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Combining ability studies in tomato (*Solanum lycopersicum* l.) for yield attributes, yield and quality

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Abstract

The experiment was conducted with 45 F_1's developed through diallele mating design (without reciprocals) along with ten parents (EC-165749, EC-157568, EC-164838, LE-56, LE-62, LE-64, LE-65, LE-66, LE-67 and LE-68) in a randomized block design which was replicated thrice. The study revealed that the significant general combing ability effects were shown by parents. and they were good general combiners for fruit yield. Most of the crosses showed high sca effects for fruit yield. plant height (cm), number of primary branches per plant, days to 50% flowering, number of fruits per cluster, average fruit weight (g), fruit yield per plant (kg)

Keywords: tomato, combining ability and yield

Introduction

Tomato (*Solanum lycopersicum* L.) (2n=2x=24) is one of the most important solanaceous vegetable crops of Peru-Euqador origin (Rick, 1969), especially grown in the tropics and subtropics. It ranks second only after potato (Bose *et al.*, 2002) [2]. In many countries it is considered as "poor man's orange" because of its attractive appearance and nutritive value. Tomatoes are being used in sandwiches, salads and processed products like paste, puree, soup, sauce, juice, ketchup, whole canned fruit and drinks (Bose *et al.*, 2002) [2]. Tomato also forms an important ingredient in the cocktail known as "Bloody Marry". Tomato is a moderate nutritional crop and is considered as an important source of vitamin A, vitamin C and minerals (Hari, 1997) [5]. Under Indian condition, the fruits are mainly consumed either as raw or in the preparation of chutney, pickles etc. Apart from these, lycopene is valued for its anti-cancer property (Bose *et al.*, 2002) [2]. It acts as an antioxidant and scavenger of free radicals, which is often associated with carcinogenesis.

Tomato is universally treated as 'Protective Food' since it is rich of minerals, vitamins, antioxidents and organic acids. Apart from contributing nutritive elements, colour and flavor to the diet, tomatoes are also a valuable source of antioxidants or chemo-protective compounds, and may thus be termed a functional food" (Ranieri *et al.*, 2004) [13]. The antioxidant potential of tomto is derived from a mixture of antioxidant biomolecules, including lycopene, ascorbic acid, phenolics, flavonoids and vitamin. In India, tomato is grown in an area of 0.882 million hectares with annual production of 18.74 million tonnes and productivity of 21.2 tonnes /ha. Therefore, present study has taken up to find out genotypes which gives higher yields. Tomato crop has a tremendous potential for heterosis breeding. Increasing productivity through exploitation of hybrid vigour is one of the most important applications in breeding and could be successfully employed in improving the quality and productivity of crop.

Keeping these points in view the present study is undertaken with the following objective to study the combining ability for fruit yield and its components.

Materials and Methods

The field experiment was carried out at Vegetable Research Station, Dr. Y.S.R. Horticultural University, Rajendranagar, Hyderabad. The experimental material consisted of ten lines (EC-165749, EC-157568, EC-164838, LE-56, LE-62, LE-64, LE-65, LE-66, LE-67 and LE-68). Ten parents were crossed with each other in diallel mating design (excluding reciprocals) during Rabi, 2010-11 at Vegetable Research Station, Rajendranagar, Hyderabad. The resultant 45 F_1s were evaluated for yield, yield contributing and quality characters.

All 57 entries comprising of ten parents and 45 F_1s along with two commercial hybrids (Siri and US-618) as checks were sown in a randomized block design which was replicated thrice. Each entry was grown in two rows with 10 plants in each row by adopting inter row spacing of

60 cm and intra row spacing of 45 cm. In each entry, five plants were tagged randomly for recording data. The cultural practices and the plant protection measures were adapted uniformly to all the treatments, as recommended by Dr. YSRHU.

Results and Discussion

The analysis of variance on combining ability revealed highly significant differences among the genotypes for all the characters studied indicating the wealth of genetic variability among the parents, hybrids and parents vs hybrids created by hybridization of diverse parents (Table 1)

The combining ability effects were estimated for all the characters as they had significant contributions to total variance. The effects due to general and specific combining ability are presented under following sub heads. The estimates of *gca* effects of parents and estimates of *sca* effects of crosses are presented in Table 2 and 3. The character wise analysis of the *gca* and *sca* effects for different characters are presented below.

