

Effect of harvest date and seed type on green-shell and dry bean yield^{1,2}

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ABSTRACT

In Puerto Rico, harvesting beans (*Phaseolus vulgaris* L.) near physiological maturity enhances the value of the crop. Whole-pod yields greater than 5,000 kg/ha were obtained from bean lines harvested about 65 days after planting. Whole-pod yields of the white bean cultivar Arroyo Loro were equal to or greater than those of bean breeding lines with different seed types. However, the green-shell seed yield of the small red line DOR364 was greater than that of Arroyo Loro. The small red line DOR364 achieved greater green-shell seed yields by partitioning a greater portion of whole-pod weight into green-shell seed weight. Whole pod and green-shell bean yields were more consistent over years and locations than dry bean yields. Whole pod yields of beans harvested at the green-shell and semi-dry stages of development were similar, thus suggesting that harvest could be delayed as much as one week after the appearance of the first brown pod without losing green-shell bean yield.

Key words: *Phaseolus vulgaris* L., stage of development, harvest

RESUMEN

Efecto de la fecha de cosecha y del tipo de semilla en el rendimiento de la habichuela verde y seca

En Puerto Rico, la cosecha de habichuela (*Phaseolus vulgaris* L.) cerca de su madurez fisiológica aumenta el valor del cultivo. Se obtuvieron rendimientos de vainas verdes enteras mayores de 5,000 kg/ha de líneas de habichuela que se cosecharon aproximadamente 65 días después de la siembra. Los rendimientos promedios del cultivar blanco Arroyo Loro fueron iguales o mayores que los rendimientos de las otras líneas con diferentes colores de semilla. Sin embargo, los rendimientos de semilla verde de la línea rojo pequeño DOR364 fueron mayores que los de Arroyo Loro. DOR364 logró un mayor rendimiento de semilla verde a través de una distribución mayor del peso de las vainas hacia el peso de la semilla. Los rendimientos de vainas enteras y semilla verde fueron más estables que los rendimientos de semilla seca. Los rendimientos de vainas enteras y semilla verde fueron similares cuando se cosechó en las etapas de habichuela verde y semi-seca. Estos resultados sugieren que se puede esperar a cosechar hasta una semana después de aparecer la primera vaina seca sin sufrir una pérdida en rendimiento de semilla verde.

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INTRODUCTION

Beans (*Phaseolus vulgaris* L.) in Puerto Rico are harvested near physiological maturity as a means of enhancing the value of the crop. Farmers often receive as much as \$2.20/kg for whole-pods of beans harvested near physiological maturity whereas the price for dry beans is less than \$1.00/kg. In 1997, more than 800 ha of green-shell beans was planted throughout the island (M. Cortés, Assistant Economist, Agricultural Experiment Station, University of Puerto Rico, Mayagüez, Puerto Rico, personal communication). Badillo et al. (1985) noted that additional advantages of green-shell bean production were a reduction in number of days from emergence to harvest, less effect of adverse weather on the quality of the crop, and escape from disease and insect damage that may occur during the end of the growing season. Kays et al. (1980) noted that green-shell bean production permits the second crop in a multiple cropping sequence to be planted earlier. A potential disadvantage of green-shell bean production is the need to market the perishable crop within a few days after harvest. González et al. (1982), however, found that green-shelled beans stored for 24 h at 27° C before canning received sensory panel evaluations similar to those of dry beans.

Román-Hernández and Beaver (1997) studied the effect of planting date on the production of green-shell beans in Puerto Rico. The greatest whole-pod and green-shelled bean yields were produced when beans were planted in October and November, when temperatures begin to decline. Beans planted during the warm and humid summer months from May to August yielded the least. However, fresh market prices during the summer months are higher because green-shell pigeon peas [*Cajanus cajan* L. (Huth)] are not available.

Stage of development at harvest can affect the yield and quality of the green-shell bean crop. Cerna and Beaver (1989) reported that physiological maturity of indeterminate red and white beans occurred when the first pod on the plant turned brown. However, Román-Hernández and Beaver (1997) found that harvesting at physiological maturity reduced both the yield and quality of green-shell beans. The most appropriate time to harvest green-shell beans was found to be when a large number of pods had become yellow but before the appearance of brown pods. In Puerto Rico, this stage occurs between 60 to 65 days after planting for white bean cultivars such as Arroyo Loro and Morales.

