Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 [11] October 2017: 131-134

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating : 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Genetic Variability and Phenotypic stability of various Cultivars of pea (*Pisum sativum L.*) under different Environment conditions

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ABSTRACT
Among pulses, field pea (Pisum sativum L.) is an important crop grown during cool weather for fresh green seeds, tender green pods, dried seeds and foliage. It is also an important off season crop of hills fetching premium price in the plains. Green peas are eaten as cooked vegetable and are marketed fresh, canned, or frozen while ripe dried peas are used as a whole, split or made into flour. They also synthesize a wide range of natural products such as flavor, drugs and dyes. The experiment was carried out at the experimental farm area of Pulses Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar, Regional Research Stations, Bawal and Rice Research Station, Kaul. The experimental material comprised of 48 genotypes of field pea (Pisum sativum L.) including advanced breeding lines from CCSHAU, All India coordinated Research Project on MULLaRP and popular varieties of NWPZ. All these entries have been developed or being maintained/ tested at CCS Haryana Agricultural University, Hisar. The present study was undertaken to assess the differential response of 48 diverse genotypes of peas (Pisum sativum L.) over different environments and to estimate the genetic variability. The experiments were conducted at three locations viz., Hisar, Bawal and Kaul for two years 2003-04 and 2004-05. In the present studies the linear portion of genotype x environment interaction was significant for the characters days to 50% flowering, Days to maturity, Primary branches per plant, plant height, number of pods per plant, length of pod, seeds per pod, 100 seed weight, yield per plant and yield per hectare. Considering the seed yield and its contributing trait; HFP-9907B was observed to be promisinged stable for six traits and DMR51 was observed to be promisinged stable for five traits. The other promisinged genotypes namely Jayanti, IFPD-3-6, HFP-9907A, HFP-2008, and KMPR 706 were observed to be stable and average responsive for four traits, as indicated by their high mean performance, average to above average response and non significant $\bar{S}^2_{di}$ *values.*
Keywords: Genetic variability, Phenotype, Pisum sativum

Received 12.07.2017 Revised 20.09.2017 Accepted 02.10.2010

INTRODUCTION

In India pea occupies an area of 7.93 lakh hectares with total production of 7.10 metric tones with average productivity of 895 Kg per hectare [1]. The All India Coordinated Research Project on MULLaRP crops have been engaged in the varietal development and testing programme for about last 30 Yrs. A large number of genotypes are developed and tested at a number of locations and Haryana has three such locations i.e. Hisar, Bawal and Kaul having different agro-climatic and soil conditions. The crop improvement programme on field peas at Hisar also involves multi-locations testing of elite genotypes on these locations. However, the genotypes are ranked only on the basis of mean yield over locations and generally no efforts are made to find out the stability of the genotypes tested over locations both in the national as well as state programmes. It is commonly observed that genotypes when tested over a spectrum of environments, their relative order of merit changes. Pea yield is highly sensitive to weather fluctuations as this shows high magnitude of genotype × environment interactions [2].

The preponderance of genotype × environment interaction makes it difficult to understand the genetic control of variability. The consistency in yield performance of genotype over the different locations is of utmost importance. The versatile performance with high genetic capacity to withstand environment vagaries has been noted earlier in this crop [3].

Breeders are often encountered with manifold difficulties created by presence of genotype × environment interactions. Methods are now available which could be utilized to provide reliable estimates of these interactions. It not only helps in planning the breeding programmes but also enables the identification of highly responsive and high yielding genotypes suitable for cultivation in a targeted environment where genetic potential of a genotype can be fully exploited.

MATERIALS AND METHODS

The experiment was conducted to assess the genetic variability and phenotypic stability (g x e interaction) of genotypes. All the genotypes were grown at three locations *viz.,* Hisar, Bawal and Kaul for two years (2003-04) and (2004-05) thereby creating total of six environments. Each genotype was raised in RBD with three replications in each of the environments during Rabi, 2003-04 and 2004-05. Six different environments as E1- CCS HAU, Hisar, E2- RRS, Kaul, E3- RRS, Bawal, E4- CCS HAU, Hisar, E5- RRS, Kaul, E6- RRS. All the recommended agronomic package of practices of CCSHAU was followed to raise the crop. The observations were recorded on *viz.* days to 50 per cent flowering, days to maturity, branches per plant, Plant Height (cm), number of pods per plant, Length of pod (cm), number of seeds per pod, 100 seed weight (g), Yield per plant (g), Yield per hectare (kgs).

