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Performance of Dry Beans Grown on the Coastal Plains of Puerto Rico[1]

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ABSTRACT

Performance of a group of white-seeded and a group of colored dry bean (*Phaseolus vulgaris* L.) genotypes was measured at the Fortuna and Isabela Research and Development Centers during 1979 to 1982. White-seeded lines W-117, W-142, and 2W-33-2 produced seed yields as great as or greater than the mean of the tests. Compared with the standard white-seeded line Bonita, W-117, W-142 and 2W-33-2 showed more resistance to the systemic mosaic strain of the Bean Common Mosaic Virus and rust (*Uromyces phaseoli* (Reben) Wint.). Violeta and Galana were among the most productive colored genotypes. Unfortunately, the seed coat color of these genotypes is unacceptable to the local consumer. Among the colored genotypes with a desirable seed type, Guayamera showed the most promising performance. Several of the colored seeded lines expressed resistance to the races of rust endemic at Isabela. On the other hand, the colored lines were generally more susceptible to bacterial blight than the white-seeded lines. Genotypes with the most promising performance will be considered for release as replacements for standard cultivars or will be utilized as parents in the local bean breeding program.

INTRODUCTION

Although dry beans (*Phaseolus vulgaris* L.) are an important part of the diet in Puerto Rico, only a small portion of the beans consumed in Puerto Rico are produced in the island. Each year Puerto Rico spends more than $10 million importing dry beans (1, 6).

In Latin America, dry beans generally are produced on small farms with low levels of purchased inputs (5). As a result, dry beans have gained the perhaps unjusitified reputation of being a crop for environments of marginal productivity. Nevertheless, some dry bean genotypes are capable of performing well when grown in higher yielding environments (7).

If the commercial production of dry beans is to become a viable option for farmers in Puerto Rico, it will be necessary to identify disease resistant dry bean cultivars with the capacity to produce high yields in favorable environments. Therefore, the objective of this research was to

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test local and introduced dry bean genotypes in Puerto Rico in an attempt to identify dry bean genotypes with superior performance.

MATERIALS AND METHODS

The experiments were conducted at the Centers of Research and Development at Isabela and Fortuna, Puerto Rico from 1979 to 1982. The soil in Isabela is a Coto clay (clayey, kaolinitic, isohyperthermic Tropeptic Eutrustox), whereas the soil at Fortuna is a Fraternidad clay (very fine, montmorillonitic, isophyperthermic Udic Chromustert).

Two sets of yield trials were conducted at each location. One set contained a group of white-seeded dry bean genotypes. The other set of trials included a group of large-seeded genotypes with seed coat colors other than white. Yield plots consisted of four rows, 4 m long with 60 cm between rows. The seeding rate was approximately 555,000 seeds/ha. All experiments were planted during the first 2 weeks of December. A pre-emergent herbicide, Decthal 75 W[3], was applied at a rate of 12 kg of commercial product per ha. Shortly after emergence, the plants received a side-dress application of granular fertilizer (10-10-10) at a rate of 1121 kg/ha. The plants were irrigated when necessary to avoid moisture stress. Insect pests and fungal diseases were controlled by spraying a mixture of Diazinon AG 400 (1.2 1/ha) and Dithane M-45 (2.25 kg/ha) on a bi-weekly basis. All the plants in the plot were harvested to estimate seed yield during 1979, 1980 and 1981. However, in 1982 seed yield estimates were obtained by harvesting 3 m lengths of the two center rows of the four row plots.

Fungicide was not applied in 1982 in order to rate the bean genotypes for field reaction to rust (*Uromyces phaseoli* (Reben) Wint.). Rust pustule size was rated on a scale from 1 to 5 with 1 having no evidence of infection with rust and 5 having pustule diameter greater than 800 μm. Percentage of leaf area infected with rust also was estimated. Bacterial blight also was rated in 1982 with a scale from 1 to 5, with 1 having no presence of infection and 5 having the canopy completely destroyed by bacterial blight. Certain agronomic traits also were measured in 1982. Plant height was measured as the distance from the base of the stem to the point of attachment of the highest pod. Lodging was rated on a scale from 1 to 5 with 1 having all plants erect and 5 having all plants prostrate.

