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Short Communication

Phenotypic stability in tartary buckwheat [*Fagopyrum tataricum* (L.) Gaertn.] under dry temperate condition of Himachal Pradesh

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Buckwheat [*Fagopyrum tataricum* (L.) Gaertn.] is an important catch crop of high altitude, dry temperate regions of Himachal Pradesh, which is cultivated after green pea (*Pisum sativum* L.). The average yield and sowing time of this crop varies according to environmental conditions from one agricultural situation to another even within the same climatic zone. Hence, stability analysis was carried out among 14 genotypes of tartary buckwheat for identifying stable and high yielding genotypes suitable for dry temperate region of Himachal Pradesh.

The experiment was conducted with 14 genotypes of tartary buckwheat during the summer season having almost same date of sowing for four years (1998-2001) at CSK HPKV, Research Sub-Station, Sangla (78^{o} 15.016 N, 31^{o} 25.941 E) having an altitude of 2680m (amsl). The experiment was laid out in Randomized Block Design with three replications. Each plot had 5 rows of 2m length with row-to-row and plant-to-plant spacing of 30 cm and 5 cm, respectively. Recommended cultural practices were followed to raise the crop. The data on seed yield (q/ha), days to 50% flowering and days to maturity were recorded on plot basis, whereas, 10 random plants in each plot were taken to record 100-seed weight (g), plant height (cm) and branches/plant. Stability analysis was carried out as per Eberhart and Russell (1).

Pooled analysis of variance (Table 1) indicated significant differences among the genotypes and the environments for all the traits except 100 seed weight suggesting the presence of variability both among the genotypes and the environments. The mean squares for genotype $\times$ environment interaction effects were significant for all the traits, indicating differential response of genotypes to different environments. The results are in accordance with the findings of earlier workers [2, 3]; who however, reported g $\times$ e interaction for these traits (except days to 50% flowering and 100-seed weight) in *Fagopyrum esculentum* Moench. High and significant mean squares due to environment (linear) indicated considerable differences among environments and their predominant effects on all the traits. Significant pooled deviations for these traits further revealed the importance of non-linear component in the manifestation of g $\times$ e interaction. Significant linear component against pooled deviation for seed yield, days to maturity and branches/plant showed that the major component for differences in stability was due to the linear regression and the performance can be predicted with some reliance under different environments. The non-significant effects of genotype $\times$ environment interaction (linear) against pooled deviation indicated that a reliable predictions of g $\times$ e interaction cannot be made for days to 50% flowering, 100 seed weight and plant height. However, for the unpredictable traits, prediction can be made on considering stability parameters of individual genotype (4).

Estimates of stability parameters (Table 2) revealed that 2 genotypes for seed yield (KBB 3 and Khaldo), 7 for plant height (Sangla B1, BWC 3, Himpriya, BWC 14, Khaldo, IC 18869 and IC 18889), 6 for 100-seed weight (Sangla B1, BWC 14, Khaldo, Whitechabru, KBB 3 and Kalachabru), and 4 genotypes for branches/plant (BWC 14, Sangla B1, Padhey and VHC 26) had above mean performance (x_i), average regression coefficient (b = 1) and least deviation from regression coefficient (S^2d = 0), which indicated these genotypes to be stable in their performance. For days to maturity, 3 genotrypes (Whitechabru, BWC 3 and Sobrash) and for days to 50% flowering, 5 genotypes (KBB 3, Whitechabru, Khaldo, BWC 14 and BWC 3) were found early with average regression coefficient (b = 1) and least deviation from regression coefficient (S^2d = 0), thus observed to be stable genotypes for these traits. Although, 'Sangla B1' exhibited highest seed yield and average regression coefficient (b = 1) it did not possess least deviation from regression (S^2 d = 0), and thus observed to be unstable genotype.

On the basis of performance and stability parameters it was concluded that the two genotypes viz., 'KBB 3' and 'Khaldo' had above mean performance, average regression coefficient (b = 1) and least deviation

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Table 1. Pooled analysis of variance (mean squares) for different traits in buckwheat

Source	df	Seed yield	Days to 50% flowering	days to maturity	Plant height	100-seed weight	Branches/ plant
Genptypes	13	88.55*	42.63*	480.29*	197.53	0.10*	0.72*
Environments	3	125.93*	949.38*	1313.2*	802.92*	0.06	2.30*
Genotype × Environment	39	22.20*	16.05**	31.95**	178.58**	0.02**	0.26**
Pooled error	104	1.38	2.75	2.22	94.11	0.01	0.06
Environment + (Genotype × Environment)	42	$29.61^{\$}$	$82.72^{\$}$	$123.47^{\$}$	$223.18^{\$}$	0.03	0.41
Environment (linear)	1	$377.80^{\$}$	$2848.17^{\$}$	$3939.91^{\$}$	$2408.80^{\$}$	$0.19^{\$}$	$6.90^{\$}$
Genotype × Environment (linear)	13	$34.07^{\$}$	21.29	$32.05^{\$}$	62.41	0.02	$0.43^{\$}$
Pooled deviation	28	$15.10^{\$\$}$	$12.47^{\$\$}$	$29.61^{\$\$}$	$219.76^{\$\$}$	$0.02^{\$\$}$	$0.17^{\$\$}$
pooled error MSS for testing pooled deviation	104	0.46	0.91	0.74	31.37	0.004	0.02

$$ Significant against pooled error MSS at P = 0.05; $ Significant against pooled deviation at P = 0.05; **Significant against pooled error at P = 0.05; *Significant against genotype × environment interaction at P = 0.05