Among the parents, LE-56 (12.37), EC-157568 (11.85), EC-164838 (7.98) and LE-64 (7.62) recorded significant positive *gca* effects for plant height. While, LE-67 (-17.39), LE-65 (-14.51), EC 165749 (-7.11), and LE-62 (-6.16) were recorded significantly negative *gca* effects for plant height thus indicating their poor general combining ability for plant height. Of all the crosses studied five crosses recorded significant *sca* effect 40.34 (LE-64 x LE-66), 32.57(LE-56 x LE-68), 26.69 (EC-157568 x LE-68), 21.78 (EC-164838 x LE-66) and 14.34 (EC-164838 x LE-64). Only two crosses viz., -32.85 (EC-164838 x LE-56) and -14.53(LE-64 x LE-68) were recorded significantly negative *sca* effects for this trait. For plant height additive gene action was found as *GCA* variance was higher than *SCA* variance. The present results are in line with the earlier reports of Premalakshmi *et al.* (2005) [12], Saidi (2008) [16], Shankar *et al.* (2013) [17] and Madhavi *et al.* (2013) [8]. In present results, it is observed that hybrids with more plant height seem to be dominant over short plants. The high positive effects obtained in the cross combinations in the desired direction might be due to high frequency of dominant alleles for more plant height.

For number of primary branches per plant among the parents EC-164838 (1.10), LE-64 (0.76), LE-68 (0.49), EC-157568 (0.39), LE-66 (0.36) and LE-56 (0.22) recorded significant positive *gca* effects while, LE-65 (-1.13), EC 165749 (-0.88), LE-62 (-0.70) and LE-67 (-0.61) recorded significant negative *gca* effects. The *sca* effects ranged from -1.26 to 3.48. The significant positive *sca* effects obtained in ten crosses. High magnitude of positive significant *sca* effects was exhibited by LE-64 × LE-66 (3.48) followed by LE-56 ×LE-68 (2.55), EC-157568x LE-68 (1.71) and EC-164838 x LE-66 (0.74). Eighteen cross combinations displayed significant and negative *sca* effects. High magnitude of negative significant *sca* effects were exhibited by LE-62 × LE-64 (-1.26), LE-66 x LE-68 (-1.12), EC-157568 x LE-64 (-1.09) and LE-56 x LE-66 (-1.05). Number of branches per plant is an important character to increase the yielding ability in tomato. More number of branches leads to more number of fruits per plant. In the present investigation for the character, number of branches per plant the ratio of *GCA* to *SCA* variance was less than unity in analysis indicating the predominant role of non-additive gene action. These results are similar with the findings of Dharmatti *et al.* (2001) [4], Pandey *et al.* (2006) [10] and Shankar *et al.* (2013) [17].

The negative *gca* effects which indicate earliness, would be considered as desirable. Among the parents tested only EC-164838 (-1.34) and LE-56 (-0.65) exhibited significant negative *gca* effect. However LE-65(0.63), LE-62 (0.62) and LE-67 (0.49) recorded significant positive *gca* effect and are considered to be poor general combiners for earliness.

Among the crosses, significant positive *sca* effects, which indicates good specific combining ability ranged from -0.02 (LE-64 x LE-67) to 0.69 (LE-64 x LE-66) for number of fruits per cluster and the top five specific cross combinations with highly significant *sca* effects were LE-64 x LE-66, LE-56 x LE-68, EC-157568 x LE-68, EC-157568 x LE-67 and LE-56 x LE-67 with the *sca* effects of 0.69, 0.48, 0.47, 0.45 and 0.38 respectively. However, six crosses recorded significant negative *sca* effects for number of fruits per cluster ranging from -0.22 (LE-65 x LE-67) and EC-157568 x LE-56 to -0.31 (LE-67 x LE-68). Total number of fruits per plant is the most important trait which determines the worthiness of hybrid. Lower ratio of *GCA* to *SCA* variances was observed for number of fruits per cluster suggesting that the trait is under the control of non-additive gene action. Similar trend of results were reported by Roopa *et al.* (2001), Mehta *et al.* (2005) [9], Shankar *et al.* (2013) [17] and Madhavi *et al.* (2013) [8].

Among the parents, five parents (EC-157568, LE-56, LE-64, LE-66 and LE-68) were good general combiners as indicated by their significant positive *gca* effects. Among the hybrids, LE-64 × LE-66, LE-56 x LE-68, EC-157568 x LE-68 and EC-164838 x LE-66 for number of fruits per cluster were identified as good specific combiners based on significant *sca* effects.

