Original Research Article

Correlation Coefficient and Path analysis of Pea (*Pisum sativum*L.)

Abstract

The present study was conducted during the rabi season of 2021-22 at Crop Cafeteria farm of Shoolini University, Solan (H.P.). The experiment consisted of 245 genotypes of pea with three check varieties viz., PB-89, PP and Arkel. The results indicated that seed yield/plant (g) exhibited positive and high significant correlations with 100-seed weight (g), biological yield/plant(g), harvest index (%) and number of pods/plant. Path analysis identified biological yield per plant (g) and harvest index (%) as important direct components for seed yield per plant. High yielding genotypes are- SHP 21, SHP73, JCR/JV-29, JCR/JV-39, IC 107452, 6363/P-3342, IC-629738, P-2236, P-2380, SHP 19, SHP17, SHP 51.

Key words:Rabi, season,varieties,genotypes

Introduction

Pisum sativum is a member of the family Fabaceae and the genus Pisum. It is the fourth-most widely grown pulse crop in the world, with three types of farmed peas: dry peas, green peas, and foraging peas. The most widely grown crop is dried pea, which was once mostly used as animal feed but is now often consumed by humans. According to the Food and Agriculture Organization, the Asia-Pacific region dominates the production of dried peas, followed by Europe. China is the main producer of peas, followed by India and the United States. In terms of both area and pea output, India is second in the globe. Globally, field pea is grown on over 6.27 million hectares with 11.16 million tons production and productivity of 1779 kg/ha. In India, field pea covers 0.76 million hectares area with production of 0.84 million tons and the productivity of 1100 kg/ha. Uttar Pradesh has the highest production and productivity of 0.38 million tons and 1495 kg/ha respectively and area of 0.3 million hectares area. Himachal Pradesh is the fifth leading pea-producing state of India with total production of 294.96 thousand metric ton. In Solan, pea production and productivity is 114200 (q) and 100 (q/ha) respectively with an area of 1142 (ha).

Peas are a nutrient-rich vegetable with high protein content, carbohydrates, vitamin A, vitamin C, calcium, and phosphorus. They are low in fat and cholesterol. Peas have a high-water content relative to their weight, with 90-96% water, which significantly impacts their qualitative traits. Peas have antibacterial, anti-diabetic, anti-fungal, anti-hypercholesterolemia, antioxidant, and anti-cancerous characteristics. Domesticated Pisum sativum has morphological characteristics that vary greatly, particularly in terms of pod quantity, pod form, pod length, seed number, pod maturity, and quality qualities. Successful conservation, protection, and exploitation of pea genotype variability in breeding programs, as well as the expansion of the genetic base of cultivated cultivars, depend on these traits. Correlation studies offer the chance to examine the strength and direction of correlation of one character with another. Path-coefficient analysis divides correlation into direct and indirect effects of yield components on seed yield, which gives a clearer picture of character association for creating an effective selection strategy. Understanding the correlations between the features is crucial for the development of a breeding project. Path analysis has

been researched in the majority of causal interactions since simple correlation analysis is unable to promote complete information about the relationship between dependent variables and predictor factors. Consequently, it is more beneficial to analyze the features that contribute to yield to study correlation together with path coefficient analysis.

Materials and methods

The experiment was conducted to evaluate 248 germplasm lines of pea with three popular check varieties viz., PB-89, PP and ARKEL. The experimental material was evaluated at Crop Cafeteria farm in Augmented Block Design during rabi (2021-22). The experimental field was divided into 7 blocks of equal size. Thirty-seven entries including checks were accommodated in each block. Each plot consisted of a single row of 5m length, inter and intra–row spacing of 30 cm and 10 cm respectively. The crop was raised following standard package of practices.

