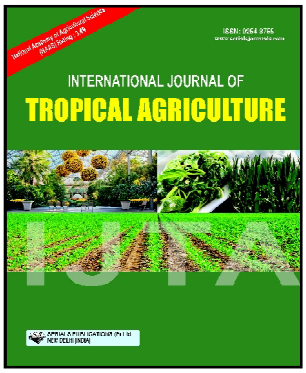

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Performance of genotypes and morphology characters in chickpea (*Cicer arietinum* L.) under rice based cropping system

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Abstract: Analysis of variance revealed that mean sum of squares due genotypes were significant for the all the characters in all three environment (E_1, E_2 and E_3). On the basis of mean per se performance the crosses JG 14 x ICCV 96030 , JG 130 x JG 97 and JG 315 x JG 97 recorded higher number of pods plan^{-1} in E_1 (CS-I), E_2 (CS-II). Similarly in E_3 (CS-III) JG 11 x JG 97, JG 14 x ICCV 96030 and JG 16 x JG 97 recorded highest pos plant^{-1}. For 100 seed weight crosses INDIRA CHANA-1 x J G-97, VAIBHAV x ICCV 96029and JG 16 x ICCV 96030 recorded more than 19 gram in E1 (CS-I) and JG 16 x ICCV 96029, JG 16 x JG 97 and JG 11 x JG 97 recoded more than 20 gram in E_2 (CS-II). for seed yield Crosses JG 14 x ICCV 96030, JG 16 x ICCV 96029, JG 130 x JG 97 and JG 16 x JG 97 recorded higher yield in all three environment E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III). For protein content VAIBHAV x ICCV 96029, JG 11 x ICCV 96029 and JG 130 x ICCV 96030 recorded protein content more than 17.0 gram in all three environment E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III) studies.

Keywords: Genetic variability, Genetic morphology and chickpea

INTRODUCTION

Chickpea [*Cicer arietinum* (L.) $2n = 2x = 16$] belongs to genus *Cicer,* tribe Cicereae, family Fabaceae, and subfamily Papilionaceae. Chickpea is the world's third most important food legume crop grown as rainfed in cool and dry climate in semi-arid regions. During the last few decades, due to increasing demand of the food for world's growing population depend to a large extent on the conservation and use of world's remaining plant genetic resources. Chickpea covers about 11.7 million ha area and 9.3 million tones production in over 45 countries of the world. India is the largest chickpea producer accounting a share of about 67% in global chickpea production with

about 8.25 million ha area, 7.33 million tones production and productivity of 889 kg/ha. Distribution of chickpea in six states *viz*., Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh together contribute 90.2% of the production and 90.8% of the area of the country. Chhattisgarh covers 0.281 million ha area with production 0.294 million tones and productivity of 1035 kg ha^{-1}. [2](Project Coordinators Report, 2015-16). Genetic variability and morphological Characters are the first pre-requisite for any crop improvement programme as it provides opportunity to select an ideal plant type. It helps for choice of better yield attributes either for selection or hybridization.

MATERIALS AND METHODS

The experimental material comprised *viz*. seven lines *viz*., Vaibhav, Indira Chana-1, JG 315, JG 11, JG 14, JG 16, JG 130 of agronomic base and three testers JG 97, ICCV 96029 and ICCV 96030 for early maturity were crossed as per Line x Tester mating design fashion (Kempthorn, 1957) to develop 21 F_1 during, 2014-15. These F_1along with their parents were evaluated two replication in one row plot during, 2015-16. Under following three rice based cropping system *viz*. **E_1**: Cropping System I: after harvest of early rice variety (Danteshwari) CS-I, **E_2**: Cropping System II: after harvest of medium rice variety (Mahamaya). CS-II, **E_3**: Cropping System III: after harvest of late rice variety (Dubraj) CS-III. The row to row and plant to plant spacing 30 x 10 cm maintained at Research cum Instructional farm, Department of Plant Breeding and Genetics, Indira Gandhi Agricultural University, Raipur The recommended packages of practices were adopted to raise the normal crops. Observations on metric traits where recorded on single plant basis on five randomly selected competitive plant of each genotypes from each replication in each cropping system were as observation on days to 50% flowering, days to maturity, plant height (cm), number of primary branches plant^{-1}, pods plant^{-1}, Biological yield plant^{-1} (g), harvest index (%), 100 seed weight (g), Seed yield plant^{-1} (g), seed volume (ml seed^{-1}), hydration capacity seed^{-1} (g), hydration index, swelling index and protein content (%) were recorded on plot basis as per the chickpea descriptor developed by ICRISAT-IBPGR- ICARDA (1993). [3]Criteria were used to test the significance differences in mean values of all the fifteen characters.

