Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP1: 435-438

Aziz-ur-Rahman
Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

Viveka Katoch
Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

Shweta Sharma
Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

Correspondence
Shweta Sharma
Department of Vegetable Science and Floriculture, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh, India

(Special Issue- 1)
2nd International Conference
"Food Security, Nutrition and Sustainable Agriculture - Emerging Technologies"
(February 14-16, 2019)

Studies on variability, correlation and path analysis in garden pea (*Pisum sativum* L.) for pod yield and its related traits under natural farming conditions

Aziz-ur-Rahman, Viveka Katoch and Shweta Sharma

Abstract
The present investigation was carried out to evaluate the eleven genotypes of garden pea for different horticultural traits under natural farming conditions. The analysis of variance showed significant differences among the genotypes. Magnitude of PCV was higher than the corresponding GCV for all the traits studied. High heritability coupled with high genetic advance was observed for number of seeds per pod indicating that trait is governed by additive gene effects and selection may be effective. Correlation studies revealed that pod yield per plant exhibit positive and significant association with all the traits under study both at genotypic and phenotypic levels. In path coefficient studies, number of pods per plant exhibit maximum positive direct effect on pod yield per plant followed by pod length, number of seeds per pod, shelling percentage, days to 50 per cent flowering and days to first picking at genotypic level and number of pods per plant followed by number of seeds per pod, pod length, shelling percentage and days to first picking at phenotypic level. Therefore, these traits can be considered as the most reliable selection indices.

Keywords: Garden pea, heritability, genetic advance, correlation and path analysis

Introduction
Garden pea (*Pisum sativum* L.), a member of Papilionaceae family, is one of the principal vegetable crops originated in Central Asia and Abyssinian region, grown during cool season throughout the world. In India, it is cultivated during winter season in northern plains and summer season in high hills. It is the second most important food legume worldwide after *Phaseolus vulgaris* (Tar'an *et al.* 2005) [9]. It is native of Mediterranean region with Near East and Ethiopia as secondary habitats (Blixt 1970) [2]. It is eaten as fresh, canned, frozen or in dehydrated forms. It ranks next to tomato as a processed vegetable (Talbert 1953) [8]. The size of frozen vegetable market in India is 9219.60 tonnes per annum, out of which 75 per cent is covered by peas only (Mahajan *et al.* 2011) [7]. Being biological nitrogen fixing legume, its value has long been recognized for maintaining and restoring soil fertility, conservation and improvement of physical properties of the soil by virtue of its deep root system. The knowledge about the magnitude and nature of genetic variability in the germplasm and the extent of heritable variation is a pre-requisite for the effective breeding programme. Pod yield is a dependent trait which is influenced by many other independent traits. The present study was undertaken to assess the nature and magnitude of association among yield and its contributing traits for selecting high yielding genotypes of garden pea under natural farming conditions. Keeping in view, the risk of health hazards encountered with the use of pesticides and inorganic fertilizers, lesser yield potential under natural farming can be compensated with high premium price.

Material and methods
The present investigation was carried out at the Experimental Farm of the Department of Vegetable Science and Floriculture, College of Agriculture, Chaudhary Sarwan Kumar

Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *rabi* 2015-16 and 2016-17 under zero input condition. It falls in mid-hill zone of Himachal Pradesh and is characterized by humid and temperate climate with an annual rainfall of 2,500 mm. The soil type is Alfisols typic Hapludalf clay having a pH of 5.7. The experimental material comprised of seven lines *viz.,* APL-55, APL-69, APL-80, APL-64, APL-84, Line 1-2 SPS5 and Line 1-2 SPS11 of garden pea along with four checks *viz*., Azad Pea-1, Lincoln, Palam Priya and Punjab-89. The experiment was laid out in randomized block design (RBD) with three replications. Each line along with four checks were grown in six rows (2.15m each) per plot (2.70 × 2.30m) in *rabi* 2015-16 and 2016-17 per replication. These lines were sown with inter and intra-row spacing of 45 cm and 5 cm respectively. N:P:K fertilizer @ 25:60:60 kg of N, P_2O_5 and K_2O were applied in the rows at the time of sowing. *Gan Jeevamrit* @ 494 kg/ha was applied in the rows at the time of sowing and *Jeevamrit* @ 494 L/ha was sprayed once before sowing, then later on after 20 days of sowing and 45 days after sowing for better growth. The standard cultural practices were followed to raise the crop as per the recommended Package of Practices for Vegetable Crops by CSK HPKV. Observations were recorded at appropriate stages of crop growth during both the seasons on characters *viz*., days to 50% flowering, days to first picking, pod length, number of pods per plant, number of seeds per pod, shelling percentage, plant height and pod yield per plant. The correlations were calculated as per Al-Jibouri *et al*. (1958) by using analysis of variance and covariance matrix. Direct and indirect contributions towards pod yield per plant obtained according to the method given by Dewey and Lu (1959) [5].

