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Exploitation Of CMS Based Pigeonpea (*Cajanus Cajan* L.) Hybrids For Yield And Its Contributing Traits

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ABSTRACT

The present investigation to estimate the extent of heterosis, combining ability effects and thereby to find out promising cross combinations using Line x Tester mating design (Kempthorne, 1957). The set of 10 parents, two females (cms lines) viz; AKCMS-92A, AKCMS-87A, and 8 males (Testers) viz., AKPR-364, AKPR-324, AKPR-372, AKPR-303, AKPR-057, AKPR-359, AKPR-215, AKPR-277 their 16 crosses along with two checks PKV-TARA and ASHA were evaluated in randomized block design with three replications at the field of Pulses Research Unit, Dr. PDKV, Akola during Kharif 2014-2015. The data were recorded on the characters viz., days to 50 per cent flowering, days to maturity, plant height (cm), number of branches, number of clusters, number of pods, number of seeds per pod, 100 seed weight (g), grain yield per plant (g) and plant fertility (%).Among female parents, ICPA-2047A recorded significant gca effect for maximum six characters such as grain yield per plant, plant height, number of clusters, number of seed per pod, 100 seed weight and days to 50% flowering. The male parent AKPR-324 was found to posses highest gca effect for plant height, number of clusters, 100 seed weight and grain yield per plant. The cross ICPA-2047A X AKPR-324 depicted high mean performance (33.67) high magnitude of useful heterosis (17.72% over check PKV-TARA and 23.17% over check ASHA), positive sca effect and both the parents involved revealed high gca effects. This cross could be successfully utilized to obtain the superior segregants in further segregating generations. Another cross ICPA-2047A X AKPR-372 revealed high mean performance (33.00g), high magnitude of useful heterosis (15.38 % over check PKV-TARA and 20.73% over check ASHA) and high sca effect. One of the parents (AKPR-372) though low combiner for grain yield but it was good combiner for number of branches, number of pods, number of seed per pod and days to 50% flowering. This cross may be employed to exploit non-additive component along with high heterotic response. However, the performances of this cross have to be evaluated in large scale trials.

Keywords - *Pigeonpea, Heterosis, Combining ability, Line x Tester Analysis, CMS.*

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INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is a short-lived perennial shrub that is traditionally cultivated as an annual crop in developing countries. It is an important pulse crop mostly produced in Asia, Africa, Latin America and the Caribbean region. It is a hardy, widely adapted and drought tolerant crop with a large temporal variation (90–300 days) for maturity. These traits allow its cultivation in a range of environments and cropping systems. It is the most versatile food legume with diversified uses as food, feed, fodder and fuel. It is one of the important pulse crops of India and ranks second to chickpea in area and production. It is commonly known as tur, red gram or arhar. In India it is cultivated on 4.09 million ha with production of 3.27 millions tonnes and the productivity is 799 kg/ha. It is sturdy crop and can be grown on wide range of soil and under diverse agro ecological environments. For commercial hybrid seed production there is need for ease in hybridization. Traditionally, it is achieved by hand emasculation followed by pollination. But in crops like pigeonpea which is cleistogamous in nature hand emasculation and pollination are not feasible for hybrid seed production because there are tedious and costly. This difficulty can be overcome by genetical method of emasculation i.e.male sterility system (Chaudhary,1986).

The few hybrids based on genetic male sterility have been released but can not be used commercially due to its own limitations i.e. in hybrid seed production,50% fertile plants from female row have to be rouged out. This amount to near about 50% loss of plant population from female plots at flowering stage (Patil et.al.,1998).The other alternative is to go for cytoplasmic genetic male sterility .Some of the scientists reported cytoplasmic male sterility in pigeonpea by various A1,A2,A3 and A4 cytoplasm. From there cms sources,A2 and A4 cytoplasm have been found to be stable and are used during in the hybrid breeding programme in India. The present study is undertaken to assess the per se performance of male sterile lines, restorer lines and their hybrids and to study the extent of heterosis and combining ability of parents and hybrids for grain yield and its components.

