Nozzle:** XR8002
Design: RCBD	**Timing:** R1 (A) & R3 (B)
Variety: Viper Small Red Beans	**Row width:** 22-inch
Population: 110,000 seeds/A	**Treated Plot Size:** 6.6' x 20'
Harvest Date: September 9, 2024	**Application date**: July 19 (A) & July 31 (B)

Table 1. Dry bean fungicide treatments, application timing, disease severity, percent infection and dry bean yield.

#	Treatments	Application Timing	Severity [ab]	% infection	Yield [c]
1	Untreated	-	7.2 a	94 a	2284 b
2	Propulse (8 fl oz)	AB	4.0 ab	59 b	3776 a
3	Propulse (10.3 fl oz)	AB	3.2 b	45 b	3659 a
4	Delaro (12 fl oz) Fb. Propulse (8 fl oz)	AB	6.7 a	73 ab	3200 a
5	Delaro (12 fl oz) + Luna Privlege (2 fl oz) Fb. Propulse (8 fl oz)	AB	4.0 ab	55 b	3796 a
6	Luna Flex (11 fl oz)	AB	3.8 ab	51 b	3888 a
7	Luna Flex (13.6 fl oz)	AB	2.8 b	46 b	3541 a
8	Luna Flex (11 fl oz) Fb. Propulse (8 fl oz)	AB	4.5 ab	59 b	3872 a
		Mean:	4.5	60	3502
		LSD:	2.2	22	587
		Cv:	42.2	32.2	16.7

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

Summary: A white mold trial was established at Gentner- Bischer Farms in a field near Harbor Beach Michigan. This field had been planted to Small Red Beans, variety Viper, on May 31, 2024. Disease pressure averaged 60% across all treatments, with an average severity of 4.5 (1-9 scale). Treatments were made at two separate timings: (A) R1 and (B) 12 d. after R1. Yield was significantly improved by all treatments when compared to the untreated control. Yield response ranged from the lowest response of 916 lbs./A to the highest of 1,604 lbs/A. Percent infection was significantly decreased by all fungicide treatments except for Delaro Fb. Propulse. While not significant the sequential application of Luna Flex (11 fl. oz.) (Fluopyram + Difenoconazole) produced the highest numerical yield in 2024, producing 3,888 lb./A. This treatment was the numerical winner of the 2023 trial as well. Fungicide trials will be continued in 2024 to continue to build a stronger data set for crop protection decisions. We would like to thank Bayer Crop Science and the Michigan Bean Commission for supporting this research.

Cover Crop Integration into Dry Bean and Sugarbeet Systems

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Locations: Richmond Brothers Farms	**Previous Crop:** Wheat	
Planting Date: August 15, 2024	**Fertility:** Liquid Dairy Manure (July 2024)	
Replicated: 3 times	**Seeding Method:** High Speed Disk	
Design: RCBD	**Following Crop:**	Sugarbeets (2025)
Plot size: 2.5 acres (7.5 acres per treatment)		Dry Beans (2026)

Table 1. Cover Crop Species and Rates, Percent Ground Cover, Below Ground Biomass, Above Ground Biomass, Total Biomass, and Rotational Crops

#	Treatments	Percent Ground Cover[ab]	Biomass (lbs./Acre)			Yield	
			Below Ground	Above Ground	Total	Sugarbeets	Dry Beans
1	Radish (5 lbs./A) + Oats (35 lbs./A)	100 a	754 a	2,614 a	3,368 a	Fall 2025	Fall 2026
2	Sorghum Sudan Grass (40 lbs./A)	100 a	1,124 a	2,382 a	3,507 a	-	-
3	Annual Rye Grass (25 lbs./A) + Radish (2 lbs./A)	100 a	1,081 a	2,374 a	3,456 a	-	-
4	Untreated Check	11 b	*NA*	*NA*	*NA*	-	-
	Mean:	77	986	2,457	3,444		
	LSD:	10	706	1181	1203		
	Cv:	7.1%	34%	22.9%	16.5%		

[a] Ground cover measured on a percentage basis of exposed soil within each replicate. Untreated ground cover was provided by volunteer wheat

[b]Means within the same column with different letters are not significantly different from each other ($\alpha \leq 0.05$).

[c] Biomass samples were dug or cut from the field, sieved in water to remove any attached soil and dried for 5 days in a forced air dryer to provide an accurate estimation of dry biomass produced by each treatment.

Summary: In 2024 a trial was established on Richmond Brothers Farms in Pigeon Michigan. This trial was implemented based on past experience with cover crop integration into the dry bean and sugarbeet system after wheat harvest. It was hypothesized that specific cover crop species had been successful for the mitigation of compaction, proving ground cover into the fall, and building soil tilth eventually resulting in higher yields throughout the rotation. To test this hypothesis a four-treatment trial was designed and planted by a high-speed disk on August 15th, 2024. This trial was allowed to grow well into the fall and was sampled right ahead of a predicted killing frost. Biomass samples were taken from both above and below ground (roots). Overall biomass production was lower than expected due to little precipitation in the fall of 2024. The MSU Enviroweather network reported 3.07" of rain from August 1, 2024, through October 1, 2024 which is under 50% of the 5 year average (6.5"). Despite the lack of growth this trial will continue to be monitored by both the research team at PRAB and SBA taking yield and quality estimated on the rotational crops. However, if conclusions are to be drawn from this type of research multiple years and locations are needed.

Testing Efficacy of Gowan Products on White Mold in Dry Edible Beans

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Locations: Gentner-Bischer Farms (Harbor Beach, MI)	**GPA:** 20
Planting Date: May 31, 2024	**PSI:** 30
Replicated: 8 times	**Nozzle:** XR8002
Design: RCBD	**Timing:** R1 (A), R2 (B), & R3 (C)
Variety: Viper Small Red Beans	**Row width:** 22-inch
Population: 110,000 seeds/A	**Treated Plot Size:** 6.6' x 20'
Harvest Date: September 9, 2024	**Application date**: July 19 (A), July 26 (B) & July 31 (C)

Table 1. Dry bean fungicide treatments, application timing, disease severity, percent infection and dry bean yield.

#	Treatments	Application Timing	Severity [ab]	% Infection	Yield [c]
1	Untreated	-	6.5 ab	87 a	2260 b
2	Domark (6.4 fl oz) + NIS (0.25%)	AC	6.8 ab	92 a	2160 b
3	Affiance (15 fl oz) + NIS (0.25%)	AC	6.3 ab	80 a	2720 ab
4	Domark (6.4 fl oz) + Badge (32 fl oz)	AB	7.0 ab	86 a	2320 b
5	Domark (6.4 fl oz) + Badge (32 fl oz)	AC	7.5 a	89 a	2300 b
6	Affiance (15 fl oz) + Badge (32 fl oz)	AB	6.0 ab	79 a	2610 ab
7	Affiance (15 fl oz) + Badge (32 fl oz)	AC	6.8 ab	89 a	2570 ab
8	Domark (6.4 fl oz) + Topsin (20 fl oz)	AC	8.3 a	94 a	2270 b
9	Domark (6.4 fl oz) + Badge (32 fl oz) Fb. Endura (8 oz)	AC	7.0 ab	95 a	2400 b
10	Propulse (10.3 fl oz) + NIS (0.25%)	AC	3.8 b	50 b	2950 a
		Mean:	6.6	84	2456
		LSD:	2.2	21	382
		Cv:	28.9%	22.3%	15.5%

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

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Summary: A white mold trial was established at Gentner- Bischer Farms in a field near Harbor Beach Michigan. This field had been planted to Small Red Beans, variety Viper, on May 31, 2024. Disease pressure averaged 84% across all treatments, with an average severity of 6.6 (1-9 scale). This is considered very good disease pressure. Treatments were made at three separate timings: (A) R1, (B) 7 d. after R1, and (c) 12 d. after R1. Yield and percent infection were significantly impacted by the treatment of Propulse at 10.3 fl. oz. per acre when applied at A and C timings compared to the untreated control. Major differences between the timings of A-B and A-C were not documented when comparing like chemistry. We would like to thank Gowan and the Michigan Bean Commission for supporting this research in 2024.

NuFarm Americas Dry Bean Fungicide Trial

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Locations: Gentner-Bischer Farms (Harbor Beach, MI)	**GPA:** 20
Planting Date: May 31, 2024	**PSI:** 30
Replicated: 8 times	**Nozzle:** XR8002
Design: RCBD	**Timing:** R1 (A) & R3 (B)
Variety: Viper Small Red Beans	**Row width:** 22-inch
Population: 110,000 seeds/A	**Treated Plot Size:** 6.6' x 20'
Harvest Date: September 9, 2024	**Application date**: July 19 (A) & July 31 (B)

Table 1. Dry bean fungicide treatments, application timing, disease severity, percent infection and dry bean yield.

#	Treatments	Application Timing	Severity [ab]	% infection	Yield [c]
1	Untreated	-	8.2 a	98 a	2090 c
2	1901SC (30 fl oz)	AB	7.5 a	94 a	2400 bc
3	T-Methyl (30 fl oz)	AB	7.5 a	95 a	2920 a
4	1901SC (30 fl oz) + T-Methyl (30 fl oz)	AB	6.0 a	85 a	3070 a
5	Proline (5.7 fl oz)	AB	7.8 a	86 a	2170 bc
6	1901 SC (30 fl oz) + Proline (5.7 fl oz)	AB	6.8 a	93 a	2630 ab
7	Endura (8 oz)	AB	6.8 a	92 a	2630 ab
		Mean:	7.2	92	2558
		LSD:	1.6	14	351
		Cv:	18.9%	13.2%	16.6%

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

Summary: A white mold trial was established at Gentner- Bischer Farms in a field near Harbor Beach Michigan. This field had been planted to Small Red Beans, variety Viper, on May 31, 2024. Disease pressure averaged 92% across all treatments, with an average severity of 7.2 (1-9 scale). Treatments were made at two separate timings: (A) R1 and (B) 12 d. after R1. Yield was significantly improved by all treatments when compared to the untreated control except for 1901SC or Proline when applied alone. Positive yield responses ranged from 540 to 980 lbs. per acre. Percent infection or disease severity were not significantly impacted by any treatment. This data speaks to the severity of disease present in this trial in 2024 overwhelming the suppression of the products in testing including the standard of Endura (8 oz). We would like to thank NuFarm Americas and the Michigan Bean Commission for supporting this research.

2024 Syngenta Fungicide Trial

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Locations: Gentner-Bischer Farms (Harbor Beach, MI)	**GPA:** 20
Planting Date: May 31, 2024	**PSI:** 30
Replicated: 8 times	**Nozzle:** XR8002
Design: RCBD	**Timing:** R1 (A) & R3 (B)
Variety: Viper Small Red Beans	**Row width:** 22-inch
Population: 110,000 seeds/A	**Treated Plot Size:** 6.6' x 20'
Harvest Date: September 9, 2024	**Application date**: July 19 (A) & July 31 (B)

Table 1. Dry bean fungicide treatments, application timing, disease severity, percent infection and dry bean yield.

#	Treatments	Application Timing	% Injury [a]	Severity [b]	% infection	Yield [c]
1	Untreated	-	0 b	7.0 a	84 a	2010 b
2	Omega (12 fl oz)	AB	0 b	6.2 a	84 a	3110 a
3	Omega (12 fl oz) Fb. Miravis Neo (13.7 fl oz)	AB	10 a	5.5 a	68 a	3170 a
4	Omega (12 fl oz) Fb. Miravis Prime (10.3 fl oz)	AB	0 b	6.7 a	79 a	3200 a
5	Propulse (10.3 fl oz)	AB	0 b	5.7 a	71 a	3650 a
		Mean:	2	6.2	77	3028
		LSD:	1	2.8	32	720
		Cv:	47.0%	34.8%	34.8%	23.2%

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

Summary: A white mold trial was established at Gentner- Bischer Farms in a field near Harbor Beach Michigan. This field had been planted to Small Red Beans, variety Viper, on May 31, 2024. Disease pressure averaged 77% across all treatments, with an average severity of 6.2 (1-9 scale). Treatments were made at two separate timings: (A) R1 and (B) 12 d. after R1. Mild injury (phytotoxicity) was observed from the application of Miravis Neo (10%), this was not unexpected or majorly concerning given the combination of active ingredients including azoxystrobin. Injury was not documented from any other treatment. Yield was significantly improved by all treatments when compared to the untreated control from the lowest response of 1,100 lbs./A to the highest of 1,640 lbs/A. While not significant the highest numerical yield was produced by the sequential application of Omega (fluazinam) followed by Miravis Prime (Pydiflumetofen + Fludioxonil). Percent infection and disease severity were not impacted by the application of any fungicide tested. This speaks to the severity of disease pressure that was applied to this location in 2024 overwhelming some of the suppression provided by treatment.
We would like to thank Syngenta and the Michigan Bean Commission for supporting this research.

