Electronic Journal of Plant Breeding, 7(3): 582-588 (September 2016)
ISSN 0975-928X
DOI: 10.5958/0975-928X.2016.00074.0

Research Article

Evaluating genotypes for combining ability through diallel analysis in okra over different environments

S.S. Patil, P.P. Patil, V.A. Lodam and D.T. Desai
Navsari Agricultural University, Navsari- 396450. Gujarat
E-mail: patils350@gmail.com

(Received:12 Aug 2015; Accepted:15 July 2016)

Abstract
A study was conducted to evaluate combining ability of eight genetically divergent parental strains of okra by diallel analysis (excluding reciprocals) with respect to fruit yield and its components. The combining ability analysis revealed significant mean sum of squares due to both, general combining ability (gca) and specific combining ability (sca) for fruit yield and its component traits. The ratio of gca : sca indicated predominance of non-additive gene action for all the characters. The parents JOL-09-7, JOL-09-8 and JOL-08-16 were good general combiners for yield and most of the yield contributing characters. Among the crosses JOL-09-7 x JOL-55-3, JOL-09-8 x JOL-08-16 and AOL-09-17 x AOL-09-13 showed significant and high sca effects for fruit yield per plant and most of the yield contributing characters.

Key words
Diallel analysis, general combining ability, specific combining ability and Okra

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is one of the most important vegetable crops of India. In crop improvement programme, the success rests upon isolation of valuable gene combinations on determination in the form of lines with high combining ability. The lines which produce good progenies on crossing are of immense value to the plant breeders. The knowledge of gene action and combining ability helps in identifying the best combiners which may be hybridized either to exploit heterosis or to accumulate gene through selection and in understanding the quantitative characters to choose the proper selection method to be followed in breeding programmes. The present investigation was undertaken to study the combining ability effects and variance using 8 x 8 diallel set.

Materials and method

The experimental material for the study comprised of thirty seven entries including eight parents (JOL-09-7, JOL-09-8, AOL-09-17, AOL-08-5, AOL-09-13, AOL-09-2, JOL-55-3 and JOL-08-16), their 28 F_1s derived by crossing in all possible combinations excluding reciprocals and one standard check GOH-2. The trial was laid out in a randomized block design with three replications over four seasons *viz*., summer-2011 (E_1), *kharif*-2011 (E_2), *rabi*-2011-12 (E_3) and summer-2012 (E_4) at Navsari Agricultural University, Navsari-396450 (Gujarat). Each entry was sown in a single row plot of ten plants, spaced 60 x 30 cm. All the recommended agronomic practices and plant protection measures were followed uniformly in all the four environments. Five competitive plants were randomly selected for recording the observations on different characters like days to 50% flowering, plant height (cm), internodal length (cm), branches per plant, no. of flowering nodes on main stem, fruit length (cm), fruit girth (cm), fruit weight (g), fruits per plant and fruit yield per plant (g). The combining ability analysis was done by following Model 1, Method 2 of Griffing (1956).

Result and discussion

Analysis of variance for combining ability on the basis of pooled data (Table 1) revealed that mean sum of squares due to GCA and SCA were highly significant for all the traits. Similar results were also reported by Kanchan *et al.* (2007), Pal and Sabesan (2009), Singh *et al.* (2009), Wammanda *et al.* (2010) and Singh (2011). This indicates involvement of both additive as well as non additive gene action in the inheritance of these traits. The mean squares due to gca x environment and sca x environment interactions were highly significant for all the characters (except gca x environment for fruit girth and ascorbic acid content and sca x environment for ascorbic acid content) thereby, indicating sensitivity of both kinds of genetic variance to the environmental fluctuation. The estimates of σ^2s were higher in magnitude than that of σ^2g for all the traits resulted in less than unit variance ratio (σ^2g/σ^2s) indicated preponderance of non-additive gene action in the expression of yield and all yield attributing traits. Similar findings were reported by Dahake and Bangar (2006), Weerasekara *et al.* (2008), Balakrishnan *et al.* (2009), Wammanda *et al.* (2010) and Singh (2011). From the present results, it was evident that the large portion of non-additive gene action was responsible in the expression of all the characters under study. Therefore, heterosis breeding may be adopted to exploit non-additive gene action and for obtaining high yield in okra at commercial scale. Reciprocal recurrent selection may also be adopted for population improvement in the present material.

