

## Heterosis and Combining Ability Analysis for Productivity Traits in Pumpkin (*Cucurbita moschata* Duch. Ex. Poir.)

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**Abstract** Exploitation of heterosis or hybrid vigor is an important approach of crop improvement adopted

in many of the crops all over the world. Gene action studies showed predominant non-additive gene action for most of the characters. The lines, Belagavi Local (7.46) and KP-41 (1.76), among the testers Pusa Vikas (2.18) were identified as the good general combiners for fruit yield per vine in order of their merit. The hybrids KP-25 × Pusa Vishwas (3.16) followed by KP-41 × Pusa Vishwas (2.28), KP-33 × Pusa Vikas (1.94), KP-53 × Pusa Vikas (1.85) and KP-2 × Arka Chandan (1.11) were identified as good specific combiners for total fruit yield per vine.

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**Keywords** Best parent, Commercial check, Standard heterosis, Recurrent selection.

### Introduction

India is the center of origin of many cucurbitaceous vegetables, where the cucurbits are capable of thriving and performing well even under the hot summer. Pumpkin is placed as high value vegetable owing to its high productivity, nutritive value, good storability, long period of availability, better transport qualities and extensive cultivation both in tropical and subtropical parts of our country. Pumpkin is cheaper source of vitamin A when compared to carrot which necessitates specific climatic requirement for its production and high productivity per unit area. Pumpkin, being a cross pollinated crop exhibits considerable variation for different traits. So far only a very few attempts have been made to improve the local types and number of released varieties available for commercial cultivation is also limited. Therefore ex-

ploitation of heterosis involving locally adapted pumpkin genotypes for commercial cultivation is priority area of research in improving the productivity, uniformity and fruit quality.

### Materials and Methods

Seven germplasm lines collected from Olericulture unit, Department of Vegetable Science, Kittur Rani Channamma College of Horticulture, Arabhavi viz., KP-2, KP-25, KP-33, KP-39, KP-41, KP-53 and Belagavi Local were crossed with three testers Arka Chandan, Pusa Vikas and Pusa Vishwas to develop 21  $F_1$  using Line  $\times$  Tester mating scheme. These 21  $F_1$  hybrids, seven parents, three testers and one commercial hybrid check (MPH-1) comprised the material for heterosis and combing ability studies which were evaluated in randomized block design with two replications at Kittur Rani Channamma College of Horticulture, Arabhavi during August month of 2012. Observations were recorded on five randomly tagged plants in each entry on vine length at 90 days (m), days to opening of first female flower, number of fruits per vine, fruit weight (kg), fruit length (cm), fruit diameter (cm) and fruit yield per vine (kg/vine). Heterosis over better parent and commercial check, were computed following standard statistical procedures. The data were subjected to combining ability analysis following the method outlined [1] and heterosis worked out over best parent and commercial check.

### Results and Discussion

Heterosis is the superiority of  $F_1$  over the mean of the parents or over the better parent (BP) or over the standard check with respect to agriculturally useful traits. The primary objective of heterosis breeding is to achieve a quantum jump in yield and quality aspects of crop plants. The extent of heterosis showed by hybrids over best parent and commercial check, MPH-1 is presented in Table 1. The extent of per cent heterosis exhibited by the  $F_1$ 's over their corresponding best parent and commercial check ranged from -47.19 (KP-2  $\times$  Pusa Vikas) to 3.21 (Belagavi Local  $\times$  Arka Chandan) and -47.92 (KP-2  $\times$  Pusa Vikas) to 1.78 (Belagavi Local  $\times$  Arka Chandan), respectively for