RESULTS AND DISCUSSION

Analysis of variance in E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III) presented in Table 1 indicated that the mean sum of squares due genotypes were significant for the all the characters studies which, revealed that there was considerable genetic variability amongst the material under the study, which can be exploited through selection. This is an indicative of existence of sufficient variability among the genotypes for the traits. These findings are in general agreement with the findings of [1]Altnbas (2002), [10]Parshuram *et al.* (2003), [4]Brar *et al.* (2004), [7]Kaur *et al.* (2004), [5]Durga *et al.* (2005), [6]Jeena *et al.* (2005) and [11]Shrivastava *et al.* (2005). Genetic parameter of variation for seed yield and its components among 31 genotypes (Parents and crosses) are presented over all mean and range for yield and its components revealed that there is statistical genetic variability.

The crosses JG 14 x ICCV 96030 , JG 130 x JG 97 and JG 315 x JG 97 recorded higher number of pods plan^{-1} in E_1 (CS-I), E_2 (CS-II). Similarly in E_3 (CS-III) JG 11 x JG 97, JG 14 x ICCV 96030 and JG 16 x JG 97 recorded high pos plant^{-1}. For 100 seed weight crosses INDIRA CHANA-1 x J G-97, VAIBHAV x ICCV 96029and JG 16 x ICCV 96030 recorded more than 19 gram in E1 (CS-I) and JG 16 x ICCV 96029, JG 16 x JG 97 and JG 11 x JG 97 recoded more than 20 gram in E_2 (CS-II). On the basis of mean per se performance for seed yield Crosses JG 14 x ICCV 96030, JG 16 x ICCV 96029, JG 130 x JG 97 and JG 16 x JG 97 recorded higher yield in all three environment E_1 (CS-I), E_2 (CS-II)

Table 1

Analysis of variance for yield, its attributes and quality characters under E_1, E_2 and E_3 in chickpea

		Mean sum of squares														
Source of variation	*D.F.*	*Days to 50% flowering*	*Days to maturity*	*Plant height (cm)*	*Primary branches plant^{-1}*	*Secondary branches plant^{-1}*	*Pods plant^{-1}*	*Biological yield plant^{-1} (g)*	*Harvest index (%)*	*100-seed weight (g)*	*Seed yield plant^{-1}(g)*	*Seed volume (ml seed^{-1})*	*Hydration capacity seed^{-1} (g)*	*Hydration index*	*Swelling index*	*Protein content (%)*
E_1: CS-I (After harvest of early rice variety of 90-110 days)																
Replication	1	0.000	0.750	22.350	7.730	45.650	9.600	11.590	16.150	0.000	26.450	0.004	0.0012	0.0005	0.136	0.944
Treatment	30	26.55**	12.190**	40.370**	6.140**	376.02**	9197.4**	881.57**	341.26**	20.60**	301.12**	0.02**	0.0213**	0.0032**	3.920**	2.160**
Error	30	1.000	1.350	16.340	0.510	14.480	366.900	35.060	51.040	0.353	9.55	0.008	0.00068	0.0001	0.0813	0.776
E_2: CS-I I (After harvest of medium rice variety of 111-135 days)																
Replication	1	22.090	17.50	165.05	2.245	45.470	650.43	58.46	157.8	0.230	0.289	0.0014	0.0067	0.00052	0.089	1.896
Treatment	30	32.79**	27.66**	102.14**	4.037**	310.01**	6475.9**	731.99**	239.4**	22.18**	317.15**	0.023**	0.209**	0.0032**	3.45**	1.898**
Error	30	0.880	0.966	14.520	0.433	17.970	526.300	57.380	56.880	0.364	12.31	0.0078	0.009	0.00012	0.165	0.5489
E_3: CS-I II (After harvest of late rice variety of above 135 days)																
Replication	1	0.0035	5.790	54.32	0.505	0.029	69.17	43.78	580.6	0.2382	17.140	0.0041	0.0033	0.00042	0.2061	0.7568
Treatment	30	32.09**	26.587**	60.40**	1.993**	262.75**	684.75**	462.16**	255.53*	23.07**	163.47**	0.019**	0.206**	0.0031**	3.124**	2.3847**
Error	30	0.688	0.632	9.77	0.4587	11.83	83.76	21.69	120.42	0.365	9.88	0.0073	0.0014	0.00001	0.3667	0.5868

