Genetic Variability, Correlation and Path Analysis in Pea (*Pisum sativum* L.)

RS Rathi[1]* and RPS Dhaka

[1]*National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012, India*
Department of Agriculture Botany, Kisan PG College, Simbhaoli, Ghaziabad, India

Thirty-five genotypes of indigenous and exotic origin were grown over eight environments to study the genetic variability, correlation and path coefficients among thirteen quantitative characters in pea (*Pisum sativum* L.). Wide range of variability was observed for most of the characters under study. Significant differences in the magnitude of PCV and corresponding GCV were observed for branches per plant, pods per plant, seed yield and harvest index suggesting greater role of environment in the expression of these traits. Plant height, grain yield per plant, dry matter yield, 100-seed weight and number of pods per plant had high phenotypic and genotypic coefficient of variations coupled with moderate to high estimates of heritability and expected genetic advances. Seed yield showed positive and significant association with number of pods per node. Seed yield was negatively associated with days to 50% flowering, days to green pod picking and days to maturity. Path coefficient analysis revealed that yield per plant is directly affected by number of pods per plant, dry matter yield, pod length, harvest index and number of seeds per pod and thus it may be treated as selection criteria for isolating higher yielding genotypes in pea.

Key Words: *Pisum sativum*, Genetic variability, Heritability, Genetic advances, Correlation, Path analysis

Introduction

Development of high yielding cultivars requires a thorough knowledge of the available genetic variation and also the extent of association among the traits of economic importance. It is well established fact that the differences among the plants, are the result of genetic difference among the plants, the environment in which they are growing and genotype environment interaction. Information on the relative magnitude of genotypic and phenotypic variances are important in judging the potential of germplasm and help in selection of parents for their use in breeding programmes.

Correlation studies provide an opportunity to study the magnitude and direction of association of one character with another, while path coefficient analysis gives the direct and indirect contribution of independent variables on dependent variable. Path analysis is a standardized partial regression coefficient, which splits the correlation coefficient into the measures of direct and indirect effects. It is important for a plant breeder to find out which of the characters are correlated with yield to bring about genetic improvement in crop plants. Hence, an experiment was conducted to study the genetic variability, correlation and path coefficients among yield and yield component traits in pea.

Materials and Methods

Thirty-five genotypes of pea of indigenous (27) and exotic origin (8) were evaluated in a randomized block design. Three replications each in eight environments were created by manipulating the dates of sowing and fertilizer dosages with N:P kg/ha 20:40 and 10:40 dates of sowing as 10-15 November and 25-30 December at experimental farm, Kisan Post Graduate College, Simbhaoli, Ghaziabad, CCS University, Meerut during *rabi* 1996-97, 1997-98. Each plot consisted of 3 m long row spaced at 45 cm apart and the plant-to-plant distance was maintained at 15 cm.

Observations were recorded on five randomly selected plants per genotype in each replication for the characters like days to flowering, days to green pod picking, days to maturity, pods/ node, dry matter yield (g), number of seeds/ pod, seed yield/ plant (g), harvest index and 100-seed weight (g). The data for eight environments was pooled and analysed. Standard statistical procedures were followed for estimating various genetic parameters. Phenotypic and genotypic coefficient of variations, heritability and genetic gain were calculated following the Burton and De Vane (1953). The genotypic and phenotypic correlation coefficients were calculated following Dewey and Lu (1959) and path analysis following the method of Fisher (1954).

Results and Discussion

Significant differences were observed among the genotypes for all the characters studied indicating presence of adequate genetic variability in the experimental material. The magnitude of genotypic

* *Part of Ph.D. thesis of the first author submitted to CCS Meerut University, Meerut (UP)*

coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were comparatively higher for seed yield per plant, dry matter yield, plant height and number of pods per plant as compared to other characters (Table 1). These findings are supported by earlier workers (Dhobal 1996; Vikas Singh *et al.,* 1996; Kumar *et al.,* 1998; Tyagi *et al.,* 1997). The lowest magnitude of GCV and PCV were observed for days to maturity. Marked differences between PCV and corresponding GCV were observed for harvest index, number of pods, number of branches, seed yield and dry matter yield per plants, confirming the predominance of GXE interaction and greater role of environment on the expression of these characters. Narrow differences observed between PCV and GCV values for 100-seed weight, days to maturity, days to flowering, pod length and plant height, indicated less environmental influence on the expression of these traits and these characters are rather stable. Therefore, selection based on these parameters may be comparatively more effective

