

Original Research Article

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Transgressive Segregation Analysis in F₂ Generation in Chickpea

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ABSTRACT

Chickpea, a cool season legume crop of the family Leguminosae and of the genus *Cicer*, is the world's largest pulse crop. This crop has high productivity and holds prominent position in the international food grain trade. An experiment was conducted to identify the transgressive segregants for yield and yield contributing characters in F₂ population of three crosses in chickpea. In most of the transgressive segregants, in each of the three crosses, 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 (59) followed by number of pods per plant (46), plant height (41), number of seeds per pod (40), 100-seed weight (39), plant spread (38), number of primary branches per plant (38) and number of secondary branches per plant (37). In most of the transgressive segregants, in each of the three crosses, better parent yield was transgressed simultaneously with transgression of one or several other characters. Simultaneous transgression of grain yield per plant in association with plant height, number of primary branches per plant, number of secondary branches per plant, plant spread, number of pods per plant and 100-seed weight was observed more frequently. It was concluded that either grain yield per plant is dependent on this character or there may be linkage drag, so that genes responsible for these characters move together. The most promising transgressive segregants observed in F₂ generation were Plant No.44 of Cross 1, Plant No.30 of Cross 2 and Plant No. 27 of Cross 3.

Keywords

Transgressive segregation,
Transgressants,
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Chickpea

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Introduction

Chickpea is an important source of protein in the diets of the poor and is particularly important in vegetarian diets. Also, it is being used increasingly as a substitute for animal protein. Chickpeas are a helpful source of zinc, folate and protein. They are also very high in dietary fiber and hence a healthy source of carbohydrates for persons with

insulin sensitivity or diabetes. Chickpeas are low in fat and most of this is polyunsaturated. One hundred grams of mature boiled chickpeas contains 164 calories, 2.6 g of fat (of which only 0.27 g is saturated), 7.6 g of dietary fiber and 8.9 g of protein. Chickpeas also provide dietary calcium (49–53 mg/100g). According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) chickpea seeds contain on

an average- 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber and 3% ash. High mineral content has been reported for phosphorus (340 mg/100g), calcium (190 mg/100g), magnesium (140 mg/100g), iron (7 mg/100g) and zinc (3 mg/100g). Recent studies have also shown that they can assist in lowering of cholesterol in the blood stream. Among the food legumes, chickpea is the most hypocholesteremic agent; germinated chickpea was reported to be effective in controlling cholesterol level in rats. Glandular secretion of the leaves, stems, and pods consists of malic and oxalic acids, giving a sour taste. Medicinal applications include use for aphrodisiac, bronchitis, cholera, constipation, diarrhea, dyspepsia, flatulence, snakebite, sunstroke and warts. Acids are supposed to lower the blood cholesterol levels.

Many plant breeders have reported transgressive segregants in hybrid progenies and suggested that transgressive segregation may be used as a positive tool in plant breeding. The conventional idea of hybridization is to recombine in a new derivative, the desirable characteristics already observed in two parents. Perhaps a more imaginative approach to plant breeding is to consider transgressive segregation. Therefore, transgressive breeding aims at improving yield or its contributing characters through transgressive segregation.

Materials and Methods

The field experiment was conducted at Botany Section Farm, College of Agriculture, Dhule (India), where nine diverse genotypes were evaluated in randomized block design with three replications. Recommended doses of fertilizers and cultural practices were adopted. Sowing was done in rows of 3.0 m length and 30 cm apart accommodating 40 plants at 10.0 cm distance between plants. Seeds were hand

dibbled in each row. Two rows were assigned to P₁ and P₂ and 8 rows for F₂ generation for each cross. From each replication at random 40 plants from F₂ generation and 10 plants from parent plot were tagged for recording observations on eight characters viz., plant height, number of primary branches per plant, number of secondary branches per plant, plant spread, number of pods per plant, number of seeds per pod, 100-seed weight and grain yield per plant.

The statistical analysis was carried out as per the procedure given by Panse and sukhatme (1995). Transgressive segregants were estimated by calculating threshold value (T.V.) by the following formula.

$$T.V. = P^{(+)} + 1.96 \times \sigma P^{(+)}$$

Where,

P⁽⁺⁾ and $\sigma P^{(+)}$ are the mean and standard deviation of increasing parent, respectively

The individuals transgressed this threshold limit were considered as the transgressive segregants.

