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HETEROSIS STUDIES FOR YIELD AND YIELD CONTRIBUTING TRAITS IN CUCUMBER (*CUCUMIS SATIVUS* L.)

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Abstract

Cucumber (*Cucumis sativus* L.) is one of the important cucurbitaceous vegetable crops. Three gynoecious Pgyn-1, Pgyn-4, Pgyn-5 and ten monoecious cucumber genotypes *viz.,* PCUC-28, PCUC-8, PCUC-83 US-832, PCUC-15, PCUC-25, PCUC-35, PCUC-208, PCUC-126 and Punjab Naveen were selected and crossed in line × tester mating design to produce 30 cross combinations during 2013. The F_1's and parents were evaluated during *spring-summer* 2014. The cross Pgyn-1 × PCUC-35 showed positive heterosis over better parent and Pgyn-5 × US-832 over standard parent for days to first female flower and days to first harvest. Eighteen crosses showed heterobeltiosis for node numbers to first female flower. Highest heterobeltiosis was observed in Pgyn-5 × PCUC-28 (31.79%) for average fruit weight. For fruit yield highest value of heterobeltiosis was recorded in cross Pgyn-5 × PCUC-28. Highest heterobeltiosis was observed in Pgyn-4 × US-832 for number of fruit/vine.

Key words : Cucumber, gynoecious, monoecious, crosses, heterosis, heterobeltiosis.

Introduction

The cucumber (*Cucumis sativus* L.) is one of the commercially important cucurbitaceous vegetables grown throughout the country. Its tender fruits are in great demand for salad and pickles round the year in almost every part of the world. Inspite of its importance, large variability, adaptability and uses, the research priority given to this crop especially in crop improvement aspect is highly meagre in our country. Wide range of genetic variability is available for this crop but little work has been done to exploit it. Thus there is a good scope for improvement in yield and its contributing traits of cucumber through genetic manipulation. Heterosis breeding is one of the most efficient tools to exploit the genetic diversity in cucumber (Hays and Jones, 1916). Development of hybrids in any crop is expensive. However, the utilisation of gynoecy is economical and easier (Behera, 2004) for exploiting hybrid vigour in many cucurbitaceous crops including cucumber that have high male:female sex ratio. This study determined the extent of heterosis in 30 F_1 hybrids by using gynoecious line as one of the parents.

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Materials and Methods

Three gynoecious and ten monoecious diverse cucumber genotypes *viz*., Pgyn-1, Pgyn-4, Pgyn-5, PCUC-28, PCUC-8, PCUC-83 US-832, PCUC-15, PCUC-25, PCUC-35, PCUC-208, PCUC-126 and Punjab Naveen were selected and crossed (2012-13)in line x tester mating design to produce 30 cross combinations. The F_1s and parents were evaluated under complete randomized block design at Vegetable Research Centre of G.B.P.U.A. & T., Pantnagar during 2013 to 2014 with prescribed agronomic practices. Observations were recorded on five competitive plants in each parents and F_1s for each treatment in each replication selected at random for days to first female flower, node number to first female flower, days to first harvest, inter-nodal length (cm), fruit length(cm), fruit diameter (cm), number of fruit/vine, average fruit weight (g) and yield per plant (kg). Heterosiswas worked out over better parent and standard variety PCUC-28 (Pant khira-1).

Results and Discussion

The estimates of heterobeltiosis (better parent) and standard heterosis (standard parent) for all the twelve traits have been presented in tables 1 and 2. The negative heterosis was considered to be desirable for days to first male flower, days to first female flower, node number of first male flower, node number of first female flower and days to first harvest as it indicates earliness. The parental genotype Pant Khira-1 was used as a standard parent for standard heterosis.

