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GCA and SCA for plant and pod parameters of Okra [*Abelmoschus esculentus* (L.) Moench]

Valluru Manju Vani, BK Singh, SVS Raju and Anand Kr Singh

Abstract
Combining ability analysis was carried out for pod yield and its components in okra in a 12 x 12 diallel cross (excluding reciprocals) in a randomized block design, with 3 replications. Both general a combining ability (GCA) and specific combining ability (SCA) variances were highly significant for all the characters indicating the importance of both additive and non-additive gene actions. However, the relative magnitude of general and specific combining ability, variance revealed that the magnitude of general combining ability was less than specific combining ability variance indicating thereby that the non-additive component was of major importance in the expression of all the characters. The highest gca effect for pod yield per plant and pod yield per hectare were recorded in IC-45802, Parbhani Kranti and VRO-3. The highest significant positive sca effect was observed in the cross combinations *viz.*, IC-45802×SB-8, IC-45802×Pusa A-4 and IC-282272×Sel-4 for pod yield per plant and pod yield per hectare. Exploitation of hybrid vigour from these crosses through heterosis breeding method is advocated.

Keywords: Okra, Diallel cross, GCA, SCA and heterosis

Introduction

Okra, lady's finger [*Abelmoschus esculentus* (L.) Moench] is one of the important vegetable crops of India, belongs to family Malvaceae and the genus *Abelmoschus*. It is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is native of tropical Africa. It is a tall, upright, fast growing, annual herb propagated by seed. It is a multipurpose and multifarious crop. Okra has importance with regard to its nutritional, medicinal and industrial value. The immature young seed pods are the edible part of this plant, which are consumed as cooked vegetable, fresh and sometimes sun-dried.

In India okra production was 6219 thousand MT from an area of 511 thousand hectares (NHB, 2018-19). Though its production is higher in India, it is not sufficient to rapid growing population. Hence, there is a need to develop and identify the high yielding and highly adaptable genotypes for commercial cultivation. Okra is an often cross pollinated crop. Breeding method for the improvement of a crop depends primarily on the nature and magnitude of gene action involved in the expression of quantitative and qualitative traits. In any sound breeding programme, the proper choice of parents based on their combining ability is a prerequisite. The studies intended to determine the combining ability is not only for information regarding the choice of parents but also for the production of hybrids or superior lines. For any podful breeding programme, the general combining ability and specific combining ability effects are the foundation. Allard (1960) [2] pointed out that the common approach of selecting the parents on the basis of *per se* performance is not a good indicator of their superior combining ability. The choice of parents in any breeding programme has to be based on complete genetic information and knowledge of combining ability of the parents. Combining ability analysis helps in the identification of parents with high general combining ability (GCA) effects and cross combinations with high specific combining ability (SCA) effects. General combining ability measures the average performance of a parent in hybrid combination. Specific combining ability (SCA) refers to those instance in which the performance of a hybrid is relatively better or worse than would be expected on the basis of the average performance of the parents involved. Additive and non-additive gene actions in the parents estimated through combining ability analysis may be useful in determining the possibility for commercial exploitation of heterosis and isolation of pure lines among the progenies of the heterotic F1. Genetic diversity in most of the agronomical and horticultural traits is available in the germplasm of okra (Reddy *et al.*, 2011, Singh *et al*. 2017a; Singh *et al*. 2017b; Singh *et al*. 2017c; Singh *et al*. 2018; Tiwari *et al*. 2018; Tiwari *et al*. 2019a; Tiwari *et al*. 2019b; Kour *et al*. 2019; Singh *et al*. 2019) [12-21]. Combining ability analysis of single crosses generated from crossing elite and diverse genotypes from the germplasm of okra has been made by several researchers (Kumar and Thania, 2007) [6]. Diallel mating design has been used extensively by several researchers to measure general and specific combining ability in okra (Wammanda *et al*., 2010) [26]. The present study was conducted to obtain the information on combining ability of 12 genotypes of Okra (*Abelmoschus esculentus* L.) for eleven plant and pod yield components.

