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Combining ability analysis of yield and yields attributing traits of pumpkin (*Cucurbita moschata Duch ex Poir*)

Mahendra Kumar Yadav, DP Singh, Rajiv, Vipul Pratap Singh and Satyendra Kumar

Abstract
The investigations were carried out to evaluate the 64 genotypes (28 F_1, 28 F_2 and 8 parental lines) of pumpkin (*Cucurbita moschata* Duch. Ex Poir.)' at Department of Vegetable Science, Kalyanpur, CSA. University of Agriculture and Technology, Kanpur (U.P.) during *Zaid* 2021. The experiments were laid out in randomized complete block design with three replications. The data were recorded for 19 characters including total fruit yield per plant and its component traits. Mean squares due to general combining ability and specific combining ability were observed to be significant for all traits except gca for flesh thickness in hybrids. Azad Pumpkin-1, Punjab Samrat, DVRP-2-5 and P-35-16 emerged as the most useful parents as either one or all of them were found good general combiner along with high *per se* performance for most of the traits studied. The best general combiner parents can be used in subsequent breeding programme. Out of the best significant specific crosses with high *per se* performance for fruit yield per plant and its contributing traits, five crosses Narendra Agrim x Punjab Samrat, Azad Pumpkin-1 x P-35-16, P-35-16 x P-40-16, Azad Pumpkin-1 x DVRP-2-5 and P-35-16 x DVRP-2-5 were found in hybrid. The crosses with best specific combiner can be used as commercial variety after proper testing and evaluation.

Keywords: Pumpkin, general combining ability, specific combining ability and yield

Introduction
Pumpkin (*Cucurbita moschata* Duch ex Poir) is an economically important vegetable crop. It is a herbaceous annual sexually propagated vegetable having an identical genomic structure *i.e.* AABB which indicates that it is an amphidiploid. It comprises about 27 species of both wild and cultivated having same chromosome number of 2n = 40. Among these species only five species *Cucurbita moschata, Cucurbita maxima, Cucurbita ficifolia, Cucurbita pepo* and *Cucurbita mixta* are commonly cultivated. These species are considered to be originated in Central America. In India, the total area covered by pumpkin is 0.104 million hectares whereas, the total production is 2.183 million tonne with productivity 20.99 tonne/ha (Anonymous 2020) [1].

Sex expression in *Cucurbita* is relatively stable and all species including *C. moschata* are monoecious and highly cross pollinated. Flowers are unisexual, solitary in the leaf axils. Generally stalks of the staminate flowers are longer (3-10 cm) and thinner (0.50-0.75 cm) than that of the pistillate flowers. The stalk of the pistillate flowers is distinctly angular and longitudinally furrowed, 2-6 cm long and 0.75-1.0 cm thick. There was much variation in the ratio of staminate: pistillate flowers (4:1 to 20:1) in the vine and staminate flowers opened after 55 to 70 days, pistillate flowers after 60-75 days of seed sowing (Mandal, 2006) [8]. The diallel cross help in determining general combining ability of parents and specific combining abilities of hybrids. Further it helps in formulating the breeding methodology to the selection of suitable parent for hybridization in crop improvement. The new set of diverse parental combinations to identify better parent and efficient hybrids of pumpkin for fruit size, high yield and good quality through combining ability analysis (Marxmathi *et al.*, 2018) [9].

Materials and Methods
The investigations were carried out to evaluate the 64 genotypes (28 F_1, 28 F_2 and 8 parental lines) of pumkin *viz*: Azad Pumpkin - 1 (P_1), P-35-16 (P_2), P-40-16 (P_3), Narendra Agrim (P_4), NDPK-7-24 (P_5), Kashi Harit (P_6), DVRP-2-5 (P_7), and Punjab Samrat (P_8). The 8 parental

