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# VARIABILITY PATTERN WITHIN 65 ACCESSIONS OF AFRICAN WILD *VIGNA* - *VIGNA AMBACENSIS* BAKER.

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## ABSTRACT

*Sixty-five screened accessions of Vigna ambacensis Baker of diverse African origin, were selected for variability study under open field conditions. Principal Component Analysis (PCA) revealed that the first three principal component axes with eigenvalues greater than one explained 60.13% of the total variation based on 20 morphological and agronomic characters among the accessions. The first two principal axes accounted for 52.13% of the total variation. Vegetative characters were very useful in grouping the accessions into six distinct groups implying a high variability in the morphological features used in grouping the accessions. Character traits such as mean length of 10 rachis(0.335); pubescence on stems(0.513); mean length of 10 petiolules(0.327); pubescence on leaves(0.44); mean length of 10 petioles(0.325); mean thickness of 10 pulvins(0.312); mean length of 10 top leaflets(0.303); with eigenvectors indicated in the parentheses, played prominent roles in the grouping.*

**Key words**: *Vigna ambacensis*, Principal Component Analysis, variability, accession, eigenvalue.

## INTRODUCTION

Wild relatives of crop species constitute invaluable genetic resources for crop improvement (Tanksley and McCouch, 1997). Africa is one of the world's richest centers of many plant species that provide genetic resources of the most fundamental importance for man's food, beverage, medicine, fibre and for animal feed (Ng, 1988).

Multivariate analyses including, Principal Component Analysis (PCA), hierarchical clusters and dendogram, have been used to measure the diversity in germplasm collections as well as to assess the relative contribution of various traits to the total variability in crop collections (Baatout, 1995; Marquez-Ortis *et al.,* 1996)

Great interests are being generated in the tropical African *Vigna* non-*unguiculata* (TVnu) species for their multi-purpose usefulness as agricultural crops. Padulosi

and Ng (1990) stated that some wild *Vigna* species could serve as cover crops, soil improvers, soil fertilizers and pasture legumes. One of the numerous African wild *Vigna* species with potentials for medicinal and food values in agriculture is *Vigna ambacensis* (Baker) with 2n = 22. Evans *et al.* (1977) reported that *V. ambacensis* is being consumed as edible tuber in Zaire (now Democratic Republic of Congo, DRC).

In plant breeding programs, information on the genetic diversity within, and among closely related crop species is essential for maximum exploitation of genetic resources (Bai *et al.,* 2000). The objective of this study was to evaluate and classify the 65 accessions of *V. ambacensis* of various African origins based on their morphological and agronomic characters.

## MATERIALS AND METHODS

The experiment was carried out in 2000 at IITA research farm at Ibadan, southwestern Nigeria (7°30'N, 3°54'E; 213 m above sea level), located in the forest-savanna transition ecology. Rainfall distribution is bimodal; the main rainy season ranges from April to August, and a minor rainy season from August to October, followed by a long dry season from November to March. The annual rainfall was 1306mm in 2000, with a 30-year average of 1312mm.

A 23 x 20 m field was ploughed twice, harrowed to loosen the soil adequately, and the experiment was then laid out in an Augmented Design comprising eight and a half blocks in single-row plots to minimize environmental variation. Twelve seeds each of the 65 accessions were scarified by scratching the seed coat with a surgical blade to facilitate water imbibitions and germination. Two seeds were sown per hole on a row, with inter row spacing of 1m. Manual weeding was carried out as at when due.

Vernier calipers and a metre rule were used to measure the various numerical parameters (N) height of first branch; mean length of 10 top leaflets; mean width of 10 top leaflets; mean length of 10 petioles; mean length of 10 petiolules; and so on, while number of branches was counted. The qualitative characters (Q) such as pubescence on leaves and on stems, streaky pattern on midrid, spreading habit, plant color, and others were visually estimated. Observations were made on the "one-row plot" for each accession. Data were collected on the 20 characters listed in Table 1.

Statistical analyses were carried out at IITA using Genstat 5 Release 3.2 (Genstat, 1995) for the PCA on the basic matrix 20 x 65. The PCA produced an eigenvector for each principal component axis, and a biplot was plotted using the first two principal component axes for grouping the 65 accessions scored.