Materials and Methods

The experiments were carried out at the Vegetable Research Farm of the Horticulture Department, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experiments were laid out in Randomized Block Design with three replications. Experimental material for the present investigation was collected from Indian Institute of Vegetable Science (IIVR), Varanasi which comprised of 12 genotypes of *A. esculentus* belonging to different morphological and productive attributes *viz.*, IC- 45831, IC- 282272, IC- 43733, IC- 43750, IC- 45802, Sel – 4, Pusa Mukhmali, Parbhani Kranti, VRO-3, Sel–10, Pusa A-4 and SB–8 and the commercial check used was Arka Anamika. Recommended agronomical practices were followed to raise the successful crop. Observations were recorded on ten plants in each replication on 11 characters *viz*., plant height (cm), number of primary branches per plant, node at which 1st flower appears, number of nodes on main stem, days to 50% flowering, pod length (cm), pod weight (g), number of pods per plant, days to edible maturity, pod yield per plant (g) and pod yield per hectare (q/ha). Among various techniques available, genetic analysis formulated by Griffing (1956) [4], provides a workable approach to evaluate newly developed cultivars for their parental usefulness and to assess the gene action involved in various attributes, so as to design an efficient breeding plan, for further genetic upgrading of the existing material. So, in the present study, the combining ability analysis was worked out by the procedure suggested by Griffing's (1956) [4] Method 2 Model 1 (fixed model).

Results and Discussion

Genetic improvement in pod yield has always been a top priority of okra breeders. Pod yield and its related parameters are quantitative traits, controlled by several genes thus showing a range of values in segregating generations. Genetic analysis helps in identifying traits for improvement of yield potential. Dependable biometrical techniques dealing with the genetic analysis of important characters have greatly helped plant breeder in tailoring new genotypes and ascertain the nature of gene action. Combining ability analysis is one of the powerful tools available to estimate the combining ability effects and aids in selecting the desirable parents and crosses.

Analysis of variance for combining ability exhibited the significance of both general combining ability (GCA) and specific combining ability (SCA) effects for all the characters under study (Table-1). This suggested the involvement of both additive and non-additive gene effects in the inheritance of characters under study. The estimates of SCA variances were higher than the GCA variances for all characters indicating predominance of non-additive gene action. Hence, exploitation of heterosis appears to be an appropriate strategy for improvement of okra through selection of suitable combiners and combinations. The GCA effects for yield and other characters of 12 genotypes are presented in Table-2.

The data fairly indicates that none of the parent was good general combiner for all the characters under study. General combining ability study had successfully led to marking choice of suitable parents. This information on the yield and its components would greatly help in proper classification of parental lines in the present study;

Parent IC-45802 exhibited maximum general combining ability effect for all the characters under study except for days to 50 % flowering and days to edible pod maturity. General combining ability effect includes both additive and additive × additive type of gene action (Griffing, 1956) [4], which represents fixable genetic variance and reported that additive parental effects as measured by gca effects are of practical importance and value, where as non-allele interactions are impracticable and cannot be manipulated.

However, it was noted that the top three parents proved to be best general combiner for different characters such as IC-45802, IC-282272 and Pusa Makhmali for plant height; IC-45831, IC-282272 and IC-45802 for number of branches per plant; IC-282272, IC-45831 and Pusa Makhmali for node at which first flower appears; IC-45802, VRO-3 and Pusa Makhmali for number of nodes on main stem; IC-43733, VRO-3 and IC-282272 for days to 50 percent flowering; IC-45802, Pusa Makhmali and SB-8 for pod length; Parbhani Kranti, IC-45802 and VRO-3 for pod weight; IC-45802, Parbhani Kranti and VRO-3 for number of pods per plant; IC-45831, IC-43750 and IC-282272 for days to edible pod maturity; IC-45802, Parbhani Kranti and VRO-3 for pod yield per plant; IC-45802, Parbhani Kranti and VRO-3 for pod yield per hectare. For days to 50% flowering and days to edible pod maturity negative GCA is desirable, as earliness is desirable in both these characters. Similar reports have been also reported by Singh and Kumar (2010) [24]; Singh *et al*. (2012) [25] and Parmar *et al*. (2012) [10].

The estimates of gca effects indicated that two parents *i.e.*, IC-45802 and Pusa Mukhmali exhibited significant positive gca effect for pod length. Whereas, only one parent *i.e.*, VRO-3 expressed significant negative gca effect. In the examination of gca value revealed that the genotypes Parbhani Kranti, IC-45802 and VRO-3 were good general combiners for pod weight. Number of pods per plant is an important character as it indicates the ultimate yield of the plant. Parent IC-45802, showed good general combining ability followed by VRO-3 and Parbhani Kranti, which indicated that improvement in the number of pods by the use of these parents leads to improvement in total and marketable yield.