Results and Discussion

The analysis of variance revealed highly significant differences among the genotypes for all the characters studied (Table 1). It offers opportunity for improvement in yield and related traits in garden pea. Wide range was observed for days to 50 % flowering (93.67-100 days) and days to first picking (142.50-149 days), which determine the earliness of the genotype. Significant differences were observed with respect to pod length (6.41-7.51 cm), number of seeds per pod (5.17-6.98), number of pods per plant (7.70-9.22), shelling percentage (52.83-54.41 %), plant height (32.40-37.20 cm) and pod yield per plant (29.67-39.00 g).

Table 1: Analysis of variance for various horticultural traits in garden pea

Source Character	Mean Sum of Squares			
	Replications	Genotypes	Errors	Total
Df	2	10	20	32
Days to 50 per cent flowering	1.83	8.26*	2.06	12.15
Days to first picking	1.12	8.49*	1.12	10.73
Pod length (cm)	0.02	0.33*	0.01	0.36
Number of seeds per pod	0.03	1.65*	0.02	1.70
Number of pods per plant	9.26*	0.64*	0.09	9.99
Shelling percentage	0.00	0.50*	0.14	0.64
Plant height (cm)	6.35*	8.35*	1.00	15.70
Pod yield per plant (g)	162.03*	24.42*	1.15	187.59

*Significant at 5% level of significance

Magnitude of Phenotypic coefficient of variation (PCV) was higher than the corresponding Genotypic coefficient of variation (GCV) for all the traits studied which indicates that the environment plays important role in expression of these traits (Table 2). Phenotypic coefficients of variation (PCV) ranged from 0.96 % for shelling percentage to 12.97 % for number of seeds per pod. Whereas, genotypic coefficient of variation (GCV) ranged from 0.65 % for shelling percentage to 12.74 % for number of seeds per pod.

The estimates of heritability (broad sense) varied from 45.63-96.47 % for different traits under study. It was found high for the traits *viz.,* number of seeds per pod (96.47) and pod length (93.21). Moderate heritability was observed for pod yield per plant (87.07), plant height (71.13), days to first picking (68.16), number of pods per plant (66.09) and days to 50 per cent flowering (50.11) whereas, found low for shelling percentage (45.63).

Values of genetic advance ranged from 0.90-25.77 for the traits under study. High heritability coupled with high genetic advance was observed for number of seeds per pod indicating that trait is governed by additive gene effects and selection may be effective. High heritability coupled with low genetic advance for pod length and moderate to high heritability with low genetic advance for days to 50 per cent flowering, days to first picking, number of pods per plant, shelling percentage and plant height were recorded and indicates non-additive gene effects. Therefore, hybridization should be followed to improve the trait.

After gaining information regarding the genetic variability available in experimental material, the knowledge of association among different traits is important. As most of the traits of economic importance in the crop plants depend on one or the other traits and the degree of expression of one trait increases or decreases with the increase or decrease in the other trait. The findings clearly indicated that in general genotypic correlations were higher in magnitude than the corresponding phenotypic correlations, thereby suggesting strong inherent relationship among the traits studied (Table 3). All the traits *viz.,* number of pods per plant (0.987, 0.905), plant height (0.967, 0.738), number of seeds per pod (0.930, 0.877), pod length (0.869, 0.781), shelling percentage (0.710, 0.394), days to first picking(0.626, 0.545) and days to 50 % flowering (0.609, 0.426) had significant and strongly positive correlation with pod yield per plant both at genotypic and phenotypic levels. It indicated that these traits are useful for taking them as the basis of selection for high yielding genotypes. Days to 50 per cent flowering exhibited significant and positive correlation with days to first picking, pod length (cm), number of seeds per pod and number of pods per plant at genotypic and phenotypic levels and with plant height at genotypic level. Days to first picking showed significant and positive correlation with pod length (cm), number of seeds per pod, number of pods per plant and plant height at genotypic and phenotypic levels. Pod length was positively associated with number of seeds per pod, number of pods per plant and plant height at genotypic and phenotypic levels and with shelling percentage at genotypic level. Number of seeds per pod exhibited significant positive association number of pods per plant and plant height at genotypic and phenotypic levels and with shelling percentage at genotypic level. Number of pods per plant exhibited significant and positive association with shelling percentage at genotypic level and with plant height at genotypic and phenotypic levels.

