

2000 DRY BEAN YIELD TRIALS

J.D. Kelly, J. Taylor, N. Blakely, M. Ender and M. Frahm

Crop and Soil Sciences

Twenty-three yield trials were conducted in 2000 in Saginaw, Montcalm, Presque Isle, Delta and Huron counties in addition to 20 acres of early generation nurseries under development in 10 different market classes. At the Saginaw Bean & Sugarbeet Research Farm, 13 yield trials were planted on seven acres. These included five navy bean tests, a 56-entry standard test, two 64-entry preliminary tests, one 56-entry preliminary tests and a 56-entry recombinant inbred backcross population developed from Seafarer; a 30-entry standard black test, a 49-entry preliminary black bean test, and a 56-entry recombinant inbred backcross population developed from Tacana; two pinto bean trials included a 36-entry advanced trial, and a 42-entry preliminary test; two great northern bean trials included a 36-entry advanced test and a 42-entry preliminary test; a 30-entry red and pink bean test; a 20-entry standard vine cranberry test, and a 30-entry Midwest Performance Trial with pintos and great northern from Michigan, Nebraska, North Dakota, and Colorado.

At the Montcalm Research Farm, seven yield trials were planted on five acres. These included a 30-entry standard red and white kidney trial, a 36-entry preliminary red kidney trial, a 49-entry standard bush cranberry, a 20-entry preliminary yellow-eye test, and a 64-entry variety trial to evaluate reaction to white mold was grown under sprinkler irrigation. Three regional trials were conducted cooperatively with new navy, black, pinto, great northern and kidney bean varieties in Huron county (12-entry), and 16-entry trials in Presque Isle, and Delta counties.

The 2000 field season was highly variable due to extreme variations in precipitation depending on the location within the state. Plot yields on the research farm in Saginaw exceeded 43 cwt/acre and were high despite the extremely dry growing conditions in July. Prior to July 27 -31, when over 2.5" fell, only 0.44" had fallen in the previous 28 days that included an extended 11-day period without any rain. Early season materials that were setting pods during this period were the most affected, whereas full-season materials recovered and performed to near potential. Compared to the favorable 1999 season, yields were similar in these full-season materials, but not in early season materials. The upright indeterminate varieties continue to perform best under the variable weather conditions of Michigan. With the exception of some common bacterial blight and white mold in certain preliminary nurseries, diseases were not a serious problem in Saginaw in 2000.

In Montcalm, however, white mold seriously damaged all the nurseries. Top yields reached 26 cwt in one test but did not exceed 18 cwt in the standard test. Most noticeable were the range of low yields from 6 to 8 cwt in varieties that had the potential to triple those values in the absence of white mold. The level of disease incidence in the white mold trial averaged 98% indicating the severity of the disease. Yields in this trial exceeded 30 cwt/acre whereas other lines fell under 5 cwt/acre.

In the out-state trials the same two navy and great northern varieties topped the trials in the two Northern Michigan locations suggesting that growers should consider other market classes rather than the traditional

red kidney market class currently grown in the region.

The data for all tests are included in an attached section with procedures and details on nursery establishment 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 hundred weight per acre (cwt/acre) standardized to 18% moisture content.
2. Percent site mean is the percent above or below the mean value for the test, set at 100% of all entries in the trial.
3. Pounds per acre per day is a measure of yield efficiency where the actual yield per acre is divided by the number of days that particular variety required to mature.
4. Hundred seed weight is a measure of seed size, determined by weighing in grams a pre-counted sample of 100 seeds.
5. Days to flower is the number of days from planting to when 50% of plants in a plot have one or more open flowers.
6. Lodging is scored from 1 to 5 where 1 is erect while 5 is prostrate or 100% lodged.
7. Days to maturity is the actual number of days from planting until date when all the plants in a plot have reached harvest maturity.
8. Height is determined at physiological maturity, from soil surface to the top of plant canopy, and is recorded in cms.
9. Desirability score (DS) is a visual score given the plot at maturity that takes into consideration such plant traits as; height, lodging, pod load, pod to ground distance, uniformity of maturity, and disease, if any. The higher the score (from 1 to 9) 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 values refer to the Least Significant Difference between entries in a test at two levels of probability. 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 ($p=.05$), on the average, or once in 100 times ($p=.01$) 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 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. 0101: Standard Navy Bean Yield Trial

