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Combining ability analysis for yield and yield contributing traits in pumpkin

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Abstract

An experiment on “Combining ability analysis for yield and yield related traits in pumpkin” was conducted at Instructional farm, Department of vegetable science, Faculty of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, during Summer-2023 and Kharif-2023. The experiment was laid out in Randomized block design with two replications. Observations were recorded on twelve yield and yield contributing characters, and combining ability analysis was carried out to estimate general combining ability (GCA) and specific combining ability (SCA) effects. Analysis of variance revealed significant differences among genotypes, lines, testers and Line $\times$ Tester interactions for most traits, indicating substantial genetic variability. Both additive and non-additive gene actions governed the inheritance of characters; however, non-additive gene action predominated for fruit yield and related traits, suggesting greater scope for heterosis breeding. Among the parents, IC-618054, AKL-1, IC-618052 and IC-599410 were identified as good general combiners for important yield and quality traits. The hybrids IC-618054 $\times$ IC-320175, AKL-1 $\times$ IC-320175, IC-618054 $\times$ IC-599410 and IC-618052 $\times$ IC-599410 exhibited superior *per se* performance along with significant positive SCA effects for fruit yield and associated traits. The cross IC-618054 $\times$ IC-320175 recorded the highest fruit yield per vine during both seasons. The identified superior parents and hybrids may be effectively utilized in future pumpkin breeding programmes for the development of high yielding and quality hybrids suitable for commercial cultivation.

Keywords: Combining ability, Crop improvement, GCA, SCA, Yield

Introduction

Pumpkin (*Cucurbita moschata*) is an important cucurbitaceous vegetable crop grown throughout tropical and subtropical regions, including India. It has a chromosome number of $2n = 40$ and is a vigorous, annual, running or trailing vine characterized by large, bristly leaves and prominent yellow flowers. Pumpkin is well known for its high carotene content in the fruit and serves as an excellent source of vitamin A (972 IU per 100 g of edible portion), which plays a vital role in providing antioxidants, particularly carotenoids, in the human diet (Hidaka *et al.*, 1987) [5]. Pumpkin is one of the widely cultivated vegetables in India, with a total area of 106 million hectares and an annual production of 2205 million metric tonnes (Anon, 2022) [1]. Pumpkin is a monoecious and highly cross-pollinated crop, offering ample scope for the successful exploitation of hybrid vigour (heterosis). It has received limited attention, even though the crop shows high variation due to cross-pollination. Most available hybrids produce large fruits, which are less suitable for present-day nuclear families. Therefore, there is a need to develop medium-sized, high-yielding pumpkin hybrids with better quality traits for consumer preference, easy packaging and transportation.

Since pumpkin is a highly cross-pollinated crop, exploitation of heterosis through hybrid breeding offers great scope for crop improvement. The identification of suitable parents with good combining ability is an important prerequisite for successful hybrid development. Combining ability analysis helps in understanding the nature and magnitude of gene action involved in the inheritance of various quantitative characters. The variance of GCA includes the additive nature of the total variance, whereas SCA includes non-additive nature of the total variance, arising largely from dominance and epistatic deviations (Malik *et al.*, 2004). The knowledge on the relative importance of the additive (GCA) and non-additive (SCA) gene actions within a breeding population is significant because it determines the breeding

method for genetic improvement (Sincik, 2005) ^[14]. Line $\times$ tester analysis is widely used to estimate combining ability effects and to identify superior parental lines and promising hybrids.

Several studies in cucurbits have revealed the importance of both additive and non-additive gene action for yield and quality traits. For the development of superior hybrids, estimates of general combining ability of parents and specific combining ability of the crosses help in proper selection of parents for hybridization (Dogra and Kanwar, 2001) ^[2]. In this context, the present investigation was undertaken to evaluate pumpkin hybrids for yield and quality traits and to identify promising parental combinations for future breeding programmes.

Material and methods

The Line $\times$ Tester mating design proposed by Kempthorne (1957) was used for the development of hybrids. Six lines IC-608054(L1), IC-284729 (L2), IC-599437 (L3), IC-608052 (L4), IC-599403 (L5), AKL-1 (L6) were crossed with five testers), IC-332324 (T1), AKL-4 (T2), IC-320175 (T3), IC-599410 (T4) and AMT-1 (T5) to obtain thirty F₁ hybrids during Kharif-2022. The resulting hybrids along with parents and standard check were evaluated in Randomized Block Design (RBD) with two replications during summer-2023 and Kharif-2023 at the Instructional farm, department of vegetable science, faculty of horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. Observations were recorded on yield and yield contributing traits, and combining ability analysis was carried out to estimate general combining ability (GCA) and specific combining ability (SCA) effects. The plants were spaced at a distance of 3 m between rows and 1.0 m within plants.

