

Variation at Isozyme Loci in Phaseolus vulgaris

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Electrophoresis of raw extracts with subsequent staining for specific enzyme activities has been used to measure variability in numerous plant species. In Phaseolus vulgaris distinct allozymes have been described in several isozyme systems (1-3). These studies demonstrated that allozymic variation is present among the major classes of cultivated beans and in closely related species. Unfortunately, only a small number of assays were used in the surveys, severely restricting the amount of variability that could be identified. A compilation of the polymorphic isozyme loci in this species would be very useful for cultivar identification, marking of commercially important traits and further genetic characterization of the bean genome. With such a goal in mind I have initiated a survey of isozyme variability in this species and report here the identification of polymorphism at 15 loci during a survey of 134 lines using 27 different assays.

Electrophoresis was performed on horizontal starch gels using methods and assays described in Weeden and Gottlieb (4), Shaw and Prasad (5) and Weeden (in prep.). Seeds were obtained from Dr. M. P. Dickson at the N.Y. State Agricultural Experiment Station or directly from seed companies. An intense effort was made in snap beans to identify loci which would be useful for distinguishing cultivars. Each cultivar was then screened at most if not all these loci to determine their genotype. In most cases over 20 plants were tested from each line. Additional bean samples, representing other commercial classes or experimental lines, were also subjected to electrophoretic analysis using a smaller number of assays.

The results of this survey are presented in Tables 1 and 2. Table 1 consists of the snap bean varieties and breeding lines surveyed. These are listed in a sequence based on the basis of isozyme fingerprints, placing cultivars with identical fingerprints adjacent to each other. Occasionally, more than one isozyme fingerprint was found to characterize a particular cultivar and such variation is indicated by a second entry for that cultivar in the table. Table 2 lists the additional varieties and lines primarily on the basis of their commercial class.

The snap bean cultivars exhibited a minimum of 79 distinct fingerprints out of a possible 6912 different combinations. Fifty-five of the 103 cultivars possessed unique fingerprints and, thus, could be easily and reliably identified as seedlings. Several lines had to be described by two fingerprints, this ambiguity being caused by allelic variants at one locus. However, this variation did not seriously affect the identification of cultivars. Certain other cultivars, such as Bountiful and Roma or Black Valentine and Pure Gold, which could not be distinguished by isozyme fingerprint are easily differentiated using morphological characters.

In addition to the loci listed in the tables, 6 other loci were found to be polymorphic: glucose phosphate isomerase, xanthine dehydrogenase, succinate dehydrogenase, malate dehydrogenase, isocitrate dehydrogenase and

amylase. Many of the less common alleles were found only in the lines listed in Table 2. This latter group, as might be anticipated, exhibited greater variability in isozyme phenotype than did the snap beans. However, both the xanthine dehydrogenase and succinate dehydrogenase phenotypes differed among snap bean lines and may aid in the differentiation of cultivars.

References

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- (2) Wall, J.R. and S. W. Wall 1975. Isozyme polymorphisms in the study of evolution in the Phaseolus vulgaris--P. coccineus complex of Mexico. In: C.L. Markert (ed.), Isozymes, vol. IV, Academic Press, New York, pp. 287-305.
- (3) Bassiri, A. and M.W. Adams 1978. An electrophoretic survey of seedling isozymes in several Phaseolus species. Euphytica 27:447-459.
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TABLE 1

