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Phenotypic Stability and Adaptation of Certain Pearl Millet Cultivars

R. APPADURAI,[1] U.S. NATARAJAN[2] and T.S. RAVEENDRAN[3]

Four cultivars of pearl millet, consisting of an open-pollinated variety CO. 6 and three hybrids KM_2 UCH 4 and KM_1 were tested for stability and adaptation in nine different environments with in Tamil Nadu. The highest mean yield was registered by CO.6 while KM_1 recorded the lowest mean yield. All the four cultivars were found to be generally adapted to all the environments because of the unit regression coefficients. With regard to stability as measured by coefficient of determination, KM_2 was outstanding. The other three cultivars were similar in their stability levels.

In pearl millet (*Pennisetum typhoides* (Burm.) Stapf. and Hubb.) allogamy and cytoplasmic-genic male-sterile system have enabled the production of commercial hybrids. Heterogeneous populations consisting of heterozygous individuals have also been releasad as commercial varieties. Such heterogeneity and heterozygosity in this crop confer adaptability to plant populations which reflects upon a stable grain output. Information on the phenotypic stability and general adaptability of open - pollinated varieties, composite populations and F_1 hybrids which have been released in pearl millet can be useful in recommending a generally adapted variety for a range of environments. Specific varieties can also be suggested for special environments. In the present paper the results of such an investigation involving four cultivars of pearl millet are reported.

MATERIALS AND METHODS

The four varieties utilised in the study are (1) CO.6, (a variety resistant to downy mildew), (2)UCH 4, (F_1 hybrid) (TNAU), (3) KM1 (BJ.104) and (4) KM2 (BK.560) (F_1 hybrids).

These four varieties were tested in nine different environments spread over eight locations in Tamil Nadu under rainfed conditions. Only three trials (Env. 1, 8 and 9) conducted at the experiment stations, had four replications each in a randomized block design. The other six trials in large scale demonstration plots at cultivators' fields were non-replicated.

Mean hectare yields were subjected to statistical analysis following the model given by Eberhart and Russel (1966) namely,

1-3: Department of Agricultural Botany, Tamil Nadu Agricultural University, Coimbatore-3.

$$V_{ij} = \mu_i + \beta_{iIj} + \delta_{ij}$$

Where,

V_{ij} = i th variety mean over j th environment

β_i = regression coefficient of i th variety on environmental index

I_j = environmental index(i.e.) The deviation from the overall mean attributable to particular environments estimated as the difference between the mean yield of all the varieties in each environment and the mean yield of all varieties in all the environments.

$$[\Sigma_i V_{ij} /v] - \Sigma_i \Sigma_j V_{ij} /vn$$

δ_{ij} = deviation from regression of i th variety over j th environment.

The regression coefficients, were statistically tested for their difference from 'O' as well as unity. Test of significance between any two regression coefficients was also made. Coefficient of determination (r^2) was calculated for each variety. This parameter of stability which serves the same function as that of δ_{ij} suggested by Eberhart and Russel (1966) is more advantageous because it is independent of unit of measurement and easy to interpret.

RESULTS AND DISCUSSION

The mean yield of the four cultivars over all environments, the regression coefficients and coefficients of determination are given in Table I. The linear regression of the grain yield of the cultivars over the environmental index is illustrated in Fig. 1. The deviations from the regression for each variety have also been given so as to

TABLE I. Grain yield stability parameters of the cultivars.

