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Assessment of Genetic Variability and Interrelation Between Yield and Its Contributing Components in Field Pea (*Pisum sativum* L.)

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Abstract

Thirty field pea (*Pisum sativum*) genotypes were evaluated during *rabi* of 2009-10 for 12 quantitative traits to examine the nature and magnitude of variability, correlation and path coefficient analysis. Analysis of variance revealed that the differences among 30 genotypes were significant for all the characters. Moderate to high levels of genotypic coefficient of variability (GCV), heritability and genetic advance were observed for plant height, number of primary branches per plant, pods per plant, seeds per pod, cluster per plant, 100 seed weight, harvest index, biological yield per plant and grain yield per plant. Among all traits plant height exhibited high estimates of GCV and PCV (38.8 and 38.82) followed by biological yield (36.88 and 37.1) and harvest index (32.13 and 33.78). Broad sense heritability was high for plant height (99%) and biological yield (99%) followed by number of pods per plant (97) and cluster per plant (97), which suggested that these traits would respond to selection owing is their high genetic variability and transmissibility. Correlation and path coefficient analysis revealed that pod per plant, harvest index and biological yield but pod per plant and harvest index were the most important yield components that could be used as selection indices for further improvement in field pea.
Key words : Field pea, Variability, Heritability, Genetic advance, Correlation.

Pulses are important and excellent crop for natural, resources management, environment security, crop diversification and consequently for viable agriculture. In India field pea occupies 0.62 million ha with an annual production of 0.56 million tonnes with an average productivity of 906 kg/ha. Protein content of pea ranges from 15.5—39.7%. The technology to enhance genetic potential of crop species, hybrid technology has been widely acclimatization and accepted in various species. High magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters. Coefficient of variation are helpful in exposing and understanding the clear picture of existing variability in population. Correlation studies permit only a measure of relationship between two traits. Hence path coefficient analysis becomes necessary as it indicate separation of direct and indirect effect via other related traits by partitioning through correlation coefficient that helps in designing appropriate breeding procedure for evolving high yielding genotypes.

Methods

The experiment was conducted to evaluate 30 field pea genotypes during *rabi* of 2009-10 at the field experimentation center, Department of Genetics and Plant Breeding, SHIATS, Allahabad, in randomized block design with three replications. Each entry were sown in 5 row with 5 meter row length. Five representative plants for recording the data for 10 quantitative characters viz. plant height, number of primary branches per plant, number of pods per plant, pod length, number of seeds per pod, number of clusters per plant, 100 seed weight, seed yield per plant, harvest index and biological yield. Days to 50% flowering and days to maturity recorded on plot basis. Standard method of analysis of variance was worked out formula were suggested by Panse and Sukhatme (1). Coefficient of variation (GCV and PCV) were calculated by the formula suggested by Burton (2). Heritability (broad sense) and genetic advance was obtained by the formula suggested by Johnson et al. (3). Cor-

Table 1. Phenotypic and genotypic variance, phenotypic and genotypic coefficients of variation (PCV and GCV), heritability (h^2) and genetic advance (GA), genetic advance as percent of mean for grain yield in field pea germplasm.

	Characters	VP	VG	PCV (%)	GCV (%)	h^2 (%)	GA	GA percent of mean
1	Days to 50% flowering	7.13	5.00	3.18	2.67	70.00	3.86	4.60
2	Plant height	1701.32	1699.70	38.82	38.80	99.00	84.89	79.90
3	Number of primary branches per plant	0.17	0.14	17.01	15.42	82.00	0.69	28.77
4	Number of pods per plant	14.44	14.08	18.76	18.52	97.00	7.63	37.67
5	Pod length	0.35	0.32	9.78	9.37	92.00	1.12	18.50
6	Number of seed per pod	0.54	0.51	15.63	15.09	93.00	1.42	30.03
7	Number of cluster per plant	2.30	2.24	21.42	21.13	97.00	3.04	42.93
8	Days to maturity	5.36	3.87	1.84	1.56	72.00	3.44	2.74
9	100 seed weight	4.23	3.86	13.64	13.03	91.00	3.87	25.65
10	Harvest index	136.38	123.42	33.78	32.13	90.00	21.77	62.97
11	Biological yield per plant	193.83	191.49	37.10	36.88	99.00	28.33	75.51
12	Grain yield per plant	6.38	5.76	21.32	20.25	90.00	4.70	39.63

relation coefficient were computed by using formula given by Al-Jibouri et al. (4). Path coefficient analysis is calculated by the method suggested by Dewey and Lu (5).