Result and Discussion

The analysis of variance presented in Table 1 revealed highly significant differences among genotypes, crosses, lines, testers and Line $\times$ Tester interactions for most of the characters studied during both summer and kharif seasons. This indicates the presence of substantial genetic variability among the parental lines and hybrids for yield and yield contributing traits in pumpkin.

The analysis of variance revealed highly significant differences among genotypes for all the traits, indicating the presence of substantial genetic variability and scope for selection in pumpkin. Significant mean squares due to lines and testers suggested the importance of additive gene action, whereas significant Line $\times$ Tester interactions for most traits indicated the predominance of non-additive gene action. The significant SCA variances for fruit yield, fruit weight, fruit diameter and flowering traits suggested ample scope for heterosis breeding in pumpkin improvement. Overall, both additive and non-additive gene actions governed the inheritance of yield and related traits, with non-additive gene action playing a major role for economically important characters.

Therefore, exploitation of heterosis through hybrid breeding along with selection of good combiners would be effective for the improvement of pumpkin. Similar findings in cucumber by Mule *et al.* (2012) ^[10] and in pumpkin were reported by Kumar *et al.* (2018) ^[7] who observed significant combining ability variances for yield and related traits in cucurbits.

General combining ability

The general combining ability is the performance of genotypes in several hybrid combinations. It is estimated from sib families. Dhillon (1975) suggested that combining ability

Table 1: Analysis of variance for combining ability effect for various characters in Pumpkin

source	DF	MSS											
		Length of vine (m)		Number of branches vine ⁻¹		Days to first male flower initiation		Days to first female flower initiation		Days to 1 st harvest of fruit		Node at which first female flower appeared	
		Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif
Replication	1	0.14	2.15	1.37	1.12	12.33	7.32	5.42	0.98	0.12	63.67	0.19	2.74
Genotype	40	1.33**	1.40**	3.04**	1.97**	10.57**	12.25**	7.23**	10.50*	119.28**	108.21**	10.16*	6.55**
Cross	29	1.15**	1.44**	1.95**	0.91**	5.02*	5.92**	7.11*	6.87**	61.03**	45.79**	4.87**	3.62**
Line(c)	5	3.81**	2.58**	1.85**	0.84*	6.94*	11.99*	12.91**	13.45**	30.79**	58.64**	9.79**	5.37*
Tester(c)	4	1.58**	3.74**	5.51**	0.22	8.25**	14.17*	8.62*	8.82*	65.78*	19.35*	5.95**	1.82**
LXT (c)	20	0.40**	0.70**	1.26**	1.06**	3.89*	2.75**	5.36*	4.84**	67.64**	47.87**	3.42**	3.55**
Parent	10	0.65**	0.51**	0.43**	0.14**	9.40**	15.53**	5.23**	10.09**	8.80**	9.61**	11.41**	5.67**
Error	29	0.13	0.22	0.35	0.50	2.85	3.78	3.13	3.25	34.40	23.63	2.43	1.95

Source	DF	MSS											
		Fruit length (cm)		Fruit diameter (cm)		Fruit weight (kg)		Flesh thickness (cm)		Number of fruits vine ⁻¹		Fruit yield vine ⁻¹ (kg)	
		Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif
Replication	1	31.21	1.47	1.78	0.28	0.68	0.05	0.00	0.02	0.19	0.21	0.18	0.17
Genotype	40	33.38**	28.79**	41.08**	52.85**	0.90**	0.78**	0.78**	0.34*	0.50**	0.92**	17.11**	19.69**
Cross	29	24.04*	21.08*	40.28**	54.67**	0.46**	0.42**	0.56*	0.32*	0.31**	0.72**	11.05**	12.16**
Line(c)	5	69.17**	53.44**	46.02**	82.12**	0.61**	0.48**	0.70**	0.70**	0.92**	2.33*	25.51*	38.96**
Tester(c)	4	37.00**	49.49**	46.46**	116.56**	1.37*	0.76**	1.69**	0.29	0.14	0.72**	17.23**	11.20**
LXT (c)	20	10.17	7.31	37.61**	35.43**	0.24**	0.33**	0.30*	0.23**	0.19**	0.42**	6.20**	5.66**
Parent	10	62.51**	51.89**	9.96**	10.31**	0.10	0.13	0.11**	0.06**	0.46**	0.42**	2.66**	2.16
Error	29	7.70	4.66	3.89	8.55	0.31	0.21	0.14	0.14	0.17	0.26	3.30	3.21

provides useful information for the choice of parents in terms of expected performance of the hybrids and progenies.