The number of genotypes in the test varied from year to year. As a result, a separate analysis of variance was conducted for each year. The experimental design during 1979, 1980, and 1981 was a balanced incom-

[3] Trade names in this publication are used only to provide specific information. Mention of a trade name does not constitute a warranty of equipment or materials by the Agricultural Experiment Station of the University of Puerto Rico, nor is this mention a statement of preference over other equipment or materials.

plete block with three replications per genotype. In 1982 the design was a randomized complete block with three replications per genotype. Means were compared with Fisher's protected L.S.D. (2).

RESULTS AND DISCUSSION

Mean seed yields of the white-seeded genotypes at Isabela ranged from 795 kg/ha in 1982 to 1814 kg/ha in 1980 (table 1). Although none of the genotypes were identified as having a consistently superior performance, it should be noted that genotypes W-117 and W-142 were among the three highest yielding genotypes in 1979 and 1981. Lines L-698 and 2W-33-2 produced seed yields significantly higher than the other lines in 1982. Bonita is the white-seeded cultivar most widely grown in Puerto Rico. Bonita has shown remarkable durability having been released as a cultivar almost 40 years ago (3, 4). Although the seed type is uniform,

TABLE 1.—*Mean seed yield of white-seeded beans grown at Isabela, Puerto Rico*

Genotype	Seed yield (kg/ha)			
	1979	1980	1981	1982
W-117	1776	1843	1297	717
W-142	1637	1285	1279	693
Bonita	1979	—	—	—
Bonita 4	—	1928	1266	779
Bonita 7	—	1864	1252	753
Bonita 8	—	1710	1394	750
Cuarentena	1469	2146	1240	830
Abrams Africa	—	1924	1266	561
L-698	—	—	—	1138
L-599	—	—	—	609
L-793	—	—	—	809
2W-33-2	—	—	—	1108
Mean	1715	1814	1285	795
L.S.D. (0.05)	403	291	185	231

observation of Bonita in the field indicated that it was heterogeneous for agronomic and, perhaps, disease resistance characteristics. As a result, several selections were made from Bonita. Three of these selections (Bonita 4, Bonita 7, and Bonita 8) were tested in 1980, 1981 and 1982. Seed yields of the three selections did not differ significantly. Cuarentena is another white-seeded cultivar grown in Puerto Rico. In spite of the fact that Cuarentena is at least 2 weeks earlier than the other genotypes in the test, it ranked as one of the four highest yielding genotypes in 1979, 1980 and 1982.

Mean seed yields of the white-seeded genotypes at Fortuna ranged from 1395 kg/ha in 1981 to 1897 kg/ha in 1980 (table 2). Genotype W-142 produced the highest seed yields during the 3 years of the test.

TABLE 2.—*Mean seed yield of white seeded beans grown at Fortuna, Puerto Rico*

Genotype	Seed yield (kg/ha)		
	1979	1980	1981
W-117	1729	1843	1321
W-142	2422	2185	1494
Bonita	1499	—	—
Bonita 4	—	1928	1344
Bonita 7	—	1567	1321
Bonita 8	—	1710	1403
Cuarentena	—	2146	1374
Abrams Africa	—	—	1437
Mean	1883	1897	1385
L.S.D. (0.05)	NS[1]	260	284

[1] Not calculated because the *F* test for treatments was nonsignificant.