The high general combiners for yield and yield attributing components identified in this study will produce desirable segregates for selection when crossed together. The parental varieties that showed good general combining ability may be used in a multiple crossing programme for isolating high yielding varieties reported in West Africa okra *A. caillei* stevels by Ariyo (1993) [3]. The selected lines from such multiple crosses could be released as conventional varieties or used as improved parents for F1's hybrid production, Ahmad

(2002) [1].

Evaluation of the hybrids on the basis of SCA effects is the second most important criteria because SCA effects of the hybrids has been attributed to the combination of positive favourable gene from different parents on might be due to presence of linkage in repulsion phase. Specific combining ability effects are indicative of heterosis. Similarly they represent both dominant and epistatic gene actions. The promising F1 hybrids based on specific combining ability effect for yield and its components are presented in Table 3. The relative magnitude of general and specific combining ability, variance revealed that the magnitude of general combining ability was less than specific combining ability variance indicating thereby that the non-additive component was of major importance in the expression of all the characters. The findings are in close agreement with those of Wammanda *et al*. (2010) [26], Singh *et al*. (2012) [25], Reddy *et al*. (2018) [11] and Sapavadiya *et al*. (2019) in okra. Hence, it can be utilized in generation like F_1 in evolving of best F_1 hybrids. During the study none of the cross combination had high SCA effects for all characters under study.

The significant and desirable crosses in order of merit were IC-45831×SB-8, IC-43733×Sel-4 and IC-43750×SB-8 for plant height; IC-45831×Pusa Makhmali, IC-43750×Sel-10 and IC-45831×VRO-3 for number of branches per plant; IC-45802×Sel-4, VRO-3×Pusa A-4 and IC-45802×Parbhani Kranti for node at which first flower appears; IC-45831×SB-8, IC-282272×Sel-4 and IC-43733×Sel-10 for number of nodes on main stem; IC-45831×Pusa Makhmali, IC-45831×Parbhani Kranti and Pusa Makhmali×Sel-10 for days to 50 percent flowering; Parbhani Kranti×Sel-10, VRO-3×SB-8 and Pusa Makhmali×Sel-10 for pod length (cm); IC-45802×Pusa A-4, IC-282272×Sel-4 and Pusa A-4×SB-8 for pod weight (g); IC-45831×IC-43733, IC-43750×Sel-4 and IC-45802×VRO-3 for number of pods per plant; IC-45802×Pusa A-4, IC-45831×Parbhani Kranti and Sel-10×Pusa A-4 for days to edible pod maturity; IC-45802×SB-8, IC-45802×Pusa A-4 and IC-282272×Sel-4 for pod yield per plant (g); IC-45802×SB-8, IC-45802×Pusa A-4 and IC-282272×Sel-4 for pod yield per hectare (q) were showed significant and desirable specific combinations. Similarly, a critical combination of *per se* performance of three best crosses for the eleven characters also revealed that there is no direct relationship between the *per se* performance of crosses and their parents. Similar findings have also been reported by Kumar *et al.* (2014) [7].

However, the most desirable cross combinations based on *per se* performance and SCA effects were IC-45831× SB-8 for plant height (cm) and number of nodes on main stem; IC-45831× Pusa Makhmali for number of branches per plant; IC-45802× Sel-4 for node at which 1st flower appears; IC-282272× Sel-4 for number of nodes on main stem; Pusa A-4×SB-8 for pod weight (g); IC-45802× VRO-3 for number of pods per plant; IC-45802× SB-8 for pod yield per plant (g) and pod yield per hectare (q). These results were in close conformity of Jindal *et al.* (2010) [5]; Murugan *et al.* (2010) [8]; Sawadogo *et al*. (2014) [14], Kumar *et al.* (2014) [7] and Reddy *et al*. (2018) [11].

It is general observation that good cross combinations are obtained between high × high and poor ones between low × low, general combiners. But in the present study, superior cross combinations involved high × high, high × low, high × moderate, moderate × moderate, moderate × low and low × low general combiners for the characters under study indicating that good cross combinations are not always obtained by crossing between high general combiners.