MATERIAL AND METHODS

The experimental material for the present study comprised of 10 piegeonpea genotypes: 2 genotypes AKCMS-92A, AKCMS-87A were used as a lines and remaining 8 genotypes AKPR-364, AKPR-324, AKPR-372, AKPR-303, AKPR-057, AKPR-359, AKPR-215, AKPR-277
were ued as a testers. These genotypes were crossed in a line x tester design. The set of 10 parents, two females (cms lines) viz; AKCMS-92A, AKCMS-87A, and 8 males (Testers) viz., AKPR-364, AKPR-324, AKPR-372, AKPR-303, AKPR-057, AKPR-359, AKPR-215, AKPR-277 their 16 crosses along with two checks PKV-TARA and ASHA were evaluated in randomized block design with three replications at the field of Pulses Research Unit, Dr. PDKV, Akola during Kharif 2014-2015. Each entry was grown in the two rows plot of 4 meter lenth with intra and inter row spacing of 20 cm and 60 cm respectively. Recommended crop management practices were followed during the crop growth period. The observations were recorded onfive randomly selected plants on nine characters viz: days to 50% flowering,days to maturity,plant height,number of branches,number of clusters,number of pods,number of seed per pod,100 seed weight and grain yield per plant.The mean data were subjected to line x tester analysis to estimate combining ability (Kampthrone,1957).

RESULTS AND DISCUSSION

The mean squares due to genotypes were highly significant for all the traits studied (Table no.1). This indicated the presence of substantial genetic variability among genotypes all the traits studied. Further partitioning of genotypic variance into components viz., parents, crosses and parents vs. crosses revealed that the parents differed significantly among themselves for all the characters under study. The mean square due to crosses also showed highly significant differences for all the traits. The mean squares due to parents vs. crosses were also showed significant for all the characters except days to maturity indicating the significant differences between parents and crosses. Similar results were reported by Pawar and Tikka (2003), Sunilkumar et al. (2003) and Aher et al. (2006).

Useful heterosis estimated over the checks

The percentage of useful heterosis over the checks PKV-TARA and ASHA for the character under study is given in (Table no.2) The highest standard heterosis in desirable direction was recorded for days to 50% flowering in AKCMS-92A X AKPR-372 (-6.33% over check PKV-TARA and -8.51% over check ASHA), for days to maturity in AKCMS-92A X AKPR-372 (-5.42% over check PKV-TARA and -8.39% over check ASHA), for plant height in AKCMS-92A X AKPR-324 (17.16% over check PKV-TARA and 4.75% over check ASHA), for number of branches in AKCMS-87A X AKPR-324 (8.99% over check PKV-TARA and 13.68% over check ASHA), for number of clusters in AKCMS-87A X AKPR-324 (28.74% over check PKV-TARA and 37.00% over check ASHA). The cross AKCMS-87A X AKPR-324 showed highest positive significant standard heterosis for number of pods (27.74% over check PKV-TARA and 33.19% over check ASHA).for number of seeds per pods in the cross AKCMS-87A X AKPR-324 (20.35% over check PKV-TARA and 24.40% over check ASHA). The cross AKCMS-87A X AKPR-324 showed highest standard heterosis simultaneously for 100 seeds weight (7.92% over check and PKV-TARA and 12.17% over check ASHA) and grain yield per plant. (27.63% over check PKV-TARA and 37.39% over check ASHA).

Similar results were reported in pigeaonpea for above character by several workers viz.Manivel et.al (1999),Singh et.al (1999) .

Analysis of variance for combining ability

Combining ability analysis gives information on genetic artitechture of the crosses under study.Line x tester analysis of 16 crosses obtained by crossing 2 CMS lines with 8 testers was carried out and the total variance due to crosses was partitioned into portions attributable to females (lines), males (testers), interaction females vs. males (lines vs. testers) and error sources (Table no.3).The variance due to females were significant for days to 50% flowering, number of clusters, number of pods, number of seeds per pod and grain yield per plant. While the variance due to males were significant for days to 50% flowering, days to maturity and grain yield per plant. The variance due to females vs. males were highly significant for days to maturity, plant height, number of branches, number of clusters, number of pods, number of seeds per pod, 100 seed weight and grain yield per plant. This indicated the presence of significant differences between males and females. Similar results were reported for above characters by Banu et al. (2006) and Beekham and Umaharan (2010).