Among the parents, LE-66 (5.07), LE-68 (4.31) EC-165749(4.17), LE-56 (3.23), LE-64 (2.66) and EC-164838 (1.94) recorded significant positive *gca* effect for average fruit weight, while LE-67 (-8.17), LE-65 (-4.64), LE-62 (-4.48) and EC-157568 (-4.08) recorded significantly negative *gca* effect for this trait. Positive *sca* effects were desirable for average fruit weight. Among the crosses, significant positive *sca* effects were recorded in seven crosses ranging from 0.62 (LE-66 x LE-68) to 11.52(EC-157568 x LE-68). Four superior crosses for average fruit weight were EC-157568 x LE-68 (11.52), LE-64 x LE-66 (9.12), EC-165749 x LE-62 (5.74) and EC-165749 x EC-164828 (5.68). For the character average fruit weight, non-additive gene action was found to be important as *GCA* variance was less than the *SCA* variance. The present results are similar to the earlier reports of Mehta *et al*. (2005) [9], Pandey *et al*. (2006) [10], Rao *et al*. (2007) [14] and Shankar *et al*. (2013) [17]. In the present investigation, six parents, EC-165749, EC-164838, LE-56, LE-64, LE-66 and LE-68 as good general combiners with significant positive *gca* effects and four crosses LE-64 × LE-66, LE-56 x LE-68, EC-157568 x LE-68 and EC-164838 x LE-66 with significant positive *sca* effects.

Among all the parents, LE-56 (0.14), LE-64 (0.14), EC-157568 (0.09), EC-164838 (0.09) and LE-66 (0.07) exhibited significant positive *gca* effects and are adjudged as good general combiners for fruit yield. However four parents *viz*., LE-65 (-0.19), LE-67 (-0.15), EC-165749(-0.10) and LE-62 (-0.10) exhibited significant and negative *gca* effects for fruit yield and they are presumed to be poor general combiners for fruit yield per plant.

Among the crosses significant and positive *sca* effects which indicates good specific combining ability for fruit yield were observed in seven crosses and the best specific cross combinations with highly significant positive *sca* effects were LE-64 x LE-66 (1.32), LE-56 x LE-68 (1.01), EC-157568 x

LE-68 (0.72), EC-164838 x LE-66 (0.36), EC-164838 x LE-65(0.33), EC-165749 x LE-62 (0.27) and LE-62 x LE-65 (0.24). However, four crosses recorded significantly negative *sca* effects for fruit yield ranged from -0.23 (EC-165749 x LE-66) to -0.31(LE-64 x LE-68), thus considered to be poor specific cross combinations for fruit yield per plant. For the character total yield per plant, non-additive gene action was found to be important as *GCA* variance was less than *SCA* variance. The present results are in consonance with the earlier findings of Kalloo *et al.* (1992), Dhaliwal *et al.* (2000) [3], Dharmatti *et al.*(2001) [4], Roopa *et al.* (2001), Pandey *et al.* (2006) [10], Kavita *et al.*(2007) [6], Rao *et al.* (2007) [14], Saidi *et al.* (2008) [16], Shankar *et al*. (2013) [17] and Madhavi *et al*. (2013) [8].

Among the parents, five parents (EC-165749, EC-164838, LE-56, LE-64, LE-66 and LE-68) were good general combiners as indicated by their significant positive *gca* effects. Among the hybrids, four crosses (LE-64 × LE-66, LE-56 x LE-68, EC-157568 x LE-68 and EC-164838 x LE-66) were identified as good specific combiners on the basis of significant *sca* effects.

Among the parents, LE-68 (0.39), LE-64 (0.28), EC-164838 (0.24) and LE-66 (0.15) showed positive and significant *gca* effects and are considered to be good general combiners for TSS, while, LE-56 (-0.35), EC-157568 (-0.26), EC-165749(-0.25) and LE-67 (-0.15), exhibited negative and significant *gca* effects and were found to be poor general combiners for TSS. Significant positive *sca* effects for this trait was noticed in eight crosses, which ranged from 0.83 (EC-164838 x LE-62) to 2.01 (EC-157568 x LE-68) and considered to be good specific combiners for TSS. However, significant negative *sca* effects were exhibited by nine crosses ranging from -0.41 (EC-165749 x LE-68) to -0.93 (EC-164838 x LE-68). For total soluble solids, the estimates of *SCA* variance were found to be more than that of the *GCA* variance pointing out the importance of non-additive gene action in the inheritance of the trait. These results are in consonance with the findings of Mehta *et al.* (2005) [9], Pandey *et al.* (2006) [10], Kumari and Srivastava (2007) [7], Shankar *et al*. (2013) [17] and Madhavi *et al*. (2013) [8].

