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Estimating combining ability for yield and yield contributing traits in cucumber

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ABSTRACT

A study was conducted on a 8 × 8 diallel set of cucumber excluding reciprocals to find out the extent of combining ability for yield and yield attributing characters. The magnitudes of variance due to general as well as specific combining ability were highly significant indicating the importance of both additive and non-additive gene action. Among parents, gynoecious line GBS-1(P_1) showed maximum *g.c.a* effects in desirable direction for node number of first female flower, days to first female flower anthesis, days to fruit set from opening of first female flower, days to first fruit harvest, number of fruits per plant, and vine length. The parent P_5 (Pusa Uday) exhibited highest positive *g.c.a* effect for fruit length, fruit diameter, average fruit weight and yield per plant. In order of merit the gynoecious hybrids $P_1 \times P_5$ (GBS-1 × Pusa Uday) and $P_1 \times P_6$ (GBS-1 × Punjab Naveen) followed by monoecious hybrid $P_3 \times P_5$ (GS-4 × Pusa Uday), which exhibited highest *s.c.a* effects for number of characters including total fruit yield per plant. In case of yield and other yield contributing characters like node number of first female flower, days to first female flower anthesis, days to fruit set from opening of first female flower, days to first fruit harvest, number of fruits per plant and yield per plant where specific combining ability component of variance (s^2s) is more than general combining ability component of variance (s^2g), which indicated preponderance of non-additive gene action. Hence, an improvement programme based on heterosis breeding would be appropriate for improving different traits under study.

Key words: General combining ability, specific combining ability, cucumber.

INTRODUCTION

India being native place of cucumber (*Cucumis sativus* L.) possesses vast genetic variability for vegetative and fruit characters. In breeding high-yielding varieties of crop plants, the breeders often face with the problem of selecting parents and crosses. Combining ability analysis is one of the powerful tool available which gives the estimates of combining ability effect and aids in selecting desirable parents and crosses for further exploitation. Combining ability describes the breeding value of parental lines to produce hybrids. Sprague and Tatum (9) used the term general combining ability to designate the average performance of a line in hybrid combination and used the term specific combining ability to define those cases in which certain combination do relatively better or worse than expected on the basis of average performance of the lines involved. The importance of combining ability studies lies in the assessment of parental lines and their hybrids showing significant additive and non additive effect with respect to certain traits. In a systematic breeding programme, it is essential to identify superior parents for hybridization and crosses to expand the genetic variability for selection of superior genotypes (Inamullah *et al.*, 4). The heterozygous nature and virtually the obligatory out crossing breeding system of cucumber may open the scope of development of open pollinated as well as hybrid variety. 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. The present investigation is therefore, undertaken to identify the best combiners among the existing germplasm as well as gene action of different quantitative characters in 8 × 8 half-diallel set to facilitate the formulation of a sound breeding programme in this crop.

MATERIALS AND METHODS

The experiment was carried out at experiment farm of the Division of Vegetable Science, IARI, New Delhi during the spring-summer and *kharif* seasons for two years. Eight genetically diverse inbreds of cucumber, *viz.*, GBS-1 (P_1; gynoecious line), DC-319-B (P_2), GS-4 (P_3), DC-1-1 (P_4), Pusa Uday (P_5), Punjab Naveen (P_6), LOM-404 (P_7) and 7026 B-76 (P_8) were crossed in all possible combinations excluding reciprocals. The 28 F_1 hybrids along with 8 parental lines consisting of diallel set were grown in a randomized block design with three replications. The

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crop was sown in rows of 1.5 m apart with spacing of 60 cm between the plants. Each treatment comprised of ten hills. Two plants were allowed to grow in each hill and finally one plant was kept for taking final observations. Standard and uniform agronomic practices recommended under irrigated conditions were followed throughout the growing seasons to raise a healthy crop. Five plants were randomly selected for taking observations after discarding the border plants at both the ends. Observations on individual plant were recorded on 10 economically important quantitative characters, *viz*., node number of first female flower, days to first female flower anthesis, days to fruit set from opening of first female flower, days to first fruit harvest, number of fruits per plant, fruit length (cm), fruit diameter (cm), average fruit weight (g), vine length (cm) and yield per plant (g). Statistical analysis of combining ability for different characters was worked out according to Method 2, Model 1 of Griffing (3) using statistical package for Agricultural Research (SPAR-1) developed by Indian Statistical Research Institute, New Delhi. Significance of the combining ability effects was determined at 5 and 1% probability.