RESULTS AND DISCUSSION

Table:1 Estimates of stability parameters [Perkins and Jinks (1968a)] for days to 50%flowering&days to maturity and yield per plant

Sr. no.	Genotypes	Days to 50%flowering			Days to maturity			Yield per plant		
		Mean	Bi	Sd^{-2}	Mean	Bi	Sd^{-2}	Mean	Bi	Sd^{-2}
1 Dwarf	HFP-0106	74.00	.33	7.63**	122.66	-.22*	27.12**	12.27	.67*	14.47**
2 "	HFP-0127	88.66	.11	-.10	130.16	-.03	-.31	13.08	.83*	11.81**
3 "	HFP-0128	88.05	1.4*	-.52	130.00	.04	-.59**	13.36	1.09*	14.15**
4 "	HFP-0129	79.88	.03	-.51	125.33	-.19	19.48**	12.69	.81*	9.25**
5 "	HFP-0132	82.55	.29	9.10**	128.33	-.14	10.27**	14.36	1.16*	15.95**
6 "	HFP-0133	82.83	.29	11.34**	129.33	-.11	5.65**	13.63	.62*	11.24**
7 "	HFP-0143	79.38	.34	5.33**	124.83	-.10	4.68*	10.95	.38	4.58**
8 "	JAYANTI	89.72	.10	.17	130.73	.03	-.144	10.05	.25	6.31**
9 "	Pant P-26	81.16	.13	3.31**	126.23	.05	.73	11.27	.21	2.10**
10 "	IPFD-3-6	82.55	.19	5.05**	130.43	.01	-.98	8.54	-.22	4.48**
11 "	RFP-4	81.88	.20	3.28**	131.33	-.03	-.60	12.69	-.79*	7.95**
12 "	DDR-70	79.88	.08	-.29	127.00	-.04	.045	10.26	.16	6.03**
13 "	IPFD 3-7	81.83	.14	7.47**	128.16	-00	-.99	11.17	.20	4.50**
14 "	DDR 69	76.33	.31	4.59**	125.33	-.22	27.12**	9.75	14	1.62**
15 "	Pant P 25	81.44	.13	1.92**	125.66	.07	1.90	11.78	-.05	9.43**
16 "	RFD 3	77.22	.38	30.11**	131.50	.01	-.88	7.42	-.39	3.40**
17 "	HUDP 26	87.16	.22	19.70**	131.66	-.07	2.42	9.26	-.31	1.03*
18 "	KPMR 683	79.83	.72	13.51**	129.50	-.20*	21.27**	10.20	.18	2.51**
19 "	KPMR 682	76.05	.40	32.29**	129.16	-.10	1.58	8.97	-.19	-.77
20 "	IM 3001	78.38	.19	8.61**	128.50	-.18	17.75**	6.92	-.39	7.20**
21 "	LFP 363	75.72	.40	32.00**	130.00	.00	-.98	7.26	-.56*	11.97**
22 "	DMR 7 (ch) Tall	83.16	.07	.81	129.00	-.07	2.24	11.39	.32	1.64**
23 "	HFP 4 (ch)	87.44	.14	2.94*	131.16	-.05	.48	8.75	.15	2.86**
24 "	KPMR 522 (ch)	85.83	.48	27.99**	133.16	-.05	.48	8.49	-.50*	8.22**
25 Tall	HFP-0110	82.66	.17	5.84**	125.83	1.01*	-.88	10.04	-.34	2.33**
26 "	HFP-0118	74.66	.63	11.53**	124.33	.31*	55.87**	10.15	-.29	1.31**
27 "	HFP-2005	75.27	2.03*	18.34**	131.67	.25	24.81**	10.88	-.39	.11*
28 "	HFP-9907A	76.83	.29	10.23**	126.50	.13	8.39**	11.80	-.01	.62*
29 "	HFP-9907B	79.16	.45	23.93**	127.33	.18	18.6**	11.93	.16	-.55
30 "	HFP-2008	72.50	.27	6.43**	126.66	.12	7.27**	10.30	-.04	2.37**
31 "	RACHNA	83.66	.18	3.76**	133.50	-.00	-.81	11.07	-.33	8.12**
32 "	DMR 51	80.16	.05	-.46	133.52	.03	-.46	9.96	.15	9.76**
33 "	IFP 3-17	84.50	.10	1.92*	134.33	.10	5.15*	8.29	-.53*	8.03**
34 "	KPMR 706	80.33	.13	1.18*	131.16	.11	6.16**	11.62	-.62*	10.79**
35 "	HFP 2008 (retesting)	74.61	.26	5.77**	124.16	.08	2.60	12.42	.48	11.82**
36 "	VL 44	73.38	.16	2.07*	132.65	.04	-.14	8.36	-.43	11.56**
37 "	KPMR 704	85.22	.09	-.10	133.56	.04	-.14	9.38	-.54*	7.78**