An overall appraisal of *gca* effects revealed that none of the parents was good general combiner for all the traits. However, the parents JOL-09-7, JOL-09-8 and JOL-08-16 were good general combiners for fruit yield per plant and some of its direct components. Among these parents JOL-09-8 were found to be best general combiners as they possessed significant and positive *gca* effects for all the traits except internodal length and fruit girth, while JOL-08-16 for fruit yield, fruit weight, fruit girth, no. of flowering nodes on main stem, branches per plant, ascorbic acid content and days to 50% flowering. The parent JOL-09-7 was also good general combiner for fruit yield per plant, fruits per plant, no. of flowering nodes on main stem, branches per plant and plant height. The parents JOL-09-8 and AOL-09-17 exhibited highly significant *gca* effects for days to 50 per cent flowering and plant height indicating their good general combining ability for earliness and tallness while, these parents were also found to be best general combiner for the traits fruits per plant and ascorbic acid content. These good general combiners could be used in transferring economic characters in breeding programme. The estimates of *gca* effects further revealed that the parental lines showing high *gca* effects for fruit yield also exhibited high to average gca effects for one or other yield components. Srivastava *et al.* (2008), Khanpara *et al.* (2009), Singh *et al.* (2009), Wammanda *et al.* (2010) and Raghuvanshi *et al.* (2011) also reported similar results which supported the present findings.

Specific combining ability is an important component, which may be utilized for heterosis breeding. None of the cross combination was superior for all the characters. However, on the basis of pooled data as many as 12 cross combinations exhibited significant positive *sca* effects for fruit yield per plant. The best hybrids on the basis of significant positive *sca* effects for fruit yield per plant were JOL-09-7 x JOL-55-3, JOL-09-8 x JOL-08-16, AOL-09-17 x AOL-09-13, JOL-09-7 x JOL-09-8, AOL-09-17 x JOL-08-16, JOL-09-7 x AOL-09-2 and JOL-09-8 x JOL-55-3. Of these hybrids, JOL-09-7 x JOL-55-3 depicted significant positive *sca* effects in desired direction for plant height, branches per plant, no. of flowering nodes on main stem, fruit length, fruit girth, fruit weight and fruits per plant whereas, JOL-09-8 x JOL-08-16 for plant height, internodal length, branches per plant, no. of flowering nodes on main stem, fruit length, fruit girth, fruit weight and fruits per plant. Third hybrid, AOL-09-17 x AOL-09-13 for days to 50% flowering, plant height, internodal length, branches per plant, no. of flowering nodes on main stem, fruit length, fruit girth, fruit weight and fruits per plant. Therefore, these crosses with high yielding potential should be exploited for hybrid okra breeding programme. Significant positive *sca* effects for fruit yield and its component traits have also been reported by Prakash *et al.* (2002), Borgaonkar *et al.* (2003), Dahake and Bangar (2006) and Pal and Sabesan (2009).

Among the parents, JOL-09-7, JOL-09-8 and JOL-08-16 were good general combiners for yield and most of the yield contributing characters. The crosses with high *sca* effects for fruit yield and its components involved good x good, good x average, good x poor, average x average, average x poor and poor x poor general combiners. This reflected the role of both additive and non-additive gene actions in the genetic control of these characters. The presence of additive gene action would be enhanced the chance for making improvement through simple selection. For exploitation of non-additive effects, it appears worthwhile to intermate the selected progenies in early segregating generations, which would be resulted in the accumulation of favourable genes for the characters. Hence, bi-parental progeny selection may be useful to get some desirable transgressive segregants from such crosses.

References

Balakrishnan, D., Sreenivasan, E., Radhakrishnan, V.V., Sujata, R. and Babu, V.S. 2009. Combining ability in okra. *Electronic J. of Plant Breedin.,* **1**: 52-55.

Borgaonkar, S.B., Vadodaria, M.A. and Poshiya, V.K. 2003. Genetic architecture of yield and its components in okra. (*Abelmoschus esculentus* (L.) Moench). *GAU Res. J.,* **28**(1-2): 1-4.

Dahake, K.D. and Bangar, N.D. 2006. Combining ability analysis in okra. *J. Maharashtra Agric. Univ.,* **31**(1): 39-41.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.,* **9**:453-493.