* Significant at 5 % level; **Significant at 1 % level of probability

Table 2
Plant growth habit and seed characters of different parents and crosses' used under the experiments

Parents/ Crosses	*Plant Growth Habit*	*Seed Shape*	*Seed Texta Texture*
VAIBHAV	Erect	Angular	Tuberculated
INDIRA CHANA-1	Semi- Erect	Angular	Smooth
JG-315	Semi- Erect	Angular	Tuberculated
JG 11	Semi- Erect	Angular	Smooth
JG 14	Semi- Erect	Angular	Tuberculated
JG 16	Semi- Erect	Angular	Smooth
JG 130	Semi- Erect	Angular	Smooth
JG 97	Semi- Erect	Angular	Smooth
ICCV 96029	Semi- Erect	Angular	Tuberculated
ICCV 96030	Semi- Erect	Angular	Tuberculated
VAIBHAVx JG 97	Semi- Erect	Angular	Tuberculated
VAIBHAVx ICCV 96029	Semi- Erect	Angular	Tuberculated
VAIBHAVx ICCV 96030	Semi- Erect	Angular	Tuberculated
INDIRA CHANA-1xJG-97	Semi- Erect	Angular	Smooth
INDIRA CHANA-1x ICCV 96029	Semi- Erect	Angular	Smooth
INDIRA CHANA-1x ICCV 96030	Semi- Erect	Angular	Tuberculated
JG 315 x JG 97	Semi- Erect	Angular	Smooth
JG 315 x ICCV 96029	Semi- Erect	Angular	Tuberculated
JG 315 x ICCV 96030	Semi- Erect	Angular	Tuberculated
JG 11 x JG 97	Semi- Erect	Angular	Tuberculated
JG 11 x ICCV 96029	Semi- Erect	Angular	Tuberculated
JG 11 x ICCV 96030	Semi- Erect	Angular	Smooth
JG 14 x JG 97	Semi- Erect	Angular	Tuberculated
JG 14 x ICCV 96029	Semi- Erect	Angular	Smooth
JG 14 x ICCV 96030	Semi- Erect	Angular	Smooth
JG 16 x JG 97	Semi- Erect	Angular	Smooth
JG 16 x ICCV 96029	Semi- Erect	Angular	Tuberculated
JG 16 x ICCV 96030	Semi- Erect	Angular	Smooth
JG 130 x JG 97	Semi- Erect	Angular	Tuberculated
JG 130 x ICCV 96029	Semi- Erect	Angular	Tuberculated
JG 130 x ICCV 96030	Semi- Erect	Angular	Tuberculated

Table 3

Top ranking specific cross combination on the basis of per se performance for different characters in chickpea

