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COMBINING ABILITY FOR SEED YIELD AND ITS ATTRIBUTING CHARACTERS IN CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

The experimental material compressed Line into tester analysis is done by using five lines- JG-97, JG-2003-210, Vaibhav, Indira Chana-1 and JG-315 with three testers- JG-74, K-850 and L-550. The analysis further revealed highly significant differences for all the characters among the lines, testers and line × tester and parents vs hybrids. The GCA effect of lines revealed that JG-97, Vaibhav and Indira Chana-1 were identified as a good general combiner for pod plant biological yield (g), 100-seed weight (g), harvest index (%) and seed yield plant-1 on the basis of highly significant level and The SCA effect of crosses JG-97 × K-850, JG-2003-210 × K-850, Vaibhav × JG- 74, Indira Chana-1 × JG-74 found highly significant for seed yield plant-1, pods plant1, 100-seed weight (g) and harvest index (%).

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INTRODUCTION

The chickpea (*Cicer arietinum L.*, 2n=2x=16) is the prime pulse most important pulse crop among all pulses, Bengal gram is an edible self fertilizing annual diploid grain legume of the family fabaceae and sub family faboideae. It is the third most important pulse crop of the world after dry bean and dry pea. The success of any plant breeding method depends on the choice of appropriate genotypes as parents in the hybridization programme. The combining ability studies of the genotypes provide information which helps in the selection of better parents for effective breeding. Its role is important to decide parents, crosses and appropriate breeding procedure to be followed to select desirable segregants (Salgotra *et al.*, 2009). Good general combining parent result in higher frequency of heterotic hybrids than poor combining parent. From the genetic point of view, general combining ability measures additive gene effects and specific combining ability measures non-additive gene effects, depending on genes with dominance (intra-allelic interactions) and epistasis (inter-allelic interactions).Combining ability analysis enables the breeder in his task of selecting the parents. It also provides the vital and necessary information on the nature of gene action governing the expression of the character in question and thus helps in deciding upon the future breeding strategy.

To identify the suitable genotypes for rainfed rice based cropping system. In Chhattisgarh state under area of chickpea is increasing by occupying rice fallows. Usually early rice harvest week of October, medium rice harvest in 2nd week of November whereas late rice harvest in first week of December. The chickpea under rice fallow depend mainly on the time of rice harvest. The chickpea behave differently when grown after harvest of rice varied duration. Hence there is urgent an need to develop suitable chickpea varieties for cultivation after early rice variety.

MATERIALS AND METHODS

The Experiment was comprised of 5 lines and 3 testers of chickpea and crosses were attempted using L x T design. The resultant 15 F_1s and 8 parents are grown in Randomized Completely Block Design with two replications during *kharif* 2013-14 in research cum instructional farm Department of Genetics and Plant Breeding, College of Agriculture, I.G.K.V. Raipur (C.G.) The row to row and plant to plant spacing's were 30 cm and 10 cm, respectively and plot size of 4.8 m^2 (1.2 m × 4 m). All the recommended agronomic practices were followed. Observations were recorded on quality traits viz.,Days to 50% flowering and days to maturity were recorded on plot basis whereas, observations for the quality traits *viz.,* seed volume, hydration capacity seed^{-1}, hydration index, swelling capacity seed^{-1} and swelling index protein content cooking time were recorded in the laboratory. The combining ability analysis was performed following the method outline by Kempthorne (1957).

RESULTS AND DISCUSSION

The variance due to treatment (Table 2) recorded highly significant for all the characters. The variance due to parents found highly significant for all the characters

Table 1: Analysis of Variance for Line x Tester and combining ability in chickpea

