

# Green-shell bean production in Puerto Rico at different planting dates<sup>1,2</sup>

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## ABSTRACT

Field experiments were conducted at the Isabela and Fortuna substations during a 4-year period to measure the whole pod and green-shell yields of five white-seeded bean genotypes planted at different dates. Results from this study show that green-shell beans can be produced in Puerto Rico over a wide range of planting dates. The greatest yields were produced when beans were planted from October to December. Results from a yield stability analysis show that whole pod yields tended to be lower and more variable when beans were planted during the warm and humid summer months. However, higher prices during the summer help to offset the greater risk associated with green-shell bean production during this time of year. The variety Arroyo Loro had the greatest overall yield and the most yield stability. Early maturity and disease susceptibility contributed to the poor yield stability of the variety Cuarentena. Since whole pod yield was positively and highly correlated with green-shell yield, whole pod yields can be used by bean researchers to predict green-shell yield.

## RESUMEN

Producción de habichuelas verdes en Puerto Rico en distintas épocas de siembra.

Durante 4 años se hicieron experimentos de campo en las subestaciones de Isabela y Fortuna para medir el rendimiento de vainas enteras y granos frescos de cinco genotipos de habichuela blanca sembrados en diferentes épocas. Los resultados indican que en Puerto Rico se puede producir habichuelas en una amplia gama de épocas de siembra. Los mayores rendimientos se obtuvieron cuando las habichuelas se sembraron entre octubre y diciembre. El análisis de estabilidad de rendimiento mostró que los rendimientos de las vainas enteras fueron más bajas y variables cuando se sembró en el verano, los meses más cálidos y húmedos. Sin embargo, los precios de la habichuela verde son mayores durante el verano. La variedad Arroyo Loro produjo los rendimientos más altos y los más estables. La precocidad y susceptibilidad a las enfermedades redujo la estabilidad del rendimiento de la variedad Cuarentena. Hubo una correlación positiva y alta entre los rendimientos de vainas enteras y los rendimientos de habichuelas frescas. Esto les permite a los investigadores en habichuela utilizar el rendimiento de vainas enteras para predecir el rendimiento de vainas frescas.

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## INTRODUCTION

Green-shell beans (*Phaseolus vulgaris* L.) are harvested near physiological maturity. Badillo-Feliciano<sup>3</sup> et al. reported that green-shell bean production has several advantages. Green-shell beans can be harvested at least 15 days earlier than dry beans, thus avoiding disease and insect damage that may occur at the end of the growing season. Green-shell beans can be harvested during unfavorable weather conditions. In addition, this short season crop is well suited to rotations or intercropping. Yields of green-shell beans is often 300% greater than that of dry beans. Moreover, the market value of green-shell beans on a unit of weight basis is twice the value of dry beans. Badillo-Feliciano et al.<sup>3</sup> identified the perishability of green-shell beans as the greatest disadvantage of the crop. Green-shell beans need to be marketed within a few days after harvest. However, there are facilities in Puerto Rico that could be used for canning green-shell beans.

As a fresh market crop, green-shell beans should be produced throughout the year. In Puerto Rico, the performance of dry beans and snap beans at different planting dates has been studied by Guadalupe<sup>6</sup> and Beaver et al.<sup>7,8</sup> There are no data, however, concerning the effect of planting date on green-shell bean production. Moreover, the green shell yields of recently released white-seeded varieties and breeding lines such as "Arroyo Loro" have not been compared with traditional white-seeded varieties such as "Cuarentena."

## MATERIALS AND METHODS

Field experiments were conducted at the Isabela and Fortuna substations. At Isabela, the experiments were planted in October and December 1985; January, October and December 1986; February, June, October and December 1987; and February and June 1988. At Fortuna, the experiments were planted in November and December 1985; March, April and December 1987; and January, May and June 1988. The soil at Isabela is an Oxisol of the Coto series whereas at Fortuna it is a Mollisol of the San Antón series.