Broad sense heritability was high (>70%) for 100-seed weight, plant height, days to flowering, days to maturity and pod length but observed low for number of pods per plant, harvest index, seed yield and number of branches per plant (Table 1). Similar results have also been reported by Singh (1995), Dhobal (1996) and Gupta *et al.* (1998). High heritability coupled with high genetic advance over the mean was observed for plant height, dry matter yield, 100-seed weight and grain yield per plant indicating the preponderance of additive gene effect and desired improvement in these characters can be brought through direct selection of these component traits. Mohanta *et al.* (2001) also observed high heritability coupled with high genetic advance for seed yield per plant, pods per plant, plant height, seeds per pod and 100-seed weight, suggesting additive gene effects. The findings also get supported by Kumar *et al.* (1998). Pod length and number of seeds per pod exhibited high heritability with low genetic advance indicating non-additive genetic effects. Low heritability estimates with low genetic advance were observed for branches per plant, number of pods per plant and seed yield per plant indicating high degree of non-heritable genetic effects for these characters in pea.

Grain yield is the result of interaction of a number of interrelated characters with positive and negative effects on yield per se. Therefore, selection should be based on those component characters which have positive correlation with grain yield. Character association reveals the mutual relationship between two characters and it is very important parameter for deciding the nature of selection to be followed by improvement in the crop under investigation. In general, the genotypic correlations were greater in magnitude than the corresponding phenotypic correlations. In the present study, the seed yield per plant was positively associated with number of pods per plant, dry matter yield per plant, pod length, number of seeds per pod and number of pods per node (Table 2). Kaloo *et al.* (1976) observed positive association of seed yield with number of pods per plant and number of pods per

Table 1. Estimation of genetic variability in pea (*Pisum sativum* L)

Characters	Mean	PCV (%)	GCV (%)	H (%)	G.A.	G.A. Over Mean (%)
Days to flowering	75.79	4.34	3.89	80.10	5.43	7.16
Days to green pod picking	99.89	4.23	3.05	52.10	4.53	4.54
Days to maturity	118.19	2.61	2.26	75.10	4.77	4.05
Plant height (cm)	89.25	32.46	29.16	80.70	48.16	53.96
No. of branches/plant	2.75	18.89	10.96	33.60	0.36	13.09
No. of pods/plant	11.53	31.45	15.03	22.80	1.71	14.83
Pod length (cm)	5.61	12.66	10.79	72.70	1.06	18.89
No. of pods/node	1.63	19.13	13.74	51.60	0.33	20.24
Dry matter yield (g)	27.87	35.59	24.36	46.80	9.57	34.34
No. of seeds/pod	4.61	14.57	10.66	53.80	0.74	16.05
Seed yield/plant (g)	9.07	41.30	24.40	35.00	2.69	29.66
Harvest index	31.50	21.23	10.23	23.20	3.20	10.16
100 seed weight (g)	16.04	16.11	15.82	96.50	5.13	31.98

PCV = Phenotypic Coefficient of Variation
GCV = Genotypic Coefficient of Variation
H = Heritability
GA = Genetic Advance

Table 2. Estimates of phenotypic and genotypic correlation coefficients among different thirteen characters

Characters		Days to flowering	Days to green pod picking	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pod length (cm)	No. of pods/ node	Dry matter yield (g)	No. of seeds/ pod	Seed yield/ plant (g)	Harvest index	100-seed weight (g)
Days to flowering	P	1.00	0.65**	0.77**	0.09	0.13	-0.16	-0.10	0.13	0.14	-0.32	-0.12	-0.35	0.23
	G	1.00	0.89**	0.91**	0.09	0.22	-0.33	-0.12	0.22	0.15	-0.50	-0.20	-0.72	0.26
Days to green pod picking	P		1.00	0.69	0.05	0.05	0.06	-0.03	0.70	0.14	-0.21	-0.07	-0.23	0.22
	G		1.00	0.97	0.07	0.19	-0.21	-0.04	0.23	0.24	-0.36	-0.12	-0.58	0.31
Days to maturity	P			1.00	0.22	0.10	0.03	0.02	0.10	0.31	-0.28	-0.07	-0.22	0.41*
	G			1.00	0.07	0.27	0.09	0.03	0.21	0.45**	-0.41	0.15	-0.45	0.48**
Plant height (cm)	P				1.00	0.34**	0.26	-0.13	-0.44	0.55**	-0.04	0.20	-0.28	0.18
	G				1.00	0.63**	0.43*	-0.19	-0.62	0.68**	-0.21	0.23	-0.56	0.20
No. of branches/ plant	P					1.00	0.32	-0.16	-0.10	0.40**	0.06	0.22	-0.09	-0.04
	G					1.00	0.44*	-0.34	-0.43	0.73**	-0.07	0.16	-0.68	-0.09
No. of pods/plant	P						1.00	0.07	0.21	0.67**	0.06	0.83**	0.37*	0.09
	G						1.00	0.06	0.14	0.82**	0.13	0.79**	0.20*	0.20
Pod length (cm)	P							1.00	0.52**	0.18	0.50**	0.35**	0.35	0.39**
	G							1.00	0.76**	0.23	0.60**	0.57**	0.75**	0.46**
No. of pods/node	P								1.00	0.11	0.25	0.36**	0.45**	0.30
	G								1.00	0.09	0.29	0.57**	0.81**	0.42*
Dry matter yield (g)	P									1.00	0.09	0.69**	-0.01	0.36
	G									1.00	0.10	0.80**	0.05	0.52**
No. of seeds/pod	P										1.00	0.30	0.40*	-0.16
	G										1.00	0.41	0.58**	-0.23
Seed yield/ plant (g)	P											1.00	0.55**	0.36*
	G											1.00	0.65**	0.61
Harvest index (%)	P													0.13
	G													0.28
100 seed weight (g)	P													1.00
	G													1.00