Source	df	Characters 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Replication	1	0.06	9.13**	0.34	0.05	0.41	13.06**	2.00	0.47	4.75	0.14	0.0013**	0.0045	0.078	0.012	1.15	1.34
Treatments	22	14.10**	2.68**	17.13**	0.62**	7.35**	658.29**	140**	50.26**	469.46**	13.29**	0.004**	0.85**	0.063**	2.73**	4.36**	72.4**
Parents	7	14.46**	3.82**	2.69*	0.50**	3.35**	560.87**	13.81**	54.25**	531.08**	6.37**	0.006**	0.0067	0.034	2.89**	9.85**	113.40**
Hybrids	14	13.05**	1.65	22.51**	0.65	9.21**	761.72**	127.33**	27.05**	121.24**	10.28**	0.0035**	1.30**	0.039	2.35**	1.09	37.80**
Parent vs. hybrids	1	26.31**	8.89**	42.91**	1.01**	13.31**	495.10**	1201.49**	347.35**	4881.38**	104**	0.0094**	0.65**	0.009*	7.03**	11.34**	270.23**
Lines	4	39.74**	4.39*	22.31**	0.48**	8.50**	1149.07**	234.00**	90.91**	235.23**	15.98**	0.0082**	1.19**	0.061	0.61	1.35	99.42**
Testers	2	1.35	0.09	9.48*	0.97**	12.73**	187.70**	21.23**	1.72	85.42**	7.37**	0.0015*	1.38**	0.013	4.35**	2.67	42.57**
Line x Tester	8	2.64	0.67	25.87**	0.65**	8.68**	711.55**	100.51**	1.46	73.20**	8.16**	0.0016**	1.32**	0.034	2.72**	0.57	5.79*
Error	22	1.33	0.99	1.18	0.03	0.31	0.87	0.63	0.77	1.64	0.11	0.00016	0.0043	0.019	0.15	0.58	1.31
Variance of GCA		2.23	0.19	-1.24	0.009	0.24	-5.40	3.38	5.60	10.89	0.43	0.000040	0.00043	0.034	-0.03	0.18	8.05
Variance of SCA		0.65	-0.16	12.34	0.31	4.18	355.34	49.94	0.34	35.78	4.02	0.000072	0.65	0.0094	1.28	0.20	2.24
Variance of GC A/Variance of SCA		3.40	-1.18	-0.10	0.02	0.05	-0.01	0.06	16.47	0.30	0.10	0.55	6.61	0.03	-0.02	6.90	3.63

* = significant of p = 0.05 level, ** = significant of p = 0.01 level; 1. Days to 50 % flowering; 2. Days to maturity; 3. Plant height (cm); 4. Primary branches plant^{-1}; 5. Secondary branches plant^{-1}; 6. Pods plant^{-1}; 7. Biological yield (g); 8. 100-seed weight (g);; 9. Harvest Index (%); 10. Seed yield plant^{-1}; 11. Seed volume (ml.); 12. Hydration capacity seed^{-1}; 13. Hydration index; 14. Swelling index; 15. Protein content (%); 16. Cooking time (min.)

Table 2: General Combining Ability (GCA) effect of different parents for qualitative and quantitative characters in chickpea

Parents	Characters 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lines																
JG -97	0.42	0.27	1.31**	0.38**	1.00**	5.38**	-2.14**	1.08**	2.45**	1.22**	-0.01	-0.24**	0.25	-0.03	0.82**	-0.21
JG-2003-210	-0.01	0.46	7.7**	0.18*	-1.29**	-17.52**	1.74**	5.45**	0.08	1.16**	0.06	-0.09**	-0.08	-0.27	-0.27	-2.32**
VAIBHAV	2.74**	0.07	1.41**	-0.25**	1.40**	16.60**	9.97**	1.00**	-8.73**	0.71**	-0.01	0.79**	0.79	0.18	-0.11	-5.40**
INDIRA CHANA-1	-4.21**	0.68*	-0.24	-0.29**	-0.08	-10.74**	-3.53**	-3.27**	8.36**	-0.42**	0.02	-0.22**	-026	-0.32*	-0.37	3.62**
JG-315	1.05*	-1.48**	-3.24**	-0.02	-1.02**	6.28**	-6.04**	-4.25**	-2.17**	-2.67**	-0.04	-0.24**	0.25	0.45**	-0.08	4.31**
SE (Lines)	0.31	0.28	0.34	0.07	0.18	0.29	0.28	0.27	0.36	0.12	0.14	0.02	0.02	0.12	0.24	0.32
TESTERS																
JG-74	0.42	0.03	-0.37	-0.25**	1.11**	-4.10**	1.11**	0.41	-2.87**	-0.08	-0.02	0.43**	0.45	-0.71**	-0.59*	-2.34**
K-850	-0.24	-0.10	1.10**	0.35**	0.04	4.53**	0.54*	0.64	-0.10	0.90**	-0.01	-0.22**	0.26	0.12	0.25	0.80*
L-550	-0.18	0.08	-0.74*	-0.10	-1.15**	-0.43	-1.65**	-0.42	2.97**	-0.82**	0.01	-0.21**	0.25	0.59**	0.34	1.54**
SE(Testers)	0.22	0.20	0.24	0.05	0.13	0.20	0.20	0.19	0.25	0.08	0.001	0.02	0.03	0.09	0.17	0.22