## RESULTS

Principal component analysis carried out on the 65 operational taxonomic units (OTUs) based on 20 characters showed that the first three principal components with eigenvalues greater than one were able to explain 60.13% of the total variance (Table 2). The first two principal axes accounted for 52.13% of the total variation among the 20 characters that described the 65 OTUs. The scores (latent

vectors or eigenvectors) of the major characters describing the first two principal axes are presented in Table 3. A plot of accessions on axes 1 and 2 presented in figure1 showed that only TVnu 2, in group **a,** and TVnus 877 and Tvnu 1782, belonging to group **e**, were most distinct among the accessions. Group **d** was made up of TVnu 557 and TVnu 452, while group **b** has 20 accessions clustered in it. Group **c** had 10 accessions while group f had the largest number of accessions consisting of 50% of the total number of accessions studied. Accessions in group **e** (TVnu 877 and TVnu 1782) were best described by height of first branch (hfb), mean length of 10 pulvins (pull), and other leaf characters with positive eigenvalues in Prin.1 and Prin.2 as shown in Table 3. However, the only accession in group **a**, (TVnu 2), was best described by the streaky pattern on the midrib (mpm) with negative eigenvalues (-0. 032; -0.154) on Prin.1 and Prin.2 (Table 3).

TVnu 877 smothered all the plants growing within its area of spread by its heavy canopy and consequently affected the growth and the development of the neighboring TVnu 452 planted a meter away (Table 4). When the latter was already producing flowers, the former was still growing luxuriantly and then suppressed its neighbors with its heavy vegetation.

## DISCUSSION

The Principal Component Analysis help in the interpretation of results as the latent root associated with each principal component measures the contribution of each principal component to the total variance, while the coefficient of latent vector associated with a given principal component indicates the degree of contribution (or loading) of each original variable to the principal component in question.

Leaf characteristics studied on the 65 accessions of *V. ambacensis* were useful in grouping them into six distinct groups, meaning that there exists a high variability in the morphological features of leaves of the accessions. Many of the accessions, particularly those belonging to group **f** were found to possess leaves that formed high density of vegetation that smothered weeds and covered the ground adequately. Members of this group would be very useful as both cover crops and fallow crops (Padulosi and Ng, 1990) to protect tropical soils that are characteristically vulnerable to the negative impacts of high torrents of rainfall leading to leaching of the soil nutrients and removal of top soils in erosion. TVnu 2 has extremely small leaves and bunchy growth with mean leaflet length of 5.5cm and leaf thickness of 1.7cm. Only TVnu 1197 has smaller values for the leaf characters with 4.6 cm and 1.5 cm for mean leaflet length and mean leaflet thickness respectively. Both TVnu 2 and TVnu 1197, natives of Tanzania and East Africa respectively, have light green color when young and produced characteristic purple flowers. A more detailed study on these accessions may give enough evidence that they both belong to the same *Vigna* species different from the others.

TVnu557 and TVnu 452 have medium leaf size, and profuse vegetative growth, which is compact and semi-erect. These

accessions, which are natives of Chad and Malawi in Western and Southern Africa respectively, may be amenable to routine farm management when adopted as cover crops in a tropical agriculture. However, where the use of this leguminous crop for the improvement of soil fertility is the objective, it is recommended that TVnu 377 with highly profuse luxuriant vegetative growth be selected because of possibilities of relatively higher rate of nitrogen fixation, and biomass accumulation.

Groups **c** and **f** have many accessions lumped into each of them. The implication being that the twenty characters scored upon which the 65 accessions were grouped are not sufficient for the exercise.

A study of more characters on a lesser number of accessions may produce better results.

***TABLE 1.*** Characters scored, scoring system, and rating scales for analysis of *V. ambacensis* accessions.

| S/N | Characters | Abbreviation | Scoring method | Rating scale of Qualitative characters | Nature of character |
|---|---|---|---|---|---|
| 1. | Number of branches | Nb | counted | | N |
| 2. | Height of first branch 2MAP* | Hfb | measured | | N |
| 3. | Pubescence on leaves | Lfp | felt | 0=absence; 1=presence | Q |
| 4. | Pubescence on stems | Stp | felt | 0=absence; 1=presence | Q |
| 5. | Streaky pattern on midrid | Mpm | visually estimated | 0=absence; 1=presence | Q |
| 6. | Spreading habit | Sph | visually estimated | 1=erect; 2=semi-erect; 3=prostrate | Q |
| 7. | Plant color pltc | | visually estimated | 1=light green; 2=green; 3=dark green | Q |
| 8. | Mean length of 10 top leaflets (cm) | Lftl | measured | | N |
| 9 | Mean width of 10 top leaflets (cm) | Lftw | measured | | N |
| 10. | Mean length of 10 petioles (cm) | Petl | measured | | N |
| 11. | Mean length of 10 petiolules (cm) | Petul | measured | | N |
| 12. | Mean length of 10 rachis (cm) | Racl | measured | | N |
| 13. | Mean length of 10 pulvins (cm) | Pull | measured | | N |
| 14. | Mean thickness of 10 pulvins (cm) | Puth | measured | | N |
| 15. | Vegitativeness | Vegi | visually estimated | 1=poor; 2=fairly moderate; 3=moderate; 4=profuse; 5= highly profuse | Q |
| 16. | Forage quality | Frgq | visual assessment | 1=not eaten; 2=lightly eaten; 3=badly eaten | Q |
| 17. | Top leaflet form | Tlf | visually estimated | 1=ovate; 2=ovate-lanceolate; 3=lanceolate; 4=obovate | Q |
| 18. | Top leaflet apex | Tlfa | visually estimated | 1=acuminate; 2=acute; 3=mucronate; 4=obtuse | Q |
| 19. | Top leaflet texture | Tlft | visually estimated | 1=smooth; 2=succulent; 3=membraneous | Q |
| 20. | Stem girth (mm) | Steg | measured | | N |