Results and Discussion

A wide range of variation was observed among 30 field pea genotypes for 12 quantitative characters. The perusal of data revealed that variance due to treatment was highly significant for all the characters. Coefficient of variation studied indicated that estimates of phenotypic coefficient of variation were slightly higher than the corresponding genotypic coefficient of variation for all the characters (Table 1). Similar findings was earlier reported by Kumar et al. (6) and Sirohi et al. (7). Maximum GCV and PCV was recorded for plant height (38.80 and 38.82) followed by biological yield per plant (36.88 and 37.10), harvest index (32.13 and 33.78) and seed yield per plant (20.25 and 21.32). Maximum GCV and PCV for plant height was earlier reported by Singh et al. (8), Kumar et al. (6) and Sirohi et al. (7). The high values of GCV and PCV for these traits suggested the possibility of yield improvement through selection of these traits. Minimum GCV and PCV value was recorded for days to maturity (1.56 and 1.84) followed by days to 50% flowering (2.67 and 3.18) and pod length (9.37 and 9.78). The above findings are conformity by Kumaran et al. (9). High heritability coupled with high genetic advance were recorded for plant height (99, 84.89) followed by biological yield per plant (99, 28.33), number of pods per plant (97, 7.63) and harvest index (90, 21.77). Similar result was earlier reported by Kumar et al. (6). High heritability coupled with low genetic advance were recorded for number of primary branches per plant (82, 0.69) followed by pod length (92, 1.12), number of clusters per plant (97, 3.04), days to maturity (72, 3.44) and 100 Seed weight (91, 3.87). Highest and lowest genetic advance as percent of mean were observed for plant height (79.90) and days to maturity (2.74), respectively. Maximum genetic advance as percent of mean observed for plant height was earlier reported by Ramesh et al. (10). Minimum genetic advance as percent of mean for days to maturity was earlier observed by Singh and Dhillon (11). The characters that show high heritability with high genetic advance are controlled by additive gene action (1) can be improved through simple or progeny selection methods. The character showing high heritability along with low genetic advance can be improved by intermating superior genotypes of segregating population developed from combination breeding.

The magnitude of genotypic correlation coefficient is higher than phenotypic correlation coefficient (Table 2) for all the characters. Similar findings was earlier reported by several workers (12). Grain yield per plant showed highly significant and positive association with harvest index ($r_g = 0.34$, $r_p = 0.388$), pods per plant ($r_g = 0.33$, $r_p = 0.312$) and biological yield

Table 2. Phenotypic (rp) and genotypic (rg) correlation coefficient among different yield component. **Significant at 1% level. *Significant at 5% level.

Characters		Days to 50% flowering	Plant height	Primary branches/ plant	Pods/ plant	Pod length	Seeds/ pod
Days to 50% flowering	rp	1.00	– 0.0941	– 0.1880	0.1202	– 0.1198	– 0.2507*
	rg	1.00	– 0.1067	– 0.2355*	0.1431	– 0.1213	– 0.2923**
Plant height	rp		1.00	0.3364**	0.2834**	– 0.1592	– 0.0829
	rg		1.00	0.3745**	0.2887**	– 0.1668	– 0.0854
Primary branches/plant	rp			1.00	0.1786	0.0853	– 0.2171*
	rg			1.00	0.1933	0.0981	– 0.2533*
Pods/plant	rp				1.00	– 0.2368*	– 0.2485*
	rg				1.00	– 0.2609*	– 0.2509*
Pod length	rp					1.00	0.3762**
	rg					1.00	0.4102**
Seeds / Pod	rp						1.00
	rg						1.00
Clusters / plant	rp						
	rg						
Days to maturity	rp						
	rg						
100 seed weight	rp						
	rg						
Harvest index	rp						
	rg						
Biological yield/plant	rp						
	rg						

Table 2. Continued.