The estimates of heterobeltiosis and standard heterosis for days to first male flower are presented in table 1. Heterosis over better parent and standard values ranged from -10.79 to -39.61 per cent and -18.42 to -42.76 per cent, respectively. The heterobeltiosis was significant for all the crosses in negative direction except Pgyn-5 × PCUC-8. All crosses were found to be significant for standard heterosis ranged from -18.42% (Pgyn-5 × Punjab Naveen) to -42.76% (Pgyn-4 × PCUC-8). For days to first female flower, the magnitude of heterobeltiosis for days to first female flower ranged from -19.44% (Pgyn-5 × PCUC-8) to -44.57% (Pgyn-1 × PCUC-35). The maximum value of significant negative heterobeltiosis was observed in Pgyn-1 × PCUC-35 (-44.57%) followed by Pgyn-4 × PCUC-83 (-43.27%). For standard parent all crosses showed highly negatively significant heterosis (table 2). The maximum standard heterosis was observed for cross Pgyn-5 × US-832(-48.90%) followed by Pgyn-4 × PCUC-8 (-47.25%) and Pgyn-4 × PCUC-83 (-46.70%).

The range for heterobeltiosis for node number to first male flower was rangedbetween -46.15% (Pgyn-1 × Pant Khira-1) to 71.43% (Pgyn-1 × PCUC-83). Two crosses showed significant heterobeltiosis in negative desirable direction. The standard heterosis was ranged from Pgyn-5 × US-832 (-25.00%) to Pgyn-4 × PCUC-8 (62.50%), respectively. For node number to first female flower, the heterobeltiosis and standard heterosis ranged from -65.22% (Pgyn-4 × PCUC-35) to 100% (Pgyn-4 × PCUC-8) and -46.15% (Pgyn-1 × Pant Khira-1, Pgyn-4 × Pant Khira-1 and Pgyn-4 × PCUC-35) to 53.85% (Pgyn-5 × PCUC-83), respectively. Eighteen crosses showed significantly negative heterosis over better parent. Out of which maximum heterobeltiosis was found in Pgyn-4 × Punjab Naveen (-65.22%) followed by Pgyn-4 × PCUC-35 (-65.00%).

The magnitude of heterosis over better parent for days to first harvest wasranged from -18.71% (Pgyn-5 × PCUC-8) to -41.25% (Pgyn-1 × PCUC-35). All the crosses were negatively significant over better parent and standard parent. The highest significant and negative value for heterobeltiosis was -41.23% (Pgyn-1 × PCUC-35) followed by -40.40% (Pgyn-4 × PCUC-83) and -38.39% (Pgyn-4 × PCUC-35), respectively. Crosses Pgyn-5 × US-832 (-45.45%), Pgyn-4 × PCUC-83 (-43.54) and Pgyn-4 × PCUC-8 (-43.06%) exhibited negatively significant heterosis over standard variety. For inter-nodal length (cm), the estimate of heterobeltiosis ranged from -31.43% (Pgyn-1 × PCUC-25) to 40.11% (Pgyn-5 × PCUC-83). Ten crosses exhibited significant heterosis over better parent in negative direction which is desirable for this trait. Promising crosses of the ten with significant negative heterosis were Pgyn-1 × PCUC-25 (-31.43%) followed by Pgyn-1 × PCUC-8 (-24.13%) and Pgyn-1 × PCUC-208 (-23.76%). Standard heterosis was found to be significant for thirteen crosses out of which seven crosses showed significant negative heterosis. Highest of heterotic response was observed in Pgyn-1 × PCUC-25 (-31.43%) followed by Pgyn-1 × PCUC-83 (-28.57%) and Pgyn-1 × PCUC-208 (-26.19%), respectively.

The estimates of heterosis for fruit length (cm), over better parent ranged from -46.86% (Pgyn-1 × PCUC-83) to 27.66% (Pgyn-5 × PCUC-126). The highest value of heterobeltiosis was recorded in Pgyn-5 × PCUC-126 (27.66%) followed Pgyn-4 × US-832 (22.36%) and Pgyn-1 × PCUC-126 (13.83%).The standard heterosis value ranged from -37.48% (Pgyn-1 × PCUC-83) to 14.79% (Pgyn-5 × PCUC-126). Twenty two crosses showed significant heterosis over standard variety out of which only six were in positive direction. For fruit diameter (cm), the heterobeltiosis varied from -27.59% (Pgyn-4 × PCUC-15) to 29.25% (Pgyn-1 × PCUC-126). Among them, maximum significant heterobeltiosis was observed in Pgyn-4 × PCUC-15 (-27.59%) followed by Pgyn-1 × PCUC-83 (-25.17%) and Pgyn-4 × Pant Khira-1 (-19.63%). Standard heterosis ranged from 18.18% (Pgyn-1 × US-832) to 57.02% (Pgyn-1 × PCUC-126). Twenty five crosses showed significant positive heterosis over standard parent.