lines and their 28 F_1 were grown in a randomized complete block design with three replications during *Zaid* 2021 at the Main Experiment Station, Department of Vegetable Science, Kalyanpur, CSA University of Agriculture and Technology, Kanpur (U.P.). Each 28 F_1, F_2 and parents were grown in rows spaced 3 meters apart with a plant to plant spacing of 0.50 meter. All the recommended agronomic package of practices and plant protection measures were followed to raise good crop. Observations were recorded on nineteen quantitative traits *viz.*, days to first male flower appearance, days to first female flower appearance, node numbers to first male flower appearance, node numbers to first female flower appearance, vine length, internodal length, branches plant^{-1}, days to first harvest, average fruit weight, fruits/plant, equatorial circumference of fruit, polar circumference of fruit, flesh thickness, total soluble solids, dry matter content, moisture content, seed/fruit, Specific gravity and fruit yield/plant. The data recorded from 28 F_1, 28 F_2 and 8 parental lines on nineteen characters were subjected to estimate nature and magnitude of the recorded data which were analysed by (Panse and Sukhatme 1954) [14] for analysis of variance. Combining ability analysis was carried out following the Model I, method II (Parents and one set of crosses) of Griffing (1956) [5].

Result and Discussion

Combining ability variances and their effects

The mean squares due to general and specific combining ability variances for all the characters were presented in Table-1. It is evident from the table that variances due to gca and sca were found highly significant for all the characters except gca for flesh thickness (0.01 and 0.01) in hybrid.

General combining ability effects

The estimates of general combining ability (gca) effects of eight parents for all nineteen characters are presented in Table-.2. The negative estimates of general combining ability effects were considered for days to first male flower appearance, days to first female flower appearance, node number to first male flower appearance, node number to first female flower appearance, internodal length, days to first fruit harvest, moisture content and number of seeds per fruit. However, for remaining characters positive general combining ability effects were considered desirable

The significant and positive gcs effects for fruit yield per plant were exhibited by Azad Pumpkin-1 (0.60) followed by Punjab Samrat (0.56), DVRP-2-5 (0.27) and P-35-16 (0.22) in F_1.These were found good general combiners for higher fruit yield per plant on the basis of significant positive GCA effects.

On the basis of gca effects; parent Azad Pumpkin-1 was found good general combiner for node number to first female flower appearance, vine length, number of primary branches per plants, average fruit weight, number of fruits per plant, equatorial and polar circumference, total soluble solids, dry matter content, moisture content and fruit yield per plant in F_1. Punjab Samrat was found good general combiner for average fruit weight, number of fruits per plant, fruit yield per plant in F_1. DVRP-2-5 was good general combiner for days to first male and female flower appearance, vine length, days to first fruit harvest, average fruit weight, number of seeds per fruit and fruit yield per plant in F_1. P-35-16 was good general combiner for node number to first male flower appearance, vine length, internodal length, average fruit weight, equatorial and polar circumference and fruit yield per plant in F_1. P-40-16 was good general combiner for node number of first male flower appearance, vine length, internodal length, days to first fruit harvest, number of fruits per plant, equatorial and polar circumference, total soluble solids, dry matter content and moisture content in F_1. Narendra Agrim was good general combiner for days to first male and female flower appearance, node number to first female flower appearance in F_1. NDPK-7-24 was good general combiner for days to first fruit harvest, number of seeds per fruit and specific gravity in F_1. Kashi Harit was good general combiner for days to first male and female flower appearance, node number to first female flower appearance, internodal length, days to first fruit harvest, number of fruits per plant, number of seeds per fruit in F_1.

The above two parents (Azad Pumpkin-1 and Punjab Samrat) in both the generations showed positive and significant gca effects for total fruit yield per plant and other important characters as mentioned in above paragraphs may serve as valuable parents for hybridization programme or multiple crossing programme for obtaining high yielding variety or transgressive segregants for developing varieties of pumpkin. Thus, Azad Pumpkin-1 and Punjab Samrat emerged as the most useful parent as these parents were found good general combiner along with high *per se* performance for most of the characters studied. Hence, these parents may also be recommended for exploitation in hybridization programme aimed at improving the yield components for which they were good general combiner. Good general combining ability for various traits has also been reported by earlier researchers *viz.*, fruit yield per plant which corroborate the findings of previous workers (Maurya *et al.*, 2004 [10]; Pandey *et al.*, 2004 [13]; Singh *et al.*, 2005 [16]; in bottle gourd and Jha *et al*,., 2009 [7]; Pandey *et al.*, 2010 [12]; Nisha and Veeraragavathatham, 2014 [11], Begum *et al.*, 2016 [4], Abdein *et al*,. 2017 [2], Marxmathi *et al*,. 2018 [9], Singh *et al*,. 2019, in pumpkin).

