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Estimation of Correlation and Path Coefficient for Yield and Yield Attributing Traits in Vegetable Pea (*Pisum sativum* L. var. *Hortense)*

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A B S T R A C T

The experiment was carried out at Department of vegetable science Chandra Shekhar Azad University of Agriculture and Technology Kanpur, U.P. during 2016-2017 in randomized block design with three replications. The observation was recorded on Plant height (cm), Days to first flowering, Days to 50% flowering, Number of primary branches per plant, Pod length (cm), Pod width (cm), Number of pods per plant, Number of podding nodes per plant, Shelling percentage, 100 seeds weight (g), Number of seeds per pod, Resistant to powdery mildew and yield per plant. The correlation analysis revealed that yield per plant exhibit a significant positive association with pods per plant, seeds per pods. Path coefficient analysis revealed that there was a very high significant direct positive effect of the pods per plant on yield per plant and Seeds per pods, days to 50% flowering and 100 seeds weight also had shown the direct positive effect on the yield per plant.

Introduction

Garden Pea (*Pisum sativum*) is a diploid (2n=2x=14) cultivated species of genus *pisum*, family fabaceae (Leguminosae) is native of region between Mediterranean and near East and is believed to evolved from *P. sativum* spp. *elatius* and *P sativum* spp. *humile* (Zohary and Hopf, 1973). However the exclusive origin and primary source of diversity of the crop ancestor is not well known (Davis1976). Vegetable Pea is an important vegetable crop grown mainly as winter vegetable in the plain of north India and as summer vegetable in hills of other states. Pea is utilized mainly as vegetable beside it is also Consume as pulse. It is mainly used as fresh vegetable or in soup or processed canned, or dehydrated forms. Vegetable Pea is leguminous crop which fix atmospheric nitrogen through their root nodules. This reduces the use of chemical fertilizers like urea and ammonium nitrate. Among various green vegetables grown in India table Pea has its prime position because of its divers uses. Mostly the cultivation of table peas are concentrated around cities or near marketing places where transportation

facilities and human labour for picking green pods and irrigation facilities are available. Such facility helps to collect the ready pods for transportation and proper marketing to get higher return. The available cultivars belong to three type of plant i.e. determinate, indeterminate and semi determinate associated with early, medium and late flowering. For the availability of green pod in all times to longer duration, the cropping system is launch in three types (early sowing to late sowing).

The available cultivars are poor yielder and not conducive economically for early sowing but early availability of pods is more remunerative. The major constraint in garden pea production is its infection by powdery mildew disease (caused by *Erysiphe pisi*, an obligate fungal pathogen). It adversely affects the garden pea cultivation by affecting the total biomass yield, number of pods/plant, number of seeds/pod, number of nodes (Gritton and Ebert 1975) and ultimately yield reduction from 25% to 86%, Nisar et al 2006).

Correlation studies help in determination of interrelationship between various plant characters. Simple correlation gives mutual association between two variables but they do not provide information about the cause and effects. Furthermore, when correlation studies involve many traits, the direct association becomes more complex. In such situation path analysis suggested by Wright (1921) provides an effective measure to find out the direct and indirect effects of association. Path coefficient analysis gives information about into the estimates of direct and indirect contribution of each character towards yield.

Materials and Methods

The experimental plant material consisted eighteen important germplasm (lines) maintained at Department of Vegetable Science CSAU&T Kalyanpur Kanpur were selected for the study. KS-224, KS-216, AP-5, KS-228, AP-3, KS-185, KS-205, KS-210, KS-222, AP-2, AP-4, KS-220, KS-223, KS-221, KS-225, AP-1, KS-219, KS-218.

The experiment was laid out in Randomized Block Design with three replications and observations to be recorded as Plant height (cm), Days to first flowering, Days to 50% flowering, Number of primary branches per plant, Pod length (cm). Pod width (cm), Number of pods per plant, Number of podding nodes per plant, Shelling percentage, 100 seeds weight (g) and Number of seeds per pod, Rsistant to powdery mildew and yield per plant.