38 ”	DMR 52	77.77	1.51*	11.25**	130.26	.02	-.71	11.49	-.17	10.23**
39 ”	VL 43	80.77	.15	7.78**	129.33	.09	3.38*	11.23	-.29	4.43**
40 ”	KPMR-698	79.05	1.55*	16.78**	131.33	.05	.73	10.67	.11	5.62**
41 ”	HFD 2005	79.44	.16	9.49**	126.50	1.00*	-.99	10.79	-.58*	8.19**
42 ”	Pant P 48	84.50	.30	17.68**	131.21	.02	-.71	11.56	.04	2.46**
43 ”	IFP 3-13	84.88	.29	13.84**	131.50	.01	-.88	10.87	.21	5.17**
44 ”	DMR 7 (ch)	83.27	.23	8.04**	129.46	.10	4.23*	11.37	-.41	8.75**
45 ”	DMR 49 (retesting)	81.61	.93	19.26**	129.00	.21*	26.10**	11.37	.39	8.60**
46 ”	KPMR 7 (ch Dwarf)	91.05	.06*	.20	129.50	-.29*	28.77**	11.45	-.36	13.70**
47 ”	Rachna (ch)	83.55	.10	.88	129.16	-.08	2.98*	10.81	.52*	11.15**
48 ”	HFP-9426	82.66	.41	15.44**	126.66	.09	3.37*	10.67	-.36	5.37**
	Mean	81.09			129.15	1.0		10.69		
	S.E.(M)	.19	.45		.13	.19		.15	.42	

Days to 50 % flowering

A perusal of Table 1 indicated that eight genotypes namely HFP-0127, HFP-0129, JAYANTI, DDR-70, DMR 7 Tall, DMR 51, KPMR 704 and Rachna had non-significant Bi and $\bar{S}^{2}di$ value. Five genotypes were observed to have significant Bi values but were not stable. Thirty-eight genotypes had significant $\bar{S}^{2}di$ value. It indicated that the response could not be predicted across the environments for these genotypes. The results also indicated that HFP-0143, DDR 70,DDR 69, RFD 3, KPMR 683, KPMR 682, IM 3001, LFP 363, HFP-0118, HFP-2005, HFP-9907A, HFP-9907B, HFP-2008, VL 44, DMR 52 and KPMR 698 flower earlier where as Pant P-26, RFP-4, IPFD 3-7,Pant P 25 and DMR 49 have average flowering while remaining 24 genotypes flowered late. Kapoor [4] pointed out that, even for the unpredictable characters, prediction can still be made when one consider stability parameters of individual genotypes. Based on the studies of environmental additive effects (Ij), the environment E_4 could be termed as the most favorable environment for days to 50% flowering and days to maturity, yield per plant (Table 2).

