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STUDIES ON COMBINING ABILITY IN CUCUMBER (*CUCUMIS SATIVUS* L.)

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ABSTRACT

General combining ability of 4 female (2 gynoecious and 2 monoecious) and 8 male parents, and specific combining ability of 32 F_1 hybrids (using line × tester analysis) were studied in cucumber. Magnitude of $\hat{\sigma}^2$ gca was greater than that of $\hat{\sigma}^2$sca for nodal position, days to anthesis, average fruit weight, fruit length, fruit diameter, vine length, and early yield. It was inferred that additive genetic component played predominant role in the expression of these characters. The results on general combining ability revealed that SR 551F among females and Balam among males were the best combiners for maximum number of characters. Hybrid SR 551F × Poona Khira was the best specific combination, which showed significant $\hat{s}_{ij}$ effects for 5 out of 9 characters studied.

Key words: Cucumber, combining ability, gca, sca.

In the absence of gynoecious lines specifically developed for the tropical conditions of India, F_1 hybrid breeding programme in India would depend on the introduced temperate materials as the seed parent. The recommended hybrid Pusa Sanyog [1] has a Japanese gynoecious line as female parent but does not perform well in the plains of Northern India. This highlights the need for proper evaluation of the introduced temperate gynoecious lines to identify the most adapted strains for the tropical conditions of India. Previous studies on combining ability of cucumber in India did not include gynoecious genotypes, whose performance and potential for exploitation in heterosis breeding is, therefore, unknown. The present investigation has been undertaken to fill this gap.

MATERIALS AND METHODS

Two gynoecious (WI 2757, SR 551F) and two monoecious (SR 551f, Poinsett) cucumber genotypes were crossed with eight monoecious lines to raise 32 F_1 hybrids according to the model of Kempthorne [2]. The hybrids and their 12 parents were sown on January 25, 1987 in polythene bags placed in a plastic house. They were transplanted in the field on February 16 in randomized block design with two replications at the experimental plots of the Division of Vegetable Crops, Indian Agricultural Research Institute, New Delhi. The trials for the hybrids and parents were conducted separately in adjacent blocks. Each experimental plot was a single row of 20 plants in the hybrids and 16 plants in the parental blocks, with two plants transplanted per hill. The hills were spaced 60 cm.

Data were recorded on individual plants, excluding the two border plants in each row, for nine characters (Table 1) and averaged. The length and diameter of five fruits per genotype free from crook-necks and other deformities were also recorded.

The variation among the hybrids for each character was partitioned into sources attributable to general combining ability (gca) and specific combining ability (sca) according to the procedure described by Kempthorne [2].

RESULTS AND DISCUSSION

Significant differences due to interaction between females and males were observed for all characters except fruit number, total yield, and early yield (Table 1), suggesting that the gca of parents was largely responsible for the performance of the hybrids for these three characters. This indicated the importance of utilising good combiners for yield in a breeding programme designed to raise yield levels.

Table 1. Analysis of variance for combining ability in cucumber (M.S.S.)

Source	d.f.	Vine length	Node of first female flower	Days to first anthesis	Average fruit weight	Fruits per plant	Fruit length	Fruit diameter	Total yield per plant	Early yield per plant
Females	3	1699.2**	28.28**	264.1**	2849.7**	17.11**	9.61*	0.27	0.35**	0.07
Males	7	2593.7**	2.11	33.0*	872.9	2.24*	39.46**	0.47*	0.05*	0.02
Females × males	21	268.6*	2.14**	9.9**	351.3**	0.85	2.42**	0.17**	0.02	0.01
Error	31	115.0	0.33	1.0	86.4	1.81	0.40	0.03	0.04	0.01
$\hat{\sigma}^2$ gca/$\hat{\sigma}^2$ sca		4.9	1.80	4.2	1.6	N	5.02	0.65	N	3.00

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

N—not calculated because of negative estimates of $\hat{\sigma}^2$ sca.

The estimates of variance components of the F_1 hybrids were used to calculate the $\hat{\sigma}^2$ gca: $\hat{\sigma}^2$ sca ratios (Table 1). The ratios for fruit number and total yield are not included, since the sca estimates for these characters were nonsignificant and negative. The ratios indicated that additive genetic variances were more than nonadditive genetic variances for all the characters except fruit diameter. The gca estimates were significant for all the characters, whereas the estimates of sca were nonsignificant only for fruit number, total yield, and early yield. This suggests that breeding methods designed to exploit additive genetic variance would be appropriate for yield improvement in cucumber. Predominance of additive genetic effects for the expression of high yield in cucumber has been reported earlier [3–5].

The large differences for gca among the female lines (combined with larger variances of $\hat{\sigma}^2_t$) for characters such as node of first female flower, days to first anthesis, average fruit weight, fruit number, total yield, and early yield indicated that the female lines were responsible for the majority of additive gene effects for these characters. Therefore, genetic improvement for earliness and yield would be achieved, to a large extent, by selection among the female lines.

The female parents WI 2757 and SR 551F showed significant $\hat{g}_i$ effects for low nodal position (Table 2). For low nodal position as well as early flowering, WI 2757 had higher $\hat{g}_i$ effects over SR 551F. Among the male parents, Balam and Japanese Long Green for low nodal position, and Poona Khira, SMR 18, Balam and RKS 295 for early flowering expressed significant $\hat{g}_i$ effects.

