



## Genetic variability and correlation in garden pea (*Pisum sativum* sub sp Hortense) for yield and yield attributing traits

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### ABSTRACT

Assessment of genetic variability and relationship among important horticultural traits was done in garden pea. There was wide variability among the 32 genotypes for all traits. Little or no difference between genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) for all traits confirmed low environmental influence on the characters under study. High PCV for pod yield (q/ha), number of pods/plant and average pod weight indicated additive gene action. High variability with high to moderate genetic advance for pod yield (q/ha), pod yield/plant, number of pods/plant, 10 pod weight, shelling percentage and plant height suggested additive gene action and ability of improvement through selection. Higher genotypic correlations revealed inherent association among traits. Strong character association of number of pods/plant with pod yield suggested it as selection criterion for high yield. Adequate genetic variability within germplasm indicates scope for genetic improvement of yield and quality traits. Pods/plant had maximum direct effect on pod yield. Conclusively, selection based on higher pods/plant, number of seeds/pod, average pod weight, pod width and plant height may improve pod yield.

**Key words:** Correlation, Genetic advance, Heritability, Hortense, Path analysis, *Pisum sativum* sub sp., Yield characters

Garden pea (*Pisum sativum* L sub sp. Hortense Asch. and Graebn.) commonly known as vegetable pea is a highly nutritive vegetable containing high percentage of digestible protein (amino acid, methionine and cysteine), carbohydrate, vitamin A, vitamin C and minerals like calcium, potassium, phosphorus and iron and holds a very coveted position as off-season double cropped, vegetable (cultivated twice in a year) in Kashmir, India. It gives cash revenue to farmers by selling the produce in neighbouring states and metropolitan cities as off-season. Farmers of the region are having edge over the growers of the plains in pea because it is free from powdery mildew disease, which is a major problem in plains. Besides, this annual legume is a significant contributor to agriculture sustainability because of its ability to fix the atmospheric nitrogen. In order to maximize such benefits, there is a need of genetic restructuring of garden pea for increasing the productivity of green pods to bridge the gap between potential yield and actual yield realized at farmers' field, considering the preference of consumers for long attractive green pods coupled with maximum sweeter seeds/

pod with high shelling percentage. However, the horticultural specification required in pea leaves the breeder with very limited options for improvement, as yield is a complex trait influenced by many component characters, which makes the direct selection based on yield performance ineffective. Success of a breeding programme depends on variability in the available germplasm. Knowledge in respect of nature and magnitude of associations of yield with various component characters is prerequisite to bring the improvement in desired direction. A crop breeding programme, aimed at increasing plant productivity requires consideration not only of yield but also its components that have direct or indirect bearing on yield. Correlation coefficient empowers a breeder to know the degree of association between the independent and dependent variable traits. Path coefficient analysis measures direct influence of one variable upon another and permits separation of correlation coefficient in component direct and indirect effect, which can be used for crop improvement through selection of component traits (Nalini *et al.* 2009, Sonia *et al.* 2011). Hence, an attempt was made with specific objectives to examine the genetic parameters of variability to identify major characters for achieving the higher yield.

### MATERIALS AND METHODS

The present investigation was carried out for two consecutive years, i.e. 2010-11 and 2011-12 at the

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experimental farm of Central Institute of Temperate Horticulture, Srinagar, J&K. The experimental farm is situated at latitude of 34°05 N and longitude of 74°50 E at an altitude of 1 640 m above the sea level. The experimental material comprised 32 genotypes (PS-1100, Arkel, PB-89, FC-1, AP-3, SP-1, PB-87, Kashi Samarth, VL-8, Pusa Pragati, Arka Kartik, VL-7, PMP-1, PSM-4, Pea No. 30, VP-266, VL-6, Early Giant, NDVP-8, JP-83, PMR-32, PM-69, Arka Sampurna, VP-9305, PB-88, Arka Ajit, PSM-1, CITH-P-1, VL-1, Kashi Mukhti, PSM-2 and VL-3). Seeds were sown on 15 November during both years at 30 × 10 cm with inter and intra row spacing in 6 m<sup>2</sup> plots with three replications under randomised block design. The soil of experimental field was loam with normal soil pH. The recommended uniform agronomic and cultural practices were adapted to obtain good and phenotypic expression of characters (package and practices, Shere-e-Kashmir University of Agricultural Sciences and Technology, Srinagar). The observations were recorded from 10 plants selected randomly in each plot and replications on plant height (cm), number of branches/plant, pod length (cm), pod width (cm), 10 pod weight (g), shelling percentage, pod yield/plant (g) and green pod yield (q/ha). Pooled data over the years were subjected to statistical analysis on agromorphological traits using XL STAT-2013 and SAS 9.2 software SAS Institute (2011).