Table 2: Environmental index of ten characters of field pea under six environments

Sr. No.	Character	E1	E2	E3	E4	E5	E6
1	Days to maturity	2.159	-0.340	-5.340	5.173	-3.826	2.143
2	Days to 50% flowering	2.458	-4.541	-3.541	11.875	-7.125	0.875
3	Plant height	16.485	5.085	-14.648	-6.789	3.817	3.693
4	Number of pods per plant	8.364	1.726	-0.065	2.678	-6.503	-6.259
5	Length of pods	0.216	-0.225	0.465	0.175	0.162	-0.569
6	Seeds per pod	0.215	0.365	-0.653	-0.213	-0.179	0.465
7	Primary branches per plant	0.268	0.207	-0.171	0.168	0.068	0.541
8	100 seed weight	2.133	-1.218	1.573	0.808	-2.801	-0.459
9	Yield per plant	5.027	0.593	-5.812	1.483	-1.304	0.113
10	Yield per hectare	438.655	190.655	-131.615	180.814	-75.518	-602.990

Days to maturity

The examination of stability parameters revealed that only 24 genotypes had non-significant Bi and $\bar{S}^{2}di$ value. Five genotypes had both Bi and $\bar{S}^{2}di$ values significant and 22 genotypes had their $\bar{S}^{2}di$ value significant.

The results in the Table 1 indicated that amongst the genotypes one had the earliest maturity and 17 genotypes were early maturing where as 9 genotypes namely HFP-0133, KPMR 683, KPMR 682, DMR 7 Tall, HFP 4, DMR 7, DMR 49 (retesting), KPMR 7 and Rachna had average maturing while remaining 21 genotypes are late maturity. High heritability was observed for most of the cultivars by [6], [7].

Yield per plant

The examination of stability parameters revealed that only two genotypes produced non-significant Bi and $\bar{S}^{2}di$ value. Fourteen genotypes had both Bi and $\bar{S}^{2}di$ value significant while 46 genotypes had significant $\bar{S}^{2}di$ value. Genotypes HFP-0132 had the highest yield per plant but unstable due to its significant $\bar{S}^{2}di$ value. Genotype HFP-9907B had more yield than average yield per plant and stable because both Bi and $\bar{S}^2 di$ value were no significant. Twenty- seven genotypes provided more yield than average and remaining 21 genotypes produced less per plant yield than average. Yield per plant showed low to medium heritability also reported by [3-9].

CONCLUSION

Based on the studies of environmental additive effects (Ij), the environment E_4 could be termed as the most favorable environment for days to 50% flowering and days to maturity, whereas environment E_1 was favorable for yield per plant Thus, environment E_1 was observed to be the most favorable environment for yield and most of its contributing traits.

Out of forty-eight genotypes, none was observed to be stable for all the traits studied. From the present study it could be concluded that the response of the genotypes to changing environments was not same for all the traits. Simultaneous assessment of three stability parameters *viz*., m, Bi and $\bar{S}^2 di$ considering seed yield and its contributing traits revealed that genotypes *viz*., HFP-0128, HFP-0110 and HFD-2005 were observed to be ideal for richer/favorable environments as they exhibit high mean performance, above average response and non significant $\bar{S}^2 di$ values. Whereas, the genotype IM 3001 was observed to be ideal for poor environment as it exhibited high mean, negative response and non significant $\bar{S}^2 di$ value. The genotypes DDR-51 and HFP-9907B were observed to be suitable, with respect to yield and some contributing traits, for all types of environment as indicated by high mean performance, average response and non significant High amount of genetic variability was present for seed yield per plant and yield per hectare and some of its components $\bar{S}^2 di$ values. . Characters like length of pod, days to 50% flowering and days to maturity appeared to have relatively low genetic variability as well as genetic advance (Table 2).

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CITATION OF THIS ARTICLE

Zahra Shafie, A. Khosh Konesh. Explore the Relationship between body image and coping styles among employed and unemployed women. Bull. Env. Pharmacol. Life Sci., Vol 6 [11] October 2017: 131-134