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RESPONSE TO ENVIRONMENTAL CHANGES OF THE COMPONENTS OF VARIATION AND OTHER GENETIC PARAMETERS IN MAIZE

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Twenty five varieties of maize (*Zea mays* L.) were tested under four environments to evaluate the nature of response of the components of variation and their genetic parameters to genotype x environmental interaction. The characters studied were days to pollen shed, days to silk, plant height, ear height and grain yield. The evidence has been there for the occurrence of genotype x environmental interaction. Genetic components and different parameters were reduced after elimination of the interaction component from the total variance. This drop varied in degree between the components characters. The relative importance of the genotype x environmental interaction in determining genetic parameters and the needs for their elimination to arrive at precise estimates have been discussed.

Key words: Maize, Genotype x environmental interaction, Genetic parameters.

Introduction

Maize is a crop of economic importance which can be used both as human food and feed for animals. It can also be used as the raw materials of some industrial products [1]. Its high per hectare yield may play an inportant role in reducing world food crisis. Variance components and genetic parameters assume greater significance in the context of crop improvement. They enable the prediction of the likely genetic gain through breeding exercise. The accuracy of such prediction would depend on the stability with which these parameters respond to environments. These estimates are expected to be very much influenced by the genotype environmental interactions and conseuqently do not reflect the true values. To avoid dubiety, under such circumstances, the interaction component may be eliminated from the total variance before estimating the genetic components of variance. It is with this objective that the data for 25 maize varieties grown under four environments were analysed and the results are discussed here.

Materials and Methods

The 25 maize varieties namely Comp. Hunius, Across 7729, Savar-2, J-1, Ferke (II) 7539, JC-2, Chequisacha (I) 7833, Pantnoyar (I) 8033, Tlaltizapan 8033, Chequisacha 7845, Obregon 8045, Antalya (I) 8045, Obregon 8046, Adapazari 7948, Tlaltizapan 7948, Sadaf, Lamaquina 7827, Obregon 7748, Pozarica 7737, Alazuala 7725, Arnd (I) 8156, Across 8156, Khaibhutta, Barnali and Shuvra, were grown in four environments in randomized blocks with three replications. All the 4 trials were conducted in the Bangladesh Agricultural University Farm, Mymensingh, Bangladesh during Rabi season of 1987-88. The environments were created by varying the plant density (8.89 and 5.33 plants/m^2). The experiments were repeated over two sowing dates (Dec. 2, 1987 and Jan. 2, 1988). The four environments were designated as E_1 (early sowing narrow spacing), E_2 (early sowing broad spacing), E_3 (late sowing narrow spacing) and E_4 (late sowing broad spacing). Each variety was grown in single-row plot of 5m long. Data on days to 75% pollen shed, days to 75% silk emergence, plant height (cm), ear height (cm) and grain yield (t/ha) were taken. Data on days to pollen shed, days to silk and grain yield were recorded on the basis of whole plot, while the rest of the data were taken from ten random plants in each plot.

The mixed model (a-varieties fixed and b-environments random) in its linear form was adopted in estimating the components of variance. The combined analysis of variance was carried out according to Singh and Chaudhary [2]. Genotypic and phenotypic variances and coefficients of variation, genetic advance at 5% selection intensity and broad sense heritability were computed [3-5].

Results and Discussions

Combined analysis (Table 1) indicated differential influences of the environments on the development of all five characters through the significant variances due to environments. The variances due to genotype x environmental interaction were significant with all characters studied, indicating that the variances were not homogeneous in their response to environmental changes. Genotype x environmental interaction is said to constitute a decisive factor in judging the reliability of genetic parameters. Significant genotype x environmental interactions in the inheritance of all characters indicated their unstable and less reliable nature.

In E_1 and E_2 highest genotypic coefficient of variation, heritability and genetic advance in percentage of mean were observed for ear height (Tables 2 and 3). Though grain yield showed high genotypic coefficient of variation and genetic gain, it was lowered by low heritability in these environments (Tables 2 and 3). In E_3 and E_4 grain yield exhibited highest genotypic coefficient of variation accompanied by highest genetic advance in percentage of mean and it was followed by ear height (Tables 4 and 5). All characters except ear height had low heritability estimates in E_3 (Table 4). In E_4, the trials registered medium to high broad sense heritability (Table 5).