Early Planting of Michigan Dry Beans

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Introduction:

In the last decade the varietal landscape of Michigan dry beans has transformed rapidly. We have documented high levels of variety improvement and adoption in both black and navy beans, this accounts for over 80% of total Michigan acres. With this transition we have also observed a few trends: 1.) longer average maturities are providing additional yield potential and are being accepted by growers 2.) Improved plant vigor with newly adopted varieties 3.) higher levels of fungicide use in crop 4.) more focus on winter wheat planting dates. With these trends it has provided the opportunity to reanalyze the traditional dry bean production system. Growers have responded to trend #1 and have adopted varieties that have long term average maturities that are longer than 100 days, a historical upper limit. While this has provided yield to offset the opportunity cost of delayed harvest it has also pushed back wheat planting dates in the fall. In the past this was not a major concern unless fall weather became inclement. However, recent MSU research documented a yield loss of 0.6 bushel per day for seedings planted after October 1 in Michigan (Pennington & Singh 2022) and has driven trend #4. This direct economic cost is in addition to the unquantifiable quality risk of harvesting dry beans in October rather than September. The risk of late harvest has appeared to be greater in the last decade with variable rainfall and temperature patterns, and also helped growers understand trend #2. With early season waterlogging (wet feet) becoming commonplace it has become clear that modern dry bean varieties are much more tolerant of this type of stress than previous generations. Anecdotally, areas of water damage would get larger over time in the field after the initial wet period. However, it has been much more common for these areas to shrink as beans on the margins are able to recover from injury and provide a harvestable yield by the end of the season. This overall improvement in the system has increased total yield potential and made room in the balance sheet for a higher management system that includes inputs such as fungicide during the reproduction stages of development. Survey data from Michigan producers estimated more than 50% of all acres receive at least one fungicide application. While this has documented a positive return on investment for growers, it can contribute to longer yet maturities as leaf retention and 'green stem' can be more likely to persist after fungicide applications. With these challenges come opportunities and growers have adapted. It has become more commonplace to plant dry beans earlier in the spring than was traditionally the norm. In 2025 (weather allowing) more beans will be planted in the third week of May than the third week of June. Historically this was not true. Questions arise about what pressures do we put on the system as we look at adjusting this planting date. To research this question multiple projects were implemented in 2024, including a variety trial with the added factor of planting date that is the focus of this report.

Table 1. Varieties tested, market class, and average maturity in 2024.

Variety	Market Class	Maturity [a]
Black Beard	Black	95
Kona	Black	95
Spectre	Black	99
HMS Bounty	Navy	96
AuSable	Navy	90
Viper	Small Red	99

[a] average maturities for 2024 were 1-4 days earlier than normal due to high levels of GDD accumulation and late season dryness

Methods:

Dry beans were seeded in four-row plots that measured 6.6' wide by 25' long, with 20" rows at five separate timings: May 6th, 13th, 20th, 27th and June 13th. Planting population was 130,000 seeds per acre for all entries. Entries included three black beans, two navy beans and one small red (Table 1.) 60 lb. of nitrogen was applied at plating utilizing 2x2 placement of 28-0-0 fertilizer. The trial was designed as a Split-Plot design.

Main plot effect was planting date with **Four replications** per planting date. Subplot effect was variety planted with four replications per planting date. Care was taken to select commercial varieties at each end of the maturity spectrum when possible (short vs. long). Trials received industry standard seed treatments, fertilization, and weed control applications at labeled rates. PPI herbicide treatments and tillage were applied directly ahead of planting for each planting date. Yield data was obtained by direct harvest. Following harvest, samples were cleaned, weighed, and moisture tested. All yield data is adjusted to a standard 18% moisture for standardization.

Results:

Overall trial quality was poor in 2024. Early season heavy and repeated rain followed by a relatively dry reproductive period led to areas of waterlogging and low overall dry bean yields regardless of planting date or variety. However, the main plot effect of planting date was significant. The subplot effect of variety was also significant in this testing. There was not a significant interaction between factors.

Planting Date: When averaged across all entries the mean results from planting dates ranged from 9.5 cwt.- 15.7 cwt./acre (Table 2.). May 20th was the only date that was significantly different (Pr>F= 0.01). On May 21st more than 2 inches of rainfall was received on the freshly planted beans greatly impacting early season root health.

Variety: When averaged across all panting dates entries yielded from 10.9 cwt.- 17.8 cwt./acre (Table 3.). Black Beard significantly outyielded all other entries *(Pr>F= 0.007)* with an average performance of 17.8 cwt./acre when averaged across all planting dates.

Table 2. Dry bean response to planting date averaged over varieties tested (Main plot)

Planting Date	Yield [ab]
6-May	1266 a
13-May	1463 a
20-May	955 b
27-May	1397 a
13-Jun	1574 a

Table 3. Dry bean yield by variety averaged over planting dates (Sub plot)

Variety	Yield [ab]
Black Beard	1780 a
Kona	1417 b
Viper	1237 b
HMS Bounty	1233 b
Ausable	1105 b
Spectre	1094 b

[a] Yields followed by the same letter are not considered to be different P<0.05.
[b] Yield is in pounds per acre obtained by direct harvest, adjusted to 18% moisture.

Discussion:

As previously stated, no significant interactions between factors existed in 2024. Meaning one variety was not superior at an individual planting date. This data need repetition over years where early season waterlogging is not such a significant factor on trial quality and yield potential is not limited to such a great extent. However, these preliminary results do support the grower hypothesis that the black bean variety 'Black Beard' handles stress better than some other varieties in the marketplace. The development of a viable data set on a complex trait such as response planting date will take years of continued trialing to grasp the scale of which genetics * environment * management= yield. We would like to thank the Michigan Bean Commission for supporting this work in 2024.

Progress Report on SCBG Genetic Advancement Objectives
Submitted by: Valerio Hoyos-Villegas and Evan Wright (MSU Dry Bean Breeding Program)

Black and Navy bean yield trials were established at SVREC (Tuscola Co.) and MRC (Montcalm Co.) research farms, in addition to on-farm near Harbor Beach (Huron Co.) in 2024. Eight yield trials in total were conducted to evaluate the yield potential, agronomic characteristics, white mold tolerance and maturity of 188 black and 92 navy bean breeding lines and relevant commercial varieties as checks. Roughly 30% of the entries have been tested previously with preliminary results indicating their yield potential, maturity, and efficient dry down is suitable for Michigan production conditions. These lines were included at both locations to further gauge stability of yield and maturity across environments. 184 entries represented new breeding lines developed by the MSU breeding program and were planted at the rainfed SVREC location for initial yield and agronomic screening. They were also replicated at MRC under high management, irrigated conditions conducive to white mold development, with disease ratings collected in addition to yield and agronomic data.

High throughput phenotyping (HTP) via UAS-based RGB images was conducted at both SVREC and Huron sites during the growing season. Seven flights were performed at the Huron site, while eight flight dates were recorded at SVREC and included 2x weekly flights during the senescence phase to enhance the precision of maturity estimates. Maturity notes were also collected visually by our team of experienced plant breeders to validate information collected by the drone imaging. Data analysis is currently ongoing, and we will apply the techniques recently developed in our program by Volpato et al (https://doi.org/10.21203/rs.3.rs-3160633/v1) to estimate maturity via modeling decay of canopy greenness. Average plant height of each plot will also be calculated from images to facilitate selection of upright plant types that meet desirable dry down characteristics. Breeding lines that show uniform and efficient dry down in the target range of 95-102 days maturity with improved yield potential beyond that of current commercial standards will be advanced to canning trials this winter to ensure that they also meet processing quality standards for the dry bean industry. HTP phenotyping efforts in the development of improved canning quality are underway, as part of a broader project in the validation of genomic selection for black beans.

At the MRC location, experimental HTP via UAS-based multispectral (MS) imaging was conducted across eight flight dates with the goal of developing an image-based method for monitoring and evaluation of white mold disease development. 2024 marks the second season this method has been employed, and initial analysis suggests that the MS imaging may offer sufficient precision for accurately modeling white mold development, both spatially and temporally across the season. Notes collected by experienced staff using conventional ground based visual disease ratings will be used to assess how well the HTP method works. RGB images were also collected at this site and can be used similarly to the image data collected in Huron Co. for assessing maturity, uniform dry down, and plant height. A graduate student (John Hawkins) is involved in this effort and is now in the process of extracting data from UAV imagery to model white mold disease. There is scope for merging UAV data for white mold and canning quality as influenced by management practices.

EXPERIMENT 2401 STANDARD NAVY BEAN YIELD TRIAL								PLANTED: 6/12/24	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
N22610	N18122/N19253	18	27.4	21.5	42.5	86.8	1.0	48.3	5.5
N23702	N18122/N19226	28	27.3	24.8	42.0	92.8	2.3	47.5	3.3
N23717	N19226/B19309	23	27.1	22.7	44.0	89.5	1.5	44.5	5.0
N19277	N14229/N14218	1	27.0	19.6	40.0	88.3	1.5	44.8	5.0
N22602	N17505/N18122	15	26.5	23.2	42.5	85.8	1.0	46.8	5.5
N21510	N15306/N14229	9	26.1	19.9	40.0	84.8	1.0	43.0	5.8
N22616	N19216/N17505	3	25.5	21.2	41.5	87.0	1.5	44.5	5.3
N22617	N19216/N17505	7	25.3	20.1	41.0	85.8	1.3	47.0	5.5
N21522	N17504/B15430	13	25.1	21.0	42.5	86.3	1.3	44.8	5.0
N22623	N19241/N18103	5	25.0	22.7	41.5	84.5	1.5	41.8	5.0
N23732	B18201/B18204	29	24.8	20.3	40.0	83.5	1.0	45.0	5.3
N23705	N18128/N19253	27	24.7	20.3	43.5	88.0	1.0	46.5	5.0
N23731	N20351/N19253	36	24.4	21.4	43.5	86.3	1.8	48.3	4.5
N23716	N19226/B19309	21	24.4	22.8	43.5	86.3	1.0	45.5	5.5
N20395	B16504/N17504	10	24.3	20.9	43.0	87.3	1.0	43.8	5.0
N23706	N18128/N19253	24	24.1	20.3	44.0	88.3	1.0	45.8	5.0
N23721	N19253/N18122	35	23.8	20.9	42.0	85.5	1.0	46.5	5.0
N21511	N15306/N15337	8	23.5	22.2	43.0	85.8	1.0	42.0	5.3
N22622	N19216/B18224	2	23.2	21.0	42.5	88.3	1.0	43.0	4.8
N22005	N15306/B17023	6	23.2	20.4	39.5	86.5	1.0	47.0	5.3
N23708	N18128/N19253	31	22.9	21.0	44.5	87.3	1.0	45.0	4.5
N22630	N19253/B19309	12	22.5	20.1	44.5	91.0	1.0	45.5	3.5
I22001	**LIBERTY**	11	22.3	22.0	40.0	90.8	1.8	36.8	4.0
N23715	N19226/B19309	22	22.2	21.3	42.5	85.8	1.0	39.5	4.0
N22605	N17505/B18224	17	22.2	21.0	42.0	84.5	1.3	46.3	5.8
N21520	N17504/N14229	16	22.1	19.6	40.5	86.0	1.3	41.5	4.0
N18105	N13131/N14201	4	21.9	22.3	42.0	87.5	1.5	43.5	4.3
N23707	N18128/N19253	32	21.7	20.5	44.5	88.3	1.0	44.0	5.0
N23720	N19226/B20597	26	21.6	22.0	42.5	85.5	1.0	39.5	4.3
N23725	N19284/N19226	25	21.4	21.1	43.0	85.8	1.3	41.0	4.0
N23709	N18128/B19346	34	21.3	20.0	43.0	86.0	1.0	41.8	4.5
N23726	N19302/B20599	33	20.4	19.8	43.0	86.0	1.0	45.0	4.3
N11283	MEDALIST/N08003, **ALPENA**	14	19.8	20.0	39.5	86.5	1.3	47.0	4.3
N23724	N19284/N19226	30	19.7	21.3	44.0	85.3	1.3	41.8	4.0
N18103	N13120/PR00806-81, **AuSable**	20	19.0	21.6	40.0	83.8	1.0	44.3	5.0
I21920	**HMS BOUNTY**	19	18.0	18.3	39.5	89.3	1.0	46.0	4.5
MEAN (36)			23.4	21.1	42.1	86.8	1.2	44.3	4.8
LSD (0.05)			2.4	1.1	1.5	1.7	0.4	3.1	0.6
CV (%)			8.7	4.2	2.1	1.7	27.8	6.0	11.1

