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Short Communication

Genotype × environment interactions for pod yield and quality traits in garden pea (*Pisum sativum* L.)

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The study of genotype × environment interactions help in the identification of stable genotypes for use in future breeding programme. Besides, high yield potential garden pea is high priced for its tender green pods and sweet taste of grains. Keeping this in view twenty eight genotypes of garden pea (*Pisum sativum* L.) were evaluated in randomized block design (RBD) under six environments of Himachal Pradesh *viz.*, dry temperate zone (summer season): Kukumseri, 2003 (E_1); Kukumseri, 2004 (E_2), wet sub-temperate zone (winter season): Palampur, 2003-04 (E_3); Palampur, 2004-05 (E_4) and humid sub-temperate zone (winter season): Bajaura, 2003-04 (E_5) and Bajaura, 2004-05 (E_6). Each entry was sown in two rows at spacing of 45 cm × 5 cm and data were recorded on ten competitive plants chosen at random on pod yield per plant (g), TSS (%) and chlorophyll content (mg/g). The data were analyzed as per Eberhart and Russell [1] model. The significance of regression coefficient (bi) from unity and deviation from regression (S^2di) for each genotype was tested using t-test and F-test, respectively.

Significance of variance (Table 1) arising from genotype, environment and genotype × environment marks the adequacy of analysis of the measures of stability. Genotype × environment interactions for pod yield have been reported by Dev and Rastogi [2] and Karmakar and Prasad [3]. Significant environment (linear) variance implies linear variation among environments for all the characters. However, variance due to genotype × environment (linear) was significant for only pod yield per plant and TSS. The linear component of genotype × environment interaction was found to be more than the non-linear component (pooled deviation) for pod yield per plant and TSS. Hence, prediction of performance of pea genotypes appears to be feasible from their linear regression on environmental indices. These results are in consonance with those of Sharma and Sharma [4] who have reported predominance of linear component of g × e interaction for green pod yield. For chlorophyll content, non-linear portion was more than linear portion and therefore, prediction across environments for this particular trait was difficult.

Table 1. Joint regression analysis of variance for three characters in garden pea

Source of variation	df	Pod yield per plant (g)	TSS (%)	Chlorophyll content (mg/g)
Genotypes (G)	27	276.93*	8.52*	1.98*
Environment (E)	5	40120.75*	18.38*	0.40*
G × E	135	120.00*	4.10*	0.009*
E + (G × E)	140	1548.60*	2.04*	0.023
E (Linear)	1	200603.7*	91.93*	2.20*
G × E (Linear)	27	423.60*	2.00*	0.0053
Pooled deviation	112	42.52*+	1.33*+	0.0096**
Pooled error	324	28.22	0.98	0.0012

*Significant against pooled deviation mean square (ms) at 5 % level; **Significant against pooled error mean square (ms) at 5 % level.

For pod yield per plant, among 18 stable genotypes (with non significant S^2di) eight genotypes *viz.*, NDVP 24, VL 8, Azad P-1, Palam Priya, Lincoln, GC 477, DPP 9418-06 and Pb-88 (Table 2) manifested high mean performance as compared to grand mean and bi > 1.0. This implies that they were adapted to more favourable growing conditions and show decline in performance under unfavourable/poor conditions. Under intensive agriculture where inputs are not limitation, such varieties can yield maximum whereas, 5 genotypes *viz.*, DPP 9411, DPP 4, NDVP 9, Kukumseri selection 6 and NDVP 250 (bi < 1.0) were suited for unfavourable/poor growing conditions and are not able to take advantage of better growing conditions. For the character TSS, 14 genotypes were stable in performance (non significant S^2di). Among them; Azad P-I, DPP 9418-06 and Pb-88 manifested high mean values than the grand mean and above average responsiveness thus, making them suitable for conducive environments whereas, five genotypes *viz.*, VP-5, Lincoln, GC 477, NDVP 9 and KS 221 were above average in

Table 2. Stability parameters for pod yield per plant, TSS and chlorophyll content in garden pea

