

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.912.075>

Identification of Desirable Recombinants through Transgressive Segregation and Association Analysis in Soybean

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ABSTRACT

Soybean is economically the most important bean in the world, providing vegetable protein for millions of the people and ingredients for hundreds of chemical products. The aim of this study was to identify the superior transgressive segregants and estimate the correlation coefficient between seed yield, and yield components. Six generation of this cross were evaluated at Botany Section Farm, College of Agriculture, Dhule, during *Kharif*, 2019. The field experiment was arranged in a randomized block design (RBD) with non-replicated fashion. In most of the transgressive segregants, the better parent yield was transgressed with transgression of one or several other characters. In general, the highest proportion of transgressive segregants were recorded for grain yield per plant (24) followed by number of seeds per pod (26), 100-grain weight (25), plant height (23), number of primary branches per plant (9) and number of pods per plant (8). The most promising transgressive segregants observed in F_2 generation were Plant No 64, which yielded 119.17% more grain yield than increasing parent. Phenotypic correlation of grain yield per plant with nine other characters studied in F_2 generation of this cross indicated, significant and positive correlations with number of primary branches per plant, number of pods per plant, and number of seeds per pod. These characters also showed significant and positive correlation among themselves uniformly. These observations indicated that, the improvement in grain yield of soybean appears to be possible by making selection through these characters.

Keywords

Transgressive segregation, Correlation coefficient, Inter-relationship, Soybean

Article Info

Accepted:
07 November 2020
Available Online:
10 December 2020

Introduction

Soybean, (*Glycine max* L.), also called soja bean or soya bean, annual legume of the pea family (fabaceae) and its edible seed. The soybean is economically the most important bean in the world, providing vegetable protein for millions of the people and ingredients for hundreds of chemical products. Like other legumes the plant adds nitrogen to the soil by

means of nitrogen-fixing bacteria and historically has been an important soil enriching crop, though this practice is not common in most industrial agriculture systems.

The soybean is one of the richest and cheapest sources of protein and is a staple in the diets of people and animals in numerous parts of the world. The seed contains 17 percent oil

and 63 percent meal, 50 percent of which is protein. Because soybeans contain no starch, they are good source of protein for diabetics. In East Asia the bean is extensively consumed in the forms of soy milk, a whitish liquid suspension, and tofu a curd somewhat resembling cottage cheese. Soybeans are also sprouted for use as a salad ingredient or as a vegetable and may be eaten roasted as a snack food. Young soybeans, known as edamame, are commonly steamed or boiled and eaten directly from the pod. Area under soybean crop during 2020-21 in Maharashtra 39.292 lakh hectare and production 45.131 lakh tone having productivity 1148kg/ha (Anon., 2020).

Materials and Methods

The field experiment was conducted at Botany Section Farm, College of Agriculture, Dhule. The single direct cross was affected by using two diverse parents, JS-335 and KDS-344, during kharif-2018 and F₁'s was grown to obtain F₂ seeds during Summer-2019. The experimental material was evaluated in randomized block design with non-replicated fashion. Recommended doses of fertilizers and cultural practices were adopted to get normal crop. Two rows for parents and twenty five rows for F₂ generation of 4m length and 45cm apart accommodating 1000 plants at 10 cm distance between plants. The random 600 plant from F₂ generation and 10 plants from parent plot were tagged for recording observations on ten characters viz., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod, 100 grain weight, oil content (%), protein content (%) and grain yield per plant. For understanding the association among the yield and yield contributing character, correlation coefficients were worked out by using the data of 600 F₂ individual plants as per the procedure of Dewey and Lu (1959). Statistical analysis was carried out and

transgressive segregants were estimated by calculating threshold value (TV) and normal deviation value (ND) as per the procedure given by Panse and Sukhatme (1995).

$$1. r_{Pxy} = \frac{\text{Cov. } xy}{\sqrt{V_x \cdot V_y}} \text{ Where,}$$

Cov.xy = Covariance between the characters x and y

V_x = Variance of the character x

V_y = Variance of the character y

$$2. \text{Threshold Value (T.V.)} = P^{(+)} + 1.96 \times \sigma P^{(+)} \text{ Where,}$$

P⁽⁺⁾ and σ P⁽⁺⁾ are the mean and standard deviation of increasing parent, respectively

The individuals transgressed this threshold limit were considered as the transgressive

Results and Discussion

The conventional idea of hybridization is to recombine the desirable characteristics in a new hybrid derivative, already observed in two parents involved in hybridization. The occurrence of transgressive segregants in segregating generation suggests that, the concept of transgressive segregation can be used as a positive tool in plant breeding.