Although white beans are used in Puerto Rico for green-shell bean production, knowledge of the performance of bean lines having other seed types would be helpful for the choice of parents in a bean-breeding program. Therefore, the first objective of this research was to compare

whole-pod and green-shell bean yields of the white bean cultivar Arroyo Loro with yields of breeding lines that have different seed types. A better understanding of the effect of stage of harvest on green-shell bean yield would permit more effective evaluation of bean lines for this trait. Thus, the second objective was to measure the effect of harvest date on yield and quality of green-shelled beans.

MATERIALS AND METHODS

Variety trial

Four field experiments were planted at the Isabela and Fortuna Substations over a two-year period to compare whole-pod and green-shell bean yield after different planting dates. The experiments were planted at Isabela in October 1992 and January 1993. At Fortuna, the experiments were planted in January 1992 and 1993. A randomized complete block design with four replications was used. Five bean lines with different seed types were evaluated. Arroyo Loro is a white-seeded bean, PR9180-25 is a red mottled bean, DOR364 has small red seed, PR9156-61 is a pink bean line and PR9226-5 is a pinto bean. Experimental units consisted of two four-meter rows spaced 0.6 m apart. The beans were planted at a rate of 200,000 seed/ha. Green-shell beans were harvested after yellow pods developed but before brown pods appeared (Román-Hernández and Beaver, 1997). Whole-pod and green-shell seed weights were recorded for each experimental unit. Results were analyzed in an analysis of variance, and means were compared by using Least Significant Differences (0.05).

Harvest date study

Field experiments were planted at the Isabela and Fortuna Substations in October 1991, October 1992 and January 1993. A randomized complete block design with three replications was used. Experimental units consisted of four-meter rows spaced 0.6 m apart. The white bean cultivar Arroyo Loro was planted at the rate of 200,000 seed/ha. The green-shell beans were harvested after yellow pods developed but before brown pods appeared. The semi-dry harvest was made seven to 10 days after the green-shell harvest, when several pods had turned brown. The dry bean harvest was conducted when all the pods had dried. Fresh whole pod weights were measured for the green-shell and semi-dry harvests. Fresh seed weights were measured for all three harvest treatments. Results were analyzed in an analysis of variance, and means were compared by using Least Significant Differences (0.05).

RESULTS AND DISCUSSION

Mean whole-pod yields at Isabela were similar both years whereas at Fortuna, the 1992 whole-pod yields were greater than the 1993 yields (Table 1). Most of the lines produced whole-pod mean yields greater than 5,000 kg/ha in all environments. The whole-pod yields of the white bean cultivar Arroyo Loro were equal to or greater than those of lines with different seed types (Table 1). Whole-pod yields of the small red line DOR364 and the pink line PR9156-61 were similar to that of the white seeded check cultivar Arroyo Loro. The determinate red mottled line PR9180-25 produced the lowest whole-pod yields whereas the pinto line PR9226-5 showed the most variability over locations and years (Table 1).

Mean green-shell seed yields were similar over years and locations, ranging from 2,260 to 2,514 kg/ha (Table 2). The green-shell seed yield of DOR364 was greater than that of Arroyo Loro at both Fortuna and Isabela. DOR364 achieved greater green-shell seed yields than Arroyo Loro by partitioning a greater portion of whole-pod weight into green-shell seed weight. This line, which is resistant to bean golden mosaic virus, should be considered as a parent to improve the green-shell yield of white beans. Green-shell yields of the red mottled, pink and pinto lines were similar to the yield of Arroyo Loro across years and locations (Table 2).

Whole-pod and green-shell seed yields of Arroyo Loro were similar over years and locations (Table 3). However, green-shell seed yields were more consistent over years and locations than dry bean yields. These results suggest that harvesting beans at the green-shell stage of development would provide farmers with a more reliable source of in-

TABLE 1.—Whole-pod bean yield of six bean lines evaluated at the Isabela and Fortuna Substations in 1992 and 1993.

