

2015 DRY BEAN YIELD TRIALS

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The dry bean breeding program initiated its seventh season on the new 320 acre Saginaw Valley Research & Extension Center (SVREC) research farm near Frankenmuth in 2015. A total of 1723 yield trial plots (12 tests) were harvested in 2015 and 1655 single plant selections were made in the early generation nurseries. Yield trials at the Saginaw Valley Research Extension Center (SVREC) near Richville included 42-entry standard navy test; 30-entry standard black test; 56-entry prelim navy tests; 72-entry prelim black test; 42-entry standard GN and pinto test; 20-entry standard red/pink test; 48-entry prelim red test; 24-entry drought trial and 48-entry Co-op and regional test that includes pinto, GN, red and pinks. At the Montcalm Research Farm (MRF) near Entrican yield trials included 56-entry kidney and bush cranberry test; 64-entry white mold test; and 9 entry BNF test. All trials were direct harvested except for kidney and cranberry beans at Montcalm. Temperatures were moderate for the 2015 season and only exceeded 90F for a few days in July. Overall rainfall for the 3-summer months at SVREC was equivalent to the 30-year average of 8.5". A moderate dry period occurred from June 16-July 13 with only 0.7" of rainfall which reduced the overall plant size and resulted in lower overall yields. A high incidence of common bacterial blight resulted in the nurseries and allowed for selection of resistant lines in a range of seed types.

Rainfall patterns at MRF were more extreme with a total rainfall of over 5" within two days of planting. This resulted in major flooding in some areas, soil crusting and compaction in other areas which resulted in low germination. In addition soil temperatures remained low in this critical period and a high incidence of root rot diseases occurred which also reduced germination and stands. The Andean kidney and cranberry beans were the most affected by the stresses whereas the Mesoamerican small and medium seeded black, navy, pinto, GN, and red beans managed to tolerate the conditions and had near normal stands. Overall vigor of the kidney and cranberry beans was poor resulting in small plants that had low overall yields. The unfavorable conditions allowed for the selection of early generation lines with improved tolerance to root rot and with resistance to common bacterial blight in the kidney bean nurseries. White mold plots at MRF had supplemental irrigation to encourage disease development. However, disease incidence in the National Sclerotinia Initiative nursery was very low in the susceptible checks despite the overall lower temperatures and excess irrigation. The major disease problem at Montcalm was the presence of severe root rots mainly *Fusarium* that was accentuated by the cooler soil conditions early in the season. The unfavorable condition allowed for the selection of lines with increased tolerance to root rot and with resistance to common bacterial blight in the kidney bean nurseries.

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. 5101: Standard Navy Bean Yield Trial

This 42-entry trial included standard commercial navy bean varieties, and advanced lines from the MSU breeding program, which carry the N-prefix. Yields ranged from 14.6 to 28.7 cwt/acre with a mean of 21.3 cwt/acre. Variability in this trial was high (CV=14.9%) and the LSD needed for significance was 3.7 cwt/acre. Many entries failed to effectively partition and dry down properly and several exhibited severe leaf retention at maturity. Seven MSU lines significantly out-yielded the test mean and included two top yielding lines from 2012 and 2013 trials, as well as several promising lines from 2014 prelim navy trial. The newly released variety Alpena performed well, slightly out yielding Merlin and was the top yielding commercial variety. Mist was the highest yielding Canadian variety tested at 21.3 cwt/acre. Mist outyielded Lighthouse, and performed significantly better than T9905 and Fathom. Medalist was the lowest yielding variety as a result of severe leaf retention and failure to dry down. Canning tests will be conducted on all new MSU breeding lines before being considered for release.

Expt. 5102: Standard Black Bean Yield Trial

This 30-entry trial included the standard commercial black bean varieties and advanced breeding lines. Yields ranged from 18.3 to 31.3 cwt/acre with a test mean of 23.8 cwt/acre. Variability was moderate in this test, (CV=12.6%) and the LSD was 3.5 cwt/acre. Five entries significantly outyielded the test mean including top three that were crosses with stress tolerant lines from outside the MSU program. The other two top were B14302 and B14303 lines that showed excellent yield potential in 2014 prelim trial. All top five lines also showed excellent levels of resistance to CBB. Zenith was the top commercial variety at 23.3 cwt/acre and significantly outyielded Zorro. NDSU line NDF09304 ranked just below Zenith, followed by Eclipse, and then Shania. T-39 was the lowest performing variety in the trial. Four entries showed complete resistance to CBB and were among the highest yielding lines despite severe disease pressure. Canning tests will be conducted on breeding lines to ensure only those with canning quality similar to Zenith are advanced.