## RESULTS AND DISCUSSION

The 32 genotypes involved in the study varied

significantly for all horticultural traits, except pod width (Table 1) as revealed by analysis of variance over the years. Maximum variability was observed for pod yield (q/ha), pod yield/plant, 10 pod weight, plant height and number of pods/plant. These results support the selection programme for better yield and quality of garden pea. The mean plant height ranged from 65.00-118.33 cm. The range of variation for number branches/plant, pod length and pod width was 8.00-19.17, 6.33-10.00 cm and 1.03-2.37 cm, respectively. Similarly, number of pods/plant and number of seeds/pod ranged from 12.67 to 70.00 and 6.00 to 9.67, respectively. The range of variation was also high for average 10 pod weight (30.16 to 96.47g), shelling percentage (35.95 to 58.51), pod yield/plant (47.14 to 276.92g) and green pod yield (66.03 q/ha to 492.30 q/ha (Table 2). The range and mean differences of studied traits indicated the existence of genetic variability among genotypes for the majority of the characters, which reflect the potential improvement of garden pea. Similar pattern of variability in germplasm evaluation of different sizes for various horticultural traits in garden pea have earlier been reported by Ghobary (2010), Tripathi *et al.* (2011) and Kumar and Sharma (2006) under their environmental conditions. The degree of variability shown by different characters can be judged by GCV and PCV. A close proximity in phenotypic and genotypic coefficient of variability was observed indicating a little influence of environment in the expression of various horticultural traits studied. This suggests that selection will be effective on the basis of genotype alone with equal chance of success. Similar

Table 1 Mean square of different traits in garden pea

Source of variation	Degree of freedom	Plant height (cm)	No of branches/plant	Pod length (cm)	Pod width (cm)	No. of pods/plant	No. of seeds/pod	10 pod weight (g)	Shell% (wt)	Yield/plant (g)	Yield (q/ha)
Replications	2	14.54	20.69	0.12	0.17	0.87	0.82	9.26	2.34	62.55	364.80
Genotypes	31	372.66**	75.76**	1.93**	0.23	338.84**	2.21*	603.47**	184.93**	782.84**	4126.62**
Error	62	19.76	8.80	0.26	0.09	2.00	0.33	6.35	3.45	45.12	189.24

\*\* Significant at 1% level, \* Significant at 5% level.

Table 2 Range, mean, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability and genetic advances (GA) in garden pea

Traits	Range	Mean ± Sem	Genotypic variance (%)	Phenotypic variance (%)	Phenotypic coefficient variation (%)	Genotypic coefficient variation (%)	Heritability in broad sense (%)	Genetic advance (%)	Genetic gain means (%)
Plant height (cm)	65.00-118.33	91.67±1.84	117.698	137.272	12.970	12.010	85.70	20.48	22.67
No. of branches/plant	8.00-19.17	13.65±0.56	22.309	31.114	26.160	22.151	71.70	8.21	38.50
Pod length (cm)	6.33-10.00	8.70±0.167	0.556	0.824	11.597	9.526	67.50	1.24	15.95
Pod width (cm)	1.03-2.37	1.78±0.091	0.047	0.141	29.322	16.950	33.40	0.258	20.37
No. of pods/plant	12.67-70.00	38.64±1.079	112.280	114.284	29.618	29.357	98.20	21.40	58.81
No. of seeds/pod	6.00-9.67	7.68±0.100	0.625	0.964	12.950	10.428	64.80	1.39	17.27
10 pod weight (g)	30.16-96.47	47.01±1.45	199.040	205.399	29.590	29.128	96.60	28.31	58.47
Shelling (%)	35.95-58.51	47.23±2.75	61.645	61.645	14.674	14.674	98.70	15.96	15.96
Pod yield/plant(g)	47.14-276.92	298.68±5.00	2412.572	2457.699	29.376	29.105	98.90	99.24	58.88
Yield (q/ha)	66.03-492.30	279.16±11.73	13312.461	13501.706	30.011	29.800	98.60	233.58	60.32

results were reported by Rathi and Dhaka (2007) in pea. The estimate of heritability acts as a predictive instrument exercising the reliability of phenotypic value. Therefore, it helps a breeder to make a selection for particular character when heritability is high. Genetic advance is useful indicator of the progress that can be expected as a result of exercising the selection on pertinent population. The heritability was very high for all the traits studied except pod width (33.4%) indicating less influence of environment on expression of these traits. Heritability coupled with genetic advance is more useful than heritability alone in predicting the result of selecting the best individual genotype as it suggests the presence of additive gene effects. High estimates of heritability alone with higher genetic advance for 10 pod weight (g), number of pods/plant, plant height and pod yield/plant and high heritability with moderate genetic advance in shelling percentage and number of branches/plant indicates that heritability of these traits is mainly owing to additive effects and consequently genetic gain is expected under such situation. Similar result has been reported by Singh *et al.* (2011) for these traits in field pea.

