SOURCES OF VARIATION OF COMMON BEAN FOR DROUGHT TOLERANCE

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Introduction

Drought is considered the major factor limiting crop production worldwide and is responsible for heavy production losses in food legumes. Some losses are due to intermittent drought during the vegetative phase while other is due to terminal drought during reproductive development (Serraj et al. 2004). The severity of drought stress is unpredictable as it depends on many factors such as occurrence and distribution of rainfall, evaporative demands of the atmosphere and moisture storing capacity of the soils. Moderate to high drought stress can reduce biomass, number of seeds and pods, days to maturity, harvest index, seed yield and seed weight in common bean. Management practices can contribute to a decrease in yield loss in water-deficient environments, but major progress can also be achieved through genetic improvement. Plant responses to water stress include morphological and biochemical changes that lead first to acclimation and later, as water stress become more severe, to functional damage and the loss of plant parts (Chaves et al. 2002). In common bean, the main selection criteria for drought resistance are parameters related to plant growth and grain production. The objective of this work was to identify common bean sources of variation for breeding for drought tolerance.

Materials and Methods

Thirty nine common bean accessions (31 landraces and 8 resistant and susceptible checks) were evaluated in two locations in the northwest of Spain, 1) Location 1 (Pontevedra) (42° 24' N, 8° 38' W, 40 masl) and 2) Location 2 (Lalin) (42° 39' N, 8° 06' W, 745 masl) for drought tolerance under non stressed (NS) and drought stressed (DS) conditions according to a randomized complete block design with two replications. Each experimental plot consisted of four 25-plant rows with a crop density of 200000 plant ha^{-1}. The NS plot received additional irrigation and the DS plot not received irrigation. The Drought Intensity Index (DII) for each location was calculated as DII=1-Xds/Xns, where Xds and Xns are the mean of all genotypes under DS and NS environments, respectively. Drought Susceptibility Index (DSI) for each genotype was calculated as follows: DSI= (1-Yds/Yns)/DII, where Yds and Yns are the average yields of a given genotype under DS and NS conditions, respectively. The following traits were determined: days to flowering, days to maturity, 100 seed weight (g), seed yield (g $plant^{-1}$) and Percent of Reduction (PR), measured in the two central rows of each plot. For data analysis, locations and replications were considered as random effects and DS versus NS treatments and common bean genotypes as fixed effects. All data were analyzed using as SAS statistical package (SAS Institute, 2000).

Results and Discussion

The effect of treatments was significant for days to maturity, 100 seed weight and seed yield in Pontevedra and for all characters except seed yield in Lalin. The effect of accessions in location 1 was significant for days to flowering and maturity, and 100 seed weight and in location 2 for all characters except seed yield. The interactions between genotypes and DS *versus* NS conditions were also significant for days to flowering and 100 seed weight in Pontevedra and they not were significant in Lalin. The DII based on seed yield of all genotypes was higher (0.77) in Pontevedra than in Lalin (0.031). Among the 39 accessions used in this study, SEA 5 (31.4 g $plant^{-1}$) and L88-18 (13.25 g $plant^{-1}$) have the highest yield in NS conditions in location 1 and 2, respectively (Table 1). Under the DS conditions, PHA-0471 (3.02 g $plant^{-1}$) and PHA-0683 (19.0 g plant-1) had the highest yield in the two locations, respectively. The lowest yield in NS conditions was for PHA-0493 and PHA-2076 in Pontevedra and Lalin and for DS conditions were Ica Palmar and Pinto Sierra. In general, seed yield for 39 accessions in DS was significantly lower than in NS conditions. The drought resistant controls did not adapt well to the conditions from the Northwest of Spain. Drought stress, on the average, reduced bean yield by 40% and reduction in seed weight due to drought stress was ranged from 0-27%. Teran and Singh (2002) also reported yield reduction between 41 and 95 % due to DS. It is possible identify different accessions as drought resistant from those environments with higher DII values. PHA-0122, PHA-0483, PHA-0493, PHA-0543, PHA-0595 had low DSI and Pinto Sierra, SEA 5, L88-18, PHA-0006 and PHA-0118 had high DSI. PHA-0432, PHA-0471, PHA-0683, PHA-2074, Linex, and Alavesa, possessed moderate levels of drought resistance; they yielded well in DS and moderate in NS conditions. PHA-0483, PHA-0543, PHA-0595, LEF2RB, UI239, and Othello had high level of drought resistance, with DSI<1.0 indicating below-average susceptibility to drought. Variation for drought tolerance was found in other studies (Muñoz et al. 2006). Breeding crops for drought resistance is often considered to be a slow and difficult process. Moreover, drought may not be representative of that occurring in the major drought endemic regions of the world. Thus, while breeding for resistance to drought stress, either PR or DSI could be used in combination with yield in DS and NS or GM yield to identify superior genotypes. Effects of DS versus NS environments for seed yield and differences among genotypes for all characters except PR and DSI were significant. Under such conditions common bean genotypes with high yield in NS and DS environments and low DSI value are desirable.

References

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Table 1. Seed yield for common-bean selected genotypes evaluated in DS and NS conditions in two locations

Accessions	Seed yield (g plant-1) (Pontevedra)				Seed yield (g plant-1) (Lalin)			
	NS[a]	DS [b]	PR(%)	DSI	NS[a]	DS[b]	PR(%)	DSI
ALAVESA	9.21	2.53	72.53	0.94	11.59	5.30	54.27	17.51
L88-18	8.63	1.43	83.43	1.08	13.25	8.02	39.47	12.73
LEF2RB	3.20	2.31	27.81	0.36	2.36	7.88		
LINEX	8.70	2.65	69.54	0.90	11.34	6.54	42.33	13.65
OTHELLO	8.83	1.97	77.69	1.01	7.38	5.85	20.73	6.69
ICA PALMAR	4.94	0.66	86.64	1.13	4.22	2.38	43.60	14.07
PHA-0006	5.32	1.14	78.57	1.02	4.64	5.16		
PHA-0118	7.66	0.92	87.99	1.14	4.63	2.80	39.52	12.75
PHA-0122	3.54	1.16	67.23	0.87	2.21	3.73		
PHA-0432	7.38	2.36	68.02	0.88	5.97	10.09		
PHA-0471	8.22	3.02	63.26	0.82	9.15	10.82		
PHA-0483	4.12	1.45	64.81	0.84	5.56	5.14	7.55	2.44
PHA-0493	1.83	0.77	57.92	0.75	6.57	7.87		
PHA-0543	8.01	2.80	65.04	0.84	7.26	5.30	27.00	8.71
PHA-0595	6.85	2.43	64.53	0.84	10.47	7.76	25.88	8.35
PHA-0683	7.26	0.96	86.78	1.13	9.58	19.00		
PHA-2074	4.51	1.79	60.31	0.78	2.51	10.03		
PHA-2076	6.24	1.29	79.33	1.03	1.33	3.39		
PINTO SIERRA	7.69	0.75	90.25	1.17	4.59	1.77	61.44	19.82
SEA 5	31.40	2.16	93.12	1.21	12.25	6.35	48.16	15.54
UI 239	6.54	2.07	68.35	0.89	7.97	8.85		
Overall average	6.62	1.56	73.23	0.95	6.12	6.23	37.22	12.01

[a]LSD ($p \leq 0.05$)=6.0 [b]LSD ($p \leq 0.05$)=4.3

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