VARIETY	OBSERVED ALLOZYMES ^{1,2}										VARIETY	OBSERVED ALLOZYMES ^{1,2}										
	1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10	
FLO	F	F	F	F	F	F	S	F	S	-	BOUNTIFUL	S	S	F	F	F	S	F	F	F	-	
LAKELAND	F	F	F	F	F	S	F	S	S	S	ROMA	S	S	F	F	F	S	F	F	F	-	
TENDERPOD	F	F	F	F	S	S	F	F	S	S	CASCADE	S	S	F	F	F	S	F	F	S	S	
LANCER	F	F	F	F	S	S	F	S	S	-	EAGLE	S	S	F	F	F	S	F	F	S	S	
KENTUCKY WONDER	F	F	S	F	-	S	F	S	S	F	GOLDRUSH	S	S	F	F	F	S	F	F	S	S	
EARLY BIRD	F	F	S	F	S	S	F	S	S	-	NCX 8014	S	S	F	F	F	S	F	F	S	S	
BBP-14	F	F	S	F	S	F	F*	S	S	F	FEAK	S	S	F	F	F	S	F	F	S	S	
DREGAN 55	F	F	S	F	S	F	F*	S	S	S	XBP 108	S	S	F	F	F	S	F	S	S	S	
DREGAN 83	F	F	S	F	S	F	F*	S	S	S	BOWANZA	S	S	F	F	F	S	F	S	S	-	
BOBP-65	F	F	S	F	S	S	F	S	S	F	SPRITE	S	S	F	F	F	S	S	F	S	-	
BOBP-70	F	F	S	F	S	S	F	S	S	S	STRIKE	S	S	F	F	F	S	S	S	S	-	
BOBP-84	F	F	S	F	S	S	F	S	S	S	TENDERLAKE	S	S	F	F	S	F	S*	F	S	-	
BBP-14	F	F	S	F	S	S	F*	S	S	F	BBL-GV2	S	S	F	F	S	S	F	S	S	-	
ORBIT	F	F	S	S	S	F	F	S	-	-	EXPRESSWAY	S	S	F	F	S	S	S	F	S	-	
EPOCH	F	F	S	S	S	F*	S	S	-	-	BLACK VALENTINE	S	S	F	S	F	S	-	F	S	-	
AURORA	F	F	U	F	S	U	S	S	F	-	PURE GOLD	S	S	F	S	F	S	-	F	S	-	
HCCASLAN	F	F*	S	F	S	S	S	S	S	-	G8953	S	S	F	S	F	S	F	F	F	-	
DANDY	F	S	F	F	F	F	F*	F	S	-	PROVIDER	S	S	F	S	F	S	F	F	S	-	
PIROL	F	S	F	F	F	S	F	F	S	S	GOLDEN POD	S	S	F	S	F	S	F	F	S	S	
STRETCH	F	S	F	S	S	S	F	F	S	-	GREEN CROP	S	S	F	S	F	S	F	F	S	S	
GREENSLEEVES	F	S	F	S	S	S	S	F	F	-	REBEL	S	S	F	S	F	S	F	F	S	S	
MIAMI	F	S	F	S	S	S	S	F	F	-	W26	S	S	F	S	F	S	F	F	S	S	
PIROL	F	S	S	F	F	S	F	F	S	S	IMPROVED TOPNOTCH	S	S	F	S	F	S	F	S	S	-	
GREENWAY	F	S	S	S	F	S	F	S	S	-	PLATEAU PROVIDER	S	S	F	S	F	S	F	S	S	-	
SLIMGREEN	F	S	S	S	F	S	S	S	S	-	SPLENDOR GOLD	S	S	F	S	F	S	F	S	S	-	
SPARTAN PRIDE	S	F	F	F	F	S	F	S	-	-	EARLIWAX	S	S	F	S	F	S	S	F	S	S	
COMETA	S	F	F	F	F	S	S	S	-	-	RODEO	S	S	F	S	F	S	S	F	S	S	
TENDERCROP	S	F	F	F	F	S	-	S	S	-	SINCLAIR BUTTERWAX	S	S	F	S	F	S	S	F	S	S	
TENDERETTE	S	F	F	F	F	S	-	S	S	-	MIDAS	S	S	F	S	F	S	S	S	S	-	
WIN	S	F	F	F	F	S	F	F	S	-	RAIDER	S	S	F	S	F	S	S*	F	S	S	
BBL-109	S	F	F	F	F	S	F	S	S	S	GOLDEN WAX	S	S	F	S	F	S	S*	S	F	-	
EARLY GALLATIN	S	F	F	F	F	S	F	S	S	S	GOLD CROP	S	S	F	S	S	S	F	F	S	S	
G4219	S	F	F	F	F	S	F	S	S	S	DEL RAY	S	S	F	S	S	S	S	-	S	S	
GALLATIN 50	S	F	F	F	F	S	F	S	S	S	CUMBERLAND	S	S	F	S	S	S	S	F	S	S	
PAYMASTER	S	F	F	F	F	S	F	S	S	S	HARVESTER	S	S	F	S	S	S	S	F	S	S	
SLENDERETTE	S	F	F	F	F	S	F	S	S	S	SLENDERWHITE	S	S	F	S	S	S	S	S	S	-	
WONDERGREEN	S	F	F	F	F	S	S	S	S	S	MOONGOLD	S	S	S	F	F	S	F	F	S	S	
GRAND CANYON	S	F	F	F	F	S	S*	S	S	S	BBP-8	S	S	S	F	F	S	F	S	S	-	
SPARTAN PRIDE	S	F	F	F	S	F	S	F	S	-	REGAL	S	S	S	F	F	S	S	F	S	S	
GALASLIM	S	F	F	F	S	S	F	S	S	-	GATORGREEN	S	S	S	F	F	S	S	S	S	-	
VALIANT	S	F	F	F	S	S	S	F	S	-	LAKE GENEVA	S	S	S	F	S	F	F	S	S	S	
VITAGREEN	S	F	F	F	S	S	S*	S	S	-	BBL-92	S	S	S	F	S	S	S	F	F	S	S
GINA	S	F	F	S	F	S	F	F	F	-	LAKE SUPERIOR	S	S	S	F	S	S	S	F	S	S	
MAJESTIC	S	F	F	S	F	S	F	F	S	-	IMPROVED TENDERGREEN	S	S	S	S	F	S	F	F	S	-	
SUNRISE	S	F	F	S	S	S	S*	F	S	-	GOLD COAST	S	S	S	S	F	S	F	F	S	-	
CHECKMATE	S	F	S	F	F	S	F	F	S	-	BURLY	S	S	S	S	F	S	F	S	S	-	
GREEN ISLE	S	F	S	F	F	S	F	S	S	S	IMPROVED HIGRADE	S	S	S	S	F	S	F	S	S	-	
SLENDERETTE	S	F	S	F	F	S	F	S	S	S	REGAL	S	S	S	S	F	S	S	F	S	S	
BBL-47	S	F	S	F	F	S	F*	F	S	-	BBL-274	S	S	S	S	S	S	F	F	F	S	
LAKE SHASTA	S	F	S	F	S	F	F	S	S	-	BLUE CROP	S	S	S	S	S	S	F	F	F	S	
SHASTA	S	F	S	F	S	F	F	S	S	-	BURLY	S	S	S	S	S	S	F	S	S	-	
DREGAN 43	S	F	S	F	S	F	F*	S	S	-	BBL-274	S	S	S	S	S	S	S	F	F	S	
DREGAN 916	S	F	S	F	S	F	S	S	S	-	LAKE SENECA	S	S	S	S	S	S	S	F	S	F	
GREENPAK	S	F	S	S	F	S	F	S	S	-	G742	S	S	S	S	S	S	S	S	S	-	
BBL-283	S	F	S	S	S	S	F*	S	S	-	TORRENT	S	S	S	S	S	S	S	S	S	-	

