GENETIC VARIABILITY, CORRELATION AND PATH ANALYSIS STUDIES IN GARDEN PEA (*PISUM SATIVUM* L.)

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ABSTRACT

In a study conducted at Vegetables Research Institute, AARI, Faisalabad, Pakistan during 2005-06, 12 pea genotypes were planted in a randomized complete block design with three replications. The objective was to ascertain genetic variability, correlation and path coefficient of different traits. Analysis of variance revealed highly significant differences among genotypes for days to emergence, days to 50 percent flowering, number of pods per plant, weight of pods per plant (g), pod length (cm), number of seeds per pod, 100-seed weight (g) and green pod yield (kg/plot). Green pod yield per plot, 100-seed weight, number of pods per plant and weight of pods per plant showed high GCV accompanied with high heritability and genetic advance indicating good scope for selection. The correlation studies revealed that in general, estimates of genotypic correlation coefficient were higher than corresponding phenotypic correlation coefficient. Green pod yield per plot showed positive and significant correlation with number of seeds per pod and weight of pods per plant at genotypic and phenotypic levels. A strong association was observed between pod length and number of seeds per pod. The results suggested that these traits could be considered as major green pod yield contributing characters in garden peas. 100-seed weight, number of pods per plant, number of seeds per pod and days to 50 percent flowering exhibited maximum positive direct effect on green pod yield per plot, respectively. It indicated that these are main contributors towards yield. Based on results expressing character association and path coefficients for yield and its contributing characters, breeders should give attention to the characters like 100-seed weight, number of pods per plant, number of seeds per pod and days to 50 percent flowering while making selection of high yielding genotypes in garden pea.

KEYWORDS: *Pisum sativum;* genotypes; phenotypes; agronomic characters; Pakistan.

INTRODUCTION

Garden pea (*Pisum sativum* L.) relating to family leguminosae is an important winter vegetable crop in Pakistan due to its extraordinary qualities. Like pulse crops, peas are a rich source of protein having essential amino acids particularly lysine (cereals are low in lysine). This is the cheapest source of

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protein in diet. In Pakistan, peas were grown on an area of 11501 hectare during 2006-07 with a production of 91314 tons green pods with an average of 7.94 tons per hectare. It is mostly consumed as fresh vegetable in the form of green/fresh grains. Therefore, there is a dire need to develop high yielding genotypes of garden pea.

The possibility of improvement in any crop is measured by variability available in the crop. Hence, it is essential to partition overall variability into its heritable and non-heritable components with the help of genetic parameters like genetic coefficient of variation, heritability and genetic advance. Knowledge of correlation among different traits and further partitioning them into direct and indirect effects is one of approaches to understand nature and extent of such relationship. Some earlier workers (5, 6, 9, 11, 12, 13) reported considerable genetic variability in peas. Significant association between different traits were reported by Sharma *et al*. (11), Ramesh *et al.* (9), Chaudhary and Sharma (3), Kumar *et al.* (7) and Kumar and Sharma (8) whereas Ramesh and Tewatia (9) and Chaudhary and Sharma (3) reported direct and indirect effects for different traits in peas.

This study was conducted to obtain information on the genetic variability, character association and path coefficient for yield and its contributing characters in garden pea.

MATERIALS AND METHODS

These studies were conducted at Vegetables Research Institute, AARI, Faisalabad, Pakistan during 2005-06. Experimental material comprised 12 genotypes of garden peas viz. Climax, PF-400, Green Arrow, Tere-2, GRW-45, FS-21-87, 2001-60, NUYT-5, NUYT-2, DP-1-04, DP-2-07 and DP-1-11. Pure seed of each genotype was grown in a RCBD with three replications in a plot size of 6.0 × 2.5 meter. Sowing was done on 21st November, 2005 with 125 cm row and 10 cm plant spacing. All recommended agronomic practices were followed to raise good crop. The data were recorded on days to emergence, days to 50 percent flowering, number of pods per plant, weight of pods per plant (g), pod length (cm), number of seeds per pod, 100-seed weight (g) and green pod yield (kg/plot). Variability for recorded traits was estimated as per procedure for analysis of variance suggested by Steel and Torrie (15). The data were analysed using MSTAT-C 1.5.

Genotypic and phenotypic coefficients of variability, heritability estimates in broad-sense and genetic advance as percentage of mean were estimated

following Burton (2) and Allard (1). Path coefficient analysis was calculated according to Dewey and Lu (4).

