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Stability Analysis over Various Filial Generations in Bread Wheat

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Summary. Stability analysis on 7 parent varieties and all their possible crosses (excluding reciprocals) in generations F_1 to F_5 are reported. The regression coefficient (b) of the parents ranged from 0.66 ('Sonalika') to 1.34 ('Kalyansona'). On the average the 'b' value was lower in F_3 (.87) and F_2 (.88) followed by F_1 (1.04), F_4 (1.06) and F_5 (1.16). Phenotypic stability appeared to be associated with genetic constitution of the parents as well as level of heterozygosity and heterogeneity of the populations. Distinct differences were observed in general combining ability values for regression coefficients among the parents, indicating transmissibility of this trait. However, no such trend was observed for deviation mean squares. The data on yield and stability parameters showed that high mean yield is not necessarily associated with average regression, indicating the possibility of combining high mean yield with high stability.

Key words: Stability - Grain Yield - Filial Generations - Combining Ability - Transmissibility

Introduction

The ability of some varieties to maintain a relatively uniform performance over a wide range of environments has long been appreciated by plant breeders. Breeding for such varieites has received much attention and several methods have been proposed for determining the stability of different genotypes (Finlay and Wilkinson 1963; Eberhart and Russell 1966; Tai 1971). Phenotypically stable lines are of great significance in countries with diverse geographical regions or where violent environmental fluctuations occur over the years in the same ecogeographic region. The present study was undertaken to estimate genotype-environment interaction and stability in the parents, F_1's and segregating bulk populations (F_2 to F_5), and to observe the transmission of stability of performance over various filial generations.

Materials and Methods

F_1 to F_5 diallel crosses (excluding reciprocals) involving seven varieties, viz. 'Kalyansona', 'Sharbati-Sonora', 'Sonalika' and 'S 413' of Mexican origin, 'C 273' and 'K 68' from India, and 'Argelto' from France, were studied together with parents. The experiment was carried out at Ludhiana, Jullundur and Gurdaspur, representing different agroclimatic regions of the Punjab (India). The layout was in randomised block design with four replications. The parents, F_2's, F_3's, F_4's and F_5's were allotted 4 rows each, whereas F_1's had only one row. The plants in each row were spaced 15 cm apart with row-to-row distance of 30 cm. The yield data were recorded on 10 randomly selected plants from each row. The analysis for phenotypic stability was carried out on progeny mean following the method described by Eberhart and Russell (1966). The mean, the regression coefficient and the deviation from regression were computed for each genotype and used as measures of stability. Normally the Ms for VX Env. (linear) is required to be tested against the Ms for pooled deviations but could not be done in this case due to heterogeneity of deviations and was therefore tested against the pooled error. "The heterogeneity of the deviations may mean that the G × E for some lines is explicable in terms of a linear regression on to environmental means, while for others it is not". General combining ability effects of the parents for regression coefficients (b) and deviation mean squares (s^2_{di}) were estimated following Method II, Model I of Griffing (1956).

Results and Discussion

The pooled analysis of variance showed that the mean squares due to genotypes, environments and their interactions were significant (Table 1). The variances for genotype × environment (linear) and pooled deviations were also significant, indicating that the genotypes differed significantly from each other for these stability parameters.

The regression coefficients (b) of seven parent varieties ranged from .66 ('Sonalika') to 1.34 ('Ka-

Table 1. Analysis of variance of the pooled data

Source	d.f.		M.S.
Total	335		18.1113**
Environments (Env.)	2		40.1659**
Progenies (V)	111		39.6761**
V × Env.	222		3.8735**
Env.	2	224	4.1974**
V × Env.	222		
Env. (linear)	1		80.3316
V × Env. (linear)	111		3.4700**
Pooled deviations	112		4.2525**
Pooled error	999		0.1151

** Significant at 1 % level

lyansona') (Table 2). On average the 'b' value was lower in F_3 (.87) and F_2 (.88), followed by F_1 (1.04), F_4 (1.06) and F_5 (1.16). In the present study the phenotypic stability appeared to be associated with genetic constitution of the parents as well as levels of heterozygosity and heterogeneity of the populations. Simmonds (1962) reviewed literature on the subject which indicated that stability varies with different genotypes. Finlay and Wilkinson (1963), Finlay (1963), Johnson et al. (1968) have also given similar reports.

