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Studies on Combining Ability and Gene Action in PEA *(Pisum Sativum L.)*

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ABSTRACT

A study of 20 F_1 hybrids developed through Line x tester mating design by crossing ten lines as female parents viz; multifreezer, Burpean, GC-195, JP-747, VL-6, RPD 9-1, VG-9, JN-5, GC-66 and Early Badger and two tester (male) parents viz; Lincoln and VL-3 was carried out at University of Horticulture & Forestry, Regional Horticultural Research Station, Bajaura Kullu during Rabi 1995-96. The results indicated the presence of significant differences among crosses for pod yield and its component traits. The general combining ability and specific combining ability effects were highly significant indicating the presence of both additive and non-additive type of gene action. The ratio of additivevariance (6^2A) to dominance variance (6^2D) indicated the predominent role of non additive gene action for pod yield and related traits viz; pods/ plant, grain weight, days to pod maturity and shelling percent6age whereas additive gene action for plant height. Parents VG-9 and GC-195 were good general combiners for yield and its contributing traits. Crosses VG-9 × VL-3 and GC-66 × VL-3 had high specific combining ability effects for almost all the quantitative traits studied. This indicated the possibility of getting transgressive segregants in later filial generations. Based upon the nature of gene effects, delayed selection for getting stable yielding lines was suggested.

Pea *(Pisum sativum)* is one of the most important vegetable cash crops in the hilly tgracts of the Kullu valley of the Himachal Pradesh. But little empasis had been paid to the development of high yielding varieties in the past decade. It is impertive to study the genetic architecture of the available germplasm for its rational manipulation in the development of new cultivars through appropriate selection and breeding methodology. As the previous material of pea is largely unselected, in the present study, line x tester method has been adopted to study the nature of gene action in the promising cultivars.

MATERIALS AND METHODS

The experimental material comprised of F_1 populations of 20 crosses developed by crossing 10 genetically diverse genetypes of pea (Multifreezer, Burpean, GC-195, JP-747, VL-6, RPD 9-1, VG-9, JN-5, GC-66 and early Badger as female parents and Lincoln and VL-3 as tester (male) parents) in the line x tester mating design. The F1 populations, alongwith parents were grown in randomised block design with three replications at University of Horticulture and Forestry, Regional Horticultural Research Station, Bajaura during rabi 1995-96. The row length was 2 m long with plant to plant distance 10 cm and row to row distance 60 cm. All the recommended cultural operations were followed. The observations were recorded on randomly selected five competitive plants for various morphological characters. The covariance of half-sibs and full sibs were used for obtaining the estimates of general and specific combining ability effects and variances. Additive (6^2A) and dominance (6^2D) components of variance were worked out following standard method.

RESULTS AND DISCUSSION

The analysis of variance showed significant differences among the crosses for all the traits. Further partitioning of the mean squares due to crosses into lines testers and their intereaction (Table 1) revealed that mean squares due to lines and testers were significant for all the traints against error mean square but non-significant against interaction component indicating the significant differences exist among lines as well as testers but dominance component of gene effects predominates except testers for plant height where it is non-significant. Line x tester interaction also showed significant differences for all the traints except plant height indicating the genetic diversity exist for dominance component of gene effects for all the traits except plant height where only additive component of gene effects was predominant. So, ANOVA for com-

Table 1. Analysis of variance for combining ability and gene effects.

Source of variation	d.f	pods/ plant	Grain weight (g)	Green pod yield/ plant (g)	Days to maturity	Plant height (cm)	Shelling percentage
Lines	9	163.69**	380.21	1636.08**	19.61*	3812.20*	327.96**
Testers	1	9.96	28.85**	62.55**	14.00	72.38	33.22
Line X Testers	9	158.75**	953.23**	2769.44**	13.24	529.15	267.43**
Error	38	3.92	6.92	26.73	9.16	732.79	23.64
6^2 gca (F)		0.82	-9550	-188.94	1.06	547.17	10.09
6^2 gca (M)		-4.96	-30.81	-90.24	0.03	-15.23	-7.81
6^2 sca (M×F)		51.61	315.44	914.34	1.36	-67.88	81.26
CV (HS)		-3.99	-41.59	-106.69	0.19	78.51	-4.82
CV (FS)		43.62	232.24	700.95	1.75	89.13	71.61
6^2 A		-7.99	-83.19	-213.38	0.40	157.02	-9.65
6^2 D		51.61	315.44	914.34	1.36	-67.88	81.26