Characters	E_1		E_1		E_1	
	Cross combinations	*Value of per se performance*	*Cross combinations*	*Value of per se performance*	*Cross combinations*	*Value of per se performance*
Days to 50 % Flowering	JG 14 x JG 97	51	JG 14 x JG 97	50	VAIBHAV x JG 97	46
	VAIBHAV x ICCV 96029	52	VAIBHAV x ICCV 96029	51	JG 14 x JG 97	47
	JG 14 x ICCV 96029	52	JG 14 x ICCV 96029	51	VAIBHAV x ICCV 96029	48
	JG 14 x ICCV 96030	52	JG 14 x ICCV 96030	51	JG 14 x ICCV 96030	48
	JG 130 x ICCV 96030	53	JG 130 x ICCV 96030	52	JG 14 x ICCV 96029	49
Days to maturity	JG 16 x ICCV 96029	102	JG 130 x ICCV 96029	102	VAIBHAV x JG 97	96
	JG 130 x ICCV 96029	102	VAIBHAV x JG 97	103	JG 130 x ICCV 96030	96
	VAIBHAV x JG 97	103	JG 16 x ICCV 96029	103	JG 16 x ICCV 96029	96
	JG 16 x ICCV 96030	103	JG 16 x ICCV 96030	103	JG 16 x ICCV 96030	97
	JG 130 x JG 97	103	JG 130 x JG 97	103	JG 130 x JG 97	97
Plant Height (cm)	JG 130 x ICCV 96030	46.90	JG 130 x ICCV 96030	43.75	JG 14 x ICCV 96030	32.35
	VAIBHAV x JG 97	49.20	JG 11 x JG 97	49.45	JG 16 x JG 97	33.20
	JG 11 x JG 97	49.50	JG 16 x ICCV 96030	49.55	JG 16 x ICCV 96030	34.00
	JG 16 x ICCV 96030	50.10	VAIBHAV x JG 97	50.15	INDIRA CHANA-1xJG-97	35.16
	JG 130 x ICCV 96029	51.50	INDIRA CHANA-1xJG-97	51.85	JG 315 x ICCV 96030	36.35
Primary branches plant^{-1}	JG 16 x JG 97	8.10	JG 16 x JG 97	7.55	JG 16 x JG 97	5.75
	JG 11 x ICCV 96030	7.70	JG 14 x ICCV 96029	6.95	JG 130 x JG 97	5.65
	JG 14 x ICCV 96029	7.50	JG 130 x ICCV 96029	5.95	JG 11 x JG 97	5.15
	VAIBHAV x JG 97	6.75	JG 14 x ICCV 96030	5.95	JG 130 x ICCV 96029	4.90
	JG 130 x ICCV 96029	6.50	VAIBHAV x JG 97	5.85	JG 16 x ICCV 96030	4.85
Secondary branches plant^{-1}	JG 16 x ICCV 96029	54.00	JG 130 x JG 97	50.55	JG 16 x ICCV 96030	43.45
	JG 130 x JG 97	49.90	JG 16 x ICCV 96029	47.65	JG 130 x ICCV 96030	42.55
	JG 16 x JG 97	43.70	JG 16 x ICCV 96030	46.55	JG 130 x JG 97	40.55
	JG 16 x ICCV 96030	42.30	JG 16 x JG 97	41.35	JG 14 x ICCV 96029	37.85
	JG 11 x JG 97	39.70	JG 130 x ICCV 96029	35.65	JG 16 x ICCV 96029	37.15