Among the parents and hybrids, four parents (EC-164838, LE-64, LE-66 and LE-68) and five hybrids EC-157568 × LE-68, EC-164838 x LE-66, EC-164838 x LE-64, EC-157568 x LE-68 and LE-56 x LE-68 recorded significant positive *gca* and *sca* effects.

Among the parents, LE-66 (0.47), EC-165749(0.39), LE-68 (0.37) and LE-56 (0.28) recorded significant positive *gca* effects for lycopene content, while EC-157568 (-1.07), LE-67 (-0.47) and LE-64 (-0.26) exhibited significant negative *gca* effect indicating poor general combiners for lycopene content.

Among the crosses significant and positive *sca* effects, which indicates good specific combining ability for lycopene content observed in twenty crosses and the best five specific cross combinations with highly significant positive *sca* effects were EC-157568 x LE-68, EC-164838 x LE-64, EC-164838 x LE-62, EC-165749 x LE-67 and LE-56 x LE-65 with the *sca* effects of 2.87, 2.33, 1.91, 1.83 and 1.77 respectively. However, nine crosses recorded significant negative *sca* effects for lycopene content, ranging from -0.65 (LE-65 x LE-67) to -4.03 (LE-64 x LE-68).Lycopene content non-additive gene action was found to be important as *GCA* variance was less than *SCA* variance. The present results are in line with the earlier reports of Roopa *et al.* (2001), Kumari and Srivastava (2007) [7], Mondal *et al*. (2009), Shankar *et al*. (2013) [17] and Madhavi *etal.(*2013) [8].

Among the parents, two parents (EC-157568 and EC-164838) and among hybrids five hybrids (EC-157568 × LE-68, EC-164838 x LE-62, EC-164838 x LE-64, EC-164838 x LE-66 and EC-157568 x LE-64) recorded significant positive *gca* and *sca* effects respectively.

Conclusion

The ratio of *gca* variance to *sca* variance is less than unity for number of primary branches per plant, number of fruits per cluster, average fruit weight, fruit yield per plant, TSS and lycopene content, indicating the preponderance of non-additive gene action for yield, yield components and quality parameters. Hence, heterosis breeding and recombination breeding with postponement of selection at later generations are ideal for improvement of yield and quality in tomato. Of the four superior general combiners identified for fruit yield per plant *viz*., EC-157568, EC-164838, LE-56 and LE-64 the former (EC-157568) also happens to be the superior general combiner for number of fruits per cluster, TSS and lycopene content, while the latter (LE-64) also happens to be the superior general combiner for number of fruits per cluster, average fruit weight and lycopene content. These can be utilized in commercial breeding programmes as good donors for yield and quality.

Of the best four promising specific combiners identified for fruit yield per plant, the crosses LE-64 x LE-66, LE-56 x LE-68, EC-157568 x LE-68 and EC-164838 x LE-66 having high or average *per se* performance, good fruit quality and one of the parents in the cross with high *sca* effect, could be utilized in recombination breeding and single plant selection can be practiced in the passing generations to coin the additive gene action to evolve hybrids with higher fruit yield per plant and good fruit quality.

In the present investigation, the cross combinations with high *sca* effects involved not only parents with high × high *gca* effects but also crosses with high × low and low × low *gca* effects. High performance of these crosses may be due to additive × additive (high × high), additive × dominance (high × low) or dominance × dominance (low × low) epistatic interactions. Ideal combination to be exploited is the one, where high magnitude of *sca* is present in addition to high *gca* in both or at least one of the parents.

Table 1: ANOVA for combining ability (Half diallel) for yield, yield attributes and quality characters in tomato.

Source	DF	Mean sum of Squares						
		Plant Height (cm)	No. of Primary Branches/Plant	No. of Fruits/Cluster	Average Fruit Weight (g)	Fruit Yield/Plant (kg)	Total Soluble Solids (ºbrix)	(Lycopene Content mg/100 g)
Replications	2	57.37	0.24*	0.11	9.47	0.02	0.03	0.19
Treatments	54	1096.39**	6.00**	0.41**	218.19**	0.38**	1.40**	7.88**
Parents	9	996.16**	5.26**	0.28**	53.28	0.09*	1.05**	4.73**
Hybrids	44	1122.75**	6.22**	0.35**	250.89**	0.39**	1.46**	8.58**
Parent Vs. Hybrids	1	838.35*	2.80**	4.24**	263.52**	2.46**	1.75**	5.25**
Error	108	159.17	0.08	0.04	27.66	0.04	0.14	0.36
Total	164	466.53	2.03	0.16	90.17	0.15	0.55	2.84

* Significant at 5% level ** Significant at 1% level

Table 2: Estimates of *gca* effects for parents for yield, yield contributing and quality characters in tomato.