vine length at 90 days after sowing. Earliness is an important trait in a vegetable like pumpkin. Earliness is required in such crops for realizing the potential economic yield in as less time as possible which is an important consideration for a vegetable grower. The heterosis was observed in the range of -31.77 (Belagavi Local  $\times$  Pusa Vikas) to -8.10 (KP-33  $\times$  Pusa Vikas) per cent over best parent and -27.68 (Belagavi Local  $\times$  Pusa Vikas) to -8.15 (Belagavi Local  $\times$  Pusa Vishwas) per cent over commercial check for days to opening of first female flower. Out of 21 hybrids, all over better parent and 20 hybrids over commercial check showed heterosis in the negative (desired) direction. Number of fruits, fruit weight, fruit length and fruit diameter together form the most important closely related productivity parameters. The significant best parent heterosis in the positive direction was observed for number of fruits per vine in three hybrids with maximum of 17.20% in Belagavi Local  $\times$  Pusa Vishwas and KP-53  $\times$  Pusa Vikas cross followed by Belagavi Local  $\times$  Pusa Vikas (16.49%). However, 12 hybrids demonstrated significant standard heterosis in the desired positive direction for the trait under consideration. Among these crosses Belagavi Local  $\times$  Pusa Vishwas and KP-53  $\times$  Pusa Vikas (42.79%) exhibited highest positive significant standard heterosis followed by cross Belagavi Local  $\times$  Pusa Vikas (41.92%). Similar results were also reported [2] in pumpkin. In eight hybrids, heterosis for fruit length was observed significant heterosis over best parent with maximum of 21.26% in KP-2  $\times$  Pusa Vikas followed by 13.14% in Belagavi Local  $\times$  Pusa Vikas and 10.30% in KP-33  $\times$  Pusa Vishwas. None of the hybrids exhibited positive heterosis over the commercial check. For fruit diameter almost all hybrids showed non-significant heterosis over commercial check, only ten hybrids showed significant positive best parent heterosis. Among these KP-33  $\times$  Pusa Vishwas (20.83%) showed maximum heterosis followed by KP-41  $\times$  Pusa Vishwas (19.85%). Only ten hybrids showed fruit diameter in acceptable range and accordingly these hybrids showed desirable heterosis for this character. For average fruit weight out of 21 hybrids, five hybrids showed the significant positive heterosis over best parent, maximum best parent heterosis exhibited by the cross Belagavi Local  $\times$  Pusa Vikas (33.11%) followed by KP-41  $\times$  Pusa Vishwas (25.28%), Belagavi Local  $\times$  Pusa Vishwas (21.92%), KP-25  $\times$  Pusa Vishwas

**Table 1.** Magnitude of heterosis (%) over best parent and commercial check for various yield and yield parameters in pumpkin. \*–Significant at 5%, \*\*–Significant at 1% BTP: Best Parent CC: Commercial check.