This 56-entry trial included standard commercial navy bean varieties, breeding lines entered through the Cooperative Dry Bean Nursery and advanced lines from the MSU breeding program which carry the N-prefix. Yields ranged from 22 to 38 cwt/acre with a mean of 30 cwt/acre. Despite the midseason drought, variability was well controlled ($CV < 10\%$) and the LSD needed for significance was 4 cwt/acre. Only three entries significantly out-yielded the test mean and these included the varieties, Newport, Mackinac and ISB 1256 navy, followed by the commercial varieties Schooner, Vista, Gryphon and Mayflower. The extended dry period in July resulted in lower yields among the earlier maturing lines, those maturing in 95 days or less. Early-season varieties like Avanti, Laser and AC Compass reflected this trend. Full-season materials recovered from the water stress and significantly outperformed the earlier entries.

Expt. 0106: Standard Black Bean Yield Trial

This 30-entry trial included the standard commercial black bean varieties including advanced breeding lines with resistant to race 73 of anthracnose, to which all current commercial varieties are susceptible. Yields ranged from 22 to 40 cwt/acre with a mean for the test of 33 cwt/acre. Variability was well controlled in this test, ($CV = 5.5\%$) and the LSD was 2.5 cwt/acre. Four lines were significantly higher yielding than the test mean. For the second year, B98304 derived from a cross of Vista with black bean breeding line B98102 topped the trial. This cross appears to offer considerable yield potential as other sibs were among in the top ten lines. Among the top ten were the new varieties Jaguar and Phantom and the checks, T-39, Black Jack and Midnight. Tacana from Mexico which performed well in 1999 was above the test mean but not significantly different. B98306 derived from Crestwood navy bean, continues to show considerable promise. It exhibited excellent dry-down combined with early maturity and a different architectural structure, that may offer avoidance to white mold. B98306 yielded 34 cwt/acre and was lower yielding in 2000 because all early-maturing lines were reduced by the prolonged dry period in July. The drought tolerant line B98311 was among the ten top yielding lines along with a line from USDA-WA, WN9908-972 that was also among the top ten in 1999.

Expt. 0109: Standard Pinto Bean Yield Trial

This 36-entry trial included standard commercial pinto bean varieties, breeding lines entered through the Cooperative Dry Bean Nursery and advanced lines from the MSU breeding program which carry the P-prefix. The trial ranged in yield from 24 to 35 cwt/acre with a mean of 28 cwt/acre. Variability was well controlled ($CV < 9\%$) and the LSD needed for significance was 3.3 cwt/acre. Yields were lower than in the black and navy beans since many of the entries matured earlier and were effected by the drought in July. Five entries significantly out-yielded the test mean and these included type-III varieties Mesa, Montrose, and UI94:1009 and two type-II lines P99139, and P99121 from MSU. Many of the current commercial varieties Maverick, Buster, Burke, Poncho, and Kodiak fell in the middle of the pack as in past years, whereas Elizabeth, Buckskin and Pintoba were among the lowest yielding. Progeny with Matterhorn which performed well in 1999 were lower yielding due to the water-stress conditions in 2000.

Expt. 0111: Standard Great Northern Bean Yield Trial

This 36-entry trial included MSU great northern breeding lines and standard commercial check varieties and breeding lines entered as part of the Cooperative Dry Bean Nursery. The test ranged in yield from 21 to 35 cwt/acre with a mean yield of 31 cwt/acre. Variability was well controlled (CV= 7.4%) resulting in a modest LSD value (3.2 cwt/acre) for significance. Three breeding lines significantly outperformed the test mean but not the check variety Matterhorn. Many of the lines, however, are derived from Matterhorn and do not appear to offer significantly improved potential for yield over the G93414 parent. G99750 with a DS=6, had the largest seed size (45g/100seeds) and yielded with Matterhorn which produced only 32 cwt/acre due in part its early maturity. Matterhorn significantly out-yielded the new varieties, Weihing from Nebraska, 9S:207G from Idaho and Crocus an early variety from Saskatchewan.

