

2018 DRY BEAN YIELD TRIALS

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The dry bean breeding program initiated its tenth season on the 450 acre Saginaw Valley Research & Extension Center (SVREC) research farm near Frankenmuth MI in 2018. The MSU dry bean breeding and genetics program conducted 23 yield trials in 2018 in ten market classes and participated in the growing and evaluation of the Cooperative Dry Bean, Midwest Regional Performance, National Drought and the National Sclerotinia Nurseries in Michigan and winter nursery in Puerto Rico. A total of 2870 bean plots were trialed in 2018, 1890 plots at SVREC, 516 plots at the Montcalm Research Center (MRC), and 464 plots at East Lansing. The nurseries at SVREC were planted in June 2018 into drier than normal soil moisture conditions, which continued through June and July. Bean trials received only 3.45" of rain during that 60-day period of June and July, which was confounded with high temperatures in excess of 90F. The plants were under considerable stress during this vegetative phase and recovered with substantial rainfall totals of 7.90" in August. Resulting yields were well above average with navy beans yielding 33 cwt/acre and black beans averaged 39 cwt/acre. MRF details and weather; Weather patterns followed a similar trend at MRC, but low rainfall amounts in June and July were offset with supplemental irrigation applied 10 times for a total of 5.4" during the course of the season. Despite the higher management, yields were average in 2018. Planting of the bean trials on the MSU Soils farm in East Lansing was delayed to June 26, due to the dry conditions. Rainfall in June (1.6") was followed by hot (90+F) and dry conditions in July (2.18"). Despite the unfavorable conditions early in the season, conditions improved in August (4.21") and the crop responded producing above average yields of 36 cwt/acre.

In 2017, anthracnose was observed in fields of Zenith black bean in Northern Michigan. Zenith is resistance to the current races 7 and 73 known to be present in Michigan. A disease survey was conducted across nine counties of the Michigan bean growing region and 39 infected pod samples were collected. Isolates were characterized for their reaction on twelve differential cultivars of *Phaseolus vulgaris*. Twenty-seven isolates were identified as Race 73 that commonly occurs when conditions are conducive for disease development. An isolate from western Michigan was identified as Race 7, which overcomes the Co-1 gene present in kidney beans. Six isolates from Northern Michigan were characterized as Race 109, previously reported in Manitoba, but not previously found in Michigan. Race 109 is virulent on the Co-1² gene possessed by Zenith, which previously conferred resistance to all known races found in Michigan. Due to the emergence of Race 109, KASP markers will be deployed to pyramid additional resistance genes such as Co-4², Co-5 and Co-6 genes into future dry bean cultivars. Race 109 anthracnose was detected in Zenith fields in 2018 in Alcona County, but the incidence was much lower than in 2017 as growers used preventative Priaxor spray and weather conditions were less favorable for development and spread in 2018. Anthracnose samples collected in 2018 will be race characterized over the winter.

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

1. Yield is clean seed weight reported in hundredweight per acre (cwt/acre) standardized to 18% moisture content. Dry beans are commercially marketed in units of 100 pounds (cwt).
2. Seed weight is a measure of seed size, determined by weighing in grams a pre-counted sample of 100 seeds, known as the 100-seed weight. To convert to seeds per 100g (10,000/100 seed wt); for example, 100-seed weight of 50 converts to 200 seeds per 100 g (used in marketing).
3. Days to flower are the number of days from planting to when 50% of plants in a plot have one or more open flowers.
4. Days to maturity are the actual number of days from planting until date when all the plants in a plot have reached harvest maturity.
5. Lodging is scored from 1 to 5 where 1 is erect while 5 is prostrate or 100% lodged.
6. Height is determined at physiological maturity, from soil surface to the top of plant canopy, and is recorded in centimeters (cm).
7. Desirability score is a visual score given the plot at maturity that takes into consideration such plant traits as; moderate height, lodging resistance, good pod load, favorable pod to ground distance, uniformity of maturity, and absence of disease, if present in the nursery. The higher the score (from 1 to 7) the more desirable the variety, hence DS serves as a subjective selection index.