Results and Discussion

In the present investigation, transgressants were recorded in each of the three crosses in F₂ generation for all the eight characters (8.33 to 16.67%). In case of grain yield per plant 15.83 to 16.67% individuals transgressed beyond the increasing parent in three crosses. Transgressive segregants were 8.33 to 15.83% for plant height, 10.00 to 10.83% for number of primary branches per plant, 8.33 to 11.70% for number of secondary branches per plant, 8.33 to 12.50% for plant spread, 10.83 to 14.20% for number of pods per plant, 10.00 to 11.67% for number of seeds per pod and 9.16 to 13.33% for 100-seed weight in three crosses. The highest proportion of transgressive segregants were observed for

grain yield/plant 16.67%, number of seeds/pod 11.67% and number of primary branches/plant 10.83% in cross 2 and 3. For number of pods/plant 14.20% and for number of primary branches/plant 11.70% transgressive segregants were observed in cross 1. The 15.83% transgressive segregants had more plant height and 12.50% had more plant spread than their respective increasing parent in cross 2. The 13.33% individuals transgressed the better parent for 100-seed weight in cross 3 (Table 1). Auckland and Singh (1976) 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 chickpea. 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%). Kant and Singh (1998) observed transgressive segregants in lentil for plant height, yield per plant, primary branches per plant, secondary branches per plant, pods per plant, seed per pod and 100-seed weight. Girase and Deshmukh (2002) 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. Karkute *et al.* (2016) observed highest percentage of transgressive segregants for cluster per plant followed by number of pods per plant and seed yield per plant. In all the three crosses the highest proportions of transgressive segregants were recorded for number of pods per plant (46), followed by seed yield per plant (43), pod length (40), number of seeds per pod (36) and 100-seed weight (28) in mungbean.

The highest number of simultaneous transgressive segregants were observed in

cross 1 and 2 (19), followed by cross 3 (18). In cross 1, one transgressive segregants transgressed the grain yield along-with other six characters. Comparatively more number of simultaneous segregants were observed for grain yield along-with number of primary branches/plant, number of secondary branches/plant, plant spread, number of pods/plant and 100-seed weight (Table 2). The transgressants observed for grain yield were also found simultaneously transgressed for above traits, indicating their dependency on each other or there may be linkage drag among the genes of these traits. This kind of dependency or desirable linkage drag has great importance in plant breeding for simultaneous improvement. These results are in conformity with the results of Girase and Deshukh (2002).

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 each of the crosses. 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 cross 1, 2 and 3 produced 36.50, 37.10 and 35.08 g grain yield per plant, respectively as against 18.39, 18.75 and 18.67 g per plant, produced by their respective increasing parents (Table 3). These intensities for grain yield per plant were 98.47 (Cross 1), 97.86 (Cross 2) and 97.75 (Cross 3) per cent higher than those of their respective increasing parents (Table 4).

If we consider transgressive segregants for grain yield per plant in the cross Vishal x Digvijay, Plant No.44 was found to be most promising as it has given 98.47 per cent more grain yield per plant in addition to higher expression of number of secondary branches per plant, plant spread, number of pods per plant and number of seeds per pod than the increasing parent. The transgressive

segregants No. 30 was most promising in cross PG-13107 x BDNG-797 which out yielded the increasing parent by 97.86 per cent more grain yield per plant in addition to higher expression of plant height (cm), number of

primary branches per plant, number of secondary branches per plant, plant spread, number of pods per plant and number of seeds per pod.

Table.1 Threshold value (T.V.), normal deviation value, percentage and range in the values of transgressive segregants (T.S.) in three crosses of Chickpea

Crosses and Characters	F2 generation				
	Threshold value	N.D.	Frequency	T.S.%	Range in values of T.S.
Vishal x Digvijay	Cross-1				
Plant height	70.16	1.02	10	8.33	71.00-80.00
No. of primary branches/plant	02.61	1.35	12	10.00	3.00-3.00
No. of secondary branches/plant	15.04	1.07	14	11.70	16.00-25.00
Plant spread	33.39	1.20	10	8.33	34.00-57.00
No. of pods/plant	143.30	1.22	17	14.20	150.00-185.00
No. of seeds/pod	01.11	0.97	12	10.00	01.12-01.31
100-seed weight	22.21	1.58	12	10.00	22.26-23.04
Grain yield/plant	30.30	1.25	19	15.83	30.87-36.50
PG-13107 x BDNG-797	Cross-2				
Plant height	79.82	1.03	19	15.83	80.00-90.00
No. of primary branches/plant	02.92	1.84	13	10.83	3.00-3.00
No. of secondary branches/plant	14.83	1.36	10	8.33	15.00-20.00
Plant spread	28.08	1.09	15	12.50	29.00-43.00
No. of pods/plant	138.70	1.21	16	13.33	140.00-182.00
No. of seeds/pod	01.35	1.03	14	11.67	01.36-01.95
100-seed weight	20.84	1.72	11	9.16	21.02-22.10
Grain yield/plant	30.23	0.98	20	16.67	32.98-37.10
Vijay x BDNG-797	Cross-3				
Plant height	72.30	1.31	12	10.00	75.00-98.00
No. of primary branches/plant	02.65	1.34	13	10.83	3.00-3.00
No. of secondary branches/plant	15.40	1.06	13	10.83	16.00-25.00
Plant spread	30.40	1.19	13	10.83	31.00-48.00
No. of pods/plant	159.00	1.4	13	10.83	160.00-197.00
No. of seeds/pod	01.11	0.29	14	11.67	01.13-01.66
100-seed weight	21.20	1.11	16	13.33	21.28-23.17
Grain yield/plant	30.90	1.09	20	16.67	31.05-36.92

