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Short Communication

Combining ability and generation mean analysis in *Capsicum*

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Based on the morphology and yield and yield attributing characters four diverse lines of *Capsicum*: IC-119367, IC-119797, EC-321437, EC-305591 and three testers: cv. RHRC-CE, Punjab Lal (all *Capsicum annuum* L.) and cv. Pusa Sadabahar (*Capsicum frutescens* L.) were chosen for line × tester analysis to obtain 12 F_1 hybrids excluding reciprocals. The experimental lay out (1996 2000) consisted of 12 hybrids and 7 parents in a randomized block design in three replications. Each plot consisted of three rows accommodating 40 plants in each row, with row to row and plant to plant spacings as 80 cm and 45 cm, respectively. F_2 and F_3 generations were also raised in the same design. Thirty plants from each of F_1s, F_2s, F_3s and parents were randomly selected from each replication for recording data on fourteen quantitative characters. The general and specific combining ability were estimated as per Method-2, Model-1 [1]. The scaling tests [2] were applied to the data to assess (i) the additivity of gene effects and (ii) independence of heritable components from non-heritable ones. Five-parameter model [3] was used for the estimation of various genetic components, comprising of mean (m), additive gene effects (d), dominance gene effects (h) and the two non-allelic gene interactions: additive × additive (i) and dominance × dominance (l).

Line × tester crosses including high yielding testers showed significant differences among parents *vs.* crosses for all the 14 characters under study, except number of primary branches and 100-seed weight. The interaction between line × tester (L × T) also showed significant differences for as many as ten characters . The four characters which did not show significant differences are fruit length, fruit diameter, 100-seed weight and the capsaicin content (Table 1).

The lines EC-321437, IC-119797, RHRC-CE and Pusa Sadabahar are good general combiners for the number of fruits/plant. For total fresh fruit yield/plant the good general combiners are RHRC-CE, Punjab Lal and EC-321437, while for total dry fruit yield/plant the good general combiners are RHRC-CE, EC-321437 and IC-119797. The good general combiners ability for ascorbic acid is shown by RHRC-CE, EC-305591 and Pusa Sadabahar, whereas for capsaicin content superior combiners are EC-305591, RHRC-EC, IC-119367 and Pusa Sadabahar. Considering the *gca* and *per se* performance it was concluded that RHRC-CE is the best tester for yield and its components followed by IC-119797, EC-321437 and Punjab Lal.

The main yield components in *Capsicum* are the number of fruits/plant, fruit length and the number of seeds/fruit. The present investigation also revealed that the parents having significant positive *gca* effect for the yield/plant also showed positive *gca* effect for one or more of the yield components studied. Several crosses showed significant *sca* for various characters under study. It was also noted that the best F_1s were not the cross combinations which showed maximum *sca* effects. Though the parents RHRC-CE and IC-119797 were the best general combining tester and line, respectively for total fresh fruit yield/plant their F_1s exhibited negative *sca* effects. Hence, it is not necessary that the parents having higher estimates of *gca* effects would also give higher estimates of *sca* effects when crossed together.

With respect to biochemical parameters hybrids IC-119367 × RHRC-CE and EC-305591 × Punjab Lal for ascorbic acid and crosses IC-119367 × RHRC-CE

Table 1. Analysis of variance for combining ability of quantitative characters in line × tester (4 × 3) crosses of *Capsicum*

Source	df	Plant height (cm)	No. of primary branches	Leaf area (cm^2)	First flowering initiation	Days to maturity	Fruit length (cm)	Fruit diameter (cm)	No. of fruits/ plant	No. of seeds/ fruit	100-seed wt. (g)	Total fresh fruit yield/ plant (g)	Total dry fruit yield/ plant (g)	Ascorbic acid (mg/ 100g)	Capsaicin content (%)
Replication	2	25.77*	0.11	0.81*	2.08	0.71	0.05*	19.51**	23.20	7.16	0.01	298.88**	20.55*	72.91	0.01
Line	3	27.70**	3.09**	7.29**	25.06**	5.62*	1.30**	0.01	325.60**	40.43**	0.01	5356.63**	170.86**	1138.55**	0.06**
Tester	2	222.95**	1.18**	10.29**	19.8*	33.00**	2.82**	0.41**	5724.42**	95.18**	0.02	3883.95**	102.45**	9178.37**	0.25**
Line × tester	6	28.61**	0.75**	5.19**	19.37**	4.91**	2.81**	0.02	909.25**	5.77	0.01	1301.79**	64.39**	307.52**	0.01
Error	22	±5.81	±0.03	±0.15	±3.70	±1.21	±0.01	±0.01	±7.89	±2.86	±0.01	±48.69	±4.06	±24.49	±0.01

Table 2. Estimates of *gca* and *sca* variances and the additive (A) and dominance (D) components of *Capsicum*

