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COMBINING ABILITY FOR YIELD AND ITS COMPONENTS IN PUMPKIN

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ABSTRACT

Combining ability studies of an 8-parent diallel cross of pumpkin revealed contribution of both additive and nonadditive gene action controlling the expression of yield and its components except average fruit weight which was exclusively regulated by nonadditive gene effect. Epistasis was pronounced for all the characters. A close correspondence was observed between *per se* performance and combining ability effects for the attributes studied. Among parents, Pusa Vishwas ranked as top general combiner for yield and its components followed by Baidyabati and Ambili. Higher yield was mainly associated with increased number of fruits/plant, average fruit weight and flesh thickness. Most good specific combinations involved high × low general combiners. Exploitation of heterosis appeared to be limited. Ten crosses were identified for developing high yielding genotypes of pumpkin with other desirable characters.

Key Words : *Cucurbita moschata*, pumpkin, combining ability, yield components

Combining ability studies help to assess the prepotency of parents in hybrid combinations. A judicious choice of parents promotes in improvement process leading to a well planned hybridization programme. The combining ability studies in a single location may not provide precise information as the environmental effects greatly influence the combining ability estimates. In the present investigation, efforts were made to study the combining ability effects for yield and its components in pumpkin (*Cucurbita moschata* Duch. ex. Poir.) over two locations.

MATERIALS AND METHODS

A set of 8 × 8 diallel cross of pumpkin without reciprocals was evaluated along with their inbred parents, viz., Guamal local, Ambili, Baidyabati, Khurda local, Cuttack local, BBS 8, BBS 10 and Pusa Vishwas in a randomized block design with three replications simultaneously at two locations, i.e., Horticultural Research Station, Bhubaneswar and Regional Research Station, Bhawanipatna during rabi, 1994-95. Each

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of the 36 genotypes in a replication comprised of 4 hills spaced 2.0 m apart in a plot of 4.0 m × 4.0 m with 2 plants/hill. Normal recommended cultural practices were followed during experimentation to raise a successful crop for better phenotypic expression of characters. Observations were recorded on seven quantitative traits, viz., vine length, number of primary branches, number of female flowers and fruits/plant, average fruit weight, flesh thickness and yield/plant from four randomly selected competitive plants in each genotype at both locations. Progeny means pooled over environments were analysed to estimate combining ability following Griffing's Method-2, Model-I [1].

RESULTS AND DISCUSSION

Pooled analysis of variance for combining ability revealed that the mean squares due to general (gca) and specific combining ability (sca) effects were significant for all the characters except average fruit weight indicating the importance of both additive and nonadditive genetic variance in their inheritance. Significant mean square due to sca effect alone for average fruit weight suggested that the trait was exclusively governed by nonadditive gene action. The mean square estimates for location were significant for vine length, flesh thickness and number of primary branches and female flowers/plant explaining wide difference between the cropping environments. The interaction of gca and sca with location were nonsignificant for all the attributes except vine length denoting that the parents as well as the hybrids were resistant to environmental fluctuation.

The estimates of gca effect (Table 1) showed that the only parent Pusa Vishwas was a good general combiner for all the characters simultaneously. Baidyabati also displayed greater potentiality as a good general combiner for six attributes (except number of primary branches/plant) followed by BBS 10 for five (except number of fruits and yield/plant) and Ambili for four (except vine length, flesh thickness and number of primary branches/plant) out of seven traits studied.

It was observed that the parents which were high performing were also good general combiners for the respective characters. It can be inferred that the potential parents for breeding to improve the yield and its contributing characters in pumpkin, may be judged on the basis of their *per se* performance. The results are in consonance with [2-6].

Out of 28 crosses, two for vine length, two for number of primary branches/plant, three for number of female flowers/plant, three each for average fruit weight and number of fruits/plant, seven for flesh thickness and ten for yield/plant manifested

Table 1. Pooled estimates of general combining ability effects of parents for yield and its components in pumpkin

