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GENOTYPE ENVIRONMENT INTERACTION IN MUNGBEAN

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Abstract

Twelve genotypes of mungbean (No. 7-2, NCM 201, NCM 209, No. 1, NCM 205, AEM 6/20, NM 18, AEM 30/20, NM 93, NM 90, NM 121-25, M 20-24) were evaluated for stability of grain yield under seven diverse environments of Pakistan. The interaction between the genotypes and environments (G X E interaction) was used as an index to determine the yield stability of genotypes under all the environments. The G X E interaction was highly significant and both linear as well as non-linear components were equally important for determining the yield stability. The genotype "NM 90" gave the highest yield with above average regression value and non-significant standard deviation, showing consistently better performance in favorable environments. The genotype "NCM 209" also had high mean yield over the environments and did extremely well under less favorable conditions. The genotypes "No.1" and "NM 18" responded well under favorable conditions as compared to unfavorable conditions. The genotypes "NCM 201", "M 20-24" and "AEM 30/20" had below average yield, whereas their stability parameters revealed above average stability with specific adaptation to unfavorable environments.

Introduction

Plant breeders engaged in crop improvement programs often desire to develop genotypes or varieties which are adapted to a wide range of environments. The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is grown. A variety or genotype is considered to be more adaptive or stable if it has a high mean yield but a low degree of fluctuation in yielding ability when grown over diverse environments. Eberhart & Russel (1966) proposed a model to test the stability of varieties under various environments. They defined a stable variety as having unit regression over the environments ($b = 1.00$) and minimum deviation from the regression($S^2d_i = 0$). Therefore, a variety with a high mean yield over the environments, unit regression coefficient ($b=1$) and deviations from regression as small as possible ($S^2d_i = 0$), will be a better choice as a stable variety. The stability parameter have been studied in grain legumes for measuring phenotypic stability (Khan *et al.*, 1987; Khan *et al.*, 1988; Bakhsh *et al.*, 1995, Sharif *et al.*, 1998, Qureshi, 2001), but very little information is available on stability of mungbean varieties. Experiments were therefore, carried out to evaluate some genotypes of mungbean for their yield stability under different agroclimatic conditions of Pakistan.

Materials and Methods

Twelve varieties used in this study (No. 7-2, NCM 201, NCM 209, No. 1, NCM 205, AEM 6/20, NM 18, AEM 30/20, NM 93, NM 90, NM 121-25, M 20-24) were advanced lines or candidate varieties developed by various plant breeders in the country. The yield performance of varieties was tested at seven locations viz., National Agriculture Research

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center, Islamabad, Northern Punjab; Nuclear Institute for Agriculture and Biology, Faisalabad, Central Punjab; Adaptive Agriculture Research Farm, Karor, Layyah and Regional Agriculture Research Institute, Bahawalpur, Southern Punjab; Agriculture Research Station, Sarai Naurang, Bannu, Southern NWFP; Rice Research Institute, Dokri, Northern Sindh and Atomic Energy Agriculture Research Center, Tandojam, Southern Sindh which represent different agro-climatic conditions of the country. The experiment was conducted at each location during kharif 1996 in a randomized complete block design with four replications. The experimental plots consisted of six rows of four meter length. Row to row distance was 30 centimeter and plants were spaced at 10 centimeter. Stability parameters for grain yield were worked out as suggested by Eberhart & Russell (1966), using a computer software written in "BASIC".

Results and Discussion

Pooled analysis of variance showed highly significant differences among the genotypes and environments for grain yield (Table 1), indicating the presence of variability among the genotypes as well as environments under study. The genotype X environment (G X E) interaction was further partitioned into linear and non-linear (pooled deviation) components. Mean square for both these components were found highly significant, indicating that the both predictable and un-predictable components shared G X E interaction. The G X E (linear) interaction was highly significant when tested against pooled deviation which revealed that there were genetic differences among genotypes for their regression on the environmental index.

Table 1. Pooled analysis of variance for grain yield in twelve mungbean genotypes.

Source	Degree of freedom	Mean square
Genotypes	11	33557.82**
Environment + (G X E)	72	91224.89**
Environment (linear)	1	4723068**
G X E (linear)	11	60914.46**
Pooled deviation	60	19584.38**
Pooled error	252	6954.70 **

Significant at the 1% level.

Table 2. Stability parameters of twelve mungbean varieties grown in seven environments.