Association among different components of characters are due to pleiotropic gene action or linkage or both. Phenotypic correlation includes genetic and environmental effects, which provides information about total association between desirable characters. Phenotypic correlation provides association between two characters, whereas genotypic correlation provides a magnitude of genetic association between the characters and used in selection,

while environmental as well as genetic architecture of a genotype plays a vital role in achieving higher yield combined with better quality. Genetic and phenotypic correlation for green pod yield and its components in garden pea are presented in Table 3. The genotypic correlations were higher than their corresponding phenotypic correlation coefficient for all traits studied indicates strong inherent association between these traits which is in agreement with the findings of Chaudhary and Sharma (2003), Ghobary (2010) and Rathi and Dhaka (2007). Results indicate that pod yield per plant exhibited highly significant positive correlation with number pods per plant and pod width at genotypic and phenotypic level. A significant positive correlation with plant height, number of branches per plant and 10 pod weight was observed with pod yield and these characters may be considered a major pod yield contributing traits in garden pea. Hence, for effective crop yield improvement selection should be oriented towards the higher value for these component characters like number pods per plant, pod width, plant height, number of branches/plant and average 10 pod weights. Significant and positive correlation in pod yield/plant, number of pods/plant, pod width, plant height, number of branches/plant and 10 pod weights was also reported by Chet Ram *et al.* (2010), Rathi and Dhaka (2007) and Tripathi *et al.* (2011). Number of seeds/pod has significant and positive correlation with shelling percentage which indicated that maximum seeds/pod will enhance the shelling percentage. Similar results were reported by Rathi and Dhaka (2007) and Tripathi *et al.* (2011). Pod yield (q/

Table 3 Genotypic (G) and phenotypic (P) coefficient correlation estimation among the traits of pea genotypes

Traits		No. of branches	Pod length (cm)	Pod width (cm)	No. of pods / plant	No. of seed / plant	10 pod weight (g)	Shelling (%)	Pod yield / plant (g)	Pod yield (q/ha)
Plant height (cm)	G	0.094	0.482**	0.151	-0.116	0.119	0.121	0.055	0.007	0.024
	P	0.144	0.378**	0.127	-0.104	0.065	0.116	0.051	0.009	0.025
No. of branches /plant	G	1	0.321**	-0.052	0.329**	0.215*	0.162	-0.189	0.374**	0.338**
	P	1	0.275**	-0.082	0.281**	0.117	0.113	-0.160	0.297**	0.271**
Pod length (cm)	G		1	0.191	0.176	0.566**	0.175	0.184	0.325**	0.286**
	P		1	0.004	0.122	0.411**	0.158	0.151	0.252*	0.219*
Pod width (cm)	G			1	-0.075	-0.460	0.547**	0.157	0.478**	0.456**
	P			1	-0.058	-0.148	0.318**	0.091	0.263**	0.260**
No. of pods/plant	G				1	0.158	-0.407	0.074	0.500**	0.383**
	P				1	0.111	-0.408	0.073	0.499**	0.383**
No. of seeds/pod	G					1	-0.103	0.192*	0.065	0.078
	P					1	-0.083	0.155*	0.042	0.055
10 pod weight (g)	G						1	-0.038	0.560**	0.630
	P						1	-0.0381	0.559**	0.626*
Shelling (%)	G							1	-0.004	0.013
	P							1	-0.004	0.013
Pod yield /plant(g)	G								1	0.926**
	P								1	0.925**
Pod yield (q/ha)	G									1
	P									1

\*Significant at 5% level, \*\* significant at 1% level

Table 4 Estimates of direct (bold) and in direct of significant traits on yield of peas

