

1999 DRY BEAN YIELD TRIALS

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Twenty-three yield trials were conducted in 1999 at Saginaw (seven acres), Montcalm, Presque Isle, Delta and Huron counties in addition to 20 acres of early generation nurseries under development in 10 different market classes. In Saginaw, three navy bean yield trials included a 36-entry standard test, and a 64-entry preliminary test, a 100-entry recombinant inbred backcross population developed from Seafarer, a 30-entry standard black test and a 49-entry preliminary black bean test, two pinto bean trials included a 30-entry advanced trial, and a 49-entry preliminary test and two great northern bean trials included a 36-entry advanced test and a 56-entry preliminary test. A 25-entry Midwest Performance Trial with pintos and great northern beans from Nebraska, N. Dakota, Colorado and a 25-entry small red trial for Washington and Idaho was planted. A standard 16-entry and a 25-entry preliminary vine cranberry trial were planted to identify lines with potential grown under rainfed conditions on fine textured lake-bed soils in Saginaw.

At the Montcalm Research Farm, seven yield trials were planted on eight acres. These included a 30-entry standard red and white kidney trial, a preliminary 42-entry red kidney trial, a 30-entry standard bush cranberry and a 36-entry preliminary bush cranberry test, two 81-entry kidney canning tests were planted in collaboration with NDSU, 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 1999 field season was among the best in recent history and bean yields were exceptional exceeding 21 cwt/acre statewide. Plot yields on the research farm exceeded 45 cwt/acre using standard management techniques without the benefit of irrigation. Compared to the 1998 season, yields increased 150%. The environmental factor(s) most critical in determining yield potential in 1999 were the timely well-distributed rainfall and the moderate temperatures during the season. Michigan approached an optimum rainfall in terms of amount and distribution for beans in 1999. Interestingly, the rainfall recorded at the Farm over the three summer months was very similar to the long term 26-year average, but the distribution pattern was different. Rainfall during the critical flowering and early pod fill in July, exceeded the norm by over 2". This coupled with moderate temperatures produced a bean crop with record yields. New genotypes clearly responded to the favorable weather and had the genetic potential to exploit those conditions. This is best illustrated by a difference of 10 cwt/acre in yield that was observed between current varieties and the old Seafarer variety grown on the Farm. The upright indeterminate varieties appear best adapted to the weather conditions of Michigan. The breeding potential of all new varieties was attained in 1999, whereas yield is lost to many negative factors such as biological and physical stresses in other years. The crop matured a little too fast complicating harvest as humidity was too low on certain days in September to permit bean pulling. An additional inch of rainfall in September would have helped prevent losses due to shattering and lessen mechanical damage. With the exception of common bacterial blight in certain preliminary nurseries, diseases were not a problem in 1999. The long-term selection for performance in the MSU bean breeding program clearly paid dividends in 1999.

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. 9101: Standard Navy Bean Yield Trial

This 36-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 N97 or N98 prefix. Yields ranged from 27 to 45.6 cwt/acre with a mean of 38 cwt/acre. Due to the high productivity, variability was well controlled ($CV < 8\%$) and the LSD needed for significance was under 4 cwt/acre. Only three entries significantly out-yielded the test mean and these included the varieties, Schooner, Vista and N97774. N97774, derived from the cross Bunsu/Huron, was bred for improved levels of tolerance to white mold and appears to also exhibit improved yield potential. Other lines that performed well were N98120, N98111, N98104 and the new variety, Commander

from North Dakota. The test permitted a clear separation between those lines with yield potential under ideal conditions and those lacking the same.