¹Columns represent 10 polymorphic isozyme loci. The sequence of isozymes is: (1) shikimic dehydrogenase, (2) malic enzyme, (3) diaphorase, (4) ribulose biphosphate carboxylase, (5) adenylate kinase, (6) esterase-1, (7) esterase-2, (8) peptidase, (9) acid phosphatase, (10) cathodal peroxidase.

²Genotype for each cultivar is given for each locus by a single letter abbreviation of the isozyme phenotype observed. Abbreviations are: S = slow; S* = low activity of slow allozyme; F = fast; F* = low activity of fast allozyme; F+ = allozyme with mobility faster than F; U = different than S, F, or F+; dash = no data.

Table 2

Variety	Observed Allozymes									
	1	2	3	4	5	6	7	8	9	10
<u>Dry beans</u>										
Brazil 2	-	-	-	F	F	U	S	-	-	S
Ciat P560	F	F+	U	F	-	U	S	-	S	-
Horsehead	S	S	F	F	F	F	-	F	F	-
State Half Runner	F	F	S	F	S	S	S	S	S	F
Swedish Brown	S	-	-	-	F	-	F	-	-	-
<u>Green shell</u>										
Genuine Cornfield	F	F	F	F	S	-	U	F	S	-
Limelight	F	F+	S	-	S	F	-	F	S	-
<u>Navy (pea)</u>										
Ex Rico	-	-	-	F	S	-	S	-	-	-
Sanalac	F	F+	S	-	S	-	-	S	S	-
Seafarer	F	F+	S	F	S	-	-	S	S	-
<u>Red Kidney</u>										
California RK	S	S	F	S	F	S	F	F	-	-
Cal LRK	-	-	F	S	-	-	F	-	S	-
Red Kloud	S	S	F	S	-	-	F	-	S	-
Red Kloud GC	-	F	F	-	F	-	F	-	S	-
Sacramento Red	S	S	F	S	-	-	F	-	S	-
<u>Other</u>										
336	S	-	-	S	F	U	S	-	-	S
924R	-	-	-	F	F	-	F	-	-	S
2114-12	F	U	S	F	S	U	S	-	S	S
9505	-	-	-	F	F	U	F	-	-	S
165426c	-	F	S	F	S	U	S	-	S	S
165426w	-	F	S	F	-	U	S	-	S	-
165435	-	F	S	F	S	U	S	-	S	-
Andino	S	U	F	S	S	-	-	F	F	-
G06391	-	U	F	F	F	-	F	F	S	-
G08050	-	U	F	S	-	-	F	-	-	-
ICA Tui	F	-	-	-	S	-	S	-	-	S
L1	S	S	S	-	-	-	S	-	S	-
P459	F	-	-	-	S	-	S	-	-	S
P717	F	F+	U	F	S	-	S*	S	S	F
Porillo Sentetica	F	-	-	-	S	U	F	-	S	S
Remus	F	S	F	-	F	-	F	-	-	-

Column and letter designations are the same as for Table 1.