

Inheritance Study of Common Bean, Phaseolus vulgaris L.
to ambient O₃ Injury

T. Mebrahtu, M. Rangappa, and P. S. Benepal
Virginia State University
Petersburg, VA 23803

Introduction:

Beans are among the most sensitive crops to ozone (O₃) injury (Davis and Kress, 1974). Crop losses resulting from O₃ injury can therefore be reduced by using insensitive cultivars. (Knudson-Butler et al., 1979). They suggested that under acute laboratory testing conditions O₃ tolerance is recessive and controlled by a few major genes and the estimated heritability of tolerance to O₃ to be 0.83. In contrast, Hucle and Beversdorf (1982) reported that under field conditions O₃ insensitivity may be dominant to sensitivity, broad sense (H) estimate ranged from 0.10 and 0.21. The degree of insensitivity in segregating populations appears to vary with environmental testing conditions.

Procedure:

The genetic materials were obtained by crossing 'BBL 254' and PI 300 657, and between 'BBL 290' with PI 304 833 to obtain F₁ seeds. The cultivar BBL 290 and BBL 254 are sensitive to ozone. While PI 300 657 and PI 304 833 are insensitive to O₃.

On the first of July 1987, the four parents, 2 F₂s and their corresponding 2 F₃s were planted in randomized complete block design with four replications. Each plot consisted of four rows 3 m long and 0.9 m apart. Plants were spaced 0.5 m apart within the row. The average ambient O₃ concentrations for the months of July, August and September was .083 ppm, 0.066 ppm, and .053 ppm, respectively. Data were recorded on O₃ leaf injury on an individual plant basis and was analyzed using ANOVA and means were separated using least significant difference (LSD). The heritabilities (H) of F₂s and F₃s were estimated as the formula described by Mahmud and Kramer (1951).

Results and Discussion:

Significant differences for O₃ injury rating was observed among the genotypes tested (Table 1). The two sensitive parents BBL290 and BBL254 had significantly higher mean O₃ injury rating than their corresponding F₂s, F₃s progenies, and than the two insensitive parents used. The insensitive parents PI 300 657 and PI 304 833 had also significantly lower mean O₃ injury rating than their corresponding F₂s and F₃s progenies. Among the Parents used PI 300 657 had the lowest O₃ injury rating.

In all of the populations evaluated the mean score of the F₂s and F₃s population was not significantly different from the mid-parent value (Table 1). These observations provide evidence for suggesting that the genes involved in the expression of

ambient O₃ insensitivity are primarily additive effect. The assumption that total genetic variance is primarily an expression of additive variance is an important speculation when referring to heritability and predicting the expected response from selection. Broad sense heritability estimates for these populations studied ranged from 60 % to 69 % (Table 1). If in fact, total genetic variance is all additive then the estimates of broad sense heritability are also estimates of narrow sense heritability and can be used with greater confidence in predicting the expected genetic advance.

Based on the predominantly additive nature of the genes for ambient O₃ insensitivity and with moderately high heritability values. These data suggest that a breeder should utilize breeding procedure which allows for the maximum accumulation of desirable genes for this trait.

Table 1. Mean ambient O₃ injury rating of parents, F₂s, and F₃s of Common beans.

Genotype	Mean O ₃ injury rating [§]	Mid Parent Value	Broad sense heritability (H)%
BBL 254 (P ₁)	3.13	2.20	--
PYI 300 657 (P ₂)	1.27	--	--
F ₂ (P ₁ x P ₂)	2.41	--	62
F ₃ (P ₁ x P ₂)	2.40	--	60
BBL 290 (P ₃)	3.48	2.67	--
PI 304 833 (P ₄)	1.85	--	--
F ₂ (P ₃ x P ₄)	2.41	--	69
F ₃ (P ₃ x P ₄)	2.58	--	67
LSD 0.05	0.38		

§ 1 = 0 to 20 % injury, 2 = 21 to 40 %, 3 = 41 to 60 %, 4 = 61 to 80 % and 5 = > 80 %.

References:

- Davis, D. D. and L. Kress. 1974. Relative susceptibility of ten bean varieties to ozone. Plant Dis. Rep. 58:14-26.
- Hucle, P. and W. D. Beversdorf. 1982. the response of selected Phaseolus vulgaris L. Cultivars to ozone under controlled fumigation and ambient field levels. Can. J. Plant Sci. 62: 561-569.
- Knudson-Butler L., T. W. Tibbits, and F. A. Bliss. 1979. Inheritance of resistance to ozone in Phaseolus vulgaris L. J. Amer. Soc. Hort. Sci. 104: 211-213.
- Mahmud, I. and H. H. Kramer. 1951. Segregation for yield, height and maturity following a soybean cross. Agron. J. 43: 605-609.