Table.2 Number of simultaneous transgressive segregants for yield in combination with other characters in three crosses of Chickpea

Character combinations Grain yield +	Number of simultaneous transgressive segregants in F2 generation		
	Cross 1	Cross 2	Cross 3
1. PLH + PBP + SBP + PLS + PPP + SWT	1	-	-
2. PLH + SBP + PLS+ PPP + SWT	1	1	-
3. PBP + SBP + PLS + PPP + SWT	-	3	2
4. PLH + SBP + PLS + SPP	-	-	1
5. PBP+ SBP + PLS + SWT	1	-	-
6. PBP + PLS + PPP + SPP	-	1	-
7. PLH + SBP + PPP	2	1	-
8. PLH + PBP + PPP	1	-	-
9. PBP + PLS + PPP	1	1	-
10. PBP + SBP + PPP	-	1	2
11. SBP + PPP + SWT	2	1	1
12. PLH + PPP + SWT	1	-	-
13. PLS + PPP + SWT	1	-	-
14. PLH + PPP + SPP	-	1	-
15. PLH + SPP + SWT	-	2	1
16. PBP + PLS + SWT	1	-	1
17. PPP + SWT	2	-	-
18. PLH + PLS + PPP	1	-	2
19. PLS + PPP	1	-	-
20. SBP +PLS + PPP	-	1	1
21. SBP + PLS + SPP	-	1	1
22. PPP + SWT	-	1	1
23. PLS + SPP	-	-	1
24. PPP	3	2	3
25. SPP	-	2	1
Total simultaneous transgressive segregants	19	19	18

Table.3 The upper limits achieved by transgressive segregants in respect of eight characters in F₂ generation of three crosses

Sr. No.	Characters	Highest intensity of characters expression in three crosses		
		Cross-1	Cross-2	Cross-3
1.	Plant height (cm)	80 (60.9)	90 (63.8)	98 (56.6)
2.	Number of primary branches/plant	3 (1.6)	3 (2)	3 (1.7)
3.	Number of secondary branches/plant	25 (9.4)	20 (9.9)	25 (10.9)
4.	Plant spread (cm)	57 (22.3)	43 (18.7)	48 (21.4)
5.	Number of pods/plant	185 (89.9)	182 (84.1)	197 (100.9)
6.	Number of seeds/pod	1.31 (1.04)	1.95 (1.16)	1.66 (1.07)
7.	100-seed weight (g)	23.81 (19.41)	22.10 (18.93)	23.17 (18.86)
8.	Grain yield/plant (g)	36.50 (18.39)	37.10 (18.75)	36.92 (18.67)

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

Table.4 Promising transgressive segregants having combinations of desirable attributes

Characters	Plant No.	PLH (cm)	PBP	SBP	PLS	PPP	SPP	SWT	GRY	% yield increased over increasing parent	
Cross-1 : Vishal x Digvijay											
F ₂	44	51	1	14 ⁺	24 ⁺	185 ⁺	1.04 ⁺	19.12	36.50 ⁺	98.47	
Vishal		60.10	1.50	7.90	18.90	71.80	1.03	19.17	17.31		
Digvijay		60.90	1.60	9.40	22.30	89.90	1.04	19.41	18.39		
Cross-2 : PG-13107 x BDNG-797											
F ₂	30	85 ⁺	2 ⁺	11 ⁺	24 ⁺	140 ⁺	1.52 ⁺	17.43	37.10 ⁺	97.86	
PG-13107		52.30	2.00	9.30	18.00	79.60	1.16	18.13	16.91		
BDNG-797		63.80	1.70	9.90	18.70	84.10	1.16	18.93	18.75		
Cross-3 : Vijay x BDNG-2015-3											
F ₂	27	50	2 ⁺	25 ⁺	37 ⁺	160 ⁺	1.01	22.85 ⁺	36.92 ⁺	97.75	
Vijay		55.50	1.60	10.70	21.40	100.90	1.07	18.86	18.67		
BDNG-2015-3		56.60	1.70	10.90	17.50	69.30	1.03	18.67	16.51		
1.	PLH (cm) = Plant height					5.	PPP = No. of pods/plant				
2.	PBP=No. of primary branches/plant					6.	SPP= No. of seeds/pod				
3.	SBP=No. of secondary branches/plant					7.	SWT = 100-seed weight (g)				
4.	PLS = Plant spread					8.	GRY = Grain yield/plant (g)				

⁺ Intensity of expression of character higher than the increasing parent

In the cross Vijay x BDNG-2015-3 the transgressive segregants No. 27 was transgressed beyond the increasing parents with 97.75 per cent more grain yield per plant. It also produced more number of primary branches per plant, number of secondary branches per plant, plant spread, number of pods per plant and 100-seed weight (g) than the increasing parent (Table 4).

From this investigation, it can be suggested that the most promising transgressive segregants listed in (Table 4) need 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.

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