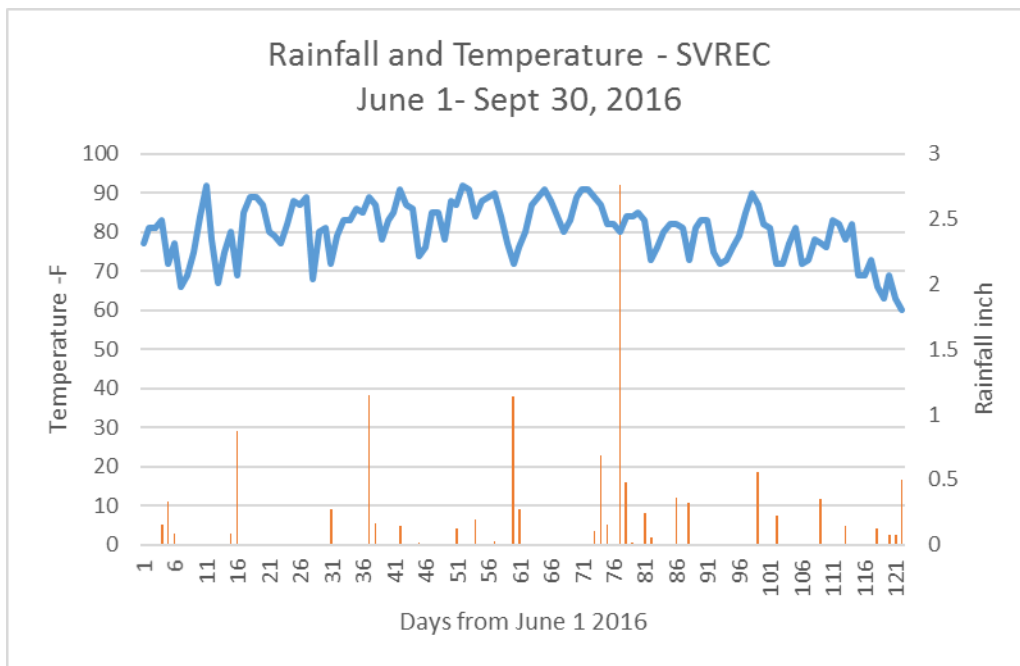


## 2016 DRY BEAN YIELD TRIALS

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The dry bean breeding program initiated its eighth season on the 450 acre Saginaw Valley Research & Extension Center (SVREC) research farm near Frankenmuth MI in 2016. A total of 2001 yield trial plots (14 tests) were harvested in 2016 and 1004 single plant selections were made in the early generation nurseries. Yield trials at the SVREC included 48-entry standard navy test; 48-entry standard black test; 64-entry standard GN test; 32-entry standard pinto test; 40-entry standard red/pink test; 30-entry drought trial and 36-entry Co-op and regional test that includes pinto, GN, red and pinks from other programs. At the Montcalm Research Farm (MRF) near Entrican, MI, kidney bean yield trials were dramatically increased to include 24-entry standard kidney and bush cranberry test; 80-entry preliminary dark red kidney test; 88-entry white kidney test; 64-entry light red kidney test; 9-entry yellow bean trial and 64-entry white mold test. All trials were direct harvested except for kidney and cranberry beans at Montcalm. Weather during the early growing season was dry and hot and beans were under considerable stress during the critical flowering period in Frankenmuth (see figure). Temperatures were above average in the 2016 season and exceeded 90F during June and July. Rainfall late in August resulting in plants re-greening and setting a double crop that reflected in lower yields and necessitated chemical desiccation in commercial fields. Selection for tolerance to drought stress during the extended dry period was possible in all nurseries based on performance under these conditions. White mold plots at MRF had supplemental irrigation to encourage disease development. However, disease incidence in this nursery was very low in the susceptible checks due to high temperatures and lack of prior bean production on this particular land parcel where the nursery was located.



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. 6101: 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 12.1 to 25.1 cwt/acre with a mean of 18.9 cwt/acre. Variability in this trial was high (CV=13.2%) and the LSD needed for significance was 2.9 cwt/acre. Many entries failed to effectively partition and dry down properly and several exhibited severe leaf retention at maturity. Eight MSU lines significantly out-yielded the test mean and included top yielding line N14229 from 2015 trials. The top yielding entry had the highest agronomic rating (5.3) as it showed excellent dry down unlike many of the standard varieties that exhibited severe leaf retention. Three cultivars, Vigilant, Alpena and Merlin grouped around the test mean. Mist was the highest yielding Canadian variety tested at 16.3 cwt/acre. As in 2015, Mist significantly out-yielded Lighthouse, and performed significantly better than T9905, Blizzard and Medalist. Similar to 2015, Medalist was the lowest yielding variety as a result of severe leaf retention and failure to dry down. The inability of many lines 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. Canning tests will be conducted on all new MSU breeding lines before being considered for release.