A perusal of data presented in table 1 revealed that for vine length, the estimate of heterobeltiosis varied from -50.43% (Pgyn-4 × PCUC-126) to 115.69% (Pgyn-4 × PCUC-25). Fourteen crosses showed significant heterosis over better parent out of which five were in positive direction. The range of standard heterosis was observed between -48.21% (Pgyn-4 × PCUC-126) to 96.43% (Pgyn-4 × PCUC-25) and eight crosses were found to be significant in positive direction. Highest standard heterosis was observed in Pgyn-4 × PCUC-25 (96.43%) followed by Pgyn-4 × US-832 (61.61%) and Pgyn-5 × PCUC-126 (28.21%).

Heterobeltiosis for number of fruits per vine was ranged from -21.91% (Pgyn-1 × PCUC-15) to 80.89% (Pgyn-4 × US-832) and twenty two crosses exhibited significant heterosis over better parent. The best three crosses for heterobeltiosis in positive direction were Pgyn-4 × US-832 (80.89%), Pgyn-4 × Pant Khira-1 (79.15%) and Pgyn-4 × PCUC-126 (56.37%). The range of significant standard heterosis varies between 16.10% (Pgyn-5 × PCUC-208) to 128.54% (Pgyn-4 × US-832). Twenty nine crosses exhibited significant heterosis over standard parent and all were found positive. The highest value of standard heterosis was estimated for cross Pgyn-4 × US-832 (128.54%) followed by Pgyn-4 × Pant Khira-1 (126.34%).

The magnitude of heterobeltiosis ranged from -37.39% (Pgyn-5 × PCUC-8) to 31.78% (Pgyn-5 × Pant Khira-1) for average fruit weight. Twenty eight crosses exhibited significant heterosis over better parent out of which only eight crosses were in positive direction. Highest heterobeltiosis was observed in Pgyn-5 × Pant Khira-1 (31.79%) followed by Pgyn-5 × PCUC-25 (27.70%) and Pgyn-5 × PCUC-208 (26.44%).The standard heterosis varied between -29.39% (Pgyn-5 × PCUC-8) to 31.78% (Pgyn-5 × Pant Khira-1). Fourteen crosses showed positive heterosis over standard parent. Highest was observed in 31.78% (Pgyn-5 × Pant Khira-1) followed by 30.52% (Pgyn-4 × PCUC-8) and 29.48% (Pgyn-5 × PCUC-25).

The range of heterobeltiosis for fruit yield per hectare varied from 20.43% (Pgyn-5 × PCUC-8) to 117.51% (Pgyn-5 × Pant Khira-1). Twenty five crosses showed significant heterobeltiosis in positive direction. The highest value of heterobeltiosis was recorded in cross Pgyn-5 × Pant Khira-1 (117.51%) followed by Pgyn-5 × PCUC-126 (114.69%) and Pgyn-5 × PCUC-25 (109.59%). The magnitude of standard heterosis ranged from 28.73% (Pgyn-4 × PCUC-15) to 157.91% (Pgyn-1 × US-832). All crosses exhibited significant heterosis over standard parent in positive direction. The highest value of standard heterosis was found in crosses Pgyn-1 × US-832 (157.91%) followed by Pgyn-5 × Pant Khira-1 (157.13%) and Pgyn-5 × PCUC-126 (153.80%).