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

Expt. 8101: Standard Navy Bean Yield Trial

This 48-entry trial included standard commercial navy bean varieties, and advanced lines from the MSU breeding program, which carry the N-prefix. Yields ranged from 27.8 to 37.1 cwt/acre with a mean of 33 cwt/acre. Variability in this trial was low (CV=8.9%) and the LSD needed for significance was 3.5 cwt/acre. However, only two new lines significantly out-yielded the test mean and the overall yields were disappointing low compared to those of black beans. Alpena was the top variety in the trial followed by Vigilant, and Merlin that grouped around the test mean. Similar to the past four years, Medalist was the lowest yielding variety and the low performance of Medalist results from severe leaf retention and failure to dry down. The inability of many varieties to mature uniformly was the result of the early drought stress resulting in the inability of the plants to set sufficient pod load (sink) to mature out normally. The yield potential in navy beans needs to be improved, as they are no longer competitive with black beans. Canning tests will be conducted on all new MSU breeding lines before being considered for advance.

Expt. 8102: Standard Black Bean Yield Trial

This 54-entry trial included the standard commercial black bean varieties and advanced breeding lines. Yields ranged from 33.1 to 44.5 cwt/acre with a test mean of 38.6 cwt/acre. Variability was low in this test, (CV=6.1%) and the LSD was 2.8 cwt/acre. Seven entries significantly outyielded the test mean and they included B16504 for the third consecutive year. The top entry, B18504 is an anthracnose (race 109) resistant selection out of B16504 that appears to perform equivalently. All other varieties, Black Bear, Zorro, Black Tails and Eclipse yielded below the test mean. ACUG 15-B4 and Eclipse were the lowest yielding entries in the test. Canning tests will be conducted on new breeding lines to ensure only those with canning quality similar to Zenith are advanced.

Expt. 8103: Black Bean Yield Trial #2

This 84-entry trial included recombinant inbred lines (RILs) developed by crossing Zenith with advanced black bean breeding lines, B12724, B14311 and B14302 and inbreeding the progeny over several generations. This experiment was designed to determine the combining ability of different black beans that are known to possess excellent color retention when canned. Yields ranged from 31.7 to 45.9 cwt/acre, with the test mean of 40.1 cwt/acre. Variability was low (CV=6.3%), resulting in a LSD of 3.4 cwt/acre. Eleven lines significantly outyielded the test mean and included the two lines B18504 and B16504. Zenith was the top commercial check, followed by Black Tails, Zorro, Black Bear and Eclipse was the lowest yielding entry similar to test 8102. The entire RIL population was canned last year, and most lines maintained a dark black color after canning, some being darker than Zenith. Lines will be selected for this year's canning tests based on yield, agronomic, and previous canning data. Some actual plot yields in this trial exceeded 50 cwt/acre indicating the yield superiority of black beans over other commercial classes. These high yields were significant given the severe drought and heat stress conditions experienced early in 2018.

Expt. 8104: Preliminary Black Bean Yield Trial

This 48-entry trial included new black bean lines (B18-prefix) and check varieties. Yields ranged from 33.6 to 45.5 cwt/acre with a mean of 40.2 cwt/acre. Variability was well controlled in this 3-

rep test (CV=6.3%) and the LSD was 3.5 cwt/acre. Nine lines significantly outyielded the test mean. Zenith (43.0 cwt) outyielded Zorro (40.7 cwt) and Black Bear (40.2 cwt) as in tests 8102 and 8103. Many of the lines in this trial carry anthracnose resistance in addition to improved levels of CBB resistance but future advances of any new breeding lines will largely depend on confirmation of disease reactions and canning quality of the entries.