### **Expt. 6102: Standard Black Bean Yield Trial**

This 48-entry trial included the standard commercial black bean varieties and advanced breeding lines. Yields ranged from 13.9 to 28.9 cwt/acre with a test mean of 23.3 cwt/acre. Variability was moderate in this test, (CV=12.4%) and the LSD was 3.4 cwt/acre. Five entries significantly outyielded the test mean and the top four lines were new B16-entries. Zenith was the top commercial variety at 25.1 cwt/acre and significantly outyielded Zorro which produced a disappointing low yield (16 cwt/a), due to drought stress. Seed size of Zenith was large at 26 g/100 seed. Entry XRAV-40-4 from Puerto Rico and BK11-8 from USDA-WA underperformed in this test. Canning tests will be conducted on new breeding lines to ensure only those with canning quality similar to Zenith are advanced.

### **Expt. 6103: Standard Great Northern Yield Trial**

This 64-entry trial included MSU great northern and otebo breeding lines (G-prefix) and standard commercial check varieties. The test ranged in yield from 12.0 to 26.1 cwt/acre with a mean yield of 19.2 cwt/acre. Variability was moderate (CV= 11.9%) resulting in a LSD value of 3.1 cwt/acre needed for significance. Nine entries significantly outperformed the test mean and included the new Samurai otebo variety. In statewide testing at three locations, Samurai yielded 34.8 cwt compared to 24.0 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. New ND-line from NDSU yielded at test mean, but matured very late (110d). Drought caused some lines to mature very early or regreen and mature much later than normal. Powderhorn check variety was among the lowest yielding entries, matured earlier (97d) due to drought. Many of the new G-lines matured very late (>105d), result of regreening due to early drought stress. These lines will need to be retested to determine the adaptation under more normal conditions.

### **Expt. 6104: Standard Pinto Bean Yield Trial**

This 32-entry trial included MSU pinto lines (P-prefix) and standard commercial check varieties. The test ranged in yield from 11.1 to 25.0 cwt/acre with a mean yield of 18.6 cwt/acre. Variability was moderate (CV= 10.1%) resulting in a LSD value of 2.6 cwt/acre needed for significance. Seven entries significantly outperformed the test mean and included largely new pinto P16-breeding lines. La Paz was the top yielding check compared to Eldorado and Longs Peak. We have encountered some problems with virus in P14815 and P16913 that trace back to the Longs Peak parent. Since most MSU lines carry the I gene, we overlooked the fact that Longs Peak carries the *bc-2<sup>2</sup>* gene, so we were not screening progeny from those crosses. As a result, we lost virus resistance in these crosses, as we mistakenly assumed most cultivars carried the I gene. Palomino the new slow darkening pinto from NDSU underperformed in this test and in test 6106 yielding just 11 cwt/acre.

### **Expt. 6105: Standard Small Red and Pink Bean Yield Trial**

This 40-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 7.8 to 25.8 cwt/acre with a mean yield of 19.5 cwt/acre. Variability was moderate (CV=11.7%) resulting in a LSD value of 3.1 cwt/acre for significance. The top ten lines mainly new R16-lines plus three small red varieties Viper, Ruby, Merlot and R12844 breeding line significantly outperformed the test mean, while Desert Song, Gypsy Rose and Rosetta pink ranked below the mean yield. Seed size of Viper (33g) and Ruby (34g) is significantly smaller than that of Merlot (41g). R12844 which has performed well in previous years continues to show yield potential combined with erectness and larger seed size (40g). Overall more progress was observed among the small red R- lines than the pink S-lines. 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. One line R16503 in particular showed promise based on high agronomic score (6.3). All lines will be evaluated for canning quality and BCMV reaction prior to advancing to 2017 trials.