Exploitation of heterosis in cultivated plants is one of the most important accomplishments of plant breeding in agriculture. Production of hybrids may be the best way to exploit the heterosis in F_1s. The phenomenon of heterosis could be explained by the epistasis and dominance theory of heterosis. As a general rule, hybridization has been commercialized successfully with many kind of high value vegetable crops (Janick, 1996). Heterosis is only one of the several determinants to the success of hybridization (Duvick, 1999).

In the present study, the extent of heterosis was studied in 30 F_1 hybrids of cucumber developed by 13 parents in line × tester design. Promising F_1 hybrids for different characters have been identified on the basis of estimates of heterosis given in table 3. For the development of early fruiting genotypes, negative heterosis is desirable for days to first male flower, days to first female flower, node number of first male and female flower and days to first harvest.

For days to first male flower, all crosses showed negative heterosis except one (Pgyn-5 × PCUC-8) over better parent (table 1). All crosses were early as compared to standard variety for days to first male flower. All crosses were early for days to first female flower over better parent and similar results were also recorded for standard heterosis. Only two crosses showed significant negative heterosis over better parent for node number to first male flower were crosses Pgyn-1 × PCUC-8 and Pgyn-1 × PCUC-208 whereas, none of the cross was significant for node number to first male flower over standard variety. Eighteen crosses showed significant negative heterosis for node number to first female flower over better parent and eight crosses were significant in negative direction over standard variety. All crosses showed negative heterosis over better parent and standard parent for days to first harvest and highest was recorded in PGyn-1 × PCUC-35 over better parent. Cizov (1945) found considerable heterosis under polyhouse for earliness. Pyzhenkov and Kosareva (1981) reported heterosis for earliness in 14 hybrids. Vijayakumari *et al.* (1991) reported that the gynoecious and monoecious hybrids were promising for earliness.

The negative heterosis will be desirable for inter-nodal length. Ten crosses were found significant over better parent for inter-nodal length. Seven crosses showed significant heterosis over standard variety. Cross Pgyn-1 × PCUC-25 showed highest heterosis over both better parent and standard parent for inter-nodal length.For fruit length eight F_1 hybrid showed significant positive heterosis over better parent and six over standard variety (table 2). Similar results for fruit length were also reported by Munshi *et al.* (2005). For fresh consumption cucumber with less diameter is considered to be better. For fruit diameter, seven crosses showed desirable heterosis over better parent. None of the crosses was significant over standard parent. Singh *et al.* (2012) observed that crosses had best heterotic effect for fruit length and fruit diameter. For vine length, five crosses showed positive heterosis over better parent. Cross Pgyn-4 × PCUC-25 showed 115.69% heterosis over better parent. Eight crosses were significant over standard variety. Nienhuisand Lower (1980) and Lower *et al.* (1982) recorded significant

Table 1 : Heterosis in cucumber over better parent for twelve characters.

