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YIELD STABILITY STUDY IN OIL PALM (*Elaeis guineensis Jacq*) USING DESCRIPTIVE METHOD OF GROUPING GENOTYPES

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ABSTRACT: Twenty oil palm genotype of diverse origin were assessed at two locations within the Nigerian Oil Palm belt for stability of yield in relation to their total bunch weight, single bunch weight and bunch number. Significant genotype x environment interaction was observed leading to differences in yield between the two locations. Nonetheless, the genotype – grouping technique proposed by Francis and Kannenberg was valuable in identifying high yielding and stable genotypes of oil palm. The best genotype (i.e. stable) is one with a high yield (65kg/palm/year) and low coefficient of variation (37%). This technique is as potent as any other procedures in classifying oil palm genotypes and thus it is recommended in the identification of high yielding and stable genotypes, especially when large number of genotypes is involved. Although plant breeders generally prefer developing materials with broad adaptability to yield over a range of environments, materials for specific environment should not be ignored.

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INTRODUCTION

In Nigeria, the oil palm (*Elaeis guneensis Jacq*) is cultivated over a wide range of environments with varying yields across these environments. The variability in yield from one environment to the other generally referred to as genotype x environment interaction has long been known by plant breeders (Lee and Rajanaidu 1999) and is a major concern to the industry. (Okoye *et al* 2008, 2009). This phenomenon occurs when genotypes perform differently relative to each other in different environments.

Consistency or stability of performance is usually the goal of plant breeders. Consequently, the plant breeder has to develop cultivars and strains which will be stable over a range of environments.

An array of techniques are available for the study of genotype x environment interaction such as analysis of variance, linear regression, principal component analysis, multivariate analysis, cluster analysis, ranking and other parametric test. One of the methods commonly used is a conventional analysis of variance followed by a joint regression analysis. This technique was first proposed by Yates and Cochran (1938) and later modified by Finlay and Wilkinson (1963) and was further refined and adopted by other workers including Eberhart and Russell (1966). A major advantage of this technique is that it provides a visual picture as well as a summary (Lee and Rajanaidu, 1999) and thus the approach is favoured because of its inherent appeal. Lin *et al* (1986) reviewed the various methods employed to identify stable genotypes when genotype x environment interaction is present including the genotype – grouping technique proposed by Francis and Kannenberg (1978).

This paper therefore highlight the outcome of using genotype–grouping technique as proposed by Francis and Kennenberg (1978) in determining relative stability of oil palm progenies grown in two different locations in Nigeria. A major attractiveness of this technique for classifying genotypes for stability is that it is simple and does not require sophisticated computation and would therefore be quite beneficial to breeders in developing countries where computer facilities may be lacking. In addition the technique could assist in identifying cultivars that respond to changes in environment and likely to give satisfactory returns to added inputs like fertilizers and pesticides.

MATERIALS AND METHODS

The study was carried out at two locations within the oil palm belt of Nigeria viz Abak (3^{o}N, 7^{o}50'E) and Acharu (7^{o}40'N, 7^{o}10'E) (Fig 1). These locations are two contrasting environments. Twenty oil palm progenies (*dura x tenera crosses*) of diverse origins (Ataga, 1993) were used for the study. These progenies formed part of a series of crosses within the first cycle modified reciprocal recurrent selection (RRS) programme of the Nigerian Institute For Oil Palm Research (NIFOR), Benin City, Nigeria. The experimental layout was a randomized complete block design with four replications. A spacing of 8.8 meters triangular was adopted. There were eight palms per plot and data was collected on individual palm for five years period (from 1966 – 1970) for fresh fruit bunch i.e. total bunch weight, (TBW) single bunch weight (SBW) and bunch number (BN).