Kanchan, M.W., Todkar, L.P. and Navale, P.A. 2007. Combining ability studies for seed oil content in okra. *J. Maharashtra Agric. Univ.,* **31**(2): 22-24.

Khanpara, M.D., Jivani, L.L., Vachhani, J.H., Shekhat, H.G. and Mehta, D.R. 2009. Line x tester analysis for combining ability in okra [*Abelmoschus esculentus* (L.) Moench.]. *International Journal of Agricultural Sci*., **5**(2): 554-557.

Pal, A.K. and Sabesan, T. 2009. Cmbining ability through diallel analysis in okra. *Electronic J. of Plant Breeding.,* **1**: 84-88.

Prakash, M., Kumar, M.S., Saravanan, K., Kannan, K. and Ganesan, J. 2002. Line x tester analysis in okra. *Annals Agric. Res.,* **23**(2):233-237.

Raghuvanshi, M., Singh, T.B., Singh, A.P., Singh, U., Singh, V.P. and Singh, B. 2011. Combining ability analysis in okra. *Veg. Sci.,* **38**(1): 26-29.

Singh, D.R., Singh, P.K., Syamal, M.M. and Gautam, S.S. 2009. Studies on combining ability in okra. *Indian J. Hort.,* **66**(2): 277-280.

Singh, S.P. 2011. Combining ability analysis for yield and yield contributing characters in okra. *Veg. Sci.,* **38**(2): 212-214.

Srivastava, M.K., Kumar, S. and Pal, A.K. 2008. Studies on combining ability in okra through diallel analysis. *Indian J. Hort.*, **65**(1): 48-51.

Wammanda, D.T., Kadams, A.M. and Jonah, P.M. 2010. Combining ability analysis and heterosis in a diallel cross of okra (*Abelmoschus esculentus* (L.) Moench). *African J. of Agric. Res.,* **5**(16): 2108-2115.

Weerasekara, D., Jagadeesha, R.C., Wali, M.C., Salimath, P.M., Hosamani, R.M. and Kalapanawar, I.K. 2008. Combinig ability of yield and yield components in okra (*Abelmoschus esculentus* (L.) Moench). *Karnataka J. Agric. Sci.,* **21**(2): 187-189.

Electronic Journal of Plant Breeding, 7(3): 582-588 (September 2016)
ISSN 0975-928X

Table 1. Analysis of variance for combining ability (pooled data)

Source of Variation	GCA	SCA	Error	Environments	GCA X E	SCA X E	σ2g	σ2s	σ2g/σ2s
D.F.	**(7)**	**(28)**	**(280)**	**(3)**	**(21)**	**(84)**	**-**	**-**	**-**
Days to 50 % flowering	23.096**	13.873**	0.916	168.717**	1.913**	2.365**	0.555	3.239	0.172
Plant height(cm)	1112.806**	738.657**	27.419	77825.522**	115.851**	72.430**	27.135	177.809	0.153
Internodal length (cm)	1.629**	0.645**	0.108	72.166**	0.216**	0.198**	0.038	0.134	0.283
Branches per plant	0.223**	0.051**	0.003	0.343**	0.040**	0.030**	0.005	0.013	0.420
No. of flowering nodes on main stem	11.341**	4.696**	0.153	138.543**	0.992**	0.930**	0.279	1.136	0.246
Fruit length (cm)	2.458**	1.889**	0.158	81.436**	0.351**	0.224*	0.057	0.433	0.133
Fruit girth (cm)	0.445**	0.587**	0.033	5.013**	0.045	0.048**	0.010	0.138	0.074
Fruit weight (g)	2.341**	1.756**	0.137	74.251**	0.298**	0.238**	0.055	0.405	0.136
Fruits per plant	15.604**	6.203**	0.291	235.008**	1.187**	0.861**	0.383	1.478	0.259
Fruit yield per plant (g)	3783.174**	1676.156**	51.775	73459.690**	192.132**	150.910**	93.285	406.095	0.230
Ascorbic acid content (mg/100g)	3.906**	1.972**	0.068	0.070	0.040	0.061	0.0956	0.475	0.202

*, ** Significant at 5 % and 1% level, respectively

Electronic Journal of Plant Breeding, 7(3): 582-588 (September 2016)
ISSN 0975-928X