	Days to first male flower	Days to first female flower	Node number to first male flower	Node number to first female flower	Days to first harvest	Inter-nodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Vine length (cm)	Number of fruit per vine	Average fruit weight (g)	Yield (q/ha)
Gyn-1×PCUC-8	-16.67**	-27.78**	-46.15**	44.44	-25.15**	-24.13**	-19.85**	0.64	-1.88	8.35**	2.60	77.83**
Gyn-1×PCUC-28	-34.21**	-40.11**	-12.50	-46.15**	-37.80**	-15.71*	1.85	4.08	-16.96	40.24**	9.80**	61.81**
Gyn-1×US-832	-17.74**	-28.39**	0.00	-33.33	-27.07**	21.31*	-23.36**	-2.72	-40.32**	27.49**	6.31**	83.29**
Gyn-1×PCUC-83	-31.91**	-38.60**	71.43**	-33.33**	-36.87**	-7.01	-46.86**	-25.17**	5.17	22.71**	-28.64**	-3.80
Gyn-1×PCUC-15	-32.41**	-40.57**	-25.00	-52.63**	-35.15**	18.89*	-24.90**	2.30	13.45	-21.91**	-0.24	1.82
Gyn-1×PCUC-25	-32.21**	-38.55**	-25.00	-43.75**	-35.44**	-31.43**	-9.40**	-6.67	14.94	27.89**	-5.76**	56.86**
Gyn-1×PCUC-35	-39.61**	-44.57**	-30.00	-15.00	-41.23**	-21.32**	9.43**	19.73**	2.77	28.52**	-4.79**	37.59**
Gyn-1×PCUC-208	-31.69**	-38.37**	-45.45**	-26.32*	-36.18**	-23.76**	6.21	20.41**	-21.35	26.69**	-14.93**	35.63**
Gyn-1×PCUC-126	-29.32**	-36.81**	-11.11	-31.58**	-33.16**	-16.32*	13.83**	29.25 **	-32.48 **	30.68**	-12.82**	78.38**
Gyn-1×Punjab Naveen	-32.37**	-39.05**	-30.00	-56.52**	-34.18**	0.83	11.07**	18.37**	-34.29**	26.69**	-32.82**	-4.23
Gyn-4×PCUC-8	-23.68**	-33.33**	0.00	100.00**	-30.41**	-13.03	-18.46**	-9.82 *	16.67	2.45	15.73**	26.76**
Gyn-4×PCUC-28	-31.58**	-37.91**	0.00	-46.15**	-35.89**	13.03	9.24**	-19.63 **	22.32*	79.15**	19.08 **	24.51**
Gyn-4×US-832	-22.58**	-32.26**	33.33	-16.67	-30.39**	8.22	22.36**	-3.07	63.66**	80.89**	-17.13**	52.42**
Gyn-4×PCUC-83	-37.59**	-43.27**	42.86	-22.22	-40.40**	-18.58**	-40.71**	-19.63 **	-39.66**	27.76**	-29.22**	56.85**
Gyn-4×PCUC-15	-34.48**	-40.57**	-12.50	-57.89**	-38.12**	-6.86	-8.93**	-27.59**	-43.15 **	18.49**	-10.32**	-3.35
Gyn-4×PCUC-25	-32.21**	-38.55**	0.00	-6.25	-36.41**	5.63	9.40**	6.06	115.69**	4.63*	-26.88**	-2.80
Gyn-4×PCUC-35	-35.06**	-40.76**	-30.00	-65.00**	-38.39**	5.99	4.09	-10.43*	16.36	30.89**	-28.07**	42.48**
Gyn-4×PCUC-208	-24.65**	-32.56**	-18.18	-47.37**	-31.16**	-13.03	-2.46	-6.75	31.37**	28.61**	-7.04**	76.35**
Gyn-4×PCUC-126	-25.56**	-33.74**	-11.11	-47.37**	-32.11**	-19.19**	3.74	15.34 **	-50.43 **	56.37**	-31.31**	58.23**
Gyn-4×Punjab Naveen	-30.94**	-37.87**	-10.00	-65.22**	-35.71**	-17.96**	-4.92	-6.13	-18.57 *	34.75**	-19.52**	69.75**
Gyn-5×PCUC-8	-6.14	-19.44**	-23.08	30.00	-18.71**	23.64**	-30.00**	9.55	8.56	-1.02	-37.39**	20.43**
Gyn-5×PCUC-28	-29.61**	-36.26**	12.50	-38.46*	-34.45**	30.48**	-15.46**	-7.53	-2.68	16.34**	31.78**	117.51**
Gyn-5×US-832	-28.23**	-40.00**	0.00	0.00	-37.02**	3.69	-16.45**	-1.37	-40.32 **	24.53**	-22.22**	50.88**
Gyn-5×PCUC-83	-24.82**	-32.75**	57.14*	11.11	-31.31**	40.11**	-17.14**	6.85	8.62	16.68**	-3.60*	97.34**
Gyn-5×PCUC-15	-19.31**	-28.00**	12.50	-5.26	-27.23**	19.20*	-15.97**	-10.34*	-32.27**	-1.06	5.56**	73.55**
Gyn-5×PCUC-25	-18.79**	-27.37**	37.50	0.00	-22.33**	9.67	10.43**	-5.45	-13.92	2.01	27.70**	109.59**
Gyn-5×PCUC-35	-23.38**	-30.98**	-20.00	-40.00**	-29.86**	-16.31*	0.89	4.79	2.56	-11.67**	-11.07**	21.06**
Gyn-5×PCUC-208	-23.24**	-31.40**	-27.27	-31.58**	-30.15**	-15.35	-13.21**	-3.42	-23.05	-18.80**	26.44**	90.72**
Gyn-5×PCUC-126	-15.04**	-25.15**	0.00	-57.89**	-24.74**	-4.62	27.66**	26.03**	22.74**	0.61	-6.37**	114.69**
Gyn-5×Punjab Naveen	-10.79**	-21.30**	-20.00	-60.87**	-21.43**	24.69*	-15.47**	0.00	-0.31	48.75**	-9.32**	68.26**