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

node. Teotia *et. al.* (1983) also observed that seed yield was positively associated with number of seeds per pod, length of pod and number of pods per plant. Seed yield was negatively associated with days to 50% flowering, days to green pod harvesting and days to maturity. This kind of association puts a significant limitation in breeding high yielding and early maturing varieties. Number of pods per plant had significant and positive association with dry matter yield per plant at both phenotypic and genotypic levels (Table 2).

Path-coefficient analysis helps in understanding the magnitude of direct and indirect contribution of each character on the dependent character, like grain yield in the present study. Partitioning of correlation coefficient into direct and indirect effects provide the information about the nature and magnitude of effects of other characters on seed yield. In present investigation, the path coefficient analysis (Table 3) revealed that direct and indirect effects at genotypic level were higher than corresponding phenotypic effects. Highest positive direct effect on seed yield per plant was exhibited by number of pods per plant (0.61), 100-seeds weight (0.26 g) and dry matter yield per plant (0.24 g). Highest indirect positive effect was observed via number of pods per plant (0.61), dry matter yield (0.16 g) and harvest index (0.23). Number of pods per plant, pod length, number of pods per node, dry matter yield per plant, number of seeds per pod, harvest index and 100-seed weight showed significantly positive correlation with seed yield per plant. It was observed that seed yield per plant is directly affected by number of pods per plant, harvest index and number of pods per plant while it is indirectly affected via number of pods per node, 100-seed weight, plant height and number of branches per plant. Thus, it appears that number of pods per plant, number of pods per node, number of seeds per pod, pod length, dry matter yield, harvest index

Table 3. Path coefficient analysis of phenotypic (P) and genotypic (G) correlation coefficient to determine the direct and indirect effects of different triats on yield in pea