Table 2. Estimates of stability parameters for different traits in buckwheat

Genotype	Seed yield			Days to 50% flowering			Days to maturity			Plant height			100-seed weight			Branches/plant		
	X_i	bi±Se	S^2di	X_i	bi±Se	S^2 di	X_i	bi±Se	S^2di	X_i	bi±Se	S^2di	X_i	bi±Se	S^2 di	X_i	b±Se	S^2 di
Sangla B1	25.42	−0.33± 0.74	11.28*	63.25	1.34± 0.26	13.63*	112.92	0.63± 0.32	28.35*	138.39	1.71± 0.14	−28.27	2.75	−0.45± 1.24	0.02	4.65	0.99± 0.35	0.04
KBB 3	21.08	−0.09 ± 0.37	2.63	59.50	0.77± 0.10	1.32	113.42	0.52± 0.18	8.74*	117.45	0.75± 0.28	−18.35	2.60	0.96± 0.62	0.00	4.40	0.61± 0.20	0.00
BWC 14	17.41	0.12 ± 1.13	27.01*	64.17	1.15± 0.20	6.87	122.58	1.19± 0.63	111.62*	131.62	0.92± 1.15	195.04	2.65	1.49± 1.75	0.04	5.23	1.71± 0.27	0.01
Khaldo	19.01	0.14 ± 0.33	1.86	62.92	0.91± 0.11	1.77	119.17	0.91± 0.41	47.47*	129.73	1.97± 1.09	171.54	2.64	1.73± 1.64	0.03	5.09	0.07± 1.05	0.52*
Whitechabru	21.84	0.22 ± 1.09	25.18*	62.25	0.52± 0.15	3.42	116.58	0.69± 0.06	0.30	116.88	−0.10± 1.52	364.94*	2.64	2.32± 0.62	0.00	4.36	1.12± 0.35	0.04
Kalachabru	16.41	0.59 ± 0.51	5.22*	64.50	1.11± 0.25	11.89*	119.50	1.00± 0.36	36.83*	124.70	1.98± 1.04	155.28	2.50	1.35± 1.07	0.01	4.26	0.80± 0.32	0.03
BWC 3	20.75	0.86 ± 1.14	27.63*	62.67	0.65± 0.17	5.18	116.67	0.56± 2.0	−0.35	135.03	1.07± 0.77	72.15	2.51	−0.33± 2.15	0.06*	4.42	1.44± 0.33	0.03
Padhey	16.04	0.41± 0.66	8.87*	65.08	1.16± 0.30	17.02*	111.33	1.31± 0.22	13.60*	117.60	0.67± 0.66	43.43	2.42	−2.33± 1.07	0.01	4.64	−0.69± 0.46	0.08
Sobrash	13.24	0.90± 0.72	10.71*	66.08	0.77± 0.17	5.06	122.00	0.98± 0.15	5.68	127.99	0.18± 3.21	520.80*	2.43	0.81± 1.07	0.01	4.70	0.96± 0.65	0.19*
Himpriya	12.41	2.16± 0.90	16.99*	71.50	1.25± 0.42	34.42*	142.58	1.02± 0.18	8.88*	132.14	0.57± 0.58	27.00	2.49	1.62± 1.86	0.04*	4.17	2.82± 0.85	0.33*
PRB 9001-1	11.79	3.14± 0.96	19.13*	68.75	1.75± 0.30	17.23*	139.75	1.29± 0.27	20.60*	126.68	1.11± 2.53	1066.91*	2.28	2.70± 1.07	0.01	4.35	1.17± 0.10	−0.02
VHC 26	13.10	0.99± 0.98	20.04*	65.67	1.05± 0.12	1.80	132.17	1.77± 0.60	101.65*	117.53	1.16± 0.94	120.12	2.46	2.46± 1.39	0.02	4.55	1.15± 0.44	0.08
IC 18869	10.03	1.89± 0.37	2.49	68.58	0.76± 0.39	29.73*	139.08	1.04± 0.23	14.65*	129.62	1.11± 0.23	−22.21	2.31	0.03± 0.62	0.00	3.67	2.22± 0.59	0.15
IC 18889	10.99	3.01± 1.11	25.99*	69.17	0.81± 0.26	12.48*	139.50	1.08± 0.16	6.18*	128.34	0.89± 0.04	−31.02	2.17	1.63± 1.24	0.01	3.81	−0.36± 1.10	0.58*
G.mean	16.39			65.29			125.16			126.72			2.49			4.45		
SE (m) ±	2.24			2.04			3.14			8.56			0.09			0.24		
SE (b) ±	0.75			0.25			0.32			1.13			1.30			0.58		

*P = 0.05

from regression (S^2d = 0) for atleast one yield contributing trait along with seed yield and therefore, may be recommended for large-scale cultivation in high hills of dry temperate region of Himachal Pradesh.

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