Expt. 5103: Preliminary Navy Bean Yield Trial

This 56-entry trial included new navy bean lines and check varieties. Yields ranged from 13.8 to 31.1 cwt/acre with a mean of 21.9 cwt/acre. Variability was moderate in this 3-rep test (CV=12.3%) and the LSD was 3.7 cwt/acre. Ten lines significantly outyielded the test mean including several with improved levels of CBB resistance. Alpena yielded above the mean at 23.5 cwt/acre. New germplasm release from Puerto Rico PR0806-80A yielded 22 cwt/acre, while PR0806-81A was lower yielding (17.2cwt). Merlin (17.3 cwt) and Medalist (16.5 cwt) were among the lowest yielding entries due to poor dry down as in test 5101. Future advances of many of the new breeding lines will largely depend on disease reactions and canning quality of the entries.

Expt. 5104: Preliminary Black Bean Yield Trial

This 72-entry trial included new black bean lines and check varieties. Yields ranged from 16.4 to 36.6 cwt/acre with a mean of 30.3 cwt/acre. Test 5104 was the top yielding test in 2015 and was overall higher yielding than the standard test 5102, suggesting the yield potential of new black bean lines. Variability was well controlled in this 3-rep test (CV=9.2%) and the LSD was 3.8 cwt/acre.

Eight lines significantly outyielded the test mean. Zenith (31.1cwt) significantly outyielded Zorro (25.4cwt) as in test 5102. 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. 5105: Standard Great Northern and Pinto Bean Yield Trial

This 42-entry trial included MSU great northern and otebo breeding lines (G-prefix) as well as pinto lines (P-prefix) and standard commercial check varieties. The test ranged in yield from 10.2 to 24.7 cwt/acre with a mean yield of 18.5 cwt/acre. Variability was high (CV= 13.5%) resulting in a LSD value of 2.9 cwt/acre needed for significance. Eight entries significantly outperformed the test mean and included Eldorado and Lapaz pinto and the new Samurai otebo varieties. Samurai nearly matched the productivity of Eldorado, which represents a great improvement from previous bush type otebo varieties. Three great northern breeding lines, pinto PT11-13 that performed well in 2014 MRPN nursery, and P14815 that exhibits excellent dry down and agronomic characteristics completed this top yielding group. Powderhorn and Matterhorn GN varieties were among the lowest yielding entries, suffering from poor dry down similar to some navy varieties. Likewise, SF103-8 slow darkening pinto failed to mature properly and was the lowest yielding entry, contrasting to its performance in 2014. The other slow darkening pinto in the test 23ST-27 also yielded below the test mean. In statewide testing at four locations, Samurai yielded 27.4 cwt compared to 21.5 cwt for the Fuji variety. Samurai is an upright type suitable for direct harvest and is comparable in yield to current upright black and navy bean varieties.

Expt. 5106: Standard Small Red and Pink Bean Yield Trial

This 20-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 19.7 to 32.4 cwt/acre with a mean yield of 25.1 cwt/acre. Variability was low (CV=9.4%) resulting in a LSD value of 2.8 cwt/acre for significance. Three small red varieties including Viper and Ruby and R13752 breeding line outperformed the test mean. Seed size of Viper (30g) and Ruby (34g) is significantly smaller than that of Merlot (40g). Merlot red and Rosetta pink performed above the trial mean, while Desert Song and Gypsy Rose ranked below the mean yield. R12844 which has performed well in previous years was equivalent to Merlot. Sibling family members R12843-45 showed improved levels of CBB resistance compared to commercial varieties. Likewise family S14706-08 showed similar CBB resistance in the pink seed class. Progress in small red breeding program has been limited by a lack of useful variability and inability to combine performance with upright architecture and suitable canning quality in new lines. All lines will be evaluated for canning quality and BCMV reaction prior to advancing to 2016 trials.

Expt. 5107: Preliminary Small Red and Pink Bean Yield Trial

This 48-entry trial included new small red (R-prefix) and pink bean (S-prefix) lines from MSU as well as new breeding lines from USDA-Washington (SR and PK codes) along with check varieties. Yields ranged from 18.6 to 36.9 cwt/acre with a mean of 25.8 cwt/acre. Variability was well controlled in this 3-rep test (CV=9.7%) and the LSD was 3.4 cwt/acre. Nine lines significantly outyielded the test mean. Several top lines from test 5106 were in this group including Viper, Ruby,

R12844, and R12845. Viper was the top yielder (36.9 cwt) with the smallest seed size and longer maturity (102d). WA breeding line PK12-3 was the only pink in this group and was equivalent to Ruby. The remaining top lines were selections made from R12844-45. R13752 performed well at 28.4 cwt/acre but was not significantly better than the trial mean. Merlot and Rosetta yielded similarly to test 5106. Some new R15 lines showed similar levels of CBB resistance to R12843-45 family although disease pressure was generally lower in this trial as in test 5106. Future advances of many of the new breeding lines will largely depend on disease reactions and canning quality of the entries.

