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RESEARCH ARTICLE

HETEROSIS AND INBREEDING DEPRESSION FOR YIELD AND ITS COMPONENT TRAITS IN CUCUMBER

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ABSTRACT

Heterosis and inbreeding depression were studied for yield and its component traits in a 8X8 parent diallel cross excluding reciprocals. The range of economic heterosis was observed -34.09 to 211.70 per cent for yield/vine. The cross combinations PCUC-15 X PCUC 15-1 followed by CHC-2 X C 99-12, PCUC 15 X CHC 2, PCUC 15-1 X BIHAR and EC 43342 X C 99-12 were top hybrids exhibited high economic heteriosis for yield/vine. Crosses PCUC 15 X PCUC 15-1 and PCUC 15 X CHC 2 were not only exhibited high economic heterosis for yield/vine but also showed desirable heterosis for six other traits, namely, node no. of first male flower, node no. of first female flower, fruit length, fruit diameter, fruit weight and vine length. These crosses can be exploited for high yield/vine hybrid development programme.

Key Words : Heterosis, inbreeding depression, cucumber.

Cucumber (*Cucumis sativus* L.) is one of the most popular vegetable crops of the family Cucurbitaceae. It is an ideal summer vegetable crop chiefly grown for its edible tender fruits, preferred as salad ingredient, pickles, desert fruit and as a cooked vegetable. Cucumber has got cooling effect, so in the eastern countries; fruits are often used as cooling vegetable. It is ideal for people suffering from jaundice and allied diseases and also very much useful in preventing constipation. Seeds contain oil, which is helpful for brain development and body smoothness. Hence, it is being used in Ayurvedic preparations (Robinson and Decker-Walter, 1999). Besides this, the whole fruit is used in cosmetic and soap industries.

Cucumber is a highly cross pollinated crop and usually monoecious in nature preferring warm weather and bright light for its better growth and development. However it can be grown in both summer and rainy season, but it can’t tolerate cold injury (Rastogi, 1998). It has great scope to utilize hybrid vigour commercially because of its monoecious nature of flowering, more number of seeds per fruit and cultivation around the year throughout the country. Heterosis breeding has come to play a pivot role in crop improvement for high production and productivity. The extent of heterosis over superior/economic parent is a prerequisite for commercial exploitation of hybrid vigour in cucumber.

MATERIALS AND METHODS

Eight genotypes of cucumber; namely, PCUC 15, EC 43342, PCUC 15-1, CHC 2, BIHAR 1, C 99-12, C 98-6 and C 99-10 were used to make all possible crosses excluding reciprocals. The experiment material consisting 8 parents, 28 F_1s and 28 F_2s was sown in randomized block design with three replications at Department of Vegetable Science, C. S. Azad University of Agriculture and Technology, Kanpur. All the parents and F_1s were sown in a single row while F_2s were sown in two rows in each replication. The length of row was kept 6.0 m while row to row and plant to plant distance was maintained at 3.0 m and 5.0 m, respectively. All the recommended agronomic practices were adopted to ensure a good crop. The data were recorded on five selected plants in each parents and F_1s as well as ten plants in F_2s for 10 characters; viz., days to first male flower, days to first female flower, node number of first male flower, node number of first female flower, fruit length (cm), fruit diameter (cm), fruit weight (g), number of fruit/vine, vine length (cm) and yield/vine (g). The mean data of each treatment were used for estimation of hetrosis values following the method suggested by Allard (1966). Inbreeding depression was worked out as percentage loss of vigour and size in F_2 generation over the F_1s.