Genotypes	Vine length at 90 days after sowing (m)		Days to first female flowering		Number of fruits per vine		Average fruit weight (kg)	
	BTP	CC	BTP	CC	BTP	CC	BTP	CC
KP-2×Arka								
Chandan	- 37.95**	- 38.81**	- 27.06**	- 22.69**	- 55.20**	- 45.41**	- 24.16**	- 42.05**
KP-2×Pusa Vikas	- 47.19**	- 47.92**	- 19.36**	- 14.52**	- 26.16**	- 10.04**	- 6.94**	- 28.89**
KP-2×Pusa Vishwas	- 30.72**	- 31.68**	- 24.77**	- 20.26**	- 56.99**	- 47.60**	- 21.03**	- 39.66**
KP-25×Arka								
Chandan	- 14.86**	- 16.04**	- 19.27**	- 14.42**	- 14.34**	4.37**	- 45.19**	- 58.12**
KP-25×Pusa Vikas	- 22.29**	- 23.37**	- 20.32**	- 15.54**	- 13.98**	4.80**	- 16.55**	- 36.24**
KP-25×Pusa Vishwas	- 18.27**	- 19.41**	- 23.09**	- 18.48**	- 15.05**	3.49**	- 20.81**	- 7.69**
KP-33×Arka								
Chandan	- 21.69**	- 22.77**	- 25.54**	- 21.07**	- 44.09**	- 31.88**	- 24.61**	- 42.39**
KP-33×Pusa Vikas	- 3.41**	- 4.75**	- 8.10**	- 2.59	- 9.32**	10.48**	- 3.36**	- 26.15**
KP-33×Pusa								
Vishwas	- 33.73**	- 34.65**	- 17.51**	- 12.56**	- 39.43**	- 26.20**	- 18.34**	- 37.61**
KP-39×Arka								
Chandan	- 9.44**	- 10.69**	- 15.32**	- 10.24**	- 43.01**	- 30.57**	- 18.12**	- 37.44**
KP-39×Pusa Vikas	- 12.65**	- 13.86**	- 24.54**	- 20.02**	- 13.98**	4.80**	- 5.15**	- 27.52**
KP-39×Pusa								
Vishwas	- 7.03**	- 8.32**	- 22.78**	- 18.15**	- 32.26**	- 17.47**	- 15.66**	- 35.56**
KP-41×Arka								
Chandan	- 29.52**	- 30.50**	- 27.19**	- 22.82**	- 13.98**	4.80**	- 26.62**	- 43.93**
KP-41×Pusa								
Vikas	- 31.53**	- 32.48**	- 26.77**	- 22.38**	- 9.32**	10.48**	- 2.24**	- 25.30**
KP-41×Pusa								
Vishwas	- 31.73**	- 32.67**	- 29.16**	- 24.91**	- 7.53**	12.66**	25.28**	- 4.27**
KP-53×Arka								
Chandan	- 9.24**	- 10.50**	- 19.91**	- 15.11**	- 42.65**	- 30.13**	- 21.48**	- 40.00**
KP-53×Pusa								
Vikas	- 28.92**	- 29.90**	- 27.89**	- 23.57**	17.20**	42.79**	- 16.33**	- 36.07**
KP-53×Pusa								
Vishwas	- 4.82**	- 6.14**	- 22.17**	- 17.50**	- 26.52**	- 10.48**	- 26.17**	- 43.59**
Belagavi Local×								
Arka Chandan	3.21**	1.78**	- 23.85**	- 19.29**	- 8.96**	10.92**	7.38**	- 17.95**
Belagavi Local×								
Pusa Vikas	- 10.44**	- 11.68**	- 31.77**	- 27.68**	16.49**	41.92**	33.11**	1.71**
Belagavi Local×								
Pusa Vishwas	- 6.43**	- 7.72**	- 13.35**	- 8.15**	17.20**	42.79**	21.92**	- 6.84**

**Table 1.** Continued.

Genotypes	Fruit length (cm)		Fruit diameter (cm)		Fruit yield per vine (kg)	
	BTP	CC	BTP	CC	BTP	CC
KP-2×Arka Chandan	- 36.92**	- 24.67**	- 4.68**	- 13.01**	- 59.65**	- 67.14**
KP-2×Pusa Vikas	21.36**	- 8.57**	- 14.66**	- 25.74**	- 24.86**	- 38.80**
KP-2×Pusa Vishwas	- 3.11**	- 11.44**	15.84**	- 13.99**	- 58.29**	- 66.02**
KP-25×Arka Chandan	7.33**	- 4.95**	- 3.14**	- 16.71**	- 47.27**	- 57.05**
KP-25×Pusa Vikas	2.32	- 2.75**	10.07**	- 8.32**	- 25.41**	- 39.24**
KP-25×Pusa Vishwas	1.32	- 1.54	- 5.27**	- 13.16**	10.47**	- 10.01**
KP-33×Arka Chandan	- 7.28**	- 8.69**	- 6.11**	- 18.45**	- 54.74**	- 63.13**
KP-33×Pusa Vikas	- 4.49**	- 12.78**	- 8.72**	- 25.55**	4.46**	- 14.91**

Table 1. Continued.