Table 2. Estimates of general combining ability effects of parents for various characters in okra (pooled data)

Parents	Days to 50% flowering	Plant height	Internodal length	Branches per plant	No. of flowering nodes on main stem	Fruit length	Fruit girth	Fruit weight	Fruits per plant	Fruit yield per plant	Ascorbic acid content
JOL-09-7	-0.065 A	5.204** G	-0.083 A	0.053** G	0.686** G	-0.054 A	0.042 A	0.074 A	0.630** G	7.519** G	-0.011 A
JOL-09-8	-1.331** G	4.215** G	0.018 A	0.052** G	0.766** G	0.484** G	0.048 A	0.313** G	0.995** G	16.993** G	0.082* G
AOL-09-17	-0.681** G	5.831** G	0.048 A	-0.065** P	0.096 A	-0.048 A	0.038 A	-0.263** P	0.220** G	-0.198 A	0.183** G
AOL-08-5	0.644** P	1.410 A	0.255** P	-0.033** P	-0.569** P	-0.149* P	-0.199** P	-0.089 A	-0.588** P	-8.010** P	-0.058 A
AOL-09-13	0.869** P	-6.187** P	0.140** P	0.0006 A	-0.661** P	-0.195** P	-0.121** P	-0.360** P	-0.859** P	-13.531** P	-0.696** P
AOL-09-2	0.110 A	0.988 A	0.082 A	-0.134** P	-0.237** P	-0.174** P	0.003 A	-0.095 A	-0.439** P	-6.852** P	-0.052 A
JOL-55-3	0.735** P	-7.849** P	-0.428** G	0.098** G	-0.261** P	0.282** G	0.101** G	0.242** G	-0.074 A	-0.627 A	0.293** G
JOL-08-16	-0.281* G	-3.611** P	-0.032 A	0.029** G	0.181** G	-0.146* P	0.088** G	0.179** G	0.114 A	4.706** G	0.258** G
S.E.gi	0.142	0.774	0.048	0.007	0.058	0.058	0.027	0.055	0.079	1.064	0.038

G = Good general combiner P = Poor general combiner A = Average general combiner

*, ** Significant at 5 % and 1% level, respectively

Table 3. Estimates of specific combining ability effects for various characters in okra (pooled data)