Genotype	Pod yield per plant (g)			TSS (%)			Chlorophyll content (mg/g)		
	Mean	bi	D^2di	Mean	bi	D^2di	Mean	bi	D^2di
DPP 9415-1	69.59	1.09	14.78*	16.09	1.29	0.25*	1.63	1.00	0.00
VL 3	61.71	0.51*	5.75*	16.99	2.41	0.24*	1.48	0.74	0.00
VP-6	68.04	0.88	64.22*	17.75	3.02*	0.77*	2.48	0.97	0.00
NDVP 24	76.20	1.53*	–17.80	17.07	0.52	–0.63	1.51	0.91	0.00
DPP 9411	72.14	0.95	–27.38	17.31	1.20	–0.49	2.29	1.20	0.00
DPP 4	71.21	0.90	–20.80	16.07	1.46	0.14	1.58	0.92	0.00*
VL 8	72.44	1.03	–15.50	18.46	1.54	0.75*	1.76	0.82	0.00
VP-5	76.97	1.42*	185.80*	18.44	0.70	–0.02	2.62	0.87	0.01*
NDVP 8	63.80	0.92	–16.89	19.20	2.16	0.44*	2.85	1.00	0.00
Azad P-1	88.33	1.38*	–30.71	18.43	1.55	–0.05	2.00	1.25	0.01*
VRPMR 10	68.27	0.81	6.39*	17.36	0.91	–0.04	1.64	1.00	0.01*
Palam Priya	75.22	1.08	–21.75	17.07	0.97	–0.30	1.89	1.18	0.00*
Pb-87	68.42	1.19	32.03*	16.13	0.76	–0.40	1.65	1.16	0.00*
Lincoln	78.70	1.17	–21.20	17.58	0.58	–0.21	2.81	1.05	0.01*
GC 477	77.23	1.02	–14.72	17.65	0.50	–0.58	2.67	1.24	0.00*
DPP 9414	61.37	1.00	–17.56	17.37	0.76	0.31*	3.03	0.75	0.00*
NDVP 104	65.01	1.11	27.41*	17.07	1.23	0.11*	2.60	1.00	0.00*
DPP 9418-06	80.93	1.15	–24.90	17.59	1.54	–0.36	3.00	0.87	0.01*
NDVP 9	70.74	0.95	–14.90	20.41	0.85	–0.71	2.98	1.19	0.01*
Kukumseri Selection 6	71.73	0.90	–22.70	16.11	–0.08	0.68*	1.47	0.96	0.01*
KTP 8	69.06	1.15	–5.89	18.68	0.65	0.33*	1.58	1.15	0.00*
DARL 401	68.49	1.14	–2.39*	15.91	0.25	0.49*	1.48	1.92	0.00*
DPP 62	59.65	0.82	–24.15	17.32	0.26	1.82*	1.79	0.89	0.01*
KS 221	67.79	0.87	–16.68	17.92	0.29	–0.41	1.74	0.91	0.00
NDVP 250	71.00	0.79	–22.20	15.33	0.28	1.50*	1.45	0.84	0.00
KTP 4	68.35	0.77*	1.03*	18.94	1.04	2.60*	1.56	0.99	0.00
CHP-1	58.89	0.59*	79.63*	15.33	0.95	1.96*	1.60	0.98	0.00
Pb-88	79.07	1.34*	–28.60	17.83	1.32	–0.43	2.60	0.22	0.17*
Grand mean	70.50	1.01		17.40	1.00		2.06	1.00	
SE (m)±	2.91	0.077		0.51	0.63		0.043	0.36	

*Significant at 5 % level

performance, below average responsive and suitable for poor environment. With regard to chlorophyll content, 12 genotypes were stable and out of them NDVP 8, DPP 9411 and VP-6 were average responsive, above average responsive and below average responsive, respectively in addition to their consistent performance over all the environments.

Taking into account all the parameters of stability for three characters it can be inferred that Azad P-I, DPP 9418-06 and Pb-88 were promising and stable genotypes for conducive environment, while the genotype NDVP 9 was suitable for poor environment for pod yield per plant and TSS. In addition to them, DPP 9411 also showed consistent performance over all the environments for pod yield per plant and chlorophyll content. Consequent upon the above findings Azad P-I, DPP 9418-06, Pb-88, NDVP 9 and DPP 9411 may be recommended for commercial cultivation in garden pea growing belts of Himachal Pradesh.

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