The estimates of general combining ability effects presented in Table 2 indicated that none of the parents was a good

general combiner for all the traits, suggesting differential combining ability of parents for different characters.

Among the lines, IC-618054 was identified as a good general combiner for important yield and quality traits as it exhibited significant positive GCA effects for vine length (0.92 and 0.77), number of branches per vine (0.34), fruit length (2.54 and 2.30), flesh thickness (0.24), number of fruits per vine (0.32 and 0.44) and fruit yield per vine (1.29 and 2.15) during summer and kharif seasons, respectively. It also showed desirable negative GCA effect for node at first female flower appearance (-1.32), indicating earliness. The line AKL-1 also proved to be a good general combiner with significant positive GCA effects for vine length (0.66 and 0.77), number of branches (0.35 and 0.50), fruit diameter (1.85 and 2.37), number of fruits per vine (0.31 and 0.43) and fruit yield per vine (1.25 and 2.13). Further, it recorded significant negative GCA effects for days to first female flowering (-0.96) and days to first harvest (-2.80), indicating suitability for developing early maturing hybrids.

The parent IC-618052 exhibited desirable positive GCA effects for fruit length (2.82 and 2.41), fruit diameter (2.72 and 4.40), flesh thickness (0.41) and also negative significant GCA effects for node at first female flower

appearance (-1.20 and -1.08), suggesting its usefulness for quality improvement and earliness. The line IC-284729 showed positive GCA effects for days to first male flowering (1.45 and 1.88) and days to first female flowering (1.84 and 2.19 positive, hence late), while it recorded negative GCA effects for fruit weight (-0.41 and -0.37), number of fruits per vine (-0.32 and -0.36) and fruit yield per vine (-2.14 and -2.23), indicating poor combining ability for yield traits. Among testers, IC-599410 emerged as a desirable combiner for fruit diameter with positive GCA effects of 2.14 and 4.33 and flesh thickness (0.56). However, it showed positive GCA effects for days to flowering and harvest, indicating comparatively late maturity. Tester IC-320175 exhibited desirable negative GCA effects for days to first male flowering (-0.81 and -1.17), days to first female flowering (-0.28 and -1.00) and days to first harvest (-0.34 and -0.06), indicating its usefulness for earliness. It also recorded positive GCA effects for fruit yield per vine (1.27 and 0.72). Similar results were obtained by, Mule *et al.* (2012) ^[10] in cucumber, Singh *et al.* (2013) ^[15] in bittergourd, Nisha and Veeraragavathatham (2014) ^[12] in pumpkin, Hatwal *et al.* (2018) ^[3] in pumpkin, Yadav *et al.* (2021) ^[17] in pumpkin.

Table 2. Estimate of General combining ability effects of parents for various characters

Sr.no	Genotypes	Length of vine (m)		Number of branches vine ⁻¹		Days to first male flower initiation		Days to first female flower initiation		Days to 1 st harvest of fruit		Node at which 1 st female flower appeared	
		Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif
	Lines												
1	IC-618054	0.86**	0.73**	0.34**	0.02	0.38	0.41	-1.32**	-0.80	1.17	3.06	-1.05**	-0.32
2	IC-599437	0.92**	0.65**	-0.07	0.12	-0.61	-0.56	0.52	-0.17	-0.68	0.73	0.08	-0.33
3	IC-284729	-0.75**	-0.07	-0.57**	-0.15	1.45**	1.88**	1.84**	2.19**	0.07	1.36	1.43**	0.45
4	IC-618052	0.19*	-0.11	0.41**	-0.16	-0.27	-0.32	-0.29	-0.79	2.38**	-3.54*	-1.20**	-1.08**
5	IC-599403	-0.56**	-0.86**	-0.46**	-0.33	-0.88**	-0.04	0.23	0.29	-0.14	0.54	0.48	0.98**
6	AKL-1	0.66**	0.77**	0.35**	0.50*	-0.09	-1.37*	-0.96**	-0.70	-2.80**	-2.15	0.27	0.31
	Testers												
1	IC-332324	-0.31**	0.56**	-0.58**	0.00	0.68	1.09*	0.03	0.66	1.59	1.91	0.27	0.12
2	AKL-4	0.89**	0.71**	0.86**	0.11	0.10	-0.89	-1.18**	-0.74	-2.45**	-1.61	0.00	0.12
3	IC-320175	-0.24*	0.00	-0.14	0.15	-0.81**	-1.17*	-0.28	-1.00**	-0.34	-0.06	0.69	0.07
4	IC599410	-0.22*	-0.74**	-0.67**	-0.08	0.92*	1.15*	0.27	0.10	3.11**	-0.37	-1.18**	-0.67
5	AMT-1	0.74*	0.62*	0.54**	-0.18	-0.88**	-0.18	1.16**	0.96**	-1.90	0.14	0.22	0.35
	SE(Lines)	0.12	0.15	0.16	0.23	0.40	0.60	0.48	0.57	1.12	1.67	0.50	0.44
	SE (Testers)	0.11	0.14	0.15	0.21	0.40	0.55	0.47	0.42	1.56	1.52	0.45	0.40

