STABILITY PERFORMANCE OF SHORT – DURATION COWPEA (*VIGNA UNGUICULATA* (L.) WALP) GENOTYPES IN HUMID AND SAVANNA ENVIRONMENTS

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ABSTRACT

Eight selected cowpea were evaluated in four environments of rainforest and humid savanna agroecology to determine the grain yield stability and the response patterns. A regression method and a genotype-grouping technique were employed in the evaluation. The results showed significant variations in the variety, environment and variety × environment interaction. The regression analysis and cultivar grouping technique are similar as they both identify more stable and less stable cultivars across diverse environments. Thus, genotype IT84s – 2246, IT85D – 3577 and IT86D – 1010 were considered stable in the two-agro ecological zones. Using the regression and cultivar grouping techniques.

Key words: Vigna unguiculata, stability, regression, Genotype-grouping technique.

INTRODUCTION

Selection for high yield and consistency of performance is a major concern to plant breeders. Low grain yield in cowpea an important and cheap protein source in developing countries of Africa especially Nigeria, is a major set back in cowpea production. Some of the factors responsible for this low yield include climate, soil fertility, cultural practices, pest and disease incidences, genotype inherent factors etc. (Ngundo and Tailor, 1974)

Genotypes may respond differently to environmental conditions. If all genotypes respond similarly to all the environments tested, their relative performance in other environment may be predicted with some confidence.

A number of techniques have been used to determined genotype stability across environments. The most often used parameters in selecting genotypes are mean yield, regression coefficients, and deviation mean square (Eberthert and Russell, 1966; Acciaresi *et al.*, 1997). The analysis of variance detects genotype × environment interaction but it fails to determine the individual genotype response to the environment. The genotype – grouping technique and joint regression analyses exposes the responses of individual genotypes to different environments. Though the validity of regression technique had been criticized it still remained a reliable tool in developing cultivars performance, Perkins and Jinks (1968) for *Nicotiana rustica*; Ariyo (1995), for soybean. The genotype – grouping technique is a complement to regression analysis and it has been used in stratifying genotype mean yield across locations (Acciaresi *et al.*, 1997).

The purpose of this study was to determine and compare the stability of performance of early maturing cowpea cultivars using regression and genotype – grouping techniques.

MATERIALS AND METHOD

This study was conducted at the IITA research field under the rainforest condition of Ibadan (30° 54'E, 07° 18'N) in 1997 and 1998 cropping season. And the Teaching and Research farm of Ladoke Akintola University of Technology under the moist savanna condition of Ogbomoso (04°E, 8°N) during the 1999 and 2000 cropping season. The randomized complete block design with three replications was used. Each genotype was grown in 2 × 2 m plot and spaced 50 cm between rows and 20 cm within rows. Three seeds were planted per hole and later thinned to two plants stand. There were ten plants per row to give a total population of 100 plants per plot. Insect pests were controlled using cymbush (Cypermethrin) at the rate of 50 ml per 15 litres of water during the planting seasons. Weeding was done manually as at when due. Data on the grain yield were collected from the three competitive inner rows.

Two methods were used to investigate the response of the cultivars to different environments as by Freeman (1973) and Eberhert and Russell (1966). The linear regression model is

$$Y_{ijk} = \mu + Gi + E_j - b_iE_j + di_j + r_{jk} + e_{ijk}$$

where

Y_{ijk} = yield in kg per hectare of the ith cultivar in the kth replicates of the jth environment

G = is the ith cultivar,

E = j^{th} environment

b_i = is the linear regression coefficient of the ith cultivar

d_{ij} = is the deviation from regression

r_{jk} = effect of the kth replicates of the jth environment

e = error term

In the first method the mean grain yields were regressed against the different environments. In this method a cultivar with a unit regression coefficient (b = 1) showed average stability. Regression coefficient greater than 1 (b > 1) showed below average stability.

The second method is a genotype grouping technique (Francis and Kannenberg, 1978; Yau, 1995). This method plots the mean yield of each genotype against its coefficient of variation (C.V). This method groups genotypes into four classes.

Group I: High or above average mean yield but below average C.V

Group II: Above average mean yield and above average C.V

Group III: Below average yield and below average C.V

Group IV: Below average yield but above average C.V

The use of coefficient of variation as by Francis and Kannenberg (1978), Yau (1995) is a convenient tool because it is essentially a log transformation of the mean deviation and therefore decreases problems in comparing unequal variances (Pfahler and Linskens, 1999). Stable genotypes can be chosen from either of these methods compared.