The path coefficient analysis allows partitioning of correlation coefficients into direct and indirect effects of various traits towards dependent variable and thus, helps in assessing the cause-effect relationship as well as effective selection. Number of pods per plant (1.055) exhibited maximum

positive direct effect on pod yield per plant followed by pod length (0.218), number of seeds per pod (0.194), shelling percentage (0.157), days to 50 per cent flowering (0.021) and days to first picking (0.015) at genotypic level and number of pods per plant (0.539) followed by number of seeds per pod (0.326), pod length (0.154), shelling percentage (0.121) and days to first picking (0.043) at phenotypic level (Table 4). While plant height (-0.575, -0.077) exhibited negative direct effect on pod yield per plant both at genotypic and phenotypic levels and days to 50 per cent flowering (-0.018) showed negative direct effects on pod yield per plant at phenotypic level. Low direct effects of days to first picking and days to 50 per cent flowering on pod yield per plant was compensated by high indirect effect *via* by number of pods per plant. Residual effects at genotypic and phenotypic levels were low (0.01166 and 0.09923) which suggested that the variables chosen in the study might be sufficient to explain the dependable trait *i e*. pod yield per plant.

Flowering in garden pea lines started on an average by 4^{th} - 5^{th} standard meteorological weeks of *rabi* 2015-16 and 2016-17. During first cropping season average maximum temperature during 4^{th} - 5^{th} standard meteorological week was 13.1°C and 13.6°C and the minimum temperature was 3.90°C and 4.1°C whereas, in second year range of maximum temperature was 16.24°C and 17.53°C and the minimum temperature was 7.39°C during 4^{th} week and 6.87°C in the 5^{th} week. Temperature encountered in the second year of the trial was more favorable for the garden pea crop thus; higher yield was recorded in *rabi* 2016-17 as compared to *rabi* 2015-16. Amongst seven lines and four checks Line 1-2SPS5 was found to be the promising line as this line exhibited more number of pods per plant, long pods with more number of seeds per pod and more number of primary branches per plant and exhibit resistant reaction to powdery mildew.

Lesser pod yield was recorded under natural farming conditions and the possible reasons for low yield may be, the field selected for evaluation of the garden pea lines was put under natural farming conditions for the first time and the basic principle of natural farming is to accrue/ utilize soil micro flora to improve the soil health. In the present study soil micro flora might not have build up to the desired level as the soil micro flora augment the availability of nutrients from the soil to the plant. The nutrient availability to the plants due to stress (low soil micro flora) might have resulted in slow release of nutrients present in organic formulations. It might take few more years for conditioning of the soil and to build up soil micro flora to yield comparable with conventional farming. Gopinath (2009) [6], Chadha *et al*. (2013) [6] and Chadha (2015) [4] studied the performance of different varieties of pea (*Pisum Sativum* L.) under organic farming conditions.

Table 2: Estimates of parameters of variability for pod yield and other horticultural traits in garden pea

Traits	General Mean ± S.E.(d)	Range	Coefficient of variation		Heritability h^2bs (%)	Genetic advance	Genetic advance (% of Mean)
			PCV (%)	GCV (%)			
Days to 50 per cent flowering	96.70±1.17	93.67-100	2.10	1.49	50.11	2.10	2.17
Days to first picking	145.42±0.87	142.50-149	1.30	1.08	68.66	2.68	1.84
Pod length (cm)	6.85±0.07	6.41-7.51	4.96	4.79	93.21	0.65	9.53
Number of seeds per pod	5.79±0.12	5.17-6.98	12.97	12.74	96.47	1.49	25.77
Number of pods per plant	8.26±0.25	7.70-9.22	6.37	5.18	66.09	0.72	8.67
Shelling percentage	53.45±0.31	52.83-54.41	0.96	0.65	45.63	0.48	0.90
Plant height (cm)	34.06±0.82	32.40-37.20	5.45	4.60	71.13	2.72	7.99
Pod yield per plant (g)	32.49±0.88	29.67-39.00	9.19	8.57	87.07	5.35	16.48

Table 3: Estimates of phenotypic (P) and genotypic (G) correlation coefficients between pod yield per plant and other horticultural traits in garden pea

Traits		Days to first picking	Pod length (cm)	Number of seeds per pod	Number of pods per plant	Shelling percentage	Plant height (cm)	Pod yield per plant (g)
Days to 50 per cent flowering	P	0.656**	0.415*	0.464**	0.418*	-0.010	0.300	0.426*
	G	1.286**	0.544**	0.670**	0.607**	0.257	0.626**	0.609**
Days to first picking	P		0.480**	0.579**	0.496**	0.131	0.412*	0.545**
	G		0.593**	0.665**	0.624**	0.222	0.637**	0.626**
Pod length (cm)	P			0.853**	0.686**	0.259	0.846**	0.781**
	G			0.884**	0.937**	0.450**	1.042**	0.869**
Number of seeds per pod	P				0.809**	0.251	0.817**	0.877**
	G				0.985**	0.360*	1.002**	0.930**
Number of pods per plant	P					0.305	0.698**	0.905**
	G					0.542**	0.990**	0.987**
Shelling percentage	P						0.247	0.394*
	G						0.339	0.710**
Plant height (cm)	P							0.738**
	G							0.967**