<sup>3</sup>Badillo-Feliciano, J., I. Reyes-Soto and J.S. Beaver, 1985. A comparison of yields of common bean at physiological and harvest maturity. *J. Agric. Univ. P.R.* 69: 19-24.

<sup>6</sup>Guadalupe, R. 1977. Influencia de la época de siembra en el comportamiento de la habichuela (*Phaseolus vulgaris* L.). MS Thesis. University of Puerto Rico, Mayaguez.

<sup>7</sup>Beaver, J.S., J. Badillo-Feliciano and I. Reyes-Soto, 1985. Performance of dry beans grown on the coastal plains of Puerto Rico. *J. Agric. Univ. P.R.* 69: 125-132.

<sup>8</sup>Beaver, J.S., O. Román-Hernández and L.E. Rivera, 1988. Dry beans and varying cultural practices at two locations on the coastal plain of Puerto Rico. *J. Agric. Univ. P.R.* 72: 521-530.

The treatments consisted of five white-seeded bean genotypes. Arroyo Loro is a recently released variety and L-227, 8541-34, 8542-225 are breeding lines. Cuarentena is the variety that has traditionally been used for green-shell bean production. The experimental units consisted of plots that were 5 m long and 2.4 m wide. A spacing of 0.6 m was used between the four rows planted in each experimental unit. Fifty-five seeds were planted in each row. Four-meter lengths of each of the two middle rows were harvested. Approximately 0.5 m at both ends of each row was considered border and was not harvested. After whole pod yields were recorded, a 1-kg sample of pods were shelled.

A randomized complete block design was used. The effects of genotypes and planting dates were considered fixed. Means of genotypes within a particular planting date were compared by using least significant differences ( $P=0.05$ ). Regression analyses were used to estimate the stability of green shell yields over planting dates and locations<sup>9</sup>. Correlations coefficients were calculated between green-shell and whole pod yields.

#### RESULTS AND DISCUSSION

Arroyo Loro and 8542-225 had the greatest overall whole pod yield, averaging 6748 and 6482 kg/ha, respectively (Table 1). The whole pod yield of Cuarentena was significantly lower than the mean of the test. Cuarentena also had the lowest regression coefficient and significant deviations from regression. A regression coefficient smaller than 1 indicates that in higher yielding environments a genotype tends to produce lower yields than the other entries. Line 8542-225 tended to produce the greatest yields in higher yielding environments. Early maturity and susceptibility to rust, common bacterial blight and bean common mosaic virus contributed to the less stable yields of Cuarentena. Early maturity does not permit Cuarentena to take full advantage of favorable environmental conditions. Cuarentena has been observed to have premature defoliation due to rust and common blight, which reduces both yield and seed quality. Arroyo Loro has desirable yield stability characteristics, combining high mean yield with an average response to productivity and minimum deviations from regression.

At Isabela, the greatest yields were produced for the October and December-January planting dates (table 2). Arroyo Loro had the best overall performance at the February planting date. The summer was

<sup>9</sup>Eberhart, S.A. and Russell. 1966. Stability parameters for comparing varieties. *Crop Sci.* 6: 36-40.

TABLE 1.—Mean whole pod yield and yield stability characteristics of five white-seeded bean genotypes planted in 17 environments in Puerto Rico.

Genotype	Whole pod yield	Regression coefficient	Deviations from regression <sup>1</sup>
	<i>kg/ha</i>		
Cuarentena	5245	0.87	817397*
Arroyo Loro	6748*	0.90	498056
L227-1	6040	1.00	478450
8541-34	6128	1.05	600631
8542-225	6482*	1.19	480082
Mean	6128		
L.S.D. (0.05)	299		

<sup>1</sup>The pooled error mean square was 76726.

