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Full Length Research Paper

Assessment of selection techniques in genotype X environment interaction in cowpea *Vigna unguiculata* (L.) walp

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Ten genotypes of cowpea were grown in four environments comprising the early and late seasons of Ogbomoso and Abeokuta locations in 2005 and 2006. Joint linear regression analysis indicated the presence of Genotype x Environment interaction even though, a proportion was non-linear. The differences in the values of the regression coefficient and the correlation of grain yield revealed that the genotypes responded differently to the environments and that regression coefficient as a technique could not be used to identify genotype performance in specific locations. The use of Deviation mean square and Ecovalence mean square techniques produced similar results on the consistency of genotypes performance hence, Deviation mean square and Ecovalence mean square may not be simultaneously used. However, regression coefficient, Si^3, Pi, and Modified rank sum techniques can be jointly used to select genotypes based on their yielding ability and response to environmental changes.

Key words: Genotype X environment interaction, selection techniques, cowpea, *Vigna unguiculata*.

INTRODUCTION

Cowpea is world's most important protein source. The grain has the largest usable protein content of all cultivated legumes. In Nigeria, production and release of improved cowpea varieties have been slow especially in the humid and semi humid regions of Nigeria. Highest yields have been obtained in the drier region of the country (FAO, 2000). Stability performance of cowpea varieties across contrasting environments is essential for the successful selection of stable and high yielding varieties (Dashiell et al., 1994; Ariyo and Ayo-Vaughan, 2000). Integration of cultivar stability with yield is important for the purpose of selecting high yielding and stable genotypes. Therefore, a number of techniques that simultaneously combine high yield and stability of performance have been proposed. The regression technique (Eberhart and Russell, 1966) has been used. In this technique, genotype response to a given environment is considered.

The Deviation mean square, (Si^2d) considered the mean squares for the deviations from regression as a stability parameter. Ecovalence mean square (Wricke, 1962) (WMS), also determines the response of genotypes to a given environment. These stability parameters fail to select genotypes on the basis of high yield and stable performance. The limitations resulting from these parameters therefore led to the development of techniques combining high yield with stable performance (Kroonenberg, 1995). Lin and Binns (1988) cultivar superiority measure (Pi) based genotype yield in each environment on ranks with the lowest rank assigned to most desirable genotype. By this technique, only genotypes with wide adaptation are selected. A non -parametric statistic (Si^3) of Huhn (1979) was also developed. This technique also based desirable genotype selection on lowest rank value. With these techniques, selection becomes more precise in wide and specific environments. This study therefore, determined the effect of environment on the stable performance of ten elite cowpea genotypes and evaluated the relationship between the stability and selection techniques.

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Table 1. The mean yield, environment index and ecology of the cowpea genotypes.

Environment	Environment index	Mean seed Yield (kg/ha)	Ecology
Ogbomoso 1	697.4	1697.2	Guinea savanna
Ogbomoso 2	420.3	1401.7	Guinea savanna
Abeokuta 1	208.7	1083.9	Rainforest
Abeokuta 2	-416.7	905.4	Rainforest

1=Ogbomoso and Abeokuta early season; 2= Ogbomoso and Abeokuta late seasons.

MATERIALS AND METHODS

Ten elite cowpea varieties were grown in the early and late seasons of 2005 and 2006 to give a total of four environments. Using a randomized complete block design with three replications, each of the genotype was grown into a five-row plot of 2.7 x 2.4 m and spaced 60 and 45 cm between and within rows to give a total of 24 plants per plot. Insect pests were controlled using karate at 50 ml to 20 liters of water. Weeding was done manually as at when due. The three inner competitive rows were harvested to determine the yield. Data were subjected to combined analysis of variance and joint linear regression analysis following the procedure of Eberhart and Russell (1966). In this study, a mixed model was assumed where the genotypes were fixed and environment random as the effects of environments on genotypes were tested.

The regression coefficient (b) measures the response of genotypes to environments. When b= 1 there is average stability and adaptable to both poor and good environments. when b > 1 genotypes give above average stability only in good environment. Whereas, when b < 1, it indicates genotypes adaptation to poor environment. Deviation mean square parameter (Si^3d) measures genotype stability. A genotype is stable when the Si^3d is not different from zero. Wrickes (1965) Ecovalence mean square (WMS) stability implies low adaptation. In addition to these stability parameters, three selection parameters were used. Lin and Binns (1988), proposed a statistic which measures genotype superiority as follows:

$$Pi = \sum_{j=1}^{n} \frac{(X_{ij} - Mj)^2}{n}$$

Where:

Pi = Mean square between the cultivar's yield and the overall yield for each location

Xij = yield of i^{th} genotype grown in j^{th} location.

Mj = Maximum yield response among all cultivars in j^{th} location.

n = number of locations.

Another selection statistic as proposed by Huhn (1979) was calculated as follows:

$$S_i^3 = \frac{\sum_j (rij - \bar{r}_i)^2}{\bar{r}_i}$$

Where:

rij = rank of i^{th} genotype in j^{th} environment

$\bar{r}_i$ = mean of ranks over all environment for i^{th} genotype

In this statistic the lower the Si^3, the more desirable the genotype. Kang and Pham (1991) rank-sum technique was used as the third selection statistics. Ranks and stability ratings were assigned genotype mean yield, such that highest yielding genotype had a rank of 1 and least yielding, had the highest rank. Stability rating of 0 was equally assigned genotype with non significant Si^2d and a rating 4, if significant at 5% probability level and 8 if significant at 1% probability level. This ranting was added to the yield rank, such that genotypes with the lowest rank sums were adjourged high yielding and stable.

Table 2. Joint regression analysis of cowpea yield.

Source	DF	MS
Total	199	
Treatment	39	11831.44
Genotype	9	16304.23**
Environment	3	28117.75**
G x E	27	37666.21**
HR	9	5029.41
CR	1	2926.20
DC	8	9347.12*
DR	18	6112.65
Error	80	3646.41

RESULTS AND DISCUSSION

The mean yield of the cowpea genotypes averaged over environments is presented in Table 1. The grain mean grain yield ranged from 905.4 kg/ha for Abeokuta late season to 1692.2 kg/ha for Ogbomoso early season; Early season of Ogbomoso had the largest environment index of 697.4 and therefore the best environment for this study. The late season of Abeokuta recorded least environment index of –416.7 and hence the poorest environment.

The joint linear regression analysis of the 10 cowpea yield across the four environments is presented in Table 2. Genotype and environment effects were significant. Mean square of the deviation from concurrence and regression were significant as tested against the pooled error. This indicated the presence of GXE interaction and that a large proportion of the genotype x environment interaction was non-linear as revealed in the significant interaction of Genotype and Environment. Even the regression concurrence was not significant. The joint linear regression alone could not predict the individual genotype performance with respect to environmental influence Aremu (2005). This therefore places Joint regression analysis as unreliable parameter in selecting for high yield and