EXPERIMENT 2402 STANDARD BLACK BEAN YIELD TRIAL								PLANTED: 6/12/24	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	100 SEED WT. (g)	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B23921	B19309/B18201	35	29.7	22.2	42.0	84.5	1.5	44.0	5.5
B23923	B19309/B18204	44	29.6	23.7	43.0	84.3	1.5	43.3	5.0
B22031	B15434/B18204	23	29.4	23.7	39.9	83.8	1.3	43.5	5.3
B23925	B19309/B20591	43	29.4	24.8	42.5	86.5	1.0	44.3	4.5
B23948	B20617/B19309	53	28.9	22.1	41.7	84.0	1.3	45.8	5.5
B23926	B19309/B20591	37	28.8	23.9	42.6	86.5	1.0	46.3	4.8
B23909	B18201/B19309	41	28.8	24.3	41.2	87.5	1.3	45.0	4.5
B22054	B18210/B18232	27	28.3	24.9	43.1	84.8	1.3	45.8	5.8
B22854	B19309/B18222	8	27.9	23.9	42.1	84.8	1.3	42.8	5.5
B23924	B19309/B20591	51	27.7	24.4	41.9	85.3	1.0	48.0	5.5
B23911	B18201/B19345	34	27.7	23.1	42.0	85.5	1.5	45.0	4.8
B23912	B18204/B19346	33	27.6	24.1	40.6	82.8	1.3	43.0	4.8
B23941	B20549/B20591	48	27.6	21.4	44.6	84.5	1.0	44.8	5.0
B20536	B15430/B16504, **KONA**	19	27.4	24.9	41.5	87.0	1.0	46.3	6.3
B23935	B19346/B19309	40	27.4	23.4	41.0	84.5	1.5	43.8	5.0
B22875	B18231/B18233	24	27.4	23.4	42.0	82.0	1.0	42.0	4.8
B23922	B19309/B18201	50	27.4	23.1	42.5	85.0	1.5	45.8	5.0
B22874	B18231/B18233	21	27.4	24.1	42.1	82.3	1.0	42.8	5.0
B23927	B19330/B19309	47	27.2	23.5	41.1	82.8	1.5	45.0	4.8
B22041	B17536/B18504	2	27.1	21.7	42.5	83.8	1.8	44.3	5.5
B23946	B20617/B19309	38	26.7	23.1	41.9	83.8	1.5	41.5	5.3
B23939	B19346/B20597	45	26.5	23.2	43.5	83.8	1.0	44.0	5.0
B22823	B17207/B18504R	26	26.4	21.5	42.0	86.3	1.3	43.8	4.0
B23934	B19346/B19309	32	26.4	22.8	40.4	84.8	1.3	42.8	4.8
B23947	B20617/B19309	49	26.3	22.3	41.5	82.5	1.0	44.5	5.0
B22844	B18232/B17207	22	25.9	22.7	40.4	82.3	1.0	43.8	5.5
B23920	B19309/B18201	54	25.5	22.2	41.0	84.0	1.3	41.3	4.3
B21715	B16501/B16504	7	25.5	22.4	40.6	86.0	1.3	44.3	4.3
B20591	B16505/B16504	29	25.4	21.3	40.0	82.8	1.0	44.3	4.5
B23905	N19226/B20597	55	25.4	21.8	44.5	84.0	1.0	39.0	4.3
B20602	B16506/B16504	20	25.3	23.5	40.0	81.8	1.0	44.3	4.8
B22062	B18231/B18233	3	25.1	24.6	42.5	84.0	1.3	46.5	5.5
B23931	B19344/B19330	42	25.1	23.1	41.2	84.0	1.0	45.0	4.3
B22033	B15434/B18204	13	25.1	22.2	40.5	84.3	1.3	45.0	5.0
B22843	B18232/B16501	14	24.9	22.8	40.2	82.5	1.0	41.0	4.5
B22043	B17536/B18504	4	24.9	21.5	43.5	86.3	1.0	45.8	5.0
B23950	B20617/B20591	52	24.9	24.2	41.5	84.3	1.0	45.5	4.8

EXPERIMENT 2402 STANDARD BLACK BEAN YIELD TRIAL								PLANTED: 6/12/24	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**100 SEED WT. (g)**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**
B22035	B15434/B18504	16	24.8	21.8	41.6	84.5	1.0	44.3	4.8
B19344	B16506/B16507, **BLACK PEARL**	25	24.0	21.0	40.6	83.0	1.3	44.3	4.5
B23949	B20617/B19344	36	23.9	22.9	40.0	82.3	1.0	41.5	4.8
B22827	B17897/B18204	10	23.9	23.2	42.3	83.3	1.0	46.8	5.3
B20547	B16501/B16504	5	23.9	23.4	41.5	86.5	1.0	42.0	4.8
B22044	B17536/B18504	6	23.7	21.9	41.0	84.5	1.0	45.3	4.5
B23936	B19346/B19309	46	23.7	22.4	40.0	83.0	1.0	44.0	4.0
B22805	N18122/B18224	28	23.6	22.5	39.8	82.0	1.0	43.3	4.5
B22042	B17536/B18504	1	23.4	20.7	42.4	84.3	1.0	40.8	4.5
B22039	B15434/B18504	17	23.4	22.8	40.0	83.5	1.0	45.5	5.3
B22852	B19302/B18232	18	23.4	20.7	41.4	81.8	1.0	45.8	5.5
B23910	B18201/B19345	39	23.1	21.8	40.9	85.8	1.0	45.0	5.0
B21710	B16501/B15430	12	23.0	21.0	41.6	82.8	1.0	42.8	4.8
B22812	N15306/B10244	11	22.5	19.4	42.5	82.8	1.0	42.8	4.0
I23021	SEQ 342-87 ML/RRH 333-12	56	21.4	22.5	40.5	82.8	2.0	42.5	3.8
I19702	BL14497, **BLACK SPECTRE**	15	20.0	22.9	42.1	87.8	1.3	45.5	4.0
I21901	BL14500, **NIMBUS**	31	19.9	24.1	45.2	88.8	1.3	44.8	4.3
I23023	SEQ 342-89/RRH 333-83	57	19.8	23.2	38.5	82.0	1.8	46.5	3.0
B10244	B04644/ZORRO, **ZENITH**	9	19.5	21.4	42.5	83.8	1.0	41.0	4.5
I23027	MEN 322-49/PR 0650-31	58	19.1	21.3	38.6	78.5	1.5	42.5	3.3
B04554	B00103*/X00822, **ZORRO**	30	17.6	20.8	41.6	83.3	1.0	45.5	4.3
I23030	PR06-80*2/Sankara	60	14.8	22.3	39.0	82.5	1.0	45.3	3.0
I23020	Aifi Wuriti 55/RRH 333-12	59	11.3	19.9	39.9	79.8	1.0	37.5	3.8
MEAN (60)			24.9	22.7	41.5	84.0	1.2	44.0	4.7
LSD (0.05)			2.7	1.0	1.5	1.7	0.4	3.4	0.7
CV (%)			9.4	3.8	2.2	1.7	29.2	6.6	12.7

EXPERIMENT 2418 STANDARD KIDNEY BEAN YIELD TRIAL							PLANTED: 6/10/24		
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE	CBB (1-5)
K19832	K16981/K16962	8	39.2	40.7	102.0	1.0	46.0	5.0	2.0
K23908	K19831/K19830	37	38.5	41.3	99.0	1.0	45.0	5.0	2.0
K23705	K19610/K19120	28	38.2	40.2	95.7	1.0	49.8	5.9	1.9
I15622	DYNASTY	20	36.2	40.7	100.3	1.0	46.0	5.0	3.5
K19817	K15901/K16980	2	35.7	40.7	101.3	1.0	41.5	4.7	1.0
K22801	K18912/K15601	3	33.7	34.3	102.3	1.0	49.0	4.3	3.5
K22601	K15601/K17703	4	33.6	40.3	97.7	1.0	44.0	5.3	2.5
K23702	K17703/K19610	38	33.6	40.0	98.0	1.0	41.0	5.3	2.0
K19830	K16638/K16980	14	32.6	40.3	97.7	1.0	41.5	5.3	1.5
K23212	K19120/K17703	30	32.3	40.3	95.3	1.0	39.5	5.0	1.0
K22613	K17703/I18642	18	31.4	40.7	100.7	1.0	39.0	4.7	2.5
K23913	K19831/K18312	41	31.0	40.7	99.3	1.0	39.0	5.0	2.0
K22612	K16131/I18645	12	30.7	39.7	101.0	1.0	40.5	4.7	1.5
K23203	K17703/K17201	45	30.6	40.0	102.7	1.0	46.0	4.0	2.5
K23707	K19610/K19830	31	30.6	41.0	97.7	1.0	51.5	4.7	3.0
K23710	K19610/K17703	39	30.4	41.0	95.7	1.0	41.5	5.3	2.0
K22604	K15601/K19605	1	30.3	40.3	98.7	1.0	44.0	5.7	1.5
K23703	K18312/K17703	46	30.2	40.7	99.0	1.0	45.0	5.0	3.5
K22605	K17703/15Mbeya_55	7	30.2	39.3	100.3	1.0	39.5	5.0	2.0
K23210	K19111/K16924	44	29.7	40.3	98.7	1.0	42.0	5.0	2.5
K23704	K19120/K17703	34	29.4	40.7	102.3	1.3	46.5	4.3	1.0
I17507	ND122386, ND WHITETAIL	22	28.5	40.3	99.0	1.3	42.5	4.7	2.5
K08961	K04604/USDK-CBB-15, SNOWDON	24	28.4	33.0	91.3	1.0	36.0	4.7	3.0
K23219	I19745/K19124	29	28.3	40.0	95.3	1.0	38.5	4.7	1.5
K22110	K16136/I18633	19	28.0	40.0	96.0	1.0	36.5	4.0	2.0
K20715	K16136/K16640	5	27.9	38.7	92.0	1.0	42.5	5.3	2.0
K90902	BEA/50B1807//LASSEN, BELUGA	16	27.4	40.7	100.7	1.0	44.5	4.3	2.0
K74002	MDRK/CN(3)-HBR(NEB#1), MONTCALM	21	27.3	37.7	101.3	1.0	38.5	4.0	2.0
K23912	K19831/K18312	43	27.2	41.3	99.0	1.0	47.0	5.3	1.5
K20745	K17703/K17816	6	27.0	40.7	100.3	1.0	40.5	4.7	1.5
K22103	K15601/K11306	15	27.0	41.0	98.0	1.0	41.0	4.3	2.0
K23208	K18312/X20702	32	26.4	40.0	96.3	1.0	40.0	5.0	2.5
K11306	K06621/USDK-CBB-15, RED CEDAR	9	24.6	38.7	93.7	1.0	41.0	5.0	2.5
I11201	Pink Panther//ZAA/Montcalm, CLOUSEAU	25	24.3	34.0	93.7	1.3	39.5	3.7	4.5
K20743	K17703/K17816	17	23.3	39.3	94.7	1.0	39.0	5.0	1.5
I22027	ND151660	48	22.9	33.3	92.4	1.0	36.5	4.5	2.0
K23709	K19610/K17703	33	22.8	39.7	93.2	1.0	39.8	4.4	2.9

EXPERIMENT 2418 STANDARD KIDNEY BEAN YIELD TRIAL							PLANTED: 6/10/24		
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**	**CBB (1-5)**
K16924	K11917/SNOWDON, DENALI	13	22.6	33.7	94.0	1.0	37.0	5.0	1.5
K23202	K17201/X20702	42	22.5	40.3	95.3	1.0	34.5	4.3	2.5
I23002	ND Redbarn	47	22.1	39.7	92.7	1.0	39.5	5.0	2.5
K15601	RED CEDAR/K11916, COHO	10	20.8	40.7	95.0	1.0	37.0	5.0	1.5
K23209	K18312/X20702	36	20.5	41.3	93.7	1.0	38.0	4.7	3.5
K22107	15Arusha_30/K11306	11	20.3	40.7	100.0	1.0	39.0	4.3	1.0
K23904	K19830/K16924	40	19.8	35.3	96.4	1.0	37.5	4.0	1.0
I07104	Chardonnay/CELRK, PINK PANTHER	27	18.9	34.3	98.3	1.0	37.0	4.3	4.0
K23909	I20817/K19830	35	16.3	40.7	93.3	1.0	34.0	4.0	1.5
K90101	CHAR/2*MONT, RED HAWK	23	15.4	39.7	94.0	1.0	35.0	4.0	2.5
I90013	CELRK	26	15.0	33.0	86.3	1.0	35.5	3.3	5.0
MEAN (48)			27.6	39.2	97.1	1.0	40.9	4.7	2.2
LSD (0.05)			5.8	1.3	2.8	0.2	6.7	0.8	1.4
CV (%)			15.4	2.4	2.1	13.8	9.8	11.8	36.3