Estimation of combining ability effects

The estimates of general combining ability effects of the female and male parents are presented in (Table no.4). The GCA effects revealed that among the female parents AKCMS-92A (-2.29) and among the male parents AKPR-372 (-10.25) and AKPR-303 (-4.58) were the best general combiners for days to 50% flowering. The female parent AKCMS-92B (-0.52) and among male parent AKPR-372 (-9.31) were the best general combiners for days to maturity. The female parent AKCMS-92A (2.45cm) and among male parent AKPR-324 (7.29cm) and AKPR-057 (5.39cm) were the best general combiners for plant height. For number of branches the female parent AKCMS-87A (0.02) and among male parent AKPR-324 (1.14) were best general combiners. For number of clusters the female parent AKCMS-87A (3.48) and among male parent AKPR-324 (8.65) were the best general combiners. The female parent AKCMS-87A (10.44) and among male parent AKPR-324 (24.70) were best general combiners for number of pods. The female parent AKCMS-87A (0.01) and among male parent AKPR-324 (0.42) were best general combiners for number of seeds per pods. The female parent AKCMS-87A (0.01g) and among male parent AKPR-324 (1.14g) were best general combiners for 100 seed weight, and the female parent AKCMS-87A and among male parent AKPR-324 (9.10g) and AKPR-359 (2.71g) were best general combiners for grain yield per plant.

Among female parents, AKCMS-87A recorded significant gca effect for maximum three characters such as number of clusters, number of pods and grain yield per plant also female parent AKCMS-87A was found to posses highest gca effect for days to 50% flowering, days to maturity, number of branches, number of seeds per pods. The female AKCMS-92A was found to posses highest gca effect for plant height. The male parent AKPR-324 was found to posses highest significant gca effect for plant height, number of branches, number of clusters, number of pods, number of seeds per pods,100 seed weight and grain yield per plant. The male parent AKPR-372 recorded highest significant gca effect for days to 50% flowering and days to maturity Hence, these genotypes were recognized as the best parental material among the available genotypes and can be used as parents in hybridization programmes. Similar results were reported by Pawar and Tikka (2003), and Sunilkumar et al. (2003), Banu et al. (2006), Singh and Singh (2009) and Gupta et al. (2011).

Estimation of specific combining ability effects of crosses

The estimates of specific combining ability effects of the crosses are presented in (Table no.5). The highest significant desirable sca effect was observed for plant height in AKCMS-87A X AKPR-359 (7.26), for number of branches in AKCMS-87A X AKPR-359 (0.60), for number of seed per pods in AKCMS-87A X AKPR-359 (0.17), for 100seed weight AKCMS-87A X AKPR-324 (0.69) and for grain yield per plant in AKCMS-87A X AKPR-324 (3.05), and highest sca effect for days to 50% flowering AKCMS-92A X AKPR-277 (-3.04), for days to maturity AKCMS-87A X AKPR-303 (-1.35), for number of cluster AKCMS-87A X AKPR-359 (3.23) and for number of pods AKCMS-87A X AKPR-359 (8.84).

The crosses viz, AKCMS-87A X AKPR-324 (100 seed weight, grain yield per plant) and AKCMS-87A X AKPR-369 (plant height, number of branches, number of seeds per pods) revealed significant desirable sca effect simultaneously for more than one characters studied. Hence, these crosses were found to be promising to exploit non-additive component for particular character and can be utilized in breeding programme. It was observed that the crosses with high and significant specific combining ability for grain yield per plant had also high specific combining ability for one or more other yield components suggesting that the improvement in grain yield per plant could be obtained by improving its component characters. Similar results were reported by Pawar and Tikka (2003), and Sunilkumar et al. (2003), Banu et al. (2006), Singh and Singh (2009) and Gupta et al. (2011). Two promisings crosses were selected on the basis of per se performance, heterotic response, gca and sca effects. The crosses AKCMS-87A X AKPR-324 and AKCMS-87A X AKPR-359 were found to be the most promising crosses among all the 16 crosses studied.

The cross AKCMS-87A X AKPR-324 depicted high mean performance (38.62) high magnitude of standard heterosis (27.63% over check PKV-TARA and 37.39% over check ASHA), positive sca effect and both the parents involved revealed high gca effects. This cross could be successfully utilized to obtain the superior segregants in further segregating generations. Another cross AKCMS-87A X AKPR-359 revealed high mean performance (36.17g), high magnitude of standard heterosis (19.53 % over check PKV-TARA and 28.67% over check ASHA) and high sca effect. One of the parents (AKPR-372) though low combiner for grain yield but is was good combiner for days to 50%flowering and days to maturity. This cross may be employed to exploit non-additive component along with high heterotic response. However, the performances of this cross have to be evaluated in large scale trials. From the present experiment, it can be calculated that, the estimates of sca variances were higher than gca variances for most of the of the yield attributing traits, it indicates the importance of non additive gene effects in the expression of the traits in pigeonpea.