The studies on transgressive segregation in the segregating generation, suggest that parent do not represent the extremes in terms of intensities of desired characters. If some genes for enhanced expression of a character are lacking in the genotype of the promising parent but are present in donor parent, some individuals among the hybrid derivatives, emanating from the cross of these parents, might receive a fortuitous gene combination showing a larger effect than produced by either of the parents (Gardner, 1968).

Table.1 Threshold value (T.V), normal deviation value(N D), frequency, percentage and range in the values of transgressive segregants for six characters in F₂ generation of cross

Sr No.	Characters	Transgressive segregation in F ₂ generation JS-335 X KDS-344			
		Threshold value	N.D Value	Frequency	Range
1.	Plant height (cm)	65.31	1.72	23 (3.83)	66.00-88.00
2.	Number of primary branches	6.60	2.28	9 (1.50)	06.70-07.00
3.	Number of pods per plant	93.71	2.67	8 (1.33)	95.00-111.00
4.	Number of seeds per pod	2.58	1.98	26 (4.33)	02.60-02.90
5.	100 grain weight (g)	19.09	1.68	25 (4.66)	19.10-20.18
6.	Grain yield per plant (g)	34.61	2.31	24 (3.83)	35.11-42.98

Figures in bracket indicate the percentage of transgressive segregants.

Table.2 Promising transgressive segregants having combinations of desirable characters

Characters	Plant No.	PLH (cm)	PBP	PPP	SPP	GWT	GRY	% yield increased over increasing parent
Cross- 2: JS-335 x KDS-344								
F ₂	64	55 ⁺	6 ⁺	111 ⁺	2.2 ⁺	14.39	42.98 ⁺	119.17
JS-335		53	5	59	2.2	15.18	19.61	
KDS-344		49	4	61	2.2	14.16	18.53	

+: Performance of Transgressive Segregant superior than increasing parent

1. PLH (cm) = Plant height
2. PBP= No. of primary branches/plant
3. PPP= No. of pods/plant
4. SPP= No. of seeds/pod
5. GWT = 100-Grain weight(g)
6. GRY= Grain yield/plant (g)

Table.3 The uppermost limits achieved by transgressive segregants over their increasing parents in respect of various characters in F₂ generation

Sr. No.	Characters	Highest intensity of characters expression this cross
		JS-335 X KDS-344
1	Plant height	88 (53.7)
2	Number of primary branches	7(5.0)
3	Number of pods per plant	111(61.3)
4	Number of seeds per pod	2.9 (2.21)
5	100 grain weight	20.18 (15.18)
6	Grain yield per plant	72.67 (19.61)

* Figures in the bracket are the mean values of respective increasing parent

Table.4 Phenotypic correlation coefficients between different pairs of characters in F₂ generation of cross JS-335 X KDS-344

Characters	Days to 50% Flowering	Days to maturity	Plant height (cm)	Primary branches/ plant	No. of pods/plant	No. of seeds/pod	100-grain weight	Oil content (%)	Protein content (%)	Grain yield/plant
Days to 50% flowering	-	0.1490**	-0.0627	-0.0146	-0.0156	0.0103	-0.0618	0.1493**	0.0345	0.0492
Days to maturity		-	-0.0724	-0.0592	-0.0863	-0.0351	-0.0211	0.2059**	0.1638**	-0.0097
Plant height (cm)			-	0.0268	0.2698**	0.1501**	0.0907*	0.0648	0.0894	0.0164
Number of primary branches per plant				-	0.3496**	0.2004**	0.0389	-0.2929**	-0.1228**	0.3588**
Number of pods per plant					-	0.2150**	0.0954*	0.1429**	-0.0059	0.3585**
Number of seeds per pod						-	0.0082	0.2202**	-0.2633**	0.2693**
100-grain weight(g)							-	-0.3169	0.3927**	0.0310
Oil content (%)								-	0.0233	-0.0471
Protein content (%)									-	-0.2039**
*, ** Significant at 5%, and 1%, level, respectively.										

It is interesting to note that, in present study, transgressant were recorded in F₂ generation for all the six character (Table 1). In case of grain yield per plant 3.83 percent individuals transgressed beyond the increasing parent in this cross. Transgressive segregants were 3.83 per cent for plant height, 1.5 per cent for number of primary branches per plant, 1.33 per cent for number of pods per plant, 4.33 per cent for number of seeds per pod and 4.66 per cent for 100-grain weight in this cross.