Table 1: ANOVA for different characters studied in parents and F_1 generations of diallel in okra

Source	df	Plant height (cm)	Number of branches per plant	Node at which 1st flower appears	Number of nodes on main stem	Days to 50% flowering	Pod length (cm)	Pod weight (g)	Number of pods per plant	Days to edible pod maturity	Pod yield per plant (g)	Pod yield per ha (q)
Replicates	2.00	29.32	0.00	0.00	0.43	0.03	0.13	6.01	0.34	0.02	735.68	403.45
Treatments	77.00	84.73**	19.48**	0.54**	5.24**	3.60**	1.93*	12.46**	2.13**	0.03*	3916.73**	2149.08**
Parents	11.00	111.66**	2.21**	0.66**	2.44*	1.79	3.54**	50.18**	1.60	0.08**	10139.04**	5563.12**
Hybrids	65.00	78.80**	3.45**	0.26**	1.74**	1.36	1.42	4.65*	1.68*	0.02	1914.50**	1050.48**
Parent Vs.Hybrids	1.00	174.14**	1251.05**	17.76**	263.73**	169.24**	17.44**	105.30**	37.10**	0.01	65616.17**	36003.26**
Error	154.00	11.19	0.08	0.04	0.91	1.13	1.13	2.75	1.00	0.01	243.97	133.87
Total	233.00	35.65	6.49	0.21	2.33	1.94	1.39	5.99	1.37	0.02	1461.94	802.15
GCA	11.00	17.61**	2.10**	0.14**	0.63*	0.55	0.97*	9.79**	1.36**	0.01*	3248.91**	1782.68**
SCA	66.00	30.02**	7.22**	0.19**	1.93**	1.31**	0.59*	3.21**	0.60*	0.01*	981.69**	538.64**
Error	154.00	3.73	0.03	0.01	0.30	0.38	0.38	0.92	0.33	0.00	81.32	44.62

*significance at 0.05 probability level; *significance at 0.01 probability level

Table 2: Estimation of general combining ability (GCA) effect of 12 parents for 11 characters of okra

Genotype	Plant height		No. of branches/pt		I st flowering node		No. of nodes/stem		Days to 50% flower		Pod length		Pod weight		No. of Pods/plant		Days to Edible pod maturity		Pod Yield/ Plant		Pod Yield/ ha	
IC-45831	-1.49	*	0.72	**	-0.16	**	-0.27		0.39	*	-0.17		-1.34	**	-0.01		-0.06	*	-16.36	**	-12.12	**
IC-282272	1.52	*	0.46	**	-0.19	**	0.13		-0.17		-0.13		-1.15	**	-0.03		-0.01		-15.13	**	-11.21	**
IC-43733	-0.67		0.03		0.06	*	-0.46	*	-0.32	*	0.14		-0.52	*	-0.49	*	0.00		-17.14	**	-12.70	**
IC-43750	0.45		0.18	*	-0.01		0.08		-0.03		-0.01		-0.56	*	0.01		-0.02		-6.99	*	-5.18	*

				*																		
IC-45802	2.35	**	0.41	*	0.09	*	0.31	*	0.00		0.42	*	1.01	**	0.85	**	0.02		33.27	**	24.65	**
Sel-4	-1.32	*	-0.11	*	0.08	*	-0.06		0.01		-0.15		-0.38		-0.10		-0.01		-7.17	*	-5.31	*
PM	0.49		-0.30	**	-0.06		0.16		-0.02		0.33	*	0.50	*	-0.21		0.05	*	0.54		0.40	
PK	-0.83		0.04		-0.04		0.03		0.03		-0.03		1.42	**	0.12		0.00		20.92	**	15.50	**
VRO-3	-0.05		-0.60	**	0.04		0.18		-0.26		-0.59	**	0.66	*	0.04		0.02		8.72	**	6.46	**
Sel-10	-0.47		-0.27	**	-0.01		0.04		0.14		0.04		-0.02		-0.19		0.01		-5.16	*	-3.82	*
Pusa A-4	-0.33		-0.38	**	0.10	**	-0.12		0.00		-0.03		0.05		0.01		0.01		0.74		0.55	
SB-8	0.35		-0.19	**	0.10	*	-0.04		0.24		0.19		0.32		-0.01		-0.02		3.75		2.78	
CD Comparisons												**		**		**		**		**		
Gi <> 0 at 95%	1.09		0.09		0.07		0.31		0.35		0.35		0.54		0.32		0.04		5.08		3.76	
Gi <> 0 at 99%	1.53		0.13		0.09		0.44		0.49		0.49		0.76		0.46		0.06		7.17		5.31	
Gi--Gj at 95%	1.61		0.13		0.10		0.46		0.51		0.51		0.80		0.48		0.06		7.50		5.56	
Gi--Gj at 99%	2.27		0.19		0.14		0.64		0.72		0.72		1.12		0.68		0.08		10.59		7.84	

