PERFORMANCE OF DRY BEAN LINES IN A LOW N SOIL IN PUERTO RICO

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Low nitrogen (N) availability is an important constraint for crop production in highly weathered soils of the Tropics (Graham and Vance, 2000). Selection of dry beans (*Phaseolus vulgaris* L.) for improved adaptation to low N soils may help to improve seed yield on farms where N fertilization is limited or unavailable. Field experiments were conducted at Isabela, Puerto Rico to identify N efficient dry bean lines in an Oxisol (very-fine, kaolinitic, isohyperthermic Typic Eutrustox). An initial screening of 228 lines from the bean breeding programs of the Escuela Agrícola Panamericana, Honduras and the University of Puerto Rico was performed in February 2007 using a moderate level (50 kg ha^{-1}) of N fertilization. Thirty-four lines were selected based on seed yield, adaptation and rust resistance. These lines were evaluated for agronomic performance in field experiments planted in June 2007 and January 2008 using a split plot arrangement of a RCB design with five replications. Two fertilization regimes, 50 kg N ha^{-1} (+N), 57 kg P_2O_5 ha^{-1} (+P), 54 kg K_2O ha^{-1} (+K), and –N, +P, +K, were the whole plots and the bean breeding lines were the sub-plots. The experimental units were single rows, 4 m in length that were spaced 0.6 m apart. Another field experiment was planted in January 2008 using an intermediate level of N fertilization (25 kg N ha^{-1}) to study nodulation and the partitioning of N of 13 lines that performed well in 2007. The experimental design was a RCB with 5 replications. The experimental unit was three rows, 3 m in length that were spaced 0.6 m between rows. The seed in all experiments was treated at planting with inoculant containing 2.9 x 10^6 viable cells g^{-1} of *Rhizobium leguminosarum* bv. *phaseoli*. The mean seed yield of the trial in 2008 was lower than 2007. Because the experiment was conducted on the same site, this seed yield reduction may have been the result of a depletion of the availability of N in the soil. The black bean line PR0443-151 had the best overall performance. At both levels of N, the mean seed yield of PR0443-151 was ranked no lower than third in the 2007 and 2008 field experiments (Tables 1 and 2). In the – N treatment, the small red line VAX 3 produced the greatest seed yield in 2007 and was ranked 2nd in 2008. The performance of PR0340-3-3-1 in 2007 was inconsistent. However, this line did produce the greatest seed yield at all levels of N fertilization in 2008 (Tables 1 and 2). In 2007 and 2008, PR0443-151 and VAX 3 had the greatest efficiency of N use (kg of seed yield in the – N plots/ kg N in the soil) (Table 1). PR0443-151, IBC 309-23 and MER 2226-28 had the greatest agronomic efficiency means (kg of seed yield / kg of N applied) which suggested that these lines were most responsive to N fertilization in 2007 and 2008 (Table 1). In the experiment using an N fertilization rate of 25 kg ha^{-1}, PR 0340-3-3-1 and A 774 accumulated the greatest amount of N in the aerial biomass (Table 2). PR0443-151 accumulated the greatest amount of N in the seed resulting in the highest % of total N in the seed. Mean nodulation scores were intermediate to poor (> 6.5). Cardenal and PR0443-151 had the lowest nodulation scores. In a related study, VAX 3 was identified as having a shallow root system and PR 0443-151 had an intermediate root system in a low N soil.

REFERENCE

Graham P.H. and C. P. Vance. 2000. Nitrogen fixation in perspective: an overview of research and extension needs. Field Crops Res. 65:93-106.

Table 1. Performance of bean lines in + N (50 kg/ha) and – N (0 kg/ha) plots planted at Isabela, Puerto Rico in June 2007 and January 2008.

Line	Seed yield (kg/ha)		Rank in the trial		Efficiency of N use (kg of seed yield in – N / kg N in the soil)	Agronomic efficency (kg of seed yield / kg of N applied)
	+ N	- N	+ N	- N		
June 2007 planting						
PR0443-151	2544	1707	2	2	55.0	18.8
IBC 309-23	2184	1258	6	4	47.2	25.8
A 774	2162	1167	8	6	44.2	21.5
MER 2226-28	2205	1102	15	7	40.8	15.2
VAX 3	1929	1880	16	1	62.5	1.2
PR0340-3-3-1	2270	820	3	25	27.6	31.0
Mean	1874	941			34.0	20.9
LSD (0.05)	748				39.8	34.0
January 2008 planting						
PR0443-151	1918	1461	2	3	72.3	15.9
IBC 309-23	1460	950	3	9	44.5	13.7
A 774	1359	1343	8	4	60.6	0.5
MER 2226-28	1192	805	16	15	37.3	12.0
VAX 3	1467	1479	3	2	66.1	0.5
PR0340-3-3-1	2300	2065	1	1	89.8	7.6
Mean	1199	837			35.6	10.4
LSD (0.05)	509				30.4	20.0

Table 2. Mean seed yield, N accumulation of the aerial biomass, seed N accumulation, and % of total N in the seed of bean lines in low N (25 kg ha^{-1}) plots planted at Isabela Puerto Rico in January 2008.

Line	Seed yield (kg ha^{-1})	Total N accumulation (kg ha^{-1})	Seed N accumulation (kg ha^{-1})	% of total N in the seed	Mean nodulation score[1]
PR 0340-3-3-1	997	81.5	29.6	47.0	7.0
PR 0443-151	876	69.3	33.8	53.9	6.0
VAX 3	809	74.7	21.1	31.1	6.5
RAB 655	808	62.6	22.9	29.6	6.7
A 774	724	87.6	26.1	28.6	9.0
Arroyo Loro Negro	548	62.3	25.1	41.6	8.0
Cardenal	512	44.5	13.5	32.7	5.0
Mean of the trial	554	56.2	18.1	34.9	6.4
LSD (0.05)	205	37.3	8.3	24.6	2.6
CV (%)	29.2	39.6	26.0	42.0	24.4

[1] Evaluated 67 days after planting using the CIAT 1-9 scale where 1 = > 80 nodules/plant, 3 = 41-80 nodules/plant, 5 = 21-40 nodules/plant, 7 = 10-20 nodules/plant and 9 = < 10 nodules/plant.