Results and Discussion

Correlation coefficient analysis Correlation coefficient depicts the linear relationship between two variables (Table 1 and 2). Final character that the plant breeders are ultimately interested in yield and it envisaged that yield has complex inheritance and governed by several component characters, which are generally positively associated with yield. Increase in yield through improvement in one or a particular set of characters may adversely affect simultaneous gain for other characters referred to as genetic slippage.

Thus, it becomes imperative to characterize the nature and magnitude of association among yield and yield components which will be of great help in assigning rational weight to different component characters of yield during selection. In the present investigation, a highly significant phenotypic correlation was found between days to first flowering and yield per plant (0.799**). Thus, it can be concluded that one can get higher yield per plant by cultivating varieties.

Table.1 Phenotypic correlation coefficient

S.N.	Characters	Days to first flowering	Days to 50% flowering	Primary branches /plant	Pod length	Pod width	Pods per Plant	Podding nods per plant	100 seeds weight	Shelling %	Seeds/pod	Resistant to powdery mildew	Yield per plant
1.	height Plant	-0.071	-0.095	0.358	0.369	0.093	0.441*	0.142	-0.132	-0.308	0.193	0.051	0.405
2.	Days to first flowering		0.799**	-0.040	0.406	0.139	0.064	-0.112	0.052	-0.174	-0.215	-0.453	-0.099
3.	Days to 50% flowering			-0.222	0.377	0.067	-0.028	-0.079	0.100	-0.124	-0.174	-0.434	-0.158
4.	Primary branches per plant				0.014	-0.038	0.343	-0.302	-0.078	-0.098	0.129	-0.067	0.376
5.	Pod length					0.441*	0.184	0.005	-0.111	-0.246	-0.168	-0.269	0.040
6.	Pod width						0.374	0.322	-0.127	-0.009	0.104	-0.209	0.342
7.	Pods per Plant							0.396	-0.152	0.105	0.352	0.119	0.945**
8.	Podding nods per plant								0.214	0.177	-0.093	0.534**	0.325
9.	100 seed Weight in gram									-0.028	-0.147	0.081	-0.188
10.	Shelling %										-0.405	0.275	0.179
12.	Seeds per pod											-0.136	0.466*
13.	Rsistan to powdery mildew												0.126

*Significance at 5% level, ** Significance at 1% level

Table.2 Genotypic correlation coefficient

S.N.	Characters	Days to first flowering	Days to 50% flowering	Primary branches Per plant	Pod length	Pod width	Pods per Plant	Podding nods per plant	100 seed Weight in gram	Shelling %	Seeds per pod	Resistant to powdery mildew	Yield per plant
1.	Plant height	-0.73	-0.102	0.395	0.410	0.101	0.452	0.144	-0.137	-0.311	0.222	0.053	.406
2.	Days to first flowering		0.915**	-0.044	0.420	0.205	0.075	-0.105	0.045	-0.192	-0.212	-0.479	-0.10
3.	Days to 50% flowering			-0.265	0.466	0.025	-0.003	-0.084	0.126	-0.123	-0.295	-0.452	-0.175
4.	Primary branches per plant				0.050	-0.099	0.415	-0.353	-0.046	-0.107	0.232	-0.064	0.414
5.	Pod length					0.628**	0.220	0.010	-0.113	-0.281	-0.208	-0.307	0.047
6.	Pod width						0.524*	0.416	-0.135	0.014	0.061	-0.249	0.411
7.	Pods per Plant							0.411	-0.159	0.107	0.404	0.115	0.978**
8.	Podding nods per Plant								0.229	0.186	-0.115	0.552**	0.332
9.	100 seed Weight in gram									-0.038	-0.155	0.095	-0.195
10.	Shelling %										-0.472	0.276	0.182
11.	Seeds per pod											-0.161	0.534*
12.	Rsistan to powdery mildew												0.129