Expt. 9103: 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 28 to 43 cwt/acre with a mean for the test of 37 cwt/acre. Variability was well controlled in this test, ($CV < 7\%$) and the LSD was 3.5 cwt/acre. Four lines were significantly higher yielding than the test mean. These included a new line B98304 derived from a cross of Vista with black bean breeding line B98102. This cross appears to offer considerable yield potential as five out of the top seven entries in this trial possessed this pedigree. The second top yielding line was B95556, which significantly out-yielded the check variety, T-39. B95556 was just released as Jaguar and it appears to be highly adapted to narrow row production. Although second in this trial (by only 0.2 cwt/acre), B95556 has topped the standard black bean trial for the last three years. Jaguar will be recommended for narrow row bean production over T-39 and the other new release Phantom which appears better suited to wider (>20 "inch) row production. Among the top three yielding entries, B98306 derived from Crestwood navy bean, showed considerable promise. It exhibited excellent dry-down combined with early maturity (90 day) and a different architectural structure, that may offer avoidance to white mold. Commercial varieties such as T-39, Midnight, Blackknight, Blackhawk, Onyx, and Raven grouped in the middle of the test whereas Black Jack yielded 6 cwt/acre less than the test mean and 12 cwt/acre less than Jaguar. New varieties such as Phantom and Jaguar carry more resistance to anthracnose than other commercial varieties.

Expt. 9105: Standard Pinto Bean Yield Trial

This 30-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 P94, P95, P96 and P97 prefixes. The trial ranged in yield from 25.7 to 40.5 cwt/acre with a mean of 34 cwt/acre. Variability was well controlled ($CV < 10\%$) and the LSD needed for significance was 4.7 cwt/acre. Four entries significantly out-yielded the test mean and these included varieties Mesa, Kodiak, Buster and P98511, a sib of Kodiak. The test presented no great surprises among the common varieties and no new breeding lines showed potential over the checks. Many of the current commercial varieties Frontier, Poncho Aztec, Maverick, and Burke fell in the middle of the pack.

Expt. 9107: 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 30 to 41 cwt/acre with a mean yield of 37 cwt/acre. Variability was well controlled ($CV = 7.4\%$) resulting in a modest LSD value (3.9 cwt/acre) for significance. No breeding lines significantly outperformed the test mean or 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. Matterhorn was the earliest maturing line among the ten highest-yielding lines. Matterhorn significantly out-yielded the new varieties, Weihing from Nebraska and UI 465 from the University of Idaho but it did not significantly out-yield the check variety, US 1140.

Expt. 9110: Standard Small Red and Pink Bean Trial

This 25-entry trial included small red and pink breeding lines from the USDA program at MSU and standard commercial check varieties and breeding lines entered as part of the Cooperative Dry Bean Nursery. The test ranged

in yield from 18 to 31 cwt/acre with a mean yield of 24 cwt/acre. Variability was high ($CV > 15\%$) resulting in a large LSD value (5.4 cwt/acre) for significance. Only one line R97022 significantly outperformed the test mean. The highest yielding variety was Brooks 18 small red developed by Dr. Adams, followed by Viva pink. Other checks included NW 63, and UI 257 small red varieties and a new pink line L94C356 from AgCanada, Alberta. Overall yield potential in this test was low, due to the high incidence of common blight.

Expt. 9211: 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 is generally higher at this location, but was acceptable ($CV > 11\%$) and the large LSD value (5.2 cwt/acre) needed for significance, was due to the high average yields. Yields were equivalent to those in Saginaw and ranged from 20 to 44 cwt/acre with a mean of 32 cwt/acre. Seven lines significantly out-yielded the test mean and these included the new LRK variety, Chardonnay, followed by DRK variety Red Hawk from MSU. Among the standard varieties were Isles, Montcalm, Chinook 2000, Redkanner, Lassen, Drake, and Beluga which fell in the middle of the test. Most of the potential new breeding lines fell in the lower half of the test indicating problems with disease and an overall lack of yield potential.

