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Inheritance of an Indehiscent Anther Character in the Common Bean

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Abstract. **Inheritance of an indehiscent anther (*ia*) mutant in the common bean (*Phaseolus vulgaris* L.) was studied. Dehiscence was incompletely dominant in heterozygotes making classification difficult in backcross and F_2 populations. Progeny tests were necessary to determine that the character was conditioned by a single recessive gene. The symbol *ia* is proposed to denote the indehiscent anther gene.**

Several bean breeding lines with complete or partial male sterility have been described in recent years (1, 2, 3, 5, 6, 7, 8, 9). Their discovery has intensified interest in developing a recurrent selection breeding system for this autogamous species. Such a system could infuse increased genetic diversity into bean breeding programs and help to broaden the gene base of the cultivated bean.

A male-sterile mutant bean line was described (5) in which sterility was attributed to *ia* (indehiscent anthers) in conjunction with low pollen fertility (7% to 9%). Male sterility in that line was controlled by a single recessive gene. The mutation was associated with a change in shape of the stigma from introrse to extrorse in sterile or partially fertile plants.

Another *ia* mutant in snap bean germplasm was described by the author (9). That mutant functioned as a partial male sterile but was fully fertile if anthers were crushed and self-pollinations were made by hand. Pollen seemed normal when stained with acetocarmine, and stigmas were completely introrse in sterile plants. Most pods aborted when 2 to 4 cm long; an occasional pod developed which contained 1 or 2 normal seeds. This mutant is probably different from the one previously described by Ibrahim (5). The purpose of the present study was to determine the mode of inheritance of the newly described *ia* mutant.

The *ia* mutant was found in 1979 (9) among greenhouse-grown snap bean breeding lines. Homozygous *ia* lines were developed from that mutant by hand selfing white-seeded segregates for 2 generations. Plants with *ia* were used as the seed parent (P_1) in crosses with B4173-2X, a black-seeded snap bean breeding line (P_2). Crosses were made using conventional methods (4) which included emasculation of the seed parent.

Parental lines and F_1 progeny were grown in the greenhouse, and flowers of each plant were examined with low power magnification at anthesis. Anthers of F_1 plants did not dehisce to the extent of those of the normal parent; enough pollen, however, was shed within the keel to effect self-pollination. Occasionally, F_1 plants produced several small pods which aborted like most of those of the *ia* parent. Backcrosses were made to both parents using the F_1 as the pollen parent. Seed production on F_1 plants was sufficient for an adequate F_2 population.

Parental lines, backcrosses to both parents, and F_2 populations were grown in the greenhouse. At anthesis, anthers from each plant were examined on 3 sunny days between 0800 and 1200 hr, and plants were classified as either normal or *ia* based on anther dehiscence. Most plants identified as *ia* were self-pollinated as described previously (9) to provide an F_3 population. Plants were grown to maturity, and seeds were harvested separately from each plant.

Plants were found in each segregating population which were difficult to classify. Some plants were observed to shed pollen sparingly but produced either a normal complement of pods or a mixture of normal and aborted pods. Therefore, a progeny test of the 2 backcrosses and the F_2 population was conducted to clarify the mode of inheritance of *ia*. The F_3 progeny test consisted of a minimum of 16 plants from each backcross or F_2 individual if seeds were available. Anthers from each F_3 segregate were observed at anthesis and classified as either normal or *ia*. In addition, to test the hypothesis that the trait could be conditioned by more than one allele with each conferring anther indehiscence, a complete diallel was performed using progeny from 7 homozygous *ia* segregates from the P_1 x F_1 backcross. Flowers from each diallel progeny were examined and classified as normal or *ia*.

Segregation ratios of the F_2 and P_1 x F_1 populations, based on anther observation at anthesis, were inconclusive in determining inheritance of the *ia* character (Table 1). The fertility of the F_1, with a reduction in anther dehiscence, and the anther dehiscence of the backcross of F_1 to normal parent suggested that the *ia* character was determined by recessive genes and that the errant ratios were due to misclassification of some partially normal plants (intermediate in anther dehiscence) into the *ia* category.

Segregation ratios of the F_3 generation and backcross progeny generations (Table 2) indicated that the *ia* character was conditioned by a single recessive gene. Several plants that seemed to be *ia* in the F_2 produced F_3 progeny with partially dehiscent anthers. All plants classified as *ia* in the F_2 were either homozygous *ia* or segregated in F_3; none were homozygous normal. In the progeny test of the P_2 x F_1 backcross, individuals which were homozygous normal (dehiscent) had progeny which were always completely dehiscent and

Table 1. Segregation for anther dehiscence of the F_1, F_2, and 2 backcross populations derived from crosses between snap bean lines with indehiscent and normal anthers.

Generation[z]	Normal anther	Indehiscent anther	Total plants	Approximate segregation ratios
P_1		All		
P_2	All			
$P_1 \times P_2$ (F_1)	21	0	21	
$P_1 \times F_1$	19	93	112	1:5
$P_2 \times F_1$	63	0	63	
F_2	97	65	162	3:2

[z]P_1 = Indehiscent anther; P_2 = Normal anther.

Table 2. Segregation ratios and Chi-square tests of the F_3 generation and progeny of 2 backcross populations from crosses between snap bean lines with indehiscent and normal anthers.