* Months after planting

*Table 2.* **Eigenvalues and percentages of total variation of the correlation matrix for the first three principal component axes.**

| Principal axis | Eigenvalue | Total variation (%) | Cumulative variation(%) |
|---|---|---|---|
| 1 | 7.85 | 39.25 | 39.25 |
| 2 | 2.58 | 12.88 | 52.13 |
| 3 | 1.60 | 8.00 | 60.13 |

*Table 3:* **Scores (eigenvectors) of the major characters of the first two principal axes used in ordination.**

| Axis 1 | Axis 2 |
|---|---|
| Mean length of 10 rachis (0.335) | Pubescence on stems (0.513) |
| Mean length of 10 petiolules (0.327) | Pubescence on leaves (0.440) |
| Mean length of 10 petioles (0.325) | Height of first branch (0.299) |
| Mean thickness of 10 pulvins (0.312) | Forage quality (0.240) |
| Mean length of 10 top leaflets (0.303) | Mean width of 10 top leaflets (0.151) |
| Mean width of 10 top leaflets (0.302) | Mean thickness of 10 pulvins (0.149) |
| Mean length of 10 pulvins (0.288 ) | Top leaflet apex (0.138) |
| Vegitativeness (0.284) | Mean length of 10 pulvins (0.116) |
| Streaky pattern on midrid (-0.032) | Streaky pattern on midrid (-0.154) |

**Table 4. Origin and visual assessment of the morphology(vegetative growth) of the 65 accessions of *V. ambacensis* 3 months after planting (MAP).**

| Highly profuse (5) | Profuse (4) | Moderate (3) | Fairly profuse (2) | Poor (1) |
|---|---|---|---|---|
| Acc. No ORIGIN | Acc. No. | Acc. No. | Acc. No. | Acc. No |
| ORIGIN | ORIGIN | ORIGIN | ORIGIN | ORIGIN |
| TVnu877 | TVnu452 | TVnu1663 | TVnu1677 | TVnu654 |
| NIGER | MALAWI | UNKNOWN | GHANA | CONGO |
| TVnu216 | TVnu1782 | TVnu1652 | TVnu1651 | TVnu615 |
| NIGERIA | TVnu148 | TVnu1661 | TVnu1778 | TVnu1177 |
| | GHANA | UNKNOWN | GHANA | CONGO |
| | TVnu147 | TVnu1209 | TVnu1681 | TVnu1185 |
| | GHANA | UNKNOWN | GHANA | GABON |
| | TVnu1679 | TVnu1186 | TVnu1639 | TVnu185 |
| | GHANA | GABON | GHANA | GABON |
| | TVnu152 | TVnu1780 | TVnu1213 | TVnu229 |
| | GHANA | GABON | GHANA | NIGERIA |
| | TVnu1665 | TVnu1644 | TVnu1184 | TVnu156 |
| | GHANA | GHANA | GABON | GHANA |
| | TVnu557 | TVnu1707 | TVnu1197 | TVnu3 |
| | GHANA | GHANA | GABON | GHANA |
| | CHAD | GHANA | GABON | RWANDA |
| | TVnu313 | TVnu1070 | TVnu632 | |
| | CHAD | GHANA | CONGO | |
| | TVnu720 | TVnu1668 | TVnu627 | |
| | CAMEROON | GHANA | CONGO | |
| | TVnu219 | TVnu306 | TVnu223 | |
| | CAMEROON | CHAD | CAMEROON | |
| | TVnu218 | TVnu90 | TVnu374 | |
| | CAMEROON | CONGO | CAMEROON | |
| | TVnu725 | TVnu342 | TVnu1643 | |
| | NIGERIA | MALAWI | UNKNOWN | |
| | TVnu187 | TVnu1064 | TVnu1682 | |
| | NIGERIA | DRC | UNKNOWN | |
| | TVnu1791 | TVnu1069 | TVnu12 | |
| | NIGERIA | NIGERIA | DRC | |
| | TVnu101 | TVnu810 | TVnu11 | |
| | NIGERIA | BOTSWANA | DRC | |
| | TVnu600 | TVnu1150 | TVnu456 | |
| | NIGER | CAR (died) | MALI | |
| | TVnu989 | | TVnu200 | |
| | NIGER | | NIGERIA | |
| | TVnu755 | | TVnu2 | |
| | CAR | | TANZANIA | |
| | | | TVnu947 | |
| | | | NIGERIA | |

N.B. DRC = Democratic Republic of Congo
CAR = Central Africa Republic.