Sr. no	Genotypes	Fruit length (cm)		Fruit diameter (cm)		Fruit weight (kg)		Flesh thickness (cm)		Number of fruits vine ⁻¹		Fruit yield vine ⁻¹ (kg)	
		Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif	Summer	Kharif
	Lines												
1	IC-618054	2.54**	2.30**	0.05	-0.77	0.08	0.19	0.24*	0.12	0.32*	0.44*	1.29*	2.15**
2	IC-599437	-1.57**	-0.65	-2.38**	-0.67	0.13	-0.03	-0.07	-0.08	0.16	0.23	0.86	0.67
3	IC-284729	1.00	-0.26	-2.54**	-3.29**	-0.41*	-0.37*	-0.26*	-0.34**	-0.32**	-0.36*	-2.14**	-2.23**
4	IC-618052	2.82**	2.41**	2.72**	4.40**	0.12	0.15	0.41**	-0.03	-0.07	-0.15	0.02	-0.10
5	IC-599403	-0.77	0.08	0.30	-2.03	-0.18	-0.11	-0.17	-0.10	-0.38**	-0.69**	-1.71**	-2.41**
6	AKL-1	-4.02**	-3.88**	1.85**	2.37**	0.08	0.22	-0.16	0.44**	0.31*	0.43*	1.25*	2.13**
	Testers												
1	IC-332324	2.67**	3.34**	-1.93**	-3.28**	-0.40*	-0.31*	-0.26*	-0.16	-0.04	0.14	-1.22*	-0.67
2	AKL-4	-2.14**	-1.89**	0.01	0.19	-0.33*	-0.24	-0.35**	0.13	-0.11	-0.18	-1.27*	-1.25*
3	IC-320175	-0.38	-0.17	-2.00**	-2.68**	0.26	0.15	-0.15	0.19**	0.18	0.07	1.27*	0.72
4	IC-599410	0.38	0.00	2.14**	4.33**	0.30	0.24	0.56**	-0.05	0.02	0.09	0.97	1.09
5	AMT-1	-0.53	-1.29	1.78**	1.44	0.17	0.18	0.20	-0.10	-0.05	-0.12	0.25	0.10
	SE (Lines)	0.87	0.72	0.67	1.04	0.14	0.15	0.12	0.12	0.11	0.15	0.57	0.61
	SE (Testers)	0.80	0.67	0.62	0.95	0.13	0.14	0.11	0.09	0.13	0.13	0.54	0.55

Specific combining ability

Specific combining ability refers to the performance of a particular cross in relation to the average performance of the parents involved. High SCA effects suggest that certain parental combinations perform better than expected based on their general combining ability.

For fruit yield per vine, the cross IC-618054 × IC-320175 recorded superior *per se* performance with fruit yield of 13.88 kg and 14.11 kg during summer and kharif seasons, respectively. The cross also exhibited significant positive SCA effects of 2.53 and 1.93, indicating strong non-additive gene action for fruit yield. The hybrid AKL-1 × IC-320175 also showed excellent performance with fruit yield per vine of 13.70 kg and 14.50 kg along with positive SCA effects of 1.55 during kharif season. This cross also exhibited desirable performance for earliness traits such as days to male flowering (44.15), days to female flowering (53.80) and days to first harvest (91.35), indicating its suitability for developing early and high yielding hybrids. The cross IC-618054 × IC-599410 recorded high fruit yield per vine (13.38 and 14.04 kg) along with positive SCA effect for number of fruits per vine (0.76) and fruit diameter (5.73), suggesting its usefulness for yield and fruit quality improvement. For fruit weight, the cross IC-618052 × IC-

599410 recorded the highest *per se* performance (4.02 kg) and significant positive SCA effects of 0.52 and 0.90 during summer and kharif seasons, respectively. This hybrid also exhibited desirable performance for flesh thickness and early node appearance of female flowers, indicating its superiority for fruit quality traits.

