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Reducing the Dimension of Growth and Yield Characters of Sweet Potato (*Ipomoea batatas* L.) Varieties as Affected by Varying Rates of Organic and Inorganic Fertilizer

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Abstract: Bivariate correlation was carried out on the growth and yield characters of sweet potato (*Ipomoea batatas* L.) and was observed that number of branch of sweet potato at harvest is positive and highly correlated with vine length of sweet potato. Vine length of sweet potato is positive and highly correlated with number of leaves of sweet potato at harvest. No. of tuber/hill of sweet potato is negative and highly correlated with number of branch of sweet potato. Tuber fresh weight is positive and highly correlated with total dry matter of sweet potato at harvest. Tuber dry matter of sweet potato is positive and highly correlated with tuber fresh weight. Of the growth characters consider in the study, the Principal component analysis shows the reduction of the dimension of the variates from $p = 4$ to $p = 2$ component of $m<p$ i.e., total dry matter explains most of the variation followed by vine length. Likewise, tuber fresh weight explain the variation in the yield character.

Key words: Yield characters, growth characters, correlations and principal component

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is believed to have its center of origin in tropical America. The sweet potato was brought to Europe by Columbus and subsequently introduced to Africa and Asia by Portuguese and Spanish traders. The status of the sweet potato in most parts of the tropics is that of a minor secondary crop. However, cultivation is increasing as it gives high yields and requires minimum attention during cultivation. According to (FAO, 2004) statistics world production is 127,000,000 tons. The majority comes from China with a production of 105,000,000 tons from 49,000 km^2 (FAO, 2004). Other Asian producing countries include: Indonesia, Japan, Korea and Taiwan. Brazil is the most important commercial grower, but sweet potatoes are mainly consumed domestically and do not enter international trade either in the fresh state or in a processed form.

In Africa, sweet potato is an important part of the staple diet of the populations in tropical regions where it is grown up to an elevation of 2,000 m. Nutritionally, sweet potatoes usually have a rather higher protein content than other tubers such as cassava and yams. Protein content varies from 1 to 2.5%. Carotenes, precursors of vitamin A production are often present in yellow varieties. Sweet potatoes are usually consumed without special processing. The fresh tuber is boiled, baked, roasted or fried as chips, which may be sold as snacks or may be salted and eaten like potato crisps. Sweet potato flour and starch may also be prepared. The leaves of sweet potato rich in carotenes, pro-vitamin A and calcium are also a valuable addition to the diet. Sweet potato varieties with dark orange flesh and richer in vitamin A than light fleshed varieties and their increased cultivation is being encouraged in Africa where vitamin A deficiency is a serious health problem.

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Sweet potatoes are often considered a small farmer's crop. However, in African countries such as Burundi, Rwanda and Uganda, sweet potato is a staple food. According to (FAO, 2004), Per-capita production in Burundi was 130 kg.

In Africa, sweet potato is grown in abundance around upland lakes in the East African Rift valley (Uganda, Rwanda, Burundi, Tanzania, Kenya). It is also found in most African regions with large variations in relief (Cameroon, Guinea, Madagascar) or where the dry season is too marked for cassava growing like in the Sudan-Sahelian fringe or in North Africa. In Nigeria, sweet potato is grown in Sokoto, Zamfara, Kebbi, Kaduna, Kano, Katsina, Gombe, Bauchi and parts of Plateau and Nassarawa states. Nigeria is producing an average of 2,520 tons although sweet potato is not a major crop in Nigeria (Anonymous, 2001).

The purpose of the study is to apply a linear transformation to the p observed variables $x_1, x_2, ..., x_p$ of the growth and yield characters of sweet potato, to produce a new set of uncorrelated and standardized variates $Z_1, Z_2, \ldots, Z_p$. The use of principal component in data reduction had been studied by many authors among which are Aitken (1937), Hotelling (1933) and Essa and Nieuwoudt (2003).

The statistical packages used for the analysis is Genstat (1913).

MATERIALS AND METHODS

The data used for this research work are the growth and yield characters obtained in a trial conducted at the Institute for Agricultural Research Farm Samaru-Zaria (11°11' N, 07° 38'E and 688 m altitude) during the 2004 and 2005 rainy season.

The treatments of the trial consisted of two varieties of sweet potato, three rates of inorganic fertilizer and three rates of organic fertilizer. All possible combinations of the treatments were made and assigned in plots. The experimental design was randomized complete block design with three replications. The plots were regularly observed to record data relating to the experiment.