Environment	Grain yield (Kg/ha)				Environmental index (Ij)
	CO.6	KM_2	UCH.4	KM_1	
1.	1170	1063	1044	969	302.5
2.	1088	1033	1032	915	258.0
3.	963	819	813	813	93.0
4.	1289	855	218	520	86.5
5.	869	738	719	614	—24.0
6.	813	719	706	644	—38.5
7.	888	720	669	569	—47.5
8.	505	415	520	448	—287.0
9.	637	410	325	292	—343.0
Mean	914	752	727	643	—
b	0.9984	1.0537	1.0114	0.9365	—
r^2	0.7611	0.9922	0.9460	0.8473	—
S^2d	16918	476	3156	8550	—

FIG. 1

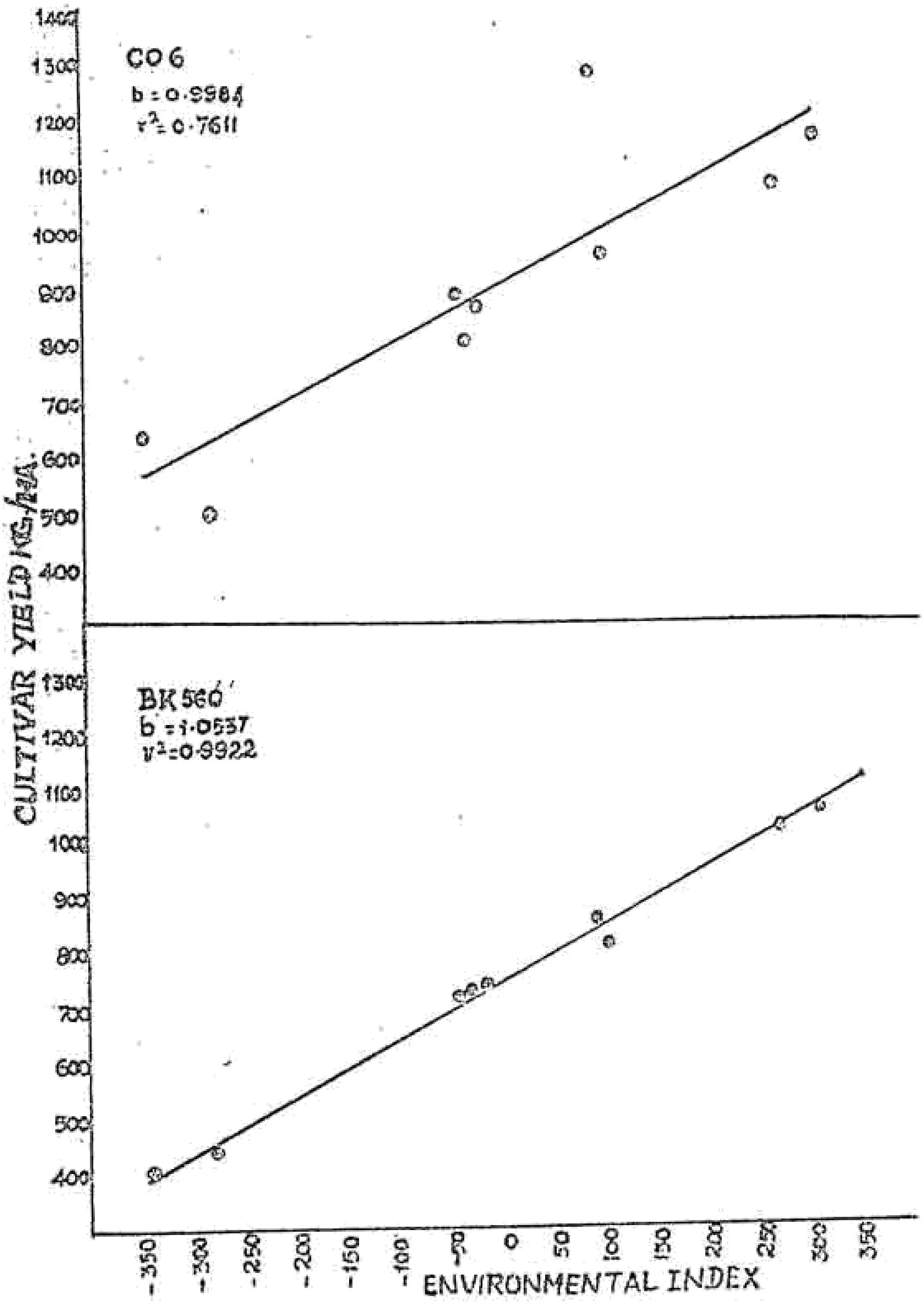

CO 6
b = 0·9984
r^2 = 0·7611
BK 560
b = 1·0537
r^2 = 0·9922
CULTIVAR YIELD KG./HA.
ENVIRONMENTAL INDEX

TABLE II. ANOVA

Source	df	SS	MS	F
Cultivars	3	346199	115400(MS_1)	15.86**
Environments } Cultivars x Environment }	32	1720512	53766	—
Cultivars x Environment linear	3	2669	890(MS_2)	0.12 NS
Environment linear	1	1514136	1514136	—
pooled deviation	28	203707	7275(MS_3)	—

