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EXPRESSION OF HETEROSIS FOR HORTICULTURE TRAITS IN *RAPHANUS SATIVUS L.*

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Abstract

The heterosis in horticulture traits was studied in four varieties viz., long white, red long, red round and sparkler of *Raphanus sativus* L. Generally all F_1 hybrids exhibited heterosis over mid parent with respect to length, breadth and weight of leaves and length, diameter and weight of roots. The cross between long white and red long is better than superior parent in length and weight of leaves and length, weight and diameter of roots. Another cross between long white and sparkler and its reciprocal appear better for breadth of leaves. Moreover, six hybrids outyielded the better parents. A positive and significant correlation was observed between foliage weight and root diameter, leaf index and root diameter and foliage weight and root weight. This study shows that the genes responsible for different horticulture traits exhibit dominance and heterosis breeding is advantageous for the improvement of horticulture traits of *R sativus* L. Correlation analysis indicated that desirable plants could be selected at the vegetative stage.

Introduction

The use of F_1 seed of many vegetables has increased tremendously during the past few years in many countries. The reciprocal crosses between different varieties of *Raphanus sativus* produced not only the intermediate characters in some of the hybrids but also new shapes and colours of roots (Raicu & Popvici, 1965). In F_1 hybrids of *R. sativus* and *R. raphanistrum* root shape and number of branches were found to be ascendant whereas the diameter of roots was lesser as compared to that of the better parent (Lazukov, 1969). Four crosses made between different varieties of *R. sativus* gave heterosis with respect to root weight and total marketable yield (Brar, 1972).

Positive heterosis for yield components was reported in *Cucumis sativus* (Ghaderi & Lower, 1979), *Pisum sativum* (Chandel & Joshi, 1979), *Vigna mungo* (Sagar & Lal, 1979) and *Psophocarpus tetragonolobus* (De Silva & Omran, 1986). F_1 heterosis is of direct interest for developing hybrids in cross pollinated crops (Arunachalam *et al.*, 1984). In this study heterosis for horticulture traits over both mid and better parents in *R. sativus* L is reported.

Materials And Methods

The experimental material included four varieties of *R. sativus* L., viz., cv. Red long (R. L.), cv. Red round (R.R), cv. Long white (L.W.) and cv. Sparkler (S) (Nasir *et al.* ,

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1985) The experiment was laid in randomized complete block design with 4 replications and the crop was irrigated three times a week. Aphids were controlled by spraying the plants with 1% malathion, 3 times in the growing seasons. Weeding was done by hands. Two weeks after sowing the plants were thinned with 20 plants in each plot. At harvest time 40 plants were selected at random and the length, weight and breadth of leaves and length, weight and diameter of roots were recorded. Among qualitative traits surface of leaves and roots, colour and shape of flower and roots and pithyness of roots were recorded. Heterosis was estimated at maturity by the magnitude of the difference in mean performance between the F_1 hybrids and their midparent or better parent and expressed as % increase over midparent or better parent. The degree of ascendancy was determined by the potance ratio (Wigans, 1944) To evaluate the statistical differences between parental and hybrid means paired t-test was used. The numerical relationships were expressed by coefficient of correlation (Zar, 1974).

Results and Discussion

In most of the hybrids studied, heterosis for horticultural traits was observed. The vigour of the foliage collectively represented by length, weight and breadth showed that F_1 hybrids attained significant heterosis for these variables (Table 1). For length of leaves all single crosses except R.L X S and R.R X L.W exhibited significant and positive vigour over mid parents. For foliage weight all crosses except R.R. X L.W showed significant heterosis with respect to mid parent. Three hybrids viz., L.W X R.L; R.L X L.W and R.L X S out yielded their superior parents. Maximum increase was recorded in R.L X S. Foliage weight showed dominance of heavy over low weight in three

Table 1. Potance ratios and the differences of mean length, weight and breadth of leaves of F_1 hybrids of four varieties of *Raphanus sativus* L with respect to their mid and better parents.