*Significance at 5% level, ** Significance at 1% level

Table.3 Genotypic path coefficient for yield per plant

S.N.	Characters	height Plant	Days to first flowering	Days to 50% flowering	Primary branches /plant	Pod length	Pod width	Pods per plant	Podding nods per plant	Shelling %	100 seed Weight in gram	Seeds/pod	Resistant to powdery mildew	Geno correlation of Yield
1.	height Plant	.085	0.012	-0.013	-0.013	-0.061	0.012	0.413	-0.023	-0.002	-0.046	0.040	0.003	0.406
2.	Days to first flowering	-0.006	-0.165	0.117	0.001	-0.063	0.024	0.069	0.017	0.001	-0.028	-0.038	-0.025	-0.100
3.	Days to 50% flowering	-0.009	-0.151	0.124	0.009	-0.070	0.003	-0.003	0.013	0.002	-0.018	-0.053	-0.024	-0.175
4.	Primary branches Per plant	0.034	0.007	-0.033	-0.033	-0.007	-0.011	0.379	0.057	-0.001	-0.060	0.042	-0.003	0.414
5.	Pod length	0.034	-0.069	0.059	-0.002	-0.150	0.072	0.201	-0.002	-0.002	-0.041	-0.037	-0.016	0.047
6.	Pod width	0.009	-0.034	0.003	0.003	-0.094	0.115	0.479	-0.067	-0.002	0.002	0.011	-0.013	0.411
7.	Pods per plant	0.039	-0.012	0.000	-0.014	-0.033	0.060	0.913	-0.066	-0.003	0.016	0.072	0.006	0.978
8.	Podding nods /plant	0.012	0.017	-0.010	0.012	-0.001	0.048	0.376	-0.161	0.004	0.027	-0.021	0.029	0.332
9.	Shelling %	-0.012	-0.007	0.016	0.002	0.017	-0.015	-0.145	-0.037	0.016	-0.006	-0.028	0.005	-0.195
10.	100 seed Weight in gram	-0.027	0.032	-0.015	0.004	0.042	0.002	0.098	-0.030	0.001	0.148	-0.084	0.014	0.182
11.	Seeds per pod	0.019	0.035	-0.036	-0.008	0.031	0.007	0.369	0.018	-0.002	-0.070	0.179	-0.008	0.534
12.	Rsistan to powdery mildew	0.005	0.079	-0.056	0.002	0.046	-0.029	0.105	-0.089	0.002	0.041	-0.029	0.052	0.129

Residual -0.0216

Table.4 Phenotypic path coefficient for yield per plant

S.N.	Characters	height Plant	Days to first flowering	Days to 50% flowering	Primary branches Per plant	Pod length	Pod width	Pods per Plant	Podding nods per plant	100 seed Weigh in gram	Shelling %	Seeds per pod	Resistant to powdery mildew	Yield per plant
1.	height Plant	0.049	0.005	-0.001	0.026	-0.017	0.004	0.354	0.001	0.002	-0.057	0.040	-0.001	0.405
2.	Days to first flowering	-0.003	-0.068	0.005	-0.003	-0.019	0.006	0.052	-0.000	-0.001	-0.032	-0.045	0.010	-0.099
3.	Days to 50% flowering	-0.005	-0.054	0.005	-0.016	-0.018	0.003	-0.023	0.000	-0.001	-0.023	-0.036	0.010	-0.158
4.	Primary branches Per plant	0.018	0.003	-0.001	0.073	-0.001	-0.002	0.275	-0.001	0.001	-0.018	0.027	0.002	0.376
5.	Pod length	0.018	-0.028	0.002	0.001	-0.047	0.018	0.147	0.000	0.002	-0.045	-0.35	0.006	0.040
6.	Pod width	0.005	-0.009	0.000	-0.003	-.021	0.042	0.300	0.001	0.002	-0.002	0.022	0.005	0.342
7.	Pods per plant	0.022	-0.004	0.000	0.025	-0.009	0.016	0.803	0.001	0.002	0.019	0.073	-0.003	0.945
8.	Podding nods per plant	0.007	0.008	0.000	-0.022	0.000	0.013	0.318	0.004	-0.003	0.033	-0.019	-0.12	0.325
9.	Shelling %	-0.006	-0.004	0.001	-0.006	0.005	-0.005	-0.122	0.001	-0.014	-0.005	-0.031	-0.002	-0.188
10.	100 seed Weigh in gram	-0.015	0.012	-0.001	-.007	0.012	0.000	0.084	0.001	0.000	0.185	-0.084	-0.006	0.179
11.	Seeds per pod	0.009	0.015	-0.001	0.009	0.008	0.004	0.283	-0.000	0.002	-0.075	0.208	0.003	0.466
12.	Resistant to powdery mildew	0.002	0.031	-0.002	-0.005	0.013	-0.009	0.096	0.002	-0.001	0.051	-0.028	-0.23	0.126