Table 2. General combining ability ($\hat{g}_i$) effects of parents in cucumber for different characters

Parent	Vine length	Node of first female flower	Days to first anthesis	Average fruit weight	Fruits per plant	Fruit length	Fruit diameter	Total yield per plant	Early yield per plant
Females:									
WI 2757	−11.12**	−1.45**	−4.15**	−18.14**	−0.38	−0.53**	0.08*	−0.13**	−0.02
SR 551F	−1.55	−0.80**	−2.67**	−0.41	1.34**	−0.68**	−0.07	0.18**	0.10**
SR 551f	13.83**	1.04**	2.45**	7.90**	0.16	0.21	0.13**	0.06	−0.02
Poinsett	−1.16	1.21**	4.37**	11.15**	−1.12**	1.01**	−0.15**	−0.11**	−0.05**
SE± ($\hat{g}_i$)	1.98	0.11	0.21	1.72	0.25	0.14	0.04	0.04	0.01
SE±($\hat{g}_i-\hat{g}_j$)	3.79	0.20	0.35	3.29	0.48	0.22	0.06	0.07	0.03
Males:									
Balam	−8.64**	−0.54**	−1.81**	−0.86	0.68	0.04	−0.05	0.09	0.09**
Japanese Long Green	39.02**	−0.87**	1.50**	18.10**	0.07	5.15**	−0.52**	0.10	−0.01
RKS 295	−9.32**	−0.20	−0.76*	−11.99**	0.91*	−1.70**	0.06	0.05	0.02
Poona Khira	−9.38**	0.38*	−2.71**	−1.29	−0.39	−1.63**	−0.02	−0.05	0.03
SMR 18	−4.56	0.48**	−2.02**	−4.98	−0.45	0.97**	0.27**	−0.08	0.02
EC 103633	−0.29	0.11	1.89**	10.65**	−0.32	0.58**	0.24**	A	A
EC 129110	−18.46**	0.60**	1.80**	−9.97**	−0.47	−0.94**	0.06	−0.10	−0.08**
Green Long of Naples	11.63	0.03	2.13**	0.35	−0.04	−0.53*	−0.03	0.00	−0.04
SE± ($\hat{g}_i$)	3.02	0.16	0.33	2.62	0.38	0.21	0.06	0.06	0.02
SE±($\hat{g}_i-\hat{g}_j$)	5.36	0.29	0.50	4.65	0.67	0.31	0.09	0.10	0.04

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

A—actual estimate was −0.0035.

Sum of $\hat{g}_i$ effects does not become zero in some cases due to rounding up to two decimal points.

Both the monoecious seed parents showed statistically similar and significant $\hat{g}_i$ effects for higher fruit weight. Among the male parents, Japanese Long Green and EC 103633 expressed maximum $\hat{g}_i$ effects for heavier fruit.

Significant $\hat{g}_i$ effects for greater fruit number and total yield were evident only for SR 551F among the female lines, whereas only RKS 295 showed significant $\hat{g}_i$ effects for large number of fruits among the males. None of the male parents showed significant $\hat{g}_i$ effects for higher yield.

Significant $\hat{g}_i$ effects for longer fruit were exhibited by Poinsett among the female lines, and by Japanese Long Green and EC 103633 among the males. WI 2757 and SR 551f (a monoecious version of gynoecious SR 551F) among the female parents, and SMR 18 and EC 103633 among the male parents expressed maximum $\hat{g}_i$ effects for larger fruit diameter.

SR 551f was the best female combiner for longer vines. Among the male parents, Japanese Long Green and Green Long of Naples exhibited significant $\hat{g}$ effects for this character. The former was statistically superior over the latter.

Significant $\hat{g}_i$ effects for higher early yield were expressed only by the female parent SR 551F and the male parent Balam. Since the harvest time has a strong positive association with both nodal position and flowering time [3], the negative $\hat{g}_i$ effects for higher early yield in WI 2757, despite its very high gca values for nodal position and early flowering, could be attributed to the unfavourable $\hat{g}_i$ effects exhibited by it for average fruit weight and fruit number. This means that selecting early genotypes on the basis of their nodal position and flowering time alone may be misleading, while yield during the first 15 days is a more reliable character for selection.

Table 3. Hybrids showing significant $\hat{s}_{ij}$ effects for three or more characters

Hybrid	Characters with significant $\hat{s}_{ij}$ effects	Total yield per plant, kg
WI 2757 × Green Long of Naples	Nodal position, days to first anthesis and fruit length	0.532
WI 2757 × Poona Khira	Nodal position, fruit length and fruit diameter	0.418
SR 551F × Japanese Long Green	Days to first anthesis, early yield and fruit diameter	0.939
SR 551F × Poona Khira	Nodal position, days to first anthesis, average fruit weight, vine length and early yield	0.895
SR 551f × EC 129 110	Nodal position, average fruit weight, fruit length and fruit diameter	0.551
Poinsett × RKS 295	Nodal position, average fruit weight, vine length and fruit length	0.792

The study of $\hat{g}_i$ effects of the 12 parents (4 females and 8 males) makes it clear that the introduced temperate gynoecious line, SR 551F, was the best combiner among the female parents. It showed significant $\hat{g}_i$ effects for as many as five characters, i.e. node of first female flower, days to first anthesis, fruit number, total yield, and early yield. SR 551F is, therefore, the best combiner for earliness and yield. Among the male parents, Japanese Long Green expressed significant $\hat{g}_i$ effects for the maximum number of characters. However, Balam, Japanese Long Green, and RKS 295 exhibited favourable $\hat{g}_i$ effects for six characters each. Balam with significant $\hat{g}_i$ effects for low nodal position, early flowering, and high early yield is the best male combiner for earliness.

The hybrid SR 551F × Poona Khira displayed significant $\hat{S}_{ij}$ effects for maximum number of characters (Table 3). The seed gynoecious parent of this cross is identified as the best female combiner in this study. This F_1 hybrid is considered to be promising for commercial release.

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