Distinct differences and consistency over various filial generations, observed in the present study for the estimates of general combining ability effects for regression coefficients (Table 3), give support to the conclusion that stability is an inherent trait. There was also close association between the regression coefficients of parents and their g.c.a. effects, except for the parent 'Sharbati Sonora'. 'Sonalika' and 'Argelto' gave consistently low combining ability values

Table 2. Mean yield (3 locations average) and phenotypic stability

Parent	Yield (gm)	Regression coefficient	Mean squares deviation
1. 'Kalyansona'	23.20	1.34	3.65
2. 'Sonalika'	26.97	0.66	8.84*
3. 'C 273'	23.16	1.09	0.31
4. 'K 68'	22.11	0.83	1.49
5. 'Sharbati Sonora'	23.54	0.73	9.82*
6. 'S 413'	14.21	1.11	0.70
7. 'Argelto'	20.14	0.92	0.21

	F_1			F_2			F_3		
Crosses	Yield (gm)	Regression coefficient	Mean squares deviation	Yield (gm)	Regression coefficient	Mean squares deviation	Yield (gm)	Regression coefficient	Mean squares deviation
1 × 2	35.05	-0.23	2.17	27.70	1.05	0.15	27.15	0.66	0.08
1 × 3	36.58	1.71	28.58**	22.05	1.70	4.96	23.36	0.84	14.33**
1 × 4	29.81	1.83	20.08**	25.22	1.17	18.92**	21.77	0.79	0.73
1 × 5	30.62	1.46	0.21	28.63	1.15	0.01	22.87	1.10	5.71
1 × 6	28.57	1.98	1.86	25.65	0.83	0.36	24.53	1.11	5.00
1 × 7	30.12	2.13	6.93*	27.29	1.21	1.08	26.48	1.65	4.77
2 × 3	28.91	1.05	0.69	23.64	0.98	0.10	19.16	0.38	1.31
2 × 4	32.26	-0.60	2.02	25.05	-0.69	2.72	23.96	0.13	1.53
2 × 5	30.88	1.17	14.68**	28.04	0.76	0.54	25.48	1.01	0.88
2 × 6	28.20	1.82	6.35*	26.19	1.12	0.57	24.31	1.48	3.13
2 × 7	29.43	-1.20	9.03*	27.65	-0.54	0.63	28.39	1.32	13.42**
3 × 4	24.58	1.48	0.95	20.88	0.67	0.29	20.75	0.85	0.02
3 × 5	31.96	2.17	0.64	26.15	1.55	0.63	22.63	1.27	0.00
3 × 6	26.94	1.67	11.95**	23.81	0.27	0.02	24.34	0.27	0.01
3 × 7	28.81	1.16	3.31	25.91	-0.61	0.00	24.68	-0.30	14.66**
4 × 5	32.93	2.37	0.07	24.65	2.19	0.41	25.97	2.35	1.45
4 × 6	31.92	-0.14	1.00	26.83	1.14	5.82	22.18	-0.14	14.60**
4 × 7	33.72	-0.91	7.54*	26.33	1.65	0.28	23.86	0.55	0.02
5 × 6	29.84	1.52	109.99**	27.45	1.63	0.04	25.78	0.97	0.83
5 × 7	27.10	0.85	0.18	25.88	0.76	0.47	24.25	0.87	1.51
6 × 7	22.22	0.49	0.24	24.14	0.48	0.14	21.34	1.19	0.05
Mean	30.02	1.04	10.88	25.67	0.88	1.82	23.96	0.87	4.00

*, ** Significant at 5 and 1 % level, respectively

for stability (regression coefficients) over different generations. 'Sharbati Sonora', though having a low regression coefficient but being a poor combiner for this trait, was not able to transmit this property to its progenies, and so produced mostly unstable crosses.

The general combining ability estimates for deviation mean squares (Table 3) indicated lack of consistency over the generations and absence of relationship with the parental values, indicating the lower contribution of this parameter compared with that of the regression coefficient. Perkins (1970) also observed that the linear component, on average, accounted for a significantly higher proportion of genotype x environmental interactions than the non-linear component. Bucio-Alanis et al. (1969) showed that it was possible to accurately predict the linear function (B_i) of advanced generations of a cross between pairs of pure breeding lines from those observed in the parental and F_1 generations.