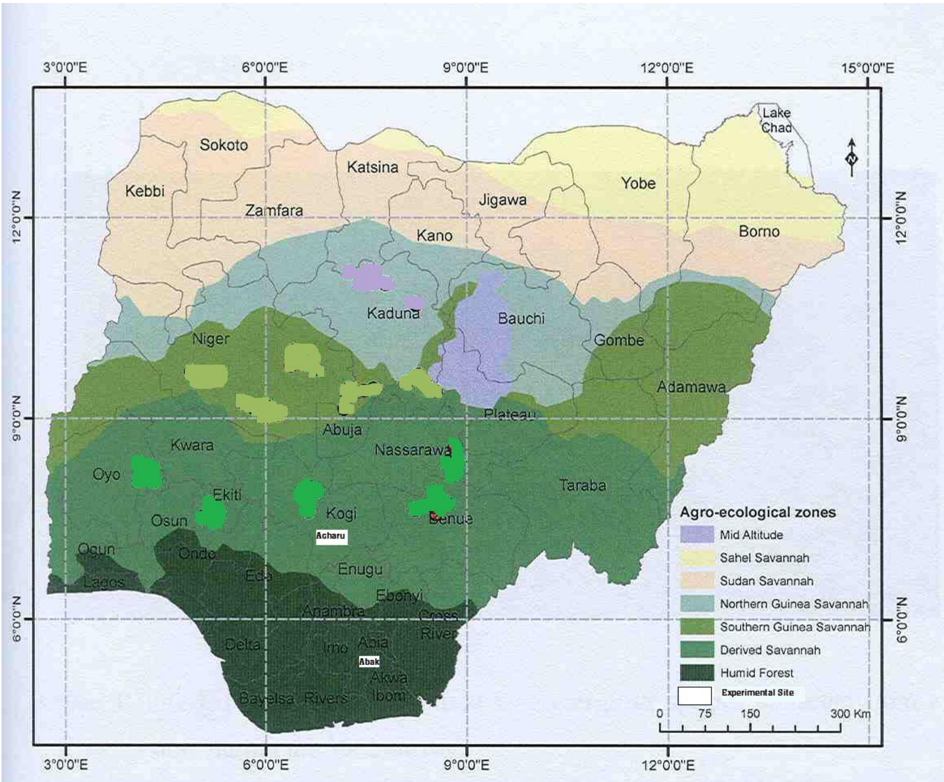

Fig 1: Map of Nigeria showing the two experimental site.

There were ten environments with each year within a location considered as an environment (Gray, 1982). The experiment was analysed as randomized complete design (Steel and Torrie, 1960) and stability analysis was subsequently performed for each of the three traits using the genotype grouping techniques proposed by Francis and Kannenberg (1978). By this procedure, the mean of each genotype averaged over environments was plotted against its coefficient of variation (C.V.) over environments.

RESULTS

The analysis of variance indicated the existence and magnitude of genotype x environment interaction in the oil palm for the three characters studied; bunch number, single bunch weight and total bunch weight (Table 1). Environmental effects were highly significant for the three traits studied; bunch number, single bunch weight and total bunch weight. Pooled data for each location over years indicated higher values in the rainforest zone than in the derived savannah zone. Pooled data over years indicated that total bunch weight range from 41.78kg/palm/year to 92.05kg/palm/year at Abak location and 21.38kg/palm/year to 50.97kg/palm/year at Acharu location. Genotype 8 was the highest yielding entry at both locations. The overall mean yield performance (total bunch weight) was 65.94kg/palm/year for the Southern location and 33.87kg/palm/year for the inland location. Their corresponding bunch number and single bunch weight (yield components) were 7.34/palm/year and 8.98kg/palm/year and 4.86/palm/year and 6.97kg/palm/year respectively for Southern and Inland location (Table 2). Thus higher values were obtained in the rainforest zone than in the derived Savannah zone.

The analysis of variance can only provide information on existence and magnitude of genotype – environment interaction but does not identify stable genotypes. Stability parameter proposed by Francis and Kannenberg (1978) was used to identify higher yielding and stable genotypes of oil palm across the two locations for five years.

