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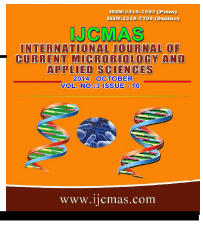

Original Research Article

Combining ability studies in Grain Sorghum using line X tester analysis

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A B S T R A C T

Combining ability for grain yield and its components was studied using four cytoplasmic male sterile (CMS) lines and ten testers at Sorghum research unit, Dr. PDKV, Akola, Maharashtra. Mean sum of squares due to lines, testers and line × tester were highly significant indicating the existence of high variability for most of the characters. The estimates of general combining ability (GCA) and specific combining ability (SCA) variances indicated the presence of higher magnitude non-additive gene action for most of the characters. The line ICS-516A and testers ICSR-44347, AKR-456 was found to be good general combiners for yield contributing traits. The F_1's ICS-40A x ICSR-44347 (5.990), ICS-516 A x ICSR-44347 (5.196) and ICS-516A x AKR-456 (5.378) were identified with high significant and positive SCA for grain yield.

Keywords

GCA, line × tester, sca sorghum.

Introduction

Sorghum (*Sorghum bicolor* (L.). Moench) is an important food and fodder crop of dry land agriculture. It has wide range of adaptability to various agroecological situations of the region. Combining ability studies provide useful information regarding the selection of suitable parents for effective hybridization programme. Also indicates the nature and magnitude of various types of gene action involved in the expression of quantitative characters. Such information is of potential use in formulating and executing an efficient breeding programme for achieving maximum genetic gain with minimum resources and time. Hence this study was conducted with the aim to understand the combining ability of the selected lines and testers in sorghum.

Materials and Methods

The present investigation was carried out at Dr. Panjabrao Deshmukh Krishi Vidyapeeth (Dr. PDKV), Akola during *rabi* 2007-08. Four cytoplasmic male sterile lines (ICS-40A, ICS-42A, ICS-18A and ICS-516A) were crossed with ten testers (ICSR-44347, ICSR-43743, ICSR-43745, ICSR-43405,

ICSR-43413, ICSR-43407, AKR-73, AKR-354, AKR-436 and AKR-456) in line x tester mating design to produce 40 F_1's. The resulting 40 F_1's along with their 14 parents and one check (CSH-16) were evaluated for various yield contributing traits of sorghum during *kharif* 2008-09 at Sorghum Research Unit, Dr. P.D.K.V., Akola.

The entries were planted in a Randomized Block Design (RBD) with three replications. Each entry consisted of row length of 3 m withinter and intra spacing of 45 cm and 15 cm respectively. Data were recorded on five randomly selected plants in each replication viz., plant height (cm), panicle length (cm), no. of primary branches/panicle, no. of secondary branches/per panicle, no. of grains/panicle, 1000-grain weight (g) and grain yield/plant(g). The collected data were subjected to statistical analysis to understand the magnitude GCA and SCA of above mentioned parents and F_1's.

Results and Discussion

The analysis of variances (Anova) for combining ability indicated that highly significant variation due to lines for no. of primaries branches/panicle, no. of secondary branches/panicle and no. of grains/panicle (Table 1). As regards testers, highly significant differences were observed for all characters except plant height at harvest. Due to lines *vs*. testers effect highly significant variation showed in plant height at harvest, no. of primaries branches/panicle, no. of secondary branches/panicle and no. of grains/ panicle (Table 1).

General combining ability (GCA) effects

Significant and positive GCA effects are desirable for plant height (Table 2). Out of four lines, ICS-42A and ICS-18A showed significant and positive GCA (4.913 and 1.840 respectively). However, line ICS-516A (-4.837) showed significant and negative GCA effects. Among the testers, ICSR-43743 (7.510), ICSR-44347 (6.418), and AKR-456 (6.193) showed significant and positive GCA effect generally which is desirable. The testers ICSR-44347 recorded not only significant positive GCA (6.418) effect but also highest mean value (191.60 cm) for plant height. ICSR-43745 (-5.390) and AKR-73 (-13.798) showed significant and negative GCAeffect which registered dwarfness for plant height for these genotypes.

