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Testing of Hybrid Vigour for Sex Phenology in Cucumber (*Cucumis sativus* L.).

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A B S T R A C T

Studies on heterosis in cucumber (*Cucumis sativus* L.) was undertaken at ZAHRS, Navule, Shivamogga district, Karnataka during *kharif* and *rabi* seasons of year 2016-17. A total of 27 crosses were developed by crossing with nine lines with each of three testers. All the crosses were evaluated along with the parents in randomized block design with two replications. The hybrid Pebkamal × Haveri Local reported the significant negative heterobeltiosis for days to first female flower appearance, node at which first male and female flower appear. The hybrids US-640 × Haveri Local exhibited the significant negative heterosis for days to first harvest over both checks. The cross NCU-1287 × Belgum Local exhibited the significant negative heterobeltiosis (-10.64%) as well as standard heterosis (-8.70%) over the check Poinsette. All the crosses made DWD and Himangi as female parent exhibit the desirable significant positive heterosis for days to last harvest.

Introduction

India is regarded as primary centre of origin of cucumber (*Cucumis sativus* L.) and exhibits rich genetic diversity along the country starts from south-east foot hills of Himalaya to southern peninsular. Original sex form of cucumber is hermaphrodite and present cultivated sex form is monoecious in open condition. Sex expression in cucumber is regulated by environmental, genetic and hormonal factors. In general, female sex expression is promoted by low temperature, short photoperiod etc., which may influence the level of endogenous hormones which in turn influence the sex expression (Agbaje *et al.*, 2012).

Apart from this sex forms and flowering sequence can be manipulated to a little extent by exploiting heterosis for sex phenology. The exploitation of heterosis is much easier in cross pollinated crops, cucumber being monoecious and poses more seed per cross,

provides ample scope for the utilization of hybrid vigour on commercial scale.

Materials and Methods

Nine genetically diverse genotypes *viz*., Himangi, Sabra, US-640, Phule Shubhangi, NCU-1287, Pebkamal, Dharwad Collection (DWD), US646, Honnavara Collection (Hnr) and three tester *viz*., Haveri Local, Belgum Local and Bagalkot Local were used to produce 27 hybrids. All the crosses and their parents along with standard check 'Poinsette' were sown in randomized block design with two replications during rabi and summer, 2016 at Zonal Agriculture and Horticulture Research Station (ZAHRS), Navule, Shivamogga, Karnataka. The crop was raised as per the package of practices (Anon., 2015). The observations were recorded on five randomly selected plants for seven important earliness parameters *viz*., days to first male flower, Node at male flower appear, Days to first female appear. Node at female flower appear, 50 % flowering, 100 % flowering, Days to first harvest and Days to last harvest.

Heterosis in positive direction is desirable for yield and its attributing traits. It is measured as percentage increase of F_1 performance over better parent (BP), standard checks Poinsette (SC1) and Malini (SC2).

Results and Discussion

The sequence of flowering in cucurbits follows the first male phase followed by female phase and mixed phase for shorter period (Bhakti *et al.,* 2016). Hence, first male flower appear were indicates the earliness parameter. Very little standard heterosis for this trait was observed and none of the crosses exhibited the significant heterobeltiosis in both directions. Only cross NCU-1287 × Belgum Local exhibited the significant heterosis over both the checks (Table 1), similarly positive standard heterosis was reported by Singh and Ram (2009) in cucumber.

Flowering at lower node is an indication of earliness. In cucurbits male flower appear at the lower node, usually 6-7 days before the female flower open. Hence, appearance of male flower is related with earliness. Heterosis in negative direction was desirable for node at first flower appear, the cross US-640 × Haveri Local exhibited the significant negative heterosis over both checks. Similar standard heterosis was recorded by Singh and Ram (2009) in cucumber. Five crosses *viz.*, Himangi × Haveri Local (-16.46 %), US-640 × Haveri Local (-36.11%), Pebkamal ×Haveri Local (-34.48%), DWD × Belgum Local (-17.07%) and DWD × Bagalkot Local (-15.29%) exhibited the significant negative heterobeltiosis for node at first male flower appear. This result is in line with research findings of Singh *et al.*, (2010), Mule *et al.*, (2012) and Singh *et al.,* (2015) in cucumber. The hybrids US-640 × Haveri Local (-9.32 %) and Pebkamal × Haveri Local (-12.66%) exhibited the significant negative heterosis for days to first female flower appear. The reason for significant negative heterosis may be due to the presence of dominant loci in different directions leading to cancellation of effects (Pandey *et al.,* 2005). Crosses not shown significant negative heterosis over commercial checks and few crosses exhibited the significant negative heterosis over better parent. The crosses showing no heterosis indicated that the parent involved in the cross do not differ in the gene frequency with respect the character under study (Pandey *et al.,* 2005). Appearance of first female flower at lower node is prime objective in development of early hybrid. For the development of early fruiting genotypes, negative heterosis is desirable for node number at which first female flower appear (Arya and Singh, 2014).