In view of the strong evidence that ability to perform uniformly is under genetic control, it may be possible to introduce stability in otherwise desirable varieties. This view is also substantiated by the findings of Johnson et al. (1968), Khehra (1968) and Bains and Gupta (1972). It emphasises the importance of evaluating germplasms for stability and giving due consideration to this attribute when choosing the parents in breeding programmes.

The variety 'Kalyansona' had been observed to have a high regression coefficient, indicating low

F_4			F_5		
Yield (gm)	Regression coefficient	Mean squares deviation	Yield (gm)	Regression coefficient	Mean squares deviation
25.69	0.90	1.14	27.28	0.63	6.91*
19.71	1.08	2.28	20.54	0.89	3.91
20.09	1.35	0.02	20.24	1.14	0.00
25.35	0.98	0.03	26.97	0.72	0.73
25.47	0.57	0.66	26.89	0.97	9.72*
26.36	1.54	-0.00	27.43	1.69	1.94
20.83	0.88	1.08	20.60	0.86	0.26
21.29	1.55	6.06	20.35	1.54	0.83
25.52	1.55	11.09*	25.80	0.95	3.65
25.90	0.80	0.33	26.37	1.28	2.03
27.89	1.25	5.17	27.14	1.44	9.61*
20.98	0.91	3.44	21.24	1.21	3.29
20.92	0.78	0.12	21.55	1.82	0.15
22.74	-0.32	0.03	23.29	0.53	2.18
24.21	0.29	0.02	23.58	1.01	0.07
21.06	2.02	2.13	21.19	2.00	1.19
22.52	1.24	5.06	22.36	0.27	2.16
23.40	0.91	0.13	22.74	0.63	0.02
26.53	1.77	-0.49	25.40	2.25	0.16
26.71	1.13	10.09*	26.63	1.06	0.97
22.52	1.14	0.25	21.76	1.52	2.18
23.65	1.06	2.32	23.77	1.16	2.47

Table 3. Estimates of general combining ability effects for stability

Parent	Regression coefficients					Deviation Mean squares				
	F_1	F_2	F_3	F_4	F_5	F_1	F_2	F_3	F_4	F_5
'Kalyansona'	0.38	0.29	0.19	0.08	0.02	-0.60	1.97	1.42	-0.62	1.39
'Sonalika'	-0.53	-0.33	-0.09	-0.01	-0.10	-2.78	0.26	0.86	2.26	1.98
'C 273'	0.36	-0.05	-0.19	-0.29	-0.04	-2.49	-0.66	1.02	-0.71	-0.46
'K 68'	-0.27	0.07	-0.11	0.14	-0.05	-3.97	2.07	-0.85	0.52	-0.59
'Sharbati Sonora'	0.32	0.26	0.21	0.15	0.15	7.41	0.07	-0.14	2.13	0.26
'S 413'	0.16	0.06	-0.01	-0.01	0.02	7.03	-0.40	0.32	-0.79	0.53
'Argelto'	-0.41	-0.27	-0.00	-0.03	-0.04	-4.60	-0.94	1.46	0.25	0.07

stability. The general exparience is that this variety has wide adaptability, as it is grown throughout the world, particularly in South Asia, the Middle East and North Africa, under different names like 'Kalyansona', 'Mexipak', 'Siete Cerros', 'Espigas' etc. At the same time it is known to be highly responsive to high fertility conditions. This high responsiveness to fertility conditions possibly results in high regression on the environment. The wide adaptability of this variety, therefore, may not be due to its inherently greater stability but due to its distinctly greater yield potential compared with previous commercial varieties. By combining high stability in varieties like 'Kalyansona', which possess high yield potential, it should be possible to increase and stabilise wheat production.

'Kalyansona' generally transmitted reduced stability in its hybrids with other parents. But its cross with 'Sonalika' was quite stable over F_1 to F_5 generations with regression coefficients of -0.23, 1.05, 0.66, 0.90 and 0.63, respectively. This hybrid combination had mostly non-significant mean square deviations and was significantly better in yield than 'Kalyansona' in all the filial generations. The performance of this most desirable combination and perusal of the data on yield and stability parameters (Table 2) indicate that high mean yield is not associated with average regression as reported by Eberhart and Russell (1966). The genotypes with high mean yield have low, medium or high regression. The absence of any relationship between yield and regression coefficients has also been reported by Johnson et al. (1968), Khehra (1968) and Bains and Gupta (1972). Breeding efforts may, therefore, be directed to combining high yield with greater stability.

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