Expt. 9215: Standard Bush Cranberry Bean Yield Trial

This 30-entry trial illustrated the continued problem of developing an improved bush cranberry bean variety as none of the entries significantly exceeded the yield of the Taylor Hort or Cardinal check varieties. Yields ranged from 20 to 37 cwt/acre with a mean of 32 cwt/acre. Despite the usual higher variability at this location, variability was well controlled ($CV > 11\%$) in this test and the LSD needed for significance was 5 cwt/acre. Only Taylor Hort significantly outyielded the test mean. Among those lines with yields not significantly different than Taylor Hort (> 32 cwt/acre) were the new MSU line C97407, and a number of lines from USDA-WA program. Other entries, such as Cran 09 and G122 from previous testing years, did not meet the yield expectations of this class. The latter line, touted for its resistance to white mold and root rot, yielded 17 cwt/acre less than Taylor Hort check.

Expt. 9117: Standard Vine Cranberry Bean Yield Trial

This 16-entry trial was planted in Saginaw to identify those lines with improved performance over Michigan Improved Vine Cranberry (MIC). Yields ranged from 15 to 26 cwt/acre with a mean of 21 cwt/acre. Variability was not well controlled in this test ($CV > 14\%$) and LSD value of 4.2 cwt/acre was needed for significance. Seed shattering continued to be a major problem in this test and that is reflected in the low yield data for certain entries and the high overall variability. Only one line, C97537 significantly outyielded the test mean, and there was no significant yield increase over the check, MIC. C96416, however, continues to perform equivalent with MIC for the fourth year. In 1997, C96416 significantly out-yielded MIC, and has been equivalent in yield in 1996, 1998, and 1999. The latter has a more desirable larger seed than MIC. Lines maintained in the program since 1996 have acquired a level of seed borne common blight that could be negatively affecting their continued performance. 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.

Expt. 9223: 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 17 to 44 cwt/acre with a mean yield

of 35 cwt/acre. As expected, variability was difficult to control due to the white mold ($CV > 12\%$), resulting in a high LSD value (6.9 cwt/acre) for significance. Genotypes included commercial navy and black bean cultivars, parents and lines from two recombinant inbred line (RIL) populations, elite MSU lines, and new sources of white mold resistance developed at the Tropical Agriculture Research Station (TARS) located in Puerto Rico, at Ag Canada, and at the Universities of Guelph, Nebraska, 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 a sample of 30 plants per plot per replication was rated for disease incidence (% infected among 30 plants sampled) and percent disease severity at harvest maturity using the same 30 plant sample. Disease incidence ranged from 6 to 88% ($CV > 49\%$) whereas disease severity ranged from 2 to 63% ($CV > 58\%$). Despite the high CV, four lines significantly outyielded the test mean. These included Kodiak, Laser, Phantom, and a resistant line from RIL mapping population. AC Compass which topped the same trial in 1998 was fifth in this test. Lines such as N97774, developed from the cross of Bunsu/Huron and designed to combine different resistance mechanisms, outperformed either parent in yield and incidence of white mold. Lines from the genetic mapping populations performed as expected in regard to their reaction to white mold. The most striking contrast was the two top yielding entries, Kodiak and Laser in the trial. Both yielded approximately 44 cwt/acre, yet Kodiak had a disease incidence of 54%, whereas Laser had a value of 6%. This stark contrast suggests that Kodiak yields despite high white mold pressure, whereas Laser appears to have architectural avoidance. In the absence of white mold, Kodiak would be the highest yielding variety whereas the yield potential of Laser may be compromised by its porous canopy and fewer nodes sites at which to set pods. For example, the variety Matterhorn produced 40 cwt/acre despite a white mold incidence of 68%. Combining tolerance with avoidance may prove to be a valuable strategy in future white mold resistance breeding. 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 other lines with high levels of resistance. Two entries G122 and PC 50 previously reported to possess tolerance to white mold showed low levels of incidence and severity. However, both lines were disappointing in yield and PC 50 did not mature in Michigan in 1999 despite overall favorable growing conditions. Overall the trial confirmed results from previous years and experiments and will continue to be a vital part of the breeding effort to improve tolerance to white mold in dry beans.