Crosses	Days to 50% flowering	Plant height	Internodal length	Branches per plant	No. of flowering nodes on main stem	Fruit length	Fruit girth	Fruit weight	Fruits per plant	Fruit yield per plant	Ascorbic acid content
JOL-09-7 X JOL-09-8	-1.037**	3.866	-0.577**	0.083**	1.808**	0.162	0.435**	0.099	1.335**	0.302	-0.140
JOL-09-7 X AOL-09-17	-2.354**	3.667	-0.681**	0.175**	-0.289	-0.131	-0.177*	-0.281**	-0.107	-0.086	0.484**
JOL-09-7 X AOL-08-5	0.405	-5.629*	-0.050	-0.091**	0.828**	1.685**	0.438**	0.520**	1.378**	1.945**	-0.281*
JOL-09-7 X AOL-09-13	1.013*	3.576	0.328*	-0.056*	-1.006**	-0.168	-0.570**	0.139	-2.084**	-0.347	0.648**
JOL-09-7 X AOL-09-2	-1.562**	21.292**	-0.336*	0.079**	-1.154**	-0.478**	0.047	-0.066	-1.830**	-0.251	1.005**
JOL-09-7 X JOL-55-3	1.813**	20.347**	-0.062	0.087**	0.038	0.805**	0.653**	-0.240**	0.354	1.315**	-0.739**
JOL-09-7 X JOL-08-16	1.496**	-16.374**	0.135	-0.046*	1.963**	0.084	0.325**	-0.232**	1.917**	0.420	-0.566**
JOL-09-8 X AOL-09-17	-0.671	-1.361	-0.333*	-0.115**	1.375**	-0.515**	0.433**	-0.392**	1.841**	-0.746**	0.984**
JOL-09-8 X AOL-08-5	1.505**	-9.923**	-0.370*	-0.073**	-0.525**	1.184**	-0.328**	0.584**	0.030	1.476**	-0.275*
JOL-09-8 X AOL-09-13	2.446**	-2.316	0.161	-0.136**	1.090**	0.049	-0.042	0.149	0.774**	0.087	-0.091
JOL-09-8 X AOL-09-2	-0.712	2.687	0.137	0.226**	0.857**	-0.668**	0.537**	-0.158	0.601*	-0.699**	-0.081
JOL-09-8 X JOL-55-3	-1.587**	15.678**	0.138	0.072**	-0.142	-0.568**	0.258**	-0.113	-0.200	-1.182**	1.062**
JOL-09-8 X JOL-08-16	-0.404	21.177**	-0.450**	0.127**	-1.643**	-0.258	0.159	-0.487**	-1.387**	-0.527*	-0.173
AOL-09-17 X AOL-08-5	1.938**	-4.156	-0.236	0.014	1.166**	0.640**	0.144	0.231**	1.643**	0.120	-0.236*
AOL-09-17 X AOL-09-13	-2.037**	5.475*	-0.368*	0.128**	0.177	0.273	0.082	0.871**	0.244	27.449**	-0.984**
AOL-09-17 X AOL-09-2	2.971**	-2.317	0.125	0.116**	0.659**	-0.078	0.427*	-0.603**	10.193**	-10.539**	-0.101
AOL-09-17 X JOL-55-3	-0.571	-0.238	0.521**	-0.124**	-0.141	0.544**	-0.074	0.797**	-3.478	16.600**	-0.460**
AOL-09-17 X JOL-08-16	-1.804**	29.218**	0.227	0.046*	0.658**	-0.460*	0.682**	-0.743**	37.712**	-36.043**	1.358**
AOL-08-5 X AOL-09-13	0.638	10.745**	-0.218	0.069**	0.496**	-0.450*	0.024	-0.168	-6.091	-21.363**	1.103**
AOL-08-5 X AOL-09-2	-0.187	4.238	0.082	-0.141**	-0.202	1.178**	0.236	0.305	-2.984	5.583	-0.049
AOL-08-5 X JOL-55-3	-4.146**	14.133**	-0.026	0.142**	0.140	0.535**	-0.170	0.731**	15.318**	33.592**	0.688**
AOL-08-5 X JOL-08-16	0.955*	-3.181	0.469**	0.081**	-0.451*	0.905**	0.270	0.991**	5.417	29.725**	-0.581**
AOL-09-13 X AOL-09-2	-3.662**	1.301	0.304*	0.099**	0.158	-0.623**	-0.232	-0.502**	-7.963*	-8.242*	-0.959**
AOL-09-13 X JOL-55-3	-0.120	-3.629	-0.135	0.026	0.668**	0.487**	0.614**	0.531**	24.355**	13.386**	0.117
AOL-09-13 X JOL-08-16	1.896**	-8.950**	-0.268	0.064**	0.400*	1.353**	0.322	1.374**	6.067	17.951**	0.264*
AOL-09-2 X JOL-55-3	1.138**	5.005*	0.263	-0.018	0.138	0.019	-0.581**	0.081	-10.233**	4.663	-0.342**
AOL-09-2 X JOL-08-16	-1.012*	0.142	-0.795**	-0.013	-0.750**	-0.291	-0.257	-0.046	-12.775**	-17.373**	1.180**
JOL-55-3 X JOL-08-16	-1.220**	0.987	0.160	-0.023	-0.410*	-0.092	-0.663**	0.002	-22.043**	17.243**	-0.218
S.E.s_{ij}	0.434	2.374	0.149	0.023	0.645**	0.180	0.658**	0.167	8.679**	3.262	0.118

*, ** Significant at 5 % and 1% level, respectively.

Electronic Journal of Plant Breeding, 7(3): 582-588 (September 2016)
ISSN 0975-928X

Table 4. Best performing hybrids and hybrids with highest *sca* effects for different characters in okra based on pooled data.