Expt. 0114: Standard Pink and Small Red Bean Yield Trial

This 30-entry trial included small red and pink breeding lines from the USDA program at MSU (USDA-MI), new pink lines from MSU, standard commercial check varieties and breeding lines entered as part of the Cooperative Dry Bean Nursery and small reds known as Honduran small reds (VIDAC) from Central America. The test ranged in yield from 17 to 30 cwt/acre with a mean yield of 24 cwt/acre. Variability was moderate (CV=7.7%) resulting in a LSD value (2.9 cwt/acre) for significance. Eight lines significantly outperformed the test mean and no line was significantly higher than the check variety. Similar to 1999, the highest yielding variety was Brooks-18 small red developed by Dr. Adams, followed by R97022 and Viva pink. Three other small reds from USDA-MI were among the top eight and two of these line R98026, and R98016 were among the top yielders in 1999. R98026 yielded well in spite of heavy common blight infection in 1999. Both R97022 and R98026 were among the top ten lines in an 90-entry trial conducted in Saginaw by Hosfield et al. (2000; reported herein). One new pink line S00809 was included in the same group along with a small red from USWA program. The VIDAC lines from CA grouped near the bottom of the trial suggesting they lack yield potential for production in temperate regions. Seed size in this group ranged from 22 to 28 g/100seeds illustrating the difference in seed characteristics from the small red market class grown in the U.S.

Expt. 0215: Standard Kidney Bean Yield Trial

This 30-entry trial was conducted on the Montcalm Research Farm to compare the performance of standard and new light red kidney (LRK), dark red kidney (DRK) and white kidney (WK) bean varieties under supplemental irrigation. Variability was very high at this location due to the severe white mold pressure (CV>28%) resulting in a large LSD value (4.3 cwt/acre) needed for significance. White mold was rated on a 1 to 9 scale (<10%>90%). The mean score for the test was 8.6 and only two lines K99976 and AC Calmont had values under 8. Yields were lower than those in Saginaw due to the white mold and ranged from 6 to 18 cwt/acre with a mean of 11 cwt/acre. Three lines significantly out-yielded the test mean and these included Sacramento LRK variety, and two white kidney lines one from MSU and WK380 from ASI. Interestingly, Sacramento outperformed CELRK by 8 cwt/acre. Among the standard varieties that produced less than 10 cwt/acre were Isles, Chinook 2000, Redkanner, Cabernet, Drake, and Beluga.

Expt. 0217: Standard Bush Cranberry Bean Yield Trial

This 49-entry trial illustrates the continued problem of developing an improved bush cranberry bean variety as none of the entries significantly exceeded the yield of the Taylor Hort check variety, despite the high white mold pressure in 2000. Yields ranged from 7 to 25 cwt/acre with a mean of 17 cwt/acre. Variability was high ($CV > 18\%$) in this test due to severe white mold infection and the LSD needed for significance was 4.4 cwt/acre. Nine lines including Taylor Hort significantly outyielded the test mean. The top yielding entry 92-198-08 from NDSU had the lowest white mold score of the test. Among the top nine lines were entries from USDA-WA program. Some of these lines exhibited desirable large sized seed with values approaching 60g/100seeds compared to T. Hort (55g). The lowest yielding entry was Hooter (7 cwt/acre) due to its high level of susceptibility to white mold which is also reflected in its unusual small-sized seed.

Expt. 0118: Standard Vine Cranberry Bean Yield Trial

This 20-entry trial was grown in Saginaw to identify those lines with improved performance over the check, Michigan Improved Vine Cranberry (MIC). Yields ranged from 17 to 28 cwt/acre with a mean of 23 cwt/acre. Variability was acceptable in this test ($CV = 10\%$) and LSD value of 3.3 cwt/acre was needed for significance. As in 1999, only one line C97537 significantly outyielded the test mean, and the check, MIC. Seed size of C97537 may be too small (52g/100seeds) for the trade. C96416, however, continues to perform equivalent to MIC for the fifth year. In 1997, C96416 significantly out-yielded MIC, and has been equivalent in yield in 1996, 1998, 1999, and 2000. The latter has a more desirable larger seed than MIC. Many of the lines yielded equivalent to MIC but have a significantly larger seed size exceeding 60g/100seeds in many instances. All of these lines have canned equivalent or better than the check. Interest in this seed type is high since large seed size combined with excellent canning quality would serve a dual purpose for both the canning and dry pack markets. None of the more recent entries with the C99-prefix met the yield expectations for this class.