*, ** *Significant at 5% and 1% level respectively*

Table 2. Parents with good gca and their mean performance

Pods/plant		Brupean	GC-195	JP-747	VG-9
SE ± 0.61	gca	1.17	10.89	4.05	2.81
	X	19.40	18.27	22.73	19.93
		GC-195	JP-747	VL-6	VG-9
Grain weight (g)	gca	3.89	8.90	3.71	11.37
SE ± .81	X	20.00	35.50	32.00	36.33
Green pod		Multifreezer	GC-195	VL-6	VG-9
yield/plant (g)	gca	8.72	19.07	11.87	22.14
SE 1.58	X	53.80	48.02	103.00	67.00
Days to		JP-748	VL-6	RPD 9-1	Early Badger
maturity	gca	– 1.02	– 1.02	2.68	– 2.68
SE ± 0.93	X	152.00	151.00	151.33	153.67
Plant height (cm)		GC-195	RPD 9-1	VG-9	JN5
SE ± 8.29	gca	13.63	16.48	26.29	32.60
	X	138.00	158.00	242.67	129.60
Shelling		GC-195	VL-6	VG-9	Early Badger
percentage	gca	3.35	10.63	0.73	7.04
SE ± 1.49	X	58.47	68.97	66.29	45.36

bining ability shows genetic differences among lines and testers for combining ability. Singh *et al* (1985) and Rastogi et al (1987) also reported similar genetic difference.

The estimates of gca and sca variances indicated that the dominance components of variances (6^2D) were greater than the additive components (6^2A) for all the traits except plant height (Table 2) reflecting the pre-dominent role of non-additive gene action governing the inheritance of these traits and additive gene effects for plant height. As the dominance variance is greater than the additive variance, and crop is highly self pollinated and still there is no source of male sterile lines selection in later generations is suggested to have stable high yielding cultivars. The predominant role of non-additive gene action for the inheritance of green pod yield and related traits in pea was also reported by Sardana and Sarma (1994), Shome *et al* (1998) and Singh *et al* (1987).

GENERAL COMBINING ABILITY EFFECTS

The general combining ability indicated that lines VG-9 and GC-195 were good general combiner for green pod yield and all other traits except days to maturity where they were average general combiner so these lines should be involved in the crossing programme to exploit additive genetic variance. It was apparent from the Table-2 that these lines were not highest yield but had good transmission power of a character. The line JP-747 had high yield for green pod yield,

Table 3. Crosses with good sca effects and their mean performance

Pods/plant SE ± 0.61		Burpean X Lincoln	VL-6 X Lincoln	Multifreezer X VL-3	GC-195 X VL-3	VG-9 X VL-3	GC-66 X VL-3
	sca	8.60	8.67	4.46	2.85	6.73	2.88
	X	36.55	32.02	30.27	41.33	36.83	25.40
Grain wiehgt (g) SE ± 0.81		Burpean X Lincoln	VL-6 X Lincoln	Multifreezer X VL-3	JP-747 X VL-3	VG-9 X VL-3	GC-66 X VL-3
	sca	19.11	20.18	16.01	9.60	13.37	4.54
	X	73.67	80.33	73.70	76.33	82.93	58.10
Green pod yield/plant (g) SE ± 1.58		Brupean X Lincoln	VL-6 X Lincoln	JN5 X Lincoln	GC-195 X VL-3	VG-9 X VL-3	GC-66 X VL-3
	sca	28.42	30.45	19.89	25.41	28.81	11.88
	X	114.53	150.67	115.70	154.87	161.33	101.60
Days to maturity SE ± 0.93		GC-66 X Lincoln	VL-6 X Lincoln	RDP 9-1 X Lincoln	Multifreezer X VL-3	Early Badger X VL-3	GC-66 X VL-3
	sca	–1.52	–1.65	–2.52	–1.65	–1.48	–0.82
	X	148.67	148.33	146.00	150.33	148.00	153.33
Plant height (cm) SE ± 8.29		Burpean X Lincoln	JP-747 X Lincoln	RPD 9-1 X Lincoln	Multifreezer X VL--3	VG-9 X VL--3	GC-66 X VL--3
	sca	6.82	4.58	16.14	18.76	7.23	3.58
	X	137.83	122.73	149.51	108.17	148.22	90.29
Shelling percentage SE ± 1.49		Multifreezer X Lincoln	JP-747 X Lincoln	JN-5 X Lincoln	GC-195 X VL-3	VL-6 X VL-3	GC-66 X VL-3
	sca	6.39	13.39	3.71	10.35	4.87	3.5
	X	59.87	54.42	45.09	59.86	54.94	43.50

number of pods per plant, pod weight, but its gca effects were lower relative to VG-9 and GC-195 and was also poor combiner for shelling percentage. So instead of JP-747 lines VG-9 and GC-195 are better to be used in the breeding programme. The other lines mentioned in Table 2 had high gca for one or other character but least desirable to be included in the breeding programme for the simultaneous improvement of all these characters.

SPECIFIC COMBINING ABILITY EFFECTS

Crosses VG-9 × VL3 and GC 66 × VL-3 (Table 3) were likely to through transgressive segregants in the later generations and should be advanced further and screened properly to have high yielding recominant line. The former cross was better than the later as it involved one parent with high gca effects for most of the traits. It is also evident here that high sca was not associated with high mean performances. So for effective genetic manipulation we should relay on gene effects rather than mean performance. The later may hinder the breeder to realise the true genetic worth of the breeding material and exploit its full potential.

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