Population[z]	Observed: Homozygous normal	Observed: Segregating	Observed: Homozygous indehiscent anther	Expected[y]	Total	X^2	P
($P_1 \times F_1$) F_2	0	48	64	56:56	112	2.29	0.1 - 0.2
($P_2 \times F_1$) F_2	18	10	0	14:14	28	2.29	0.1 - 0.2
($P_1 \times P_2$) F_3	34	90	34	39:80:39	158	2.53	0.2 - 0.5

[z]P_1 = indehiscent anther; P_2 = normal anther.
[y]Based on *ia* being conditioned by one recessive gene.

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fully fertile while heterozygous individuals had some normal progeny and some progeny which were fertile but had partially dehiscent anthers. These results, combined with the earlier observation that the F_1 was somewhat less than completely normal in anther dehiscence, indicated that the mechanism controlling anther dehiscence expressed incomplete dominance in this cross.

Results of the diallel cross among the homozygous *ia* segregates indicated that a single gene conditions *ia*. All progeny from all crosses were *ia*. If more than one allele were involved, the probability is high that some progeny would have had normal, dehiscent anthers.

The *ia* character is relatively easy to maintain and manipulate (9) and has been stable in all environments in which it has been grown. In the field, *ia* plants crossed readily with normal bean breeding lines and cultivars in the vicinity, making the character valuable as a breeding tool for recurrent selection in *P. vulgaris*. The results of this study indicate that *ia* segregates should be progeny tested for one generation to assure homozygosity of the character. The gene symbol *ia* is proposed to denote the recessive gene conditioning indehiscent anther.

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Chemical Defoliation of Cucumber Vines for Simulation of Once-over Harvest in Small-plot Yield Trials

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Abstract. **Chemical defoliation of cucumber (*Cucumis sativus* L.) vines was evaluated as a method for rapid screening of breeding lines. Six chemicals (dinoseb, diquat, ethephon, glufosinate, glyphosate, and paraquat) were used at one or 2 rates on one pickling and one fresh-market cucumber cultivar ('Calypso' and 'Poinsett 76', respectively) in 1983 to determine speed of vine defoliation and amount of fruit damage. Of the chemicals tested, paraquat at 0.6 kg/ha provided the most rapid defoliation (85% to 91% defoliation one day after treatment) but caused some bleaching and chlorosis of the fruit. If the fruit were rolled 180° during evaluation, the damage was not noticeable. Chemical defoliation of vines for simulated once-over harvest provided a rapid, labor-saving method, requiring only 42% of the time to evaluate each plot compared to the conventional method. The chemical defoliation method is especially useful for initial evaluation of populations and breeding lines for fruit yield and other horticultural characteristics.**

Yield of cucumbers (*Cucumis sativus* L.) for pickling or fresh-market can be measured using either once-over harvest or multiple-harvest trials. Once-over harvest involves a destructive machine operation, whereas multiple harvest is nondestructive and usually is done by hand. Measurement of fruit number from small plots harvested once-over was found to be an efficient estimate of yield for plant breeders to use for both once-over and multiple-harvest production systems (2). Once-over harvest of small plots is especially useful in the initial stages of selection where many families or lines must be evaluated. Normally, the plants are pulled from plots by hand and the fruit laid out for evaluation. The once-over harvest trial provides a rapid method for measuring yield without the labor required in a multiple-harvest trial, and it provides sufficiently reliable data to make selections (2).

For pickling cucumbers, the optimum time for once-over harvest is when 10% of the fruit are oversized (1). Oversized fruits for pickling have a diameter greater than 51 mm and greater than 60 mm in fresh-market cucumbers. Unfortunately, since fresh-market cucumbers are not harvested once-over in commercial production, the optimum harvest stage for this method has not been determined. If fresh-market cucumbers were harvested once-over when 10% of the fruit were oversized, however, the counts of fruit number provided a good prediction of yield in multiple-harvest trials (2).

A rapid and less labor-intensive method of once-over harvest for collection of data on fruit yield in small-plot trials could involve chemical defoliation of the vines, instead of hand-pulling the plants, removing the fruit, and lining them up in the row. In order to be useful, a chemical should defoliate the vines rapidly and cause little damage to the fruit, so that fruit quality (shape, color and seedcell ratings) could be scored accurately. It would be convenient if the plots could be evaluated the day following chemical application.

The objective of this study was to evaluate 6 chemicals for rapid defoliation of vines of pickling and fresh-market cucumbers without causing serious damage to the fruit.

One or 2 rates of 6 chemicals were evaluated for use in simulating once-over harvest on one pickling and one fresh-market cucumber cultivar. The pickling cucumber tested was 'Calypso' (a gynoecious hybrid) and the fresh-market cucumber tested was 'Poinsett 76' (a monoecious inbred), both grown extensively in the southeastern United States. Plots were planted at the Horticultural Crops Research Station at Castle Hayne, N.C., on 14 Apr. 1983. The plots consisted of 3 rows 6 m long and 1.5 m apart (center to center). Plots were overplanted and thinned to 65 plants per row for 'Poinsett 76' and 59 plants per row for 'Calypso', giving population densities of 70,000 and 64,000 plants/ha, respectively. In order to minimize contamination from spray drift, alleys 1.5 wide were left at each end of the plot, and only the

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