

Original Research Article

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Character Association and Path Analysis Studies in Garden Pea (*Pisum sativum* L.) for Yield and Yield Attributes

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ABSTRACT

Keywords

Garden pea, *Pisum sativum* L., Correlation, Path analysis and character association

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Character association and path analysis in twenty-three genotypically diverse indigenous and exotic genotypes of pea was studied for fourteen important characters. The genotypic and phenotypic association of pod yield per plant was significantly positive with TSS, 10 pod weight, pod length, number of pods per plant and fresh weight of root nodules per plant but negative and significant association was found with days to 50% flowering indicating that early flowering and early picking might be associated with increasing the pod yield per plant. Path coefficient analysis revealed that number of pods per plant had direct positive effect on pod yield per plant followed by fresh weight of root nodules per plant, node number of first flowering and pod length while, the direct negative effect on pod yield per plant was exhibited by days to 50% flowering. This indicated that these characters could be considered as criteria for selecting high yielding genotypes of pea.

Introduction

Pea (*Pisum sativum* L., $2n=2x=14$) is one of the earliest food crop. It thrives well in places with cool climate and hence is grown in almost all the temperate regions of the world (Vavilov, 1926; Blixt, 1970). Pea has a wide range of agricultural and horticultural uses. The green seeds are used as fresh, frozen or canned vegetables and the mature dry seeds are used as dhal. It is a high protein (27%) crop for human consumption. In recent years the value of peas for fodder purpose has increased (its green matter contains 14 to 24% proteins, average 16%) as well as its value as a vegetable crop (green peas are the high protein containing vegetable with a protein content of

6-7% on the fresh weight basis). The protein of peas contains all the essential amino acids important for the normal activity of living organisms (Smirnova-Ikonnikova, 1960). The inclusion of peas in crop rotation is agronomically very significant. The pea is a good predecessor to other crops as it enriches the soil with the nodule bacteria which lives in its roots and it fixes nitrogen which becomes available to other plants (Rudnicki and Wenda, 2002). Moreover, peas have a higher capacity to utilize minerals (inorganic compounds) which are difficult to assimilate and therefore practically not available for cereals (Adgo and Schulze, 2002). There is a shortage of off-season vegetables in our country, green pea can be considered as

vegetable crop as it need smaller area of land and can also be grown without competition with cereal crops (HasanMitu *et al.*, 2004). In India, annual production of vegetables is 156.325 million metric tones from the area 8.989 million hectares. In Uttarakhand state, pea is grown on an area of 0.0117 million hectares with an annual production of 0.078 million metric tones (Anon, 2013).

Understanding of the relationship between the traits, for the selection of the important traits, is the upmost importance. The correlation studies provide information about association between any two characters.

The path coefficient analysis provides the portioning of correlation coefficients into direct and indirect effects giving the relative importance of each of the casual factors. Study of association of characters is to identify the role of each individual character toward yield (Dewey and Lu, 1959). The goal of the path analysis is that, the acceptable description of the correlation between the traits, based on a model of cause and effect is presented and the importance of the affecting traits on a specific trait is estimated.

Materials and Methods

The experiment was conducted at the Department of Vegetable Science, Uttarakhand University of Horticulture and Forestry, Ranichauri Campus, District TehriGarhwal, Uttarakhand during *Rabi* 2012-13 and late *Kharif* 2013. The experiment was laid out in randomized block design (RBD) with three replications. The experimental material consisting of 23 genotypes. The crop was raised at a spacing of 30 cm × 10cm row to row and plant to plant, respectively. Data were recorded on five randomly selected competitive plants of each genotype from each replication for fourteen characters *viz.*, days to 50% flowering, node number of first flowering, shoots per plant, number of flowers

per cluster, root length (cm), fresh weight of root nodules per plant (g), plant height at first harvesting (cm), number of pods per plant, pod length (cm), number seeds per pod (g), 10 pod weight (g), shelling percentage (%), TSS (⁰Brix) and pod yield per plant (g).The correlation coefficients were estimated following method by Al-Jibouri *et al.*, (1958) and direct and indirect effects were obtained according to the procedure given by Dewey and Lu (1959).

Results and Discussion

Correlation coefficients at genotypic and phenotypic levels indicated that pod yield per plant was positively and significantly correlated with T.S.S. (0.4565 and 0.1894), 10 pod weight (0.5021 and 0.1949), pod length (0.1947 and 0.3067), number of pods per plant (0.8163 and 0.7934) and fresh weight of root nodules per plant (0.3251 and 0.1934). Whereas days to 50% flowering (-0.3769 and -0.3769) showed negative and significant correlation with pod yield per plant (Table 1). Sharma *et al.*, (2003), Rai *et al.*, (2006), Singh *et al.*, (2008) and Globary (2010) earlier reported that number of pods per plant, pod length and pod weight exhibited significant and positive association with pod yield per plant.