Line	Seed type	Isabela		Fortuna		Mean
		Oct. 1992	Jan. 1993	Jan. 1992	Jan. 1993	
----- kg/ha -----						
Arroyo Loro	White	6,249	7,037	9,181	5,487	6,989
PR9180-25	Red mottled	4,886	5,487	7,390	5,129	5,723
DOR 364	Small red	5,378	6,202	9,032	6,739	6,838
PR9156-61	Pink	6,628	6,560	7,166	6,441	6,699
PR9226-5	Pinto	4,355	6,083	10,897	4,770	6,526
Mean		5,499	6,274	8,733	5,713	
LSD (0.05)		1,444	1,066	1,785	1,145	

TABLE 2.—*Green-shell seed yield of six bean lines evaluated at the Isabela and Fortuna Substations in 1992 and 1993.*

Line	Seed type	Isabela		Fortuna		Mean
		Oct. 1992	Jan. 1993	Jan. 1992	Jan. 1993	
----- kg/ha -----						
Arroyo Loro	White	1,625	1,679	2,259	1,860	1,856
PR9180-25C	Red mottled	2,028	2,462	1,976	2,511	2,244
DOR 364	Small red	2,880	3,321	3,082	2,464	2,937
PR9156-61	Pink	2,897	2,095	2,511	2,770	2,568
PR9226-5	Pinto	1,873	2,678	2,743	1,930	2,306
Mean		2,260	2,447	2,514	2,307	
LSD (0.05)		682	522	534	492	

come. Similar whole-pod yields obtained from beans harvested at the green-shell and semi-dry stages of development suggest that farmers would have some flexibility in harvesting green-shelled beans (Table 3). Harvest could be delayed as much as one week after the appearance of the first brown pod without losing whole-pod yield. However, beans harvested at a later date would have a greater portion of brown pods, which might reduce the fresh-market value of the crop. Kays et al. (1980) reported that the yield of dark red kidney beans harvested in the pre-dry stage of development was not significantly reduced. Acceptable yields of green-shell and dry beans were obtained at both the Isabela and Fortuna Substations (Table 3). These results are in agreement

TABLE 3.—*Whole-pod and seed yield of the white bean Arroyo Loro harvested at three stages of development in trial planted at the Isabela and Fortuna Substations from 1991 to 1993.*

Stage of development		Isabela			Fortuna		
		1991	1992	1993	1991	1992	1993
----- kg/ha -----							
Whole-pod	Green-shell	6,296	6,869	6,918	7,870	7,103	6,978
	Semi-dry	6,981	6,563	6,127	8,726	5,740	7,808
	LSD (0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Seed	Green-shell	3,487	2,109	3,240	3,512	3,869	3,159
	Semi-dry	3,303	2,158	3,211	4,552	2,993	3,608
	Dry	1,987	1,461	1,751	1,122	1,826	1,508
	LSD (0.05)	1,053	363	695	1,382	1,053	645

with those of González et al. (1982), who concluded that green-shell bean production should be feasible. Farmers and processors with experience in canning cowpea (*Vigna unguiculata*) or pigeon pea might find green-shell bean production to be a viable alternative.

LITERATURE CITED

- Badillo-Feliciano, J., I. R. Soto and J. S. Beaver, 1985. A comparison of yields of common beans at physiological and harvest maturity. *J. Agric. Univ. P.R.* 69:19-24.
- Cerna, J. and J. S. Beaver, 1989. A visual indicator of the physiological maturity stage of development. *J. Agric. Univ. P.R.* 73:361-365.
- González, A. R., K. M. Edwards and D. B. Marx, 1982. Storage and processing quality of beans (*Phaseolus vulgaris* L.) harvested at the semi-dry stage. *J. Amer. Soc. Hort. Sci.* 107:82-86.
- Kays, S. J., J. W. Williams and D. R. Davis, 1980. Harvest of dry beans in the pre-dry stage of development: Effect of yield and processed product quality. *J. Amer. Soc. Hort. Sci.* 105:15-17.
- Román-Hernández, O. and J. S. Beaver, 1997. Optimum stage of development for harvesting green-shelled beans. *J. Agric. Univ. P.R.* 80:89-94.