Expt. 8105: Standard Great Northern Yield Trial

This 42-entry trial included MSU great northern breeding lines (G-prefix) and standard commercial check varieties. The test ranged in yield from 25.6 to 36.4 cwt/acre with a mean yield of 31.4 cwt/acre. Variability was moderate (CV= 10.6%) resulting in a LSD value of 3.9 cwt/acre needed for significance. Six entries significantly outperformed the test mean and included G16351 line consistent performer over the last 3-years. The top entry G17410 was the top entry in 2017 but the line matures later exhibits undesirable severe green stem trait at maturity. The checks included Powderhorn and two varieties, Taurus and Aries from Nebraska. The NE varieties lodge more and are very susceptible to white mold. Many of the new lines have smaller seed (<40 g) and will need to be selected on that basis.

Expt. 8106: Standard Otebo Yield Trial

This 24-entry trial included MSU otebo breeding lines (G-prefix) and standard commercial check varieties. The test ranged in yield from 32.7 to 45.2 cwt/acre with a mean yield of 38.4 cwt/acre. Variability was moderate (CV= 9.8%) resulting in a high LSD value of 4.4 cwt/acre needed for significance. As a result, only one new entry G18904 significantly outperformed the test mean. The check variety Samurai is an upright type suitable for direct harvest and is comparable in yield to current upright black and navy bean varieties. Seed size of Samurai (31g) is considered too small by industry, as otebo beans are graded over 11/64 slotted screen. Most of the G17-, G18-entries, derived from crosses with Samurai possess small seed size, and only two entries had seed size larger than Samurai. The majority of entries carry resistance to races 73 and 109 anthracnose. Future breeding of otebo beans is being suspending due to inflexibility in the marketplace.

Expt. 8107: Standard Pinto Bean Yield Trial

This 36-entry trial included MSU pinto lines (P-prefix) and standard commercial check varieties. The test ranged in yield from 25.0 to 39.7 cwt/acre with a mean yield of 32.4 cwt/acre. Variability was moderate (CV= 11.9%) resulting in a LSD value of 4.5 cwt/acre needed for significance. Seven entries significantly outperformed the test mean and included P16901 the top entry in 2017. Checks included standards Eldorado, La Paz and slow dark pintos Palomino, DR Wood and Staybright. Many of the higher performing SDP H/H (slow dark pinto) from MSU had undesirable agronomic traits, such as leaf retention and green stem. The emphasis on incorporating the slow dark trait into pinto beans appears to be bringing along negative traits that are negatively impacting yield due to genetic linkage drag. To overcome linkage drag, F3 lines expressing the slow dark trait were topcrossed with elite germplasm in the 2018 crossing block. The future of traditional pinto bean seed types in the marketplace is uncertain complicating future breeding efforts in this seed class.

Expt. 8108: Standard Small Red and Pink Bean Yield Trial

This 36-entry trial included small red and pink breeding lines from MSU (R-small red; S-pink prefix), in addition to standard commercial check varieties. The test ranged in yield from 34.1 to 48.8 cwt/acre with a mean yield of 40.9 cwt/acre. Variability was moderate (CV=6.9%) resulting in a LSD value of 3.3 cwt/acre for significance. The top seven lines included a series of new red (R18-) and pink S18-lines that tended to be later maturing and less erect. All checks and older lines yielded less. Three sib-lines (R17603, R17604, and R17605) that have outstanding architecture, and performed well in 2017, fell below test mean in 2018. Rosetta was the top variety followed by Viper, Cayenne and Merlot, lowest yielding entry. As in past years, seed size of Viper (34g) is significantly smaller than that of Merlot (43g) and Cayenne (39g). Progress in pink and small red breeding programs has been limited by a lack of useful variability and inability to combine performance with upright architecture and suitable canning quality in new lines. All new lines will be evaluated for canning quality and BCMV reaction prior to advancing to 2019 trials.