The components of variance were also calculated after eliminating the genotype x environmental interaction from the total variance in combined analysis and compared with the average of the four individual environmental means (Table 6).

TABLE 1. COMBINED ANALYSIS OF VARIANCE FOR VARIOUS CHARACTERS IN MAIZE.

Source	d.f.	Mean squares				
		Days to silk	Days to pollen shed	Plant height	Ear height	Grain yield
Environments(E)	3	28201.48**	23933.20**	5446.93**	3645.34**	26.15**
Genotypes (G)	24	41.64*	33.06*	1470.72**	277.85**	4.16**
G x E	72	26.39**	17.19**	246.25**	98.25**	1.97**
Replication in environments	8	20.99	15.50	497.06	9.59	0.64
Error	192	11.86	5.46	136.99	9.37	0.72

*Significant at 5% level; **Significant at 1% level.

TABLE 2. COMPONENTS OF VARIANCE AND GENETIC PARAMETERS FOR VARIOUS CHARACTERS IN E_1.

Character	Variance		Coefficient of variation		Broad sense heritability (%)	Genetic advance	Genetic advance in % of mean
	Phenotypic	Genotypic	Phenotypic	Genotypic			
Days to silk	25.27	7.57	4.84	2.63	29.42	3.07	2.94
Days to pollen shed	14.59	5.43	3.85	2.35	37.22	2.93	2.95
Plant height	286.92	174.54	9.77	7.62	60.83	21.23	12.24
Ear height	56.56	47.73	16.25	14.93	84.39	13.07	28.24
Grain yield	1.24	0.48	23.39	14.57	38.81	8.92	18.70

TABLE 3. COMPONENTS OF VARIANCE AND GENETIC PARAMETERS FOR VARIOUS CHARACTERS IN E_2.

Character	Variance		Coefficient of variation		Broad sense heritability (%)	Genetic advance	Genetic advance in % of mean
	Phenotypic	Genotypic	Phenotypic	Genotypic			
Days to silk	28.46	10.16	5.05	3.02	35.69	3.92	3.72
Days to pollen shed	15.38	8.98	3.93	2.99	58.41	4.72	4.72
Plant height	173.25	63.41	8.44	5.12	36.59	9.92	6.38
Ear height	50.18	40.15	20.76	18.57	80.03	11.68	34.22
Grain yield	1.31	0.51	24.95	15.50	38.58	9.10	19.83

TABLE 4. COMPONENTS OF VARIANCE AND GENETIC PARAMETERS FOR VARIOUS CHARACTERS IN E_3.

Character	Variance		Coefficient of variation		Broad sense heritability (%)	Genetic advance	Genetic advance in % of mean
	Phenotypic	Genotypic	Phenotypic	Genotypic			
Days to silk	10.47	2.19	4.38	2.01	20.95	1.39	1.89
Days to pollen shed	8.02	2.49	3.99	2.23	31.06	1.81	2.56
Plant height	255.35	102.15	9.19	5.82	40.00	13.17	7.58
Ear height	39.50	31.77	13.01	11.67	80.42	10.41	21.56
Grain yield	1.07	0.45	29.45	19.17	42.37	9.01	25.70

TABLE 5. COMPONENTS OF VARIANCE AND GENETIC PARAMETERS FOR VARIOUS CHARACTERS IN E_4.

Character	Variance		Coefficient of variation		Broad sense heritability (%)	Genetic advance	Genetic advance in % of mean
	Phenotypic	Genotypic	Phenotypic	Genotypic			
Days to silk	7.10	4.61	3.84	3.09	64.98	3.57	5.14
Days to pollen shed	4.78	4.02	3.28	3.01	84.22	3.79	5.69
Plant height	384.66	214.13	11.54	8.61	55.67	22.49	13.23
Ear height	69.59	58.72	17.01	15.63	84.38	14.50	29.57
Grain yield	1.43	0.75	29.63	21.42	52.23	12.86	31.88

TABLE 6. COMPONENTS OF VARIANCE AND GENETIC PARAMETERS FOR VARIOUS CHARACTERS IN COMBINED ANALYSIS.