Table 3: Estimation of specific combining ability (SCA) effect of 66 F1 hybrids for 11 characters of okra

Cross	**Plant Height**		**No. of branches/ Plant**		**Node of 1st flower**		**No. of nodes/stem**		**50% Flowering**		**Pod Length**		**Pod Weight**		**No. of pods/ Plant**		**Edible maturity (days)**		**Pod yield/plant**		**Pod yield q/ ha**	
IC-45831×IC-282272	-1.54		0.41	*	0.27	*	-0.38		-0.32		-0.11		2.41	*	-0.50		0.06		17.99	*	13.32	*
IC-45831×IC-43733	-5.90	*	-0.49	*	-0.19		-0.18		-0.44		-0.27		0.75		1.55	**	0.05		40.54	**	30.03	**
IC-45831×IC-43750	-1.35		0.69	**	-0.12		0.21		-1.06		0.11		1.39		0.05		0.11		17.81	*	13.20	*
IC-45831×IC-45802	1.72		1.72	**	-0.14		1.31	*	-0.42		0.40		0.36		1.15	*	0.00		27.92	*	20.68	*
IC-45831×Sel-4	-3.88	*	2.38	**	-0.40	**	0.08		-0.03		-0.43		-0.34		-1.14	*	0.20	*	-29.37	**	-21.76	**
IC-45831×PM	-4.99	*	2.57	**	0.33	*	-0.74		-1.27	*	0.56		-0.38		-0.06		-0.07		-6.02		-4.46	
IC-45831×PK	7.67	**	2.03	**	-0.29	*	1.32	*	-1.19	*	-1.04		0.75		0.28		-0.15	*	14.49		10.74	
IC-45831×VRO-3	3.58		2.47	**	-0.36	*	1.04	*	0.10		0.61		-0.64		1.15	*	0.03		15.24		11.29	
IC-45831×Sel-10	5.95	*	1.54	**	-0.32	*	0.84		1.03		0.38		0.20		-0.81		0.08		-15.83		-11.73	
IC-45831×Pusa A-4	6.29	**	2.05	**	-0.23	*	1.41	*	-0.16		-0.24		1.14		1.05		0.11		36.72	**	27.20	**
IC-45831×SB-8	13.90	**	1.66	**	0.17		1.93	**	1.14		-0.99		0.91		1.00		0.10		33.32	**	24.68	**
IC-282272×IC-43733	5.44	*	0.64	**	-0.16		1.41	*	-0.41		0.65		1.34		0.77		0.00		32.82	**	24.32	**
IC-282272×IC-43750	2.44		0.49	*	-0.09		1.20	*	-0.83		-0.55		1.52		0.28		0.12		24.99	*	18.51	*
IC-282272×IC-45802	6.57	**	0.06		0.22		1.43	*	0.34		0.24		-0.41		-0.09		0.09		-10.16		-7.52	
IC-282272×Sel-4	6.90	**	2.11	**	0.23	*	1.61	*	-1.14		-0.35		3.11	**	0.39		-0.02		48.07	**	35.61	**
IC-282272×PM	3.55		2.10	**	-0.44	**	0.25		0.36		-1.14	*	-0.67		0.83		-0.08		9.19		6.81	
IC-282272×PK	-3.05		0.03		-0.46	**	-0.02		0.24		0.09		-2.16	*	-0.10		0.03		-30.99	**	-22.9	**