EXPERIMENT 2419 STANDARD KIDNEY BEAN YIELD TRIAL-GREENVILLE				PLANTED: 6/8/24			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	DES. SCORE
K22110	K16136/I18633	19	45.3	36.5	93.0	2.5	4.5
K23707	K19610/K19830	31	43.7	40.5	95.5	3.0	4.5
K20715	K16136/K16640	5	43.3	36.5	93.0	3.0	5.0
K23702	K17703/K19610	38	43.3	38.0	95.0	2.5	5.0
I07104	Chardonnay/CELRK, PINK PANTHER	27	42.6	35.0	95.0	3.0	4.5
K22604	K15601/K19605	1	42.2	36.5	95.5	3.0	5.0
I17507	ND122386, ND WHITETAIL	22	42.2	38.0	95.0	3.0	5.0
K22601	K15601/K17703	4	42.0	40.0	95.0	2.5	5.0
K90101	CHAR/2*MONT, RED HAWK	23	41.0	37.0	93.0	3.0	4.5
I15622	DYNASTY	20	41.0	39.0	97.0	3.0	4.5
K23705	K19610/K19120	28	40.8	39.0	94.5	2.5	5.0
K22612	K16131/I18645	12	40.6	37.5	95.0	3.0	4.0
K23210	K19111/K16924	44	40.6	40.5	95.5	2.0	4.5
K90902	BEA/50B1807//LASSEN, BELUGA	16	40.3	38.0	97.0	2.5	5.0
K23709	K19610/K17703	33	39.7	37.0	93.0	2.5	5.0
K23202	K17201/X20702	42	39.7	37.0	93.0	3.0	3.5
K20743	K17703/K17816	17	39.5	36.5	91.0	2.5	5.0
K16924	K11917/SNOWDON, DENALI	13	39.3	34.5	94.5	3.0	5.0
K19830	K16638/K16980	14	39.2	39.0	96.5	2.0	5.0
K22605	K17703/15Mbeya_55	7	39.0	37.0	95.0	1.5	5.0
K23703	K18312/K17703	46	39.0	37.0	95.5	2.0	5.0
K23912	K19831/K18312	43	38.9	39.5	88.0	2.0	4.5
K15601	RED CEDAR/K11916, COHO	10	38.9	39.0	94.0	2.5	5.0
K23212	K19120/K17703	30	38.7	38.0	95.5	2.5	5.5
K23710	K19610/K17703	39	38.5	39.0	92.0	2.5	4.5
K20745	K17703/K17816	6	38.2	37.0	93.0	1.5	5.0
K22107	15Arusha_30/K11306	11	37.9	36.5	95.5	3.0	4.5
I11201	Pink Panther//ZAA/Montcalm, CLOUSEAU	25	37.3	35.0	91.5	3.0	4.0
K22613	K17703/I18642	18	37.1	38.5	96.0	2.5	4.5
K23913	K19831/K18312	41	37.0	39.5	95.0	2.5	4.5

EXPERIMENT 2419 STANDARD KIDNEY BEAN YIELD TRIAL-GREENVILLE				PLANTED: 6/8/24			
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	DES. SCORE
K22103	K15601/K11306	15	36.7	38.0	87.5	2.0	4.5
K23208	K18312/X20702	32	35.9	39.0	93.0	3.0	4.5
K23219	I19745/K19124	29	35.8	39.0	88.5	2.5	4.5
I22027	ND151660	48	35.6	34.0	89.5	2.5	4.0
K23704	K19120/K17703	34	35.5	38.5	95.5	3.0	4.5
I23002	ND Redbarn	47	35.4	36.0	92.0	2.0	5.0
K23908	K19831/K19830	37	34.5	39.5	95.0	3.0	5.0
K22801	K18912/K15601	3	34.4	36.0	98.0	3.0	3.5
K23904	K19830/K16924	40	34.3	34.5	96.0	3.0	4.5
K08961	K04604/USDK-CBB-15, SNOWDON	24	33.9	33.5	90.0	3.0	4.5
K74002	MDRK/CN(3)-HBR(NEB#1), MONTCALM	21	33.7	37.5	96.5	3.0	4.0
K23203	K17703/K17201	45	33.3	36.0	96.5	3.0	4.0
K11306	K06621/USDK-CBB-15, RED CEDAR	9	33.2	36.5	92.5	2.5	4.0
K23209	K18312/X20702	36	31.9	38.0	92.0	2.5	4.0
K19817	K15901/K16980	2	31.3	38.5	97.0	2.5	4.0
I90013	CELRK	26	28.8	33.5	85.5	2.0	3.0
K23909	I20817/K19830	35	28.3	36.5	91.5	1.5	5.0
K19832	K16981/K16962	8	26.6	39.0	94.0	2.0	4.5
MEAN (48)			37.6	37.4	93.7	2.6	4.6
LSD (0.05)			5.8	1.6	2.4	0.8	0.8
CV (%)			11.3	2.5	1.5	19.2	10.3

EXPERIMENT 2421 STANDARD NAVY BEAN YIELD TRIAL-HURON							PLANTED: 6/13/24	
NAME	**PEDIGREE**	**ENTRY**	**YIELD CWT /ACRE**	**DAYS TO FLOWER**	**DAYS TO MATURITY**	**LODGING (1-5)**	**HEIGHT (cm)**	**DES. SCORE**
N19277	N14229/N14218	1	40.6	44.0	95.5	3.5	43.0	3.5
N22622	N19216/B18224	2	42.7	44.5	99.5	2.5	49.0	5.0
N22616	N19216/N17505	3	43.4	43.0	98.5	2.5	42.5	5.5
N18105	N13131/N14201	4	37.5	43.5	96.0	2.5	54.0	4.0
N22623	N19241/N18103	5	38.3	44.5	99.0	3.0	44.5	4.5
N22005	N15306/B17023	6	39.2	42.5	96.5	2.0	52.0	6.0
N22617	N19216/N17505	7	38.8	43.0	96.5	2.5	47.5	5.0
N21511	N15306/N15337	8	33.4	42.5	97.0	3.0	44.0	5.0
N21510	N15306/N14229	9	35.6	43.0	97.5	2.5	46.0	5.5
N20395	B16504/N17504	10	36.8	43.0	93.0	2.5	51.0	4.0
I22001	**LIBERTY**	11	39.7	40.0	100.5	2.5	41.5	4.5
N22630	N19253/B19309	12	34.9	45.0	100.0	1.5	53.0	4.5
N21522	N17504/B15430	13	38.5	44.0	96.0	2.5	50.0	5.0
N11283	MEDALIST/N08003, **ALPENA**	14	32.2	40.0	94.5	2.5	45.0	4.0
N22602	N17505/N18122	15	37.3	44.0	95.5	3.0	44.5	4.0
N21520	N17504/N14229	16	33.9	45.0	97.0	2.5	43.5	4.5
N22605	N17505/B18224	17	34.8	43.0	96.5	2.0	50.5	5.0
N22610	N18122/N19253	18	39.2	44.5	97.5	2.5	47.0	5.5
I21920	**HMS BOUNTY**	19	35.3	40.5	98.0	2.5	50.5	4.5
N18103	N13120/PR00806-81, **AuSable**	20	33.1	39.5	90.0	2.5	40.5	4.0
N23716	N19226/B19309	21	42.0	44.5	96.5	1.5	50.0	5.5
N23715	N19226/B19309	22	38.3	45.5	92.5	2.0	47.5	5.0
N23717	N19226/B19309	23	41.3	44.0	99.0	2.0	54.0	4.5
N23706	N18128/N19253	24	36.4	45.5	95.5	1.0	49.0	5.0
N23725	N19284/N19226	25	35.8	44.0	95.5	2.0	48.0	5.5
N23720	N19226/B20597	26	37.7	44.0	96.0	2.0	50.0	4.5
N23705	N18128/N19253	27	40.0	45.5	96.5	2.0	52.5	4.5
N23702	N18122/N19226	28	42.0	45.5	99.5	3.5	40.5	3.5
N23732	B18201/B18204	29	36.8	44.5	95.0	2.0	41.5	4.0
N23724	N19284/N19226	30	31.9	45.0	93.5	2.5	43.0	4.0
N23708	N18128/N19253	31	38.1	45.5	99.0	2.5	46.5	3.5
N23707	N18128/N19253	32	36.6	44.5	96.0	1.5	53.0	4.0
N23726	N19302/B20599	33	33.7	44.5	96.5	1.5	52.5	4.0
N23709	N18128/B19346	34	39.0	44.0	91.0	1.0	56.0	4.0
N23721	N19253/N18122	35	39.3	43.0	94.5	2.0	51.5	5.0
N23731	N20351/N19253	36	38.5	44.5	94.5	3.0	52.0	4.0
MEAN (36)			37.6	43.7	96.3	2.3	48.0	4.6
LSD (0.05)			5.5	1.8	3.8	1.2	9.9	1.4
CV (%)			8.6	2.5	2.3	29.6	12.3	17.6

EXPERIMENT 2422 STANDARD BLACK BEAN YIELD TRIAL-HURON							PLANTED: 6/13/24	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B20547	B16501/B16504	5	48.2	43.0	97.5	2.0	46.5	5.0
B20602	B16506/B16504	20	47.4	42.5	96.0	2.5	44.5	5.0
B22062	B18231/B18233	3	46.9	44.5	96.5	3.0	49.5	5.0
B22041	B17536/B18504	2	46.5	45.0	92.5	2.0	49.0	6.0
B23925	B19309/B20591	43	46.4	45.5	96.5	2.5	49.0	5.5
B20536	B15430/B16504, KONA	19	46.2	42.0	97.5	2.5	48.5	6.0
B22854	B19309/B18222	8	45.9	45.0	96.0	2.0	46.5	5.5
B23911	B18201/B19345	34	45.3	44.0	98.0	2.0	42.5	5.5
B20591	B16505/B16504	29	45.1	41.0	93.0	2.5	50.0	5.5
B23948	B20617/B19309	53	45.0	43.5	95.5	2.0	48.5	5.0
B23927	B19330/B19309	47	45.0	41.5	92.0	2.5	49.0	4.0
B22039	B15434/B18504	17	44.9	41.5	92.0	1.5	51.5	5.5
B23946	B20617/B19309	38	44.8	46.0	95.0	1.5	47.0	5.0
B21710	B16501/B15430	12	44.6	43.0	97.5	1.5	47.0	4.0
B23909	B18201/B19309	41	44.5	43.5	96.5	2.5	44.0	4.5
B22875	B18231/B18233	24	44.1	43.5	92.5	1.5	49.5	5.5
B22844	B18232/B17207	22	44.0	43.0	96.5	1.5	52.0	5.5
B10244	B04644/ZORRO, ZENITH	9	43.8	42.5	95.5	2.0	41.0	5.0
B22823	B17207/B18504R	26	43.8	41.5	97.5	1.5	50.5	5.5
B21715	B16501/B16504	7	43.4	43.0	95.5	3.0	44.0	4.0
B22044	B17536/B18504	6	43.3	43.0	95.5	2.5	48.5	4.5
B22852	B19302/B18232	18	43.0	43.0	92.0	1.5	49.0	5.0
B22033	B15434/B18204	13	42.9	42.5	95.0	2.0	48.0	6.0
B23924	B19309/B20591	51	42.6	41.5	97.0	3.0	39.5	4.0
I23021	SEQ 342-87 ML/RRH 333-12	56	42.5	41.5	97.0	3.5	37.0	2.5
B23926	B19309/B20591	37	42.5	46.0	97.5	2.0	50.5	5.0
B23923	B19309/B18204	44	42.5	45.0	92.5	2.0	46.0	5.0
B23939	B19346/B20597	45	42.4	44.5	94.0	2.5	51.0	5.5
B22035	B15434/B18504	16	42.3	42.0	98.5	2.5	50.5	4.5
B22054	B18210/B18232	27	42.3	44.5	96.0	2.0	48.0	5.0
B23950	B20617/B20591	52	42.1	43.5	92.0	1.5	46.0	5.5
B22827	B17897/B18204	10	42.1	44.0	96.0	1.5	51.0	4.0
B23922	B19309/B18201	50	41.8	44.5	94.5	2.5	47.5	4.5