Characters		Cluster/ plant	Days to maturity	100 Seed weight	Harvest index	Biological yield/ plant	Grain yield/ plant
Days to 50% flowering	rp	0.1192	0.5013	– 0.0263	– 0.1409	0.1222	0.0187
	rg	0.1511	0.6685	– 0.0070	– 0.1487	0.1541	0.0536
Plant height	rp	0.0821	0.0824	0.1528	– 0.3872**	0.4954**	0.0795
	rg	0.0836	0.0954	0.1614	– 0.4064**	0.4990**	0.0844
Primary branches/plant	rp	0.2514*	– 0.4037**	– 0.1428	– 0.2977**	0.2779**	0.0061
	rg	0.2841**	– 0.4710**	– 0.1415	– 0.3322**	0.2895**	0.0188
Pods/plant	rp	0.5530**	0.0379	– 0.0951	– 0.2325*	0.4533**	0.3125**
	rg	0.5691**	0.0484	– 0.0871	– 0.2427*	0.4551**	0.3350**
Pod length	rp	– 0.1459	– 0.4319**	0.2309*	0.0579	– 0.0711	0.0581
	rg	– 0.1547	– 0.5001**	0.2502*	0.0746	– 0.0778	0.0817
Seeds/pod	rp	– 0.1913	– 0.2760**	– 0.1452	0.2096	– 0.3180**	0.0248
	rg	– 0.1986	– 0.3549**	– 0.1710	0.2133*	– 0.3283	0.0417
Clusters/plant	rp	1.00	0.0301	0.1928	– 0.2761**	0.4189	0.1791
	rg	1.00	0.0208	0.1945	– 0.2821**	0.4254	0.2043
Days to maturity	rp		1.00	0.0799	– 0.1039	0.1383	– 0.0338
	rg		1.00	0.1088	– 0.1362	0.1622	– 0.0564
100 seed weight	rp			1.00	– 0.1884	0.3242**	0.1225
	rg			1.00	– 0.2132**	0.3462**	0.1311
Harvest index	rp				1.00	– 0.7393**	0.3885**
	rg				1.00	– 0.7631**	0.3413**
Biological yield / plant	rp					1.00	0.2732**
	rg					1.00	0.2960**

Table 3. Path coefficient analysis showing direct and indirect effects of yield and other component characters at genotypic and phenotypic level.

	Character		Days in 50% flowering	Plant height	Primary branches/ plant	Pods/ plant	Pod length	Seeds/ pod
1.	Days to 50% flowering	p	**0.1203**	−0.0113	−0.0226	0.0145	−0.0144	−0.0302
		g	**0.2167**	−0.0231	−0.0510	0.0310	−0.0263	−0.0633
2.	Plant height	p	0.0067	**0.0707**	−0.0238	−0.0200	0.0113	0.0059
		g	0.0109	**0.1021**	−0.0382	−0.0295	0.0170	0.0087
3.	Primary branches/plant	p	−0.0180	0.0322	**0.0956**	0.0171	0.0082	−0.0208
		g	−0.0400	0.0637	**0.1700**	0.0329	0.0167	−0.0431
4.	Pods/plant	p	0.0134	0.0316	0.0199	**0.1114**	−0.0264	−0.0277
		g	0.0189	0.0381	0.0255	**0.1321**	−0.0345	−0.0331
5.	pod length	p	0.0006	0.0009	−0.0005	0.0013	**0.0054**	−0.0020
		g	0.0107	0.0148	−0.0087	0.0231	**0.0884**	−0.0363
6.	Seeds/pod	p	−0.0386	−0.0128	−0.0335	−0.0383	0.0580	**0.1541**
		g	−0.0670	−0.0196	−0.0581	−0.0575	0.0940	**0.2292**
7.	Cluster/plant	p	−0.0066	−0.0045	−0.0138	−0.0304	0.0080	0.0105
		g	−0.0181	−0.0100	−0.0340	−0.0680	0.0185	0.0237
8.	Days to maturity	p	−0.0261	−0.0043	0.0210	−0.0020	0.0225	0.0144
		g	−0.0816	−0.0116	0.0575	−0.0059	0.0610	0.0433
9.	100 seed/weight	p	−0.0011	0.0061	−0.0057	−0.0038	0.0093	−0.0058
		g	−0.0007	0.0169	−0.0148	−0.0091	0.0263	−0.0179
10.	Harvest index	p	−0.1852	−0.5090	−0.3914	−0.3057	0.0762	0.2756
		g	−0.2081	−0.5686	−0.4648	−0.3396	0.1043	0.2984
11.	Biological yield/plant	p	0.1532	0.6214	0.3486	0.5686	−0.0891	−0.3988
		g	0.2118	0.6859	0.3979	0.6256	−0.1070	−0.4513

