Short communication

Heterosis breeding exploiting gynoecy in cucumber (*Cucumis sativus* L.)

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Abstract

Twelve F_1 hybrids of cucumber derived from a topcross involving twelve monoecious parents and a gynoecious parent (EC 709119) were evaluated in randomized block design (RBD) with three replications to study heterosis over mid and better parents. Significant heterosis was observed for all the characters studied except average fruit weight. The hybrids EC 709119 x IC 538155 followed by EC 709119 x IC 527427, EC 709119 x IC 538186 and EC 709119 x IC 410617 exhibited high heterobeltiosis for fruit yield and fruits per plant. These hybrids can be advanced for further testing for commercial exploitation of hybrid vigour.

Key words: Cucumber, Heterosis, Gynoecy, F_1 hybrids

Cucumber (*Cucumis sativus* L.) is one of the most important and popular cucurbitaceous vegetable crops grown throughout the tropical and subtropical regions of the world. Among the cucurbits, cucumber is distinct with a unique sex mechanism and this feature can easily be manipulated for the production of F_1 hybrid seeds. Considerable heterosis is manifested in cucumber for various traits such as number of fruits per plant, earliness and high yield. Gynoecy, condition where all the flowering nodes produce only pistillate flowers, can be exploited for improving yield and economizing F_1 hybrid production. In India, only few works utilizing gynoecious lines in heterosis breeding programme have been reported in cucumber (Vijayakumari et al., 1993; More, 2002 and Sharma, 2010). Hence, the present study is undertaken to investigate the scope of heterosis breeding exploiting gynoecious line in cucumber.

Experimental materials consisted of twelve monoecious cucumber (*Cucumis sativus* L.) genotypes collected from different parts of the country and a stable gynoecious inbred introduced from USA. During the first season (February-May 2012) twelve monoecious cucumber genotypes were crossed in a top cross fashion with gynoecious inbred (EC 709119) as female parent to produce twelve hybrids. The twelve hybrids were EC 709119 x CS-127, EC 709119 x IC 527427, EC 709119 x IC 410617, EC 709119 x IC 410638, EC 709119 x IC 538155, EC 709119 x IC 527431, EC 709119 x IC 538186, EC 709119 x CS-128, EC 709119 x CS-129, EC 709119 x CS-25, EC 709119 x CS-121 and EC 709119 x CS-123. The gynoecious parent was maintained by spraying silver thiosulphate @ 200ppm at three true-leaf stage. In the second season, the 12 hybrids along with their parents were evaluated in a randomized block design (RBD) with three replications. There were five plants/genotype/replication with an area of 15m^2 per plot. Observations on important fruit and yield characters were recorded. Data recorded

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from the parents and hybrids were initially subjected to analysis of variance to detect the genotypic differences if any (Table 1). Heterosis was calculated as the deviation of the mean performance of F_1s (F_1) from their mid parent (MP) and better parent (BP) as proposed by Hayes et al. (1965) and Briggle (1963).

Significant relative heterosis and heterobeltiosis was observed for days to first harvest, number of harvests, number of fruits per plant, yield per plant, fruit length and fruit girth (Table 2). Earliness, indicated by negative estimates of heterosis is a well recognized and prime objective of any breeding programme as it helps the grower to earn a good early market price. The mean values of F_1 hybrids for days to first harvest ranged from 44.00 to 56.50 and the best performing hybrid was EC 709119 x CS-128 (44.00). Nine hybrids exhibited significant negative heterobeltiosis for days to harvest. The hybrid, EC 709119 x CS-128 exhibited maximum and significant negative relative heterosis and heterobeltiosis (-22.98% and -21.43% respectively) for this trait. Significant heterosis for days to first harvest in crosses involving gynoecious lines of cucumber were also observed by Dogra et al. (2007) and Sharma (2010).

The number of harvests of F_1 hybrids ranged from 7.5 to 14. The best performing hybrid was EC

Table 1. Mean values for different characters in parents and F_1 hybrids of cucumber