EXPERIMENT 2422 STANDARD BLACK BEAN YIELD TRIAL-HURON							PLANTED: 6/13/24	
NAME	PEDIGREE	ENTRY	YIELD CWT /ACRE	DAYS TO FLOWER	DAYS TO MATURITY	LODGING (1-5)	HEIGHT (cm)	DES. SCORE
B22874	B18231/B18233	21	41.7	44.0	97.0	2.0	48.0	4.5
B22043	B17536/B18504	4	41.5	42.5	95.5	2.5	46.5	5.0
B22031	B15434/B18204	23	41.3	43.5	97.0	2.5	52.5	5.5
B23941	B20549/B20591	48	41.3	46.0	97.5	2.5	52.5	5.0
B23936	B19346/B19309	46	41.1	43.0	92.0	1.5	44.0	5.5
B22812	N15306/B10244	11	41.0	42.0	94.5	2.0	49.0	5.0
B22805	N18122/B18224	28	40.9	43.5	97.0	2.0	43.0	5.0
I19702	BL14497, BLACK SPECTRE	15	40.9	41.5	98.0	2.0	50.5	4.5
B22042	B17536/B18504	1	40.6	43.0	98.5	3.0	45.0	4.0
B19344	B16506/B16507, BLACK PEARL	25	40.6	42.5	95.5	2.5	44.5	5.0
B23931	B19344/B19330	42	40.5	42.0	93.0	1.5	51.5	4.5
B23947	B20617/B19309	49	40.0	41.5	95.5	1.5	51.5	4.5
B23920	B19309/B18201	54	39.5	42.0	92.0	1.5	47.5	4.5
B23912	B18204/B19346	33	39.2	42.5	91.5	3.0	45.5	4.5
B23935	B19346/B19309	40	38.9	43.5	95.0	2.0	44.5	4.0
B23921	B19309/B18201	35	38.7	44.0	94.5	2.5	42.0	5.0
B23949	B20617/B19344	36	38.7	41.5	91.0	1.0	43.5	4.0
B22843	B18232/B16501	14	38.2	43.0	92.0	1.5	50.0	4.5
B23905	N19226/B20597	55	37.8	45.0	96.0	1.5	47.5	4.5
B23910	B18201/B19345	39	37.7	44.0	95.0	3.0	47.5	5.0
I23023	SEQ 342-89/RRH 333-83	57	37.4	42.0	91.0	2.5	47.5	3.0
B23934	B19346/B19309	32	37.0	45.5	96.0	3.0	49.0	3.5
B04554	B00103*/X00822, ZORRO	30	35.7	42.0	96.0	3.0	42.5	4.0
I23030	PR06-80*2/Sankara	60	33.7	40.0	92.0	1.0	48.5	3.5
I23020	Aifi Wuriti 55/RRH 333-12	59	32.0	40.5	89.5	1.0	45.5	3.5
I23027	MEN 322-49/PR 0650-31	58	31.2	39.5	89.5	2.0	41.0	3.0
I21901	BL14500, NIMBUS	31	28.9	43.5	99.0	3.0	50.5	3.5
MEAN (60)			41.6	43.1	95.0	2.1	47.2	4.7
LSD (0.05)			5.4	1.6	3.6	1.0	5.7	0.9
CV (%)			7.6	2.3	2.3	27.2	7.2	11.3

Navy Bean Canning Quality: Brine Gelling Prevalence

Karen Cichy[1], Sharon Hooper[2], Mark Uebersax[2], Evan Wright[2], Scott Bales[2], Valerio Hoyos[2]

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Introduction: Navy beans are the second most important dry bean market class grown in Michigan and they have a long history as a canned bean product. Substantial research and breeding efforts have been focused on ensuring that navy bean canning quality meets processor and consumer expectations. Canning quality is a measure of how well a bean withstands the canning process. The assessment includes hydration and texture measurements and a rating of how appealing the canned bean appearance is for customers (Wang et al., 2022). Generally, favorable navy canning quality is fully hydrated beans, soft enough texture to be edible, but firm enough that the beans stay intact with few split seed coats. Further, canned bean brine should be clear and of fluid consistency, not viscous, cloudy or with free starch from the beans. Canning quality evaluation is an integral part of the MSU and USDA-ARS programs in Michigan as it is a major factor of value for the crop.

Observation of Brine Gelling Problem: Recently (2023 and 2024 crops) within the MSU Dry Bean Performance trials and the Dry Bean breeding nurseries, some navy beans have been exhibiting a canning quality concern that can be described as gelling of the brine. In this case, the brine is highly viscous, with a jelly-like consistency. Interestingly, it does not necessarily appear to be caused by broken beans or starch leaching from the beans into the brine. In many cases, with gelling of the brine, the brine is not cloudy, but relatively clear, and the canned bean samples are fully intact and there is no sign of starch leaching. There is no clear current explanation of what is causing the observed gelling. While it is known that during thermal processing free starch swells and thickens, proteins undergo denaturation and gelation, and various hydrocolloids (pectin and soluble fiber) can serve as a matrix for this gel structure. It is noted that excessive starch or pectin/hydrocolloids leaching through intact seedcoats have not previously been observed. Thus, there is a need for directed studies and objective brine viscosity measurements and compositional analyses to better understand the nature of the problem and potential causes.

The prevalence of the problem was document in two navy bean trials conducted in Michigan in 2024: 1) MSU Bean Performance trials, 30 entries, two on-farm locations, Bay and Huron; and 2) MSU advanced yield trials, 36 entries, two locations, Saginaw Valley Research Farm (SVREC)-Tuscola, and Huron, on-farm. The Huron location was the same site for both the Performance and Breeding trials. The canned samples were rated for prevalence of brine gelling as a 'yes' or 'no' (Table 1).

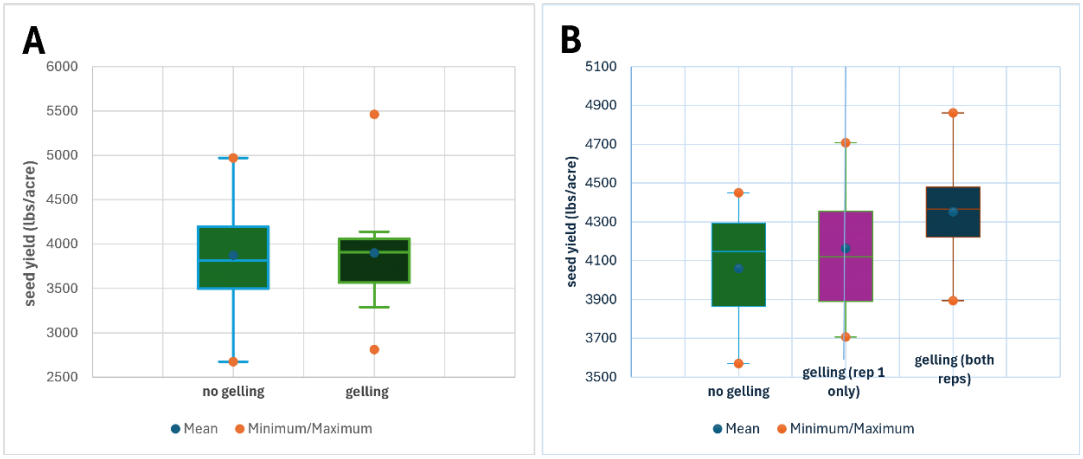
Table 1: Environmental characteristics, seed yield, harvest moisture, and canned navy bean brine gelling incidence across four Michigan field trials.

	Performance Trial		**Breeding Advanced Yield Trial**	
County	**Bay**	**Huron**	**Tuscola**	**Huron**
Nitrogen Fertilizer (lbs/acre)	45	0 (Clover)	60	0 (Clover)
Growing Degree Days	1877	1882	2027	1882
Total precipitation (inches)	10.5	10.5	11.7	10.5
Seed Yield (lbs/acre)	2244	3996	2621	4211
Harvest Moisture (%)	14.3	18.4	17	15.4
Brine Gelling (%)	0% (0/30)	27% (8/30)	0% (0/72)	39% (28/72)

Table 2: Agronomic and Canning Quality Characteristics of Navy Bean breeding lines in the Huron trial grouped by Canned Bean Brine Gelling

Canned Bean Brine Gelling	Yield	Flowering	Maturity	Lodging	Plant Height	Can rating	Seed Harvest Moisture
	lbs/acre	days	days	(1-5)	(cm)	(1-5)	(%)
No	4054	42.9	96.2	2.4	46.3	2.6	15.4
Yes (one rep only)	4116	43.8	95.9	2.3	48.4	2.1	15.4
Yes	4357	44.1	96.8	2.2	48.5	2.2	15.5

Figure 1: Box Plots of Seed Yield across trials grouped by Canned Bean Brine Gelling: (A) MSU Navy Bean Performance Trials and (B) MSU Navy Breeding trials.



Results and Discussion: These preliminary observed brine gelling characteristics is county location specific (Bay and Tuscola =no gel; Huron=gelled). It is noted that not all samples in Huron have the problem, some genotypes don't have it at all, some on only one rep, and some on both reps (Table 1). In 2023, the problem was also observed in Huron Performance trials, in 100% of navy bean samples. The 2023 plot, while in the same county as the 2024 Performance trial, was 50 miles away, so the problem cannot be said to be specific to a single farm. In the Navy bean breeding trial in Huron, there is a trend that the samples with the most consistent gelling (i.e. both reps showed the effect) were higher yielding than those that did not show the gelling (Table 2 and Figure 1B). Nine navy bean entries were grown in both the Huron Performance and Breeding trials, 67% were consistent for their gelling response, while 34% do not follow similar patterns in the two trials, suggesting there is not a clear genetic component associated with brine gelling.

Future Plans: Continue to monitor the incidence of the problem. Collect objective measures of brine viscosity via a viscometer. Evaluate the gelled brine for compositional characteristics that may be causing the gelling.

Reference: Wang, W., Wright, E. M., Uebersax, M. A., & Cichy, K. (2022). A pilot-scale dry bean canning and evaluation protocol. Journal of Food Processing and Preservation, 46, e16171. https://doi.org/10.1111/jfpp.16171

Halo Blight Variety Screening Trial

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Michigan State University

Introduction

Halo Blight, caused by the bacterium *Pseudomonas savastanoi* pv *phaseolicola* (*Psp*), reemerged in light red kidney bean fields planted to California Early (CELRK) in 2021 and 2022. Symptoms of halo blight disease were severe in infected fields. CELRK is a preferred variety by Michigan growers due to excellent canning qualities, early maturity, and good yield potential. However, this variety is known to be very susceptible to halo blight disease.

A 2-year research project was funded by MSU Project GREEEN to study variety susceptibility, seed colonization, and pathogen virulence of *Psp*. The purpose of the field study was to determine the susceptibility of light red kidney bean varieties and breeding lines for bacterial colonization and halo blight disease development. Several black bean, dark red kidney and great northern varieties were included as more resistant germplasm.

Field Trial Methods

In 2024, the variety trial was conducted at the MSU Agronomy Research Farm in East Lansing, MI. Dry beans were seeded on June 27th in four-row plots with 30” row spacing, planted plots measured 10’ wide by 17’ long. Each variety was replicated four times, and the plots were overhead irrigated. The trial plots were designed as randomized split-plot blocks, where each variety was randomly assigned within a block. The split-plot design allowed the treatments on varieties to be side-by-side for direct comparison. Treatment A: 20% of the planted seeds were inoculated with *Psp* bacteria prior to planting; seeds were soaked for 3 minutes in a bacterial solution of 100,000,000 cells/mL. Treatment B: Seeds were non-inoculated and plants were sprayed with two applications of copper (Badge at 2pt/A) on August 12th and 26th to prevent spread of bacteria and reduce bacterial populations.

Untreated seeds (with exception of the 20% bacterial inoculated) were planted, a pre-plant herbicide application of Eptam/Dual/Prowl was applied, otherwise plots were hand-weeded throughout the growing season. Disease severity (rating scale from 1 to 8, where 1= healthy and 8 = systemic plant infection with all above ground plant parts being symptomatic) and incidence (the percentage of symptomatic plants/plot) ratings were conducted at five timepoints throughout the growing season at the plot level (7/31, 8/8, 8/19,8/29 and 9/9). Bacterial populations were monitored throughout the growing season from each of the replicated split-plots with whole seedling (7/19), trifoliate leaf (7/31, 8/9/, and 8/20) or stem internode samples (8/23, 9/4, and 9/12). Yield data were obtained by hand pulling the two-center rows of each plot and mechanically threshed.