This technique (Francis and Kannenberg, 1978) subdivides genotypes into four groups in terms of their yield and coefficient of variation (CV) for the three traits studied (Figs. 2 to 4).

The four groups are:

High mean yield and low CV - -Group I
High mean yield and high CV - -Group II
Low mean yield and low CV - -Group III
Low mean yield and high CV - -Group IV

By this classification, only genotypes in group I can be considered stable. Genotypes 7, 8, 9, 13 and 15 were stable when total bunch weight was considered. Although genotypes 10, 11, 12 and 14 were regarded as stable by having below average coefficient of variation, their total bunch weight were however below average. Genotypes 2, 3 and 6 though had above average total bunch weight were characterized by large coefficients of variation. The same procedure grouped the entries on the basis of bunch number and single bunch weight. Genotypes 7 ,8 ,9 and 15 were considered stable for bunch number while genotypes 6, 7 ,8 ,9 ,12 and 15 were considered stable for single bunch weight. When the three traits were considered simultaneously genotypes 7, 8, 9 and 15 were stable.

Table 1: **POOLED ANALYSIS OF VARIANCE**

			Mean Squares	
Source	**DF**	**BN/Palm**	**SBW kg/Palm**	**TBW kg/Palm**
Replication	3	11.92	24.91	2319.67
Genotypes	19	60.76	124.86	2719.47
Environments	9	248.56**	542.07**	33291.68**
Genotype Environment	171	5.61**	14.57**	370.99**
Error	597	2.12	9.50	158.93

** Significant at 1% level of probability

Table 2: Yield Performance (Total Bunch Weight) Overall Mean Bunch Number (BN), Single Bunch Weight (SBW) Per Palm per Year Average Over Years For Each Location

Genotype	**Abak (Kg/palm/year)**	**Acharu (Kg/palm/year)**
1.	60.54	25.40
2.	71.17	26.23
3.	74.27	35.37
4.	62.62	28.68
5.	63.69	24.51
6.	77.97	38.81
7.	71.96	46.11
8.	92.05	50.97
9.	71.41	37.59
10.	68.32	29.93
11.	50.03	40.25
12.	54.73	37.33
13.	69.04	34.14
14.	41.78	31.72
15.	72.69	40.38
16.	72.35	30.61
17.	68.65	26.95
18.	67.35	28.39
19.	59.92	28.96
20.	48.34	21.38
Overall Mean	65.94	33.87
Bunch No/palm/year	7.34	4.86
Single bunch Weight (kg/palm/year	8.98	6.97