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed significant mean square for both *gca* and *sca* effects in all the characters studied (Table 1). The *gca* component of variance (s^2g) was higher and prominent than *sca* component of variance (s^2s) for fruit length, average fruit weight and vine length indicated the importance additive gene action can be improved through selection This represents a strong evidence of favourable gene flow from parents to offspring at high frequency and gives information about the concentration of predominantly additive genes. In addition, crosses involving genotypes with greater estimates of *gca* should be potentially superior for the selection of lines in the advanced generation (Franco *et al*., 2). Bairagi *et al*. (1) reported that the *gca* mean squares were higher than *sca* mean square for all the characters studied except fruit diameter. *The sca* component of variance (s^2s) was higher than the *gca* component of variance (s^2s) in node number of first female flower, days to first female flower anthesis, days to fruit set from opening of first female flower, days to first fruit harvest, number of fruits per plant and yield per plant, indicating the importance of non-additive gene action. Hence, an improvement programme based on heterosis breeding of different cross would be appropriate for improving these traits. The present results are in conformity with the findings of Munshi *et al.* (6), Yudhvir and Sharma (11), and Reddy *et al*. (7) in cucumber.

The estimated effect for the *gca* of the parents (g_i) as well as *sca* (s_{ij}) effects of the F_1 hybrids for all the 10 characters including yield are presented in Tables 2 & 3. The results of general combining ability revealed that among eight parental lines, P_1 (GBS-1) exhibited maximum favourable *gca* effect for node number of first female flower, days to first female flower anthesis, days to fruit set from opening of first female flower, days to first fruit harvest, number of fruits per plant and vine length. The parent P_5 (Pusa Uday) exhibited highest positive *gca* effect for fruit length, fruit diameter and average fruit weight, followed by

Table 1. Analysis of variance for combining ability for different quantitative traits in cucumber.

Trait	Sources of variation of *gca*		Sources of variation of *sca*		Error		s^2g	s^2s
	df	MSS	df.	MSS	df	MSS		
Node No. of first female flower	7	0.71**	28	0.18**	70	0.01	0.05	0.18
Days to first female flower anthesis	7	22.92**	28	3.31**	70	0.72	1.96	3.07
Days to fruit set from opening of first female flower	7	0.08**	28	0.04**	70	0.01	0.004	0.04
Days to first fruit harvest	7	22.18**	28	3.40**	70	0.70	1.88	3.16
No. of fruits per plant	7	11.48**	28	1.98**	70	0.15	0.95	1.93
Fruit length (cm)	7	22.51**	28	1.86**	70	0.09	2.06	1.83
Fruit dia. (cm)	7	1.09**	28	0.10**	70	0.02	0.09	0.09
Av. fruit wt. (g)	7	2802.38**	28	117.77**	70	7.40	208.46	115.31
Vine length (cm)	7	1204.44**	28	20.20**	70	0.77	118.42	19.94
Yield per plant (g)	7	128436.11**	28	78516.32**	70	5148.50	4991.97	76800.16

**Significant at 1% level

Table 2. Estimates of g.c.a effects of parents for different quantitative traits in cucumber.

Cross	NNFFF	DFFFA	DFSOFFF	DFFH	NF/P	FL (cm)	FD (cm)	AFW (g)	VL (cm)	Y/P (g)
GBS-1 (P_1)	-0.64**	-2.99**	-0.16**	-3.32**	2.53**	-3.36**	-0.69**	-35.42**	-26.83**	128.41**
DC-319-B (P_2)	-0.01	-0.10	0.05	-0.07	-0.54*	0.20	-0.10*	1.24	4.42**	-72.24**
GS-4 (P_3)	0.16**	0.39	-0.04	-0.01	-0.51*	0.84**	0.10*	4.17**	6.59**	-38.53
DC-1-1 (P_4)	0.10**	0.68*	-0.09**	0.82**	-0.44	0.52**	0.12*	8.26**	1.73**	-8.29
Pusa Uday (P_5)	0.06	1.51**	0.08**	0.99**	0.13	1.47**	0.32**	16.27**	4.12**	156.86**
Punjab Naveen (P_6)	0.08*	1.82**	0.09**	1.62**	0.00	1.00**	0.28**	11.62**	4.81**	92.26**
LOM-404 (P_7)	0.11**	-0.64*	0.02	-0.33	-0.91**	-0.23**	0.18**	6.95**	1.15**	-121.39**
7026B-76 (P_8)	0.15**	-0.68*	0.04	0.31	-0.25	-0.45**	-0.20**	-13.10**	4.01**	-137.09**
SE (g_i)	0.023	0.251	0.022	0.249	0.115	0.090	0.040	0.804	0.259	21.225
SE (g_i - g_j)	0.035	0.379	0.034	0.375	0.175	0.136	0.061	1.212	0.391	32.090
CD at 5%	0.046	0.498	0.044	0.494	0.229	0.179	0.080	1.597	0.514	42.132
CD at 1%	0.070	0.753	0.067	0.745	0.347	0.271	0.121	2.407	0.776	63.698