Table 1. Dry bean varieties and breeding lines evaluated for susceptibility to halo blight disease development due to colonization by *Pseudomonas savastanoi* pv. *phaseolicola*

Entry	Variety Name	Market Class	Breeder
1	California Early (CELRK)	Light Red Kidney	UC-Davis
2	Pink Panther	Light Red Kidney	Seminis
3	Clouseau	Light Red Kidney	Seminis
4	Big Red	Light Red Kidney	Provita
5	Red Dawn	Light Red Kidney	Provita
6	Ronnie's Red	Light Red Kidney	Provita
7	Spitfire (L103	Light Red Kidney	ADM
8	Cinder (D1034333)	Dark Red Kidney	ADM
9	Coho	Light Red Kidney	MSU
10	K20743	Light Red Kidney	MSU
11	K22601	Light Red Kidney	MSU
12	Montcalm (Resistant Check)	Dark Red Kidney	MSU
13	Andromeda (Resistant Check)	Great Northern	ADM
14	161082	Light Red Kidney	Provita
15	15923	Light Red Kidney	Provita
16	15916	Light Red Kidney	Provita
17	Zenith	Black	MSU
18	Nimbus	Black	ADM
19	Black Spectre	Black	ADM
20	Black Bear	Black	Provita

Disease Severity and Incidence Results

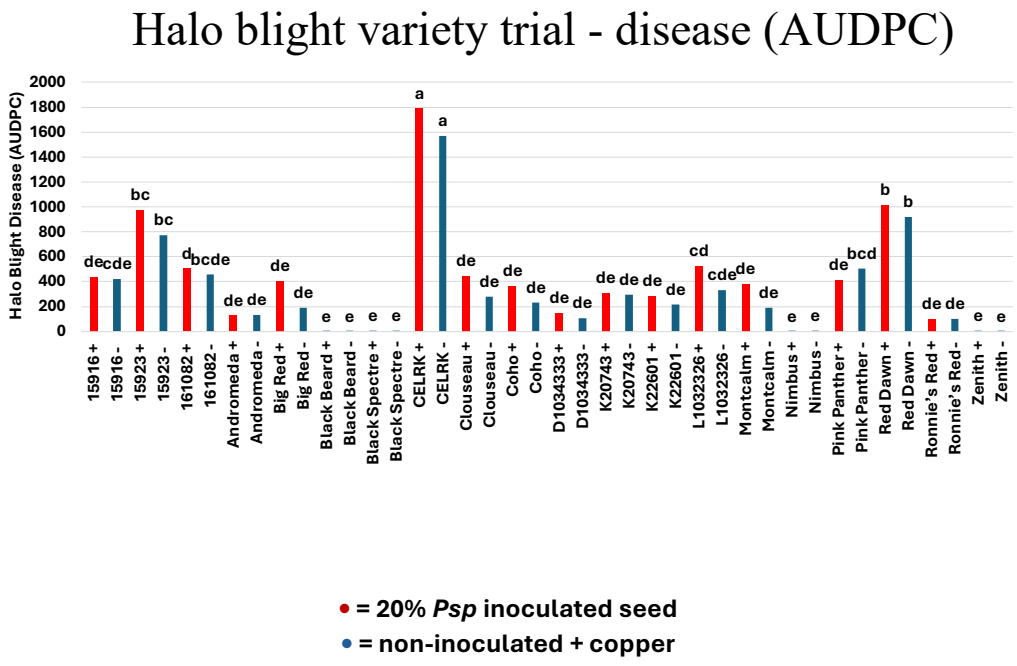


Figure 1. Disease severity and incidence ratings were taken at five timepoints throughout the growing season to quantify the overall disease progression, resulting in a single value that represents the total disease impact.

Conclusions-Disease Severity and Incidence

- The variety CELRK exhibited the worst disease severity and incidence exhibiting no resistance to halo blight.
- Other light red kidney bean varieties (Big Red, Clouseau, Coho, Ronnie's Red) and breeding lines (K20743 and K22601) performed equal to the more resistant large-seeded varieties Andromeda and Montcalm.
- The small-seeded black beans and Andromeda had the least amount of disease severity and incidence.
- The non-inoculated + copper application treatment did not significantly reduce disease severity and incidence compared to the inoculated treatment. The copper applications did not prevent bacterial spread and did not reduce populations enough to reduce disease symptom development

Yield Results

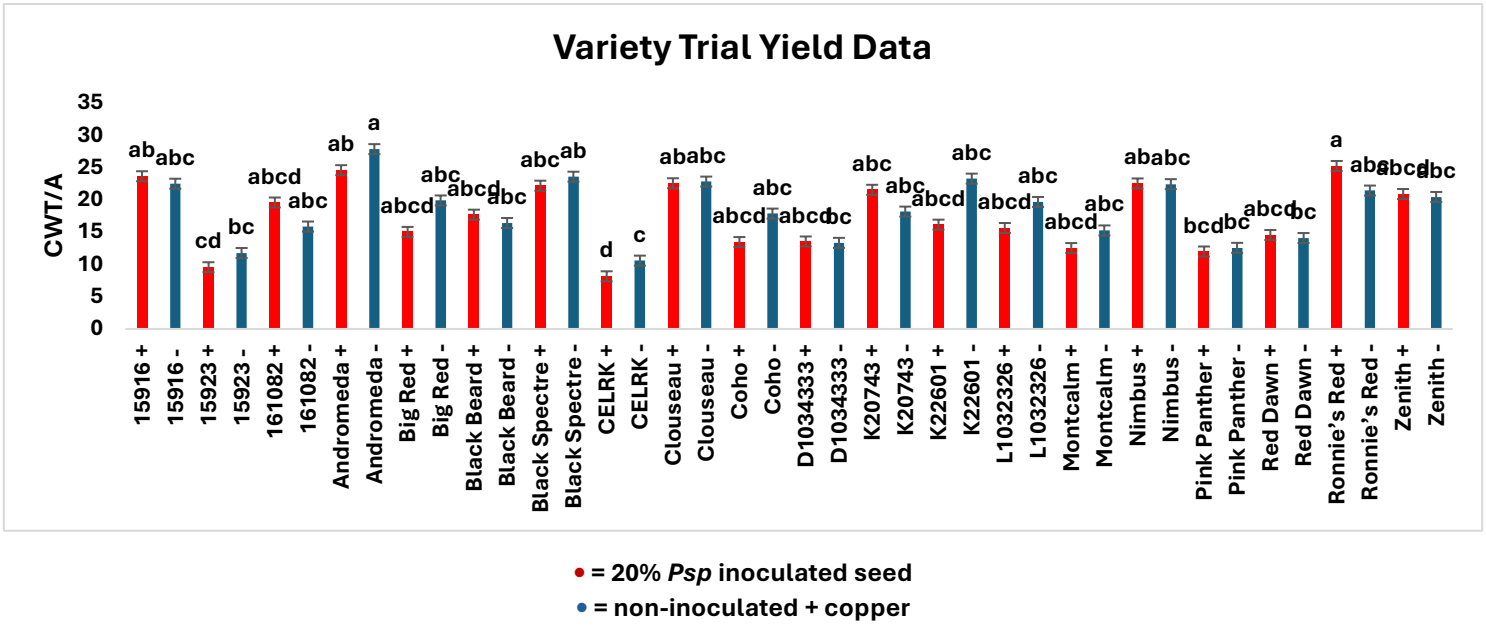


Figure 2. Hundred count weight/Acre averaged from the four replicated plots of each variety from 20% inoculated seed and non-inoculated + copper treatments.

Conclusions- Variety Yield

- The variety CELRK had the worst yield due to the high disease severity and incidence, however there was a significant difference in yield between the inoculated and non-inoculated +copper applications treatments.
- Overall, many varieties and breeding lines showed an increased trend in yield in the non-inoculated +copper application treatment, but we only observed a significant difference in yield with the CELRK non-inoculated +copper treatment.

Bacterial Populations Results

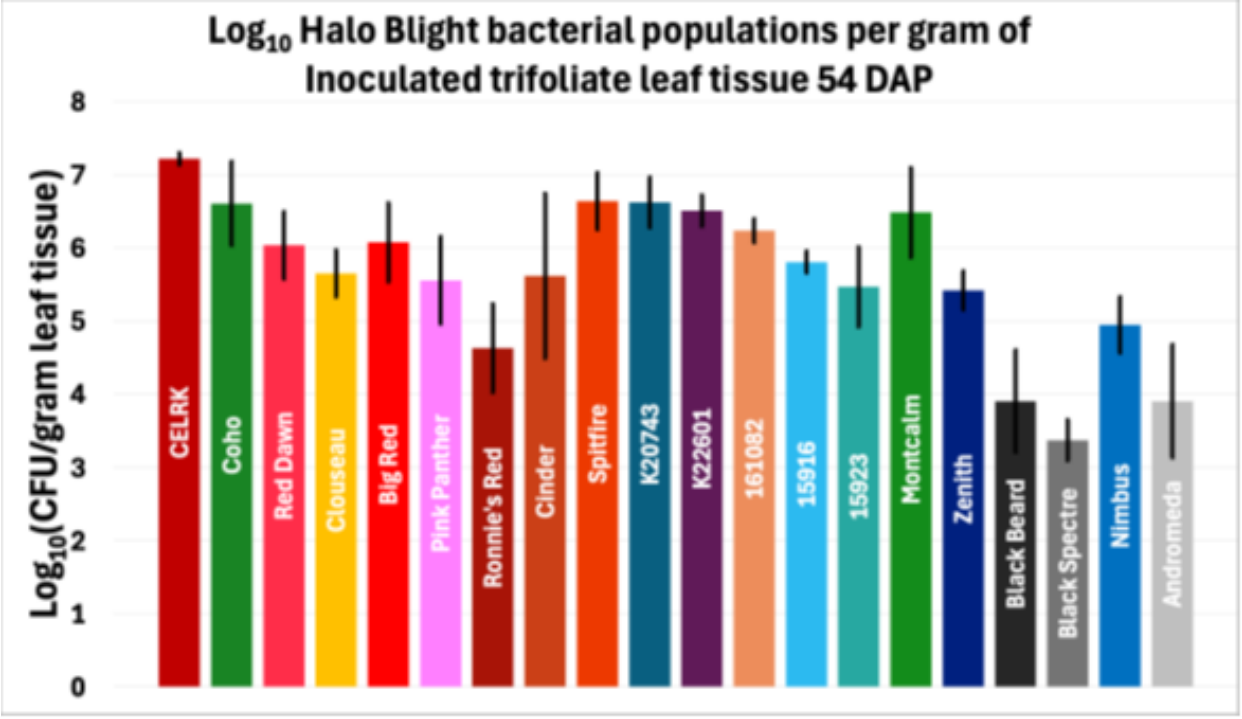


Figure 3. *Pseudomonas savastanoi* pv. *phaseolica* populations recovered from a single trifoliate leaf sampled 54 days after planting in the 20% inoculated treatment. Bacterial populations ranged from 1,000 to 10 million cells per gram of leaf tissue across the varieties tested.

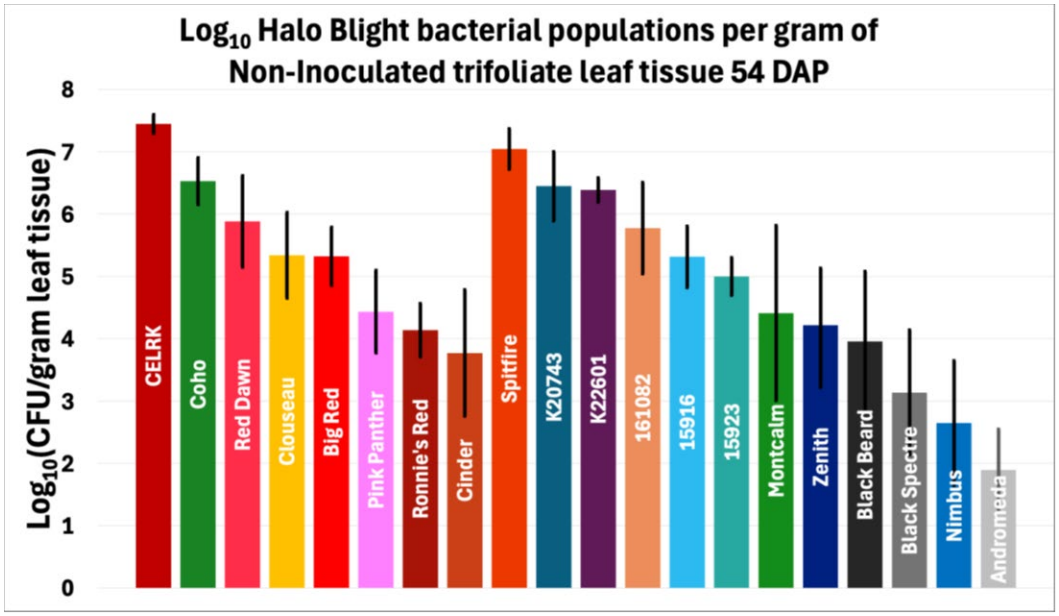


Figure 4. *Pseudomonas savastanoi* pv. *phaseolica* populations recovered from a single trifoliate leaf sampled 54 days after planting in the non-inoculated + copper applications treatment. Bacterial populations ranged from 100 to 10 million cells per gram of leaf tissue across the varieties tested.

Conclusions for bacterial populations recovered from trifoliate leaves

- Bacteria spread from the inoculated treatment plots to the non-inoculated treatment plots across all varieties screened.
- The more resistant black bean varieties and Andromeda had the lowest populations recovered in both treatments and populations were low enough to get minimal disease symptom development.
- In the inoculated treatment, Ronnie's Red light red kidney variety had low enough bacterial populations to have reduced halo blight disease symptoms.
- In the non-inoculated + copper treatment, Pink Panther and Ronnie's Red had reduced populations to limit halo blight symptom development.

Overall Field Trial Conclusions

- The variety CELRK across both treatments performed the worst using the parameters disease severity and incidence, yield, and bacterial population.
- The variety Ronnie's Red across both treatments performed the best among the light red kidney beans tested, having the best ratings for disease severity and incidence, yield performance and reduced bacterial population.
- Copper treatments need to be further studied for timing of applications and the number of applications applied to keep bacterial populations to a reduced level to avoid severe disease development.