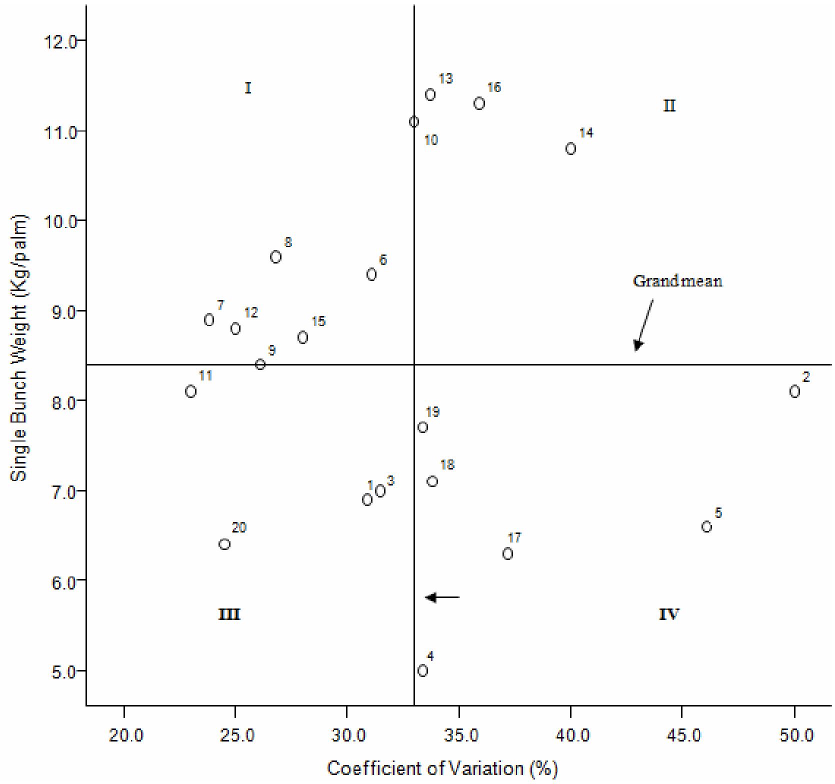

Fig 2: Single Bunch Weight (kg)/palm against coefficient of variation for 20 oil palm hybrids.

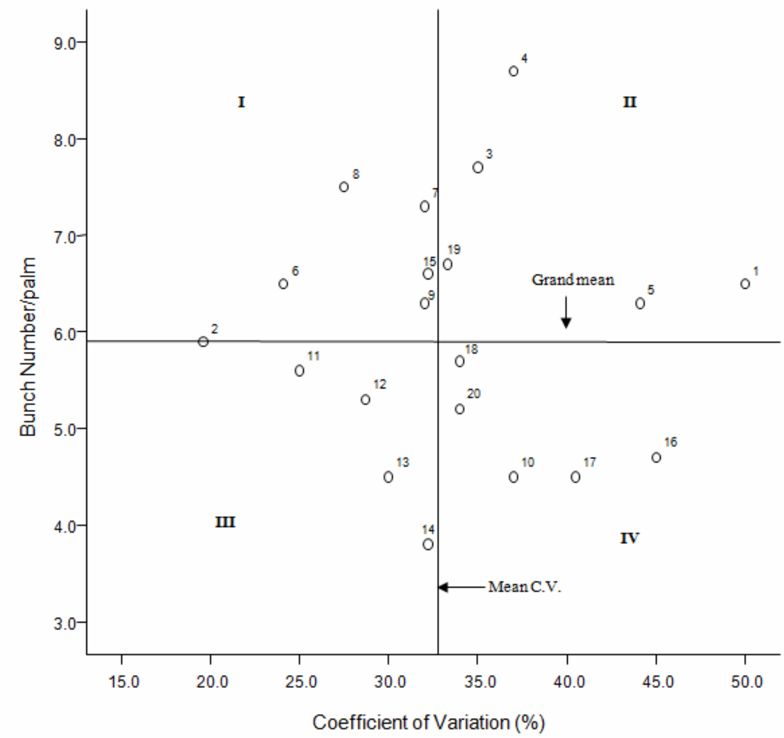

Fig 3: Bunch number/palm against coefficient of variation for 20 oil palm hybrids.