\*Significantly greater ( $P = 0.05$ ) than pooled error mean square.

the most problematic season for producing green-shell beans. We were able to harvest only one of three summer plantings at Isabela. Pod yields ranged from 4091 kg/ha for L227-1 to 5155 kg/ha for 8541-34 for the June 1987 planting. During the summer season there are higher temperatures and a greater potential for periods of intense rainfall. These environmental conditions reduce pod set and lower seed quality. In recent years, bean golden mosaic virus, a disease which is more prevalent in northwestern Puerto Rico during the summer, has caused losses to commercial growers in Isabela and surrounding municipalities. Although there is greater risk associated with the summer plantings of beans, the potential reward is also greater. Prices for green-shell beans during the summer when pigeon peas are not available are often double the price obtained during the winter months. At the Isabela substation, Arroyo Loro had the most consistent performance over different planting dates. Mean whole pod yield of Arroyo Loro ranged from 4967 kg/ha for the June 1987 planting date to 9581 kg/ha at the December 1985 planting date.

Whole pod yields at the Fortuna substation were greatest for the November and December planting dates (table 2). However, the yields of Cuarentena varied more between years than the other bean genotypes. Arroyo Loro and 8541-34 produced the greatest overall yields for the November and December planting dates. Although mean yields for the January and February planting dates were lower than for the November and December planting dates, all of the bean genotypes produced acceptable yields. As the planting date approached the summer season, there was more variability among years in whole pod yield.

TABLE 2.—Whole pod yield of five white-seeded bean genotypes tested at the Isabela substation at different planting dates.

Planting date	Genotype					L.S.D. (0.05)
	Cuarentena	A. Loro	L227-1	8541-34	8542-225	
	<i>kg/ha</i>					
Oct. 1985	5535	7140	6266	5688	7659	1260
Oct. 1987	7679	7159	5825	7577	7696	1349
Dec. 1985	6931	9581	7884	8077	9630	1466
Jan. 1986	5165	5908	6213	6462	5719	N.S.
Feb. 1987	3125	5453	3327	3911	3087	1119
Feb. 1988	4516	5933	5361	4491	4766	N.S.
June 1987	4734	4967	4091	5155	4633	1577

For the March to June planting dates, Arroyo Loro consistently produced the highest, or among the highest, mean yields. Because Fortuna receives less rainfall at the beginning of the summer season than Isabela, there may be less risk associated with a summer planting of green shell beans on the southern coastal plain of Puerto Rico.

Green-shell bean yields averaged 2,640 kg/ha at Isabela and 2,921 kg/ha at the Fortuna substation. This was 44.6% of whole pod yield at Isabela and 46.6% of whole pod yield at the Fortuna substation. The

TABLE 3.—Whole pod yield of five white-seeded bean genotypes tested at the Fortuna substation at different planting dates.

Planting date	Genotype					L.S.D. (0.05)
	Cuarentena	A. Loro	L227-1	8541-34	8542-225	
	<i>kg/ha</i>					
Nov. 1985	2622	7138	4779	6485	5158	1698
Nov. 1986	5800	9188	7071	8655	7614	961
Dec. 1986	4936	6719	7543	8474	8245	1756
Dec. 1987	8393	8275	8498	8132	7631	N.S.
Feb. 1986	5264	5999	5450	4959	5712	606
Jan. 1988	5335	5977	7518	5955	6562	N.S.
Mar. 1987	5148	6447	4046	5321	4914	1827
April 1987	2361	3274	3021	2524	3496	1144
June 1986	6587	8179	8033	7339	9110	N.S.
May 1988	3067	3685	3840	2676	4035	904

early variety Cuarentena had the greatest percentage green-shell yield, averaging 48.8%; 8542-225 had the lowest percentage, averaging 41.8%. Percentage of green-shell yield of the other genotypes ranged from 45.5 to 46.4%. Green-shell bean yields were highly correlated with whole pod yields both at the Isabela (0.94\*) and the Fortuna substations (0.91\*). This finding suggests that evaluation of whole pod yield is an adequate measure of green-shell yield potential.