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Combining Ability Analysis For Grain Yield and its Components in Chickpea (*Cicer arietinum* L.)

Kanak Saxena [1]*and Y. Ravindrababu[2]
[1]PhD Scholar, Department of Plant Breeding and Genetics, JNKVV, Jabalpur-482004(M.P), India
[2]Principal Research Scientist, Centre of Excellence for Research on Pulses, SDAU, Sardarkrushinagar-385506(Gujarat), India
*Corresponding author Email: kanak.saxena27@gmail.com

ABSTRACT
In the present investigation, ten chickpea genotypes and their all possible crosses (excluding reciprocals) were grown at the Centre of Excellence for Research on Pulses, Sardarkrushinagar Dantiwada Agriculture University, Sardarkrushinagar, Gujarat. This experiment was conducted in Randomized Block Design (RBD) with three replications and combining ability analysis was carried out in 10x10 parental diallel progenies for grain yield and its components traits in chickpea. General combining ability and specific combining ability variances were highly significant for all the characters suggested importance of both additive as well as non-additive type of gene action in the inheritance of of all traits i.e., days to flowering, days to maturity, plant height, branches per plant, number of pods per plant, number of seeds per pod, grain yield per plant, 100-seed weight, harvest index and protein content. The parent IC-269272, IC-2692310, GG-1 and GJG-3 were high yielding with good general combining ability for grain yield per plant and some of its components. These parental genotypes are thus promising for their exploitation in practical plant breeding.For grain yield per plant, the crosses IC-269269 X IC-269272, Dahod yellow X GJG-3 and IC-269273 X GG-1 recorded the highest sca effects. These crosses were found having potential to throw good recombinants in advance segregating generations.
Keywords *chickpea, General combining ability, Specific combining ability, transgressive segregants*

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important grain legume in India and plays a dominant role in the agriculture of rainfed areas of the country. It is third most important pulse crop after dry bean and pea. Among the food crops grown in India, chickpea is fifth in acreage and sixth in production, while total area under its cultivation was about 73.7 lakh hectares with a total production of 58.9 lakh tonnes and productivity of 799.19 kg/ha (Anon., 2011). The ability of parent to combine will depend on complex interaction among genes, which cannot be predicted from yield performance and adaptability of parents (Kumar *et al* 1999). The study of combining ability help in isolating useful parental lines and desirablespecific cross combinations which could be further exploited in development of improved varieties (Sindhu *et al*. 2000, Patil *et al*. 2004). The lines, which perform well in combination, are eventually of great importance to the plant breeders. Hence, investigation on general and specific combining ability would give very useful information. The present investigation aims at identification of superior parents, cross combination and evaluation of type of gene action for grain yield and as well as their respective components.

MATERIALS AND METHODS

Genetic material for the present investigation comprised of ten diverse parental lines of chickpea namely, IC-269268, IC-269269, IC-269272, IC-269273, IC-269277,IC-269295 IC-269310, Dahod yellow, GG-1 and GJG-3 along with their all possible F_1 (excluding reciprocals) were grown at Centre of Excellence for Research on Pulses (CERP), Sardarkrushinagar Dantiwada Agriculture University, Sardarkrushinagar, Gujarat The material were grown in Randomized Block Design (RBD) with three replication. All recommended agronomic practices along with plant protection measures were followed. Combining ability analysis was carried out according to the procedure given by Griffing (1956a) as per Method 2 and Model I.

RESULTS AND DISCUSSION

Analysis of variance for combining ability (Table 1) showed that general and specific combining ability variances were highly significant for all the characters suggested importance of both additive and non-additive type of gene action in the inheritance of characters. Similar results evincing involvement of predominance of additive and non additive gene effect in chickpea was reported by Chaturvedi *et al.* (1993), Jeena and Arora (2001) and Gupta *et al.* (2007). Most of the top ranking sca crosses had at least one good general combining ability parent and most of these crosses had high *per se* performance in respective traits. This indicated important role of additive X dominance or additive X additive gene interaction in high ranking sca effects of these hybrids. Thus, best cross combinations could be obtained by crossing at least one parent with good gca effect. High *per se* performances of crosses were thus related to the high sca effects and good gca effects of parents. Similar results for grain yield and component characters like number of pods per plant, number of seeds per pod and 100-seed weight were reported by Arora *et al.* (1988), Sandhu *et al*. (1989), Kamatar *et al*. (1994), Patil *et al*. (2004) and Jayalakshmi *et al*. (2009).