Characters	Plant height (cm)	No. of branches/plant	Pod length (cm)	Pod width (cm)	No. of pods/plant	No. of seeds/pod	10 pod weight (g)	Shelling %	Genetic correlation with Pod yield (g/plant)
Plant height (cm)	<b>0.044</b>	-0.009	-0.075	0.021	-0.101	0.027	0.121	-0.004	-0.001
No. of branches/plant	0.004	<b>-0.095</b>	-0.050	-0.007	0.286	0.049	0.162	0.013	-0.026
Pod length (cm)	0.021	-0.030	<b>0.004</b>	0.027	0.153	0.130	0.176	-0.013	-0.022
Pod width (cm)	0.007	0.005	-0.030	<b>0.139</b>	-0.065	-0.105	0.550	-0.011	-0.033
No. of pods/plant	-0.005	-0.031	-0.027	-0.010	<b>0.870</b>	0.036	-0.409	-0.005	-0.034
No. of seeds/pod	0.005	-0.020	-0.088	-0.064	0.137	<b>0.229</b>	-0.104	-0.014	-0.004
10 pod weight (g)	0.005	-0.015	-0.027	0.076	-0.354	-0.024	<b>0.104</b>	0.003	-0.038
Shelling %	0.002	0.018	-0.029	0.022	0.065	0.044	-0.039	<b>-0.070</b>	0.004
Pod yield/plant(g)	0.000	-0.036	-0.050	0.066	0.435	0.015	0.563	0.000	<b>-0.068</b>

Residual effect -0.3032.

ha) recorded highly significant correlation at genotypic and phenotypic level for pod yield/plant (0.9263 and 0.9256), shelling percentage (0.0136 and 0.6263) and number of pod/plant (0.3833 and 0.3835), which indicates that for higher green pod yield (q/ha) of these component characters should be taken in account while making the selection. Path coefficient analysis is an important tool for partitioning the correlation coefficient into direct and indirect effect of independent variables on dependent variable. With the inclusion of more variables in correlation study their indirect correlation becomes more complex. Two characters may show the correlation just because they are correlated with common one. In such circumstances path coefficient analysis provides an effective means of critical examination of specific forces action to produce a given correlation and measures the relative importance of each factor. In this analysis pod yield (q/ha) was taken a dependent variables and rest of the characters were considered as independent variable. Path coefficient analysis splits the total correlation and coefficient of different characters in direct and indirect effect on pod yield in such a manner that the sum of direct and indirect effect is equal to genotypic correlation (Table 4). The data indicates that number of pods/plant showed the highest positive direct effect ( $r = 0.870$ ) on pod yield followed by number of seed/pod ( $r = 0.0229$ ), pod width ( $r = 0.139$ ), ten pod weight ( $r = 0.104$ ), plant height ( $r = 0.044$ ) and pod length ( $r = 0.004$ ). The positive indirect effect of plant height was found via pod width ( $r = 0.021$ ), number of seeds/pod ( $r = 0.127$ ) and 10 pod weight ( $r = 0.121$ ) whereas, number of branches per plant showed positive direct effect via plant height (0.004), number of pods/plant ( $r = 0.286$ ), number of seed/pod ( $r = 0.49$ ), 10 pod weight ( $r = 0.013$ ) and shelling percentage ( $r = 0.013$ ). Pod length reflected indirect effect on pod yield via plant height, pod width, number of pods per plant, number of seeds per pod and 10 pod weights. Pod width contributed to pod yield indirectly in positive way via plant height ( $r = 0.007$ ), number of primary branches ( $r = 0.005$ ) and 10 pod weight ( $r = 0.50$ ). Number of seeds/pod showed positive indirect effect on

pod yield (q/ha) via plant height and number of pods per plant, whereas 10 pod weight indirectly effected the pod yield via plant height ( $r = 0.005$ ) and shelling percentage ( $r = 0.003$ ). Shelling percentage positively contributed the pod yield (q/ha) indirectly via plant height ( $r = 0.002$ ), number of primary branches/plant ( $r = 0.018$ ), pod width ( $r = 0.022$ ), number of pods/plant ( $r = 0.065$ ) and number of seeds/pod ( $r = 0.044$ ), whereas pod yield per plant contributed to pod yield (q/ha) indirectly via pod width, number of pods/plant, number of seeds/pod and 10 pod weight. High positive direct effect on pod yield number of pods per plant number of seeds per pod, pod width, plant height and 10 pod weight and their significant and positive correlation with pod yield as well as high heritability with genetic advance suggest them as most important components for yield and thus more weight value should be given to these traits in improvement programmes. Similar observations have been made by Ghobary (2010) and Today *et al* (2008) which confirmed these results. The unexplained variation in genotypic path coefficient was 0.203. It indicated that 0.797% variation at genotypic level had been determined and further indicated that some more components that contributed to pod yield had not been included in the programme therefore some more traits may be considered while selecting the genotype for high pod yield in garden pea for Kashmir region.

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