Genotype	Mean	b_i	S^2d_i
No. 7-2	981	1.34**	-2942.56
NCM 201	835	0.31	27821.25**
NCM 209	1051	0.57	4553.27
No. 1	1028	1.52**	29977.79**
NCM 205	968	0.71	21859.94**
AEM 6/20	933	0.92**	7665.49
NM 18	999	1.42**	11746.49*
AEM 30/20	902	0.69	14169.92*
NM 93	944	1.03**	9195.65*
NM 90	1063	1.40**	3040.03
NM 121-25	1005	1.30**	8516.87
M 20-24	884	0.80*	15952.10**
Average	966	1.00	12629.68

**, * Significant at the 1% and 5% levels, respectively.

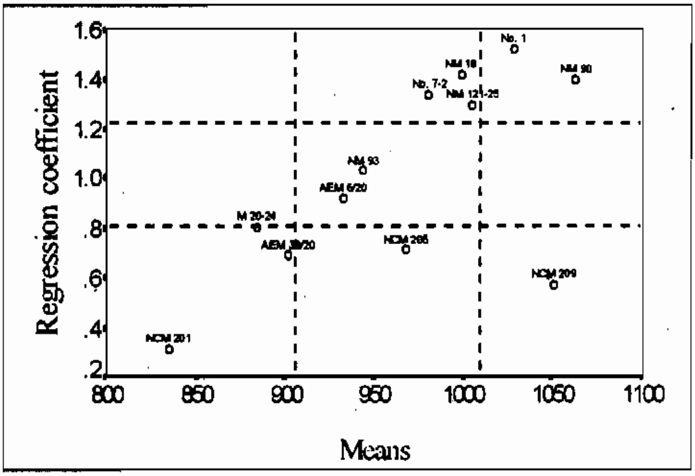

Fig. 1. Graphic presentation of means and b_i for determination of stable mungbean genotypes.

Finlay & Wilkinson (1963), considered linearity of regression as a measure of stability. Eberhart & Russell (1966), however, emphasized that both linear (bi) and non-linear (S^2d_i) components of G X E interaction should be considered in judging the phenotypic stability of a particular genotype. Further, Samuel *et al.*, (1970) suggested that the linear regression could simply be regarded as a measure of response of a particular genotype which depends largely upon a number of environments, whereas the deviation from regression line was considered as a measure of stability, genotype with the lowest or non-significant standard deviation being the most stable and vice versa. The simultaneous consideration of three parameters of stability (Table 2) for the individual genotype revealed that the genotypes NM 90 and NCM 209 would be especially good under favorable and unfavorable environments, respectively. NM 90 was the highest yielding genotype (1063 kg/ha) with regression value 1.40 and a non-significant deviation from regression. NCM 209 also had above average and high mean performance (1051 kg/ha) with a low magnitude of bi (0.57) and non significant standard deviation, indicating less response to accidental changes in the environment.

The yield performance of genotypes "No. 1" and "NM 18" was more than the average performance of all the genotypes over all the environments (grand mean). They had regression values more than 1, indicating sensitivity to environmental changes but giving higher yield when the environments were conducive. The genotype "No. 1" had 1.52 regression value with highly significant deviation, whereas "NM 18" also significantly deviated from its regression value (1.42). The genotypes "NM 121-25" and "No. 7-2" had above average (grand mean) yield performance. Both the genotypes possessed higher regression values with non-significant deviation, indicating the sensitivity to environmental changes with specific adaptation to favorable environments. The genotype "NM 93" and "AEM 6/20" had 1.03 and 0.92 regression values, respectively, with below average deviations. The mean yield performance of both these genotypes were lower than the grand mean, indicating average stability witb poor adaptation to environmental fluctuations. The yield of "NCM 205" was almost at par with the grand mean yield. It possessed below average linear response showing less sensitivity to environmental changes. This genotype had highly significant deviation from regression and thus, can be regarded as having below average stability with poor response to favorable conditions. The genotypes "NCM 201" and "M 20-24" had regression values less than 1 with highly significant deviation values. AEM 30/20 had also regression value less than unity (0.69) with significant deviation from regression. These three genotypes had below average yield and their stability parameters revealed greater stability to environmental changes with specific adaptation to unfavorable environments.

Figure 1 gives a graphic summary that can be used for selecting stable genotypes. The vertical lines are one standard deviation above and below the grand mean, whereas the horizontal lines are one standard deviation above and below the average slope (b=1.0). Two dots in the center section represent "AEM 6/20" and "NM 93" revealing average stability, but these two genotypes had the average yields below the grand mean. The genotype "NM 90" had higher response to accidental changes in the environment. Being highest yielder, it would thus, perform consistently in high management conditions. Contrarily, though "NCM 209" was the high yielder, its regression coefficient identified it as an above average stable, indicating that in unfavorable environments it could perform constantly. The genotypes No. 1 and NM 18 were specifically adapted to favorable environments.

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