*, **Significant at 5 and 1% levels; NNFFF = Node number of first female flower; DFFFA = Days to first female flower anthesis; DFSOFFF = Days to fruit set from opening of first female flower; DFFH = Days to first fruit harvest; NF/P = Number of fruits per plant; FL = Fruit length; FD = Fruit diameter; AFW = Average fruit weight; VL = Vine length; Y/P = Yield /plant

P_6 (Punjab Naveen). Pusa Uday also exhibited the highest *gca* effect for yield per plant followed by GBS-1 and Punjab Naveen (Table 1). In most of the cases it was observed that *per se* performance of parents bear direct reflection of their respective *gca* effects, *i.e.* parents showing highest *gca* effects for a character, were also observed to be good performer with respect to that particular character. The present results are in conformity with the findings of Sarkar and Sirohi (8), Singh *et al*. (9), Kumar *et al*. (5), and Reddy *et al*. (7).

Out of 28 hybrids, significance *sca* effect in favourable direction were exhibited by 14 hybrid combinations for node number of first female flower, 2 hybrid combinations for days to first female flower anthesis, 9 hybrid combinations for days to fruit set from opening of first female flower, 7 hybrid combinations for days to first fruit harvest, 6 hybrid combinations for number of fruits per plant, 10 hybrid combinations for fruit length, 6 hybrid combinations for fruit diameter, 13 hybrid combinations for average fruit weight, 11 hybrid combinations for vine length and 19 hybrid combinations for yield per plant (Table 2). Two F_1 combinations showing highest significant desirable *sca* effect for various characters in order of merit were $P_5 \times P_6$ (Pusa Uday × Punjab Naveen), and $P_1 \times P_5$ (GBS-1 × Pusa Uday) for node number of first female flower; $P_1 \times P_5$ (GBS-1 × Pusa Uday) and $P_1 \times P_6$ (GBS-1 x Punjab Naveen) for days to first female flower anthesis, days to first fruit set from opening of first female flower and number of fruits per plant; $P_1 \times P_6$ (GBS-1 × Punjab Naveen) and $P_1 \times P_5$ (GBS-1 × Pusa Uday) for days to first fruit harvest; $P_3 \times P_5$ (GS-4 × Pusa Uday) and $P_3 \times P_4$ (GS-4 × DC-1-1) for fruit length and average fruit weight; $P_3 \times P_5$ (GS-4 × Pusa Uday) and $P_4 \times P_8$ (DC-1-1 × 7026B-76) for fruit diameter; $P_3 \times P_4$ (GS-4 × DC-1-1) and $P_1 \times P_3$ (GBS-1 × GS-4) for vine length. The cross $P_1 \times P_5$ (GBS-1 × Pusa Uday) exhibited higher significant and positive *sca* effects for yield per plant followed by $P_1 \times P_6$ and $P_3 \times P_5$. Above discussion reveals that in almost all the hybrids which showed the best *sca* effects, the parental lines involved were at least one of the most outstanding parental lines, *viz.*, GBS-1 (P_1), Pusa Uday (P_5) and Punjab Naveen (P_6) which also had high *gca* effects for one or more characters contributing towards yield. This indicated that there was strong tendency of transmission of higher gain from the parents to the offspring. In majority of the cases, these hybrids which showed best *per se* performance also possessed desirable significant *sca* effects. This indicated the *per se* performance of hybrids had a direct relation with respective *sca* effects. The present results were also in conformity with the findings of Munshi *et al.* (6), Kumar *et al.* (5) and Reddy *et al.* (7) in cucumber.

The crosses which showed high *sca* effects can be best utilized in heterosis breeding. In order of merit, the gynoecious hybrids $P_1 \times P_5$ (GBS-1 × Pusa Uday) and $P_1 \times P_6$ (GBS-1 × Punjab Naveen) and monoecious hybrid $P_3 \times P_5$ (GS-4 × Pusa Uday) exhibited highest *sca* effects for a number of traits including yield per plant may be exploited for commercial cultivation.

Table 3. Estimates of s.c.a effects of crosses for different quantitative characters in cucumber.