Parents/Hybrids	Days to first harvest	No. of harvests	Fruits per plant	Yield per plant (kg)	Average fruit wt (g)	Fruit length (cm)	Fruit girth (cm)
EC 709119	56.00	4.00	6.25	0.98	225.00	15.75	16.35
CS-127	57.00	5.25	15.00	7.48	437.50	23.35	21.80
IC 527427	63.75	5.75	11.75	1.69	162.50	13.60	14.50
IC 410617	59.00	7.25	17.50	3.04	282.50	18.05	18.60
IC 410638	53.00	7.50	38.75	10.90	320.00	17.35	15.60
IC 538155	69.50	6.00	9.50	1.50	200.00	14.25	13.65
IC 527431	67.50	8.00	25.50	5.76	245.00	17.55	16.75
IC 538186	53.00	4.00	5.00	1.84	275.00	21.55	16.05
CS-128	58.25	9.50	39.25	10.48	282.50	15.60	17.05
CS-129	58.50	10.00	32.00	9.93	282.50	18.50	18.25
CS-25	56.50	7.00	20.25	5.11	307.50	20.05	17.45
CS-121	58.25	9.50	23.00	6.81	235.00	12.75	16.50
CS-123	57.50	11.25	43.75	11.10	277.50	16.90	16.95
EC 709119 x CS 127	53.00	9.00	23.00	6.78	407.50	20.10	20.48
EC 709119 x IC 527427	52.50	7.50	25.00	6.83	302.50	16.30	18.90
EC 709119 x IC 410617	53.00	12.00	43.75	11.45	325.00	17.00	18.80
EC 709119 x IC 410638	52.50	11.00	38.50	12.03	267.50	15.30	17.70
EC 709119 x IC 538155	56.50	10.25	35.25	8.16	265.00	15.90	18.05
EC 709119 x IC 527431	53.00	10.25	38.25	9.25	275.00	16.60	17.75
EC 709119 x IC 538186	56.50	8.50	18.75	4.26	275.00	16.30	16.70
EC 709119 x CS 128	44.00	8.75	27.50	7.94	405.00	17.75	20.38
EC 709119 x CS 129	53.00	10.50	27.50	7.68	297.50	18.40	19.00
EC 709119 x CS 25	53.00	9.25	32.75	8.27	242.50	15.10	16.40
EC709119 x CS 121	56.50	12.25	35.00	9.05	275.00	15.70	18.35
EC 709119 x CS 123	53.00	14.00	63.75	17.96	277.00	16.30	17.35
CD (0.05)	3.64	1.90	19.06	4.68	80.73	1.98	1.92
CV(%)	3.85	10.37	31.35	28.69	15.02	6.63	5.86

Table 2. Heterosis for different characters in 12 F_1 hybrids of cucumber

Hybrids	Days to first harvest		No. of harvests		Fruits per plant		Yield per plant		Average fruit wt		Fruit length		Fruit girth	
	RH (%)	HB (%)	RH (%)	HB (%)	RH (%)	HB (%)	RH (%)	HB (%)	RH (%)	HB(%)	RH (%)	HB (%)	RH (%)	HB (%)
EC 709119 x CS 127	-6.19**	-5.36*	94.59**	71.43**	116.47**	53.33**	60.47**	-9.30**	23.02	-6.86	2.81**	-13.92**	7.34**	-6.08**
EC 709119 x IC 527427	-12.32**	-6.25**	53.85**	30.43**	177.78**	112.77**	412.20**	303.85**	56.13	34.44	11.07**	3.49**	22.53**	15.60**
EC 709119 x IC 410617	-7.83**	-5.36*	113.33**	65.52**	268.42**	150.00**	470.82**	277.10**	28.08	15.04	0.59	-5.82**	7.58**	1.08*
EC 709119 x IC 410638	-3.67*	-0.94	91.30**	46.67**	71.11**	-0.65	102.61**	10.37**	-1.83	-16.41	-7.55**	-11.82**	10.80**	8.26**
EC 709119 x IC 538155	-9.96**	0.89	105.00**	70.83**	347.62**	271.05**	560.73**	445.82**	24.71	17.78	6.00**	0.95	20.33**	10.40**
EC 709119 x IC 527431	-14.17**	-5.36*	70.83**	28.13**	140.94**	50.00**	174.54**	60.50**	17.02	12.24	-0.3	-5.41**	7.25**	5.97**
EC 709119 x IC 538186	3.67*	6.60**	112.50**	112.50**	233.33**	200.00**	202.66**	131.52**	10	0	-12.60**	-24.36**	3.09**	4.05**
EC 709119 x CS 128	-22.98**	-21.43**	29.63**	-7.89**	20.88*	-29.94**	38.54**	-24.28**	59.61	43.36	13.24**	13.78**	22.01**	19.50**
EC 709119 x CS 129	-7.42**	-5.36*	50.00**	5.00**	43.79**	-14.06	40.83**	-22.67**	17.24	5.31	7.45**	-0.54	9.83**	4.11**
EC 709119 x CS 25	-5.78**	-5.36*	68.18**	32.14**	147.17**	61.73**	172.04**	62.00**	-8.92	-21.14	-15.64**	-24.69**	-2.96**	-6.02**
EC709119 x CS 121	-1.09	0.89	81.48**	28.95**	139.32**	52.17**	132.50**	32.89**	19.57	17.02	10.18**	-0.32	11.72**	11.21**
EC 709119 x CS 123	-6.61**	-5.36*	83.61**	24.44**	155.00**	45.71**	197.39**	61.76**	10.25	-0.18	-0.15	-3.55**	4.20**	2.36**

*Significant at 5% level, **Significant at 1% level; RH- Relaive heterosis, HB- Heterobeltiosis

709119 x CS-123 (14.00). The number of harvests exhibited significant relative heterosis in all the hybrids. The maximum relative heterosis was noticed in EC 709119 x IC 410617 (113.33%). Maximum heterobeltiosis was observed in EC 709119 x IC 538186 (112.5%).