Table.1 Per cent heterosis for earliness parameter in cucumber

Hybrids	Days to first male flower			Node at male flower appear			Days to first female			Node at female flower appear		
	BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2
Himangi × Haveri Local	2.43	2.74	5.97	-16.46*	1.54	8.20	-0.27	2.23	9.23	-15.69	4.88	-2.27
Himangi × Belgum Local	6.69	7.01	10.38	-8.86	10.77	18.03	8.70	11.42*	19.05**	-15.79	17.07	9.09
Himangi × Bagalkot Local	6.96	7.01	10.38	-11.76	15.38	22.95*	1.50	8.64	16.07**	1.89	31.71	22.73
Sabra × Haveri Local	-0.28	8.23	11.64*	22.22**	35.38**	44.26**	-0.50	11.70*	19.35**	36.36*	46.34*	36.36*
sabra × Belgum Local	-4.78	3.35	6.60	6.33	29.23**	37.70**	-3.72	8.08	15.48**	-8.77	26.83	18.18
Sabra × Bagalkot Local	3.37	12.20	15.72*	0.00	30.77**	39.34**	0.99	13.37**	21.13**	13.21	46.34*	36.36*
US-640 × Haveri Local	-6.40	-6.40	-3.46	-36.11**	-29.23**	-24.59*	-9.32*	-7.80	-1.49	-31.82*	-28.83	-31.82*
US640 × Belgum Local	0.30	0.30	3.46	-8.86	10.77	18.09	2.74	4.46	11.61	-15.79	17.07	9.09
US640 × Bagalkot Local	.000	0.00	3.14	-10.59	16.92	24.59*	-4.17	2.51	9.52	-11.32	14.63	6.82
Phule Shubhangi × Haveri Local	1.71	8.54	11.95*	-5.13	13.85	21.31*	-1.00	10.31*	17.86**	-1.85	29.27	20.45
Phule Shubhangi × Belgum Local	-3.71	2.74	5.97	10.13	33.85**	42.62**	-4.25	6.69	13.99**	-3.51	34.15	25.00
Phule Shubhangi × Bagalkot Local	-0.86	5.79	9.12	1.18	32.31**	40.98**	-1.00	10.31*	17.86**	1.85	34.15	25.00
NCU-1287 × Haveri Local	-0.29	5.18	8.49	-7.41	15.38	22.95*	-2.05	6.41	1.69**	-3.85	21.95	13.64
NCU-1287 × Belgum Local	8.67	14.63*	18.24**	2.47	27.69**	36.07**	4.62	13.65**	21.43**	3.51	43.90*	34.09*
NCU-1287 × Bagalkot Local	4.34	10.06	13.52*	1.18	32.31**	40.98**	2.31	11.14*	18.75**	5.66	36.59*	27.27
Pebkamal × Haveri Local	-8.52	-1.83	1.26	-34.48**	-12.31	-6.56	-12.66**	-1.95	4.76	-36.21**	-9.76	-15.91
Pebkamal × Belgum Local	1.24	8.84	12.26*	-2.30	30.77**	39.34**	-2.23	9.75*	17.26**	-5.17	34.15	25.00
Pebkamal × Bagalkot Local	-2.27	4.88	8.18	-2.30	30.77**	39.34**	-3.72	8.08	15.48**	-6.90	31.71	22.73
DWD × Haveri Local	-0.62	-2.74	0.31	-1.22	24.62**	32.79**	-2.08	5.01	12.20*	-15.00	24.39	15.91
DWD × Belgum Local	-5.30	-7.32	-4.40	-17.07*	4.62	11.48	-7.27	0.56	6.25	-28.33*	4.88	-2.27
DWD × Bagalkot Local	-1.87	-3.96	-0.94	-15.29*	10.77	18.03	0.00	7.24	14.58**	-18.33	19.51	11.36
US-646 × Haveri Local	-1.18	2.13	5.35	-12.00	1.54	8.20	-2.94	1.11	8.04	-16.67	-2.44	-9.09
US-646 × Belgum Local	1.47	4.48	8.18	-3.80	16.92	24.59*	4.28	8.64	16.07**	-10.53	24.39	15.91
US-646 × Bagalkot Local	-7.52	-4.42	-1.42	-12.94	13.85	21.31*	1.30	8.36	15.77**	0.00	29.27	20.45
Hnr × Haveri Local	2.02	7.62	11.01	-10.47	18.46*	26.23**	-2.00	9.19*	16.67**	-3.57	31.17	22.73
Hnr × Belgum Local	2.31	7.93	11.32	-6.98	23.08*	31.15**	-2.00	9.19*	16.67**	1.75	41.46	31.82
Hnr × Bagalkot Local	1.16	6.71	10.06	-1.16	30.77**	39.34**	-0.50	10.86*	18.45**	3.57	41.46	31.82
S.Em ±	1.76	1.76	1.76	1.79	1.79	1.79	1.56	1.56	1.56	0.68	0.68	0.68
CD @ 5%	3.61	3.61	3.61	3.68	3.68	3.68	3.20	3.20	3.20	1.41	1.41	1.41
CD @ 1%	4.89	4.89	4.89	4.97	4.97	4.97	4.33	4.33	4.33	1.90	1.90	1.90