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Table 1 .Analysis of variance for various characters

Sources of Variation	d.f.	Mean sum of squares								
		Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number o f pods per plant	Number of seeds per pod	100 seed weight (g)	Grain Yield per plant (g)
		1	2	3	4	5	6	7	8	9
Replications	2	5,11	1,88	25,52	0,27	24,97	236,21	0,16	0,71	13,61
Genotypes	25	137,16**	85,92**	613,18**	3,41**	99,19**	864,25**	0,40**	8,03**	108,72**
Parents	9	200,23**	106,60**	905,00**	3,79**	29,46**	284,84**	0,38**	6,16**	16,16
Crosses	15	100,46**	79,17**	150,67**	1,63**	112,40**	904,61**	0,19**	2,55**	90,35**
Parents Vs Crosses	1	120,04**	0,9	4924,52**	26,83**	528,61**	5473,52**	3,72**	107,07**	1217,18**
Error	50	5,6	10,27	12,63	0,11	8,47	86,44	0,09	0,25	9,59

* - Significant over check at 5 % level of significance

** - Significant over check at 1 % level of significance

Table2. Estimates of useful heterosis over checks PKV-TARA and ICPL-87119 (ASHA) (A = check PKV-TARA and B = check ICPL87119 (ASHA))

Crosses		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Grain yield per plant (g)
		1	2	3	4	5	6	7	8	9
AKCMS-92A X AKPR-364	A	-0.53	-0.90	12.19**	1.65	-24.12**	-25.01**	-5.47	-6.15*	-19.57**

	B	-2.84	-4.02*	0.31	6.05	-18.81*	-21.82**	-2.38	-2.45	-13.41*
AKCMS-92A X AKPR-324	A	3.69*	4.87**	17.16**	6.87*	18.08*	17.87*	3.36	6.49**	16.39*
	B	1.29	1.57	4.75	11.50**	26.35**	22.90**	6.85*	10.70**	25.29**
AKCMS-92A X AKPR-372	A	-6.33**	-5.42**	15.34**	-3.93	-4.84	-4.79	-5.47	-3.29	-11.28
	B	-8.51**	-8.39**	3.12	0.20	1.81	-0.73	-2.38	0.53	-4.49
AKCMS-92A XAKPR-303	A	-1.06	-1.44	-0.08	-3.29	-18.40*	-17.00	-7.39*	2.61	-21.38**
	B	-3.35	-4.55*	-10.66**	0.89	-12.69	-13.46	-4.17	6.65**	-15.37*
AKCMS-92A X AKPR-057	A	2.11	0	15.64**	-3.01	-33.61**	-29.49**	-3.84	-18.65**	-23.63**
	B	-0.26	-3.15	3.39	1.19	-28.96**	-26.48**	-0.60	-15.41**	-17.79**
AKCMS-92A X AKPR-359	A	2.90	0.72	-0.85	-4.34	-24.16**	-22.68**	-4.41	-4.32	-17.78**
	B	0.52	-2.45	-11.35**	-0.20	-18.85*	-19.39*	-1.19	-0.53	-11.49
AKCMS-92A X AKPR-215	A	3.17	-2.45	9.05**	-13.27**	-37.20**	-33.20**	-3.45	-6.23*	-26.65**
	B	0.77	-2.45	-2.50	-9.51**	-32.81**	-30.35**	-0.30	-2.54	-21.02**
AKCMS-92A X AKPR-277	A	0	-0.90	3.03	-6.24*	-40.33**	-36.18**	-6.53*	3.17	-33.64**
	B	-2.32	-4.02*	-7.83*	-2.18	-36.15**	-33.46**	-3.27	7.25**	-28.57**
AKCMS-87A X AKPR-364	A	5.28**	0.72	5.06	-4.24	-15.88	-8.57	-2.98	-16.18**	-21.58**
	B	2.84	-2.45	-6.06	-0.10	-10	-4.67	0.30	-12.87**	-15.58*