Observations Recorded:

Randomly, five plants from each plot were chosen to record observations on various characters. For various statistical studies, averages of the data of randomly chosen plants from each line in relation to various characters were considered. The following characters were recorded:

Quantitative traits:

1. Plant height (cm)
2. Days to first flowering
3. Days to 50% flowering
4. Days to maturity
5. Days of pod initiation
6. Number of pods/plant
7. Number of seeds/pod
8. 100-seed weight(g)
9. Biological yield/plant (g)
10. Seed yield/plant(g)
11. Harvest index (%)

The correlation coefficients were calculated following Pearson algorithm (1904).
Path coefficient was analyzed as per Dewey and Lu (1959). The assumption was made that seed yield is a dependent variable (effect) that is both directly and indirectly affected by each of the ten characteristics, the independent variable (causes), through other characters.

Experimental Results

The estimate of simple correlation coefficient among 11 characters under study are given in table 1.

Days to first flower showed positive and highly significant correlation with days to pod initiation. Positive significant correlations were observed with days to 50 per cent flowering and days to maturity.

The days to pod initiation showed positive and highly significant correlations with days to 50 per cent flowering. Positive significant correlations of days to pod initiation was observed for days to maturity. Pod initiation showed negative significant correlations with number of biological yield per plant per plant (g), 100-seed weight (g), seed yield per plant (g).

The days to 50 per cent flowering showed positive and highly significant correlations with days to maturity.

Days to maturity showed positive significant correlations with days to 50 per cent flowering, days to first flower, days to pod initiation and showed negative significant correlation with 100-seed weight and seed yield.

Pods/plant exhibited positive and highly significant associations with biological yield/plant (g), 100-seed weight (g) and seed yield (g).

Biological yield/plant/plant (g) showed positive and significant correlations with seed yield/plant (g), 100-seed weight (g), harvest index (%) and number of pods/plant and showed negative significant correlations were found with days to pod initiation. Harvest index showed positive and significant correlations with seed yield/plant, biological yield/plant and100-seed weight (g).

Seedyield/plant exhibited positive and significant correlations with biological yield/plant, harvest index, number of pods/plant and 100-seed weight and exhibited negative significant associations of seed yield/plant with days to pod initiation.

100-seed weight (g) showed positive and highly significant correlations with seed yield/plant (g), harvest index (%), biological yield/plant (g), number of pods/plant and exhibited highly negative significant association with days of pod initiation and plant height (cm).

Table 1: Estimates of simple correlation coefficients between eleven characters in pea genotypes

	Days to first flower	Days of pod initiation	Days to 50 per cent flowering	Days to maturity	Plant height(cm)	Number of pods/plant	Number of seeds/pod	Biological yield/plant (g)	100-seed weight (g)	Harvest index (%)	Seed yield(g)
Days to first flower	1.000	0.742*	0.375*	0.323*	0.006	-0.019	0.008	-0.132	-0.120	-0.012	-0.116
Days of pod initiation		1.000	0.647*	0.591*	-0.030	-0.064	0.028	-0.164*	-0.145*	-0.008	-0.143*
Days to 50 percent flowering			1.000	0.866*	-0.024	0.017	0.007	-0.131	-0.137	-0.085	-0.134
Days to maturity				1.000	-0.051	0.026	0.019	-0.054	-0.054	-0.010	-0.049
Plant height(cm)					1.000	0.037	0.043	-0.132	-0.149*	-0.130	-0.147*
Number of pods/plant						1.000	-0.144	0.194*	0.193*	0.104	0.195*
Number of seeds/pod							1.000	-0.098	-0.104	-0.084	0.105
Biological yield/plant (g)								1.000	0.977*	0.443*	0.975*
100-seed weight (g)									1.000	0.608*	0.997*
Harvest index (%)										1.000	0.629*
Seed yield(g)											1.000

Path coefficient analysis

Estimates of direct and indirect effects of different traits on seed yield/plant in path coefficient analysis using simple correlations are given in Table 2 and phenotypic path diagram for seed yield in Figure 1.

According to the study, the highest positive and substantial direct effects on seed yield/plant were exerted by biological yield/plant (0.76020) followed by harvest index (0.21790) and 100-seed weight (0.12100). However, other characters having positive direct effect on seed yield were number of seeds/pod (0.00130), days to maturity (0.0020), number of pods/plant (0.00170). The negative direct effects on seed yield/plant were exerted by days to pod initiation (-0.0009), days to 50% flowering (-0.0008), plant height (-0.0008).