*and ** indicates significance at 5% and 1% level respectively

Hybrids	50 % flowering			100 % flowering			Days to first harvest			Days to last harvest		
	BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2	BP	SC1	SC2
Himangi × Haveri Local	3.13	3.13	6.45	4.29	4.29	10.61	0.00	0.00	2.22	0.52	8.33**	8.33**
Himangi × Belgum Local	0.00	7.81	11.29	7.14	7.14	13.64*	4.35	4.25	6.67	-1.02	7.78**	7.78**
Himangi × Bagalkot Local	4.48	9.38	12.90*	2.70	8.57	15.15*	2.13	4.35	6.67	-2.55*	6.11**	6.11**
Sabra × Haveri Local	0.00	9.38	12.90*	-1.30	8.57	15.15*	4.35	4.35	6.67	-2.22	-2.22	-2.22
sabra × Belgum Local	-5.71	3.13	6.45	-5.19	4.29	10.61	2.17	2.17	4.44	-11.22**	-3.33**	-3.33**
Sabra × Bagalkot Local	4.29	14.06*	17.74**	2.60	12.86*	19.70**	4.26	6.52	8.89*	-12.24**	-4.44**	-4.44**
US-640 × Haveri Local	-7.69	-6.25	-3.23	-4.29	-4.29	1.52	-6.52	-6.52	-4.44	1.11	1.11	1.11
US640 × Belgum Local	-4.35	3.13	6.45	1.45	0.00	6.06	0.00	0.00	2.22	11.22**	-3.33**	-3.33**
US640 × Bagalkot Local	-1.49	3.13	6.45	-2.70	2.86	9.09	-2.13	0.00	2.22	-8.67**	-0.56	-0.56
Phule Shubhangi × Haveri Local	1.43	10.94	14.52*	-2.67	10.00	16.67**	2.13	4.35	6.67	0.00	0.00	0.00
Phule Shubhangi × Belgum Local	-5.71	3.13	6.45	-5.33	1.43	7.58	0.00	2.17	4.44	-8.67**	-0.56	-0.56
Phule Shubhangi × Bagalkot Local	-1.43	7.81	11.29	-1.33	5.71	12.12*	2.13	4.35	6.67	-8.16**	0.00	0.00
NCU-1287 × Haveri Local	0.00	6.25	9.68	1.37	5.71	12.12*	-1.06	1.09	3.33	-1.11	-1.11	-1.11
NCU-1287 × Belgum Local	8.70	17.19**	20.97**	10.96*	15.71**	22.73**	-10.64**	-8.70*	-6.67	-12.24**	-4.44**	-4.44**
NCU-1287 × Bagalkot Local	4.41	10.94	14.52*	4.05	10.00	16.67**	2.13	4.35	6.67	-10.20**	-2.22	-2.22
Pebkamal × Haveri Local	-1.54	0.00	3.23	-1.41	0.00	6.06	-4.26	-2.17	0.00	-3.33	-3.33**	-3.33**
Pebkamal × Belgum Local	1.45	9.38	12.90*	5.63	7.14	13.64*	0.00	2.17	4.44	-13.27**	-5.56**	-5.56**
Pebkamal × Bagalkot Local	2.99	7.81	11.29	1.35	7.14	13.64*	0.00	2.17	4.44	-13.27**	-5.56**	-5.56**
DWD × Haveri Local	-1.56	-1.56	1.61	-2.86	-2.86	3.03	-1.04	3.26	5.56	0.00	8.89**	8.89**
DWD × Belgum Local	-14.49**	-7.81	-4.84	-7.14	-7.14	-1.52	-2.08	2.17	4.44	0.00	8.89**	8.89**
DWD × Bagalkot Local	-7.46	-3.13	0.00	-6.76	-1.43	4.55	2.08	6.52	8.89*	0.00	8.89**	8.89**
US-646 × Haveri Local	-5.88	0.00	3.23	0.00	5.71	12.12*	2.17	2.17	4.44	-1.11	-1.11	-1.11
US-646 × Belgum Local	-8.70	-1.56	1.61	-4.05	1.43	7.58	0.00	0.00	2.22	-13.27**	-5.56**	-5.56**
US-646 × Bagalkot Local	0.00	6.25	9.68	0.00	5.71	12.12*	2.00	2.17	4.44	-9.18**	-1.11	-1.11
Hnr × Haveri Local	2.99	7.81	11.29	0.00	7.14	13.64*	2.13	4.35	6.67	0.00	0.00	0.00
Hnr × Belgum Local	-1.45	6.25	9.68	-2.67	4.29	10.61	2.13	4.35	6.67	-9.18**	-1.11	-1.11
Hnr × Bagalkot Local	5.97	10.94	14.52*	2.67	10.00	16.67**	2.13	4.35	6.67	-9.18**	-1.11	-1.11
S.Em ±	1.79	1.79	1.79	1.86	1.86	1.86	1.74	1.74	1.74	1.02	1.02	1.02
CD @ 5%	3.68	3.68	3.68	3.83	3.83	3.83	3.58	3.58	3.58	2.10	2.10	2.10
CD @ 1%	4.97	4.97	4.97	5.17	5.17	5.17	4.84	4.84	4.84	2.83	2.83	2.83