### **Expt. 6106: 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 36-entry trial ranged in yield from 9.2 to 32.9 cwt/acre with a mean of 20.8 cwt/acre. Variability was moderate (CV=11.0%) resulting in a LSD value (3.1 cwt/acre) for significance. As a result, twelve lines were significantly higher in yield than the test mean including varieties Samurai, Merlot, Viper and La Paz. In the top group were pinto lines from MSU, USDA-WA (PT-prefix), Colorado, and NDSU. Performance of slow darkening pintos COSD-7 from CSU and Palomino from NDSU was very poor. At this point none of the new slow darkening pintos appear to match the traditional lines in yield potential. Small red breeding line R12844 and GN line G13444 continue to show overall superior performance. 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. 6107: National Dry Bean Drought Nursery**

This 30-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 6.9 to 31.1 cwt/acre with a mean of 21.5 cwt/acre. Variability was moderate (CV=10.5%) and the LSD needed for significance was 3.1cwt/acre. Eleven lines significantly out-yielded the test mean, including varieties Zenith, Stampede, Eldorado and Merlot, while Marquis was the lower yielding entry. Since drought was a major factor in 2016, it was gratifying to see that 8/11 top yielding lines were either MSU lines or varieties. This suggests that continued selection for high performance under local precipitation patterns has resulted in materials that exhibit improved performance under stressful conditions.

### **Expt. 6208: Standard Kidney Bean Yield Trial**

This 24-entry trial was conducted on new 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), cranberry bean varieties from MSU and CDBN under supplemental irrigation (5x total 3.3”) and 14/24 entries were commercial varieties. 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 22.9 to 40.0 cwt/acre with a mean of 32.6 cwt/acre. Variability was moderate (CV=11.8%) resulting in a LSD value of 4.6 cwt/acre needed for significance. Only three lines significantly out-yielded the test mean, including the variety Chaparral and two new lines from the same cross on DRK15304 and LRK15601. The same K15304 line was in the top group in 2015. Both lines have K11306 as a parent, which ranked 4<sup>th</sup> in this test and is under consideration for release. These results provide a comparison of all current red and white kidney bean varieties.

### **Expt. 6209: Preliminary Dark Red Kidney Bean Yield Trial**

This 80-entry trial was conducted on new ground at MRF to compare the performance of new dark red kidney (DRK) bean lines from MSU under supplemental irrigation (5x total 3.3”). These entries were all survivors of the severe root rot (*Fusarium solani* species complex, clade 2) disease pressure on MRF in 2015. 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 15.5 to 43.9 cwt/acre with a mean of 32.3 cwt/acre. Variability was well controlled (CV=7.4%) in this 3-rep experiment resulting in a LSD value of 3.2 cwt/acre needed for significance. Twenty-four lines significantly outyielded the test mean and these are all new K16-lines including LRK variety Rosie that showed excellent root rot resistance. Red Hawk, Montcalm and Snowdon varieties dropped below the test mean. These results were encouraging as we now have a large group of new DRK lines that may possess moderate levels of root rot and CBB resistance based on field ratings in 2016. Since canning quality is vital in kidney beans, only those DRK lines equivalent in canning quality to Red Hawk will be advanced in 2017.

### **Expt. 6210: Preliminary Light Red Kidney Bean Yield Trial**

This 64-entry trial was conducted on new ground at MRF to compare the performance of new light red kidney (LRK) bean lines from MSU under supplemental irrigation (5x total 3.3”). These entries were all survivors of the severe root rot (*Fusarium solani* species complex, clade 2) disease pressure on MRF in 2015. 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 46.4 cwt/acre with a mean of 31.1 cwt/acre. Variability was well controlled (CV=9.1%) in this 3-rep experiment resulting in a LSD value of 3.8 cwt/acre needed for significance. Eighteen lines significantly outyielded the test mean and these are all new K16-lines including LRK variety Rosie that showed excellent root rot resistance. Clouseau and CELRK varieties dropped below the test mean, due largely to heavy CBB infection (rated 5). The top entry K16640 was highly significant as it exceeded the yield of the next entry by 6.1 cwt/a. Overall the test was not as impressive as DRK test 6209, but the results were encouraging as we now have a large group of new LRK lines that may possess moderate levels of root rot and CBB resistance based on field ratings in 2016. Since canning quality is vital in kidney beans, only those LRK lines equal or better than CELRK will be advanced in 2017.

#### **Expt. 6211: Preliminary White Kidney Bean Yield Trial**

This 88-entry trial was conducted on new ground at MRF to compare the performance of new white kidney (WK) bean lines from MSU under supplemental irrigation (5x total 3.3”). These entries were all survivors of the severe root rot (*Fusarium solani* species complex, clade 2) disease pressure on MRF in 2015. 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 16.3 to 43.1 cwt/acre with a mean of 29.7 cwt/acre. Variability was moderate (CV=10.9%) in this 3-rep experiment resulting in a LSD value of 4.4 cwt/acre needed for significance. Eighteen lines significantly outyielded the test mean and these are all new K16-lines and top entry K16980 exceeded the yield of the next entry by 3.4 cwt/a. Red Hawk, Snowdon and Beluga varieties dropped below the test mean. These results were encouraging as we now have a large group of new WK lines that may possess moderate levels of root rot and CBB resistance based on field ratings in 2016 that exhibit a range of maturities (93-104 d). Since canning quality is vital in kidney beans, only those WK lines equivalent to Beluga will be advanced in 2017.

