BROAD-SENSE HERITABILITY ESTIMATES OF SEVERAL ARCHITECTURAL AND SEED TRAITS IN DRY BEANS (Phaseolus vulgaris L.)

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While broad-sense heritability estimates are limited in utility to specified materials and environmental conditions, they nonetheless furnish the breeder with a useful approximation of the relationship between genetic and non-genetic forces as they influence character expression.

In a preliminary investigation of heritability of several architectural and yield traits in common bean (Phaseolus vulgaris L.), six crosses (Table 1) were produced from a 2 x 3 factorial mating of two pinto cultivars (UI 114 and Olathe) and three navy or tropical black genotypes (C-20, X80149 and Midnight). The study was conducted in the summer of 1985. For each cross, the F_2 population was planted in 32 short rows of 8 plants each, spaced 50 cm between rows and 20 cm between plants within a row. Four rows of each parent from each cross were also planted. The rows were completely randomized. Five plants with uniform competition were sampled from each row for data collection at maturity.

Broad-sense heritability estimates were made for two distinct groups of traits; namely, architectural and seed and pod traits, using the following formula:

$$H = (VF_2 - \frac{1}{2}(VP_1 + VP_2)) / (VF_2) = V_g/V_p$$

where VF_2, VP_1 and VP_2 are variances of F_2, parent 1 and parent 2, respectively; and V_g and V_p are genotypic and phenotypic variances, respectively (Briggs and Knowles, 1967).

Data on 14 architectural traits were collected on single plants at maturity. These traits were: height--length of central axis minus vine; architype--rating of desirability of plant architecture on a scale of 1-5, 1 being least desirable; nbranch--number of basal branches; hypodiam--hypocotyl diameter; hypolen--hypocotyl length (soil level to base of first branch); angle--branch angle (inclination of branch to central axis); podsup, podsmid, podslow-number of pods in the upper, middle and lower third of plant, respectively; nodesup, nodesmid, nodeslow--number of nodes in the upper, middle and lower third of plant, respectively; lowpodht--lowest pod height (from pod attachment on plant to soil level); and podsmain--number of pods on the main stem.

The seed and pod trait measurements which were made on a sample of six pods were: seedwt--seed size estimated as the weight of 100 seeds, replicated four times; seednum--average number of seeds per pod; podlen--average pod length; and podwidth--average pod width.

Broad-sense heritability estimates were generally higher for the seed and pod traits than for the architectural traits and were also more consistent among crosses (Table 1). The estimates ranged from low to moderately high for the architectural traits and moderate to high for the seed and pod traits.

Kelly and Adams' (1987) choice of a phenotypic recurrent selection system to develop erect type II architecture in pinto beans seems to have been appropriate on the basis of the heritability estimates. The traits used as

indices and included in the list investigated in this report were at least moderately heritable in the genetic material and environment selected. In this study, all the substantive indicators of erect plant architecture in beans (height, branch angle, number of pods on the main stem, number of pods in the middle, and hypocotyl diameter), previously identified by the authors in a separate experiment, produced a moderate range of heritability estimates over the crosses.

Likewise, seed and pod traits with moderate to high heritability allowed effective selection of recombinants as early as the F_2 generation. Recognizing that Kelly and Adams (1987) did not find suitable recombinants until after four cycles of recurrent selection and since both groups of traits are moderately heritable, a repulsion linkage between architecture and medium seed size traits must have existed in the original genetic materials used in the breeding program.

Table 1. Broad-sense heritability estimates for architectural and seed traits in six dry bean crosses.

Trait	Olathe/ X80149	UI-114/ X80149	Olathe/ Midnight	Olathe/ C-20	UI-114/ C-20	C-20/ Midnight
Height	45.06	38.58	--	8.50	43.53	37.95
Architype	51.70	--	9.89	--	--	--
Nbranch	--	56.64	41.88	--	--	56.55
Hypolen	55.60	68.22	12.97	65.69	14.73	19.80
Hypodiam	38.12	33.36	--	--	32.10	31.13
Angle	55.24	64.64	--	--	50.72	51.41
Podsup	80.30	57.39	--	--	19.10	4.89
Podsmid	85.26	54.54	30.94	25.10	72.78	50.01
Podslow	61.75	54.59	40.30	63.75	49.66	--
Nodesup	45.65	--	48.58	58.38	--	55.75
Nodesmid	31.86	--	29.44	45.70	--	--
Nodeslow	36.24	64.56	--	30.99	--	25.79
Lowpodht	88.88	31.36	1.56	--	26.22	9.36
Podsmain	60.63	18.46	9.70	--	--	79.67
Podwidth	81.06	65.06	87.61	--	72.32	38.96
Podlen	67.43	31.82	84.09	44.00	85.52	65.02
Seednum	29.66	--	55.60	22.95	45.69	--
Seedwt	76.94	87.51	62.46	74.39	52.61	69.37

Negative estimates are omitted from the table.

References

1. Briggs, F.M. and P.F. Knowles, 1967. Introduction to plant breeding. Reinhold Publishing Co. New York. pp. 104-105.
2. Kelly, J.D. and M.W. Adams, 1987. Phenotypic recurrent selection in ideotype breeding of pinto beans. Euphytica 36:69-80.