*and ** indicates significance at 5% and 1% level respectively

Table.2 Range of heterosis for earliness parameter in cucumber

Sl. No.	Characters	BP	SC1	SC2
1	Days to first male flower	-8.52 to 8.67	-7.32 to 12.2	-4.4 to 11.32
2	Node at male flower appear	-12.94 to 10.13	-12.31 to 16.92	-6.56 to 18.09
3	Days to first female	-7.27 to 8.7	-7.8 to 8.64	-1.49 to 11.61
4	Node at female flower appear	-18.33 to 13.21	-28.83 to 41.46	-15.91 to 13.82
5	50 % flowering	-31.57 to 10.83	-18.36 to 20.47	-28.76 to 5.12
6	100 % flowering	-25.25 to 50.93	-33.64 to 48.85	-37.39 to 40.43
7	Days to first harvest	-32.25 to 36.68	-28.84 to 40.47	-39.20 to 6.17
8	Days to last harvest	-3.33 to 1.11	-2.22 to 1.11	-2.22 to 1.11

Note: BP – Better Parent; SC1- Standard Check 1

The crosses Pebkamal × Haveri Local (-36.21%) and DWD × Belgum Local (-28.33%) exhibited the significant heterobeltiosis in negative direction for node number at which first female flower appear. This is in accordance with the research findings of Bairagi *et al.,* (2005), Hanchinamani and Patil (2009), Kumar *et al.,* (2010), Singh *et al.,* (2010) and Singh *et al.,* (2015). The crosses exhibited the positive standard heterosis over superior checks and similar findings were reported by Dogra *et al.,* (2011) in cucumber.

Negative heterosis for days to 50 per cent and 100 per cent flowering is desirable and indicated the earliness. Most of the crosses exhibited the negative heterobeltiosis and DWD × Belgum Local exhibited the significant negative heterosis over better parent for days to 50 per cent flowering, it is in accordance with research findings of Singh *et al.,* (2013) in bitter gourd. None of the hybrids exhibited the significant negative heterosis over mid parent, better parent as well as over both the standard checks.

For days to first harvest 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 (Airina *et al.,* 2013). Heterosis in negative direction is desirable for days to first harvest. The cross NCU-1287 × Belgum Local exhibited the significant negative heterobeltiosis (-10.64%) as well as standard heterosis (-8.70%) over the check Poinsette (Table 1). This is in line with the research findings of Kumar *et al.,* (2010) and Jat *et al.,* (2015) in cucumber.

As days to last harvest increases, the number of harvest will be increases and finally it results in increase the yield. Heterosis in positive direction is desirable for days to last harvest. But range of heterosis (Table 2) for this trait is narrow in both direction and the crosses Himangi × Haveri Local, Himangi × Belgum Local, Himangi × Bagalkot Local, DWD × Haveri Local, DWD × Belgum Local and DWD × Bagalkot Local exhibited the significant standard heterosis.

In conclusion, the results indicated that days to initiation of staminate and pistillate flowers varied from 39.4 to 51.17, and both staminate and pistillate flowers were first induced in genotype BG-11. The lowest ratio of staminate to pistillate flower was obtained in genotype BG-3. Staminate flowers initiated on the basal node namely 7th and continued acropetally whereas pistillate flowers initiated from 11th node and continued onward. Small and round fruit bearing genotypes produced greater number of pistillate flowers. On the other hand, all genotypes produced the greater number of staminate flowers than pistillate flowers. Lesser number of fruit induced genotypes produced the larger individual fruit weight. The results also found variations in fruit quality attributes namely total soluble solid, ascorbic acid, β-carotene and protein content which created great potentiality for developing high yielding and quality bitter gourd through breeding.

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