100-seed weight (0.74270), harvest index (0.33670) and number of pods/plant (0.14770) had an indirect significant correlation on yield/plant via biological yield/plant; biological yield/plant (0.09650), 100-seed weight (0.13260) and number of pods/plant (0.02270) had an indirect significant correlation on yield/plant via harvest index; days to pod initiation (0.00120), days to first flower (0.00070) and days to 50 percent flowering (0.00180) via days to maturity showed positive indirect effects on seed yield.

On the other hand, plant height (-0.01800), number of pods/plant (-0.01250) and days to pod initiation (-0.01760) had an indirect correlation on yield/plant via 100-seed weight; days to pod initiation (-0.0001), number of seed/pod (-0.0002) via number of pods/plant; days to first flower (-0.0007) and days to 50 per cent flowering (-0.0006) had an indirect correlation on yield/plant via days to pod initiation. The estimates of indirect effects on the path coefficient were low to be considered important. The residual factor effects (0.1989) were recorded positive.

Table 2: Estimates of genotypic direct and indirect effects of 10 characters in pea germplasm

Traits	Days to first flowering	Days to pod initiation	Days to 50 percent flowering	Days to maturity	Plant height (cm)	Number of pods/plant	Number of seeds/pod	Biological yield/plant (g)	100Seed weight (g)	Harvest index (%)	Seed yield(g)

Days to first flowering	**0.00100**	-0.00070	-0.00030	0.00070	0.00001	0.00001	0.00001	-0.10000	-0.01450	-0.00250	-0.116
Days to pod initiation	0.00080	**-0.00090**	-0.00050	0.00120	0.00001	-0.00010	0.00001	-0.12440	-0.01760	-0.00170	-0.143*
Days to 50 percent flowering	0.00040	-0.00060	**-0.00080**	0.00180	0.00001	0.00001	0.00001	-0.09940	-0.01650	-0.01840	-0.134
Days to maturity	0.00030	-0.00050	-0.00070	**0.00200**	0.00001	0.00001	0.00001	-0.04110	-0.00650	-0.00220	-0.049
Plant height (cm)	0.00001	0.00000	0.00001	-0.00010	**-0.00080**	0.00010	0.00010	-0.10000	-0.01800	-0.02830	-0.147*
Number of pods/plant	0.00001	0.00010	0.00001	0.00010	0.00000	**0.00170**	-0.00020	0.14770	0.02340	0.02270	0.195*
Number of seeds/pod	0.00001	0.00001	0.00001	0.00000	0.00000	-0.00020	**0.00130**	-0.07470	-0.01250	-0.01830	0.105
Biological yield/plant (g)	-0.00010	0.00010	0.00010	-0.00010	0.00010	0.00030	-0.00010	**0.76020**	0.11820	0.09650	0.975*
100Seed weight (g)	-0.00010	0.00010	0.00010	-0.00010	0.00010	0.00030	-0.00010	0.74270	**0.12100**	0.13260	0.997*
Harvest index (%)	0.00001	0.00001	0.00010	0.00000	0.00010	0.00020	-0.00010	0.33670	0.07360	**0.21790**	0.629*