contd. table 3

Characters	E_1		E_1		E_1	
	Cross combinations	*Value of per se performance*	*Cross combinations*	*Value of per se performance*	*Cross combinations*	*Value of per se performance*
Pods plant^{-1}	JG 14 x ICCV 96030	265.50	JG 14 x ICCV 96030	247.0	JG 11 x JG 97	98.60
	JG 130 x JG 97	242.70	JG 16 x JG 97	237.5	JG 14 x ICCV 96030	90.80
	JG 315 x JG 97	228.10	JG 130 x JG 97	215.2	JG 16 x JG 97	88.40
	JG 16 x JG 97	217.50	JG 130 x ICCV 96029	191.8	VAIBHAV x JG 97	79.60
	JG 130 x ICCV 96029	211.80	INDIRA CHANA-1x ICCV 96029	166.3	INDIRA CH-1x ICCV 96030	77.05
Biological yield Plant $^{-1}$	JG 14 x ICCV 96030	87.25	JG 14 x ICCV 96030	80.6	JG 16 x JG 97	64.10
	JG 130 x JG 97	86.40	JG 130 x ICCV 96029	76.5	JG 315 x ICCV 96030	61.40
	JG 16 x ICCV 96029	81.00	JG 11 x JG 97	75.5	JG 130 x ICCV 96029	59.00
	JG 130 x ICCV 96029	80.10	JG 16 x JG 97	75.1	JG 16 x ICCV 96029	57.10
	JG 315 x ICCV 96029	79.20	JG 315 x ICCV 96029	74.4	JG 130 x JG 97	56.80
Harvest Index (%)	JG 14 x ICCV 96030	81.77	JG 16 x ICCV 96029	83.1	JG 14 x ICCV 96029	80.23
	JG 16 x ICCV 96029	69.58	JG 14 x ICCV 96030	82.6	JG 14 x ICCV 96030	74.54
	IC-1 x ICCV 96029	54.41	JG 14 x JG 97	56.4	JG 16 x ICCV 96029	73.22
	JG 16 x JG 97	52.13	JG 130 x JG 97	54.3	JG 315 x ICCV 96029	71.65
	JG 130 x JG 97	49.09	JG 315 x ICCV 96030	53.6	VAIBHAV x ICCV 96029	70.16
100 seed weight (g)	INDIRA CHANA-1 xJ G-97	19.40	JG 16 x ICCV 96029	23.9	JG 16 x ICCV 96029	23.64
	VAIBHAV x ICCV 96029	19.25	JG 16 x JG 97	23.5	JG 16 x JG 97	23.29
	JG 16 x ICCV 96030	19.10	JG 11 x JG 97	20.6	JG 11 x JG 97	20.34
	JG 14 x ICCV 96029	18.55	INDIRA CHANA-1xJG-97	19.0	INDIRA CHANA-1 xJG-97	18.79
	JG 14 x ICCV 96030	18.52	VAIBHAV x ICCV 96029	18.9	VAIBHAV x ICCV 96029	18.64
Seed yield plant $^{-1}$	JG 14 x ICCV 96030	71.30	JG 14 x ICCV 96030	66.6	JG 16 x ICCV 96029	41.75
	JG 16 x ICCV 96029	56.00	JG 16 x ICCV 96029	55.3	JG 14 x ICCV 96030	40.55
	JG 130 x JG 97	42.40	JG 16 x JG 97	39.0	JG 130 x JG 97	36.65
	JG 16 x JG 97	41.20	JG 130 x JG 97	37.7	JG 16 x JG 97	35.45
	IC-1x ICCV 96029	39.10	IC-1 x ICCV 96029	36.9	INDIRA CH-1x ICCV 96030	32.65