** Significant at P = 0.01; NS — Not significant

compare the usefulness of these values vis-a-vis the r^2 values, as parameters of stability. The analysis of variance is given in Table II.

The differences among the means of the cultivars were found to be significant. However, the genotypic differences of the cultivars for their regression on environmental index were found to be not significant indicating that the slope of the regression lines of the different cultivars was the same. This was further evidenced from the fact that the b values of the different cultivars did not differ from each other(Table III).

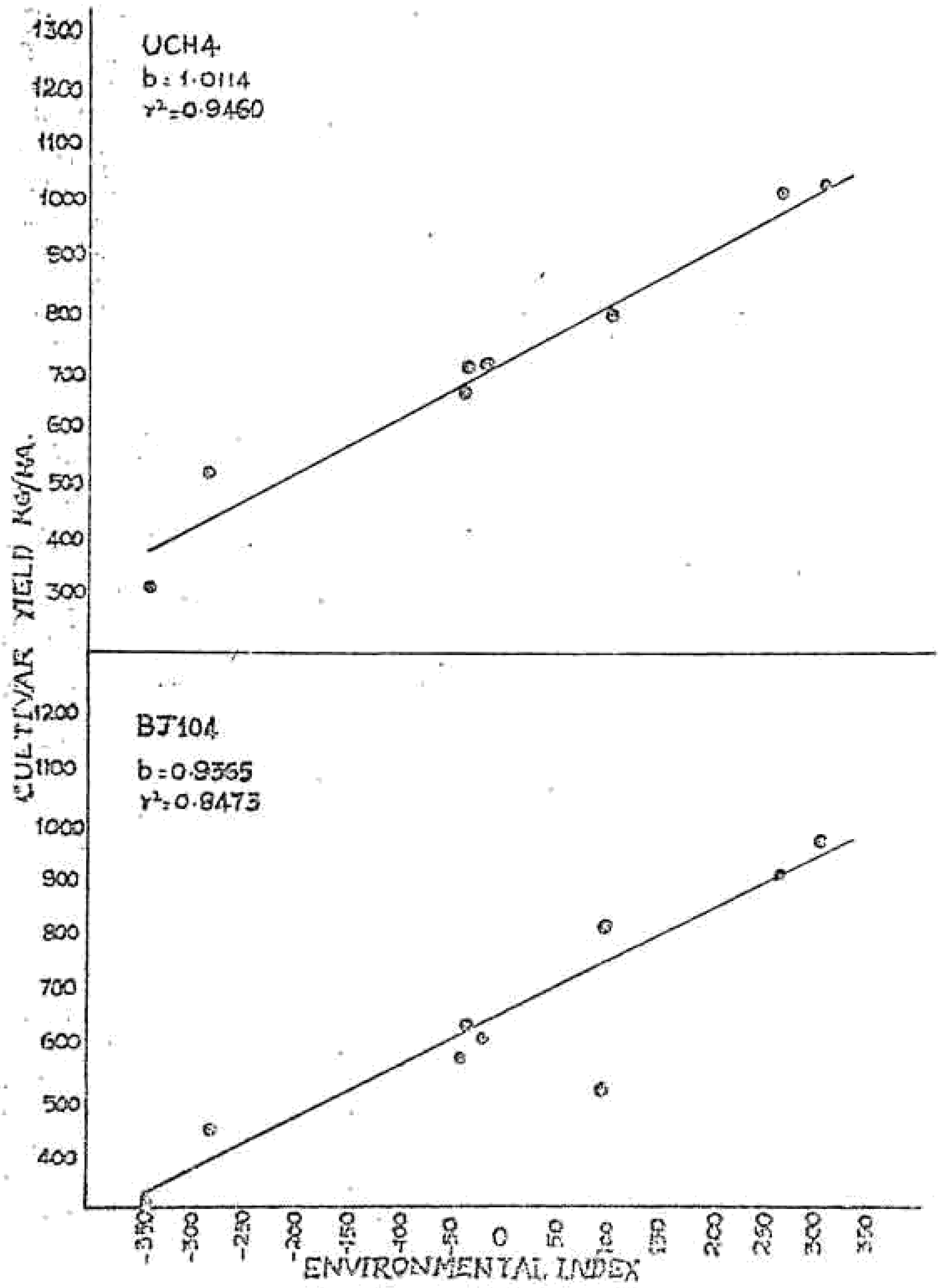
It could be seen that CO-6 which is only an open pollinated variety unlike the other three hybrid cultivars, given the highest mean yield of 914 kg/ha. The grain yields of KM 2 and UCH 4 were similar while that of KM1 was the lowest.