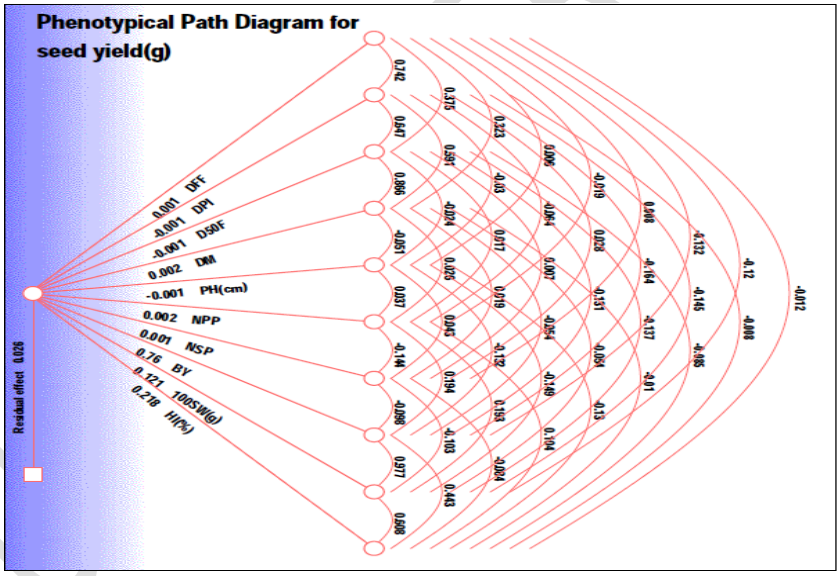

Figure 1: Phenotypic path diagram for seed yield of pea germplasm

Discussion

Correlation Coefficients

The importance of correlation coefficients in understanding the interactions between seed

yield and its component traits. The study calculated correlation coefficients among eleven characteristics and found that grain yield/plant was positively and significantly correlated with the number of primary branches/plant, plant height, and number of pods/plant. Path analysis revealed that plant height had a high positive and direct effect on grain yield/plant. It was also found that days to 50% flowering and pod length were directly affected grain yield/plant and had a positive significant association. In earlier studies, it was found that the key traits for selection for pea yield improvement were the number of leaves at the vegetative stage, number of leaves, days to first flowering, plant height (cm) at flowering stage, number of seeds/pod, individual seed weight, individual pod weight, pod coat weight, leaf area, and 100-seed weight (g). Similar traits were identified as the most critical components determining pea seed yield in some earlier studies. The high positive connection of seed production with these characteristics has already been documented in peas.

Seed yield/plant (g) is positively and highly significantly correlated with biological yield/plant (g), harvest index (%), number of pods/plant, and 100-seed weight (g). However, it has a negative significant association with days to pod initiation and plant height (cm), and a negative non-significant correlation with days to first flower, days to 50% flowering, days to maturity, and number of seeds/pod.

Biological yield/plant (g) is positively and highly significantly correlated with seed yield/plant (g), 100-seed weight (g), harvest index (%), and number of pods/plant. However, it has negative significant correlations with days to pod initiation and non-significant correlations with days to first flower, days to 50% flowering, days to maturity, plant height (cm), and number of seeds/pod.

The associations of biological yield/plant with the characters mentioned above seem logical as these traits are responsible for increasing either vegetative phase contributing straw yield or seed yield (g). Furthermore, plant height (cm) and pods/plant were strongly associated with each other and these traits add towards higher biomass.

Plant height showed positive non-significant correlations with number of seeds/pod, number of pods/plant, and days to first flowering. However, it had a negative significant correlation with 100-seed weight (g) and seed yield (g).

Number of pods/plant exhibited positive and highly significant associations with biological yield/plant, 100-seed weight (g), and seed yield (g). It showed non-significant correlation with days to 50% flowering, plant height (cm), harvest index (%), and days to maturity.

Harvest index showed positive and highly significant correlations with seed yield/plant, biological yield/plant (g), and 100-seed weight (g). This concluded that seed yield/plant (g),

harvest index, biological yield/plant (g), and number of pods/plant all had positive and significant associations with 100-seed weight.

Path-coefficient analysis

The paragraph explains that path coefficient is a technique used to split the correlation coefficients into measures of direct and indirect effects of yield components on seed yield to create a picture of character association for designing an effective selection strategy. Wright (1921) created the notion of path-coefficient analysis, which was initially utilised for plant selection by Dewey and Lu (1959). Path analysis differs from simple correlation in that the former focuses on cause and its relative relevance while the latter examines interdependence while ignoring cause. Through assessing the direct and indirect contributions of numerous characteristics to economic production, path analysis has grown into an effective and widely used method for estimating the relative worth of various yield-contributing qualities in agricultural plants.

The paragraph also states that biological yield/plant, harvest index, number of seeds/pod, days to maturity, and 100-seed weight all contributed significantly to seed output/plant. These characteristics have also been found in the literature as important direct factors to pea seed yield/plant.