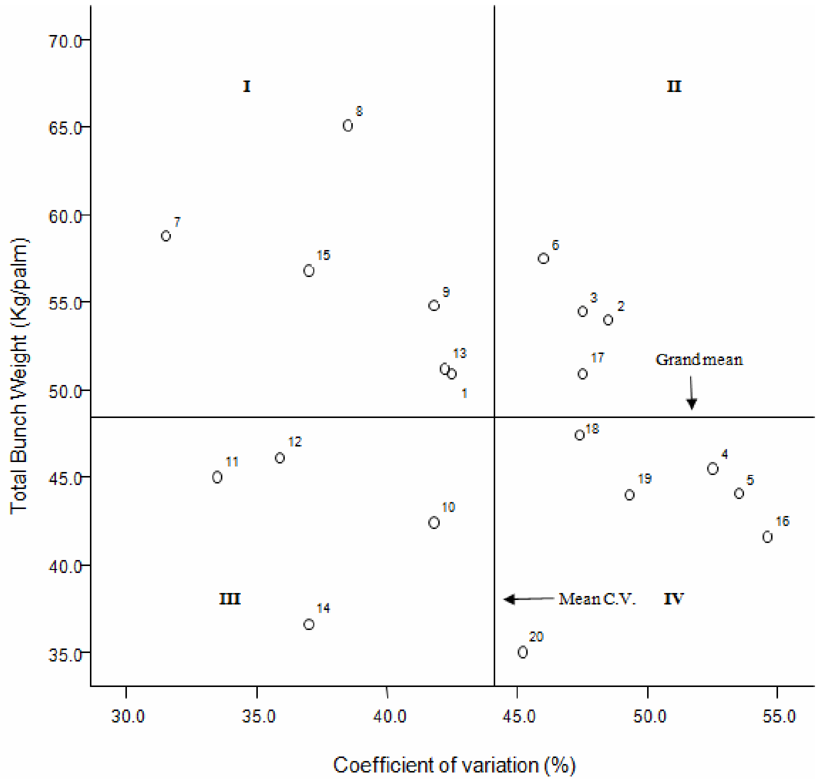

Fig 4: Total Bunch Weight (kg)/palm against coefficient of variation for 20 oil palm hybrids.

DISCUSSION

Genotype – environmental interaction were significant as higher yields were obtained in the Southern location than in the Northern location, suggesting that some of the physiological activities respond differently to changes in the environment. A change in the environment constitutes a stress to the plant which then responds according to it's genetic make-up (Lee and Rajanaidu, 1999). The stress on the oil palm arises from differences in location, rainfall, solar radiation, soil available nutrients and management practices which exert great effects on crop production. The fundamental importance of genotype x environment interaction to breeders cannot be over-estimated. Plant breeders have long recognized the ability of some crop varieties to maintain a relatively uniform performance over a wide range of environment. However, it has been established that the relative performance of different genotypes could vary with different environment due to genotype – environment interactions (Ong *et al* 1986, Okoye, *et al* 2009). This interplay of genetic and non-genetic effects reduces the correlation between genotype and phenotype (Ataga, 1993), which in turn reduces confidence in reference from experimental data, relevant to crop improvement (Moll and Stuber, 1974)

Several studies have been conducted to detect genotype x environmental interactions in oil palm as this study had also shown, using different procedures. Obisesan and Fatunla, (1983), Obisesan and Parimoo, (1985), Ong *et al* (1986), Ataga (1993), Okoye *et al* (2008) used stability parameters proposed by Eberhart and Russel (1966). In these studies, each year within a location was considered an environment, stable and high yielding oil palm progenies were identified by the procedures. On the other hand, the genotype – grouping technique proposed by Francis and Kanneberg (1978) which tends to overcome inherent large variance associated with stability parameter of Eberhart and Russell (1966) was used by Lee *et al* (1998) and Lee and Donough (1991) to identify high yielding and stable genotype of oil palm. In their study of interspecific hybrids of *Elaeis oleifera x E guineensis* Yong *et al* (2001) also used this approach to successfully classify genotypes. By this procedure, high yielding and stable genotypes among 20 oil palm genotpes grown in two contrasting locations in Nigeria were identified based on their yields and coefficient of variation. Group I genotypes are desirable as they exhibited high mean yields and consistent performances in different environments i.e. low C.Vs. In addition, the identification of a selected high yielding and stable genotypes relative to the other is easily visualized. Stability in yield is therefore a major concern to oil palm breeders. The breeder should decide whether to release a genotype that does well over a range of environment or one adapted to a specific environment.

CONCLUSION

As genotype x environment interaction is present and important in oil palm breeding, it is no longer sufficient to test for selection, genotypes in one environment as this study indicated. Thus cognizance of this phenomenon must be taken into account in the development of oil palm varieties for commercial release for various ecological zones of Nigeria. Such efforts could lead to identification of genotypes for specific adaptation due to their mean performance, and the technique proposed by Francis and Kanneberg (1978) is adequate in identifying such stable oil palm genotypes.

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