As regards panicle length,among the lines, only ICS-18A showed significant and positive GCAeffect(1.756) with higher mean performance (51.90 cm). Whereas, out of ten testers, ICSR-44337 (8.133), ICSR-43407 (6.316) and ICSR-43405 (3.741)recorded significant and positive GCAeffect with the higher average value of 68 cm, 48.77 cm and 49.40 cm respectively. However, the testers, AKR-354 (-7.501), ICSR-43413 (-3.343), AKR-456 (-3.126) showed significant and negative GCAeffect(Table 2).

For number of primary branches/per panicle, among the lines, ICS-516A (6.273) showed highly significant and positive GCA effects with highest mean value 78.10 as presented in Table 2. Likewise, out of ten testers, ICSR-43407 (8.189) and ICSR-44347 (7.023) showed highest significant and positive GCA effects with mean performance of 72 and 78.93 respectively. Whereas, AKR-73 (-6.694), AKR-354 (-5.786), ICSR-43745 (-4.178), and ICSR-43413 (-3.644), showed significant and negative GCA effects which is not desirable for no of primary branches/panicle.

Table 2 indicated that lines ICS-40A, ICS-42A and ICS-516A found with highest

significant positive GCA effect (11.306, 10.636, and 3.446 respectively) and mean performance (213.73, 272.93 and 254.97) for no. of secondary branches/panicle. However, ICS-18A (-25.388) showed significant and negative GCA effect with lowest mean performance (196.10). Among the testers, ICSR-43407 (26.423), ICSR-44347 (26.098), AKR- 456 (9.289), AKR-354 (7.097), ICSR-43743 (4.506) and AKR-436 recorded highest significant and positive GCA effects with highest average value at 379.0, 434.93, 330.23, 311.17, 289.57 and 340.50 respectively. While, ICSR-43745 (-33.436), AKR-73 (-22.778) showed significant and negative GCA effects.

Out of four lines, ICS-516A showed highest significant and positive GCA effect (32.978) with highest mean performance (1126.37) for no. of grains/ panicle as represented in Table 2. Moreover, among testers, ICSR-44347 (52.078) and AKR-456 (42.403) recorded highest significant and positive GCA effects with highest average value of 1199.80 and 1197.73 respectively. Similarly, ICSR-43745 (-84.806), ICSR-43743 (-33.281) showed highest significant and negative GCA effects for no. of grains/panicle.

As regards 1000-grain weight, among lines, ICS-516A showed highest significant positive GCA effect (1.682) with highest mean performance (55.77 g). Whereas, in testers ICSR-44347 (6.987) and AKR-456 (2.756) recorded highest significant and positive GCA effects with average value of 61.73g and 58.17 g respectively. ICSR-43743 (-3.226), ICSR-43745 (-3.101), ICSR-43413 (-2.704) showed significant and negative GCA effects.

Grain yield/plant is very important yield contributing trait. Among the lines, ICS-516A exhibited highest significant and positive GCA effect (2.202) with mean performance of 56.86 g. Likewise,out of ten testers, ICSR-44347 (7.887) and AKR-456 (2.597) showed highest significant and positive GCA effect with highest average value 62.59 g and 58.65 g respectively. However, ICSR-43745 (-3.374) and ICSR-43413 (-2.909) found with significant and negative GCA effects.

Specific combining ability (SCA) effects

Among the fortyF_1's, nine F_1's showed significant and positiveSCA effects for plant height whereas, nine F_1'srecorded significant and positive SCA effects. The F_1's with significant positiveSCA are ICS-40A x AKR-73 (14.908), ICS-516A x ICSR-44347 (14.412), ICS-516A x AKR-354 (13.345), ICS-42A x AKR-73 (10.778), ICS-516A x ICSR-43405 (9.503), ICS-516A x ICSR-43743 (8.753), ICS-516A x ICSR-43413 (7.737), ICS-516A x AKR-456 (6.890), ICS-40A x ICSR-43745 (6.833). Out of these nine F_1's some of the crosses were identified best for the plant height such as ICS-516A x ICSR-44347 (14.412), ICS-516A x ICSR-43405 (9.503), ICS-516A x ICSR-43743 (8.753), ICS-516A x AKR-456 (6.890) as along significant and positive SCA its recorded highest average values (239.47 cm, 234.90 cm, 231.53 cm and 228.57 cm respectively) as represented in Table 3.