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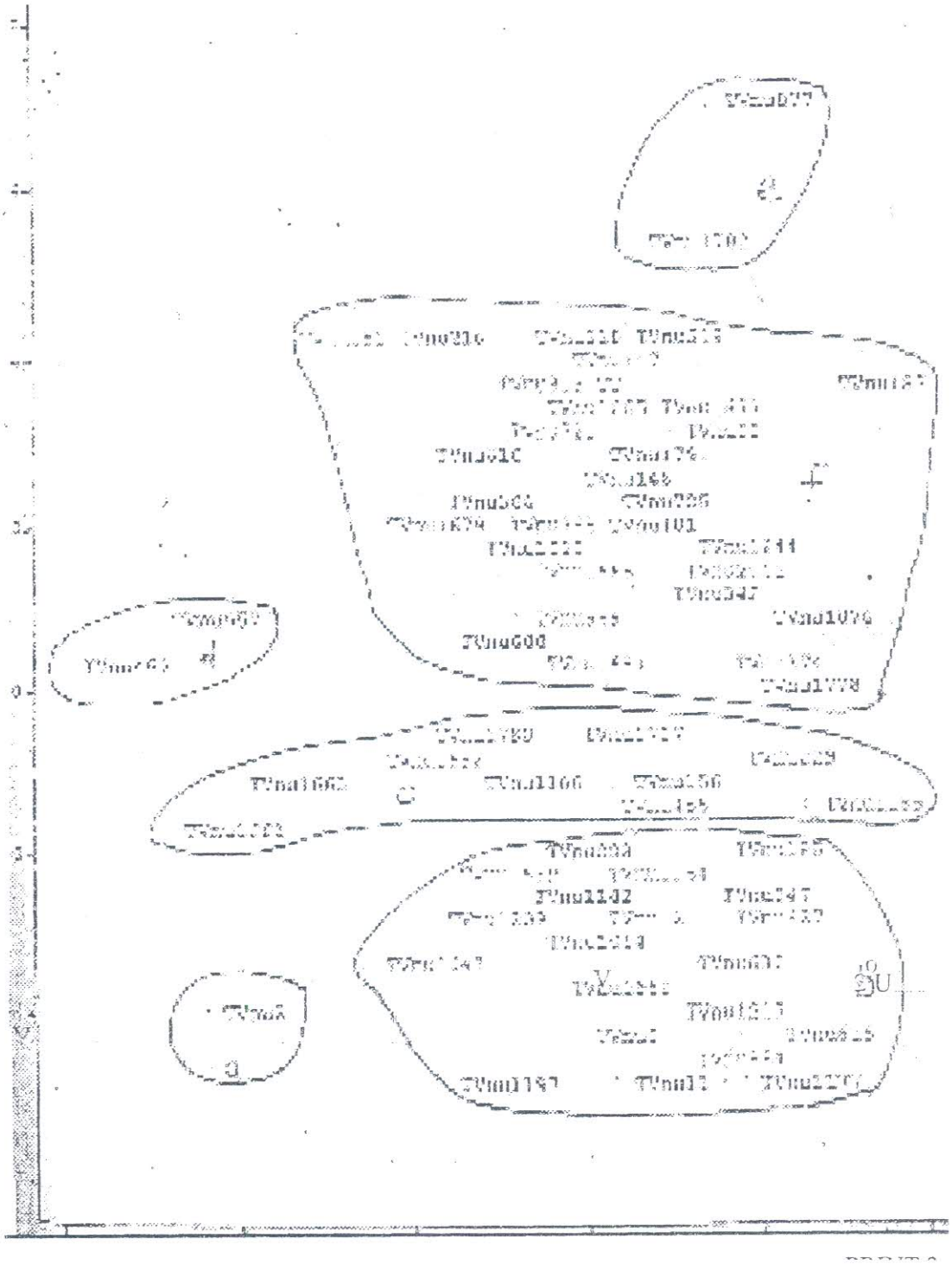

PRINT 2

Figure 1: Biplot of PRIN1 VS PRIN2 of the 65 OTU's