* = Significance p > 0.05, ** = Significance p > 0.01; 1. Days to 50 % flowering; 2. Days to maturity; 3. Plant height (cm); 4. Primary branches plant^{-1}; 5. Secondary branches plant^{-1}; 6. Pods plant^{-1}; 7. Biological yield (g); 8. 100-seed weight (g); 9. Harvest Index; 10. Seed Yield plant^{-1}; 11. Seed volume (ml.); 12. Hydration capacity seed^{-1}; 13. Hydration index; 14. Swelling index; 15. Protein content (%); 16. Cooking time (min)

Table 3: Specific Combining Ability (SCA) effect of different hybrids for qualitative and quantitative characters in chickpea

Hybrid	Characters 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
JG-97×JG-74	-0.05	-0.04	-1.97**	0.35**	1.64**	-20.91**	-2.86**	-0.88*	-3.11**	-2.43**	-0.02	-0.43	0.45	1.12**	0.49	2.38**
JG-97× K-850	-0.64	0.13	-2.08**	-0.40**	-1.44**	11.05**	0.71	-0.37	0.38	1.35**	0.05**	0.24	0.25	-0.71**	0.05	-0.88
JG-97× L-550	0.69	-0.10	4.05**	0.05	-0.20	9.86**	2.15**	1.25**	2.73**	1.07**	-0.02	0.19	0.19	-0.42*	-0.54	-1.50**
JG-2003-210× JG-74	1.96**	-0.17	2.52**	0.40**	-0.07	-2.75**	-9.54**	0.55	2.27**	-1.42**	0.01	-0.43	0.45	0.71**	-0.62	0.58
JG-2003-210× K-850	-0.55	0.10	-0.15	0.35**	1.36**	5.84**	6.82**	-0.49	0.96	2.26**	0.01	0.24	0.25	-0.75**	-0.12	-0.74
JG-2003-210× L-550	-1.41**	0.07	-2.36**	-0.75**	-1.29**	-3.09**	2.72**	-0.07	-3.23**	-0.84**	-0.01	0.19	0.19	0.05	0.73*	0.15
VAIBHAV × JG-74	0.16	-0.95*	1.68**	0.18	2.64**	33.87**	11.23**	-0.80	-3.51**	2.07**	0.02	1.68	1.55	-1.86**	0.12	-2.53**
VAIBHAV × K-850	0.10	0.39	-3.04**	-0.62**	-1.84**	-17.87**	-6.92**	0.91*	0.66	-1.84**	-0.01	-0.85	-0.84	1.47**	0.11	1.86**
VAIBHAV ×L-550	-0.26	0.56	1.35*	0.43**	-0.80**	-16.00**	-4.31**	-0.12	2.85**	-0.24	-0.01	-0.83	0.01	0.39*	-0.23	0.67
INDIRA CHANA-1×JG-74	-1.30*	0.40	2.13**	-0.33**	-1.58**	4.80**	1.13*	0.77	5.55**	1.46**	0.01	-0.46	-0.45	-0.69**	0.47	-0.84
INDIRA CHANA-1 ×K-850	0.71	-0.01	0.71	0.07	0.14	-7.03**	2.94**	-0.17	-9.58**	-0.16	-0.03**	0.18	-0.19	-0.06	-0.10	0.85
INDIRA CHANA-1× L-550	0.59	-0.38	-2.85**	0.27*	1.43**	2.23**	-4.06**	-0.60	4.02**	-1.30**	0.02	0.28	-0.26	0.75**	-0.38	-0.01
p																
JG-315× JG-74	-0.78	0.76	-4.37**	-0.60**	-2.64**	-15.01**	0.04	0.35	-1.20*	0.31	-0.01	-0.36	-0.44	0.72**	-0.47	0.41
JG-315 ×K-850	0.39	-0.61	4.56**	0.60**	1.78**	8.00**	-3.54**	0.11	7.58**	-1.61**	-0.01	0.20	0.22	0.05	0.05	-1.09
JG-315× L-550	0.39	-0.15	-0.20	0.60**	0.86**	7.01**	3.50**	-0.47	-6.37**	1.30**	0.02	0.16	-0.13	-0.76**	0.42	0.68
SE (Hybrid)	0.44	0.40	0.48	0.10	0.26	0.41	0.39	0.39	0.51	0.16	0.01	0.03	0.04	0.18	0.34	0.45