RESULTS

The mean yields and the coefficient of variation C.V. of the genotypes are present in Table 1. An overall average mean yield of 1059.55 kg/ha was recorded for all the cultivar. The C.V. gave an overall mean of 13.35%, the mean yield of each genotype ranged from 787.35 to 1214.3 (kg/ha). Cultivars H64 – 3, IT86D – 721 and K-59 recorded below average seed yield. The other genotypes gave above average yield with IT86D-1010 recording the highest mean grain yield and highest coefficient of variation.

Table 1: Mean grain yield and coefficient of variation for the cowpea varieties evaluated

Variety	Mean yield (kg/ha)	CV
IT845 - 2246	1126.33	8.21
IT85D - 3577	1172.33	8.20
IT85D – 719	1154.42	18.65
K – 59	990.83	22.69
IT86D - 880	1041.50	12.09
H64 – 3	787.33	19.35
IT86D - 721	988.83	13.51
IT86D - 1010	1214.83	8.16
LSD	89.96	14.68
Mean	1059.55	13.85

The mean yield of the cultivar across the four environments evaluated is shown in Table 2. The 1997 Ibadan environment was most favourable as it gave the highest yield of 1180.38 kg/ha with the lowest C.V. of 11.08%. The 1999 Guinea savanna environment was most unfavourable as it gave the lowest mean grain yield of 981.58 kg/ha with a CV of 15.60%.

Table 2: Mean grain yield and coefficient of variation for the varieties for the four environments

Year	Mean yield (kg/ha)	CV%
Rainforest (1997)	1180.30	11.08
Rainforest (1998)	1020.25	18.53
Humid savanna (1999)	981.58	15.50
Humid savanna (2000)	1056.58	13.56
LSD	127.22	16.10
Mean	1059.55	14.69

The combined analysis of variance for the grain yield of the cultivars evaluated is presented in Table 3. All the source of variation within the four environments were significantly different. This explains the variations among the cultivars and climatic conditions affecting each cultivar in each year. A large proportion of the cultivar × environment interaction was significant and linear thus, indicating the presence of cultivars × environment interaction.

Table 3: Combined ANOVA for grain yield of short duration cowpea varieties in 4

Source	df	SS	MS
Variety	7	1613318.82	177876.59**
Environment	3	533629.781	230474.12**
V× Environment	21	899338.80	42825.42*
Rep/ Environment	8	207373.08	25934.63
Pooled error	56	1255152.49	22413.44

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

The regression coefficient (b) and the deviation from regression (S²d) of the genotypes are presented in Table 4. Since a large proportion of variety × environment interaction was linear, the regression coefficients analysis were therefore a true index for measuring responses to the environments. IT84S – 2246, IT85D - D3577 and IT86D – 1010 were most responsive and consistent. Only IT86D – 1010 were significantly greater than zero deviation. The genotype grouping technique by Francis and Kannenberg (1978), Yau, (1995) gave a class of 4 groups (Figure 1) by this method cultivars IT84S – 2246 and IT85D-3577 were most stable and desirable as they combined above average grain yield with below average CV. Although cultivars K-59, IT86D-880 and H64-3 were stable by having below average CV but their respective mean yield were below average. Environmental changes with respect to planting season affected cultivars IT86D-721 and H64-3 in group II as evident in the high CV. The environmental variation consequently resulted in below average grain yield for IT86D-721 and H64 – 3 therefore making them least stable, and most undesirable.
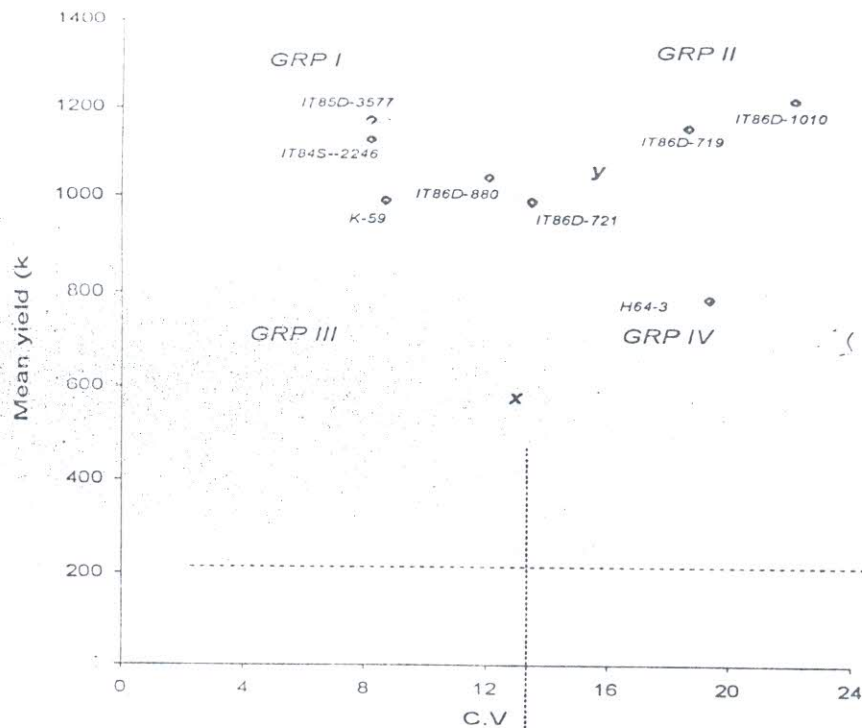