Expt. 0222: White Mold Variety Yield Trial, Montcalm county

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 field conditions. The test ranged in yield from 3 to 33 cwt/acre with a mean yield of 16 cwt/acre. As expected, variability was difficult to control due to the white mold ($CV > 22\%$), resulting in a high LSD value (5.8 cwt/acre) for significance. Genotypes included commercial navy and black bean cultivars, parents and lines from two recombinant inbred line populations, elite MSU lines, and new sources of white mold resistance entered as part of the National Sclerotinia Bean Trial. Those lines were developed at the Tropical Agriculture Research Station (TARS) located in Puerto Rico, at Ag Canada, and at the Universities of Guelph, Nebraska, OSU and NDSU. Entries were planted in two row plots with two rows of Midland (susceptible spreader) between plots. Supplemental overhead irrigation was used to maintain adequate levels of moisture for favorable disease development at the critical flowering period. Natural white mold infection occurred across the entire trial and was extremely severe. A sample of 20 plants from the westside row (due to 2" rain in 30 minutes which flattened the plot and destroyed the eastside row which lay in contact with the susceptible spreader) in each plot and replication was rated for disease incidence (% infected among 20 plants sampled) and percent disease severity at harvest maturity using the same 20 plant sample. In addition a visual white mold score was rated on a 1 to 9 scale for each plot and it correlated well with DSI. Disease incidence ranged from 78 to 100% ($CV = 4.7\%$) whereas disease severity ranged from 54 to 97% ($CV = 8.9\%$). Despite the high disease

pressure, 13 lines significantly out yielded the test mean. These included Laser and Montcalm but more importantly pinto, GN, black and navy lines were identified that produced despite high levels of white mold infection. As in 1999, navy line N97774, developed from the cross of Bunsu/Huron designed to combine different resistance mechanisms, outperformed either parent in yield under heavy white mold pressure. Lines, N00901 and N00902 from the genetic mapping populations performed as expected in regard to their reaction to white mold. The most striking surprise was the top yielding entry G99750 which produced over 32 cwt/acre whereas, Matterhorn parent produced only 11 cwt/acre. As expected the early season black line B98306, developed from Crestwood, produced a respectable 25 cwt/acre. Two other navy line N99250 and N99219 had lower DSI values and had high DS scores indicating their yield potential despite the heavy white mold pressure. Breeding line, MO 162 may have resistance not avoidance, so combining resistance with avoidance may prove to be a valuable strategy in future white mold resistance breeding. Other observations: the type III black bean V8025 from Mexico appears to have mold tolerance; G122 reported to have resistance was susceptible; PC 50 reported to possess tolerance showed lower levels of incidence and severity but it will not be a useful parent due to its low yield; whereas CH-428-4D from Australia, previously reported to be resistance showed neither resistance or yield potential. Another interesting observation was among the lowest yielding entries in the trial. These included varieties and lines such as Newport with recorded high levels of susceptibility to white mold and another line like B7354 with high levels of resistance that appear to avoid disease due to tiny plant structure. Overall the trial confirmed results from previous years and this trial will continue to be a vital part of the breeding effort to improve tolerance to white mold in dry beans.

Expt. 0227: Preliminary Yellow-eye Bean Yield Trial

This 20-entry trial was planted in Montcalm to identify new yellow-eye breeding lines with improved yield performance and adaptation over Steuben yellow-eye check. The lines in this test were bred to carry the bc-3 gene for resistance to mosaic virus to which Steuben is highly susceptible. Since the lines were developed through backcrossing they resemble Steuben, the recurrent parent in appearance, agronomic traits and adaptation. All the lines are later-maturing, with a viny (type III) growth habit similar to Steuben. Due to late maturity of some entries and the severe infection with white mold only nine lines were harvested. Yields ranged from 19 to 26 cwt/acre with a mean of 22 cwt/acre. Variability was high in this test due to white mold (CV>13%) and a high LSD value of 4.9 cwt/acre was needed for significance. As a result no lines significantly out-yielded the test mean or the check variety. One entry Y00115 did produce 4 cwt/acre more than the check, and had the highest DS score of any entry in the test, otherwise it exhibited similar agronomic and maturity traits. The best lines will continue to be re-evaluated in 2001.