The hybrid AKL-1 × AKL-4 showed desirable SCA effects for fruit weight (1.08), fruit diameter (6.20) and flesh thickness (0.66), along with superior *per se* performance for number of branches and early flowering traits. For earliness, the cross IC-618054 × AMT-1 exhibited significant negative SCA effects for days to first harvest (-9.02 and -7.91), indicating its suitability for developing early maturing hybrids. Similarly, IC-599437 × IC-320175 recorded significant negative SCA effect (-8.65) for days to first harvest during kharif season. The hybrid IC-618054 × IC-332324 showed superior *per se* performance for fruit length (30.78 and 30.95 cm) along with positive SCA effect for fruit weight (0.55), whereas IC-618052 × AMT-1 recorded maximum fruit diameter (35.05 and 37.90 cm). The studies undertaken by, Sirohi *et al.* (1986) ^[16] in pumpkin, Mohanty *et al.* (2000) ^[9] in pumpkin, Muthal *et al.* (2018) ^[11] in pumpkin, Rajaguru *et al.* (2020) ^[13] in cucumber, Harshini *et al.* (2024) ^[4] in pumpkin.

Table 3. Ranking of the best three crosses based on *per se* performance and desirable crosses showing significant SCA effects for twelve traits

Traits	Crosses with <i>per se</i> performance		Crosses with significant sca effects	
	Summer	Kharif	Summer	Kharif
Length of vine (m)	AKL-1 X IC-599410 (6.37) AKL-1 X AKL-4 (6.35) AKL-1 X IC-332324 (6.35)	IC-618054 X AKL-4(6.98) AKL-1 X IC-332324 (6.78) IC-599437 X AKL-4 (6.72)	AKL-1 X IC-599410 (0.78) AKL-1 X IC-332324 (0.72) IC-599403 X IC-599410 (0.68)	IC-618054 X AKL-4 (1.02) IC-599437 X AMT-1 (0.98)
Number of branches per vine	AKL-1 X AKL-4 (5.70) AKL-1 X IC-320175 (5.65) IC-618054 X AMT-1 (5.55)	IC-618054 X IC-320175 (5.85) AKL-1 X IC-332324 (5.75) IC-599437 X IC-332324 (5.65)	IC-618052 X IC-320175 (1.33) AKL-1 X IC-320175 (1.28)	-
Days to male flower initiation	AKL-1 × AMT-1 (44.45) IC-599437 × IC-320175 (44.95) IC-599403 X AMT-1 (45.35)	AKL-1 × IC-320175 (44.15) IC-618052 × IC-320175 (44.70) AKL-1 × AKL-4 (45.10)	IC-284729 X AKL-4 (-2.24)	-
Days to female flower initiation	AKL-1 X IC-320175 (53.80) IC-618054 X AMT-1 (54.10) AKL-1 X AKL-4 (54.30)	AKL-1 X AKL-4 (52.60) IC-618052 X IC-320175 (52.65) IC-599437 X IC-320175 (52.80).	-	-
Days to 1 st harvest of fruit	AKL-1 × IC-320175 (91.35) AKL-1 × AKL-4 (92.43) IC-618054 × AMT-1 (92.51)	AKL-1 × AKL-4 (92.57) IC-599437 X IC-320175 (92.84) IC-618052 × IC-320175 (93.04)	IC-618054 X AMT-1 (-9.02)	IC-599437 X IC-320175 (-8.65) IC-618054 X AMT-1 (-7.91)
Node at which 1 st female flower appeared	IC-618052 X IC-599410 (19.50) IC-618052 X IC-320175 (20.10) IC-618054 X AKL-4 (20.80).	IC-618052 X IC-320175 (18.25) IC-618052 X IC-599410 (19.30) IC-599437 X IC-599410 (19.80)	-	IC-618052 X AMT-1 (-2.68) AKL-1 X IC-320175 (-1.74)
Fruit length (cm)	IC-618054 × IC-332324 (30.78) IC-618052 X IC-332324 (30.31), IC-618052 × IC-320175 (29.30)	IC-618054 × IC-332324 (30.95) IC-618052 × IC-332324 (30.54) IC-618052 × IC-320175 (29.50).	AKL-1 X IC-599410 (4.83)	IC-284729 X AMT-1 (3.26)
Fruit diameter (cm)	IC-618052 × AMT-1 (35.05) IC-618052 X AKL-4 (34.30) AKL-1 × AKL-4 (34.07)	IC-618052 × AMT-1 (37.90) IC-618052 X AKL-4 (36.91) AKL-1 × AKL-4 (36.45)	IC-618054 X IC-599410 (5.73) IC-599437 X IC-599410 (5.60) IC-618054 X IC-320175 (5.08)	AKL-1 X AKL-4 (6.20)