Number of fruits per plant is an important trait which contributes to yield. Hence, positive and significant heterotic effect would be highly desirable. The data on heterotic effect pertaining to number of fruits per plant revealed that all the crosses manifested significant relative heterosis in desirable direction. The number of fruits per plant in the F_1 hybrids ranged from 18.75 to 63.75 and the maximum number of fruits were observed in the cross EC 709119 x CS-123 (63.75). With respect to relative heterosis, the best hybrid was EC 709119 x IC 538155 (347.62%) followed by EC 709119 x IC 410617 (268.42%). It is noteworthy that these hybrids also registered significant superiority over better parent with EC 709119 x IC 538155 (271.05%) recording the highest significant heterobeltiosis. Heterobeltiosis for fruits per plant ranged from -29.94 to 271.05 per cent over the better parent. Vijayakumari et al. (1993), Badgujar (1999), Dogra et al. (2007) and Sharma (2010) also reported significant heterosis among crosses involving gynoecious cucumber combinations. Similar findings were also reported in monoecious cultivars of cucumber by many workers (Gayathri, 1997; Hanchinamani and Patil, 2009; Kumar et al., 2010 and Singh et al., 2012). The mean values for average fruit weight in hybrids ranged from 242.50 to 407.50. But none of the crosses exhibited significant heterosis for average fruit weight which is in line with the observation made by Solanki et al. (1982) and Singh et al. (2012).

Heterosis for yield is a product of contributing factors such as fruit number, number of harvests and average fruit weight. The yield per plant of F_1 hybrids ranged from 4.26 to 17.96 kg. Considering the overall performance with respect to fruit yield

per vine, the most promising hybrids were EC 709119 x CS-123 (17.96 kg) followed by EC 709119 x IC 410638 (12.03 kg). Hybrid EC 709119 x IC 538155 expressed maximum relative heterosis (560.73%) and heterobeltiosis (445.82%) for yield per plant. Nine hybrids were superior to their better parent. In the superior crosses, number of fruits per vine may be contributing to the heterotic effect exhibited by yield per plant. Heterobeltiosis ranged from -24.28 to 445.82 per cent. Heterosis for fruit yield was reported in gynoecious hybrids by More (2002) and Dogra et al. (2007). Wide range of heterosis for yield has been reported in crosses involving monoecious cultivars of cucumber by Gayathri (1997), Hanchinamani and Patil (2009) Kumar et al. (2010) and Singh et al. (2012).

Fruit appearance as manifested by its length and girth is an important aspect of cucumber from the consumer point of view. The F_1 means for fruit length ranged from 15.1 to 20.1 cm and that of fruit girth ranged from 16.40 to 20.48 cm. The cross EC 709119 x CS-127 was the best performing hybrid with respect to fruit length (20.10 cm) and fruit girth (20.48 cm).With respect to fruit length, EC 709119 x CS-128 followed by EC 709119 x IC 527427 exhibited maximum relative heterosis and heterobeltiosis. Regarding fruit girth, ten hybrids showed superior positive heterobeltiosis. For fruit girth, the crosses EC 709119 x IC 527427 and EC 709119 x CS-128 exhibited maximum relative heterosis and heterobeltiosis respectively. Significant heterobeltiosis was reported for fruit length and girth in gynoecious crosses of cucumber by Dogra et al. (2007) and Sharma (2010).

From the above results, it is apparent that almost all the hybrids produced significantly higher number of fruits per plant which contributed to an increase in total yield. For yield and yield contributing characters, such as number of fruits per plant, EC 709119 x IC 538155 proved to be the best cross. The next desirable crosses with respect to number of fruits per plant and yield per plant were EC 709119 x IC 527427 and EC 709119 x IC 538186. Further, the cross EC 709119 x IC 410617 was superior with respect to most of the characters including fruits per plant, number of harvests and yield per plant. The cross, EC 709119 x CS-128 was superior regarding fruit length, fruit girth and earliness. The top ranking crosses with respect to heterosis in total yield per plant were EC 709119 x IC 538155, EC 709119 x IC 527427 and EC 709119 x IC 538186 and EC 709119 x IC 410617. Fruits of all these promising crosses except EC 709119 x IC 538155 were green in colour at harvestable maturity stage. Organoleptic evaluation of parents and hybrids revealed high crispness of the cross EC 709119 x IC 538155 which is a desirable trait in salad cucumber. Rest of the three better crosses were moderately crisp. Hence, these hybrids can be advanced for testing for commercial exploitation of hybrid vigour.

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