The regression coefficient (b) is a measure of adaptability and r^2 Is a measure of stability (Bilbro and Ray, 1976). If b > 1.0, the variety is said to be adapted to high yielding environments. On the other hand if b < 1.0 the variety is considered to be less affected by environmental changes and

TABLE III. Regression coefficients and their significance

Cultivar	b	t_b	
		$(b\text{-}0)/SE_b$	$(1\text{-}b)/SE_b$
CO.6	0.9984 ± 0.1855	5.35**	0.01NS
KM_2	1.0537 ± 0.0316	33.34**	0.70NS
UCH 4	1.0114 ∓ 0.0806	12.34**	0.14NS
KM_1	0.9365 ± 0.1327	6.94**	0.60NS

** Significant at P = 0.01 NS — Not significant


UCH4
b = 1.0114
r² = 0.9460
BJ104
b = 0.9365
r² = 0.8473
CULTIVAR YIELD KG/HA.
1300
1200
1100
1000
900
800
700
600
500
400
300
-350
-300
-250
-200
-150
-100
-50
0
50
100
150
200
250
300
350
ENVIRONMENTAL INDEX

hence adapted to low yielding environments. The regression lines for all the four cultivars are given in Fig. 1. The regression coefficients were found to be equivalent to unity in all the four cases thus, indicating that there was no difference in the adaptive capacity of the cultivars.

The stability parameter r^2 was very high for all the cultivars, thus, showing that the variation not attributable to regression was very small. However, the r^2 value of KM2 was significantly higher than those of the others indicating that it has the greatest stability. The differences among the r^2 values of the other cultivars were not significant indicating that these cultivars were more or less similar in stability. The usefulness of r^2 value as a stability parameter in place of deviation mean square is quite clear from the fact that the r^2 values of different cultivars can easily be compared and interpreted which is not possible in the case of deviation mean square.

An ideal cultivar is one which has a high mean value, a unit regression coefficient and a coefficient of determination as high as possible. The variety CO.6 meets the first two requirements while the hybrid KM2 meets the last two requirements. So it can be said that although CO.6 and KM2 are generally adapted to all types of environments, the former is a high yielder whereas the latter is a stable yielder. UCH.4, although yielding equivalent to KM2, had lesser stability of performance. KM1 is a relatively poor yielder and with less stability.

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