Contd…

Crosses		Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of clusters per plant	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Grain yield per plant (g)
AKCMS-87A X AKPR-324	A	9.50**	5.05**	9.19**	8.99**	28.04**	27.74**	20.35**	7.92**	27.63**
	B	6.96**	1.75	-2.38	13.68**	37.00**	33.19**	24.40**	12.17**	37.39**
AKCMS-87A X AKPR-372	A	-5.28**	-4.69**	0.29	-7.50*	-1.65	-1.91	-1.73	-3.71	-1.39
	B	-7.47**	-7.69**	-10.33**	-3.47	5.23	2.27	1.49	0.09	6.15
AKCMS-87A X AKPR-303	A	-1.58	-2.35	5.25	2.85	15.74	14.50	1.92	4.47	11.67
	B	-3.87	-5.42**	-5.90	7.33*	23.85**	19.39*	5.36	8.58**	20.21**
AKCMS-87A X AKPR-057	A	3.17	0.90	7.37*	-11.94**	-18.94*	-15.17	-0.67	-7.92**	-9.39
	B	0.77	-2.27	-4	-8.13**	-13.27	-11.54	2.68	-4.29	-2.45
AKCMS-87A X AKPR-359	A	5.80**	1.08	7.56*	7.73**	24.16**	22.99*	12.96**	7.58**	19.53**
	B	3.35	-2.10	-3.84	12.39**	32.85**	28.24**	16.67**	11.82**	28.67**
AKCMS-87A X AKPR-215	A	7.65**	1.62	6.05	-3.86	7.80	11.27	-1.82	-2.67	-5.72
	B	5.15**	-1.57	-5.18	0.30	15.35	16.01	1.49	1.16	1.49
AKCMS-87A X AKPR-277	A	8.44**	-0.18	-3.68	-13.17**	-3.51	-3.48	-2.69	-1.99	-12.59*
	B	5.93**	-3.32	-13.88**	-9.42**	3.23	0.64	0.60	1.84	-5.91
SE (d) ±		2.22	2.72	3.40	0.29	2.32	7.21	0.09	0.27	1.86
CD at 5 %		4.55	5.57	6.95	0.59	4.75	14.72	0.20	0.56	3.80
CD at 1 %		6.12	7.50	9.36	0.80	6.39	19.83	0.26	0.75	5.12

* - Significant over check at 5 % level of significance ** - Significant over check at 1 % level of significance

Table 3. Analysis of variance for combining ability

Sources of variation	d.f.	Mean sum of squares								
		Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Grain Yield per plant (g)
		1	2	3	4	5	6	7	8	9
Replications	2	2.25	2.27	9.56	0.16	47.92	403.44	0.01	0.10	44.48
Crosses	15	100.46**	79.17**	150.67**	1.63**	112.40**	904.61**	0.19**	2.55**	90.35**
Females (Lines)	1	252.08*	13.02	290.18	0.04	582.41**	5234.19**	0.77*	0.50	364.48**
Males (Testers)	7	157.23**	165.06**	165.40	2.42	120.23	913.63	0.23	4.26	119.13*
Females Vs Males (Lines Vs	7	22.03*	2.73	116.01**	1.06**	37.42**	277.08**	0.07**	1.14**	22.41**
Error	30	7.45	11.15	17.38	0.12	8.11	77.99	0.01	0.11	5.21

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

Table 4. Estimates of general combining ability effects of parents

Parents	Days to 50 % flowering	Days to maturity	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Grain yield per plant (g)
	1	2	3	4	5	6	7	8	9
Females (Lines)									
AKCMS-92A	-2.29	-0.52	2.45	-0.02	-3.48 *	-10.44 *	- 0.01	- 0.01	-2.75 *
AKCMS-87A	2.29	0.52	-2.45	0.02	3.48 *	10.44 *	0.01	0.01	2.75 *
SE (gi) ±	0.55	0.68	0.85	0.07	0.58	1.80	0.02	0.06	0.46
SE(gi-gj) ±	0.78	0.96	1.20	0.10	0.82	2.54	0.03	0.09	0.65
CD at 5 %	1.13	1.39	1.73	0.14	1.18	3.68	0.05	0.14	0.95
CD at 1 %	1.53	1.87	2.34	0.20	1.59	4.95	0.06	0.18	1.28
Males (Testers)									
AKPR -364	0.08	-0.14	2.10	0.17	-3.32	-8.73	-0.13	-1.03 **	-3.78 **
AKPR -324	5.41 **	9.18 **	7.29 **	1.14**	8.65 **	24.70 **	0.42 ***	1.14 **	9.10 **
AKPR -372	-10.25 **	-9.31 **	1.17	-0.29	1.33	2.61	-0.10	-0.12	0.53
AKPR-303	-4.58 **	-3.47	-4.80	0.28	1.87	4.38	-0.07	0.70**	0.97
AKPR-057	0.41	0.85	5.39 *	-0.47 *	-5.07 **	-13.41 *	-0.06	-1.28 **	-2.54
AKPR-359	2.58	1.68	-3.92	0.48 *	2.24	5.57	0.16 *	0.48 *	2.71 *
AKPR-215	3.91 *	2.18	0.87	-0.59 **	-1.85	-3.81	-0.07	-0.24	-2.45
AKPR-277	2.41	-0.97	-8.10 **	-0.71 **	-3.85 *	-11.30 *	-0.14 *	0.35	-4.54 **
SE (gj) ±	1.11	1.36	1.70	0.14	1.16	3.60	0.04	0.13	0.93
SE (gi-gj) ±	1.57	1.92	2.40	0.20	1.64	5.09	0.06	0.19	1.31
CD at 5 %	2.27	2.78	3.47	0.14	2.37	7.36	0.10	0.28	1.90
CD at 1 %	3.06	3.75	4.68	0.20	3.19	9.91	0.13	0.37	2.56