Expt. 8109: Combined Midwest Regional Performance Nursery (MRPN) & Cooperative Dry Bean Nursery (CDBN) Yield Trial

The MRPN is conducted annually in cooperation with North Dakota (ND-prefix), Nebraska (NE-prefix) and Colorado (CO-prefix) in order to test new pinto, great northern and small red lines from all four programs and assess their potential in the different regions. The CDBN is a national trial and includes all classes but only medium-sized entries were included in this trial. The 36-entry trial ranged in yield from 25.7 to 42.9 cwt/acre with a mean of 33.8 cwt/acre. Variability was low (CV=8.9%) resulting in a LSD value (4.1 cwt/acre) for significance. As a result, 11 lines were significantly higher in yield than the test mean including varieties Cayenne, La Paz and Merlot. In the top group were pinto, PT16-17, and pink PK16-7 from USDA-WA, small red R17604 from MSU and new slow dark pinto release NE2-17-18 (PTO 2) from NE. Performance of other slow darkening pintos Palomino from NDSU was below average. Two new releases from NE, pinto NE2-17-39 (PTO 7) and GN NE1-17-10 (GN 12) significantly under performed. This cooperative trial continues to be valuable as it allows an evaluation of potential new lines prior to release in other states. Canning quality will also be evaluated for all entries.

Expt. 8110: Cooperative Dry Bean Nursery (CDBN) Classic Yield Modelling Trial

This trial was organized to test theory of genomic selection based on CDBN data collected over decades across the US. The study was coordinated out of the University of Texas, Austin and was grown across the US. The 10-entry trial ranged in yield from 16.3 to 30.2 cwt/acre with a mean of 24.0 cwt/acre. Variability was low (CV=6.0%) resulting in a LSD value (2.0 cwt/acre) for significance. As a result, four lines were significantly higher in yield than the test mean including pinto varieties ND-307 and Buster. Yolano pink, Starlight GN and Aztec pinto all underperformed. Based on genomic selection model, five entries were low yielding and five were high yielding. All entries were released over 10-15 years ago and the overall low yield reflected the substantial progress that has been made in breeding over that time period. In comparing means with previous CDBN test 8109 that averaged 33.8 cwt/acre compared to 24 cwt/acre for test 8110. None of the entries reached the average of test 8109, which puts in question the potential value of genomic selection versus real world phenotypic selection based on actual yield data.

Expt. 8111: Middle American Diversity Panel – Race Mesoamerica

Expt. 8112: Middle American Diversity Panel – Race Durango

These two trials were single plot grow outs to renew seed of the Middle American Diversity Panel (MDP). The panel was split into two races – small seeded race Mesoamerica that includes navy and black beans; and medium seeded race Durango that includes pinto and great northern, red and pink beans. Test 8111 included 96-entries and test 8112 included 204-entries. Seed source was 2011 field seed and germination was more problematic in race Durango lines than in the small seeded Mesoamerican entries. No actual data was collected on the trials, but seed was renewed and is available for collaborative projects with colleagues in the Plant Resilience Institute (PRI).

Expt. 8113: National Dry Bean Drought Nursery

This 32-entry trial was conducted at the SVREC to evaluate a series of breeding lines identified through shuttle breeding between University Nebraska and USDA-TARS station in Puerto Rico as possessing improved levels of drought stress. The trial was replicated by colleagues at various locations across the US. Yields ranged from 14.9 to 44.2 cwt/acre with a mean of 30.9 cwt/acre. Variability was moderate (CV=10.5%) and the LSD needed for significance was 4.4 cwt/acre. Seven lines significantly out-yielded the test mean, including varieties Cayenne, Zenith, and new pinto from Colorado, DR Wood. The top entry was MSU black bean line B16504 followed by pinto PT from USDA-WA. As in 2017, Blackfoot was the lower yielding entry next to Marquis GN. Since drought was a factor in 2018, it was gratifying to see that new MSU varieties were in the top group. This suggests that continued selection for high performance under local precipitation patterns has resulted in materials that exhibit improved performance under stressful conditions.