Specific combining ability effects

The SCA effects represent non-additive gene action which is non-fixable. Specific combining ability effects helps in the identification of superior cross combinations for development of promising varieties/hybrids. The crosses showing high SCA effects involving parents with high GCA effects may give rise desirable segregants in future generation. The specific combining ability effects of the twenty eight crosses for nineteen characters in F_1 have been presented in Table-3. The SCA effects in negative direction considered desirable for maturity traits *viz.*, days to first male flower appearance, days to first female flower appearance, node number to first male flower appearance, node number to first female flower appearance, internodal length, days to first fruit harvest, moisture content and number of seeds per fruit while, positive value for rest of the traits were considered desirable. The character wise results are described below:

The best cross combinations having significant positive SCA effects for fruit yield per plant in order of merit were Narendra Agrim x Punjab Samrat (3.71) followed by Azad Pumpkin-1 x P-35-16 (3.05), P-35-16 x P-40-16 (2.72), Azad Pumpkin-1 x DVRP-2-5 (2.34) and P-35-16 x DVRP-2-5 (2.22), P-40-16 x Kashi Harit, Kashi Harit x DVRP-2-5, NDPK-7-24 x Kashi Harit, Narendra Agrim x NDPK-7-24, NDPK-7-24 x DVRP-2-5, P-40-16 x Punjab Samrat, Narendra Agrim x DVRP-2-5, Azad Pumpkin-1 x NDPK-7-25 and P-35-16 x Kashi Harit in F_1. The cross Narendra Agrim x Punjab Samrat was found most promising hybrid as

it had highly significant sca effect for fruit yield per plant in F_1 generation along with node number to first female flower appearance, average fruit weight, number of fruit per plant, polar circumference of fruit, number of seeds per fruit, specific gravity. Azad Pumpkin-1 x P-35-16 for days to first male flower appearance, days to first female flower appearance, average fruit weight, number of fruit per plant, equatorial and polar circumference of fruit, specific. P-35-16 x P-40-16 for node number to first female flower appearance, number of primary branches per plant, number of fruits per plant, total soluble solids, dry matter content, moisture content, Azad Pumpkin-1 x DVRP-2-5 for vine length, number of primary branches per plant, average fruit weight, number of fruits per plant, flesh thickness; P-35-16 x DVRP-2-5 for days to first harvest, average fruit weight, Equatorial and polar circumference, number of seeds per fruit in hybrid. Five crosses in hybrid mentioned above may be considered for utilization in breeding programme to enhance fruit yield.

In general, the crosses showing significant and desirable sca effects were associated with better *per se* performance for respective characters. However, the crosses having high sca effects in desirable direction did not always have high mean performance for the characters in question. Thus, the sca effect of the crosses may not be directly related to their *per se* performance. This may be attributed to the fact that *per se* performance is a realized value whereas sca effect is an estimated value of F_1's performance over parental one. Therefore, both *per se* performance along with sca effects should be considered for evaluating the superiority of a cross although the former may be more important if development of F_1 hybrids is the ultimate goal.

The foregoing observations clearly indicated that there was no particular relationship between positive and significant sca effects of crosses with gca effects of their parents for the characters under study and also advocated by previous workers in pumpkin (Begum *et al.*, 2016 [4]; Abdein *et al.*, 2017 [2]; Ahmed *et al.*, 2017 [3]; Hatwal *et al.*, 2018 [6];, Marxmathi *et al.*, 2018 [9] and Singh *et al.*, 2019).