Characters		Days to flowering	Days to green pod picking	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pod length (cm)	No. of pods/ node	Dry matter yield (g)	No. of seeds/ pod	Seed yield/ plant (g)	Harvest index	100-seed weight (g)
Days to flowering	P	0.14	-0.04	-0.03	-0.01	-0.01	-0.10	-0.001	-0.01	0.03	-0.07	-0.08	0.06	-0.01
	G	0.44	-0.09	-0.36	0.01	-0.08	-0.10	0.06	0.07	0.10	-0.26	-0.14	0.11	-0.20
Days to green pod picking	P	0.09	-0.06	-0.03	-0.01	0.00	-0.04	0.00	-0.01	0.03	-0.04	-0.05	0.06	-0.07
	G	0.38	-0.10	-0.35	0.01	0.07	-0.16	0.02	0.07	0.16	-0.18	-0.11	0.12	-0.12
Days to maturity	P	0.11	-0.04	-0.04	-0.02	0.00	0.02	0.00	-0.01	0.08	-0.06	-0.09	0.11	-0.07
	G	0.40	-0.10	-0.36	0.03	-0.10	0.03	-0.02	0.06	0.31	-0.21	-0.09	0.19	0.15
Plant height (cm)	P	0.01	0.00	-0.01	-0.09	-0.01	0.16	0.00	0.04	0.13	-0.01	-0.06	0.05	0.20
	G	0.04	-0.01	-0.09	0.12	-0.23	0.12	0.10	-0.19	0.46	-0.06	-0.11	0.08	0.23
No. of branches/ plant	P	0.02	-0.003	-0.01	-0.03	-0.04	0.19	0.00	0.01	0.10	0.01	-0.02	-0.01	0.22
	G	0.10	-0.02	-0.10	0.07	-0.36	0.13	0.18	-0.13	0.50	-0.03	-0.13	-0.04	0.16
No. of pods/ plant	P	-0.02	0.00	-0.001	-0.02	-0.01	0.61	0.00	-0.02	0.16	0.01	0.09	0.02	0.83**
	G	-0.14	0.02	-0.03	0.05	-0.16	0.29	-0.03	0.04	0.56	0.07	0.04	0.08	0.79**
Pod length (cm)	P	-0.01	0.002	-0.001	0.01	0.01	0.04	0.01	-0.04	0.04	0.11	0.08	0.10	0.35**
	G	-0.05	0.004	-0.01	-0.02	0.12	0.02	-0.52	0.23	0.15	0.31	0.15	0.19	0.57**
No. of pods/ node	P	0.02	-0.004	0.00	0.04	0.004	0.13	0.01	-0.08	0.03	0.05	0.11	0.08	0.36**
	G	0.10	-0.02	-0.07	-0.07	0.15	0.04	-0.39	0.30	0.06	0.15	0.16	0.17	0.57**
Dry matter yield (g)	P	0.02	-0.01	-0.01	-0.05	-0.02	0.41	0.00	-0.01	0.24	0.02	0.00	0.09	0.69**
	G	0.07	-0.02	-0.16	0.08	-0.26	0.24	-0.12	0.03	0.68	0.05	0.01	0.21	0.80**
No. of seeds/pod	P	-0.04	0.01	-0.01	0.00	0.00	0.04	0.01	-0.02	0.02	0.22	0.09	-0.04	0.30
	G	-0.22	0.04	0.15	-0.01	0.02	0.04	-0.31	0.09	0.07	0.52	0.11	-0.09	0.41*
Harvest index (%)	P	-0.05	0.01	0.01	0.02	0.00	0.23	0.00	-0.04	0.00	0.09	0.23	0.03	0.55**
	G	-0.31	0.06	0.16	-0.07	0.25	0.06	-0.39	0.24	0.04	0.30	0.20	0.11	0.65**
100 seed weight (g)	P	0.03	-0.01	-0.02	-0.02	0.00	0.06	0.0.004	-0.03	0.09	-0.04	0.03	0.26	0.36*
	G	0.11	-0.03	-0.17	0.02	0.03	0.06	-0.24	0.13	0.35	-0.12	0.06	0.40	0.61**

and 100-seed weight can be considered as selection criteria for yield improvement in peas.

References

Burton GW and EH De Vane (1953) Estimating heritability in tall fescue from replicated clonal material. *Agron. J.* **45:** 478-499.

Dewey DR and KH Lu (1959) A correlation and path coefficient analysis of components of created wheat grass and population. *Agron. J.* **15:** 515-518.

Dhobal VK (1996) Morphological variation associated with green pod and dry seed yield in pea *(Pisum sativum* L.) *Advance in Hort. and Forestry*, Jodhpur, India, pp. 125-135.

Fisher RA (1954) *Statistical Method for Research Workers.* Hafner publ Co Inc New York, 12 ed. 356.

Gupta MK, JP Singh and VK Mishra (1998) Heritability, genetic advance and correlation analysis in pea (*Pisum sativum* L.). *Crop Res. Hisar* **16(2):** 202-204.

Kaloo G, BS Dhankar and Mangala Rai (1976) Variability and correlation studies in pea (*Pisum sativum* L.). *Haryana J. Hort. Sci.* **5(3&4):** 252-261.

Kumar D, Ashok Kumar, JS Hooda, D Kumar and A Kumar (1998) Analysis of variability parameters for some quantitative traits in field pea (*Pisum sativum* L). *Int. J. Trop. Agri.* **15:** 251-254.

Kumar Devendra, BPS Malik, Lekh Raj, D Kumar and L Raj (1998) Genetic variability and correlation studies in field pea (*Pisum sativum* L). *Legume Res.* **21(1):** 23-29.

Mohanta IC, N Senapati, KM Samal and A Dhal (2001) Genetic variability performance character association and coheritability in field pea (*Pisum sativum* L). *Legume Res.* **24(2):** 92-96.

Singh AK (1995) Genetic variability and heritability studies in pea (*Pisum sativum* L.). *Crop Res., Hisar* **10(2):** 171-173.

Singh Vikas, SP Singh, Rajvir and R Singh (1996) Variability and inheritance of some quantitative characters in pea (*Pisum sativum* L). *Annals of Biol.* **12:** 34-38.

Teotia AS, G Kaloo and BS Dhankar (1983) Correlation and path analysis in garden pea. *Haryana J. Hort. Sci.* **12(1-2):** 76-81.

Tyagi KK, AK Joshi and AK Singh (1997) Variability and association among grain yield and its component characters in pea (*Pisum sativum* L.). *J. Applied Biol., India* **7:** 1-4.