contd. table 3

Characters	E_1		E_1		E_1	
	Cross combinations	*Value of per se performance*	*Cross combinations*	*Value of per se performance*	*Cross combinations*	*Value of per se performance*
Seed volume (ml seed^{-1})	JG 315 x JG 97	0.23	JG 315 x JG 97	0.220	JG 315 x JG 97	0.215
	JG 16 x ICCV 96030	0.22	JG 16 x ICCV 96030	0.205	JG 16 x ICCV 96030	0.215
	JG 14 x ICCV 96030	0.20	JG 14 x ICCV 96030	0.185	JG 14 x ICCV 96030	0.195
	JG 16 x ICCV 96029	0.19	JG 16 x ICCV 96029	0.180	JG 16 x ICCV 96029	0.185
	JG 11 x ICCV 96030	0.19	JG 11 x ICCV 96030	0.175	JG 11 x ICCV 96030	0.185
Hydration capacity seed $^{-1}$	JG 16 x JG 97	0.405	JG 16 x JG 97	0.405	JG 16 x JG 97	0.405
	JG 14 x JG 97	0.395	JG 14 x JG 97	0.385	JG 14 x JG 97	0.390
	JG 14 x ICCV 96029	0.385	JG 14 x ICCV 96029	0.380	JG 14 x ICCV 96029	0.380
	JG 16 x ICCV 96029	0.365	JG 16 x ICCV 96029	0.365	JG 16 x ICCV 96029	0.365
	JG 11 x ICCV 96030	0.365	JG 11 x ICCV 96030	0.365	JG 11 x ICCV 96030	0.365
Hydration index	JG 130 x ICCV 96030	0.063	JG 130 x ICCV 96030	0.062	JG 130 x ICCV 96030	0.063
	JG 14 x JG 97	0.057	JG 14 x JG 97	0.056	JG 14 x JG 97	0.057
	JG 14 x ICCV 96029	0.055	JG 14 x ICCV 96029	0.054	JG 14 x ICCV 96029	0.055
	JG 130 x ICCV 96029	0.048	JG 130 x ICCV 96029	0.047	JG 130 x ICCV 96029	0.048
	JG 11 x ICCV 96030	0.037	JG 11 x ICCV 96030	0.036	JG 11 x ICCV 96030	0.037
Swelling index	JG 315 x ICCV 96030	8.74	JG 130 x ICCV 96029	7.889	JG 11 x ICCV 96029	7.782
	JG 130 x ICCV 96029	7.89	JG 11 x ICCV 96029	7.794	JG 315 x ICCV 96030	7.722
	JG 11 x ICCV 96029	7.80	JG 315 x ICCV 96030	7.738	JG 130 x ICCV 96029	7.623
	JG 130 x ICCV 96030	6.80	JG 130 x JG 97	6.749	JG 14 x ICCV 96029	6.470
	JG 130 x JG 97	6.75	JG 130 x ICCV 96030	6.745	JG 130 x JG 97	6.434
Protein content (%)	VAIBHAV x ICCV 96029	16.80	VAIBHAV x ICCV 96029	16.80	VAIBHAV x ICCV 96029	16.75
	JG 11 x ICCV 96029	16.64	JG 11 x ICCV 96029	16.64	JG 11 x ICCV 96029	16.59
	JG 130 x ICCV 96030	16.46	JG 130 x ICCV 96030	16.46	JG 130 x ICCV 96030	16.41
	JG 11 x JG 97	16.36	JG 11 x JG 97	16.36	JG 11 x JG 97	16.31
	VAIBHAV x ICCV 96030	16.33	VAIBHAV x ICCV 96030	16.33	VAIBHAV x ICCV 96030	16.28

and E_3 (CS-III) studies. For protein content VAIBHAV x ICCV 96029, JG 11 x ICCV 96029 and JG 130 x ICCV 96030 recorded protein content more than 17.0 gram in all three environment E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III) studies.

CONCLUSION

Analysis of variance revealed that mean sum of squares due genotypes were significant for the all the characters in all three environment (E_1, E_2 and E_3). On the basis of mean per se performance the crosses JG 14 x ICCV 96030 , JG 130 x JG 97 and JG 315 x JG 97 recorded higher number of pods plan^{-1} in E_1 (CS-I), E_2 (CS-II). Similarly in E_3 (CS-III) JG 11 x JG 97, JG 14 x ICCV 96030 and JG 16 x JG 97 recorded highest pos plant^{-1}. For 100 seed weight crosses INDIRA CHANA-1 x J G-97, VAIBHAV x ICCV 96029and JG 16 x ICCV 96030 recorded more than 19 gram in E1 (CS-I) and JG 16 x ICCV 96029, JG 16 x JG 97 and JG 11 x JG 97 recoded more than 20 gram in E_2 (CS-II). for seed yield Crosses JG 14 x ICCV 96030, JG 16 x ICCV 96029, JG 130 x JG 97 and JG 16 x JG 97 recorded higher yield in all three environment E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III). For protein content VAIBHAV x ICCV 96029, JG 11 x ICCV 96029 and JG 130 x ICCV 96030 recorded protein content more than 17.0 gram in all three environment E_1 (CS-I), E_2 (CS-II) and E_3 (CS-III) studies.

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