Estimates of gca effects (Table 2) indicated that parent GJG-3 was good general combiners for all the characters. Thus the parental line GJG-3 holds promise for genetic improvement of *chickpea*. The parent GG-1 was good general combiner for grain yield per plant, days to flowering, days to maturity, plant height, number of pods per plant, number of seeds per pod, 100-seed weight and protein content. The parent IC-269268 was good combiner for days to flowering, plant height, pod per plant and harvest index. The parent IC-269272 was good combiner for number of branches per plant, number of pods per plant, grain yield per plant and protein content. The parent IC-269310 was good general combiner for grain yield per plant, number of branches per plant and protein content.

Three best crosses selected on the basis of sca effects for each of the characters are presented in Table 3. A perusal of data reveled that none of the crosses was high ranking for all the characters. The sca for most of the characters where accompanied by top ranking *per se* performance also indicating predominant role of non-additive gene effects in expression of grain yield and its components. For grain yield per plant, It was observed that the crosses IC-269269 X IC-269272 followed by Dahod yellow X GJG-3 and IC-269273 X GG-1 expressed top ranking sca for grain yield recorded the highest sca effects were also top ranking in *per se* performance and they involved poor x good gca of the parents. The preponderance of general combining ability and specific combining ability for yield and yield contributing characters in chickpea were also reported by Gautam and Gupta (2007), Gupta *et al*. (2007), Kumar *et al.* (1999), Mali *et al.* (2006), Patil *et al*.(2004).

The combining ability also elucidates the nature of gene action involved in the inheritance of the nature of gene action for yield and its component characters has a bearing on the development of efficient breeding procedures. The general combining ability is attributed to additive, additive X additive and high degree of additive X additive interaction and is fixable in nature. On the other hand specific combining ability is attributed to non additive gene action and such is non fixable.

Chickpea being a self-pollinated crop, the exploitation of heterosis is not feasible. However, the cross combinations with high sca, which involve at least one good general combiner, could throw up desirable transgressive segregants if the additive genetic system present in the good combiner and complementary epistatic effects act in the same direction to maximize the desirable plant attributes.

CONCLUSION

The present study concluded that four parental genotypes GJG-3, GJG-1, IC-269268, IC-269272 and IC-269310 were found to be good general combiner for yield and most of its contributing characters. These parents may be involved in future crossing programme of chickpea improvement. The crosses IC-269269 X IC-269272, Dahod yellow X GJG-3 and IC-269273 X GG-1 may produce desirable transgressive segregant in advance generation. The four parents and three crosses were identified and shall be handled by suitable breeding method.

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Table 1: Analysis of variance for combining ability for various characters in *chickpea*

Source of variation	d.f.	Days to flowering	Days to maturity	Plant height	Number of Branches	Pods per plant	Seed per Pod	Grain yield per plant	100-Seed weight	Harvest index	Protein content
GCA	9	43.05**	182.11**	81.90**	1.48**	6171.98**	0.46**	154.51**	42.01**	246.5**	2.33**
SCA	44	38.85**	58.19**	31.28**	0.71**	7057.31**	0.15**	83.26**	7.52**	173.86**	1.36**
Error	108	3.21	2.62	3.31	0.021	351.6	0.008	0.80	0.45	1.02	0.01
$-^{2}$ GCA		0.35	10.32	4.21	0.06	-73.7	0.026	5.93	2.87	6.05	0.08
$-^{2}$ SCA		36	55.56	27.97	0.68	6705.7	0.14	82.45	7.07	172.84	1.35
$-^{2}_{gca}/-^{2}_{sca}$		0.0098	0.18	0.15	0.09	-0.01	0.17	0.07	0.40	0.03	0.05

* and ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Table-2 Estimation of general combining ability (GCA) of parents for various traits of Chickpea