The direct contribution of days to pod initiation and days to 50% flowering had a negative influence on seed output/plant. On the other hand, 100-seed weight (0.74270), harvest index (0.33670), and number of pods/plant (0.14770) showed positive and significant association with yield/plant via indirect effect of biological yield/plant; biological yield/plant (0.09650), 100-seed weight (0.13260), and number of pods/plant (0.02270) via harvest index showed high order positive indirect effect on seed yield/plant. Finally, days to pod initiation (0.00120), days to first flower (0.00070), and days to 50 per cent flowering (0.00180) showed positive and significant association with yield/plant via indirect effect of days to maturity.

The paragraph states that biological yield/plant, harvest index, days to maturity, plant height (cm), and number of seeds/pod all have significant positive direct and indirect effects on seed yield. The highest positive and significant direct effects on seed yield/plant were exerted by biological yield/plant (0.76020) followed by harvest index (0.21790) and 100-seed weight (0.12100). On the other hand, the negative and substantial direct effects on seed yield/plant were exerted by days to pod initiation (-0.0009), days to 50% flowering (-0.0008), and plant height (-0.0008).

Plant height (-0.01800), number of pods/plant (-0.01250), and days to pod initiation (-0.01760) showed negative indirect effects on seed yield/plant via 100-seed weight; days to pod initiation (-0.0001) and number of seeds/pod (-0.0002) showed negative indirect effects on seed

yield/plant via number of pods/plant; days to first flower (-0.0007) and days to 50 per cent flowering (-0.0006) showed negative indirect effects on seed yield/plant via days to pod initiation.

Path analysis indicated biological yield/plant (g), harvest index (%), days to maturity, plant height (cm), and number of seeds/pod as essential direct yield-contributing characters, which were also discovered to be beneficial indirect contributors. The most important indirect yield components were biological yield/plant (g), harvest index (%), and plant height (cm). These characteristics should be taken into account when establishing a selection strategy for generating high-yielding pea varieties.

Since characters like biological yield, harvest index, 100-seed weight, number of seeds/pod, number of pods/plant and days to maturity showed high direct effects. Therefore, they can be considered for direct selection for high seed yield in comparison to rest of the traits which are useful in indirect selection towards yield.

Conclusion

The study evaluated 248 pea genotypes for different features during rabi (2021-22) using Augmented Block Design. The experimental material comprised of 245 germplasm lines and three check varieties viz., PB-89, PP and ARKEL. High seed yield was produced by IC 629710 followed by SHP 42 and P-3132. For traits other than seed production, the most desired genotypes were JRC/JV-37 for early flowering, early pod initiation and early maturity; P-3518 for higher plant height (cm); IC 262829 for number of pods/plant; SHP 6 for maximum seeds in each pod; EC-838190 for biological yield/plant (g); IC-629710 for harvest index (%) and IC-629710 for 100-seed weight (g). Positive and highly significant associations were found between biological yield/plant and seed yield/plant followed by (g), harvest index (%) and 100-seed weight (g). Seed yield/plant (g) had negative significant correlations with days to plant height, days to first flower, days to pod initiation, days to 50 percent flowering and days to maturity. Path analysis identified harvest index (%) and biological yield/plant (g) as significant direct components for seed yield/plant (g). The indirect effects of 100-seed weight (g), harvest index (%) and number of pods/plant had a positive indirect effect on yield/plant via biological yield/plant. The traits were recognized as significant direct and indirect components that should be taken into account when formulating an efficient selection strategy for pea in order to create high yielding varieties.

References

Asha, A. B., Devaraju, S. V., Hanumantappa, M., Aghora, T. S., Ganapathi, M., & Chithra, K. Correlation and path analysis in garden pea (*Pisum sativum* var. *hortense*L.). Journal of Pharmacognosy and Phytochemistry. 2020;9(5):1728-1731.

Bahadur L, Devi B. Estimation of correlation and path analysis coefficient among yield and yield attribution trails of field pea (*Pisum sativum* L.). Journal of Pharmacognosy and Phytochemistry. 2021;10(1):1696-9.