Based on the above findings it can be concluded that parents Azad Pumpkin-1, Punjab Samrat, DVRP-2-5 and P-35-16 emerged as the most useful parents as either one or all of them were found good general combiner along with high *per se* performance for most of the traits studied. Out of the best significant specific crosses with high *per se* performance for fruit yield per plant and its contributing traits, five crosses Narendra Agrim x Punjab Samrat, Azad Pumpkin-1 x P-35-16, P-35-16 x P-40-16, Azad Pumpkin-1 x DVRP-2-5 and P-35-16 x DVRP-2-5 were found in hybrid. Therefore, the above parents can be utilized in further breeding programme and hybrids can be utilized as variety after proper testing and evaluation.

Table 1: Analysis of variance (Mean sum of square) for combining ability for 19 characters in F_1 generations derived from 8 x 8 diallel cross of pumpkin

Source of variance	Df	Days to first male flower appear	Days to first female flower appear	Node numbers to first male flower appearance	Node numbers to first female flower appearance	Vine length (cm)	Internodal length (cm)	Number of primary branches/plant	Days to first harvest	Average fruit weight (kg)
GCA	7	52.89**	69.01**	0.23**	3.71**	0.45**	0.54**	0.26**	46.88**	0.12**
SCA	28	5.94**	10.52**	0.17**	1.12**	0.34**	0.38**	0.75**	18.56**	0.12**
Error	70	0.37	0.73	0.04	0.19	0.04	0.04	0.07	0.61	0.01

Source of variance	Df	Number of fruits/plant	Equatorial circumference of fruit (cm)	Polar circumference of fruit (cm)	Flesh thickness (cm)	Total soluble solids (^{0}Brix)	Dry matter content (%)	Moisture content (%)	Number of seeds per fruit	Specific gravity (g/cm^3)	Fruit yield per plant (kg)
GCA	7	0.28**	90.03**	74.61**	0.01	0.14**	1.18**	1.17**	2055.41**	0.01**	3.02**
SCA	28	0.25**	21.35**	16.136**	0.03**	0.24**	0.50**	0.50**	508.45**	0.003**	4.03**
Error	70	0.012	0.45	0.77	0.004	0.01	0.10	0.10	44.62	0.001	0.14

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

Table 2: Estimate of general combining ability (GCA) effect of parents for 19 characters in F_1 generations derived from 8 x 8 diallel cross of pumpkin

S. No.	Character / Parents	Days to first male flower appear	Days to first female flower appear	Node numbers to first male flower appearance	Node numbers to first female flower appearance	Vine length (cm)	Internodal length (cm)	Number of primary branches/ plant	Days to first harvest	Average fruit weight (kg)	Number of fruits/ plant
1	Azad Pumpkin-1	-0.15	0.48	0.20**	-0.34*	0.19**	-0.01	0.24**	0.09	0.09**	0.11**
2	P-35-16	5.05**	5.81**	-0.12*	0.44**	0.26**	-0.21**	-0.03	4.83**	0.07**	-0.03
3	P-40-16	0.23	-0.16	-0.17**	1.16**	0.13*	-0.32**	0.06	-0.78**	-0.09**	0.12**
4	Narendra Agrim	-1.81**	-1.50**	0.25**	-0.50**	-0.03	0.33**	-0.18*	-0.73**	-0.03	0.03
5	NDPK-7-24	0.05	-0.26	-0.12	-0.06	-0.36**	0.04	-0.26**	-0.79**	-0.02	-0.38**
6	Kashi Harit	-2.67**	-2.90**	-0.04	-0.82**	-0.13*	-0.22**	0.05	-1.76**	-0.21**	0.09*
7	DVRP-2-5	-0.98**	-1.83**	0.040	-0.033	0.12*	0.16**	0.12	-1.89**	0.10**	-0.04
8	Punjab Samrat	0.268	0.372	-0.036	0.149	-0.18**	0.22**	-0.001	1.02**	0.08**	0.11**
SE (gi)		0.18	0.25	0.06	0.07	0.06	0.06	0.08	0.23	0.02	0.03
SE (gi-gj)		0.27	0.38	0.09	0.19	0.08	0.09	0.09	0.35	0.03	0.05