Genotypes	Fruit length (cm)		Fruit diameter (cm)		Fruit yield per vine (kg)	
	BTP	CC	BTP	CC	BTP	CC
KP-33×Pusa Vishwas	10.70**	- 3.48**	20.83**	- 10.05**	- 49.00**	- 58.46**
KP-39×Arka Chandan	- 9.52**	- 12.65**	- 12.07**	- 20.94**	- 51.00**	- 60.09**
KP-39×Pusa Vikas	- 4.85**	- 16.87**	- 12.11**	- 30.50**	- 9.56**	- 26.34**
KP-39×Pusa Vishwas	2.71*	- 14.62**	3.07**	- 28.35**	- 37.89**	- 49.41**
KP-41×Arka Chandan	0.63	- 14.11**	9.93**	- 21.25**	- 25.50**	- 39.32**
KP-41×Pusa Vikas	- 0.52	- 14.56**	- 10.54**	- 29.57**	5.19**	- 14.32**
KP-41×Pusa Vishwas	7.23**	- 8.39**	19.85**	- 15.57**	24.59**	1.48*
KP-53×Arka Chandan	- 12.74**	- 20.06**	5.33**	- 11.04**	- 50.36**	- 59.57**
KP-53×Pusa Vikas	6.26**	- 15.02**	- 23.45**	- 31.94**	14.12**	- 7.05**
KP-53×Pusa Vishwas	6.21**	- 9.78**	14.42**	- 22.09**	- 31.51**	- 44.21**
Belagavi Local×Arka Chandan	- 8.74**	- 17.64**	- 0.24**	- 22.27**	31.06**	6.75**
Belagavi Local×Pusa Vikas	13.14**	- 6.82**	13.30**	- 11.94**	72.95**	40.88**
Belagavi Local×Pusa Vishwas	- 10.35**	- 16.46**	3.50**	- 8.87**	56.19**	27.23**

(20.82%) and Belagavi Local × Arka Chandan (7.38%) in the order of merit. Almost all hybrids showed non-significant heterosis over commercial check, only one hybrid Belagavi Local × Pusa Vikas (1.71%) showed significant positive standard heterosis which is lower compared to 55.47% reported [3] in pumpkin. The selection should be made for improvement of traits like days to first female flowering, node at which first female flower appears, number of fruits per plant and average fruit weight [4].

The data on heterosis revealed that maximum heterosis exhibited in the range of -59.65 (KP-2 × Arka Chandan) to 72.95 (Belagavi Local × Pusa Vikas) and -67.14 (KP-2 × Arka Chandan) to 40.88 (Belagavi Local × Pusa Vikas) per cent, respectively over best parent and commercial check. Out of 21 hybrids, eight and only four hybrids exhibited significantly positive best parent and standard heterosis, respectively. Among the 21 hybrids, the cross Belagavi Local × Pusa Vikas had highest positive heterosis of 72.95% over best parent and 40.88% increased vigor over the commercial check hybrid (MPH-1). The next best crosses were Belagavi Local × Pusa Vishwas with 56.19 and 27.23% heterosis over best parent and commercial check respectively then Belagavi Local × Arka Chandan with 31.06 and 6.75% heterosis over better parent and commercial check respectively. Infact the cross with highest positive heterosis i.e., Belagavi Local × Pusa Vikas also showed the highest *per se* as

well as standard heterosis for number of fruits per vine also indicating the close association between number of fruits per vine and productivity. It is observed that total yield of fruits per plant in pumpkin is mainly dependent on fruit weight, fruit size and number of fruits per vine [3].

Analysis of variance for combining ability showed significant variance for GCA and SCA for all the seven characters. SCA variances were higher in magnitude for all characters, which indicated the predominance of dominance variance in control of these traits except for number of fruits per vine, fruit length and fruit yield per vine indicates the additive gene action. Identification of good general combiners can help in selection of parents for heterosis breeding. Estimates of *gca* and *sca* effects were presented in Tables 2 and 3. Among the ten parents, the highest and significant *gca* effect for fruit yield per vine (7.46) was observed in Belagavi Local followed by Pusa Vikas (2.18) and KP-41 (1.76). These parents also had maximum *gca* effects for number of fruits per vine, average fruit weight, fruit yield per vine, fruit yield per plot and fruit per hectare. Whereas, KP-41 exhibited significant *gca* effect in desired direction for days to first female flowering and number of fruits per vine. KP-2 and KP-25 had the highest negative *gca* effect for nodes at first female flower. These parents can be use in breeding for earliness. However, the parent Belagavi Local was the top general combiner for vine

**Table 2.** Estimates of general combining in ability effects of pumpkin parents for different traits. \*and \*\* indicate significance of values at  $p = 0.05$  and  $p = 0.01$ , respectively. NS: Non significant.