Cross	NNFFF	DFFFA	DFSOFFF	DFFH	NF/P	FL (cm)	FD (cm)	AFW (g)	VL (cm)	Y/P (g)
$P_1 \times P_2$	0.13*	0.75	-0.01	0.04	0.39	-0.28	-0.01	2.16	-5.29**	80.69*
$P_1 \times P_3$	0.05	0.28	0.04	0.66	0.41	-0.73*	-0.01	-3.25	-5.83**	27.70
$P_1 \times P_4$	-0.08	1.07	0.09	0.62	0.96*	-0.39	-0.07	-5.06*	-2.44**	116.45**
$P_1 \times P_5$	-0.46**	-3.79*	-0.35**	-2.93**	3.49**	-0.37	0.08	-4.39	-5.80**	548.31**
$P_1 \times P_6$	-0.45**	-3.40*	-0.30**	-4.25**	2.95**	-0.25	0.03	-3.92	-3.90**	449.16**
$P_1 \times P_7$	0.01	0.35	0.01	1.58*	-0.37*	-0.06	-0.02	-4.35	0.15	-49.51
$P_1 \times P_8$	0.15*	0.55	-0.01	1.50*	0.28	0.19	-0.17	6.68**	0.21	71.88*
$P_2 \times P_3$	-0.35**	-1.41	-0.02	-1.73**	0.78*	-0.26	0.05	-0.84	-0.15	123.40**
$P_2 \times P_4$	-0.22**	-1.19	-0.03	-1.06	0.45	-0.13	0.02	-0.53	-0.38	73.24*
$P_2 \times P_5$	-0.04	-1.29	-0.24**	0.69	-0.19	1.17**	-0.16	8.35**	-3.23**	19.33
$P_2 \times P_6$	-0.12	1.90	-0.04	2.31	0.34	1.50**	0.22	7.56**	2.12**	127.68**
$P_2 \times P_7$	-0.24**	-0.77	0.06	-0.86	0.36	0.76*	0.08	7.79**	0.52	128.15**
$P_2 \times P_8$	-0.29**	-1.38	-0.21**	-1.75**	0.48	0.58	0.34**	0.65	3.30**	94.04**
$P_3 \times P_4$	-0.13	-1.32	0.05	0.75	0.33	1.67**	-0.10	14.37**	-6.30**	155.38**
$P_3 \times P_5$	0.02	-0.74	-0.06	1.44*	1.00*	2.39**	0.66**	20.24**	11.60**	371.58**
$P_3 \times P_6$	-0.21**	0.17	-0.19**	-0.93	0.19	1.08**	0.10	9.01**	3.79**	104.17**
$P_3 \times P_7$	0.15*	-0.92	-0.13*	-1.32	0.11	1.39**	-0.01	6.56**	-0.62	63.40
$P_3 \times P_8$	-0.15*	0.09	-0.02	-1.29	0.52	0.51	0.17	-0.51	-2.10**	87.32**
$P_4 \times P_5$	-0.28**	-0.60	-0.11	0.83	-0.37	0.97**	0.11	7.97**	4.17**	-11.81
$P_4 \times P_6$	-0.21**	-0.52	-0.21**	-0.98	-0.01	0.44	0.18	11.16**	4.96**	92.05**
$P_4 \times P_7$	-0.07	-0.65	-0.02	-0.63	0.59	0.68*	0.04	6.35**	-0.89	171.23**
$P_4 \times P_8$	-0.29**	-0.98	-0.10	-1.67*	0.30	0.63	0.39**	2.37	0.55	83.96**
$P_5 \times P_6$	-0.58**	-1.48	-0.17*	-2.82**	-0.73*	0.55	-0.11	1.94	-1.73*	-114.51**
$P_5 \times P_7$	-0.38**	0.93	-0.05	-0.68	-0.09	-0.31	0.23*	6.83**	3.19**	42.77
$P_5 \times P_8$	-0.06	-0.48	0.02	-1.43*	-0.15	-0.36	0.10	-7.94**	-3.63**	-78.06**
$P_6 \times P_7$	-0.10	-0.12	-0.07	0.50	0.44*	0.23	0.36**	7.55**	-4.31**	164.85**
$P_6 \times P_8$	0.07	-1.02	-0.04	0.75	-0.07	0.18	0.26*	-3.80	0.57	-26.59
$P_7 \times P_8$	-0.58**	-1.49	-0.08**	-0.75	0.71*	1.30**	0.24	1.93	1.09	172.97**
S.E. S_{ij}	0.071	0.768	0.068	0.762	0.354	0.276	0.122	2.466	0.794	65.062
S.E. $S_{ii} - S_{jj}$	0.086	0.931	0.082	0.922	0.428	0.333	0.148	2.978	0.959	78.600
S.E. $S_{ij} - S_{ik}$	0.105	1.140	0.105	1.127	0.523	0.409	0.182	3.648	1.175	96.265
S.E. $S_{ij} - S_{kl}$	0.099	1.077	0.096	1.063	0.494	0.386	0.170	3.439	1.109	90.758

*, **Significant at 5 and 1% levels; NNFFF = Node number of first female flower; DFFFA = Days to first female flower anthesis; DFSOFFF = Days to fruit set from opening of first female flower; DFFH = Days to first fruit harvest; NF/P = Number of fruits per plant; FL = Fruit length; FD = Fruit diameter; AFW = Average fruit weight; VL = Vine length; Y/P = Yield /plant

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