Character	Variance		Coefficient of variation		Broad sense heritability	Genetic advance	Genetic advance in % of mean
	Phenotypic	Genotypic	Phenotypic	Genotypic			
Days to silk	13.13 (17.94)*	1.27 (6.13)	4.09 (4.53)	1.28 (2.69)	9.68 (37.76)	0.72 (2.99)	0.82 (3.42)
Days to pollen shed	6.78 (10.69)	1.32 (5.23)	3.09 (3.76)	1.37 (2.65)	19.50 (52.73)	1.05 (3.31)	1.24 (3.98)
Plant height	238.43 (275.05)	102.04 (138.56)	9.18 (9.74)	6.01 (6.79)	42.79 (48.27)	13.61 (16.70)	8.09 (9.86)
Ear height	24.34 (53.96)	14.97 (44.59)	11.10 (16.76)	8.71 (15.20)	61.49 (82.31)	6.25 (12.42)	14.06 (28.40)
Grain yield	0.90 (1.26)	0.18 (0.55)	22.43 (26.86)	10.11 (17.67)	20.00 (43.00)	3.97 (9.97)	9.39 (24.03)

* Figures within the brackets indicate the mean over the four environments.

There was a general drop in these values after accounting for the interaction component. This drop varied in degree between the component characters. The effect of interaction seemed to be more on the genotypic variance than on the phenotypic variance. Grain yield had the highest phenotypic and genotypic coefficients of variation in combined analysis, followed by ear height and plant height. Days to silk and days to pollen shed had relatively low values.

The heritability values and the predicted genetic advance were calculated after eliminating the interaction component in combined analysis. These two parameters were effected by genotype x environmental interaction to a varying degree (Table 6). The values of all the characters were invariably lower than the average of the four individual environmental means. The maximum heritability was for ear height in combined analysis followed by plants height. High heritability for these traits were also reported by other authors [6,7]. Heritability was low for grain yield and days to pollen shed and abnormally low for days to silk in combined analysis. The most affected character by the interaction was days to silk. This was followed by days to pollen shed and grain yield. Plant height was least affected followed by ear height by the genotype x environmental interaction.

As for predicted genetic advance, variation could be found among the characters not only in the percentage of gain but also of the magnitude of interaction effect. The heighest genetic advance was predicted for ear height, with grain yield and plant height following it in combined analysis. Among these three, grain yield was subjected to the greatest influence of genotype x environmental interaction, while plant height was least affected. The lowest genetic advance was with days to silk accompanied by the highest quantum of the interaction component. This was followed by days to pollen shed for genetic gain as well as for the influence of the interaction.

Apparent heterogeneity among the environments was established despite, the fact that the environmental factors invloved were only two, namely spacing and date of sowing. It may be noted that the spacing and date of sowing accounted for a significant amount of variance. The probable impact of the other vital environmental factors like years, location and seasons cannot be ignored. Singh and Athwal [8] have shown that the contribution of years for variance was not so much as that of contribution of years for variance was not so much as that of location and sowing dates. The pace of progress could thus be quickened by all the possible environmental factors to which the genotypes are to be exposed in a shorter period of time irrespect of the number of years.

The variance components, heritability estimates and the values of predicted genetic advance relating to component characters decreased after accounting for the genotype x environmental interaction. Presumably, therefore, the components of variation and heritability estimates based on the individual environments were very much biased. So, if more accurate predictions were aimed at, it would be necessary to evaluated the genotype, as suggested by other authors [4,5,9,10], under a wide range of environments.

The significant outcome of this study is that the ear height has fairly high heritability values and genetic gain even after elimination of the interactive effects. If this is to be a useful combination, as advocated by Johnson *et al.* [5], selection should be exercised for this character with a view to advance the structure of grain yield in maize.

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