RESULTS AND DISCUSSION

The computed value of heterosis over economic parent (Table 1) revealed that none of the crosses exhibited useful significant heterosis for all the traits. Significant and desirable heterosis was observed in 20 crosses for yield/vine, 2 for days to first male flower, 1 for days to first female flower, 6 for node no. of first male flower, 7 for node no. of first female flower, 5 for fruit length, 2 for fruit diameter, 10 for fruit weight, 14 for no. of fruits/vine and 19 for vine length, respectively. The wide range of economic heterosis was observed for yield/vine (-34.09 to 211.70), days to first male flower (-9.84 to 47.37), days to first female flower (-7.47 to 39.29), node no. of first male flower (-35.40 to 24.40), node no. of first female flower (-29.96 to 33.12), fruit length (-29.21 to 53.49), fruit diameter (-34.76 to 31.19), fruit weight (-45.88 to 173.58), no.

Table 1: Range of heterosis over economic parent (Kalyanpur Green) for 10 characters in cucumber

Character	Number of significantly superior cross over E.P.	Range of heterosis	Best cross
Days to first male flower	2	-9.84 to 47.37	C 98-6 X C 99-10
Days to first female flower	1	-7.47 to 39.29	C 98-6 X C 99-10
Node no. of first male flower	6	-35.40 to 24.40	EC 43342 X CHC 2
Node no. of first female flower	7	-29.96 to 33.12	CHC 2 x C 98-6
Fruit length (cm)	5	-29.21 to 53.49	PCUC 15 X PCUC 15-1
Fruit diameter (cm)	2	-34.76 to 31.19	CHC 2 X C 99-12
Fruit weight (g)	10	-45.88 to 173.58	PCUC 15 X PCUC 15-1
No. of fruits/vine	14	-26.58 to 61.67	PCUC 15-1 X C 98-6
Vine length (cm)	19	-25.72 to 32.49	PCUC 15-1 X BIHAR 1
Yield/vine (g)	20	-34.09 to 211.70	PCUC 15 X PCUC 15-1

Table 2: Desirable high heterosis (%) over economic parent (Kalyanpur Green) and inbreeding depression (%) for 10 characters in cucumber

Character	Cross	E.H.	I.D.	GCA effects	
				P_1	P_2
Days to first male flower	C 98-6 X C 99-10	-9.84**	-29.07**	-1.07**	1.03**
	BIHAR 1 X C 98-6	-8.39**	-10.76**	-1.60**	-1.87**
Days to first female flower	C 98-6 X C 99-10	-7.47**	-35.48**	0.80**	0.73*
Node no. of first male flower	EC 43342 X CHC 2	-35.40**	-52.48**	0.20**	-0.45**
	CHC 2 X BIHAR 1	-20.00**	-70.00**	-0.45**	-0.04
	PCUC 15 X C 99-10	-16.00**	7.94	0.21**	-0.15*
	PCUC 15 X PCUC 15-1	-15.40*	-37.80**	0.21**	0.10
	C 99-12 X C 99-10	-12.0*	3.03	-0.16	-0.15**
Node no. of first female flower	CHC 2 x C 98-6	-29.96**	-94.38**	-0.04	0.25
	PCUC 15-1 X C99-10	-23.58**	-32.99*	-0.04	-0.48**
	C 99-12 X C 99-10	-23.57**	18.56	-0.12	-0.48**
	EC 43342 X C 99-12	-22.87*	-48.47**	0.35*	-0.12
	PCUC 15 X PCUC 15-1	-18.14*	-20.19	0.63**	-0.04
Fruit length (cm)	PCUC 15 X PCUC 15-1	53.49**	47.77**	0.95**	0.08
	CHC 2 X C 99-12	53.23**	44.86**	0.91**	1.07**
	CHC 2 X C 98-6	15.97**	21.89**	0.91**	-0.70**
	EC 43342 X C 99-12	14.04**	13.42**	-0.65**	1.07**
	PCUC 15-1 X C 99-10	10.11*	27.91**	0.08	-0.93**
Fruit diameter (cm)	CHC 2 X C 99-12	31.19**	45.28**	0.20**	0.18**
	PCUC 15 X PCUC 15-1	28.57**	54.44**	0.29**	0.12
Fruit weight (g)	PCUC 15 X PCUC 15-1	173.58**	86.31**	33.09**	7.55**
	CHC 2 X C 99-12	156.29**	73.95**	29.48**	18.85**
	CHC 2 X C98-6	23.33**	32.09**	29.48**	-18.66**
	PCUC 15 X C 99-12	12.19**	35.42**	33.09**	18.55**
	PCUC 15 X C 99-10	9.64**	31.90**	33.09**	-27.24**
No. of fruits/vine	PCUC 15-1 X C 98-6	61.67**	18.42**	0.70**	-0.34**
	PCUC 15-1 X CHC 2	58.47**	46.31**	0.70**	-0.34**
	PCUC 15-1 X C 99-12	55.28**	59.59**	0.70**	-0.32**
	CHC 2 X BIHAR 1	48.90**	27.14**	0.34**	-0.02
	EC 43342 X BIHAR 1	42.04**	24.34**	0.22**	-0.02
Vine length (cm)	PCUC 15-1 X BIHAR 1	32.49**	11.71**	5.27**	-2.49**
	EC 43342 X BIHAR 1	32.39**	14.15**	7.70**	-2.49**
	PCUC 15-1 X C 99-10	29.95**	12.07**	4.31**	4.43**
	PCUC 15 X C 99-12	28.53**	17.19**	4.31**	-2.49**
	PCUC 15 X BIHAR 1	27.13**	26.53**	5.27**	-6.60**
Yield/vine (g)	PCUC 15 X PCUC 15-1	211.70**	80.20**	208.56**	133.32**
	CHC 2 X C 99-12	177.66**	73.99**	226.50**	43.10**
	PCUC 15 X CHC 2	97.35**	52.15**	208.56**	226.50**
	PCUC15-1X BIHAR 1	69.84**	45.03**	133.32**	-130.02**
	EC 43342 X C 99-12	62.10**	37.03**	-92.69**	43.10**