Expt. 8214: Standard Kidney Bean Yield Trial

This 56-entry trial was conducted on original trial ground on the Montcalm Research Farm (MRF) to compare the performance of standard and new light red kidney (LRK), dark red kidney (DRK), white kidney (WK), varieties from MSU and CDBN under supplemental irrigation (10x total 5.4”). A prominent feature of this trial was lack of root rot disease pressure as noted in past years and lack of deer feeding due to erection of a deer fence. Yields ranged from 19.1 to 33.1 cwt/acre with a mean of 26.2 cwt/acre. Variability was moderate (CV=12.7%) resulting in a LSD value of 4.5 cwt/acre needed for significance. Only two entries significantly out-yielded the test mean, included new WK K17209 and LRK K15601 under consideration for release. Check varieties Dynasty, Chaparral, Snowdon, Inferno and Clouseau were above the test mean, while Beluga and Red Cedar were equivalent to test mean and Yeti, CELRK, Big Red, Talon, Red Hawk, Rosie, and Montcalm fell below the mean. These results provide a comparison of all current red and white kidney bean varieties.

Expt. 8215: Standard Yellow Bean Yield Trial

This 24-entry trial was conducted on new ground at MRF to compare the performance of new yellow bean lines from MSU under supplemental irrigation (10x total 5.4”). This is the first yellow bean trial conducted with MSU lines (Y-prefix) and new varieties from programs in the US and Canada (AAC). Yields ranged from 17.4 to 29.5 cwt/acre with a mean of 22.6 cwt/acre. Variability

was moderate (CV=11.6%) resulting in a LSD value of 3.1 cwt/acre needed for significance. Only four lines significantly outyielded the test mean and these included the private variety SVS-0863, three lines from the MSU program. This is the second year of testing new yellow bean lines from MSU that all carry I-gene resistance to BCMV. The AAC lines from Canada are susceptible to BCMV as is SVS-0863 and MY 06326. Performance of the new Patron variety, its sib (DBY-28-1), and AAC Y012 from Canada was much lower than in 2017, due in large part to greater lodging and resulting white mold infection in 2018. These results are initial efforts to breed adapted yellow beans and retain the strong yellow (highlighter) seed color of the Mexican Peruano, Azufrado, Mayacoba seed types. The virus resistance in all new lines will be verified and the lines will be canned before being advanced in 2019.

Expt. 8216: Preliminary Kidney Bean Yield Trial

This 48-entry trial was conducted to compare the performance of new kidney bean lines from MSU grown under supplemental irrigation (10x total 5.4"). Yields ranged from 19.6 to 31.2 cwt/acre with a mean of 25.4 cwt/acre. Variability was moderate (CV=11.3%) in this 3-rep experiment resulting in a LSD value of 3.9 cwt/acre needed for significance. Seven lines significantly outyielded the test mean and these include all new K18-lines while Snowdon topped the trial. The top group included two half-sibs WK, one DRK and two LRK lines. A number of new WK lines have an indeterminate growth habit that growers may not favor, but appear to provide greater resilience and better performance coupled with earliness. Since canning quality is vital in kidney beans, only those lines equivalent in canning quality to check varieties will be advanced in 2019.

Expt. 8217: Iowa State Yield Trial

This is the second year to plant this small 4-entry trial was a collaboration with Iowa State University who were evaluating four contrasting bean types at a number of locations across the US to determine the effects of location on mineral element content of the seed. The four varieties were the yellow bean MY 06326, Taurus great northern, Eclipse black and Montcalm DRK. Yields ranged from 23.0 to 42.4 cwt/acre with a mean of 30.7 cwt/acre. Variability was well controlled (CV=5.3%) resulting in a LSD value of 2.6 cwt/acre needed for significance. Only Eclipse black bean significantly outyielded the test mean with highest yield on the farm. MY 06326 is a private variety licensed by the Kelley Bean Company and bred by Provita, but it is susceptible to BCMV; Taurus is a great northern variety from Kelley Bean in NE. Seed will be sent to ISU for nutrient analysis as part of a graduate student thesis project.