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IC-282272×VRO-3	0.43		0.53	**	-0.33	*	0.64		-0.80		0.03		0.39		0.61		0.01		18.76	*	13.89	*
IC-282272×Sel-10	-2.79		1.74	**	-0.09		-0.16		0.73		-0.15		-0.97		0.28		-0.07		-7.47		-5.53	
IC-282272×Pusa A-4	-11.32	**	1.79	**	0.00		-1.60	*	-1.00		1.11		-0.02		-0.13		-0.11		-3.77		-2.79	
IC-282272×SB-8	-5.18	*	1.66	**	0.00		-0.01		-0.03		-0.96		1.16		0.63		-0.11		28.20	*	20.89	*
IC-43733×IC-43750	-3.72	*	0.72	**	-0.34	*	-0.14		-0.61		0.71		0.60		0.20		0.01		11.27		8.35	
IC-43733×IC-45802	-4.75	*	0.95	**	-0.43	**	-0.10		-0.31		0.09		1.50		-0.04		0.07		17.87	*	13.24	*
IC-43733×Sel-4	10.62	**	1.01	**	-0.43	**	0.73		-0.32		-0.75		-0.57		0.91		-0.10		11.68		8.65	
IC-43733×PM	1.52		2.06	**	-0.09		0.45		-0.82		1.11		0.98		-0.11		-0.13		9.48		7.02	
IC-43733×PK	2.01		1.06	**	-0.31	*	0.51		-0.54		-0.19		0.58		-0.18		0.02		2.28		1.69	
IC-43733×VRO-3	-3.09		0.36	*	-0.19		0.37		0.35		0.09		-0.20		-0.70		-0.03		-19.17	*	-14.20	*
IC-43733×Sel-10	4.18	*	1.31	**	0.06		1.57	*	1.01		-0.09		1.93	*	-0.07		-0.02		20.00	*	14.82	*
IC-43733×Pusa A-4	1.17		1.21	**	-0.25	*	0.53		0.42		-0.76		-0.25		0.00		-0.05		-3.97		-2.94	
IC-43733×SB-8	3.00		0.09		-0.05		-0.21		-0.21		0.33		0.35		0.41		0.01		12.68		9.39	
IC-43750×IC-45802	4.59	*	1.20	**	-0.36	*	0.02		-1.00		0.61		-0.22		-0.60		0.03		-19.26	*	-14.26	*
IC-43750×Sel-4	-0.83		0.85	**	0.45	**	-0.41		0.79		0.44		0.11		1.28	*	0.03		28.78	*	21.32	*
IC-43750×PM	-1.37		1.18	**	-0.02		0.64		0.15		-0.75		-0.74		0.66		0.06		5.59		4.14	
IC-43750×PK	-4.12	*	1.17	**	-0.24	*	-0.83		-0.16		0.13		-0.73		0.19		-0.02		-5.37		-3.98	
IC-43750×VRO-3	-5.03	*	1.28	**	-0.18		0.22		-0.88		0.12		-0.64		0.00		-0.04		-7.98		-5.91	
IC-43750×Sel-10	3.13		2.49	**	0.33	*	0.29		-0.88		-0.32		0.80		0.50		-0.06		21.61	*	16.00	*