TABLE 3.—*Agronomic traits and disease reactions of 11 white-seeded lines grown at Isabela, Puerto Rico between December 1981 and March 1982*

Entry	Agronomic characteristics			Disease reactions		
	Plant height	Lodging[1] score	Final stand	Rust[2] (pustule size)	Rust infection	Bacterial[3] blight score
	cm		*no./plants/plot*		%	
Bonita 4	20.7	2.2	77.3	5.0	33	3.7
Bonita 7	20.7	1.2	66.0	5.0	20	2.7
Bonita 8	20.0	2.0	50.3	5.0	18	3.0
Cuarentena	20.3	1.3	70.0	5.0	27	3.3
Abrams Africa	19.7	1.3	79.0	5.0	37	2.3
W-117	22.3	2.0	74.0	4.3	10	2.3
W-142	21.7	1.7	41.7	4.7	8	2.0
L-698	25.3	1.4	73.0	5.0	9	1.7
L-699	26.3	1.6	75.0	5.0	24	2.7
2W-33-2	20.0	1.8	76.5	2.0	5	3.0
Mean	21.8	1.6	68.7	4.6	19	2.7
L.S.D. (0.05)	3.4	0.5	20.0	N.S.	11	1.1

[1] Rated on a scale from 1 to 5 with 1 having all plants erect and 5 having all plants prostrate.

[2] Rated on a scale from 1 to 5 with 1 having no evidence of infection with rust and 5 having pustules with diameters greater than 800 μm.

[3] Rated on a scale from 1 to 5 with 1 having no presence of infection with bacterial blight and 5 having the canopy completely destroyed by bacterial blight.

Cuarentena and W-117 were among the four highest yielding genotypes in 2 of the 3 years of the test.

Table 3 shows agronomic characteristics and disease reactions for 1982. Growing conditions were unfavorable in 1982 because water for irrigation was scarce. As a result, plants were short, averaging between 20 and 25 cm, and there was little or no lodging. The final stand of W-

142 was significantly less than the mean of the experiment. The low plant density of W-142 might explain the relatively poor performance of this line in 1982. Although all of the lines expressed susceptibility to rust, 2W-33-2 had a smaller pustule size and less percent infection than most lines in the test. Lines L-698 and W-142 developed the least amount of bacterial blight.

TABLE 4.—*Seed type and mean seed yields of colored beans grown at Isabela, Puerto Rico*

Genotype	Seed type	Seed yield (kg/ha)			
		1979	1980	1981	1982
Naranjito	Red with brown flecks	1330	1264	1288	1165
Galana	Cream with black stripes	1701	1584	1395	1188
Borinquen	Red, w/brown flecks	830	1486	1303	1105
R51BKA	Red, w/brown flecks	766	1663	1037	—
Calima	Red, mottled	1517	1397	1559	—
Rosita Lajas	Red, mottled	1440	1761	1247	760
Oro Rico	Brown	1828	1773	1180	901
Guayamera	Red w/brown flecks	1066	1572	1482	1180
Violeta	Purple	1445	1689	1223	1183
Dominican #5	Red, mottled	—	1599	1198	1233
Pompadour Dominicana	Red, mottled	—	1544	1363	1251
Selección Pompadour	Red, mottled	—	1371	1229	1287
BMS	Red w/brown flecks	—	1651	1370	1078
Colombia #7	Red	—	1642	995	—
Colombia 91P	Red, mottled	—	1439	1424	1161
Abrams Africa #7	Cream w/purple flecks	—	1826	1183	1157
Abrams Africa #10	Cream w/purple flecks	—	1684	999	1217
B-190	Black	—	—	—	1077
La Vega	Black	—	—	—	1200
Mean		1325	1585	1263	1133
L.S.D. (0.05)		403	398	181	227

Mean seed yields of the colored beans at Isabela ranged from 1133 kg/ha in 1982 to 1585 kg/ha in 1980 (table 4). Violeta yielded as much as the best line in the test during 3 of the 4 years of trials. Both Naranjito and Guayamera, which have seed types preferred by the Puerto Rican consumer, produced seed yields similar to the mean of the experiment during the 4 years of testing.