	Plant Height (cm)	No. of Primary Branches/ Plant	No. of Fruits/Cluster	Average Fruit Weight(g)	Fruit Yield/ Plant (kg)	Total Soluble Solids (ºbrix)	Lycopene Content (mg/100 g)
Parents							
P_1 EC-165749	-7.11**	-0.88**	-0.23**	4.17**	-0.10**	-0.25**	0.39**
P_2 EC-157568	11.85**	0.39**	0.12**	-4.08**	0.09**	-0.26**	-1.07**
P_3 EC-164838	7.98**	1.10**	0.12**	1.94*	0.09**	0.24**	0.02
P_4 LE-56	12.37**	0.22**	0.18**	3.23**	0.14**	-0.35**	0.28**
P_5 LE-62	-6.16**	-0.70**	-0.03	-4.48**	-0.10**	-0.03	0.16
P_6 LE-64	7.62**	0.76**	0.20**	2.66**	0.14**	0.28**	-0.26**
P_7 LE-65	-14.51**	-1.13**	-0.21**	-4.64**	-0.19**	-0.02	0.11
P_8 LE-66	4.41	0.36**	0.13**	5.07**	0.07*	0.15**	0.47**
P_9 LE-67	-17.39*	-0.61**	-0.29**	-8.17**	-0.15**	-0.15*	-0.47**
P_{10} LE-68	0.93	0.49**	0.02	4.31**	0.01	0.39**	0.37**
Gi	4.51	0.10	0.07	1.90	0.07	0.03	0.21
Gi-Gj	6.73	0.15	0.11	2.80	0.11	0.20	0.32

* Significant at 5% level ** Significant at 1% level

Table 3: Estiamtes of specific combining ability (*sca*) effects for yield and yield attributing characters in tomato.