RESULTS AND DISCUSSION

Highly significant differences among genotypes for all characters studied (Table 1) were observed. Significant difference among genotypes indicated to the existence of genetic variability. An effective breeding programme largely depends upon genetic variability. Thus, success of genetic improvement is attributed to the magnitude and nature of variability present for a specific character. The polygenic variation may be phenotypic, genotypic or environmental. The relative values of these three types of coefficients give an idea about magnitude of variability. Phenotypic coefficient of variation (PCV) was the highest (33.33 %) for number of pods per plant followed by pods weight per plant (21.65%) and green pod yield per plot (15.25 %) whereas, minimum value of PCV was recorded for pod length (5.96 %) (Table 2). The genotypic coefficient of variation (GCV) for green pod yield per plot was maximum (36.66 %) followed by number of pods per plant (29.55 %) and weight of pods per plant (19.41 %) while minimum for pod length (5.73 %) (Table 2). The environmental coefficient of variation (ECV) ranged from 1.66 percent (pod length) to 15.84 percent (green pod yield/plot). Interpretation of variability in terms of these coefficients is well documented (14). The highest values of phenotypic coefficient of variation for days to emergence, days to 50 percent flowering, number of pods per plant, weight of pods per plant and seeds per pod suggested not only the role of genotypes but also the environmental influence. Selection on the basis of these traits might be misleading whereas higher values of GCV were observed in 100-seed weight and green pod yield per plot than their corresponding phenotypic coefficient of variation (PCV). The highest GCV values than PCV values indicated a little influence of environment on expression of these traits and selection for these traits would be rewarding.

Table 1 Mean squares of different traits in garden pea.

Source of variation	d.f	Days to emergence	Days to 50% flowering	Pods/ plant	Weight of pods/plant (g)	Pod length (cm)	Seeds/ pod	100-seed weight (g)	Green pod yield (kg/plot)
Replications	2	0.528	4.694	11.154	37.646	0.000	0.122	3.83	3.321
Genotypes	11	2.088**	63.54**	136.53**	293.48**	0.605**	0.787**	105.69**	8.67**
Error	22	0.528	2.119	11.350	22.0879	0.016	0.030	3.428	0.508

*Significant, **Highly significant

Estimates of ECV were lower than corresponding estimates of GCV for all traits which indicated that these traits had little environmental influence in their expression (Table 2). Heritability estimates in broad sense were high for

all traits under study (78.62 to 92.46 %) except days to emergence (49.62 %). The highest estimates of heritability indicated, though a little environmental influence but selection may not be useful for improvement, as broad sense heritability is based on total genetic variance including additive, dominance and epistatic variances. The highest value of genetic advance as mean percent was obtained for green pod yield per plot (23.49 %) followed by number of pods per plant (21.32 %) and weight of pods per plant (13.57 %) (Table 2). It revealed that these characters were governed by additive genes and selection for improvement in these traits would be rewarded. In case of pod length, minimum value of genetic advance as mean percent (2.66 %) indicated that this trait was being governed by non-additive genes. In present investigation, characters like green pod yield per plot, 100-seed weight, number of pods per plant and weight of pods per plant showed high GCV accompanied with high heritability and genetic advance. It indicated considerable scope for selection as these traits were most likely to be controlled by additive gene effects. Earlier Burton (2), Chaudhary and Sharma (3), Kumar and Jain (6), Sharma *et al.* (11). Singh *et al*. (12) and Gupta *et al*. (5) also suggested that high GCV alongwith high heritability and genetic advance provided better view scope for selecting high yielding genotypes.

Table 2. Estimates of different genetic parameters for 8 traits in garden pea genotypes.

Trait	Range	Mean	Coefficient of variation %			Heritability (h^2 %)		Genetic advance
			PCV	GCV	ECV		Actual	Mean percentage
Days to emergence	9.67- 12.33	10.69	9.57	6.74	6.79	49.62	0.64	5.93
Days to 50% flowering	65.67- 84.33	77.47	9.57	5.84	1.88	90.62	2.33	3.00
Pods/plant	11.97- 33.86	21.86	33.33	29.55	15.41	78.62	4.66	21.32
Weight of pods/plant	32.81- 68.64	49.00	21.65	19.41	9.59	80.37	6.65	13.57
Pod length	7.05- 8.37	7.73	5.96	5.73	1.66	92.46	0.21	2.66
Seeds/pod	5.37- 7.13	6.17	8.61	8.14	2.80	89.37	0.27	4.42
100 seed weight	32.50- 51.07	40.17	6.14	14.54	4.61	90.86	2.96	7.37
Green pod yield (kg/plot)	2.33- 7.37	4.50	15.25	36.66	15.84	84.27	1.06	23.49

PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation,
ECV = Environmental coefficient of variation.