Parents	Vine length at 90 days after sowing	Days to first female flowering	Number of fruits per vine	Average fruit weight (kg)	Fruit length (cm)	Fruit diameter (cm)	Fruit yield per vine (kg)
Lines							
KP-2	-0.96**	-0.89	-0.73**	-0.39**	-0.71	0.30	-3.63**
KP-25	0.05	0.97	0.16	0.22	1.92*	1.33**	-0.68**
KP-33	-0.01	3.48**	-0.30*	-0.30*	0.75	0.21	-2.03**
KP-39	0.48**	0.97	-0.27*	-0.19	-0.67	-1.60**	-2.00**
KP-41	-0.57**	-3.49**	0.27*	0.34**	-0.14	-0.66	1.76**
KP-53	0.25	-0.63	0.08	-0.56**	-0.72	-0.56	-0.88**
Belagavi Local	0.74**	0.40	0.79**	1.32**	-0.43	0.98*	7.46**
SEM±	0.14	1.16	0.13	0.12	0.54	0.40	0.30
CD at 5%	0.29	2.37	0.27	0.24	1.10	0.84	0.60
CD at 1%	0.38	3.19	0.37	0.32	1.48	1.12	0.81
Testers							
Arka Chandan	0.12	-0.15	-0.32**	-0.59**	-0.66	0.28	-2.44**
Pusa Vikas	-0.14	-0.20	0.40**	0.28**	0.15	-0.92**	2.18**
Pusa Vishwas	0.03	0.35	-0.08	0.31**	0.51	0.63*	0.26
SEM±	0.09	0.75	0.09	0.08	0.35	0.27	0.19
CD at 5%	NS	NS	0.18	0.16	NS	0.55	0.40
CD at 1%	NS	NS	0.24	0.22	NS	0.74	0.53

length 90 days after sowing, number of fruits per vine, average fruit weight, fruit diameter, fruit yield per vine. So also, the top ranking parents for days to opening of female flower and nodes at first female flower recorded lower rank in respect of *per se* performance. This unequivocally suggests that combining ability of parents cannot always be judged accurately by their *per se* performance.

Vine length is the important growth parameters which act as source trait to support yield and its component traits. The estimates of *sca* effects for 21 crosses for this trait revealed that the cross KP-33 × Pusa Vikas (0.95) at 90 DAS for vine length had maximum significant *sca* effect. However, the *gca* effects were higher for Belagavi Local (0.74) for vine length at 90 DAS trait indicating that the parent PRD-5 was not a good general combiner for this trait despite its high *gca* effects. The cross KP-33×Pusa Vikas high *sca* effects for vine length at 90 DAS had parents of low negative × low negative *gca* effects.

The high total yield per vine is the ultimate motto of the breeder. In the present study, the top two crosses with high *per se* performance (Belagavi Local × Pusa Vikas and Belagavi Local × Pusa Vishwas). While, the cross Belagavi Local × Pusa Vikas also exhibits significant *sca* effects for number of days to first female flowering, fruit diameter. The crosses Belagavi Local × Pusa Vikas and Belagavi Local × Pusa Vishwas involved positive × positive general combiners with common parent Belagavi Local having highest and significant *gca* effect, demonstrated its value as good general combiner for the total yield per vine. Further, these two crosses (Belagavi Local×Pusa Vikas and Belagavi Local ×Pusa Vishwas) having positive × positive *gca* effects reveals that the high *sca* effects in these crosses was mainly through additive gene effects, which is fixable in nature. Therefore, following pedigree method or any other selection procedure or true breeding good progenies can be identified from the segregating population in succeeding generation. The similar findings were reported in ridge gourd [5]. In case of

**Table 3.** Estimates of specific combining ability effects of pumpkin hybrids for different traits. \*and \*\* indicate significance of values at  $p = 0.05$  and  $p = 0.01$ , respectively. NS: Non significant.