*, ** Significant at 5% and 1% levels, respectively

of fruits/vine (-26.58 to 61.67) and vine length (-25.72 to 32.49). In present study five superior crosses were selected for different attributes (Table 2). These were, C 98-6 X C 99-10 and BIHAR 1 X C 98-6, for days to first male flower, C 98-6 X C 99-10 for days to first female flower, EC 43342 X CHC 2, CHC 2 X BIHAR 1, PCUC 15 X C 99-10, PCUC 15 X PCUC 15-1 and C 99-12 X C 99-10 for node no. of first male flower, CHC 2 x C 98-6, PCUC 15-1 X C99-10, C 99-12 X C 99-10, EC 43342 X C 99-12 and PCUC 15 X PCUC 15-1for node no. of first female flower, PCUC 15 X PCUC 15-1, CHC 2 X C 99-12, CHC 2 X C 98-6, EC 43342 X C 99-12 and PCUC 15-1 X C 99-10 for fruit length, CHC 2 X C 99-12 and PCUC 15 X PCUC 15-1 for fruit diameter, PCUC 15 X PCUC 15-1, CHC 2 X C 99-12, CHC 2 X C98-6, PCUC 15 X C 99-12 and PCUC 15 X C 99-10 for fruit weight, PCUC 15-1 X C 98-6, PCUC 15-1 X CHC 2, PCUC 15-1 X C 99-12, CHC 2 X BIHAR 1 and EC 43342 X BIHAR 1 for no. of fruits/vine and PCUC 15-1 X BIHAR 1, EC 43342 X BIHAR 1, PCUC 15-1 X C 99-10 and PCUC 15 X BIHAR 1for vine length and PCUC-15 X PCUC 15-1, CHC-2 X C 99-12, PCUC 15 X CHC 2, PCUC 15-1 X BIHAR and EC 43342 X C 99-12 for yield/vine. These five combinations which showed significant desirable heterosis for yield/vine also showed significant inbreeding depression in F_2 generation. Qi and Chui (1991), Vijyakumari *et al*. (1993), Li *et al*. (1995), Dogra *et al*. (1979b), Cramer and Wehner (1999), Wang *et al*. (2002) and Bairagi *et al*. (2002) have also reported similar results in cucumber.