The correlation studies revealed that in general estimates of genotypic correlation coefficient was higher than corresponding phenotypic correlation coefficient, which indicated a strong inherent association among different

traits under study. The lower phenotypic values might be due to environmental interactions (Table 3). Similar observations were noticed in peas earlier (3, 7). Results indicated that days to emergence showed a

Table3. Genotypic (r_g) and phenotypic (r_p) correlation coefficients between different traits ingarden pea.

		Days to 50% flowering	Pods/plant	Weight of pods/plant	Pod length	Seeds/ pod	100-seed weight	Green pod yield (kg/plot)
Days to	r_g	0.197	0.446**	-0.301	-0.402*	-0.136	-0.418*	-0.489**
emergence	r_p	0.044	0.318	-0.210	-0.316	-0.104	-0.272	-0.228
Days to 50%	r_g		0.277	0.051	0.259	0.303	-0.566**	-0.074
flowering	r_p		0.217	0.087	0.276	0.311	-0.476**	-0.094
Pods/plant	r_g			0.518**	-0.500**	-0.322	-0.782**	-0.255
	r_p			0.448**	-0.436**	-0.240	-0.624**	-0.232
Weight of	r_g				-0.140	-0.016	-0.137	0.409*
pods/plant	r_p				-0.069	0.079	-0.074	0.362*
Pod length	r_g					0.734**	0.494**	0.342
	r_p					0.713**	0.468**	0.279
Seeds/ pod	r_g						0.187	0.485**
	r_p						0.209	0.428*
100-seed	r_g							0.151
weight	r_p							0.124

positive and significant association with number of pods per plant (0.446) which gave an understanding that an early emerging strain would give less pods as compared to late emerging strain. A negative and significant correlation of days to emergence was observed with pod length (-0.402), 100-seed weight (-0.418) and green pod yield per plot (-0.489) which indicated that decrease in days to emergence would lead to a significant increase in pod length, 100-seed weight and green pod yield per plot. Days to 50 percent flowering was negatively and significantly correlated with 100-seed weight at genotypic (-0.566) and phenotypic levels (-0.476) suggesting that delayed flowering would decrease 100-seed weight significantly. Positive and significant association of pods per plant with pods weight per plant at both levels (0.518 and 0.488) revealed that more number of pods per plant would contribute more pod weight per plant. However, this trait showed negative and significant genotypic and phenotypic correlations with pod length and 100-seed weight. A positive and significant correlation between pods weight per plant and green pod yield per plot was also noted at genotypic and phenotypic levels (0.409 and 0.362) indicating that these two traits are directly correlated. In case of pod length, a positive and significant correlation existed between number of seeds per pod and 100-seed weight at both levels which clearly indicated that increase in pod length would accommodate more seeds per pod which would ultimately result in 100-seed weight. Seeds per pod had a positive and significant correlation with green pod yield per plot both at genotypic (0.485) and phenotypic (0.428) levels. A very weak

association was observed between 100-seed weight and green pod yield per plot in this study, which suggested that environment played role in determining 100-seed weight. The ultimate goal of increased green pod yield per plot was achieved in view of increased number of seeds per pod, weight of pods per plant and pod length which are major yield contributing traits. Hence, for effective yield improvement in garden pea selection should be made for higher values of number of seeds per pod, pods weight per plant and pod length. The present results confirm the findings of Ramesh *et al.* (10) Chaudhary and Sharma (3), Kumar *et al.* (8) and Kumar and Sharma (7).