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

Table 4: Estimates of direct and indirect effects of different horticultural traits on pod yield at phenotypic (P) and genotypic (G) levels in garden pea

Traits		Days to 50 per cent flowering	Days to first picking	Pod length (cm)	Number of seeds per pod	Number of pods per plant	Shelling percentage	Plant height (cm)	Pod yield per plant (g)
Days to 50 per cent flowering	P	-0.018	0.028	0.064	0.151	0.226	-0.001	-0.023	0.426*
	G	0.021	0.019	0.119	0.130	0.640	0.040	-0.360	0.609**
Days to first picking	P	-0.012	0.043	0.074	0.188	0.268	0.016	-0.032	0.545**
	G	0.027	0.015	0.129	0.129	0.658	0.035	-0.366	0.626**
Pod length (cm)	P	-0.008	0.021	0.154	0.278	0.370	0.031	-0.065	0.781**
	G	0.011	0.009	0.218	0.172	0.988	0.070	-0.600	0.869**
Number of seeds per pod	P	-0.008	0.025	0.131	0.326	0.436	0.030	-0.063	0.877**
	G	0.014	0.010	0.193	0.194	1.039	0.056	-0.577	0.930**
Number of pods per plant	P	-0.008	0.021	0.106	0.263	0.539	0.037	-0.054	0.905**
	G	0.013	0.009	0.204	0.191	1.055	0.085	-0.570	0.987**
Shelling percentage	P	0.000	0.006	0.040	0.082	0.164	0.121	-0.019	0.394*
	G	0.005	0.003	0.098	0.070	0.572	0.157	-0.195	0.710**
Plant height (cm)	P	-0.005	0.018	0.130	0.266	0.376	0.030	-0.077	0.738**
	G	0.013	0.009	0.227	0.195	1.045	0.053	-0.575	0.967**

Residual effects (P) = 0.09923; (G) = 0.01166 Bold values indicates direct effects, *Significant at 5% level, ** Significant at 1% level

Conclusion

In the present investigation, high heritability coupled with high genetic advance was observed for number of seeds per pod indicating that trait is governed by additive gene effects and selection may be effective. All the traits *viz.*, number of pods per plant, plant height, number of seeds per pod, pod length, shelling percentage, days to first picking and days to 50 % flowering had significant and strongly positive correlation with pod yield per plant indicating that these traits are useful for taking them as the basis of selection for high yielding genotypes. Path analysis revealed that number of pods per plant is the most important trait influencing pod yield per plant as it had the maximum positive direct effect. Therefore, emphasis should be given to genotypes with more number of pods per plant and low residual effect indicated that most of the traits influencing yield were included in the present study.

References

1. Al-Jibouri HA, Mikar PA, Robinson HP. Genotypic and environmental variance and co-variance in an upland cotton cross of site-specific origin. Agronomy Journal. 1958; 50:633-636.
2. Blixt S. *Pisum*. In: Genetic resources in plants: Their Exploration and Conservation. (OH Frankel and E Bennet, eds). International Biological Programme, Blackwell Scientific Publications Oxford, 1970, 321-326.
3. Chadha S, Rameshwar, Saini JP, Sharma S. Performance of different varieties of pea (*Pisum Sativum* L.) under organic farming conditions in mid Himalayas. International Journal of Agriculture and Food Science Technology. 2013; 4:733-738.
4. Chadha S. Comparative performance of pea genotypes under organic and conventional farming conditions. Journal of Hill Agriculture. 2015; 6:29-34.
5. Dewey DR, Lu KH. A correlation and path coefficient analysis of component of crested wheat grass seed population. Agronomy Journal. 1959; 51:515-518.
6. Gopinath KA, Saha S, Mina BL, Pande H, Kumar N, Srivastva AK. Yield potential of garden pea (*Pisum sativum* L.) varieties, and soil properties under organic and integrated nutrient management systems. Archives of Agronomy and Soil Science. 2009; 55:157-167.
7. Mahajan R, Garg S, Sharma PB. Indian frozen peas market: a case study on FPIL. International Journal of Globalization and Small Business. 2011; 4:154-169.
8. Talbert TJ. Growing fruits and vegetable crops. Lea and Febriger, Philadelphia, USA, 1953, p139.
9. Tar'an B, Zhang C, Warkentin T, Tullu A, Vandenberg A. Genetic diversity among varieties and wild species accessions of pea (*Pisum sativum* L.) based on molecular markers and morphological and physiological characters. Genome. 2005; 48:358.