Expt. 8218: National White Mold Yield Trial

This 32-entry trial was conducted to evaluate a range of diverse dry bean varieties and breeding lines for reaction to white mold under natural field conditions. Genotypes included commercial navy and black bean cultivars, elite MSU lines, and new sources of white mold resistance entered as part of the National *Sclerotinia* Initiative (NSI) Nursery. Lines in the National trial were developed at MSU, USDA-WA, and NDSU and one line, ND121448 from NDSU did not germinate. Entries were planted in two row plots with two rows of susceptible spreader variety Matterhorn between plots and were direct harvested. Supplemental overhead irrigation was applied 17 times for a total of 7.8" to maintain adequate levels of moisture for favorable disease

development at the critical flowering period. The trial was planted on original bean land previously infected with white mold. Natural white mold infection occurred, and was very severe on both spreader rows and check varieties. White mold was rated on a per plot basis on a scale of 1 to 9 based on disease incidence and severity where 9 had 90+% incidence and high severity index. White mold ranged from 22.2 to 96.3% with a mean value of 51%. The susceptible check Beryl had the highest white mold rating. The test ranged in yield from 7.4 to 36.1 cwt/acre with a mean yield of 25.1 cwt/acre. Variability was moderate (CV=12.8%), thus a high LSD value (4.4 cwt/acre) was needed for significance. Nine lines significantly out-yielded the test mean and included Viper, despite heavy white mold infection (78%), and two new R17-red lines, two new P16-pinto lines and two black lines including B16504. Stand ability was a key trait in avoiding white mold in this trial and new line B18504 tended to lean due to heavy pod load and contracted higher white mold levels as a result. The trade off in erectness versus yield (pod load) is a major factor in avoidance of white mold. This trial will continue to be part of the breeding effort to improve tolerance to white mold in future varieties in 2019.

Expt. 8419: Phaseolus Improvement Cooperative (PIC) Observation Trial

As part of the focus of the Plant Resilience Institute (PRI) we requested 96 PIC lines (90 lines and 6 local checks) from Dr. Timothy Porch USDA-ARS, Mayaguez PR for testing in MI. These lines are mainly large seeded kidney, cranberry and yellow lines that have been bred for tolerance to heat stress. We wanted to determine their adaptation to MI conditions as most originate from crosses with tropical germplasm from South America and East Africa. The lines were planted late (June 26) in single paired row plots (50 seeds), with a common border in East Lansing on the Soils Farm. Data was collected on maturity, height, lodging, seed size and yield (1-rep). Yields were surprisingly good ranging from zero (9 unadapted lines), from 11.9 to 45.4 cwt/acre. Top yielding check variety was Red Cedar (42.9 cwt), followed by Etna (35.5 cwt), Clouseau (34.5 cwt), Snowdon (33.1 cwt), Red Hawk (31.8 cwt), and CELRK (11.9 cwt/acre). Seed was rated based on commercial value and the best lines were selected as parents for crossing to broaden the genetic base of local kidney, cranberry and yellow bean classes. A copy of the data is publically available to anyone interested in seeing the actual data (1-rep expt).

Expt. 8420: Yield Differential Index – Fertilized

Expt. 8422: Yield Differential Index – No Fertilizer

These two trials were each 26-entry trials with two replicates and were conducted on land in East Lansing that is managed by the MSU agronomy farm. The objective of the trials was to determine the yield difference index between plots with and without N fertilizer. At planting, the fertilizer treatment of 46 lb N/acre was broadcast as 100 lb Urea, using a hand-crank fertilizer spreader. Yields of the fertilized treatment ranged from 29.9 to 43.2 cwt/acre with a mean of 36.4 cwt/acre. The variability in fertilized treatment was moderate (CV=7.5%) and the LSD needed for significance was 4.7 cwt/acre. Yields of the non-fertilized treatment ranged from 25.2 to 39.0 cwt/acre with a mean of 31.7 cwt/acre. The variability in the non-fertilized treatment was moderate (CV=8.7%) and the LSD needed for significance was 4.7 cwt/acre. On average, fertilized plots had 4.7 cwt/acre higher seed yield compared to non-fertilized plots. The moderate level of variability and elevated LSD values can be attributed to low replications (2-reps per genotype x treatment). Besides improving yield potential, the fertility did not have any apparent effects on