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

Table 5. Estimates of specific combining ability effects for crosses

Sr.No.	Crosses	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of clusters per plant	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Grain yield per plant (g)
		1	2	3	4	5	6	7	8	9
1	AKCMS-92A X AKPR-364	-1.37	-0.97	1.61	0.33	2.33	3.50	0.08	-0.01	-1.05
2	AKCMS-92A X AKPR-324	-1.37	0.35	2.09	-0.08	2.09	6.27	-0.16 *	-0.69**	-3.05*
3	AKCMS-92A X AKPR-372	1.62	-0.14	6.13*	0.21	3.04	9.22	0.06	0.12	1.25
4	AKCMS-92A X AKPR-303	2.62	1.35	-5.50 *	-0.29	-1.26	-2.85	-0.03	-0.00	-2.24
5	AKCMS-92A X AKPR-057	1.62	-0.31	2.26	0.49 *	1.44	4.39	0.07	-0.53*	0.60
6	AKCMS-92A X AKPR-359	0.45	0.18	-7.26 **	-0.60 **	-3.23	-8.84	-0.17 *	-0.60 **	-2.88 *
7	AKCMS-92A X AKPR-215	-0.54	-0.31	-0.74	-0.46 *	-2.77	-8.33	0.09	-0.10	-0.41
8	AKCMS-92A X AKPR-277	-3.04	-0.14	1.40	0.39	-1.63	-3.36	0.06	0.41 *	-0.42
9	AKCMS-87A X AKPR-364	1.37	0.97	-1.61	-0.33	-2.33	-3.50	-0.08	0.01	1.05
10	AKCMS-87A X AKPR-324	1.37	-0.35	-2.09	0.08	-2.09	-6.27	0.16 *	0.69**	3.05*
11	AKCMS-87A X AKPR-372	-1.62	0.14	-6.13 *	-0.21	-3.04	-9.22	-0.06	-0.12	-1.25

12	AKCMS-87A X AKPR-303	-2.62	-1.35	5.50 *	0.29	1.26	2.85	0.03	0.00	2.24
13	AKCMS-87A X AKPR-057	-1.62	0.31	-2.26	-0.49 *	-1.44	-4.39	-0.07	0.53 *	-0.60
14	AKCMS-87A X AKPR-359	-0.45	-0.18	7.26 **	0.60 **	3.23	8.84	0.17 *	0.60 **	2.88 *
15	AKCMS-87A X AKPR-215	0.54	0.31	0.74	0.46 *	2.77	8.33	-0.09	0.10	0.41
16	AKCMS-87A X AKPR-277	3.04	0.14	-1.40	-0.39	1.63	3.36	-0.06	-0.41 *	0.42
	SE (Sij) ±	1.57	1.92	2.40	0.20	1.64	5.09	0.06	0.19	1.31
	SE (Sij-Skl) ±	2.22	2.72	3.40	0.29	2.32	7.21	0.09	0.27	1.86
	SE (Sij-Sik) ±	1.36	1.67	2.08	0.17	1.42	4.41	0.06	0.16	1.14
	CD at 5 %	3.21	3.93	4.91	0.42	3.35	10.41	0.14	0.39	2.69
	CD at 1 %	4.33	5.30	6.61	0.56	4.52	14.02	0.19	0.53	3.62

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

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