Devi S, Nagar A, Kumar M & Kumar S. Morphological Characterization of garden pea (*Pisum sativum* L.) Germplasm through regression and principal component analysis. Pharma Innov J. 2021;10(3):449-53.

Dewey DR, Lu K. A correlation and path- coefficient analysis of components of crested wheatgrass seed production 1. Agronomy journal. 1959 Sep;51(9):515-8.

Manggoel W, Uguru MI, Ndam ON & Dasbak MA. Genetic variability, correlation and path coefficient analysis of some yield components of ten cowpea [Vigna unguiculata (L.) Walp] accessions. Journal of Plant Breeding and Crop Science. 2012 Mar 15;4(5):80-6.

Mishra R. Genetic variability and diversity analysis for improvement of yield and its related characters in fieldpea (*Pisum sativum* L.). Journal of Food Legumes. 2014;27(3):255-7.

Parihar, A. K., Dixit, G. P., Pathak, V & Singh, D. Genetic diversity and trait inter-relationship studies in a diverse set of field pea (*Pisum sativum* var. *arvense*L.) genotypes. Journal of Food Legumes. 2014;27(4):297-301.

Parihar, A. K., Dixit, G. P., Pathak, V & Singh, D. Genetic diversity and trait inter-relationship studies in a diverse set of field pea (*Pisum sativum* var. *arvense*L.) genotypes. Journal of Food Legumes. 2014;27(4):297-301.

Pratap V, Sharma V, Kamaluddin GS. Assessment of genetic variability and relationship between different quantitative traits in field pea (*Pisum sativum* var. *arvense*) Germplasm. Legum. Research. 2021;1:6.

Rajangam J, Selvi BS & Muthuselvi R. genetic divergence in pea (*Pisum sativum* L.). Plant Archives. 2014;14(2):887-91.

Rajangam J, Selvi BS & Muthuselvi R. genetic divergence in pea (*Pisum sativum* L.). Plant Archives. 2014;14(2):887-91.

Rathi RS, Dhaka RP. Genetic variability, correlation and path analysis in pea (*Pisum sativum* L.). Indian Journal of Plant Genetic Resources. 2007;20(02):126-9.

Sanwal, S. K., Kesh, H., Devi, J & Singh, B. Analysis of trait association and genetic diversity in garden pea (*Pisum sativum* var. *hortense*L.) genotypes under middle Gangetic Plain region of India. Legume Research-An International Journal. 2021;1:6.

Shah SM. Aman F, Ara N, Genetic diversity among pea (*Pisum sativum* L.) genotypes for maturity and yield traits. Sarhad Journal of Agriculture. 2021 Jun 1;37(2):386-97.

Sharma A, Sharma S, Kumar N, Rana RS, Sharma P, Kumar P & Rani M. Morpho-molecular genetic diversity and population structure analysis in garden pea (*Pisum sativum* L.) genotypes using simple sequence repeat markers. Plos one. 2022 Sep 16;17(9):e0273499.

Sharma MK, Chandel A & Kohli UK. Genetic evaluation, correlations and path analysis in garden pea (*Pisum sativum* var. *hortense* L.). Annals of Horticulture. 2009;2(1):33-8.

Spearman C. Correlation calculated from faulty data. British journal of psychology. 1910 Oct 1;3(3):271.

Srivastava A, Sharma A, Singh T, Kumar R. Correlation coefficient and path coefficient in field pea (*Pisum sativum* L.). International Journal Current Microbiology and Applied Sciences. 2018;7(2):549-53.
Tiwari S, Sharma RK, Kushwah SS & Pandey B. Correlation analysis on different characters in garden pea (*Pisum sativum* var *hortense* L.). International Journal of Conservation Science 2020;8(3):1180-3.
Tiwari S, Sharma RK, Kushwah SS & Pandey B. Correlation analysis on different characters in garden pea (*Pisum sativum* var *hortense* L.). International Journal of Conservation Science 2020;8(3):1180-3.
Vartika S, Lal GM, Kunj C & Singh CM. Estimation of genetic distance in field pea (*Pisum sativum* L.). Environment and Ecology. 2012;30(1):136-8.