The direct and indirect relationship of pod yield per plant with competent traits and estimates of correlation among path analysis helps in indirect selection for genetic improvement in yield as shown in Fig. and Table 4. The data revealed that 100-seed weight had maximum positive direct effect on green pod yield per plot (3.1621), which was minimized by negative indirect effects

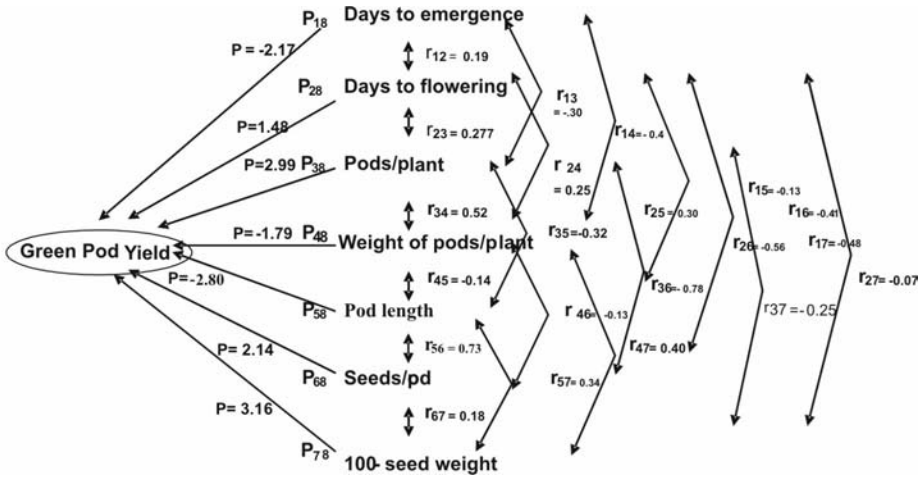

Fig. 1. Causal relationship of the path-coefficient analysis for peas green pod yield. Doubled-arrowed lines indicate mutual associations that are measured by correlation coefficients (r_{ij}), and single-arrowed liens represent direct influence as measured by path-coefficients (P_{ij}).
1 = Days to emergence, 2 = Days to flowering, 3 = Pods/plant, 4 = Weight of pods/plant, 5 = Pod length, 6 = Seeds/pod, 7 = 100-seed weight, 8 = Green pod yield.

Table 4. Direct and indirect effects of different traits on green pod yield in peas.

	Days to emergence	Days to 50% flowering	Pods/ plant	Weight of pods/plant	Pod length	Seeds/ pod	100-seed weight	r_g
Days to emergence	**-2.1703**	0.2922	1.3347	0.5403	1.1272	-0.2910	-1.3218	-0.4890
Days to 50% flowering	-0.4275	**1.4831**	0.8289	-0.0916	-0.7263	0.6491	-1.7897	-0.0740
Pods/plant	-0.9680	0.4108	**2.9925**	-0.9299	1.4021	-0.6900	-2.4728	-0.2550
Weight of pods/plant	0.6533	0.0756	1.5501	**-1.7951**	0.3926	-0.0340	-0.4332	0.4090
Pod length	0.8725	0.3841	-1.4963	0.2513	**-2.8041**	1.5724	1.5621	0.3420
Seeds/ pod	0.2952	0.4494	-0.9636	0.0287	-2.0582	**2.1422**	0.5913	0.4850
100-seed weight	0.9072	-0.8394	-2.3401	0.2459	-1.3852	0.4006	**3.1621**	0.1510

of pod number per plant (-2.3401) and pod length (-1.3852). Pods number per plant, seeds per pod and days to 50 percent flowering also exhibited positive direct effect on green pod yield per plot (2.9925, 2.1422 and 1.4831) whereas pod length (-2.8041), days to emergence (-2.1703) and pods weight per plant (-1.7951) had negative direct effect on green pod yield per plot. The data further revealed that days to emergence, days to 50 percent flowering and pods weight per plant showed maximum positive indirect effects through number of pods per plant on green pod yield per plot. Pod length showed maximum negative direct effect on green pod yield per plot but had maximum indirect effects through number of seeds per pod and 100-seed weight. These results indicated that 100-seed weight, pods per plant, seeds per pod and days to 50 percent flowering are main contributors towards yield which confirm earlier findings of Ramesh and Tewatia (9), Chaudhary and Sharma (3) and Kumar *et al.* (8).

It is concluded that sufficient genetic variability is present for all traits studied. Therefore, crop improvement could be made on the basis of this genetic variability. In view of character association and path coefficients for yield and its contributing characters, it can also be concluded that breeders should give attention on characters like 100-seed weight, number of pods per plant, seeds per pod and days to 50 percent flowering while selecting high yielding genotypes in garden pea.

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