S. No.	Characters / Parents	Vine length (m)	Number of primary branches/ plant	Number of female flowers/ plant	Number of fruits/ plant	Average fruit weight (kg)	Flesh thickness (mm)	Yield/ plant (kg)
1.	Guamal local	0.06	–0.22*	–0.10	0.27*	–0.48*	–3.03*	–0.28
2.	Ambili	–0.19*	–0.23*	0.03	**0.32***	0.01	–2.00*	1.31*
3.	Baidyabati	**0.23***	–0.04	0.11	0.24	0.16	0.07	1.37*
4.	Khurda local	–0.17*	0.07	–0.32*	–0.28*	–0.07	–1.50*	–1.26*
5.	Cuttack local	–0.07	–0.01	–0.08	–0.18	–0.08	2.37*	–0.75
6.	BBS 8	–0.04	–0.12	–0.04	–0.35*	–0.11	0.37	–2.26*
7.	BBS 10	0.17*	**0.32***	0.02	–0.21	0.19	0.47	–0.13
8.	Pusa Vishwas	0.01	0.23*	**0.37***	0.19	**0.38***	**3.27***	**1.99***
	SE ($\hat{g}i$) ±	0.05	0.07	0.12	0.13	0.19	0.67	0.56

Significant at * P = 0.05; the figures in bold indicate the top gca effects for different characters

significant specific combining ability values. As the estimates of sca effect in most of the crosses were not very high and only a few hybrids expressed significant effects, exploitation of heterosis, using these parents, appears to be of limited value. Development of biparental progenies at successive generations may be followed under such circumstances. However, ten out of twenty eight cross combinations turned out to be promising for exploitation of hybrid vigour. Suneel Kumar [3], Sirohi *et al* [7] and Sirohi [8] noted appreciable heterosis for yield and its components in pumpkin, whereas Doijode [2], Doijode *et al.* [9] and Doijode and Sulladmath [10] reported less manifestation of heterosis for these traits in pumpkin.

None of the F_1 hybrids (Table 2) displayed simultaneous significant sca estimates favourably for all the characters studied. However, the cross combination Guamal local × Cuttack local was considered as the top specific combiner for yield and its major components. Comprehensive examination of three crosses, i.e., Guamal local × Ambili, Baidyabati × Khurda local and Khurda local × BBS 8 explained an inverse association between vine length and yield. It became obvious that higher yield was related to reduction in vine length [2]. Critical verification of the hybrids exhibiting significantly favourable sca effect for yield clearly demonstrated that higher yield was, to a large extent due to higher number of fruits/plant, average fruit weight

Table 2. Pooled estimates of specific combining ability effects of promising crosses for yield and its components in pumpkin

Character / Cross	Vine length (m)	Number of primary branches/ plant	Number of female flowers/ plant	Number of fruits/ plants	Average fruit weight (kg)	Flesh thickness (mm)	Yield/ plant (kg)
1 × 2	0.48*	–0.18	0.11	–0.18	–0.17	1.35	–1.54
1 × 3	–0.08	0.06	0.23	0.90*	–0.04	2.61	2.50
1 × 5	0.10	**0.86***	**2.33***	**2.15***	0.50	1.15	**10.48***
1 × 8	–0.06	0.61*	1.10*	1.45*	–0.02	**7.41***	6.66*
2 × 3	0.18	0.18	0.33	0.19	0.20	5.25	2.07
2 × 5	0.20	–0.02	0.45	0.77	1.56*	7.28*	8.56*
2 × 7	0.21	0.37	0.47	0.64	**1.76***	7.18*	8.98*
2 × 8	0.15	0.00	0.29	–0.26	–0.18	0.38	–1.85
3 × 4	**1.18***	0.05	0.03	–0.38	–0.43	2.08	–3.32
3 × 6	–0.31	0.00	0.67	0.52	0.25	–0.62	3.51*
3 × 7	–0.27	0.06	0.41	0.39	0.99	4.11*	4.80*
3 × 8	–0.01	0.04	0.59	0.32	0.98	2.15	4.51*
4 × 6	–0.40	0.05	0.21	0.37	–0.30	5.28*	0.56
4 × 7	–0.04	0.17	0.62	0.74	0.36	0.85	0.95
4 × 8	0.15	0.20	0.64	0.50	1.40*	4.88*	7.11*
6 × 8	0.04	0.18	1.19*	0.57	0.62	–0.65	3.97*
SE ±	0.16	0.23	0.38	0.40	0.59	2.04	1.71

Significant at *P = 0.05; The figures in bold indicate the top sca effects for different characters

and flesh thickness and to a lesser extent due to higher number of primary branches and female flowers/plant and shorter vine length. Since sca effect is considered as a measure of heterosis, it was inferred that the heterosis for yield was the cumulative or synergistic effect of heterosis for component characters. It would thus seem possible to achieve yield improvement in this crop by manipulating any or a number of specific component characters as per earlier findings [3, 5, 7-10].