Mean colored bean seed yields at Fortuna ranged from 1346 kg/ha in 1981 to 2193 kg/ha in 1979 (table 5). Violeta, Calima, Borinquen, Guayamera, and Galana produced seed yields which ranked in the top five during 2 of the 3 years of trials. Table 5 also shows agronomic characteristics and disease reactions for 1982. Plants were from 16.5 to 26.8 cm tall. Nevertheless, a few of the lines, such as Galana, 4M-99, and Abrams Africa #10 expressed moderate levels of lodging. Final stand did not differ among the genotypes. Several lines expressed a good level of resistance to the races of rust endemic at Isabela in 1982. The colored seeded lines developed more bacterial blight than the white-seeded lines. Line 4M-99 had less bacterial blight at the time the readings were made.

TABLE 5.—*Mean seed yields of colored beans grown at Fortuna, Puerto Rico*

Genotype	Seed yield (kg/ha)		
	1979	1980	1981
Naranjito	2343	1563	1232
Galana	2419	1901	1148
Borinquen	2036	1928	1541
R51BKA	2511	1187	1159
Calima	2509	1784	1435
Rosita Lajas	2128	1596	1321
Oro Rico	2018	1533	1287
Guayamera	1649	2019	1725
Violeta	2128	2052	1155
Dominican #5	—	1727	1340
Pompadour Dominicana	—	1648	1514
Selección Pompadour	—	1733	1701
BMS	—	—	1372
Colombia #7	—	1515	—
Colombia 91P	—	1771	1440
Abrams Africa #7	—	1770	1186
Abrams Africa #10	—	936	982
Mean	2193	1667	1346
L.S.D. (0.05)	N.S.[1]	389	347

[1] Not calculated because the *F* test for treatments was nonsignificant.

However, the low bacterial blight reading of 4M-99 might be related to the fact that it is at least 2 weeks later in maturity than most lines in the test.

Results from these trials provide a base of information from which promising white and colored bean lines can be identified. White-seeded lines such as W-142, W-117, 2W-33-2, and L-698 have been found to yield as much as or more than the standard white-seeded cultivar Bonita. Moreover, these lines tend to possess more desirable agronomic traits and express more resistance to rust and/or bacterial blight than Bonita. Unlike the standard cultivar Bonita, lines W-117, W-142 and 2W-33-2

are resistant to the systemic mosaic strain of the Bean Common Mosaic Virus.[4] These lines will continue to be tested in Puerto Rico. The line determined to possess the best overall performance will be considered for release as a replacement for Bonita. All four lines have been utilized as parents in a breeding program designed to develop white-seeded bean cultivars for Puerto Rico.

TABLE 6.—*Agronomic characteristics and disease reactions of 17 colored-seeded lines grown at Isabela, Puerto Rico between December 1981 and March 1982*

Entry	Agronomic characteristics			Disease reactions		
	Plant height	Lodging[1] score	Final stand	Rust[2] (pustule size)	Rust infection	Bacterial[3] blight score
	cm		*no./plants/plot*		%	
Dominican #5	19.8	1.5	77.0	1.0	0	2.3
Naranjito	18.0	1.1	70.0	1.0	0	3.3
Pompadour Dominicana	23.3	1.9	75.3	1.3	3	3.3
Galana	21.3	2.8	81.3	2.3	7	3.0
BMS	19.8	1.9	74.8	2.3	5	3.0
Selección Pompadour	23.0	1.8	82.5	1.0	0	3.0
4M-99	26.8	2.9	73.0	1.0	0	2.0
Borinquen	19.8	1.3	75.0	1.0	0	3.0
Abrams Africa #10	21.3	2.9	77.0	1.0	0	4.0
Colombia 91P	22.3	1.1	80.0	1.7	3	3.0
Abrams Africa #7	19.0	1.8	71.8	1.0	0	3.0
Rosita Lajas	16.5	1.5	82.3	5.0	23	5.0
Oro Rico	19.8	2.5	78.8	3.3	13	4.3
Guayamera	18.3	1.3	72.0	3.0	0	4.0
Violeta	23.5	1.0	84.3	1.0	0	4.0
B-190	23.8	2.3	68.0	(3.3)[4]	(3)[4]	3.3
La Vega	21.3	2.4	81.0	5.0	8	3.3
Mean	21.1	1.9	76.7	2.0	4	3.4
L.S.D. (0.05)	2.7	0.6	N.S.	1.6	8	0.9

[1] Rated on a scale from 1 to 5 with 1 having all plants erect and 5 having all plants prostrate.