* Significant at 5%, ** Significant at 1%.

Table 2 : Heterosis in cucumber over standard variety (Pant Khira -1) for twelve characters.

	Days to first male flower	Days to first female flower	Node number to first male flower	Node number to first female flower	Days to first harvest	Inter-nodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Vine length (cm)	Number of fruit per vine	Average fruit weight (g)	Yield (q/ha)
Gyn-1×PCUC-8	-37.50 **	-42.86 **	-12.50	0.00	-38.76**	-26.19 **	-12.44**	30.58 **	-16.07	53.22**	15.72**	150.23**
Gyn-1×PCUC-28	-34.21 **	-40.11 **	-12.50	-46.15**	-37.80**	-15.71 *	1.85	26.45**	-16.96	71.71**	9.80**	127.68**
Gyn-1×US-832	-32.89 **	-39.01 **	-25.00	-38.46*	-36.84**	9.52	-31.09**	18.18**	-41.07 **	56.10**	4.41*	157.91**
Gyn-1×PCUC-83	-36.84 **	-42.31 **	50.00*	-7.69	-40.19**	-28.57 **	-37.48 **	-9.09	8.93	50.24**	-11.37**	35.37**
Gyn-1×PCUC-15	-35.53 **	-42.86 **	-25.00	-30.77	-37.32 **	10.00	-6.72*	47.11**	20.54*	-4.39	7.65**	43.27**
Gyn-1×PCUC-25	-33.55 **	-39.56 **	-25.00	-30.77	-36.36 **	-31.43**	-10.92 **	27.27 **	-8.66	56.59**	-4.44*	120.72**
Gyn-1×PCUC-35	-38.82 **	-43.96 **	-12.50	30.77	-40.67**	-8.10	3.36	45.45**	7.36	82.44**	2.96	93.61**
Gyn-1×PCUC-208	-36.18 **	-41.76 **	-25.00	7.69	-39.23**	-26.19**	-8.07*	46.28**	-37.50**	55.12**	-15.12**	90.85**
Gyn-1×PCUC-126	-38.16 **	-43.41 **	0.00	0.00	-39.23**	-13.81	2.35	57.02**	-29.46**	60.00**	4.10*	150.99**
Gyn-1×Punjab Naveen	-38.16 **	-43.41 **	-12.50	-23.08	-38.28 **	-18.57*	-3.87	43.80**	-17.86*	55.12**	-24.81**	34.75**
Gyn-4×PCUC-8	-42.76 **	-47.25 **	62.50**	23.08	-43.06 **	0.76	-10.92 **	21.49**	6.25	44.88**	30.52**	68.83**
Gyn-4×PCUC-28	-31.58 **	-37.91 **	0.00	-46.15**	-35.89**	30.95 **	9.24**	8.26	22.32 *	126.34**	19.08**	65.84**
Gyn-4×US-832	-36.84 **	-42.31 **	0.00	-23.08	-39.71**	25.38 **	10.02**	30.58**	61.61**	128.54**	-18.61**	103.02**
Gyn-4×PCUC-83	-42.11 **	-46.70 **	25.00	7.69	-43.54 **	-5.67	-30.25 **	8.26	-37.50**	61.41**	-12.10**	108.91**