Path coefficient analysis, it was evident that number of seeds per pod, node number of first flowering, number of pods per plant, fresh weight of root nodules per plant, shoots per plant, number of flowers per cluster and pod length were main yield contributing characters as these registered high positive and direct effect on pod yield per plant. Therefore, effective selection could be made based on these characters for improvement in pod yield per plant in garden pea. Days to 50% flowering, shelling percentage and TSS exhibited negative direct contribution to pod yield per plant (Table 2).

Table.1 Estimates of genotypic and phenotypic correlation coefficients between different characters in garden pea pooled over *Rabi* and *Kharif* seasons

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13
Days to 50% flowering	r _p	0.1866*	-0.1373	-0.0889	0.1019	-0.0072	0.0072	-0.3363**	0.0018	0.0828	-0.3053**	-0.0015	-0.1415	-0.3769*
	r _g	0.6935	-0.3000	-0.1948	0.2071	0.0324	0.8031	-0.3160	-0.0585	0.2470	-0.8212	-0.0342	-0.4409	-0.3769
Node number of first flowering	r _p		-0.1828*	0.0789	0.1109	-0.1028	0.1930*	-0.1168	0.1038	0.0523	-0.1548	-0.0290	-0.0136	-0.0097
	r _g		-0.4616	0.0079	0.3740	-0.1260	0.7444	-0.4243	0.0306	0.0487	-0.4520	-0.0657	-0.1299	-0.2892
Shoots per plant	r _p			-0.0281	0.1736*	-0.1679*	-0.0417	0.1275	0.0246	0.0687	0.1567	-0.2148*	0.1734*	0.1407
	r _g			-0.3824	0.1480	-0.3254	-0.5790	0.5851	0.0443	0.1366	0.3520	-0.5127	0.4841	0.5949
Flowers per cluster	r _p				0.0076	0.3606**	0.1599*	0.0898	-0.0249	-0.0012	-0.1541	0.0955	-0.0840	0.1216
	r _g				-0.5480	0.5803	0.1696	-0.0481	-0.0860	-0.1478	-0.1935	0.3694	-0.3133	0.2446
Root length (cm)	r _p					-0.1114	0.1599*	0.0867	0.0212	0.1269	0.0131	-0.1333	0.1680*	0.1019
	r _g					-0.2342	-0.1229	0.0775	0.0798	0.2911	0.3433	-0.2040	0.2553	0.0907
Fresh weight of root nodules per plant (g)	r _p						0.0322	0.1044	0.0092	-0.0203	-0.1171	0.1064	-0.0916	
	r _g						0.1293	0.1276	-0.0064	-0.0387	-0.1707	0.1343	-0.1411	0.1934*
Plant height at first harvesting(cm)	r _p							0.0241	-0.1839*	-0.0325	-0.2603**	-0.0701	-0.2435**	0.0200
	r _g							-0.2587	-0.7073	-0.3648	-0.6369	-0.2084	-0.8645	-0.4446
Number of pods per plant	r _p								0.0883	0.1485	0.1294	0.0739	0.1296	0.7934**
	r _g								-0.0539	0.5137	0.2910	0.1515	0.2772	0.8163
Pod length (cm)	r _p									0.3058*	0.2089*	0.1099	0.1808*	0.1947*
	r _g									*0.5552	0.5249	0.1886	0.5414	0.3067
Number of seeds per pod	r _p										0.1930*	0.4952**	0.1001	0.1325
	r _g										0.0863	0.6285	0.1600	0.4434
10 pod weight(g)	r _p											0.1801*	0.4178**	0.1949*
	r _g											-0.1829	0.5486	0.5021
Shelling %	r _p												-0.0505	0.0155
	r _g												-0.2977	0.0115
T.S.S (⁰Brix)	r _p													0.1894*
	r _g													0.4565

*Significant at 5% level

** Significant at 1% level

- 1. Node number of first flowering
- 4. Root length (cm)
- 7. Number of pods per plant
- 10. 10 pod weight (g)
- 13. Pod yield per plant (g)

- 2. Shoots per plant
- 5. Fresh weight of root nodules per plant
- 8. Pod length (cm)
- 11. Shelling %

- 3. Flowers per cluster
- 6. Plant height at first harvesting (cm)
- 9. Number of seeds per pod
- 12. T.S.S. (⁰Brix)

Table.2 Path coefficient analysis showing the direct and indirect effect of 13 characters on pod yield per plant in garden pea at genotypic level during *Rabi* 2012-13