Fruit weight (kg)	AKL-1 × IC-320175 (3.94 kg) IC-599437 X IC-599410 (3.89) IC-618054 × IC-320175 (3.88)	IC-618052 × IC-599410 (4.02) AKL-1 × AKL-4 (3.77) IC- 599403 X IC-599410 (3.70).	IC-618052 X IC-599410 (0.52) IC-618054 X AMT-1 (0.42) IC-284729 X AKL-4 (0.42)	AKL-1 X AKL-4 (1.08) IC-618052 X IC-599410 (0.90) IC-618054 X IC-332324 (0.55)
Flesh thickness (cm)	IC-618054 × IC-599410 (4.79) IC-618052 × IC-599410 (4.73) IC-618052 × AMT-1 (4.62)	AKL-1 × AKL-4 (4.28) AKL-1 × IC-320175 (4.11) IC-618054 × IC-320175 (3.99)	AKL-1 X AKL-4 (0.66)	-
Number of fruits per vine	IC-618054 × IC-320175 (3.60) AKL-1 × IC-320175 (3.50), IC-618054 × IC-599410 (3.50)	AKL-1 × IC-320175 (4.30) IC-618054 × IC-320175 (4.10) AKL-1 × AMT-1 (4.00).	-	IC-618054 X IC-320175 (0.80) IC-618054 X IC-599410 (0.76) AKL-1 X IC-320175 (0.74)
Fruit yield per vine (kg)	IC-618054 × IC-320175 (13.88) AKL-1 × IC-320175 (13.70) IC-618054 X IC-599410 (13.38)	AKL-1 × IC-320175 (14.50) IC-618054 × IC-320175 (14.11) IC-618054 X IC-599410 (14.04)	IC-618054 X IC-320175 (2.53) IC-618052 X IC-599410 (2.27) IC-599437 X IC-599410 (2.23)	IC-618052 X AKL-4 (2.84) IC-618054 X IC-320175 (1.93) AKL-1 X IC-320175 (1.55)

It is apparent that most hybrids showing high SCA effects involved at least one good general combiner. It implies that there is a strong tendency of transmission of specific genetic architecture for higher gain from parents to its offspring.

Such crosses are likely to produce desirable transgressive segregants if additive genetic system is present in good general combiner. It is also possible that the cross which is showing high SCA effect may have parents with high GCA

effects, in which case both additive and non-additive gene actions can be utilized.

Conclusion

The present study revealed significant genetic variability among the parents and hybrids for yield and quality traits in pumpkin. Both additive and non-additive gene actions were involved in the inheritance of different characters; however, non-additive gene action predominated for fruit yield and related traits, indicating the usefulness of heterosis breeding. Among the parents, IC-618054, AKL-1, IC-618052 and IC-599410 were identified as good general combiners for yield and quality traits. Among the hybrids, IC-618054 × IC-320175, AKL-1 × IC-320175, IC-618054 × IC-599410 and IC-618052 × IC-599410 exhibited superior *per se* performance along with significant positive SCA effects for fruit yield and associated characters. Therefore, these parents and hybrids may be effectively utilized in future pumpkin breeding programmes for the development of high yielding, early and quality hybrids suitable for commercial cultivation.

Future Scope

The promising hybrids identified in the present study may be utilized in future breeding programmes for developing high yielding and quality pumpkin hybrids. Superior combiners can be exploited in heterosis breeding due to the predominance of non-additive gene action. Further multilocation and disease resistance studies are needed for commercial utilization of these hybrids.

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