It is clear from most of the promising crosses, PCUC 15 X PCUC 15-1and PCUC 15 X CHC 2 that these had not only exhibited high economic heterosis for yield/vine but also showed desirable heterosis for node no. of first male flower, node no. of first female flower, fruit length, fruit diameter, fruit weight and vine length (Table 3). CHC 2 X C 99-12 was one of the best crosses for yield/vine, which showed significant heterosis for fruit weight, no. of fruits/vine and vine length. Cross PCUC15-1X BIHAR 1 for vine length and EC

Table 3: Top ten crosses exhibited significant heterosis over economic parent for yield/vine and other traits in cucumber

Cross	E.H. (%)	I.D. (%)	GCA effect P_1	P_2	SCA effect F_1	F_2	Desirable heterosis in other traits
PCUC 15 X PCUC 15-1	211.70**	80.20**	208.56**	133.32**	1261.27**	-484.68**	III*, IV**, V**, VI**, VII**, IX**
CHC 2 X C 99-12	177.66**	73.99**	226.50**	43.10**	982.15**	-420.73**	III*, IV**, V**, VI**, VII**, IX
PCUC 15 X CHC 2	97.35**	52.15**	208.56**	226.50**	95.39**	-57.51*	VII**, VIII**, IX
PCUC15-1X BIHAR 1	69.84**	45.03**	133.32**	-130.02**	318.65**	-0.05	IX**
EC 43342 X C 99-12	62.10**	37.03**	-92.69**	43.10**	301.62**	-0.05	IV**, VII**, VIII**, IX**
PCUC 15-1 X C 98-6	53.79**	20.19**	133.32**	-154.99**	198.68**	35.29	VIII**, IX**
PCUC 15-1 X CHC 2	53.08**	57.34**	133.32**	226.50**	-229.27**	305.93**	VIII**
CHC 2 X C 98-6	52.85**	44.94**	226.50**	-154.99**	57.04**	-329.84**	IV**, V**
PCUC 15 X C 98-6	52.10**	40.22**	208.56**	-154.99**	108.17**	27.88	VIII**, IX**
PCUC 15 X C 99-10	50.40**	41.19**	208.56**	-273.77**	211.79**	47.79	VII**, VIII**, IX**

*, ** Significant at 5% and 1% levels, respectively

Note: (I)-Days to first male flower, (II)- Days to first female flower, (III)- Node no. of first male flower, (IV)- Node no. of first female flower, (V)- Fruit length (cm), (VI)- Fruit diameter (cm), (VII)- Fruit weight (g), (VIII)- No. of fruits/vine, (IX) - Vine length (cm) and (X)- Yield/vine (g).

43342 X C 99-12 for node no. of first female flower, fruit weight, no. of fruits/vine and vine length exhibited desirable significant heterosis. Heterosis for yield might be due to heterotic response via other yield attributing traits. Cross combinations, namely, PCUC-15 X PCUC 15-1 CHC-2 X C 99-12, PCUC 15 X CHC 2, PCUC 15-1 X BIHAR and EC 43342 X C 99-12 where, both parent being good general combiners exhibited highly significant heterosis over economic parent and crosses also had significant SCA effect in F_1 generation. The heterosis in these combinations might be attributed to preponderance of non-additive gene effects, which dissipated in F_2 generation.

At the same time of presence of predominantly large amount of non-additive gene action for yield and its related traits as observed in the present study, necessitates the maintenance of the heterozygosity in the population. Genetic variance due to non-additive gene action is non fixable in nature and breeding method such as biparental mating followed by recurrent selection are likely to result in faster rate of genetic improvement for characters governed by such type of gene action. Crosses PCUC-15 X PCUC 15-1 CHC-2 X C 99-12, PCUC 15 X CHC 2, PCUC 15-1 X BIHAR and EC 43342 X C 99-12 can be exploited for high yield/ vine hybrid development programme.

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