S. No.	Characters Parents	Equatorial circumference of fruit (cm)	Polar circumference of fruit (cm)	Flesh thickness (cm)	Total soluble solids (^{0}Brix)	Dry matter content (%)	Moisture content (%)	Number of seeds per fruit	Specific gravity (g/cm^3)	Fruit yield per plant (kg)
1	Azad Pumpkin-1	5.06**	4.86**	0.03	0.14**	0.51**	-0.51**	23.83**	0.02	0.60**
2	P-35-16	1.17**	0.99**	-0.02	0.05	0.13	-0.13	14.19**	-0.01	0.22*
3	P-40-16	2.68**	1.98**	-0.02	0.17**	0.36**	-0.36**	-0.98	-0.04**	-0.06
4	Narendra Agrim	-2.07**	-1.36**	-0.06**	-0.12**	-0.02	0.02	-0.68	0.003	-0.03
5	NDPK-7-24	-2.13**	-1.36**	-0.01	-0.046	-0.47**	0.47**	-12.04**	0.05**	-0.98**
6	Kashi Harit	-4.45**	-4.43**	0.02	-0.17**	-0.36**	0.36**	-20.04**	-0.01	-0.59**
7	DVRP-2-5	-0.48*	-0.59*	0.03	-0.03	-0.24*	0.24*	-9.64**	-0.02	0.27*
8	Punjab Samrat	0.22	-0.09	0.02	0.02	0.10	-0.10	5.36**	0.001	0.56**
SE (gi)		0.20	0.26	0.02	0.03	0.09	0.09	1.97	0.01	0.11
SE (gi-gj)		0.30	0.39	0.03	0.04	0.14	0.14	1.98	0.02	0.17

Table 3: Estimates of specific combining ability (sca) effects of crosses for nineteen characters in pumpkin F_1