Cross	Plant Height		No. of branches/ Plant		Node at which 1st flower		No. of nodes/ Stem		50% Flowering		Pod Length		Pod Weight		No. of pods/plant	Edible maturity		Pod yield/plant		Pod yield q/ha	
IC-43750×Pusa A-4	-1.45		1.33	**	0.22		0.72		-0.60		0.52		1.91	*	-0.27	0.07		17.93	*	13.28	*
IC-43750×SB-8	10.54	**	0.14		-0.18		1.51	*	0.76		-0.33		1.82	*	-0.08	0.00		21.97	*	16.27	*
IC-45802×Sel-4	4.72	*	1.29	**	-0.85	**	0.49		-0.84		0.23		0.83		0.17	0.09		14.84		10.99	
IC-45802×PM	-1.64		-0.26		0.35	*	-0.40		-0.94		-0.45		-1.29		0.88	-0.01		1.99		1.47	
IC-45802×PK	6.37	**	2.34	**	-0.53	**	0.33		0.54		-0.29		-0.79		0.86	0.07		11.72		8.68	
IC-45802×VRO-3	-0.49		0.11		-0.21		0.86		-0.50		-0.44		-0.69		1.23	-0.11		20.41	*	15.12	*
IC-45802×Sel-10	3.22		0.65	**	0.24	*	0.79		0.36		-1.43	*	0.05		0.26	0.04		6.44		4.77	
IC-45802×Pusa A-4	3.15		0.90	**	0.12		1.15	*	-0.63		0.53		3.36	**	0.06	-0.16	*	48.46	**	35.89	**
IC-45802×SB-8	-1.82		0.17		-0.27	*	1.21	*	-0.80		0.58		2.33	*	0.61	-0.04		49.85	**	36.92	**
Sel-4×PM	3.40		1.00	**	0.29	*	0.57		-0.89		0.17		0.01		0.90	-0.05		21.28	*	15.76	*
Sel-4×PK	-3.33		0.92	**	0.27	*	0.31		-0.73		0.33		-1.13		0.10	-0.03		-12.51		-9.26	
Sel-4×VRO-3	-1.66		0.76	**	0.40	**	0.43		-1.11		-0.21		0.72		-0.89	-0.08		-11.71		-8.68	
Sel-4×Sel-10	-4.90	*	0.17		0.25	*	0.50		-0.78		0.15		-0.21		0.48	0.03		7.72		5.72	
Sel-4×Pusa A-4	0.92		0.68	**	-0.07		1.26	*	-0.91		0.35		0.70		-0.26	-0.07		3.53		2.61	
Sel-4×SB-8	-4.56	*	0.29		-0.06		0.85		-0.61		0.23		-0.04		-0.31	0.02		-8.56		-6.34	
PM×PK	1.28		-0.82	**	0.01		1.42	*	-0.84		0.42		-1.16		-0.05	0.00		-16.22		-12.01	
PM×VRO-3	-4.15	*	-0.11		-0.27	*	0.04		0.38		1.09		0.02		-0.38	-0.05		-7.05		-5.22	
PM×Sel-10	2.79		-0.24		-0.49	**	0.67		-1.15	*	1.14		-0.59		-0.34	-0.03		-14.62		-10.83	
PM×Pusa A-4	2.54		0.47	*	-0.13		1.04	*	-0.01		0.93		0.55		0.12	0.13	*	10.75		7.96	
PM×SB-8	-8.95	**	1.68	**	-0.26	*	-0.64		-0.71		0.64		0.14		-0.86	-0.04		-18.01	*	-13.35	*
PKi×VRO-3	-4.79	*	2.15	**	0.11		-0.53		-0.33		0.49		-1.81	*	0.16	-0.06		-19.13	*	-14.17	*

PKi×Sel-10	-7.33	**	1.42	**	-0.24	*	0.27		-0.60		1.49	*	-1.23		0.40	-0.09		-5.43		-4.02	
PKi×Pusa A-4	-6.06	*	-0.07		-0.35	*	-0.03		-0.13		-0.30		-0.55		-0.24	0.01		-12.53		-9.28	
PKi×SB-8	0.48		2.08	**	0.05		1.09	*	-0.90		-0.29		-1.26		-0.66	-0.09		-31.07	**	-23.01	**
VRO-3×Sel-10	1.45		0.66	**	0.08		1.19	*	-0.38		0.72		0.62		0.07	0.06		10.11		7.49	
VRO-3×Pusa A-4	-2.26		0.91	**	-0.63	**	-0.64		-0.38		0.62		-0.26		0.33	-0.10		5.03		3.72	
VRO-3×SB-8	4.22	*	0.38	*	-0.49	**	0.15		-0.88		1.21	*	-0.46		0.08	0.06		-3.91		-2.90	
Sel-10×Pusa A-4	-0.31		-0.55	**	-0.32	*	0.29		-0.98		0.07		-0.27		-0.10	0.14	*	-5.61		-4.16	
Sel-10×SB-8	3.65	*	0.12		-0.18		0.55		-1.08		0.64		1.20		-0.21	-0.03		10.31		7.64	
Pusa A-4×SB-8	-2.50		1.37	**	-0.16		-0.76		-0.07		0.17		3.01	*	-0.49	0.00		27.31	*	20.23	*
C. D. Comparisons																					
Sij <> 0 at 95%	3.59		0.30		0.22		1.02		1.14		1.14		1.78		1.07	0.13		16.78		12.43	
Sij <> 0 at 99%	4.77		0.39		0.29		1.36		1.52		1.52		2.37		1.43	0.17		22.30		16.52	
Sij--Sik at 95%	5.26		0.43		0.32		1.50		1.67		1.67		2.61		1.57	0.19		24.54		18.18	
Sij--Sik at 99%	6.98		0.58		0.43		1.99		2.22		2.22		3.46		2.08	0.25		32.61		24.16	
Sij--Skl at 95%	5.05		0.42		0.31		1.44		1.61		1.61		2.50		1.51	0.18		23.58		17.47	
Sij--Skl at 99%	6.71		0.55		0.41		1.91		2.13		2.13		3.33		2.00	0.24		31.33		23.21	

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