Table 3. Continued.

	Characters		Cluster plant	Days to maturity	100 seed weight	Harvest index	Biological yield/ plant
1.	Days to 50% flowering	p	0.0143	0.0603	−0.0032	−0.0169	0.0147
		g	0.0327	0.1449	−0.0015	−0.0322	0.0334
2.	Plant height	p	−0.0058	−0.0058	−0.0108	0.0274	−0.0350
		g	−0.0085	−0.0097	−0.0165	0.0415	−0.0510
3.	Primary branches/plant	p	0.0240	−0.0386	−0.0137	−0.0285	0.0266
		g	0.0483	−0.0801	−0.0240	−0.0565	0.0492
4.	Pods/plant	p	0.0616	0.0042	−0.0106	−0.0259	0.0505
		g	0.0752	0.0064	−0.0115	−0.0321	0.0601
5.	Pod length	p	0.0008	0.0023	−0.0012	−0.0003	0.0004
		g	0.0137	0.0442	−0.0221	−0.0066	0.0069
6.	Seeds/pod	p	−0.0295	−0.0425	−0.0224	0.0323	−0.0490
		g	−0.0455	−0.0813	−0.0392	0.0489	−0.0752
7.	Cluster/plant	p	**0.0550**	−0.0017	−0.0106	0.0152	−0.0231
		g	**0.1195**	−0.0025	−0.0232	0.0337	−0.0508
8.	Days to maturity	p	−0.0016	**−0.0521**	−0.0042	0.0054	−0.0072
		g	−0.0025	**−0.1220**	−0.0133	0.0166	−0.0198
9.	100 seed/weight	p	0.0077	0.0032	**0.0401**	−0.0076	0.0130
		g	0.0204	0.0114	**0.1050**	−0.0224	0.0363
10.	Harvest index	p	−0.3630	−0.1366	−0.2477	**1.3147**	−0.9720
		g	−0.3947	−0.1906	−0.2983	**1.3991**	−1.0676
11.	Biological yield/plant	p	0.5255	0.1735	0.4067	−0.9274	**1.2544**
		g	0.5848	0.2229	0.4759	−1.0489	**1.3745**

per plant ($r_g = 0.29$, $r_p = 0.372$). Seed yield per plant had significant and positive association with harvest in-

dex was earlier reported by Singh and Singh (13). Seed yield per plant had significant and positive association with pods per plant was earlier reported by Pathak and Jamwal (14). The positive and non-significant association showed with number of clusters per plant (r_g = 0.20, r_p = 0.179), 100 seed weight (r_g =0.13, r_p = 0.122), plant height (r_g =0.08, r_p = 0.079), pod length (r_g =0.08, r_p = 0.058), seeds per pod (r_g = 0.04, r_p = 0.024), days to 50% flowering (r_g = 0.05, r_p =0.018) and primary branches pre plant (r_g =0.018, r_p =0.006), while negative and non-significant association showed with days to maturity (r_g =–0.056, r_p = –0.033). Negative and nonsignificant association showed with days to maturity was earlier reported by Singh and Singh (13). The variable grain yield is a result of interaction between component characters, which are either positively or negatively associated with each other. The path coefficient analysis (Table 3) revealed that biological yield followed by pods per plant and primary branches had greatest positive and direct effect. The direct contribution of plant height, primary branches per plant, pods per plant, pod length, 100 seed weight and cluster per plant, biological yield and harvest index show positive effect. Days to maturity showed negative direct effect on seed yield per plant. The negative direct effect for seed yield with days to maturity was earlier reported by Chaudhary and Sharma (15).

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