Sr. No	Crosses	Plant Height (cm)	No. of Primary Branches/Plant	No. of Fruits/Cluster	Average Fruit Weight (g)	Fruit Yield/Plant (kg)	Total Soluble Solids (ºbrix)	Lycopene Content (mg/100g)
1	P1xP2 EC-165749xEC-157568	6.13	-0.19	-0.14	-2.16	0.03	0.25	-0.23
2	P1xP3 EC-165749xEC-164838	7.10	0.31*	0.12	5.68*	0.14	0.14	1.14**
3	P1xP4 EC-165749xLE-56	4.04	-0.75**	-0.27*	3.14	-0.07	0.13	-2.48**
4	P1xP5 EC-165749xLE-62	0.82	0.04	0.14	5.74*	0.27*	0.25	1.11**
5	P1xP6 EC-165749xLE-64	-9.69	-0.89**	0.12	-0.17	-0.03	-0.27	1.69**
6	P1xP7 EC-165749xLE-65	0.82	-0.33*	0.12	0.53	0.17	-0.14	0.66*
7	P1xP8 EC-165749xLE-66	-5.11	0.18	0.05	3.61	-0.23*	-0.34	-0.76*
8	P1xP9 EC-165749xLE-67	0.82	0.28	0.21	-1.37	0.17	0.40*	1.83**
9	P1xP10 EC-165749xLE-68	-4.65	-0.82**	-0.11	2.28	-0.13	-0.41*	-1.06**
10	P2xP3 EC-157568xEC-164838	4.73	-0.02	-0.17	-7.40*	-0.11	-0.50*	-0.96**
11	P2xP4 EC-157568xLE-56	3.04	-0.95**	-0.22*	-4.49	0.14	0.12	-0.90**
12	P2xP5 EC-157568xLE-62	-0.18	0.31*	0.19	-6.14*	0.03	-0.20	-1.10**
13	P2xP6 EC-157568xLE-64	-10.70	-1.09**	-0.04	-4.09	-0.10	-0.48*	1.04**
14	P2xP7 EC-157568xLE-65	-0.18	-0.26	0.17	-5.85*	0.01	0.15	-2.08**
15	P2xP8 EC-157568xLE-66	-6.11	-0.35*	0.03	-1.79	-0.25*	-0.52*	-0.45
16	P2xP9 EC-157568xLE-67	-0.18	0.01	0.45**	-6.18*	0.18	-0.35	1.09**
17	P2xP10 EC-157568xLE-68	26.69**	1.71**	0.47**	11.52**	0.72**	2.01**	2.87**
18	P3xP4 EC-164838xLE-56	-32.85**	0.28	-0.09	-1.47	-0.08	-0.35	-0.29
19	P3xP5 EC-164838xLE-62	6.37	0.27	0.19	-1.60	0.11	0.83**	1.91**
20	P3xP6 EC-164838xLE-64	14.34*	0.00	0.23*	-0.92	0.10	1.28**	2.33**
21	P3xP7 EC-164838xLE-65	6.37	0.63**	0.37**	1.59	0.33**	0.51*	-0.03
22	P3xP8 EC-164838xLE-66	21.78**	0.74**	0.29**	3.53	0.36**	1.54**	1.50**
23	P3xP9 EC-164838xLE-67	6.37	0.64**	-0.15	-2.98	0.03	0.02	-0.36
24	P3xP10 EC-164838xLE-68	0.89	0.48**	0.21	2.15	-0.13	-0.93**	-0.37
25	P4xP5 LE-56xLE-62	4.68	-0.85**	0.20	-2.20	-0.01	-0.05	1.57**
26	P4xP6 LE-56xLE-64	-5.84	-0.72**	-0.09	-0.38	-0.15	-0.16	1.69**
27	P4xP7 LE-56xLE-65	4.68	-0.56**	0.38**	-0.74	0.01	-0.13	1.77**
28	P4xP8 LE-56xLE-66	-0.22	-0.09	-0.67**	0.11*	3.75**	-0.25**	1.07**
29	P4xP9 LE-56xLE-67	0.06	-0.04	0.17	-0.11**	2.33**	-0.03	1.77**
30	P4xP10 LE-56xLE-68	0.00	-0.34*	1.09**	-0.10*	-3.20**	0.97**	1.29**
31	P5xP6 LE-62xLE-64	-0.09	-0.34*	-0.11	-0.03	-3.87**	-0.01	-1.68**
32	P5xP7 LE-62xLE-65	-0.30*	-0.06	-0.15	0.11**	8.06**	-0.41**	-2.21**
33	P5xP8 LE-62xLE-66	-0.09	0.08	-0.08	-0.03	-4.85**	-0.16**	1.06**
34	P5xP9 LE-62xLE-67	-0.07	-0.07	0.29	-0.06	-3.54**	0.41**	-1.30**
35	P5xP10 LE-62xLE-68	-0.06	-0.15	-0.85**	-0.01	-0.81	-0.51**	0.62
36	P6xP7 LE-64xLE-65	0.04	-0.33*	0.24	-0.01	2.59**	0.25**	-0.20
37	P6xP8 LE-64xLE-66	-0.15	-0.15	0.70**	-0.05	-6.18**	-0.45**	-1.69**
38	P6xP9 LE-64xLE-67	-0.26	0.00	0.28	-0.05	-0.21	-0.24**	-1.13**
39	P6xP10 LE-64xLE-68	-0.12	-0.35*	-0.17	0.09*	6.94**	-0.15**	-4.03**
40	P7xP8 LE-65xLE-66	-0.02	0.04	-0.34	0.00	2.75**	-0.02	1.52**
41	P7xP9 LE-65xLE-67	-0.01	-0.14	0.27	-0.02	-5.55**	-0.08	-0.65*
42	P7xP10 LE-65xLE-68	-0.13	-0.11	-0.54**	0.07	8.63**	-0.07	1.07**
43	P8xP9 LE-66xLE-67	-0.13	0.01	0.10	-0.05	8.45**	-0.12**	-1.88**
44	P8xP10 LE-66xLE-68	-0.19	-0.10	-0.18	0.00	0.76	1.06**	0.08
45	P9xP10 LE-67xLE-68	0.10	0.02	-0.67**	0.08	-3.54**	-0.23**	-1.06**
	Sij--at 99%	0.38	0.39	0.53	0.11	2.14	0.12	0.86
	Sij--Sik at 99%	0.56	0.58	0.78	0.16	3.15	0.17	1.27
	Sij--Skl at 95%	0.40	0.41	0.56	0.12	2.25	0.12	0.90

* Significant at 5% level ** Significant at 1% level

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