* = Significance p>0.05, ** = Significance p>0.01; 1. Days to 50 % flowering; 2. Days to maturity; 3. Plant height (cm); 4. Primary branches plant^{-1}; 5. Secondary branches plant^{-1}; 6. Pods plant^{-1}; 7. Biological yield (g); 8. 100-seed weight (g); 9. Harvest Index (%); 10. Seed yield plant^{-1}; 11. Seed volume (ml.); 12. Hydration capacity seed^{-1}; 13. Hydration index; 15. Protein content (%); 16. Cooking time (min)

except hydration capacity seed and hydration index for plant height (cm). The variance due to crosses was recorded highly significant for all the characters except days to maturity, primary branches plant-[1], hydration index and protein content (%).The variance due to parent vs crosses recorded highly significant for all the characters. The variance due to lines recorded highly significant for all the trait except hydration index, swelling index and protein content (%).The variance due to testers found highly significant for all the characters excepts days to 50 % flowering, days to maturity, 100-seed weight, hydration index and protein content. The variance due to line × testers found highly significant for all the characters excepts days to 50 % flowering, days to maturity, 100-seed weight, hydration index and protein content.

Estimation of GCA effects of lines (table-2). The parent JG-2003-210 (7.7) and Vaibhav (1.41) is highly good general combiner for plant height and JG-97 (0.38) for primary branches per plant and JG-74 (1.11) for secondary branches per plant, Vaibhav (16.60) for pods per plant and biological yield, JG-2003-210 (5.45) for 100 seed weight, Indira Chana-1 (8.36) and L-550 (2.97) for harvest index, JG-97 (1.22), JG-2003-210 (1.16) for seed yield per plant, JG-315 (0.45), L-550 (0.59) for swelling index, JG-97(0.82) for protein content and 2003-210 (-2.32), Vaibhav (-5.40) are the good general combiner for cooking time. The high gca effects are generally ascribed to additive gene effects or additive×additive interaction effects (Griffing 1956), hence the good general combiners can be used for the genetic amelioration of chickpea. Similar result were reported by Bhardwaj *et al.*, (2009), Monpara *et al.*, (2014), Bhatt *et al.*, (2013), Bhatnagar and Singh (2005), Kulkarni *et al.*, (2004), Jeena and Arora *et al.,* (2001), Kashyap *et al.*,(2003), Gupta et al, (2007), Verma and Waldiya (2010), Jayalakshmi *et al.,* (2009).

The SCA effect for grain yield per plant Among the 15 hybrids, 12 hybrids has found good specific combiner for various traits. The crosses JG-2003-210 × JG-74 (1.96) showed significant and negative sca effects for days to 50 % flowering, JG-97× L-550 (4.05), JG-2003-210× JG-74 (2.52) found highest sca effect for plant height. The crosses JG-315 ×K-850 (0.60) for primary branches per plant, JG-97× JG-74 (1.64), for secondary branches per plant, JG-97× K-850 (11.05) for pods per plant, JG-2003-210× K-850 (6.82) for biological yield. JG-97× L-550 (1.25) for 100 seed weight. INDIRA CHANA-1 ×JG-74 (5.55) for harvest index. JG-2003-210× K-850 (2.26) for seed yield per plant. JG-97× L-550 (0.05), for seed volume, JG-97× JG-74 (1.12) for swelling index, JG-2003-210× L-550 (0.73) for protein content and the crosses JG-97× JG-74 (2.38), found good specific combiner for cooking time. The crosses with high per se performance possessed high sca effects. Thus, even the parents with low/ medium general combining abilities can lead to high sca effects in the crosses indicating, thereby the influence of nonadditive interaction in these crosses. In self-pollinated crops, the ultimate aim is to generate desirable transgressive segregants for developing potential homozygous lines through hybridization. Similar finding were reported by Bhardwaj *et al.,* (2010), Gadekar *et al.,* (2013), Mishra *et al.*, (2013), Jadhav and Gawande (2013), Dodiya *et al.* (2012), Bhatt *et al.* (2013), Hemati *et al.* (2010), Khan *et al.* (2006). Kaur *et al.* (2004). Jayalakshmi *et al.* (2009), Kulkarni *et al.* (2004), Bhadouria *et al.* (2003).

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