Expt. 5108: 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 and great northern 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 48-entry trial ranged in yield from 7.8 to 32.8 cwt/acre with a mean of 22.6 cwt/acre. Variability was moderate (CV=12.7%) resulting in a LSD value (3.9 cwt/acre) for significance. As a result eleven lines were significantly higher in yield than the test mean including MSU varieties Eldorado and Desert Song. In the top group were pinto lines from MSU, USDA-WA, Colorado, and Idaho Seed Bean. Performance of slow darkening pintos SF103-8 and 23ST-27 from NDSU was similar to test 5105. New slow darkening pintos from CSU (COSD-prefix) were included in this test and ranged in yield from 24.9-18.6 cwt/acre with many of them exhibiting poor dry down similar to SF103-8. At this point none of the new slow darkening pintos appear to match the traditional lines in yield potential. Samurai fell below the average in this trial. 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 in this trial.

Expt. 5209: Standard Andean Bean Yield Trial

This 56-entry trial was conducted 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), cranberry, and yellow bean varieties from MSU and CDBN under supplemental irrigation (4x total 2.4"). A prominent feature of this trial was prevalence of severe Fusarium root rot induced by 5" rain prior to seedling emergence. Stand counts were taken and rated on 1-5 scale, 1 under 10%, 3 equivalent to 50% and 5 above 90%. Although new efforts to control variability due to deer feeding at this site were effective, yields varied widely from 8.7 to 30.0 cwt/acre with a mean of 17.6 cwt/acre due largely to the incidence of soil borne diseases. Variability was extremely high (CV=24.3%) resulting in a LSD value of 5.0 cwt/acre needed for significance. Fourteen breeding lines significantly out-yielded the test mean, including nine commercial varieties across DRK, LRK, WK, and cranberry seed types. The remaining lines in this group were the yellow bean lines MSU Y11405 and OSU DBY-28-1 and new DRK series K15302-304. These results were encouraging in that the test allowed for selection of root rot tolerant varieties and lines across market classes that will be useful for improving root rot resistance of future Andean breeding lines. Several new varieties were tested including NDSU Rosie (LRK) that showed excellent root rot resistance, Talon (DRK), and private varieties Chaparral (DRK) and Big Red (LRK). Fusarium root rot was

determined to be the major disease problem in these soils and its presence allows for continued selection for resistance in large seeded kidney bean lines. Since canning quality is vital in kidney beans, only those DRK lines equivalent in canning quality to Red Hawk, LRK lines equal or better than CELRK and WK lines equivalent to Beluga will be advanced in 2016.

Expt. 5210: National White Mold Yield Trial

This 64-entry trial was conducted at Montcalm 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 Guelph. 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 9 times for a total of 5.85" to maintain adequate levels of moisture for favorable disease development at the critical flowering period. Natural white mold infection occurred, but disease severity was generally low in 2015 across the entire trial despite generally favorable weather conditions in terms of rainfall and moderate temperatures. The same stressful conditions following planting resulted in overall poor early growth and a smaller plant canopy at flowering. 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 11.1 to 37% with a mean value of 17.3% in 2015. The test ranged in yield from 8.6 to 34.7 cwt/acre with a mean yield of 22.9 cwt/acre. Variability was high (CV=14.7%), thus a high LSD value (4.6 cwt/acre) was needed for significance. As a result 14 lines significantly out-yielded the test mean and included the Eldorado, Zenith, Ruby, and Viper varieties along with black, navy, great northern, and small red lines. Also among those entries exceeding the test mean were Samurai and Lighthouse. Bunsu (resistant) and Beryl (susceptible) checks were among the lowest yielding entries and had similarly low disease scores due to the low disease pressure. G122 (resistant check) was the lowest yielding entry similar to previous years. Yields of pink and some small red lines were also reduced due to poor stand (1-5) but overall this trial had better tolerance to the Fusarium root rot that severely damaged stands in the Andean seed types (test 5209) at Montcalm in 2015. This trial will continue to be part of the breeding effort to improve tolerance to white mold in 2016.

Expt. 5111: National Dry Bean Drought Nursery

This 24-entry trial was conducted at the SVREC to evaluate a series of breeding lines identified through shuttle breeding as possessing improved levels of drought stress. The trial was replicated by colleagues at various locations across the US. Yields ranged from 13.6 to 30.8 cwt/acre with a mean of 21.8 cwt/acre. Variability was moderate (CV=12.6%) and the LSD needed for significance was 3.8 cwt/acre. Six lines significantly out-yielded the test mean, including varieties Zenith, and Stampede. Zorro, Powderhorn, and Matterhorn were also above test mean, with Merlot and Marquis among the lower yielding entries. Since rainfall patterns were adequate in 2015, these results were similar to those observed in the near ideal growing conditions of 2014.

Early Generation Breeding Material grown in Michigan in 2015

F3 through F5 lines

Navy and Black - 89 lines
Pinto - 297 lines
GN - 578 lines
Pinks and Reds – 210 lines
Kidneys (DR, LR, White) - 155 lines
Yellow - 16 lines

F2 populations

Navy and Black -115 populations
Pinto - 65 populations
GN - 49 populations
Pinks and Reds - 41 populations
Kidneys (DR, LR, White) – 119 populations
Yellow – 13 populations

F1 populations: 541 different crosses among ten contrasting seed types.