Halo Blight Management Recommendations

- The best way to manage halo blight disease is to select a variety of bean that is known to have some level of resistance. Plant clean seed to reduce initial bacterial populations present in the field. Copper applications will slow down the spread of halo blight but they are only moderately effective. They must be applied early in the season and repeatedly to provide control.

Comparison of weed control systems in early planted dry bean

Jacob Felsman, Christy Sprague, and Brian Stiles, Michigan State University

Location: Ingham County	**Tillage:** Conventional
Replicated: 4 times	**Row width:** 30-inch
Ultra-Early Planting: May 6, 2024	**Variety:** 'Zenith' black beans
Early Planting: May 20, 2024	**POST application:** ~28 d after planting
Normal Planting: June 4, 2024	**LPOST application:** ~5 d after POST

Summary: Dry beans are a short-season crop, maturing within roughly 100 days, which creates some unique weed management challenges. This shortened growing window provides growers opportunities to plant later and harvest earlier than typical corn and soybean systems. Traditionally, dry beans in Michigan are planted the first week of June, but recent studies suggest potential agronomic benefits to earlier planting dates in other crops. Consequently, there is growing interest among Michigan dry bean producers in exploring earlier planting. Planting dry beans earlier could lead to earlier harvest and a longer window to seed winter wheat or an overwintering cover crop. The objective of this research was to compare weed management systems and yield in ultra early- and early planted 'Zenith' black beans with a normal planting date. A field experiment was established in 2024 Michigan State University Agronomy Farm (MSU; East Lansing, MI). The experiment was setup with three planting dates and four weed control programs. The three planting dates included: "ultra-early" (targeting the 1st week of May), "early" (3rd week of May) and "normal" (1st week of June). Weed management systems included: (1) preplant incorporated (PPI) Prowl H_2O (2 pt) + Outlook (11 fl oz), (2) the PPI treatment followed by (fb.) POST Varisto (21 fl oz) + COC + AMS, (3) PPI treatment fb. POST Varisto + Outlook (10 fl oz) + CAC + AMS, (4) PPI treatment fb. POST Varisto + Outlook fb. late postemergence (LPOS) of Reflex (1 pt) +COC 5 d after POST. Weed control was evaluated 7 and 21 days after treatment (DAT) after POST, and weed counts were recorded 21 DAT. Annual grasses (giant foxtail and barnyardgrass) and common lambsquarters were effectively controlled with all herbicide programs within the different planting dates. For common ragweed control the LPOS of Reflex was needed. Weed biomass showed a two pass system with a PPI and POST was necessary for sufficient weed control that did not vary by planting date. PPI and PPI + POST treatments reduced weed biomass by >32 and >90%, respectively (Figure 1). Dry bean stands were counted and harvested for yield. A 15% reduction in dry bean stands was observed for the non-treated control plots across all planting dates. The highest yielding treatments across all three planting dates included PPI fb. POST programs. The PPI alone and the non-treated control exhibited a 24 and 50% reduction in yield, respectively (Figure 2). Averaged across all weed management strategies, black beans planted at the normal time outyielded the early and ultra-early planting times by 11 and 28%, respectively. Overall, we did not see an advantage in this first year of data to plant dry beans early. Additional research is needed to further understand the impact of dry bean planting dates on weed control and yield.

Figure 1. Main effects of planting date[a] and herbicides program[b] for weed biomass collected 21 d after POST.

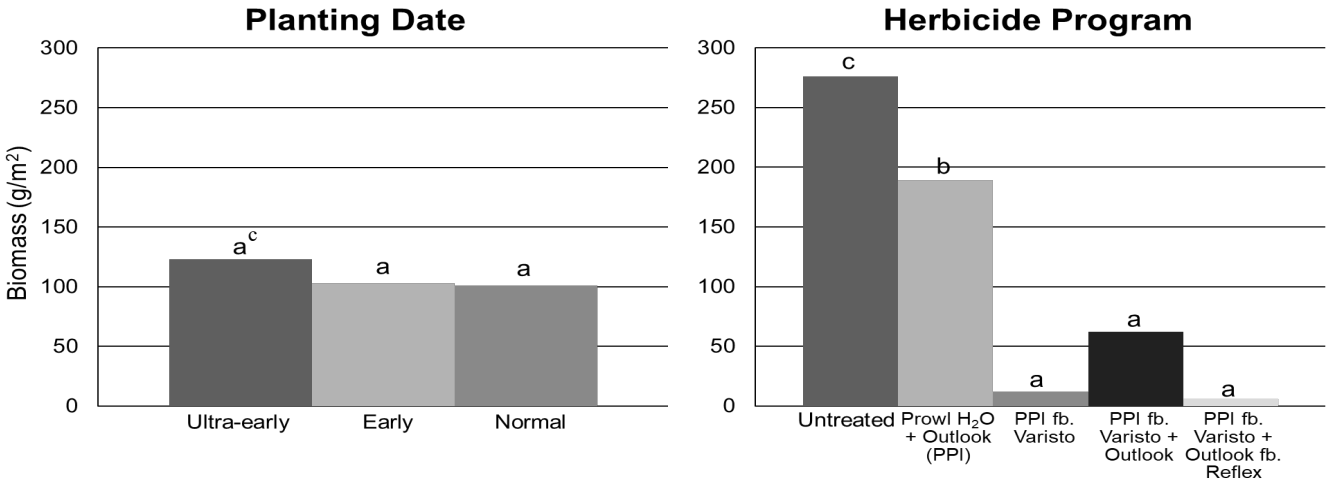
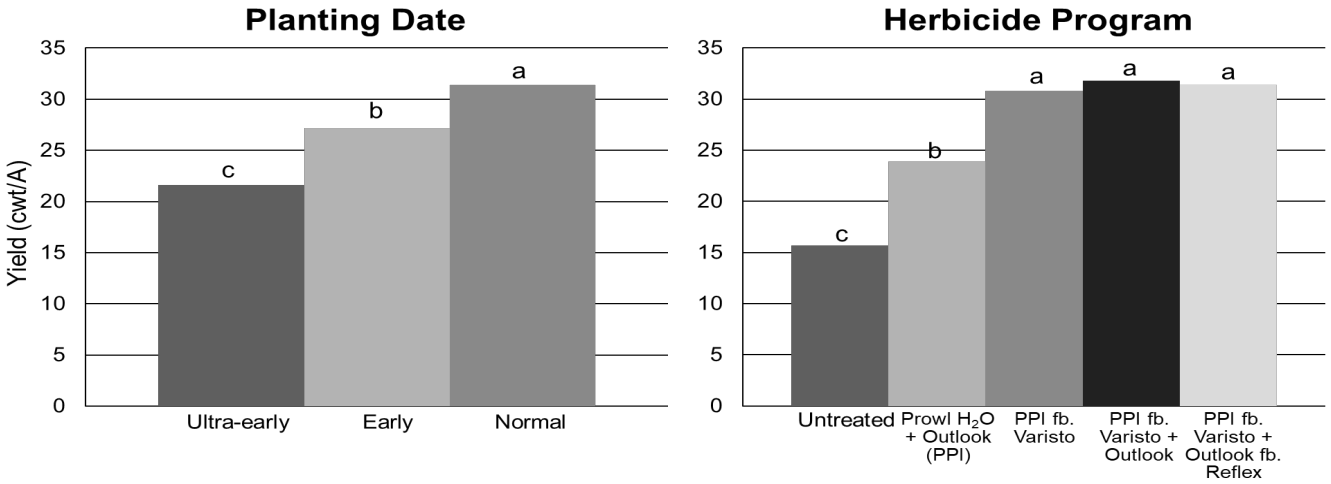


Figure 2. Main effects of planting date[a] and herbicides program[b] for black bean yield.



[a] Planting date is analyzed as main effect combined over all herbicide programs.
[b] Herbicide is analyzed as main effect combined over all planting dates.
[c] Columns within a graph with different letters are significantly different from each other.

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Overlapping residuals for waterhemp control in dry edible beans

Christy Sprague and Brian Stiles, Michigan State University

Location: Shiawassee County	**Tillage:** Conventional
Replicated: 4 times	**Row width:** 30-inch
Planting Date: June 13, 2024	**PRE application date:** June 13, 2024
Variety: 'Zenith' black beans	**EPOS application:** 35 d after planting (DAP) **POST application:** 42 d after planting

Table 1. Waterhemp control from various treatments comparing applications timings of the Group 15 residual herbicides, Outlook and Dual Magnum.

		Waterhemp control	
Herbicide treatments		**At POST[a]**	**60 DAP[b]**
PREs	**EPOS/POST[c]**	— % —	— % —
None	Varisto (21 fl oz) (EPOS)	0 e[d]	0 e
None	Reflex (1 pt) (EPOS)	63 d	72 d
None	Reflex (1 pt) + Varisto (21 fl oz) (EPOS)	85 ab	79 bcd
None	Outlook (14 fl oz) + Reflex (1 pt) (EPOS)	78 c	80 bcd
None	Dual II Magnum (1.33 pt) + Reflex (1 pt) (EPOS)	79 c	77 cd
Outlook (14 fl oz)	Varisto (21 fl oz) (POST)	91 abc	91 ab
Dual Magnum (1.33 pt)	Varisto (21 fl oz) (POST)	90 abc	86 bc
Outlook (11 fl oz)	Outlook (10 fl oz) + Varisto (21 fl oz) (POST)	98 a	89 abc
Dual Magnum (1 pt)	Dual Magnum (1 pt) + Varisto (21 fl oz) (POST)	84 bc	85 bcd
Outlook (11 fl oz)	Outlook (10 fl oz) + Reflex (1 pt) + Varisto (21 fl oz) (POST)	95 ab	100 a
Dual Magnum (1 pt)	Dual Magnum (1 pt) + Reflex (1 pt) + Varisto (21 fl oz) (POST)	87 ab	100 a

[a] The at POST evaluation was ~42 DAP and 4 d after the EPOS application.
[b] The ~60 DAP evaluation was ~ 21 d after the POST application.
[c] All treatments were applied with crop oil concentrate (COC) (1% v/v) + AMS (2.5 lb).
[d] Means within a column with different letters are significantly 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. **Outlook** and **Dual Magnum/Dual II Magnum** are **residual** (Group 15) herbicides labeled

postemergence **(POST)** applications after dry beans reach the 1st trifoliate stage (V1). The total maximum use rates per season for dry beans are 21 fl oz/A for Outlook and 2 pt/A for Dual Magnum. There is a 70 d preharvest interval (PHI) for Outlook and a 50 d PHI for Dual Magnum. In 2024, we conducted a field study to examine various treatments and treatment timings for control of glyphosate- and ALS-resistant waterhemp in dry beans. We compared standard-use rate applications (PRE or EPOS) and split-applications (PRE followed by POST) of the Group 15 herbicides Outlook and Dual Magnum with and without Reflex. Reflex was included to control emerged waterhemp. This is effective on waterhemp populations that are not yet resistant to the Group 14 herbicides, as in this study. However, in certain fields in the state where Group 14 resistance is present the POST application of Reflex would not be effective.

This year immediately after planting there was 1.21-inches of rainfall within one week of application. This rainfall provided good incorporation of the PRE herbicide applications. The higher rate of Dual Magnum and applying 11- 14 fl oz/A of Outlook PRE provided similar waterhemp control at the time of POST (~42 DAP). Early POST applications Reflex + Varisto provided slightly greater control than Reflex alone or in combination with Outlook or Dual Magnum. Waterhemp control 21 d after the POST herbicide application indicated that split applications with Outlook or Dual Magnum in combination of Reflex and Varisto POST provided the greatest control. Overall, 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 or Dual Magnum, PRE followed by EPOS/POST, especially if Reflex is in the POST application.

Recommendations for waterhemp control in dry bean:

- Start out with a soil-applied application of Outlook or Dual Magnum.
    - Use the appropriate rate for the soil type.
    - Preplant incorporated applications will improve crop safety.
- Split-applications (overlapping) of Outlook or Dual Magnum will provide extended waterhemp control. Apply the POST application prior to new waterhemp emergence. Tank-mixing these applications with Reflex will control emerged waterhemp if they are not resistant to the Group 14 herbicides.
    - Outlook 11 fl oz/A (PPI) followed by 10 fl oz/A (POST)
    - Dual Magnum 1 pt/A (PPI/PRE) followed by 1 pt/A (POST)

MICHIGAN STATE UNIVERSITY EXTENSION

Michigan State University AgBioResearch

Comparison of soil-applied preplant incorporated (PPI) treatments

Christy Sprague and Brian Stiles, Michigan State University

Location: Ingham County	**Tillage:** Conventional
Planting Date: June 4, 2024	**Row width:** 30-inch
Replicated: 4 times	**Population:** 109,000 seeds/A
Varieties: 'Zenith' black beans	**PPI application:** June 4, 2024 **POST application:** July 1, 2024 (27 d after planting)

Table 1. Weed control from various PPI treatments at POST and 40 d after POST herbicide application and dry bean yield.

