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POTENTIALITIES OF HETEROSIS BREEDING IN *PISUM*

M. N. SINGH, B. RAI AND R. M. SINGH

Department of Genetics and Plant Breeding, Institute of Agricultural Sciences
Banaras Hindu University, Varanasi 221005

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ABSTRACT

Economic heterosis for dry seed yield in 66 hybrids of pea (*Pisum sativum* L.) has been recorded up to 68%. Mean BP heterosis was maximum in the crosses involving exotic x exotic parents. Heterosis for yield was generally accompanied by heterosis for pods/plant. Two crosses, viz., T 163 x Bonneville and T 163 x Sel-2 could be considered promising heterotic crosses. Possibilities for the exploitation of hybrid vigour in pea are discussed.

Key words: *Pisum sativum* L., economic heterosis, residual heterosis.

The successful development and cultivation of hybrid rice varieties [1] has encouraged the plant breeders working with the self-pollinated crops to explore the possibilities of utilizing hybrid vigour for breaking the yield plateau in these crops. For such a breeding efforts, the knowledge about the extent of heterosis for grain yield as also spotting the best heterotic combinations is essential. The present study is an attempt to obtain information on this aspect in 66 pea hybrids.

Twelve diverse and ecogeographically distinct (5 exotic and 7 indigenous) cultivars/strains [2] of pea (*Pisum sativum* L.) were crossed in a diallel fashion excluding reciprocals. All the F_1 and F_2 progeny and their 12 parents were grown in compact family block design with three replications. Single-row plots of 2 m length were spaced 45 cm apart with plant-to-plant spacing of 15 cm. The parents and F_1s had single row each, while the F_2s had five rows. Observations on quantitative characters were recorded on 10 random plants in each plot. The F_1 hybrid performance was calculated as heterosis over better parent (BP) and economic heterosis (EH) (i.e. comparison of F_1 with the standard variety prevalent in the region). Inbreeding depression (ID) was calculated as per cent depression from F_1 mean to F_2 mean in each cross.

The extent of desirable (i.e. positive) BP heterosis and economic heterosis up to 228 and 68%, respectively was observed in the hybrids studied (Table 1). The crosses showing high positive heterosis also exhibited high level of inbreeding depression for seed yield. This indicates the importance of nonadditive gene action governing seed yield in pea, as was also reported earlier [2]. The feasibility of heterosis breeding depends on the extent of superiority of the F_1 hybrids over the best commercial/check varieties of the locality. In this context, 68% EH in the cross T 163 x Bonneville is very encouraging. Usually the yield heterosis more than 20% is considered to be adequate for commercial exploitation [3].

It has been generally observed that genetically/geographically diverse parents gave higher heterosis than genetically related ones [4]. The occurrence of highest heterosis for grain yield (68.1%) in the exotic x exotic (Table 2), followed by exotic x indigenous (60%) and indigenous x indigenous (45.3%) crosses, suggests that diverse parents of exotic origin should be selected for higher heterotic effects in this crop.

Among the component characters, maximum positive heterosis was observed for pods/plant, followed by plant height and number of primary and secondary branches, whereas negative heterosis was recorded for test weight, pod length and seeds/pod. This indicates that pods/plant is the main component for yield heterosis in this crop, as was also observed earlier [5]. Further, the effect of plant height on yield heterosis indicated that tall x medium tall and tall x dwarf combinations gave the highest values while tall x tall crosses, by and large, yielded negative heterotic effects (Table 1). Therefore, due consideration should be given while selecting the parents for heterosis breeding.

For commercial exploitation of heterosis in pea, though genetic male sterility has been reported [6, 7], suitable pollinator genotypes (flower with open keel) are yet to be located. Certain chemical gametocides including ethrel (2-chloroethyl phosphoric acid) have been reported to induce male sterility without affecting the ovule function [8]. Emphasis is, therefore, laid on exploring the possibilities of its utilization for producing pea hybrids. Anther culture technique, particularly in relation to early fixation of homozygosity through production of dihaploids, would be helpful in breeding hybrid varieties in short time. The other alternative for hybrid seed production on commercial scale is through residual heterosis [5], which usually results from fixable type of gene effects as observed in the heterotic crosses T 163 x Bonneville and T 163 x Sel. 2. It may be suggested to grow F_2, F_3 and F_4 generations of such of the highly heterotic crosses and evaluate their relative performance with the standard checks so as to observe the extent of useful residual heterosis present in advanced generations. If some of the pea populations supercede the check varieties in yield performance by a perceptible margin, this approach may help in breaking the yield barriers by exploiting the residual heterosis in this important pulse crop of our country.