Crosses	Length of leaves			Weight of leaves			Breadth of leaves		
	Difference (%)		Potance Ratio	Difference (%)		Potance Ratio	Difference (%)		Potance Ratio
	Mid Parent	Better Parent		Mid Parent	Better Parent		Mid Parent	Better Parent	
S x L.W.	+ 5.13*	1.066^{ns}	+0.75	+ 7.69**	–28.80^{ns}	– 0.076	+22.56**	+12.56**	+ 3.08
L.W x S	+ 4.19*	0.25^{ns}	–0.94	+10.16**	–24.99^{ns}	– 0.211	+25.00**	+16.10**	+ 3.182
R.L x L.W.	+ 0.87^{ns}	3.48^{ns}	–3.34	+22.63**	+13.74**	+ 2.41	+22.86**	–26.07^{ns}	– 1.466
L. W xR.L	+ 4.19*	1.86*	+2.07	+14.75**	+ 6.60**	+ 1.91	+11.10**	– 3.36^{ns}	+ 0.743
R.R. x R.L.	+ 4.34*	25.92^{ns}	–0.33	+26.34**	–19.46^{ns}	– 0.45	+21.57**	– 6.56^{ns}	– 0.653
R.L. x R.R.	+16.82**	17.06^{ns}	–0.36	+49.70**	– 4.50^{ns}	+ 0.86	+ 9.72**	–15.66^{ns}	– 0.144
R.R x L.W	+ 2.86^{ns}	23.87^{ns}	+0.04	+ 3.37^{ns}	–36.16^{ns}	– 0.072	+ 0.2247^{ns}	– 7.46^{ns}	– 0.078
R.L. x S	– 3.2^{ns}	8.05^{ns}	–0.611	+88.85**	+22.13**	+ 1.63	+ 1.12**	– 3.60^{ns}	+ 0.78

ns = Non Significant, * = Significant at 0.05 level of probability, ** = Significant at 0.01 level of probability.

Table 2. Potance ratios and the differences of mean length, diameter and weight of roots of F_1 hybrids of four varieties of *Raphanus sativus L* with respect to their mid and better parents.

Crosses	Length of root			Weight of root			Diameter of roots		
	Difference (%)		Potance Ratio	Difference (%)		Potance Ratio	Difference (%)		Potance Ratio
	Mid Parent	Better Parent		Mid Parent	Better Parent		Mid Parent	Better Parent	
S x L.W.	+ 3.92*	–15.40^{ns}	–0.043	+38.99**	+25.49**	+ 1.93	+20.91**	– 1.00^{ns}	– 0.96
L.W x S	+ 4.19*	–11.38^{ns}	–1.00	+67.46**	+22.09**	+ 1.81	+ 3.33**	–15.39^{ns}	+ 0.15
R.L x L.W.	+ 7.82**	+ 3.36**	+2.06	+25.55**	+14.34**	+ 2.60	+ 5.24**	– 4.91^{ns}	– 0.49
L. W xR.L	+10.59**	+ 7.59**	+3.51	+19.49**	+ 9.035**	+ 2.02	+34.67**	+21.67^{ns}	+ 3.24
R.R. x R.L.	+16.23**	-14.23^{ns}	–0.23	+ 5.98**	–28.74^{ns}	– 0.087	+19.27**	+18.84^{ns}	+ 7.33
R.L. x R.R.	+18.67**	– 3.37^{ns}	–0.81	+51.01**	–10.34^{ns}	+ 1.0	+25.45**	+25.00^{ns}	+ 9.30
R.R x L.W.	+ 2.867^{ns}	–25.08^{ns}	–0.07	+25.55**	+14.34**	+ 2.60	+47.5**	+ 6.88^{ns}	+ 1.69
R.L. x S	+12.5**	– 5.59^{ns}	–0.59	+26.52**	–12.93^{ns}	– 0.38	+ 6.91**	– 4.31^{ns}	– 0.49

ns = Non Significant, * = Significant at 0.05 level of probability, ** = Significant at 0.01 level of probability.

crosses viz., R.L X L. W; L.W X R.L; R.L X S. Significant dominant effects and substantial amount of heterosis has been reported in *Cucumis sativus* (Ghaderi & Lower , 1979).

All F_1 hybrids except R.R X L.W showed significant heterosis than the mid parent for breadth of leaves (Table 1), while the two reciprocal combinations of L.W and S were superior than the better parents. Maximum heterosis for breadth of leaves was observed in L.W. X S., which showed an increase of 16% over better parent. Uphof (1924) reported that the length of foliage in *R. sativus* was determined by a single factor pair and the heterozygotes were intermediate between two homozygotes. The present investigation showed that the F_1 individuals develop a strong foliage, though less vigorous than that of the superior parents. The F_1 generation produced by reciprocal crosses were alike and more vigorous than the parents.