Crosses	Vine length at 90 days after sowing (m)	Days to first female flowering	Number of fruits per vine	Average fruit weight (kg)	First length (cm)	Fruit diameter (cm)	Fruit yield per vine (kg)
KP-2 × Arka Chandan	-0.09	-2.03	0.07	0.28	-1.51	0.68	1.11*
KP-2 × Pusa Vikas	-0.28	3.07	0.15	0.19	1.26	-0.80	0.32
KP-2 × Pusa Vishwas	0.37	-1.03	-0.22	-0.47*	0.25	0.12	-1.43**
KP-25 × Arka Chandan	0.07	1.21	0.33	-0.82**	0.25	-1.12	-0.47
KP-25 × Pusa Vikas	-0.05	0.58	-0.39	-0.41*	-0.07	1.85*	-2.70**
KP-25 × Pusa Vishwas	-0.01	-1.79	0.06	1.23**	-0.17	-0.72	3.16**
KP-33 × Arka Chandan	-0.22	-5.40*	-0.04	0.18	0.58	-0.38	0.06
KP-33 × Pusa Vikas	0.95**	6.05**	0.20	0.26	-1.14	-0.67	1.94**
KP-33 × Pusa Vishwas	-0.73**	-0.65	-0.15	-0.44*	0.56	1.05	-2.01**
KP-39 × Arka Chandan	-0.11	3.78	-0.05	0.36	1.12	0.91	0.44
KP-39 × Pusa Vikas	0.00	-2.19	0.04	0.07	-0.62	0.09	0.37
KP-39 × Pusa Vishwas	0.11	-1.59	0.01	-0.43*	-0.50	-1.00	-0.81
KP-41 × Arka Chandan	-0.05	0.49	0.22	-0.55*	0.27	-0.10	-0.52
KP-41 × Pusa Vikas	0.11	0.81	-0.38	-0.33	-0.63	-0.65	-1.76**
KP-41 × Pusa Vishwas	-0.07	-1.30	0.15	0.88**	0.36	0.75	2.28**
KP-53 × Arka Chandan	0.14	2.38	-0.38	0.58**	-0.47	1.96**	-0.61
KP-53 × Pusa Vikas	-0.58*	-2.78	0.56*	-0.06	-0.16	-1.24	1.85**
KP-53 × Pusa Vishwas	0.45	0.40	-0.18	-0.52	0.63	-0.72	-1.24*
Belagavi Local × Arka Chandan	0.27	-0.42	-0.16	-0.02	-0.23	-1.95**	-0.01
Belagavi Local × Pusa Vikas	-0.15	-5.54**	-0.17	0.27	1.37	1.43*	-0.03
Belagavi Local × Pusa Vishwas	-0.12	5.96**	0.33	-0.26	-1.14	0.52	0.04
SEM±	0.25	2.01	0.23	0.02	0.93	0.69	0.51
CD at 5%	0.51	4.10	0.47	0.41	NS	1.41	1.05
CD at 1%	0.69	5.53	0.64	0.55	NS	1.89	1.41

high × high crosses there are possibilities of complementary epistatic effect acting in the direction of additive effects of the good performer that can be exploited for development of high yielding pure lines through progeny selection in pumpkin [6].

#### References

1. Kempthorne O (1957) An introduction to genetic statistics. John Wiley and Sons, New York, pp 408—711.
2. Sirohi PS, Reddy YS, Behera TK (2002) Heterosis for yield and its attributing traits in pumpkin (*Cucurbita moschata* Duch. Ex. Poir). Veg Sci 29 : 178—179.
3. Vidya H, Sirohi PS (2002) Heterosis in pumpkin (*Cucurbita moschata* Duch. Ex. Poir). PKV Res J 26 : 36—39.
4. Aastik J, Pandey S, Rai M, Yadav DS, Singh TB (2009) Heterosis in relation to combining ability for flowering behaviors and yield parameters in pumpkin. Veg Sci 36 : 43—44.
5. Neeraja PB (2008) Combining ability and heterosis for fruit yield and yield components in ridge gourd (*Luffa acutangula* L.). J Res Angrau 36 : 24—32.
6. Mohanty BK, Mishra RS (1998) Manifestation of heterosis for yield and yield contributing characters in pumpkin. Veg Sci 25 : 58—62.