Fig. 1: Mean grain yields (kg/ha) plotted against coeffcient of variation from four environments.

x = mean CV
y = grand mean yield

Table 4: Regression Coefficient (b) and deviation Mean Square (S^2d) Value for the Cowpea Varieties.

Variety	Regression (b)	Mean square deviation (S^2d)
IT845 - 2246	2.55[a]	68,946.24[b]
IT85D - 3577	0.75	82,222.17[b]
IT85D – 719	0.43	71,979.09[b]
K – 59	0.30	80,910.26[b]
IT86D – 880	0.41	12,961.71[b]
H64 – 3	0.19	97,221.54[b]
IT86D – 721	0.48	84,702.31[b]
IT86D - 1010	1.83[a]	184,662.22[b]

a = Regression coefficient (b) significantly greater or less than 1.0.

b = Deviation mean square (S^2d) significantly greater than 0.

DISCUSSION

The variation in yield of the cultivars across the year indicated a wide genetic divergence of the cultivars and influence of the environments on the performance of each of the cultivars studied. Breeding methods can therefore be designed towards producing high yield varieties with considerable degree of general adaptability Langer and Bailey (1979), Acciaresi *et al.* (1997). Selection of cultivars for high yield and stability of performance based on the values of the mean yield, regression coefficients and minimum deviation from linear regression can be reliable (Okeleye *et al.*, 1999). From this study, IT86D-1010, IT85D-3577 and IT84S-2246 can be said to be stable as they gave above average grain yield and had regression coefficients significantly greater than unity and zero respectively. This supports the findings of Byth *et al.* (1996) on large data analysis evaluating genotype adaptation using ryes. Furthermore, since a large proportion of the cultivars responded linearly to the environments the regression coefficients is therefore said to be a reliable index of the cultivars responses to the environments. However, selection of cultivars IT86D-1010, IT85D-3577 and IT845-2246, across the humid and savanna environments will be a reliable attempt in further improving their mean yield and adaptability. Although IT86D-719 gave above average grain yield but the regression coefficient was not significantly greater than unity and zero. This therefore exposes the non-reliability in using the regression coefficient method to determine genotype mean yield performance across environments. The most undesirable cultivars were IT86D-721 and H64-3, which combined below average yield with above

humid and savanna environments and therefore most undesirable.

From the result, the climatic conditions can favour breeding for short duration cowpea cultivars. This can be a tremendous achievement in improving cowpea yield in Nigeria as they can be grown in three seasons within a year. It is therefore suggested that short duration cultivars be tested in a wider range locations to ensure a more reliable selection programme. According to Okeleye *et al*, 1999 in the study of performance of cowpea cultivars using regression analysis, it was emphasized that lines should be tested in more diverse locations to assure better reliable recommendations.

The regression analysis and cultivars grouping technique are similar by identifying more stable and less stable cultivars Francis and Kannerberg (1976), Ntare and Aken Ova (1985). The cultivar grouping technique further stratifies mean yields across environmental variations. This decreases the complexity in selecting cultivars with consistent performance in a given environment.

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