The heterosis for root was determined by length weight and diameter (Table 2). Seven hybrids were found to be better than their mid parents for length of root, whereas 2 were superior than the better parents. Maximum increase was recorded in L.W X S. The results for root weight demonstrated that 5 of the F_1 crosses out yielded their better parents. Maximum yield (over better parents) was produced by F_1 of S. X L.W and it's reciprocal cross as the yields were 25 and 22% more than their respective superior parents. The increase in the yield of hybrids has also been reported in *R.sativus* (Jareeva, 1968; Brar, 1972) and *Sesamum indicum* (Bhagwan & Kamala, 1986). Increase in thickness of roots by hybridization has been reported by Lazukov (1969). In the present study all F_1 hybrids were significantly better in thickness of roots than their mid parents, and 4 of these hybrids were even better than their better parents (Table 2). The better individuals showed a potance ratio of more than one, which exhibited an over dominance.

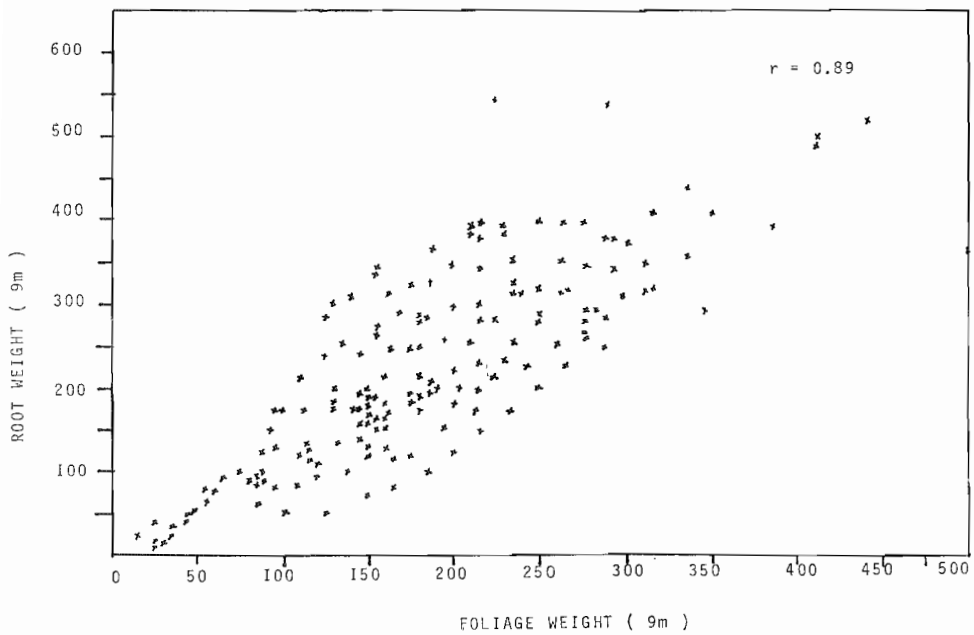

Fig. 1. Scattergram showing positive correlation between root weight and foliage weight.

The shape of roots of F_1 individuals was intermediate between the parents. When crosses were made between round and long shaped varieties i.e. R.L X S.L; W. XS; L.W XS , and R.R X L. W, the individuals developed a slender shape which resembled the long parent in length and round parent in thicknes. The hybrid showed a pronounced heterosis for the shape of root. When red and white varieties were crossed, the sufrace colour of petiole, midrib, side veins, flower, root and flesh colour of root became purple which could be due to incomplete dominance as suggested by Ponetsos & Baker (1967) . In red radishes the red pigment was found in the epidermis and two or three layers of cortex. The presence of malvidin and peonidin seems to be responsible for the purple and pelargonidine for red colour of the hybrids (Nasir *et al.*, 1985).

It is important to consider how far the other characters studied contribute towards the increase in yield of the hybrid. The coefficient of correlation for foliage weight vs root diameter (r=0.78) and leaf index vs root diameter (r=0.88) showed a positive association between them. Presumably the increase in thickness of root depends directly upon foliage weight and index, and this could be used as a criterion for the selection of long tap roots. Similar correlation has been studied by Banga & Smeets (1956). The coefficient of correlation analysis for foliage weight over root weight showed an inter-dependence (r=0.89, Fig. 1) . Among the hybrids a positive and significant correlation was observed between yield component in *Vigna mungo* (Sagar & Lal, 1979). Similarly, the root, shoot and leaf weight are positively and significantly correlated in *Catharanthus roseus* (Levy

et al., 1983). It would suggest that selection of plants should be done at vegetative state since plants having vigorous foliage tend to produce high yielding varieties. The genes responsible for size and weight of leaves and roots, and thickness and length of root exhibit dominance. Some crosses which show positive or negative non significant heterosis are not good enough for the expression of heterotic effect. The present and earlier results (Nasir *et al.*, 1985) suggest that it would be advantgeous to adopt heterosis breeding for improving the economic characters in radish provided correlation studies are used as selection criterion.

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