seed weight, anthesis date, maturity, lodging, plant height, or desirability score. In both trials, the black bean line B16504 demonstrated the highest yield potential. Surprisingly, B18504 performed well with nitrogen fertilizer but had yield equivalent to the trial mean in the non-fertilized treatment. Comparison of average seed yield and % yield relative to the fertilized control revealed that 11 lines yielded 90 to 106% relative to the fertilized control. However, with the exception of B16504 all lines with $\geq 90\%$ yield relative to the fertilized control had commercially unacceptable yield potential (Figure 1). The preliminary data produced in this study is encouraging and has motivated us to pursue Project GREEN funding for a larger scale black bean trial at SVREC in 2019.

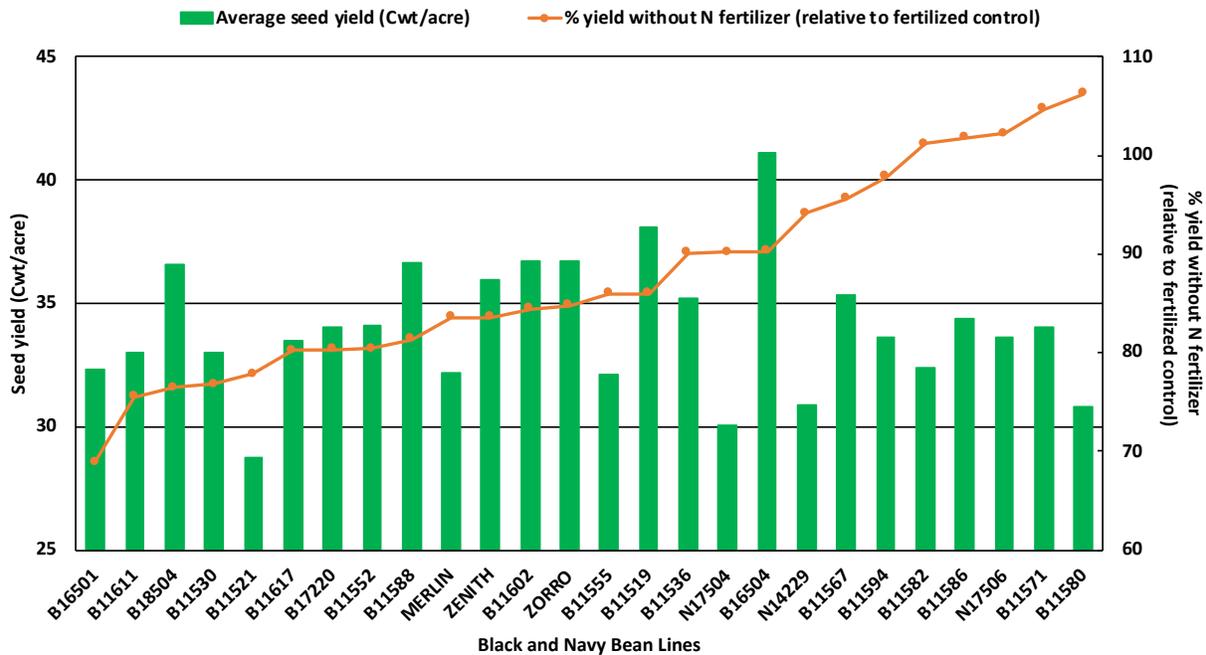


Figure 1. Comparison of average yield and % yield relative to fertilized control of 26 black and navy bean lines tested in East Lansing, MI.