Sr. No.	Character	Hybrids with highest *sca* effects		*sca* effects	Superior crosses on the basis of *per se* performance	
1.	Days to 50 % flowering	AOL-08-5 x JOL-55-3	(PxP)	-4.146**	JOL-09-7 x AOL-09-17	(AxG)
		AOL-09-13 x AOL-09-2	(PxA)	-3.662**	AOL-09-17 x JOL-08-16	(GxG)
		JOL-09-7 x AOL-09-17	(AxG)	-2.354**	AOL-08-5 x JOL-55-3	(PxP)
2.	Plant height (cm)	AOL-09-17 x JOL-08-16	(GxP)	29.218**	AOL-09-17 x JOL-08-16	(GxP)
		JOL-09-7 x AOL-09-2	(GxA)	21.292**	JOL-09-7 x AOL-09-2	(GxA)
		JOL-09-8 x JOL-08-16	(GxP)	21.177**	JOL-09-8 x JOL-08-16	(GxP)
3.	Internodal length (cm)	AOL-09-2 x JOL-08-16	(AxA)	-0.795**	AOL-09-2 x JOL-08-16	(AxA)
		JOL-09-7 x AOL-09-17	(AxA)	-0.681**	JOL-09-7 x AOL-09-17	(AxA)
		JOL-09-7 x JOL-09-8	(AxA)	-0.577**	JOL-09-7 x JOL-09-8	(AxA)
4.	Branches per plant	JOL-09-8 x AOL-09-2	(GxP)	0.226**	JOL-09-7 x JOL-55-3	(GxG)
		JOL-09-7 x AOL-09-17	(GxP)	0.175**	JOL-09-8 x JOL-55-3	(GxG)
		AOL-08-5 x JOL-55-3	(PxG)	0.142**	JOL-09-8 x JOL-08-16	(GxG)
5.	No. of flowering nodes on main stem	JOL-09-8 x JOL-08-16	(GxG)	1.963**	JOL-09-7 x JOL-09-8	(GxG)
		JOL-09-7 x JOL-09-8	(GxG)	1.808**	JOL-09-8 x JOL-08-16	(GxG)
		JOL-09-7 x JOL-55-3	(GxP)	1.685**	JOL-09-7 x JOL-55-3	(GxP)
6.	Fruit length (cm)	AOL-08-5 x JOL-55-3	(PxG)	1.353**	JOL-09-8 x AOL-09-2	(GxP)
		JOL-09-8 x AOL-09-2	(GxP)	1.178**	AOL-08-5 x JOL-55-3	(PxG)
		AOL-09-17 x AOL-09-13	(AxP)	0.905**	JOL-09-8 x AOL-09-17	(GxA)
7.	Fruit girth (cm)	JOL-09-8 x AOL-09-2	(AxA)	0.653**	AOL-09-17 x JOL-08-16	(AxG)
		AOL-09-17 x JOL-08-16	(AxG)	0.584**	JOL-09-8 x AOL-09-2	(AxA)
		AOL-08-5 x JOL-55-3	(PxG)	0.537**	JOL-09-7 x JOL-55-3	(AxG)
8.	Fruit weight (g)	AOL-08-5 x JOL-55-3	(AxG)	1.374**	AOL-08-5 x JOL-55-3	(AxG)
		AOL-09-17 x AOL-09-13	(PxP)	0.991**	JOL-09-7 x JOL-09-8	(AxG)
		JOL-09-7 x JOL-09-8	(AxG)	0.871**	JOL-09-8 x JOL-08-16	(GxG)
9.	Fruits per plant	JOL-09-7 x JOL-55-3	(GxA)	1.945**	JOL-09-8 x JOL-08-16	(GxA)
		JOL-09-8 x JOL-08-16	(GxA)	1.917**	JOL-09-7 x JOL-09-8	(GxG)
		AOL-09-17 x AOL-09-13	(GxP)	1.841**	JOL-09-7 x JOL-55-3	(GxA)
10.	Fruit yield per plant (g)	JOL-09-7 x JOL-55-3	(GxA)	37.712**	JOL-09-8 x JOL-08-16	(GxG)
		JOL-09-8 x JOL-08-16	(GxG)	33.592**	JOL-09-7 x JOL-09-8	(GxG)
		AOL-09-17 x AOL-09-13	(AxP)	29.725**	JOL-09-7 x JOL-55-3	(GxA)
11.	Ascorbic acid content (mg/100g)	AOL-09-17 x JOL-08-16	(GxG)	1.358**	AOL-09-17 x JOL-08-16	(GxG)
		AOL-09-2 x JOL-08-16	(AxG)	1.180**	JOL-09-8 x JOL-55-3	(GxG)
		AOL-08-5 x AOL-09-13	(AxP)	1.103**	AOL-09-2 x JOL-08-16	(AxG)

*, ** Significant at 5 % and 1% level, respectively.