As regards panicle length (Table 3),out of forty F_1's, three hybrids showed significant and positive SCA effects viz., ICS-516A x ICSR-44347 (8.133), ICS-18A x AKR -354 (6.961), ICS-516A x ICSR-43407 (6.316) with the mean performance at 55.50 cm, 49.57 cm and 50.63 cm respectively. However, the hybrids with negative SCA are ICS-516A x AKR-73 (-7.501), ICS-18A x ICSR-43743 (-7.431), ICS-40A x ICSR-43405 (-6.694) and ICS-42A x AKR-456 (-6.108). Among the hybrids (F_1's), six hybrids showed highest significant and

positive SCA effects while three hybrids noted significant and negative SCA effects for no. of primary branches/panicle. The crosses identified as good for no. of primary branches/panicle on the basis of significant SCA and average mean value are ICS-40A x ICSR-43407 (10.481 and 77.77), ICS-516A x ICSR-43407 (9.827 and 83.20), ICS-42A x ICSR-43413 (8.247 and 61.77), ICS-18A x AKR-43745 (7.844 and 60.87), ICS-516A x AKR-436 (7.794 and 76.13), ICS-40A x ICSR-44347 (7.253 and 64.87). However, the F_1's with negative SCA are ICS-18A x ICSR-43407 (-10.689), ICS-42A x ICSR-43407 (-9.619) and ICS-516A x ICSR-43745 (-8.639) as shown in Table 3.

For the no. of secondary branches/panicle seventeen F_1's exhibited significant and positive SCA effects. The crosses were found to be best on the basis of SCA effects and mean performance are ICS-18A x ICSR-43745 (34.896 and 245.87), ICS-516A x ICSR-44347(31.596 and 330.93), ICS-40A x AKR-456 (30.344 and 320.73), ICS-42A x ICSR-43407 (24.648 and 331.50), ICS-42A x ICSR-43405 (21.598 and 283.97) and ICS-18 A x AKR-73 (21.171 and 242.80). However, twelve hybrids showed significant and negative SCA effects and the crosses such as ICS-18A x ICSR-44347 (-53.371), ICS-516A x ICSR-43405 (-37.479). As regards no. of grains/panicle, out of forty crosses, cross ICS-40A x AKR-354 (60.744) showed significant and positive SCA effects with average value of 1180.43 which is desirable for grains per panicle. Moreover, no. other hybrid exhibited significant positive or negative SCA effect for no. of grains/panicle as shown in Table 3. Two hybrids out of forty hybrids showed significant and positive SCA effects for 1000 grains weight and those are ICS-516A x ICSR-44347 (6.987), ICS-40A x ICSR-44347 (5.983) and obtained average value as 56.69 g, 58.7 g respectively. However, the hybrid with significant and negative SCA effect is ICS-40A x AKR-456 (-6.949) which is not desirable for this trait.On the basis of significant and positive SCA effect and mean performance for grain yield /plant only three hybrids out of total forty hybrids were identified as best for grain yield/plant viz., ICS-40A x ICAR-44347 (5.990 and 62.12 g), ICS-516A x ICS-516A x AKR-456 (5.378 and 54.36 g) and ICSR-44347 (5.196 and 60.49 g). However, the hybrid ICS-40A x AKR-456 (-7.304) showed significant and negative SCA effects are not desirable for grain yield per plant.