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	G	-0.5317	-0.3687	0.1595	0.1036	-0.1101	-0.0172	-0.4270	0.1680	0.0311	-0.1313	0.4366	0.0182	0.2344	-0.3224
	P	-0.1272	-0.0237	0.0175	0.0113	-0.0130	0.0009	-0.0009	0.0428	-0.0002	-0.0150	0.0388	0.0002	0.0180	-0.3769
2	G	0.2927	0.4220	-0.1948	0.0033	0.1579	-0.0532	0.3142	-0.1791	0.0129	0.0206	-0.1908	-0.0277	-0.0548	-0.2892
	P	0.0212	0.1135	-0.0207	0.0090	0.0126	-0.0117	0.0219	-0.0133	0.0118	0.0059	-0.0176	-0.0033	-0.0015	-0.0097
3	G	-0.1372	-0.2112	0.4575	-0.1750	0.0677	-0.1489	-0.2649	0.2677	0.0203	0.0625	0.1610	-0.2345	0.2215	0.5949
	P	-0.0054	-0.0072	0.0396	-0.0011	0.0069	-0.0067	-0.0017	0.0050	0.0010	0.0027	0.0062	-0.0085	0.0069	0.1407
4	G	-0.0546	0.0022	-0.1071	0.2801	-0.1535	0.1625	0.0475	-0.0135	-0.0241	-0.0414	-0.0542	0.1035	-0.0878	0.2446
	P	-0.0002	0.0001	0.0000	0.0017	0.0000	0.0006	0.0003	0.0002	0.0000	0.0000	-0.0003	0.0002	-0.0001	0.1216
5	G	0.0016	0.0029	0.0012	-0.0043	0.0079	-0.0018	-0.0010	0.0006	0.0006	0.0023	0.0027	-0.0016	0.0020	0.0907
	P	0.0029	0.0032	0.0050	0.0002	0.0289	-0.0032	0.0046	0.0025	0.0006	0.0037	0.0004	-0.0039	0.0049	0.1019
6	G	0.0120	-0.0467	-0.1206	0.2151	-0.0868	0.3706	0.0479	0.0473	-0.0024	-0.0143	-0.0633	0.0498	-0.0523	0.3251
	P	-0.0011	-0.0160	-0.0261	0.0560	-0.0173	0.1553	0.0050	0.0162	0.0014	-0.0032	-0.0182	0.0165	-0.0142	0.1934
7	G	-0.0087	-0.0081	0.0063	-0.0018	0.0013	-0.0014	-0.0109	-0.0625	-0.1221	-0.0361	-0.1237	0.0671	-0.2255	-0.4446
	P	0.0001	0.0028	-0.0006	0.0023	0.0023	0.0005	0.0143	0.0003	-0.0026	-0.0005	-0.0037	-0.0010	-0.0035	0.0200
8	G	-0.1278	-0.1716	0.2366	-0.0195	0.0313	0.0516	-0.1046	0.4044	-0.0218	0.2077	0.1177	0.0613	0.1121	0.8136
	P	-0.2423	-0.0842	0.0918	0.0647	0.0625	0.0752	0.0174	0.7203	0.0636	0.1070	0.0932	0.0532	0.0933	0.7434
9	G	-0.0122	0.0064	0.0093	-0.0180	0.0167	-0.0013	-0.1479	-0.0113	0.2090	0.1161	0.1097	0.0394	0.1132	0.3067
	P	0.0002	0.0106	0.0025	-0.0025	0.0022	0.0009	-0.0188	0.0090	0.1021	0.0312	0.0213	0.0112	0.0184	0.1947
10	G	0.1214	0.0239	0.0671	-0.0726	0.1430	-0.0190	-0.1793	0.2525	0.2729	0.4915	0.0424	0.3089	0.0786	0.4434
	P	0.0010	0.0006	0.0008	0.0000	0.0015	-0.0002	-0.0004	0.0018	0.0037	0.0120	0.0023	0.0059	0.0012	0.1325
11	G	0.0098	0.0054	-0.0042	0.0023	-0.0041	0.0020	0.0076	-0.0035	-0.0063	-0.0010	-0.0120	0.0022	-0.0066	0.5021
	P	-0.0215	-0.0109	0.0110	-0.0180	0.0009	-0.0082	-0.0183	0.0091	0.0147	0.0136	0.0704	0.0127	0.0294	0.1949
12	G	0.0129	0.0248	0.1934	-0.1393	0.0769	-0.0507	0.0786	-0.0571	-0.0711	-0.2370	0.0690	-0.3772	0.1123	0.0115
	P	0.0001	0.0019	0.0142	-0.0063	0.0088	-0.0070	0.0046	-0.0049	-0.0073	-0.0327	-0.0119	-0.0661	0.0033	0.0155
13	G	0.0994	0.0293	-0.1092	0.0707	-0.0576	0.0318	0.1950	-0.0625	-0.1221	-0.0361	-0.1237	0.0671	-0.2255	0.4565
	P	-0.0047	-0.0005	0.0058	-0.0028	0.0056	-0.0031	-0.0081	0.0043	0.0060	0.0033	0.0139	-0.0017	0.0333	0.1894

Genotypic residual factor= 0.284 and Phenotypic residual factor= 0.249

1. Days to 50% flowering

4. Flowers per cluster

7. Plant height at first harvesting (cm)

10. Number of seeds per pod

13. T.S.S. (^oBrix)

2. Node number of first flowering

5. Root length (cm)

8. Number of pods per plant

11. 10 pod weight (g)

14. Pod yield per plant (g)

3. Shoots per plant

6. Fresh weight of root nodules per plant (g)

9. Pod length (cm)

12. Shelling %

Corroborating the findings of present investigation positive and direct effect on pod yield per plant has also been reported by Kumar and Sharma (2006) and Singh *et al.*, (2008) for number of pods per plant and Kumar *et al.*, (2013) for number of pods per plant and pod length.

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