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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 5(3): 269-271, 2002

Variation and Transgressive Segregation in the Backcross Generations of Long Bean

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Abstract: Variation and transgressive segregations were studied in the backcross generations of populations involving three crosses in long bean [*Vigna sesquipedalis* (L.) Fruw]. Trends were different for different crosses. In Cross 1, high mean, variance and significant transgressive segregation (STS) pattern were exhibited by BC_2F_1 generation for shelf life, pod yield per plant and pod weight. In Cross 2, high means were shown by BC_1F_1 generations for shelf life and pod yield per plant, but high STS were observed in BC_2F_1 generation for shelf life, BC_1F_1 for pod yield per plant and BC_1F_2 for pod weight. In Cross 3, BC_1F_2 generation revealed high variances for shelf life, pod yield per plant and number of pods per plant, but highest STS values were revealed for BC_1F_3 (selected) for shelf life and pod yield per plant, BC_2F_1 for number of pods per plant, and BC_1F_2 for pod weight. In general, shelf life was found to have exhibited high mean and STS in the BC_2F_1 generation. Pod length, in general did not show good transgressive segregation in the crosses. Exploitation of these transgressive segregants in breeding programmes for improvement of the character of interest is suggested.

Key words: Variation, transgressive segregation, backcrosses, long bean, *Vigna sesquipedalis* (L.) Fruw.

Introduction

Long bean (*Vigna sesquipedalis* (L.) Fruw) is one of the most commonly grown vegetables in Malaysia, and ranks the second in importance for total vegetable consumption (Anang, 1988). The young and unripe pods are harvested for consumption. The crude protein content of the seeds and in the pods are high, about 29 and 23%, respectively (Mak, 1973; Poh, 1976). However, as in most vegetables, long bean is highly perishable, having short shelf life. Little attention has been given on genetic improvement efforts to extend its shelf life.

Introgression of genes from donor parents with long shelf life into genetic backgrounds of the recurrent parents is one of the potential means of creating variability for qualitative as well as quantitative characters. There is no available information on gene segregation in backcross generations from crosses between parents with high and low shelf lives in long bean. The aim of the present study was to evaluate the variation and pattern of the transgressive segregation revealed in populations of long bean developed from a backcrossing programme for characters of economic importance. The effectiveness of backcross breeding programmes can be improved by evaluating transgressive segregants for shelf life, and subsequently selecting for those with high yield and other related characters, before crossing them back to the recurrent parents.

Materials and Methods

Four cultivars of long bean, namely L30, KU7, KU8 and CSL19 were used as germplasm sources in the study. L30 had long shelf life and was used as donor parent. KU7, KU8 and CSL19 had shorter shelf life but with desirable pod characteristics, and were therefore used as the recurrent parent.

Using L30 as the donor parent, a total of three populations (henceforth designated as crosses) were developed. They were Cross 1 (L30 x KU7), Cross 2 (L30 x KU8) and Cross 3 (L30 x CSL19). The F_1 of each cross was backcrossed to their respective recurrent parents to obtain the BC_1F_1 generation. Seeds of the BC_1F_1 generation of all crosses were sown to obtain seeds for BC_1F_2 generation. A total of 200 plants from each cross were grown. From these 200 plants, five plants from each cross were selected for shelf life, pod length and pod yield. BC_1F_3 seeds (from BC_1F_2 plants) from each of the five plants were grown separately along with their respective recurrent parents to be used as pollen parents. The selected BC_1F_3 plants of each cross were backcrossed to their corresponding recurrent parents to produce BC_2F_1 seeds. The resulting BC_2F_1 seeds from each cross were taken from plants with shelf life longer than the others. Seeds of the P_1, P_2, BC_1F_1, BC_1F_2 (selected) and BC_2F_1 generations of Cross 1, Cross 2 and Cross 3 were evaluated separately in the field using a randomized complete block design with four replications. Each generation was represented by six plants in each replication. Individual plants were maintained in single-row beds, each measuring 6.0 m long and 0.9 m wide. The distance between plants was 1.0 m. Shelf life, pod yield per plant, pods per plant, pod length and pod weight were recorded for each plant. Percentage of transgressive segregants in BC_1F_1, BC_1F_3 (selected) and BC_2F_1 generations were calculated according to Reddy and Singh (1990). Extreme progeny types with values that exceeded their better parent means were classified as transgressive segregants (TS) and those regarded as significantly transgressive segregants were those with values exceeding the means of their better parents, when LSD comparison at $p \leq 0.05$ was made.