The estimates of GCA effects revealed that the line ICS-516A exhibited significant GCA effects in desirable direction for grain yield/plant (2.202), 1000-grain weight (1.682), no. of grains/panicle (32.978). However, among the testers, ICSR-44347 recorded significant GCA effects for all characters and AKR-456 was obtained significant GCA effects for grain yield/plant (2.597), 1000-grain weight (2.756), no. of grains/panicle (42.403), no. of secondary branches/panicle (9.289) and plant height (60193). The results are in agreement with the results reported by Singhunia (1980), Patil (2000), Tiwari *et al.,* (2003).

The magnitude of SCA effects of the crosses along with the mean performances (Table 3) indicated that the highest SCA effect with highest mean grain yield per plant was recorded in the cross ICS-40A x ICSR-44347 (5.990 and 62.129 g). Also the crosses ICS-516A x AKR-456 (5.378 and 54.369 g) and ICS-516A x ICSR-44347 (5.196 and 60.49 g) showed significant and positive SCA effects for grain yield/plant with desirable mean grain yield/plant. The results of the current studies are in conformity with the findings of Amsalu and Bapat (1990), Rafiq *et al.,* (2002) and Kaul *et al.,* (2003).

Table.1 Analysis of variance (ANOVA) for combining ability

Source	DF	Plant height at maturity (cm)	Panicle length (cm)	No. of primary branches/ panicle	No. of secondary branches /panicle	No. of grains/ panicle	1000-grains weight (g)	Grain yield/plant (g)
Replication	2	9.26	5.51	39.01	45.16	9513.01	27.94	6.53
Lines	3	545.93	57.85	549.04**	8973.41**	15206.68*	21.56	29.88
Testers	9	519.53	291.40**	318.88*	4692.35*	17971.37**	110.51**	121.49**
Lines *vs.* Testers	27	375.11**	65.016**	114.05**	1713.45**	3970.02*	28.38	23.61
Error	78	35.07	23.19	33.08	41	2554.61	21.38	20.36

Note - *Significant at 5 % level of significance
**Significant at 1% level of significance

Table.2 General combining ability and mean performance of parents for various yield contributing characters

Parents		Plant height at Harvest (cm)	Panicle length (cm)	No. of primary branches/ panicle	No. of secondary branches/ panicle	No. of grains/ panicle	1000-grains weight (g)	Grain yield/ plant (g)
Lines								
ICS-40A	GCA	-1.917	0.014	-0.814	11.306**	-10.019	0.097	0.961
	Mean	172.07	42.23	52.30	213.73	1026.30	49.30	50.40
ICS-42A	GCA	4.913**	-0.101	-2.784**	10.636**	-5.596	0.549	0.24
	Mean	173.07	41.23	65.03	272.93	1078.90	42.99	46.78
ICS-18A	GCA	1.840**	1.756**	-2.711**	-25.388**	-17.363	-1.228	-1.403
	Mean	146.53	51.90	50.50	196.10	1078.63	51.77	53.96
ICS-516A	GCA	-4.837**	-1.641	**6.273****	**3.446***	**32.978****	**1.682***	**2.202****
	Mean	184.93	46.07	78.10	254.97*	1126.37	55.77	56.86
SE (gi) ±		1.081	0.879	1.05	1.175	9.228	0.844	0.824
CD 5 %		2.153	1.75	2.091	2.338	18.371	1.681	1.64
CD 1 %		2.855	2.322	2.773	3.101	24.365	2.229	2.175