Gyn-4×PCUC-15	-37.50 **	-42.86 **	-12.50	-38.46*	-40.19**	7.90	13.11**	4.13	-39.60**	49.71 **	-3.23	28.73**
Gyn-4×PCUC-25	-33.55 **	-39.56 **	0.00	15.38	-37.32 **	22.38**	7.56*	44.63 **	96.43**	32.20**	-25.85**	29.46**
Gyn-4×PCUC-35	-34.21 **	-40.11 **	-12.50	-46.15**	-37.80**	23.81 **	-1.68	20.66**	21.55*	85.80**	-22.21**	89.77**
Gyn-4×PCUC-208	-29.61 **	-36.26 **	12.50	-23.08	-34.45 **	0.76	-13.45 **	25.62**	19.64*	62.49**	-7.25**	134.88**
Gyn-4×PCUC-126	-34.87 **	-40.66 **	0.00	-23.08	-38.28**	-6.38	-6.72*	55.37 **	-48.21**	97.56**	-17.98**	110.75**
Gyn-4×Punjab Naveen	-36.84 **	-42.31 **	12.50	-38.46*	-39.71 **	-4.95	-15.63**	26.45**	1.79	70.24**	-9.92**	126.09**
Gyn-5×PCUC-8	-29.61 **	-36.26 **	25.00	0.00	-33.49 **	20.29 *	-23.53**	42.15**	-7.14	41.51**	-29.39**	42.37**
Gyn-5×PCUC-28	-29.61 **	-36.26 **	12.50	-38.46*	-34.45 **	30.48 **	-15.46 **	11.57	-2.68	66.34**	31.78**	157.13**
Gyn-5×US-832	-41.45 **	-48.90 **	-25.00	-7.69	-45.45**	-6.38	-24.87 **	19.01**	-41.07**	78.05**	-23.60**	78.36**
Gyn-5×PCUC-83	-30.26 **	-36.81 **	37.50	53.85**	-34.93 **	14.29	-2.52	28.93**	12.50	66.83**	19.72**	133.29**
Gyn-5×PCUC-15	-23.03 **	-30.77 **	12.50	38.46*	-29.67**	10.29	4.37	28.93**	-28.04 **	41.46**	13.91**	105.16**
Gyn-5×PCUC-25	-20.39 **	-28.57 **	37.50	23.08	-23.44**	9.67	8.57*	28.93 **	-39.29**	45.85**	29.48**	147.76**
Gyn-5×PCUC-35	-22.37 **	-30.22 **	0.00	-7.69	-29.19**	-2.24	-4.71	26.45**	7.14	26.29**	-3.83*	43.11**
Gyn-5×PCUC-208	-28.29 **	-35.16 **	0.00	0.00	-33.49**	-18.05*	-22.69**	16.53*	-42.86**	16.10**	26.16**	125.45**
Gyn-5×PCUC-126	-25.66 **	-32.97 **	12.50	-38.46*	-31.58**	-1.76	14.79 **	52.07 **	28.21 **	43.85**	11.79**	153.80**
Gyn-5×Punjab Naveen	-18.42 **	-26.92 **	0.00	-30.77	-26.32**	1.71	-24.71**	20.66 **	24.61 **	112.68**	1.50**	98.90**

* Significant at 5%, ** Significant at 1%.

Table 3 : Promising F_1 hybrids for different characters.