[2] Rated on a scale from 1 to 5 with 1 having no evidence of infection with rust and 5 having pustules with diameters greater than 800 μm.

[3] Rated on a scale from 1 to 5 with 1 having no presence of infection with bacterial blight and 5 having the canopy completely destroyed by bacterial blight.

[4] Observed on a few plants in each plot.

Colored line Violeta and Galana consistently produced seed yields as great as or greater than the mean of the tests. Unfortunately, both genotypes have seed coat colors unacceptable to the Puerto Rican consumer. As a result, the utility of these lines will be limited to use as parents in the breeding program. Among the lines with a seed type

[4] George F. Freytag, personal communication.

acceptable to the local consumer, Guayamera was the most promising. Production of colored beans in Puerto Rico would be appropriate only during the dry season until a greater level of bacterial blight resistance can be incorporated into this bean class.

RESUMEN

Se estudió el comportamiento de un grupo de habichuelas blancas y otro de varios colores. El estudio se hizo en los Centros de Investigación y Desarrollo de Isabela y Fortuna de 1979 al 1982. Las líneas blancas W-117, W-142 y 2W-33-2 produjeron rendimientos iguales o más altos que el promedio de todo el grupo incluido en la prueba. Estas líneas son resistentes a la raza del virus sistémico que causa el mosaico común de la habichuela. La cv. Bonita, usada como testigo, es susceptible a este virus. Estas líneas también tienen características agronómicas deseables y demuestran ser más resistentes a la roya (*Uromyces phaseoli*) que la cv. Bonita. Estas y otras líneas se seguirán probando experimentalmente hasta encontrar una que supere a la cv. Bonita. Las cv. Violeta y Galana fueron las de más alto rendimiento entre las líneas con testas de otros colores. Sin embargo, el consumidor acepta poco las habichuelas de estos genotipos. Entre las cultivares con testa de otros colores, Guayamera, que es muy prometedora, fue la más aceptable. Varias de las líneas con testas de otros colores fueron resistentes a las razas de roya existentes en Isabela en el 1982, aunque estas líneas generalmente son más susceptibles al añublo bacteriano que las líneas de testa blanca. Las líneas más prometedoras se han usado como padres en un programa de hibridación para desarrollar cultivares adaptables a las condiciones locales.

LITERATURE CITED

1. Anonymous, 1976. Importaciones de productos agrícolas de los Estados Unidos y otros países durante el años 1975–1976. Departamento de Comercio de los Estados Unidos, Oficina de San Juan.
2. Carmer, S. G. and M. R. Swanson, 1971. Detection of differences between means: A Monte Carlo study of five pairwise multiple comparison procedures. Agron. J. 63: 940–45.
3. González Ríos, P. y Riollano A., 1951. El mejoramiento de la habichuela blanca del país (*Phaseolus vulgaris* L.) por medio de la selección. Esta. Exp. Univ. P.R. Bol. 94: 1–21.
4. —— and ——, 1946. The improvement of native white beans (*Phaseolus vulgaris* L.) by selection, Proc. Am. Soc. Hortic. Sci. 48: 425–36.
5. Sanders, J. H. and Schwartz, H. F., 1980. Bean production and past constraints in Latin America, p. 3–13. *In* H. F. Schwartz and G. E. Gálvez (Eds) Bean Production Problems: Disease, Insect, Soil, and Climatic Constraints of *Phaseolus vulgaris* L. CIAT, Cali. Colombia.

6. Vicente-Chandler, J., 1978. Concepts, plan, and program for a modern agriculture in Puerto Rico, USDA/SEA—Agric. Exp. Stn. Univ. P.R.
7. Wright, K. T., 1978. Production trends: World, U.S., and Michigan. p. 16–27. *In* L.S. Robertson and R. L. Frazier (Eds) Dry bean production—principles and practices. Michigan State University, East Lansing.