S. No.	Crosses	Days to first male flower appear	Days to first female flower appear	Node numbers to first male flower appearance	Node numbers to first female flower appearance	Vine length (cm)	Internodal length (cm)	Number of primary branches/ plant	Days to first harvest	Average fruit weight (kg)	Number of fruits/ plant
1	Azad Pumpkin-1 × P-35-16	-3.41**	-3.96**	-0.05	0.12	-0.68**	0.16	-0.21	-0.69	0.44**	0.51**
2	Azad Pumpkin-1 × P-40-16	-1.54**	4.54**	0.12	0.44	-0.12	0.66**	0.23	3.46**	0.09	0.06
3	Azad Pumpkin-1×Narendra Agrim	1.10**	0.23	0.01	0.55	0.22	-1.12**	0.54*	-2.58**	-0.06	-0.03
4	Azad Pumpkin-1 × NDPK-7-24	2.16**	1.67*	-0.30	-0.37	-0.25	0.41*	-0.14	2.26**	-0.06	0.51**
5	Azad Pumpkin-1 × Kashi Harit	-1.84**	-3.29**	-0.11	0.05	0.33	-0.23	0.75**	-6.54**	-0.17*	-0.22*
6	Azad Pumpkin-1 × DVRP-2-5	1.33*	0.66	-0.21	-0.80	0.64**	0.69**	0.86**	-0.71	0.46**	0.22*
7	Azad Pumpkin-1×Punjab Samrat	-1.78**	-2.28**	0.01	-1.82**	0.14	0.06	0.86**	-2.92**	-0.09	-0.08
8	P-35-16 × P-40-16	2.52**	0.71	0.17	-1.61**	0.01	0.23	1.17**	5.70**	-0.06	1.32**
9	P-35-16 × Narendra Agrim	2.04**	0.82	-0.38	0.91*	0.51**	0.18	-0.79**	-0.13	0.14*	-0.16
10	P-35-16 × NDPK-7-24	-3.02**	3.01**	0.18	-0.19	0.04	-0.35	0.83**	0.71	-0.15*	-0.11
11	P-35-16 × Kashi Harit	3.82**	4.58**	-0.40*	0.53	0.10**	0.31	-0.61*	5.85**	0.01	0.38**
12	P-35-16 × DVRP-2-5	-0.03	1.09	-0.37	-0.02	-0.49**	0.16	-0.16	-2.01**	0.60**	0.05
13	P-35-16 × Punjab Samrat	1.93**	1.67*	0.03	-0.23	0.20	-0.93**	0.55*	-2.85**	-0.06	0.13
14	P-40-16 × Narendra Agrim	0.68	-0.38	-0.59**	0.63	1.01**	-0.11	-0.4	-5.89**	-0.05	-0.24*
15	P-40-16 × NDPK-7-24	-0.87	-0.56	-0.63**	-0.47	1.37**	0.32	0.76**	-0.77	0.15*	-0.61**
16	P-40-16 × Kashi Harit	2.81**	3.11**	-0.15	0.18	-0.46*	-0.02	1.23**	3.54**	0.27**	0.26*
17	P-40-16 × DVRP-2-5	-2.09**	-2.93**	-0.28	0.37	0.42*	-1.07**	0.42	-3.32**	0.05	-0.02
18	P-40-16 × Punjab Samrat	-2.16**	-3.81**	-0.56**	-0.62	-0.37*	-0.43*	-0.83**	-3.91**	0.22**	0.11
19	Narendra Agrim × NDPK-7-24	-2.15**	-6.20**	-0.01	-0.58	0.41*	-0.79**	0.71**	-3.44**	0.02	0.56**
20	Narendra Agrim × Kashi Harit	1.95**	2.28**	0.15	0.34	-0.62**	0.03	0.20	0.31	0.20**	-0.66**
21	Narendra Agrim × DVRP-2-5	-2.46**	-3.61**	0.28	-1.86**	-0.09	0.15	0.62*	-4.76**	0.10	0.27*
22	Narendra Agrim×Punjab Samrat	-1.00	0.87	-0.12	-1.49**	-0.75**	0.56**	-0.55*	7.26**	0.65**	0.42**
23	NDPK-7-24 × Kashi Harit	-3.20**	-5.48**	0.04	0.71	-0.03	0.50*	0.44	-5.43**	0.14*	0.38**
24	NDPK-7-24 × DVRP-2-5	2.30**	3.01**	-0.26	-0.41	-0.30	-1.12**	-0.73**	2.43**	0.58**	-0.23*
25	NDPK-7-24 × Punjab Samrat	-2.04**	-0.81	-0.33	-0.79	-0.31	-0.68**	-0.37	-3.16**	-0.09	0.44**
26	Kashi Harit × DVRP-2-5	-2.04**	-2.91**	0.06	-0.39	0.46*	-0.36	0.48	2.46**	0.12	0.42**
27	Kashi Harit × Punjab Samrat	-2.36**	-3.07**	-0.41*	-1.41**	0.30	0.21	0.95**	-6.63**	0.02	0.06
28	DVRP-2-5 × Punjab Samrat	-0.03	0.57	0.08	0.99*	0.14	-0.20	0.43	1.40	-0.40**	-0.02
SE (Sij)		0.55	0.77	0.19	0.39	0.17	0.18	0.24	0.71	0.06	0.10
SE (Sij-Skl)		0.77	1.08	0.26	0.55	0.24	0.26	0.33	0.99	0.09	0.14

Contd….