	At POST			40 d after POST	
PPI Treatments[a]	**annual grass**	**c. lambsquarters**	**c. ragweed**	**c. ragweed**	**Yield**
	% control			% control	(cwt/A)
Prowl H2O (1.6 pt) + Outlook (11 fl oz)	97 a[b]	96 a	68 b	99 a	34.8 a
Prowl H2O (2 pt) + Outlook (11 fl oz)	97 a	87 a	55 b	95 a	35.4 a
Pendalin H2O (2 pt) + Outlook (11 fl oz)	96 a	93 a	55 b	94 a	35.5 a
Sattelite HydroCap (2 pt) + Outlook (11 fl oz)	96 a	95 a	58 b	98 a	35.7 a
Eptam (1.5 qt) + Outlook (11 fl oz)	99 a	96 a	86 a	93 a	34.8 a
Eptam (1.5 qt) + Prowl H2O (1.6 pt) + Outlook (11 fl oz)	99 a	96 a	94 a	98 a	35.9 a
Untreated	0 b	0 b	0 c	0 b	24.5 b

[a] A POST herbicide treatment of Varisto (21 fl oz) + Outlook (10 fl oz) + crop oil concentrate (1% v/v) + AMS (2.5 lb) was applied when dry beans were at the V3 stage and weeds were 2-inches tall.
[b] Means within a column with different letters are significantly different from each other.

Summary: The objectives of this research were to compare weed control and dry bean tolerance from various PPI treatments used in a complete weed control program. Various pendimethalin herbicides (Prowl H2O, Pendalin, and Sattelite HydroCap) were also compared to see if there are any differences in weed control. There was 1.1-inches of rainfall after dry bean planting. Overall PPI applications were safe to dry beans. At the time of POST herbicide application (~4 weeks after planting), all PPI herbicide treatments provided similar annual grass (96-99%) and common lambsquarters (87-96%) control. Treatments that contained Eptam provided improved common ragweed control; those that only contained pendimethalin + Outlook provided between 55-68% control. After the POST application of Varisto + Outlook, annual grass, Powell amaranth, common lambsquarters and velvetleaf control was greater than 99%. Common ragweed control was 93% or higher but was not different between the different treatments. Dry bean yield was similar between all treatments with the exception of the untreated control which yielded 11 cwt/A less than the highest yielding treatment. This research shows the benefits of a two-pass program for effective weed control and preserving dry bean yield. If common ragweed is an issue, PPI Eptam treatments can help reduce early season common ragweed populations.

Dry bean desiccation using Defol 5

Christy Sprague and Brian Stiles, Michigan State University

Location:	Tuscola County	**Tillage:**	Conventional
Planting Date:	June 17, 2024	**Row width:**	30-inch
Replicated:	4 times	**Population:**	109,000 seeds/A
Varieties:	'Zenith' black beans	**Desiccation date:**	Sept. 4, 2024

Table 1. Preharvest treatments on 'Zenith' black bean overall and pod desiccation (%) 2, 6, 8 days after treatment (DAT) and dry bean yield.

		6 DAT			Moisture	Yield
Treatments[a]	**2 DAT**	**overall**	**pod**	**8 DAT**	**(%)**	(cwt/A)
Sharpen (1 fl oz) + Hot MES + AMS	83 bcd[b]	100 a	100 a	100 a	16.5 abc	20.2 ab
Sharpen (2 fl oz) + Hot MES + AMS	84 ab	98 ab	100 a	100 a	16.0 cde	20.0 ab
Defol 5 (2.4 qt) + Hot MES	82 cde	99 ab	98 a	100 a	17.0 ab	20.3 ab
Defol 5 (4.8 qt) + Hot MES	79 ef	99 ab	98 a	100 a	17.3 a	21.4 a
Defol 5 (2.4 qt) + Sharpen (1 fl oz) + Hot MES + AMS	87 a	100 a	100 a	100 a	15.1 e	17.9 ab
Gramoxone 3SL (21 fl oz) + NIS	86 ab	96 b	99 a	100 a	16.1 bcd	17.5 b
Defol 5 (2.4 qt) + Gramoxone 3 SL (21 fl oz) + Hot MES	85 abc	100 a	100 a	100 a	16.3 bcd	19.7 ab
Sharpen (1 fl oz) + Gramoxone 3 SL (21 fl oz) + Hot MES + AMS	86 ab	100 a	100 a	100 a	15.5 cde	19.7 ab
Untreated	76 f	78 c	93 b	97 b	17.0 ab	18.3 ab

[a] Hot MES is a surfactant + MSO blend applied at 16 fl oz/A. The liquid AMS product was applied at 2.5% v/v.
[b] Means within a column with different letters are significantly different from each other.

Summary: The objective of this research was to examine Defol 5 as a dry bean desiccant and compare it with current standard desiccation treatments. Defol 5 (42.3% sodium chlorate) is a product that has been used for seed corn defoliation for several years. Defol 5 has a dry bean label with a 0 d preharvest interval but has had very little work on its effectiveness as a dry bean desiccant. This is the second year examining Defol 5 as a dry bean desiccant. Preharvest treatments were applied at 10 gallons per acre when dry beans pods were at 70% yellow and 60% of leaves were green. This year conditions were ideal (warm and dry) at application improving the effectiveness of preharvest treatments. At 2 DAT, Defol 5 alone provided slightly less desiccation than treatments containing Gramoxone or Sharpen. However, by 6 DAT all treatments provided greater than 95% pod and overall desiccation. This was similar to our results in 2023. Dry bean yield for all treatments was similar, with the exception of Gramoxone alone which was slightly lower than the high rate of Defol. In 2023, there were no differences in yield. From this research there are some promising results for Defol 5 as a dry bean desiccant, however additional studies should be conducted under less favorable conditions to evaluate its consistency, as well as effectiveness in desiccating different weed species that may be present at dry bean harvest.

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	YELLOW NUTSEDGE
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) or 6.4 oz (5L)	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
RAPTOR[ef] + BASAGRAN 16 oz (4L) or 12.8 oz (5L)	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
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.

[e] Control of **hairy nightshade** with *Pursuit* and *Raptor* is excellent.

[f] **Common lambsquarters** will be controlled with this tank mixture ***if*** the weeds are less than 2 inches tall and ***not*** under drought stress.

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.

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Dry Edible Beans — Soil Applied *(continued)*

Weed Controlled	Herbicide	Rate lb/A a.i.	Formulation/A	Remarks and Limitations
(continued)				
Annual grasses	glyphosate + s-metolachlor *(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.

(Continued on next page)

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.

(Continued on next page)

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*.

(Continued on next page)

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.

Table 16. Potassium recommendations for selected yields of corn (mineral soils).

Soil test	CEC	140 bu/a				180 bu/a			
		4	8	12	16	4	8	12	16
ppm		— lb K_2O/a —				— lb K_2O/a —			
40		92	115	142	173	103	126	153	184
80		44	59	78	101	55	70	89	112
85		38	52	70	92	49	63	81	103
95		38	38	54	74	49	49	65	85
105		38	38	38	56	49	49	49	67
115		38	38	38	38	49	49	49	49
125		19	38	38	38	25	49	49	49
135		0	19	38	38	0	25	49	49

Numbers highlighted are maintenance amounts.

Table 17. Potassium recommendations for selected yields of corn silage (mineral soils).

Soil test	CEC	20 t/a				30 t/a			
		4	8	12	16	4	8	12	16
ppm		— lb K_2O/a —				— lb K_2O/a —			
40		214	237	264	295	294	300	300	300
80		166	181	200	223	246	261	280	300
85		160	174	192	214	240	254	272	294
95		160	160	176	196	240	240	256	276
105		160	160	160	178	240	240	240	258
115		160	160	160	160	240	240	240	240
125		80	160	160	160	120	240	240	240
135		0	80	160	160	0	120	240	240

Numbers highlighted are maintenance amounts.
Maximum annual recommendation is 300 lb K_2O/a.

Where soybeans have not been grown recently, inoculation of the soybean seed with soybean-specific Bradyrhizobia strains is essential for effective nitrogen fixation.

Soybeans are more sensitive to fertilizer placement and rate than corn. Starter fertilizer placed 2 inches to the side and 2 inches below the seed can contain up to 100 pounds of phosphate (P_2O_5) and 60 pounds of potash (K_2O) per acre. Placement of fertilizer with the seed may cause serious injury and reduced plant stands. When soybeans are drilled (7- to 10-inch spacing), broadcast and incorporate all the P_2O_5 and K_2O before planting. The P_2O_5 and K_2O required for soybeans may also be broadcast prior to the previous corn crop. For no-till soybeans, use a band-placed starter fertilizer or broadcast the required fertilizer before planting. On lake-bed soils and dark-colored soils where the soil pH is above 6.5, Mn application will usually improve soybean growth and yields. Include 2 lb Mn/a (or the recommended amount based on a soil test) in the starter fertilizer, or apply one or two applications of 1 to 2 lb Mn/a to the foliage. Broadcast applications made to the soil are not effective.

Table 18. Phosphorus recommendations for selected yields of soybean (mineral soils).

Soil test	Yield (bu/a)	
	40	60
ppm	— lb P_2O_5/a —	
5	82	98
10	57	73
15-30	32	48
35	16	24
40	0	0

Dry Edible (Field) Beans

Phosphorus and K recommendations are given in Tables 20 and 21.

Dry beans, like soybeans, are legumes and can fix N. Nitrogen fixation in dry bean can be unreliable, however, because of environmental conditions and variability among varieties. Therefore, applying 40 to 60 lb N/a is recommended to achieve maximum yield. Apply 60 lb N/a for beans grown in narrow rows (less than 23 inches) and for colored beans grown under irrigation. For beans grown with less intense management systems, apply 40 lb N/a. Applying ex-

Table 19. Potassium recommendations for selected yields of soybean.

Soil test	CEC	40 bu/a				60 bu/a			
		4	8	12	16	4	8	12	16
ppm		— lb K_2O/a —				— lb K_2O/a —			
40		110	133	160	191	138	161	188	219
80		62	77	96	119	90	105	124	147
85		56	70	88	110	84	98	116	138
95		56	56	72	92	84	84	100	120
105		56	56	56	74	84	84	84	102
115		56	56	56	56	84	84	84	84
125		28	56	56	56	42	84	84	84
135		0	28	56	56	0	42	84	84

Numbers highlighted are maintenance amounts.

Table 20. Phosphorus recommendations for selected yields of dry edible beans (mineral soils).

Soil test	Yield (cwt/a)	
	20	30
ppm	— lb P_2O_5/a —	
5	74	86
10	49	61
15-40	24	36
45	12	18
50	0	0

Table 21. Potassium recommendations for selected yields of dry beans (mineral soils).

Soil test	CEC	20 cwt/a				30 cwt/a			
		4	8	12	16	4	8	12	16
ppm		— lb K_2O/a —				— lb K_2O/a —			
40		86	109	136	167	102	125	152	183
80		38	53	72	95	54	69	88	111
85		32	46	64	86	48	62	80	102
95		32	32	48	68	48	48	64	84
105		32	32	32	50	48	48	48	66
115		32	32	32	32	48	48	48	48
125		16	32	32	32	24	48	48	48
135		0	16	32	32	0	24	48	48

Numbers highlighted are maintenance amounts.

cess N can delay bean maturity and may increase potential for white mold if the crop canopy is dense.

Dry beans are sensitive to low levels of available Zn. Providing adequate amounts of Zn fertilizer, if needed, is important because even mild Zn deficiency can delay maturity. Use a soil test to determine available Zn levels, and calculate the amount to apply from the equation on page 27. In the absence of a soil test, apply 1 lb Zn/a if the previous crop was sugar beets or if the soil pH is above 6.5.

Dry beans do not tolerate fertilizer applied with the seed. Up to 40 lb N/a, all of the P_2O_5 and 60 lb of K_2O/a may be included in a starter fertilizer placed in a band 2 inches to the side and 2 inches below the seed. Before planting, broadcast and incorporate any additional fertilizer that is needed. Additional N may also be sidedressed two weeks after planting.

Bean yield may be affected by nutrient management and cropping systems. Dry beans grown after sugar beets often experience Zn deficiency, which results in delayed maturity and reduced yield. Dry beans rely on a symbiotic relationship with mycorrhizal fungi to assist the plant in taking up nutrients. Sugar beets do not host these fungi. Reduced numbers of mycorrhizae after sugar beets result in Zn deficiency because the bean plant can not take up enough Zn on its own.

Dry beans are also more sensitive to soil compaction than some other crops, particularly soybean. So take care to avoid soil compaction after primary tillage.

MSU Field Crops Insect Guide: Management of Insects and Spider Mites in Dry Beans
Updated August 2021

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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	(a) 0.5 - 2.0 lbs					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
Biobit HP	(a) 0.5 - 1 lb														
Dipel ES	(a) 1 - 2 pints														
Javelin	(a) 0.25 - 1.5 lbs														
Xentari DF	(a) 0.5 - 1.5 lb														
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

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