Residual 0.0444

This study has the similarity with the findings of Bhardwaj and Kohli (1999), Pal and Singh (2012). Phenotypically podding nod per plant (0.534**) has positive and highly significant correlated with resistant to powdery mildew and number of pods per plant (0.945**) is positively and highly significant correlated with yield per plant. Singh *et al.,* (2018), Phenotypically plant height (0.441*) is positively and significantly correlated with number of pods, length of pod (0.441*) with width of pods, and number of seeds (0.466*) with yield per plant. Basaiwala *et al.,* (2013), Pal and Singh (2012), Guleria *et al.,* (2009). A positive correlation between desirable characters would be preferred by plant breeders while going for simultaneous improvement of the correlated characters. In addition, a negative correlation between desirable traits, (pod yield per plant) is of immense scope in plant breeding. In the present investigation, a highly significant genotypic correlation was found between number of pods per plant (0.978**) and yield per plant with number of seeds per pods (534*). Significant positive genotypic correlation in days to first flowering (0.915**) with days to 50% flowering, pod length (0.628**) with pods width, and pod width (0.524*) with number of pods. And podding nod per plant (0.552**) significant positive genotypic correlation with resistant to powdery mildew, Kumar *et al.,* (2013), Nawab *et al.,* (2008), Nandpuri *et al.,* (1973), have reported the similar finding in pea. 5.3 Path-coefficient analysis. The correlation coefficient indicates the relationship existing between two variable characters. However, a dependent variable say, yield per plant is the product of an interaction among various mutually associated component traits and the change in any one component will disturb the whole network of the cause and effect the system. An understanding of the interdependence will be helpful in evolving efficient selection and breeding strategies for minimizing the negative effects and for maximizing the synergistic effects. The interaction becomes complex with the increase in number of the components.

Path coefficient analysis measures the direct influence of one variable upon another and is useful in the separation of correlation coefficients into components of direct and indirect effects (Table 3&4). The use of this method probes into cause and effect of relationship among the variables. Thus, correlation studies when considered in conjunction with path coefficient analysis gives better insight in cause and effect of relationship between different pairs of component characters and the ultimate character. In the present study, path coefficient analysis was carried out for 13 independent characters keepings yield per plant as dependent variable. The genotypic path coefficient analysis revealed that there was a very high significant direct positive effect (0.913) of the pods per plant on yield per plant. Thus, the very high significant positive correlation between the pods per plant and yield per plant was mainly due to its direct effect on the yield per plant. Seeds per pods (0.179), days to 50% flowering (0.124) and 100 seeds weight (0.148) also had shown the direct positive effect on the yield per plant. Tofiq *et al.,* (2015) and Kumar & Sharma (2006) also confined similar result. Highest direct negative effect on yield per plant was shows by days to first flowering (-0.165) and also by primary branches per plant (-0.033). Highest indirect effect on yield per plant by shelling percentage (0.145). Genotypic path coefficient analysis revealed that there was a very high significant direct positive effect (1.958) of the days to last picking on the pod yield per plant. Pod yield per plant (0.645), harvest index (0.251) and biological yield per plant (0.126) also had shown the significant direct positive effect on the pod yield per plant. These findings are in

close harmony with the findings of Tofiq *et al.*, (2015). Over all from correlation and path analysis reveled that major yield per plant contributing traits are found namely pods per plant, seeds per pods and days to 50% flowering in Vegetable pea.

Conclusion

Study in above facts concluded that the nature and extent of correlation among various characters varied, the highest and positive correlation between yield per plant and number of pods per plant followed by length of pods and width of pods. This indicates that importance of these characters in yield improvement through selection. Path coefficient analysis revealed that there was a very high significant direct positive effect of the pods per plant on yield per plant and seeds per pods, days to 50% flowering and 100 seeds weight also had shown the direct positive effect on the yield per plant.

Authors' contributions

This work was carried out in collaboration between all authors. Author Arun Kumar Verma designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors PKT managed the analyses of the study. Authors MKY, BL, and DP smanaged the literature searches. All authors read and approved the final manuscript.

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