S. No.	Crosses	Equatorial circumference of fruit (cm)	Polar circumference of fruit (cm)	Flesh thickness (cm)	Total soluble solids (^{0}Brix)	Dry matter content (%)	Moisture content (%)	Number of seeds per fruit	Specific gravity (g/cm^3)	Fruit yield per plant (kg)
1	Azad Pumpkin-1 × P-35-16	3.07**	3.93**	0.03	-0.12	0.42	-0.42	15.83*	0.08*	3.05**
2	Azad Pumpkin-1 × P-40-16	-2.86**	0.49	0.32**	0.39**	0.93**	-0.93**	-1.01	-0.01	0.45
3	Azad Pumpkin-1×Narendra Agrim	-0.88	2.28**	-0.02	0.60**	0.15	-0.15	55.03**	0.05	-0.36
4	Azad Pumpkin-1 × NDPK-7-24	-3.31**	-1.98*	0.02	-0.05	0.52	-0.52	-19.27**	-0.01	0.95*
5	Azad Pumpkin-1 × Kashi Harit	11.27**	6.83**	-0.09	-0.07	0.26	-0.26	-19.27**	-0.02	-1.17**
6	Azad Pumpkin-1 × DVRP-2-5	-3.91**	-2.46**	0.24**	-0.05	0.29	-0.29	-3.01	-0.03	2.34**
7	Azad Pumpkin-1×Punjab Samrat	5.32**	2.27**	-0.1	0.52**	0.48	-0.48	21.33**	0.04	-0.59
8	P-35-16 × P-40-16	-0.05	0.81	0.1	0.63**	0.97**	-0.97**	46.29**	-0.01	2.72**
9	P-35-16 × Narendra Agrim	2.01**	0.58	-0.01	0.34**	0.57	-0.57	-1.67	-0.02	0.01
10	P-35-16 × NDPK-7-24	0.55	-0.18	0.06	0.10	-0.65*	0.65*	5.69	0.05	-0.87*
11	P-35-16 × Kashi Harit	0.20	0.85	-0.06	-0.01	0.52	-0.52	-18.31**	-0.02	0.78*

12	P-35-16 × DVRP-2-5	1.87**	2.78**	-0.03	0.17	-1.02**	1.02**	-20.37**	-0.01	2.22**
13	P-35-16 × Punjab Samrat	-0.47	-1.16	0.31**	-0.15	0.23	-0.23	16.96**	-0.06	0.02
14	P-40-16 × Narendra Agrim	3.35**	2.57**	-0.01	0.20*	0.11	-0.11	6.16	-0.01	-0.80*
15	P-40-16 × NDPK-7-24	10.03**	6.70**	-0.05	0.34**	0.64*	-0.64*	-10.81	0.01	-0.94*
16	P-40-16 × Kashi Harit	1.80**	0.60	-0.08	0.26**	-0.08	0.08	21.86**	0.01	1.60**
17	P-40-16 × DVRP-2-5	-1.35*	-2.35**	0.05	0.10	0.16	-0.16	-3.87	0.01	0.16
18	P-40-16 × Punjab Samrat	-0.18	2.15*	0.06	-0.18*	0.22	-0.22	7.79	-0.05	1.13**
19	Narendra Agrim × NDPK-7-24	2.08**	-0.21	0.13*	0.19*	-0.57	0.57	-2.44	-0.09**	1.35**
20	Narendra Agrim × Kashi Harit	1.77**	0.01	0.06	0.31**	0.69*	-0.69*	0.23	-0.04	-0.80*
21	Narendra Agrim × DVRP-2-5	3.55**	0.88	-0.03	0.32**	-0.77*	0.77*	15.83*	0.02	0.99**
22	Narendra Agrim×Punjab Samrat	-1.27*	3.44**	0.09	0.25**	0.35	-0.35	-26.84**	0.18**	3.71**
23	NDPK-7-24 × Kashi Harit	0.53	-0.76	0.04	0.17	-0.55	0.55	5.26	-0.06*	1.39**
24	NDPK-7-24 × DVRP-2-5	0.38	8.80**	0.09	0.11	0.91**	-0.91**	25.19**	-0.05	1.15**
25	NDPK-7-24 × Punjab Samrat	4.71**	1.75*	0.12*	0.78**	-0.93**	0.93**	20.53**	0.01	0.68
26	Kashi Harit × DVRP-2-5	-5.26**	-2.90**	0.32**	0.12	-0.08	0.08	-1.14	0.03	1.43**
27	Kashi Harit × Punjab Samrat	-5.86**	-4.44**	0.08	0.09	-0.36	0.36	0.19	-0.02	0.15
28	DVRP-2-5 × Punjab Samrat	3.03**	2.08*	-0.13*	0.14	-0.02	0.02	9.79	0.01	-1.56**
SE (Sij)		0.60	0.80	0.05	0.08	0.28	0.28	6.06	0.03	0.34
SE (Sij-Skl)		0.84	1.11	0.08	0.12	0.39	0.39	8.45	0.04	0.48

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