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Inheritance of Twisted Pods in Common Bean *(Phaseolus vulgaris* L.)

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Abstract. **Inheritance of a twisted pod characteristic, in which bean pods develop with a twist that sometimes exceeds 360°, was studied in crosses between round-podded green bean cultivars. In crosses between 'Oregon 91G' (normal) or 'Oregon 54' (normal) and OSU 5256-1 (twisted), the F_1 was normal. Segregation in F_2 populations, tested over a 4-year period and including 4,995 plants, clearly fit a 3 normal : 1 twisted ratio. All plants of backcrosses of the F, to the normal parent were normal and backcrosses of the F_1 to the twisted parent segregated 1 normal : 1 twisted. The ratios observed indicated that twisted pods are conditioned by a single recessive gene for which the symbol *tw* is proposed.**

The twisted pod condition described here was found in a green bean breeding line of Blue Lake bush type, OSU 5256-1 in 1990. It has never been observed in the mother line or sister lines of OSU 5256-l. The character was uniformly present in OSU 5256-l (5256) when it was found and has been stable in the line since that time.

The twisted pod character (Fig. 1) consists of rotation of the pod from slight to at least 360". It is variable in the extent of twisting and the number of pods affected on each plant. It is possible that plants carrying this gene occasionally fail to produce a single twisted pod, but 5256 has always produced several to many per plant in hundreds of plants examined.

Twisted pods have been noted by other bean breeders, but we have not found reports of its occurrence in the literature. In addition to being a genetic oddity, this character can be considered to be a defect in green beans. The objective of this study was to determine the inheritance of the twisted pod character.

Materials and Methods

The principal cross studied was 'Oregon 91G' (OR 9 1 G) (normal) x 5256 (twisted). Line 5256 originated as a single plant selection from an advanced breeding line that has been evaluated for several years for processing. OR 9 1 G is a commercial cultivar of bush Blue Lake type, which has been the leading processing cultivar in western Oregon since about 1984. Both are determinate, concentrated in cropping habit, and have round, dark green, stringless pods that are low in fiber. A similar cultivar, 'Oregon 54' (OR 54), was also crossed with 5256.

All crosses were made reciprocally. Backcrosses between the F_1 and each parent were made in the OR 91G x 5256 cross. All crossing was done in the greenhouse using the standard method of hand emasculating and pollinating the flowers of the seed parent. All F_2 seed was produced in the field. Except for one group of OR 91G x 5256 F_2 plants evaluated in the greenhouse in 1992, all genetic data were obtained from plants grown in the field with about the same cultural practices used commercially in the area.

Observation of plants for twisted pods was done after the crop was ready for commercial harvest, and before pods started to dry. The twisted condition could be recognized in young pods but was sometimes more difficult to identify if drying had started. Twisting usually occurred in several pods on a twisted plant. Most twisted pods were easily recognizable because twisting involved the full length of the pod, while in others, pod twisting occurred mostly in the proximal portion of the pod, beginning in the neck. If one pod could be identified as twisted, the plant was classified as twisted.

Results and Discussion

All F, data were obtained from the plants used to produce F_2 seed and make backcrosses. All 56 of the OR 91 G x 5256 F_1 plants (Table 1), and the 10 F_1 plants of OR 54 x 5256 (Table 2) were normal.

More than 3,500 F_2 plants of OR 91G x 5256 were observed during 199 l-94. Segregation in each test, including tests of reciprocal populations, fit the expected ratio of 3 normal : 1 twisted. For presentation, reciprocal crosses have been combined (Table 1). A small sample of 10 F_3 families obtained from twisted F_2 plants were grown and each was found to be all twisted. Only one of 502 plants of the twisted parent 5256 failed to produce twisted pods. Although

Fig. 1. Examples of distinctly twisted pods as they occur in OSU 5256-1 and progenies studied.

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Table 1. Segregation of twisted pod in OR 91G x 5256, 1991-94.

Test[z]	Population[y]	Expected		Observed		Ratio tested	χ^2	P
		Normal	Twisted	Normal	Twisted			
Combined	OR 91G	188.00	0.00	188	0			
Combined	5256	0.00	502.00	1	501			
Combined	F_1	56.00	0.00	56	0			
1991 Field	F_2	438.75	146.25	449	136	3:1	0.96	0.30–0.50
1992 Field	F_2	704.25	234.75	712	227	3:1	0.34	0.50–0.70
1992 Greenhouse	F_2	336.00	112.00	340	108	3:1	0.19	0.50–0.70
1993 Field	F_2	441.75	147.25	443	146	3:1	0.01	0.90–0.95
1994 Field	F_2	723.75	241.25	736	229	3:1	0.83	0.30–0.50
	BC OR 91G x F_1	265.00	0.00	265	0			
	BC 5256 x F_1	131.50	131.50	136	127	1:1	0.31	0.50–0.70

[z]F_1 plants were grown in 1990 for F_2 seed production or in 1994 when backcrosses were made in the greenhouse.
[y]Data from reciprocal crosses were combined for F_1, F_2, and backcrosses; no reciprocal of 5256 x OR 91G was tested in 1992 field.

Table 2. Segregation of twisted pod in OR 54 x 5256.

Test[z]	Population[y]	Expected		Observed		χ^2 3:1	P
		Normal	Twisted	Normal	Twisted		
Combined	OR 91G	50	0	50	0		
Combined	5256	0	100	0	100		
1990	F_1	10	0	10	0		
1992	F_2	589.50	196.50	608	178	2.32	0.10–0.20
1993	F_2[y]	531.75	177.25	529	180	0.06	0.80–0.90

[z]All F_1 plants were grown in 1990 for F_2 seed production.
[y]Data from reciprocal crosses were combined.

this plant could be an example of failed expression of the character, it was considered likely to be from a seed mixture.

A total of 1495 F_2 plants of OR 54 x 5256 was observed. In 1992, the ratio 608 normal : 178 twisted resulted in a $x^2 = 2.32$, which is small enough to indicate nonsignificant deviation from the expected at $P = 0.05$. In 1993, the x^2 for the ratio obtained by combining reciprocals was near zero (Table 2).

Backcrosses were available only for OR 91G x 5256. All plants in OR 91G **x** F, and the reciprocal were normal. Segregation in the backcross 5256 x F, and reciprocal closely approached the expected 1 normal : 1 twisted (Table 1).

Results obtained from the pod crosses described above clearly indicate that the twisted pod character is conditioned by a single recessive gene, for which we propose the designation *tw.*