Results and Discussion

The analysis of variance revealed that the backcross generations of all the crosses were significantly different for all the characters measured. Means, variances and percentages of transgressive segregants in Cross 1, Cross 2 and Cross 3 are presented in Tables 1, 2 and 3, respectively. Mean values of generations for shelf life differed with crosses, where in general, BC_1F_3 (selected) generation manifested reasonably high mean in all the crosses. BC_1F_2 in general recorded high variation for shelf life in Crosses 2 and 3, but not in Cross 1.

In Cross 1, BC_2F_1 generation produced the highest variance (0.68), while BC_2F_1 and BC_1F_1 generations produced highest STS for shelf life (both were 20.8%) (Table 1). The same trend was also true for pod weight. In the BC_2F_1 generation, high mean (1501.6 g), large variance (97975.3), high TS (75.0%) and high STS (62.5%) were obtained for pod yield per plant. For number of pods per plant, BC_2F_1 generation also gave the highest mean value, but BC F_1 $_2$ produced the highest variance.

Reddy and Singh (1990) also observed high mean values and variances for number of pods per plant, and high STS for pod yield in BC_1F_2 generation of long bean.

Table 2 shows the variations and transgressive segregations for the five characters measured in different backcross generations in Cross 2. The BC_1F_1 generation had high mean value for shelf life, revealing the effect of heterosis, while BC_1F_2 expectedly showed high variance for the trait. Cox (1984) showed

Table 1: Mean, variation and percentage of transgressive segregants for characters measured in the backcross generations of Cross 1 (L30 x KU7) of long bean

Character		Generation					
		L30 (P_1)	KU7 (P_2)	BC_1F_1	BC_1F_2	BC_1F_3 (selected)	BC_2F_1
Shelf life (score)	Mean	3.5	1.8	3.3	3.2	3.5	3.4
	Variance			0.203	0.13	0.032	0.68
	TS (%)			54.2	37.5	85.7	66.7
	STS (%)			20.8	12.5	19.1	20.8
Pod length (cm)	Mean	40.8	58.6	56.2	48.8	57.3	50.8
	Variance			49.70	26.52	27.25	4.88
	TS (%)			50.0	8.3	38.1	0.0
	STS (%)			45.8	0.0	28.6	0.0
Pod yield/plant (g)	Mean	1034.4	1195.6	1474.6	1115.9	1017.4	1501.6
	Variance			49142.02	67272.80	73435.58	97975.26
	TS (%)			91.7	33.3	28.6	75.0
	STS (%)			62.5	20.8	9.5	62.5
Pods/plants	Mean	61.0	50.8	64.5	55.7	43.6	65.9
	Variance			76.21	120.34	103.84	91.78
	TS (%)			62.5	33.3	0.0	62.5
	STS (%)			41.7	8.3	0.0	50.0
Pod weight (g)	Mean	17.0	23.5	22.9	20.0	23.3	22.7
	Variance			5.29	6.35	2.72	7.62
	TS (%)			41.7	12.5	42.9	33.3
	STS (%)			20.8	8.3	14.3	20.8

TS = transgressive segregants; STS = significant transgressive segregants (LSD at $p \leq 0.05$)

Table 2: Mean, variation and percentage of transgressive segregants for characters measured in the backcross generations of Cross 2 (L30 x KU8) of long bean

Character		Generation					
		L30 (P_1)	KU8 (P_2)	BC_1F_1	BC_1F_2	BC_1F_3 (selected)	BC_2F_1
Shelf life (score)	Mean	3.6	2.3	3.4	2.7	3.2	3.3
	Variance			0.073	0.230	0.137	0.137
	TS (%)			12.5	0.0	4.2	20. 8
	STS (%)			0.0	0.0	0.0	4.2
Pod length (cm)	Mean	42.7	51.0	45.6	46.1	46.1	44.3
	Variance			16.56	35.40	7.90	8.64
	TS (%)			12.5	17.4	4.2	0.0
	STS (%)			0.0	8.7	0.0	0.0
Pod yield/plant (g)	Mean	1248.2	1120.4	1405.9	1274.9	1011.9	1244.6
	Variance			128586.79	37287.61	62165.45	72447.11
	TS (%)			62.5	56.5	29.2	41.7
	STS (%)			50.0	13.0	0.0	20.8
Pods/plants	Mean	69.7	56.5	74.8	67.6	53.3	68.6
	Variance			187.69	101.81	111.72	136.66
	TS (%)			50.0	39.1	4.2	29.2
	STS (%)			50.0	13.0	0.0	12.5
Pod weight (g)	Mean	18.8	19.8	18.6	18.9	18.9	18.1
	Variance			2.47	3.92	3.65	2.62
	TS (%)			25.0	26.1	20.8	16.7
	STS (%)			0.0	17.4	4.2	4.2

TS = transgressive segregants; STS = significant transgressive segregants (LSD at $p \leq 0.05$)

that the genetic variance among the backcross lines derived from comparatively higher number of backcross families would be expected to be higher. TS and STS for shelf life were observed only in the BC_2F_1 generations (20.8 and 4.2%, respectively). High mean, large variance, high number of TS and STS for pod yield per plant and number of pods per plant were observed in BC_1F_1 generations. Likewise, BC_1F_2 had high mean, variance, TS and STS with respect to pod length. All the backcross generations in Cross 2 expressed similar mean values for pod weight (18.6, 18.9, 18.9 and 18.1 g, for BC_1F_1, BC_1F_2, BC_1F_3 (selected) and BC_2F_1, respectively). However, for pod weight, the BC_1F_2 generation showed high variance, high TS and high STS (Table 2).