Sr. No.	Parents	Days to flowering	Days to maturity	Plant height	Number of Branches	Pods per plant	Seed per Pod	Grain yield per plant	100-Seed weight	Harvest index	Protein content
1.	IC-269268	-1.889 ***	1.800 ***	-1.028 *	-0.118 **	14.056 **	-0.134 ***	-0.362	-0.066	8.696 ***	-0.624 ***
2.	IC-269269	2.250 ***	6.978 ***	-1.583 **	-0.312 ***	10.722 *	0.035	-4.046 ***	-1.680 ***	-2.165 ***	0.188 ***
3.	IC-269272	2.472 ***	4.606 ***	6.278 ***	0.118 **	45.778 ***	0.007	2.329 ***	-1.705 ***	-3.373 ***	0.366 ***
4.	IC-269273	0.472	4.744 ***	-0.472	-0.096 *	-15.861 **	-0.021	-1.329 ***	-1.552 ***	4.774 ***	0.300 ***
5.	IC-269277	-0.361	3.967 ***	1.944 ***	-0.229 ***	-19.417 ***	0.374 ***	-2.034 ***	-1.533 ***	-6.637 ***	0.222 ***

6.	IC-269295	1.667 ***	0.606	-0.222	-0.179 ***	-11.500 *	-0.148 ***	-2.268 ***	-0.577 **	-1.071 ***	0.586 ***
7.	IC-269310	1.111 *	-0.144	1.139 *	0.091 *	5.222	-0.271 ***	1.046 ***	0.039	-2.015 ***	0.167 ***
8.	Dahodyellow	-1.083 *	-2.922 ***	-1.722 ***	-0.257 ***	-36.194 ***	-0.165 ***	-2.773 ***	0.989 ***	-2.471 ***	-0.043
9.	GG-1	-1.528 **	-2.561 ***	-1.556 **	0.079	-3.361	0.071 **	0.871 ***	2.270 ***	0.404	-0.512 ***
10.	GJG-3	-3.111***	-3.117 ***	-2.778 ***	0.902 ***	10.556 *	0.252 ***	8.566 ***	3.814 ***	3.857 ***	-0.648 ***
	S.E.(gi) ±	0.491	0.443	0.498	0.0402	5.135	0.0253	0.245	0.184	0.277	0.030

* and ** indicates significant at P = 0.05 and P = 0.01 levels, respectively.

Table 3: Sca effects of three best crosses along with *per se* performance and gca combination for each traits

Characters	Hybrids	sca	gca	*per se* performance
Grain yield plant $^{-1}$	IC-269269 x IC-269272	32.68 **	P X G	65.4
	Dahod yellow x GJG-3	12.37 **	P X G	52.6
	IC-269273 x GG-1	11.82 **	P X G	45.8
Days to flowering	IC-269273x Dahod yellow	-9.72 **	A X G	56.67
	IC-269277 x IC-269295	-7.64 **	A X P	60.67
	IC-269268 x IC-269295	-5.78 **	G X P	61.00
Days to maturity	IC-269268 x Dahodyellow	-6.07**	A X G	112.33
	IC-269268 x IC-269310	-4.51**	P X P	126.00
	IC-269295 x IC-269310	-3.98**	A X A	116.00
Plant height	IC-269273 x GJG-3	-8.66**	A X G	42.33
	IC-269268 x IC-269277	-7.83**	G X P	47.33
	IC-269273 x IC-269310	-6.24**	A X P	48.67
Number of Branches^{-1}	IC-269269 x IC-269272	2.71**	P X G	8.10
	Dahod yellow x GJG-3	1.30**	P X G	7.53
	IC-269277 x Dahodyellow	0.90**	P X P	6.00
Pods plant $^{-1}$	IC-269272 x IC-269273	107.99**	G X P	384.00
	IC-269268 x GG-1	107.89**	G X A	364.67
	IC-269277 x Dahodyellow	91.19**	P X P	281.67
Seed pod^{-1}	IC-269269 x GJG-3	0.78**	A X G	2.87
	Dahod yellow x GJG-3	0.72 **	P X G	2.60
	IC-269273 x IC-269277	0.69**	A X G	2.83
100 seed weight	GG- 1 x GJG-3	6.64 **	G X G	27.90
	IC-269310 x GJG-3	5.87 **	A X G	24.90
	IC-269268 x IC-269269	2.04 **	A X P	15.47
Harvest index	IC-269268 x IC-269310	24.87 **	G X P	74.67
	IC-269268x Dahod yellow	15.99 **	G X P	65.33
	Dahod yellow x GJG-3	14.16 **	P X G	58.67
Protein Content	IC-269277 x GG-1	1.35**	G X P	
	IC-269310 x GG-1	1.34**	G X P	21.52
	IC-269295 x Dahod yellow	1.30**	G X A	21.45
				22.29

G = Good; A = Average; P = Poor. *, ** indicates significant at P = 0.05 and P = 0.01 levels, respectively

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