Testers								
ICSR-44347	GCA	**6.418****	**8.133****	**7.023****	**26.098****	**52.078****	**6.987****	**7.887****
	Mean	191.60	68**	78.93	434.93**	1199.80	61.73	62.59
ICSR-43743	GCA	7.510**	0.907	-0.761	4.506*	-33.281*	-3.226*	-1.734
	Mean	177.57	44.67	68.20	289.57**	1069.13	41.17	46.17
ICSR-43745	GCA	-5.390**	0.658	-4.178**	-33.436**	-84.806**	-3.101*	-3.374*
	Mean	151.53	40.60	57.87	226.33	1077.37	43.53	50.53
ICSR-43405	GCA	0.427	3.741**	2.773	-18.061**	-12.772	-0.676	-0.41
	Mean	163.10	49.40	72.07	250.57	1112.43	46.67	46.14
ICSR-43413	GCA	1.327	-3.343**	-3.644**	-2.711	12.536	-2.704*	-2.909*
	Mean	180.20	41.86	62.73	284.40**	1024.23	50.21	54.65
ICSR-43407	GCA	2.243	6.316**	8.189**	26.423**	2.761	-0.143	-0.754
	Mean	176.80	48.77	72.00	379.00**	1134.40	55.75	57.46
AKR-73	GCA	-13.798**	-7.501**	-6.694**	-22.778**	18.336	1.653	0.723
	Mean	157.07	35.67	54.77	269.80**	1143.33	54.40	58.04
AKR-354	GCA	-5.215**	-4.184**	-5.786**	7.097**	2.069	0.896	-1.503
	Mean	176.90	42.77	55.20	311.17**	1107.63	48.56	50.96
AKR-436	GCA	0.285	-1.601	2.156	3.572**	0.677	0.55	0.587
	Mean	177.50	40.93	73.47	340.50**	1157.90	50.43	52.40
AKR-456	GCA	**6.193****	-3.126**	0.923	**9.289****	**42.403****	**2.756***	**2.597***
	Mean	163.90	31.20	66.97	330.23**	1197.73	58.17	58.65
SE (gj) ±		1.709	1.39	1.66	1.857	14.591	1.335	1.303
CD 5 %		3.436	2.768	3.306	3.697	29.048	2.658	2.593
CD 1 %		4.514	3.671	4.384	4.904	38.525	3.525	3.439

Note - *Significant at 5 % level of significance, **Significant at 1% level of significance

Table.3 Specific combining ability and mean performance of F_1's (crosses) for various traits

Sr. no.	F_1's		Plant height at Harvest (cm)	Panicle length (cm)	No. of primary branches/ panicle	No. of secondary branches/ panicle	No. of grains/ panicle	1000-grains weight (g)	Grain yield/ plant (g)
1	ICS-40A x ICSR -44347	SCA	-11.408**	2.552	**7.253***	**14.169****	11.369	**5.983***	**5.990***

		Mean	216.67**	52.60	64.87	311.37**	1181.07	58.57	62.12
2	ICS-40A x ICSR-43743	SCA	-1.867	5.239	-2.603	-8.306*	-53.973	-2.264	0.043
		Mean	227.20**	51.17	55.73	277.30**	1030.37	42.07	48.56
3	ICS-40A x ICSR-43745	SCA	6.833*	0.889	-4.086	-3.564	-24.314	-1.123	-0.066
		Mean	223.00**	46.57	50.83	244.10	1008.50	43.32	46.81
4	ICS-40A x ICSR -43405	SCA	-3.25	-6.694*	4.698	-0.806	-31.781	0.21	-0.163
		Mean	218.73**	42.07	66.56	262.23**	1073.07	47.08	49.67
5	ICS-40A x ICSR-43413	SCA	2.583	-0.844	-2.819	-9.989**	6.478	1.738	1.709
		Mean	225.47**	40.83	52.63	268.40**	1136.63	46.58	49.05
6	ICS-40A x ICSR -43407	SCA	3.6	-0.869	10.481**	-26.356**	2.519	2.433	1.041
		Mean	227.40**	50.47	77.77	281.17**	1122.90	49.83	50.54
7	ICS-40A x AKR -73	SCA	14.908**	1.448	-1.736	-2.489	45.644	2.574	1.677
		Mean	222.67**	38.97	50.67	255.83**	1181.60	51.77	52.65
8	ICS-40A x AKR - 354	SCA	-22.108**	0.964	-1.144	-0.764	60.744*	-1.907	-1.761
		Mean	194.23	41.80	52.17	286.43**	1180.43	44.74	46.98
9	ICS-40A x AKR -436	SCA	4.925	0.114	-4.653	17.761**	-13.198	1.308	0.834
		Mean	226.77**	43.53	56.60	302.43**	1105.10	49.40	51.67
10	ICS-40A x AKR-456	SCA	5.783	0.306	3.114	30.344**	-3.489	-6.949*	-7.304*
		Mean	233.53**	42.20	63.13	320.73**	1156.53	42.15	44..43
11	ICS-42A x ICSR -44347	SCA	-0.505	1.201	-2.486	17.606**	-40.221	-2.689	-2.696
		Mean	234.30**	54.27*	61.70	324.13**	1133.90	52.27	54.72
12	ICS-42A x ICSR- 43743	SCA	-4.063	-0.874	1.064	1.331	51.538	-1.787	0.634
		Mean	231.83**	44.97	57.47	286.27**	1140.30	42.99	48.43
13	ICS-42A x ICSR-43745	SCA	6.403	-3.191	4.881	-12.828**	-7.004	2.012	1.478
		Mean	229.40**	42.40	57.87	234.17	1030.23	46.91	47.63
14	ICS-42A x ICSR -43405	SCA	-11.747**	2.007	6.536	21.598**	55.762	1.801	1.044
		Mean	217.07**	47.67	53.40	283.97**	1165.03	49.12	50.16
15	ICS-42A x ICSR-43413	SCA	-1.313	1.909	8.247**	3.214	9.654	-2.498	-2.964
		Mean	228.40**	43.50	61.77	280.93**	1144.23	42.79	43.66
16	ICS-42A x ICSR-43407	SCA	2.37	0.517	-9.619**	24.648**	-12.171	3.024	2.318
		Mean	233.00**	51.77	56.73	331.50**	1112.63	50.88	51.09