In Cross 3 (Table 3), BC_2F_1 generation manifested highest mean value (3.5 days) and highest TS (39.1%) for shelf life, while BC_1F_3 (selected) generation recorded highest STS. As expected, BC_1F_2 exhibited highest variance for shelf life. BC_1F_2 was also observed to have high mean and high TS and STS. Interestingly, BC_1F_1 manifested higher variance while BC_2F_1 produced no TS and STS in contrast to the other backcross generations. This could have possibly been due to selection conducted earlier on the plants causing pod length of the generation shorter than the better parent, as an indirect effect. For pod yield per plant, the BC_1F_1 generation exhibited highest mean value (1371.7 g) and TS (83.3%), while the BC_1F_2 generation showed highest variance (175309.69), and BC_1F_3 (selected) generation showed highest STS. For number of pods per plant, highest mean was expressed by BC_1F_1 generation (64.4), which also revealed highest TS (41.7). Highest variance was shown by BC_1F_2 generation (226.80), while highest STS was revealed by BC_2F_1 generation (26.1%). The different backcross generations did not differ much among each other for pod weight. High variances were shown by the BC_1F_2 and BC_2F_1 generations (7.34 and 7.67, respectively). The BC_1F_3 (selected) and BC_1F_2 generations were the highest for TS (45.8%) and STS (20.8), respectively.

In general, most of the later backcross generations in the crosses did not have transgressive segregants for pod length. This could have been due to selection of plants having optimum pod length of 50 to 55 cm previously conducted on the populations. For most other characters measured, significant amounts of

Table 3: Mean, variation and number of transgressive segregants for characters measured in the backcross generations of Cross 3 (L30 x CSL 19) of long bean

Character		Generation					
		L30 (P_1)	CSL 19 (P_2)	BC_1F_1	BC_1F_2	BC_1F_3 (selected)	BC_2F_1
Shelf life (score)	Mean	3.6	2.3	3.2	3.1	3.3	3.5
	Variance			0.194	0.221	0.109	0.073
	TS (%)			8.3	8.3	12.5	39.1
	STS (%)			4.2	0.0	8.3	4.3
Pod length (cm)	Mean	42.1	59.6	53.4	56.1	54.0	53.6
	Variance			39.56	37.21	18.75	29.49
	TS (%)			25.0	33.3	20.8	17.4
	STS (%)			8.3	8.3	4.2	0.0
Pod yield/plant (g)	Mean	1126.8	1110.7	1371.7	1325.9	1228.7	1366.8
	Variance			44732.25	175309.69	116396.97	114271.5
	TS (%)			83.3	66.7	62.5	73.9
	STS (%)			54.2	45.8	58.3	47.8
Pods/plants	Mean	66.9	50.6	64.4	61.0	56.5	64.1
	Variance			72.76	226.80	203.63	131.33
	TS (%)			41.7	37.5	25.0	34.8
	STS (%)			12.5	16.7	4.2	26.1
Pod weight (g)	Mean	16.9	22.0	21.3	21.4	21.6	21.3
	Variance			4.20	7.34	2.99	7.67
	TS (%)			33.3	37.5	45.8	34.8
	STS (%)			16.7	20.8	4.2	17.4

TS = transgressive segregants; STS = significant transgressive segregants (LSD at $p \leq 0.05$)

transgressive segregants were found in all the backcross generations of all the three crosses. The presence of transgressive segregants in backcross generations have also been reported for different characters in tomato (Franklin, 1987), grain sorghum (Rao *et al.*, 1983) and soybean (Cianzio and Fehr, 1982). These transgressive segregants were successfully exploited in developing cultivars possessing combinations of various selected traits. Higher variances coupled with higher transgressive segregation for shelf life and pod yield were observed in BC_2F_1 generation of Crosses 1 and 2. In Cross 3, high variance for shelf life and pod yield were observed in BC_1F_2 generation, but the highest transgressive segregation was found in BC_1F_3 (selected) generation. Hence a selection of segregants with the character of interest could be exploited for further improvement of the trait in all the three crosses studied.

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