A conspicuous feature was the record of negative sca effect of the hybrid Ambili × Pusa Vishwas for number of fruits and yield/plant though both the parents were good general combiners for these traits. This unusual phenomenon might be attributed to the lack of genetic diversity of alleles among the parents and accumulation of similar analogous alleles in the hybrid for the concerned characters.

Most of the hybrids which showed good *per se* performance also possessed favourably high sca effect (Table 3). This indicated that *per se* performance of hybrids were reflected in their respective sca effect. It is noteworthy that the crosses which displayed greater sca effects in desirable direction also exhibited favourably high heterosis over better parent. Hence the mean performance of hybrid could be considered as a criterion of sca effect and selection of promising crosses based on *per se* performance would be realistic [2, 4-6].

Table 3. The best five crosses (in descending order) selected on the basis of *per se* performance and sca effects for yield and its components in pumpkin (Pooled)

Characters	*Per se* performance	sca effect
Vinelength (m)	3×4, 6×7, 7×8, 1×2, 1×7	3×4(H×L), 1×2(H×L), 6×7(L×H), 1×4(H×L), 1×6(H×L)
Number of primary branches/plant	1×5, 7×8, 1×8, 4×7, 4×8	1×5(L×L), 1×8(L×H), 2×7(L×H), 2×4(L×H), 4×8(H×H)
Number of female flowers/plant	1×5, 6×8, 1×8, 3×8, 3×6	1×5(L×L) ,6×8(L×H), 1×8(L×H), 3×6(H×L), 4×7(L×H)
Number of fruits/plant	1×5, 1×8, 1×3, 2×5, 2×7	1×5(H×L), 1×8(H×H), 2×5(H×L), 4×7(L×L)
Average fruit weight (kg)	2×7, 4×8, 3×8, 2×5, 3×4	2×7(H×H), 2×5(H×L), 4×8(L×H), 3×7(H×H), 3×8(H×H)
Flesh thickness (mm)	1×8, 2×5, 5×8, 4×8, 2×7	1×8(L×H), 2×5(L×H), 2×7(L×H), 4×6(L×H), 2×3(L×H)
Yield/plant (kg)	2×7, 1×5, 2×5, 1×8, 3×8	1×5(L×L), 2×7(H×L), 2×5(H×L), 4×8(L×H), 1×8(L×H)

Low (L) and High (H) general combiners

It was evident that majority of the hybrids showing higher estimates of sca effect in desirable direction involve high × low gca parents and a few high × high and low × low combinations (Table 3). High sca effects manifested by crosses where both the parents were good general combiners might be assigned to sizeable additive × additive gene interaction. The high × low cross combinations besides expressing the favourable additive effect of the high parent manifested the complementary interaction effect and thus higher sca effect. However, a major part of heterosis displayed by such crosses may be due to additive × dominance and dominance × dominance type of gene action and was nonfixable. An appreciable portion of heterosis expressed by L × L crosses might be ascribed to dominance × dominance type of nonallelic gene action registering overdominance and were nonfixable. Thus, it is clear that the superior performance of most hybrids was largely due to epistatic interaction [2, 5].

The present investigation showed that ten hybrids namely Guamal local × Cuttack local, Ambili × BBS 10, Ambili × Cuttack local, Khurda local × Pusa Vishwas, Guamal local × Pusa Vishwas, Baidyabati × BBS 10, Baidyabati × Pusa Vishwas, BBS 8 × Pusa Vishwas, Khurda local × BBS 10 and Baidyabati × BBS 8 could be exploited for improvement in yield and its components in pumpkin. It is apparent that most of these hybrids involved atleast one good general combiner for one or more of the characters contributing towards fruit yield. This indicates that there is a strong tendency of transmission of specific genetic architecture for higher gain from the parents to the offspring. Such crosses are likely to throw up desirable transgressive segregates in subsequent generations if the additive genetic system present in the good general combiner and complementary epistasis if present in the cross acts in the same direction for maximum expression of the character under consideration. However, the best F_1 hybrid Guamal local × Cuttack local consisted of low × low gca parents for most of the traits including yield. Such poor combining parents are highly responsive to heterozygosity due to nonadditive gene effect conferring the advantage on capitalization of heterosis which can be utilized for hybrid breeding or production of homozygous lines in heterosis breeding programme [11]. It may be worthwhile to attempt population improvement through reciprocal recurrent selection, biparental mating or diallel selective mating to capitalize on additive genetic variance. Recombination breeding through multiple crosses involving high gca parents and high sca hybrids will also be a rewarding approach for amelioration of yield and its components in pumpkin.

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