Variances	Plant height (cm)	No. of primary branches	Leaf area (cm^2)	First flowering initiation	Days to maturity	Fruit length (cm)	Fruit diameter (cm)	No. of fruits/plant	No. of seeds/fruit	100-seed wt. (g)	Total fresh/fruit yield/plant(g)	Total dry fruit yield/plant(g)	Ascorbic acid (mg/100g)	Capsaicin content (%)
σ^2 *gca* (F)	−0.10	0.26	0.23	0.63	0.08	−0.17	0.00	−64.85	3.85	0.00	450.54	11.83	93.24	0.01
σ^2 *gca* (M)	16.19	0.04	0.42	0.04	2.34	0.00	0.03	401.26	7.45	0.00	215.18	3.17	739.24	0.02
σ^2 *gca* (pooled)	9.21	0.13	0.34	0.29	1.37	0.07	0.02	201.50	5.90	0.00	316.04	6.88	461.99	0.01
σ^2 *sca*	7.60	0.24	1.68	5.22	1.23	0.93	0.01	300.45	0.97	0.00	417.70	20.11	94.34	0.01
σ^2 A	18.42	0.23	0.68	0.58	2.74	0.14	0.04	403.00	11.80	0.00	632.08	13.76	923.98	0.02
σ^2 AD	7.60	0.24	1.68	5.22	1.23	0.93	0.01	300.45	0.97	0.00	417.70	20.11	94.34	0.01
σ^2 A/σ^2 D	2.42	0.96	0.40	0.11	2.23	0.15	4.00	1.34	12.16	0.00	1.51	0.68	9.79	2.00

and EC-32 1437 × Punjab Lal for the capsaicin content showed highest desirable positive *sca* effects. From the *sca* effect of certain crosses that was related to *gca* effect of its parents which involved one parent with high *gca* and the other parent with an average or poor *gca* it appears that both, the additive and non-additive genetic components play an important role in the inheritance of fruit yield and yield components. In view of high mean value and the *sca* effects the hybrids IC-119367 × Punjab Lal and EC-321437 × RHRC-CE could be considered the best exploitable combinations for the hybrid vigour and/or for generating still better recombinants, following intermating amongst selects in biparental mating fashion in early generations or recurrent selection.

Considering the significance of additive variance and the heritability estimates it is suggested that all the characters under reference respond favourably to direct selection [4]. On the other hand, non-additive genetic components seem to play a major role for the characters *viz.*, primary branches, leaf area, first flowering initiation, fruit length and total dry fruit yield per plant as the magnitude of non-additive variance was much higher than that of estimated additive variance. Under this situation, exploitation of heterosis appears to be of great value.

The generation mean for most of the characters under study showed the importance of both additive and dominant type of gene effects. Among the epistatic component of gene effects additive × additive type of epistasis was more prevalent than dominance × dominance type of epistasis for most of the characters studied. However, additive gene effect, in general, was higher than dominant gene effect. Higher frequency of complementary type of epistasis further confirmed the prevalance of additive gene effect. Thus, the choice of parents for exploiting the gene effects should be based not only on the estimates of additive and dominance gene effects, but due care should also be given to epistatic effect.

Gene action on number of fruits/plant, fruit length, fruit diameter and total fruit yield/plant was found to be in accordance with that of earlier studies [4]. Likewise, the present findings on capsaicin content and ascorbic acid conformed to those of earlier repots [5-6]. The latter workers also reported the importance of both additive and dominance components in the control of various characters of *Capsicum*.

Based on the information derived from line × tester analysis regarding genetic variance and gene effects by generation mean analysis it is concluded that both additive and dominance type of gene effects along with the additive × additive and dominance × dominance types of epistasis are important in the inheritance of various characters in *Capsicum*.

Thus, breeding *Capsicum* for higher yield would require a breeding procedure which can simultaneously exploit both the additive and non-additive types of gene effects. Some form of recurrent selection and intermating of segregants in early generation which help mop up the favourable genes and also generate adequate recombinational variability for continued exploitation should be followed.

References

1. **Greefings Br.** 1956. Concept of general combining ability and specific combining ability in relation to diallel crossing system. Austr. J. Biol. Sci., **9**: 463-493.
2. **Hayman B. I. and Mather K.** 1955. The description of genetic interaction in continuous variation. Biometrics. **11**: 69-82.
3. **Hayman B. I.** 1958. The separation of epistatic from additive and dominance variation in generation means. Heredity. **12**: 371-390.
4. **Dolgikh S. T. and Sviridova L. A.** 1983. Combining ability of sweet pepper varieties in the plastic greenhouse. Genetica, **19**: 2037-2043.
5. **Tiwari V. P.** 1990. Development of high capsaicin chillies (*C. annuum* L.) and their implications for the manufacture of export products. J. Plantation Crops, **18**: 1-13.
6. **Khadi B. M.** 1984. Genetic studies on ascorbic acid content, fruit yield, yield components and accumulation of some mineral elements in chilli (*C. annuum* L.). Mysore J. agri. Sci., **18**: 316.