Sr. no.	F_1's		Plant height at Harvest (cm)	Panicle length (cm)	No. of primary branches/ panicle	No. of secondary branches/ panicle	No. of grains/ panicle	1000-grains weight (g)	Grain yield/ plant (g)
17	ICS-42A x AKR -73	SCA	10.778**	3.101	3.264	-32.519**	-32.413	-1.812	-1.199
		Mean	225.37**	40.53	53.73	225.13	1107.97	47.84	49.05
18	ICS-42A x AKR – 354	SCA	5.462	2.451	3.389	-18.928**	-42.313	-1.386	-1.367
		Mean	228.63**	43.20	54.77	268.60**	1081.80	45.77	46.66
19	ICS-42A x AKR – 436	SCA	3.162	2.001	2.219	16.969**	21.012	1.838	1.624
		Mean	231.83**	45.33	59.10	277.03**	1143.73	50.39	51.74
20	ICS-42A x AKR - 456	SCA	-10.547**	-6.108*	-1.986	2.848	-3.846	1.498	1.13
		Mean	224.03**	35.70	56.10	292.57**	1160.60	51.05	52.14
21	ICS-18A x ICSR-44347	SCA	-2.498	-4.623	-1.856	-53.371**	12.612	-2.972	-4.41
		Mean	229.23**	50.30	62.37	217.13	1174.97	50.24	51.36
22	ICS-18A x ICSR-43743	SCA	-2.823	-7.431**	-1.439	11.854**	-41.396	2.093	0.44
		Mean	230.00**	40.26	55.00	260.77**	1035.60	45.09	46.59
23	ICS-18A x ICSR-43745	SCA	5.477	4.453	7.844*	34.896**	-14.304	-0.675	-0.432
		Mean	225.40**	51.91	60.87	245.87	1011.17	42.45	44.08
24	ICS-18A x ICSR -43405	SCA	5.493	-1.898	1.794	16.688**	-21.804	2.001	1.76
		Mean	231.23**	48.63	61.77	243.03	1075.70	47.55	49.24
25	ICS-18A x ICSR-43413	SCA	-9.007*	1.819	1.078	10.904**	31.087	-0.608	-0.038
		Mean	217.63**	45.27	54.63	252.60*	1153.90	42.91	44.94
26	ICS-18A x ICSR -43407	SCA	1.977	-0.572	-10.689**	-11.563**	27.896	-0.219	0.551
		Mean	229.53**	52.53	54.70	259.27**	1140.93	45.86	47.68
27	ICS-18A x AKR -73	SCA	-1.515	-1.689	2.061	21.171**	7.688	0.522	1.257
		Mean	210.00**	37.60	52.57	242.80	1136.30	48.39	49.87
28	ICS-18A x AKR – 354	SCA	3.302	6.961**	2.586	19.429**	20.354	1.291	1.486
		Mean	223.40**	49.57	54.00	270.93**	1132.70	46.62	47.87
29	ICS-18A x AKR – 436	SCA	1.535	-2.123	-2.923	-25.313**	-12.354	-4.852	-3.41
		Mean	227.13**	43.07	56.43	222.67	1098.60	41.92	45.06
30	ICS-18A x AKR - 456	SCA	-1.94	5.102	1.544	-24.696**	-9.779	3.419	2.796
		Mean	229.56**	48.77	59.67	229.00	1142.90	51.20	52.17