#### **Expt. 6212: Preliminary Yellow Bean Yield Trial**

This small 10-entry trial was conducted on new ground at MRF to compare the performance of new yellow bean lines from MSU under supplemental irrigation (5x total 3.3”). These entries were all survivors of the severe root rot (*Fusarium solani* species complex, clade 2) disease pressure on MRF in 2015 and in general yellow beans showed higher level of root rot tolerance than kidney beans. The trial however was heavily infected with CBB which resulted in low yields. Yields ranged from 12.8 to 27.8 cwt/acre with a mean of 20.6 cwt/acre. Variability was high (CV=15.8%) in this 3-rep experiment resulting in a LSD value of 4.6 cwt/acre needed for significance. Only two lines significantly outyielded the test mean and these included the new Patron (DBY-28-1) variety and Y16503 from the MSU program. This is the first yellow bean test with new MSU lines that all carry I-gene resistance to BCMNV. These results are initial efforts to breed yellow beans and greater genetic variability is needed to advance this program. We are hopeful to obtain yellow bean

germplasm from East Africa to broaden the genetic base but most of these material including those from CSU are susceptible to BCMNV. The lines will be canned before being advanced in 2017.

### Expt. 6213: National White Mold Yield Trial

This 56-entry trial was conducted on new ground at MRF 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 5 times for a total of 3.3” to maintain adequate levels of moisture for favorable disease development at the critical flowering period. White mold infection did not develop in this trial due to lack of inoculum in the new ground despite the extra irrigation. The test ranged in yield from 6.5 to 41.6 cwt/acre with a mean yield of 28.6 cwt/acre. Variability was moderate (CV=10.8%), thus a high LSD value (4.2 cwt/acre) was needed for significance. As a result, 15 lines significantly out-yielded the test mean and included Viper, Zenith, Merlot, Zorro and Rosetta varieties and a large number of new B15-black bean lines including R12844 small red line. As in past years, the navy beans underperformed the black beans. Bunsu (resistant), Beryl (susceptible) and G122 (resistant) checks were among the lowest yielding entries similar to previous years. Yields of one pink bean line was also reduced due to poor stand and vigor similar to situation in 2015 and may be root rot susceptible. This trial will continue to be part of the breeding effort to improve tolerance to white mold in future varieties in 2017.

### Expt. 6214: White Mold x Fertility Trial

A small trial was conducted to see the interaction between N-fertility levels on the incidence of white mold in two contrasting bean cultivars, Zenith black and Viper small red. Both varieties have similar growth habits and maturities but differ in reaction to white mold. Zenith shows greater level of resistance to white mold. The trial was conducted adjacent to test 6213 and received the same irrigation amounts. Two N-treatments, 20 lbs/a and 80 lbs/a were applied to each variety using 6 replicates. Unfortunately, white mold did not develop in this trial, but the effect of N-treatments on both seed yield and seed size was quite dramatic. Seed yield was increased by over 8 cwt/a and seed size by 1.5 g at the 80 lb rate. The yield difference was highly significant and constant across varieties but Zenith outperformed Viper by 5.7 cwt/a at both treatments. Since the trial was on new ground, the soil may have lacked Rhizobium inoculum specific for beans and in general the McBride sandy loam soils at MRF are low in organic matter and require extra fertilization.

Variety	Yield cwt/acre			100 seed wt. g		
	20 lbs N	80 lbs N	Mean	20 lbs N	80 lbs N	Mean
<b>Zenith</b>	32.7	40.9	36.8	22.8	23.5	23.1
<b>Viper</b>	27.2	35.1	31.1	29.9	32.2	31.1
<b>Mean</b>	29.9	38.0	34.0	26.3	27.8	27.1
<b>LSD .05</b>			2.3			0.88
<b>CV%</b>			6.0			2.9

## **Early Generation Breeding Material grown in Michigan in 2016**

### **F3 through F5 lines**

Navy and Black - 988 lines  
Pinto - 32 lines  
GN - 21 lines  
Pinks and Reds – 39 lines  
Kidneys (DR, LR, White) - 97 lines  
Yellow - 35 lines

### **F2 populations**

Navy and Black -142 populations  
Pinto - 27 populations  
GN - 25 populations  
Pinks and Reds - 32 populations  
Kidneys (DR, LR, White) – 79 populations  
Yellow – 2 populations

**F1 populations:** 375 different crosses among ten contrasting seed types.