Expt. 8421: Black Bean RIL Population – No Fertilizer No Inoculant Trial

Expt. 8423: Black Bean RIL Population – No Fertilizer with Inoculant Trial

These two trials were each 132-entry trials with no replication and were conducted on land in East Lansing that is managed by the MSU agronomy farm. The objective of the trials was to isolate rhizobium from nodules of inoculated and non-inoculated RILs for QTL/linkage mapping of host traits responsible for the recruitment of specific rhizobium species and strains. Seed of the inoculated trial was treated with a peat-rhizobium mixture in which equal proportions of 9 rhizobia liquid cultures (obtained from USDA) were sprayed onto the peat. Unfortunately, we suspect that unusually dry and hot weather conditions inhibited nodule formation. Rather than expending additional resources, we decided to terminate the experiment. Seed from Expt. 8421 was harvested to replenish the RIL population seed supply. Following additional growth chamber and greenhouse studies in 2019, a similar experiment may eventually be repeated.

Expt. 8124: Black Bean Seed Treatment Trial

This trial was conducted at SVREC and MRF under irrigation to test the efficacy of Excalibre inoculant applied as a seed treatment on Zenith black bean. The yields at SVREC ranged from 44.1 to 45.6 cwt/acre with a mean of 45.1 cwt/acre. The variability at SVREC was low (CV=4.3%) and the LSD needed for significance was 2.0. The yields at MRF ranged from 27.1 to 35.1 cwt/acre with a mean of 30.7 cwt/acre. The variability at MRF was higher (CV=9.4%) and the LSD needed for significance was 2.9. The Excalibre treatment had no significant or apparent effects on yield at SVREC or 100 seed weight at both locations. However, Zenith treated with Excalibre had significantly higher (6.5 cwt/acre) seed yield compared to Zenith without the Excalibre treatment. Excalibre is a rhizobia inoculum that was developed to promote nodulation and nitrogen fixation. Based on previous reports, it is clear that water deficiencies can significantly reduce nodulation in dry bean (Mnasri et al. 2007). We suspect that low soil moisture at SVREC inhibited nodulation, while irrigation at MRF promoted the effects of Excalibre. Additional studies are needed to validate these results.

Source: Mnasri B, Aouani ME, Mhamdi R. 2007. Nodulation and growth of common bean (*Phaseolus vulgaris*) under water deficiency. *Soil Biology and Biochemistry* 39:1744-1750.

| Entry | Seed Treatment | Yield cwt/acre | | 100 seed weight (g) | |
|----------------|---------------------|----------------|------|---------------------|------|
| | | SVREC | MRF | SVREC | MRF |
| B18504 | Cruiser | 45.6 | 35.1 | 23.7 | 24.0 |
| Zenith | Cruiser + Excalibre | 45.5 | 33.6 | 26.4 | 24.3 |
| Zenith | Cruiser | 45.0 | 27.1 | 26.8 | 24.3 |
| Zenith | Bare | 44.1 | 27.1 | 26.1 | 23.8 |
| Mean | | 45.1 | 30.7 | 25.8 | 24.1 |
| LSD. 05 | | 2.0 | 2.9 | 0.8 | 0.8 |
| CV % | | 4.3 | 9.4 | 3.0 | 3.1 |

Early Generation Breeding Material grown in Michigan in 2018

F3 through F5 lines

Navy and Black - 212 lines
 Pinto - 75 lines
 GN - 76 lines
 Pinks and Reds – 20 lines
 Kidneys (DR, LR, White) - 337 lines
 Yellow – 43 lines

F2 populations

Navy and Black -218 populations
 Pinto - 82 populations
 GN & Tebo - 91 populations
 Pinks and Reds - 42 populations
 Kidneys (DR, LR, White) - 55 populations
 Yellow – 22 populations

F1 populations: 529 different crosses among ten contrasting seed types.