Mansur *et al* (1996) reported transgressive segregants in respect of plant height (cm), number of seeds per pod, pod number and grain yield per plant (g) in F₂ generation in soybean. Ugale and Bahl (1980) reported transgressants for all these characters except pod length and cluster per plant with the highest proportion of individuals for plant spread (30.77%). Girase and Deshmukh (2002) and Deokar *et al.*, (2019) reported transgressive segregants in chickpea for all seven characters *viz.*, plant height, plant spread, fruiting branches per plant, pods per plant, seeds per pod, 100-seed weight and yield per plant. They observed the highest transgressive segregation for plant height (27%) followed by pods per plant, fruiting branches per plant and yield per plant in both F₂ and F₃ generation of all the three crosses.

If we consider transgressive segregants for grain yield per plant in the cross KDS-726 x NRC-102, plant No.64 was found to be most promising as it has given 119.17 per cent more grain yield per plant in addition to higher expression of number of plant height, number of primary branches, number of pods per plant, number of seeds per pod than their increasing parent (Table 2).

From this investigation, it can be suggested that the most promising transgressive segregants listed in Table 2 needs to be evaluated further. If they confirm their

superiority in further generations may be considered for multi-location evaluation for release as a variety or may be used as a parent in future breeding programme.

Apart from the frequency of transgressants, it will be of great interest to examine the intensities of the characters expression achieved in the transgressants in this cross. The character expression achieved by transgressive segregants were 66 to 88cm plant height, 6.7 to 7.0 primary branches per plant 95 to 111 pods per plant, 19.10 to 20.18g 100 grain weight, and 35.11 to 42.98 g grain yield per plant. This will provide an insight into the extended limits and intensities of desired characters expression achieved by transgressive breeding. In the present investigation, the highest yielding transgressants in this cross produced 42.98 g grain yield per plant, as against 19.61g per plant, produced by their respective increasing parents. This intensity for grain yield per plant was 119.17 per cent higher than their respective increasing parents (Table 3).

From this data it is evident that, when the desired intensity of a character is not available in the parents, the concept of transgressive segregation can be employed to extend the limit of expression of character. It is therefore, concluded that transgressive breeding is effective for extending the limit of character expression, if plant breeder is interested in isolating the rare genotypes. In this method we impose more selection pressure which result in the highest recovery of characters than that of other breeding approaches.

Among the phenotypic correlation of grain yield per plant with nine other characters studied in F₂ generation of this cross, significant and positive correlations were observed with number of primary branches per plant (0.3588), number of pods per plant

(0.3585), and number of seeds per pod (0.2693) (Table 4). The grain yield exhibited positive correlation with days to 50 per cent flowering, plant height and 100 seed weight. However, the grain yield was negatively correlated with days to maturity, oil content and protein content. These characters also showed positive and significant correlation among themselves. Significant correlation was found between days to flowering and maturity (0.1490), number of primary branches per plant and pods per plant (0.3496), number of pods and number of seeds (0.2150) and plant height and number of pods per plant (0.2598). This has been the desirable situation for improvement of grain yield in soybean. The important observation here to quote that, correlation of pods per plant and seeds per pod with 100 seed weight was positive, indicated the break down of undesirable linkage between the genes of these traits in F₂ generation due to segregation and recombination. Painkra *et al.*, (2018) reported significant positive correlation of grain yield with number of primary branches, number of pods per plant and number of seeds per pod.

The grain yield per plant was exhibited positive and significant correlation with number of primary branches per plant, number of pods plant, and number of seeds per pod. These result are in accordance with those reported by Girase and Deshmukh (2002); Malik *et al.*, (2006), Sujata and Basavaraja, (2011), Dubey *et al.*, (2015), Balla and Ibrahim (2017), Preeti Painkara *et al.*, (2018), and Deokar *et al.*, (2019). Chavan *et al.*, (2016) reported highly significant and positive correlation of grain yield per plant with number of pods per plant, and 100-seed weight.

The existence of transgressive segregants for yield and yield contributing characters and significant positive association among them,

indicated the feasibility and possibility for funneling desirable recombinant in soybean.

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How to cite this article:

Tagad, B. A., V. S. Girase, Rohini Y. Patil and Barhate, K. K. 2020. Identification of Desirable Recombinants through Transgressive Segregation and Association Analysis in Soybean. *Int.J.Curr.Microbiol.App.Sci*. 9(12): 633-639. doi: <https://doi.org/10.20546/ijcmas.2020.912.075>