S. no.	Characters	Crosses	
		Better Parent	**Standard Variety**
1.	Days to first male flower	Pgyn-1xPCUC-35	Pgyn-4xPCUC-8
		Pgyn-4xPCUC-83	Pgyn-4xPCUC-83
		Pgyn-4xPCUC-15	Pgyn-5xUS-832
2.	Days to first female flower	Pgyn-1xPCUC-35	Pgyn-5xUS-832
		Pgyn-4xPCUC-83	Pgyn-4xPCUC-8
		Pgyn-4xPCUC-35	Pgyn-4xPCUC-83
3.	Node number to first male flower	Pgyn-1xPCUC-8	–
		Pgyn-1xPCUC-208	
4.	Node number to first female flower	Pgyn-4xPunjab Naveen	Pgyn-4xPCUC-35
		Pgyn-4xPCUC-35	Pgyn-4x Pant Khira-1
		Pgyn-5xPunjab Naveen	Pgyn-1x Pant Khira-1
5.	Days to first harvest	Pgyn-1xPCUC-35	Pgyn-5xUS-832
		Pgyn-4xPCUC-83	Pgyn-4xPCUC-83
		Pgyn-4xPCUC-35	Pgyn-4xPCUC-8
6.	Inter-nodal length (cm)	Pgyn-1xPCUC-25	Pgyn-1xPCUC-25
		Pgyn-1xPCUC-8	Pgyn-1xPCUC-83
		Pgyn-1xPCUC-208	Pgyn-1xPCUC-208
7.	Fruit length (cm)	Pgyn-5xPCUC-126	Pgyn-5xPCUC-126
		Pgyn-4xUS-832	Pgyn-1xPCUC-15
		Pgyn-1xPCUC-126	Pgyn-4xUS-832
8.	Fruit diameter (cm)	Pgyn-4xPCUC-15	–
		Pgyn-1xPCUC-83	
		Pgyn-4x Pant Khira-1	
9.	Vine length (cm)	Pgyn-4xPCUC-25	Pgyn-4xPCUC-25
		Pgyn-4xUS-832	Pgyn-4xUS-832
		Pgyn-4xPCUC-208	Pgyn-5xPCUC-126
10.	Number fruit per vine	Pgyn-4xUS-832	Pgyn-4xUS-832
		Pgyn-4x Pant Khira-1	Pgyn-5xPCUC-25
		Pgyn-4xPCUC-126	Pgyn-5xPCUC-208
11.	Average fruit weight (g)	Pgyn-5x Pant Khira-1	Pgyn-5x Pant Khira-1
		Pgyn-5xPCUC-25	Pgyn-4xPCUC-8
		Pgyn-5xPCUC-208	Pgyn-5xPCUC-25
12.	Yield (q/ha)	Pgyn-1x Pant Khira-1	Pgyn-1xUS-832
		Pgyn-5xPCUC-126	Pgyn-5x Pant Khira-1
		Pgyn-5xPCUC-25	Pgyn-5xPCUC-126

heterosis for vine length over better parent.

Twenty two crosses showed positive heterosis over better parent whereas, twenty nine crosses were found significant over standard variety for number of fruits per plant. Pgyn-4 × US-832 and Pgyn-4 × Pant Khira-1 hybrids were identified to be promising in reference to both better parent and standard variety for number of fruits per vine. Hanchinamani and Patil (2009) and Singh *et al*. (2012) found considerable heterosis for number of fruits per plant.

Seven crosses showed positive and significant heterosis over better parent for average fruit weight. Maximum heterosis was observed in Pgyn-5 × Pant Khira-1 followed by Pgyn-5 × PCUC-25 and Pgyn-5 × PCUC-208 over better parent and standard variety. Kvasnikov and Beryukov (1982) reported that the 100-200g fruit was suitable for canning developed by crossing with parthenocarpic maternal line.

The main objective of a cucumber breeding is to increase fruit yield per hectare. Twenty five crosses exhibited desirable heterosis over better parent and standard variety and all crosses were found positively significant for fruit yield. F_1 hybrids Pgyn-5 × Pant Khira-1, Pgyn-5 × PCUC-126 and Pgyn-5 × PCUC-25 were found promising over better parent and Pgyn-1 × US-832, Pgyn-5 × Pant Khira-1 and Pgyn-5 × PCUC-126 over standard variety. Pandey *et al*. (2005) and Hanchinamani and Patil (2009) reported that the maximum yield attributed to increase in average fruit weight and total number of fruits per plant. Singh *et al*. (2010), Mule *et al*. (2012) and Singh *et al*. (2012)also reported promising heterosis for fruit yield and yield contributing traits in cucumber.

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