Table 1. Heterosis (%) over better parent (BP), economic heterosis (EH) and inbreeding depression (ID) for economic traits in promising hybrids of pea

Hybrid	Plant type	Pods/plant			Seeds/pod			100-seed weight			Seed yield/plant		
		BP	EH	ID	BP	EH	ID	BP	EH	ID	BP	EH	ID
T 163 x Bonneville	Tall x medium	53.2	53.2	34.7	- 5.7	11.9	6.4	- 4.3	- 4.3	6.0	68.0	68.0	44.6
T 163 x Sel 2	Tall x medium	79.3	79.3	46.9	- 1.3	- 1.3	5.8	- 13.3	- 13.3	- 1.8	65.0	65.0	48.3
T 163 x GC 141	Tall x medium	40.5	40.5	29.8	0.8	38.9	11.6	- 22.5	- 22.5	- 1.3	55.1	55.1	34.9
B 5064 x Early December	Tall x dwarf	179.3	25.8	21.4	4.2	24.8	10.2	17.6	- 16.0	12.3	228.4	41.0	37.8
B 5064 x GC 141	Tall x medium	142.8	34.8	24.7	- 15.5	16.7	- 5.2	16.6	- 23.8	7.7	150.8	30.3	26.6
B 5064 x A 474-288	Tall x dwarf	146.3	77.1	38.8	4.9	- 1.3	- 1.7	- 2.8	- 36.0	8.8	149.9	23.1	42.4
GC 141 x EC 33866	Medium x dwarf	81.0	0.6	24.0	3.0	42.1	- 0.6	- 5.4	- 25.5	3.5	132.4	20.8	26.7
L 116 x GC 322	Tall x dwarf	71.6	52.9	44.8	- 16.0	11.6	- 2.4	13.2	- 18.5	8.6	120.1	54.9	48.6
GC 322 x EC 33866	Dwarf x dwarf	111.1	- 8.5	11.7	7.1	42.4	1.4	- 8.7	- 27.9	- 0.4	111.7	7.9	16.2
EC 33866 x Early December	Dwarf x dwarf	40.3	- 46.2	- 40.2	18.8	42.8	3.7	8.0	- 14.9	3.5	81.6	- 22.1	21.5
T 163 x L 116	Tall x tall	6.9	6.9	33.6	- 7.6	- 7.1	7.7	- 22.3	- 22.3	6.8	- 21.5	- 21.5	33.4
T 163 x B 5064	Tall x tall	- 31.3	- 31.3	- 40.4	3.5	3.5	14.1	- 7.6	- 7.6	21.6	- 33.7	- 33.7	- 5.2
B 5064 x L 116	Tall x tall	29.3	15.2	22.0	- 16.5	- 16.1	- 0.1	- 2.5	- 31.9	9.8	6.5	- 25.0	29.9
Mean		57.8	6.1	15.4	- 2.6	20.8	- 0.4	- 7.3	- 24.4	- 0.9	56.6	1.9	12.2
S.E.		3.08	3.08	1.89	0.28	0.28	0.18	0.24	0.24	0.16	1.67	1.67	0.98

Table 2. Range and mean BP heterosis (%) for grain yield in three types of crosses in pea

Character	Indigenous x indigenous		Indigenous x exotic		Exotic x exotic		Over-all
	range	mean	range	mean	range	mean	mean
Days to flowering	- 0.3–34.0	12.0	- 9.8–43.1	11.6	- 5.9–38.6	16.9	13.5
Days to maturity	- 7.2–7.6	- 2.1	- 8.3–8.6	- 2.2	- 6.8–1.0	- 2.0	- 2.1
Plant height	- 27.2–52.0	10.0	- 25.7–97.6	17.0	- 15.1–105.9	34.5	20.5
Primary branches/plant	- 23.5–58.3	11.5	- 22.5–58.3	15.4	- 14.0–40.0	20.4	15.8
Secondary branches/plant	- 48.8–151.5	8.8	- 41.2–345.5	25.8	- 32.8–158.2	26.5	20.4
Pods/plant	- 33.1–114.3	41.1	- 31.1–179.3	60.2	10.8–183.0	84.6	62.0
Pod length	- 18.5–11.8	- 6.1	- 15.5–11.4	- 2.6	- 9.6–4.8	- 3.4	- 4.0
Seeds/pod	- 16.0–14.4	- 2.8	- 27.2–18.8	- 1.3	- 26.1–9.8	- 6.9	- 3.7
100-seed weight	- 29.3–13.2	- 6.4	- 25.1–17.6	- 6.2	- 28.9–17.4	- 9.4	- 7.3
Yield/plant	- 33.7–120.1	45.3	- 33.7–228.4	60.0	- 23.2–149.9	68.1	57.8

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