Sr. no.	**F_1's**		**Plant height at Harvest (cm)**	**Panicle length (cm)**	**No. of primary branches/ panicle**	**No. of secondary branches/ panicle**	**No. of grains/ panicle**	**1000-grains weight (g)**	**Grain yield/ plant (g)**
31	ICS-516A x ICSR-44347	SCA	**14.412****	**8.133****	5.594	**31.596****	16.239	**6.987***	**5.196***
		Mean	239.47**	55.50*	78.80	330.93**	1228.93	56.69	60.49
32	ICS-516A x ICSR- 43743	SCA	8.753*	0.907	2.978	-4.879	43.831	-3.226	-1.117
		Mean	234.90**	47.36	68.40	272.87**	1171.17	46.76	46.64
33	ICS-516A x ICSR-43745	SCA	-18.713**	0.658	-8.639*	-18.504**	45.622	-3.101	-0.98
		Mean	194.53	41.90	52.37	221.30	1121.43	44.71	45.13
34	ICS-516A x ICSR -43405	SCA	9.503**	3.741	0.044	-37.479**	-2.177	-0.676	-2.641
		Mean	228.57**	56.73**	69.00	217.70	1145.67	43.34	46.44
35	ICS-516A x ICSR- 43413	SCA	7.737*	-3.343	-6.56	-4.129	-47.219	-2.704	1.294
		Mean	227.70**	37.17	55.03	266.40**	1125.93	46..69	47.87
36	ICS-516A x ICSR-43407	SCA	-7.947	6.316*	9.827**	13.271**	-18.244	-0.143	-3.91
		Mean	212.93**	50.63	83.20	312.93**	1145.13	42.65	44.83
37	ICS-516A x AKR -73	SCA	-24.172**	-7.501**	-3.589	13.838**	-20.919	1.653	-1.734
		Mean	180.67	33.03	55.90	264.30**	1158.03	48.40	48.48
38	ICS-516A x AKR – 354	SCA	13.345**	-4.184	-4.831	0.263	-38.786	-0.896	1.642
		Mean	226.77**	28.83	55.57	280.60**	1123.90	49.14	49.63
39	ICS-516A x AKR – 436	SCA	-9.622**	-1.601	7.794*	14.521**	4.539	0.55	0.952
		Mean	209.30**	41.80	76.13	291.33**	1165.83	50.29	51.03
40	ICS-516A x AKR – 456	SCA	**6.890***	-3.126	-2.67	**8.496****	17.114	1.556	**5.378***
		Mean	231.53**	40.97	64.43	274.03**	1220.13	51.52	54.36
	SE (D) ±		3.419	2.78	3.321	3.714	29.181	2.67	2.605
	CD 5 %		6.807	5.535	6.611	7.395	58.095	5.316	5.187
	CD 1%		9.028	7.341	8.768	9.807	77.049	7.05	6.877

Note - *Significant at 5 % level of significance, **Significant at 1% level of significance

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