Population Principal Components

Principal components are particular linear combinations of the p random variables $X_1, X_2, ..., X_p$. Geometrically, these linear combinations represent the selection of a new coordinates system obtained by rotating the original system with $X_1, X_2, ..., X_p$ as the coordinates axes. Principal components depend solely on the covariance matrix $\sum$ (or the correlation matrix ρ) of $X_1, X_2, ..., X_p$. Let the random vector $X^1 = [X_1, X_2, ..., X_p]$ have the covariance matrix $\sum$ with eigen values $\lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_p = 0$.
Considering the linear combination,

$$
\begin{aligned}
Y_1 &= e^1{}_1 X = e_{11} X_1, + e_{21} X_2, + \ldots + e_{p1} X_p \\
Y_2 &= e^1{}_2 X = e_{12} X_1, + e_{22} X_2, + \ldots + e_{p2} X_p \\
Y\,p &= e^1{}_p X = e_{1p} X_1, + e_{2p} X_2, + \ldots + e_{pp} X_p \\
\text{Then, Var}\,(Y_i) &= e^1{}_i \textstyle\sum e_i \\
\text{cov}\,(Y_i, Y_k) &= e^1{}_i \textstyle\sum e_k
\end{aligned}
$$

Then the principal components are those uncorrelated linear combination $Y_1, Y_2, ..., Y_p$ whose variances are as large as possible (Richard and Wichern, 1974).

Basic Assumptions

In principal component analysis the basic equations are

$$\alpha_i = Q_{ir} Z_r \; (i, r, = 1,2,..., P)$$

Table 1: Latent root and vectors for growth characters

Root	1	2	3	4
$\lambda_1 = 1492.0$	0.00313	0.00559	-0.06135	0.99810
$\lambda_2 = 773.6$	0.96958	-0.24223	-0.03494	-0.00383
$\lambda_3 = 181.1$	0.23454	0.87852	0.41568	0.01990
$\lambda_4 = 3.3$	0.06995	0.41169	-0.90676	-0.05826
Variance (%)	60.90	31.58	7.39	0.13
Cumm. Variance	60.90	92.48	99.87	100.00

tr ($\sum_{growth}$) = 2450

Table 2: Latent root and vectors for yield characters

Root	1	2	3	4
$\lambda_1 = 156364$	-0.21710	0.97615	-0.00088	-0.00131
$\lambda_2 = 10598$	-0.00022	0.00042	-0.63549	0.77211
$\lambda_3 = 3$	-0.97615	-0.21710	0.00081	0.00051
$\lambda_4 = 2$	-0.00060	-0.00169	-0.77211	-0.63549
Variance (%)	93.65	6.35	0.00	0.00
Cumm. Variance	93.65	100.00		

tr ($\sum_{yield}$) = 166966

Where:

Z_r = The rth component,
Q_{ir} = The weight of the rth component in the ith variates in matrix notation,
$X = QZ$,
$X = \{\alpha_1, \alpha_2 .... \alpha_p\}$,
$Z = \{Z_1, Z_2, ... Z_p\}$ and $Q = \{Q_{ir}\}$.

We first transform to new variates $Y_1, Y_2, ..., Y_p$
Satisfying,

$$Y = U^1X, \quad X = UY$$

Where, $Y = (Y_1, Y_2, ..., Y_p)$ and U is an orthogonal matrix. Let Ur denotes the rth column of U.
Then, U_1 is chosen first in such a way that the variance of Y_1 is maximized. When this is done, U_2 is chosen so that the variance of Y_2 is maximized, subject to the conditions that Y_2 is uncorrelated with Y_1.

Procedure for Obtaining Latent Root and Vector

- Obtain the variance-covariance $\sum$ matrix for the p-variates.
- Obtain an identity matrix I, in the order of $\sum$.
- Multiply a scalar λ with the I matrix.
- Equates the det I $\sum - \lambda$ I = 0.

The value of λ are the latent root. For any latent root there exist a corresponding latent vectors, obtained by (v) $\sum x = \lambda x$.

RESULTS AND DISCUSSION

Using Pearson correlation coefficient, the bivariate relationship showed that the number of branch of sweet potato at harvest is positive and highly correlated with vine length of sweet potato. Vine length of sweet potato is positive and highly correlated with number of leaves of sweet potato at harvest. Number of tuber/hill of sweet potato is negative and highly correlated with number of branches of sweet potato. Tuber fresh weight is positive and highly correlated with total dry matter of sweet potato at harvest. Tuber dry weight of sweet potato is positive and highly correlated with tuber fresh weight.

The first two principal component that explain the total variation in the original p-variates for the growth characters are:

$$P_1Y_{growth} = 0.00313 \text{ (No. of branches)} + 0.96958 \text{ (Total dry matter)} + 0.23454 \text{ (vine length)} + 0.06995 \text{ (No. of leaves)} \quad (1)$$

$$P_2Y_{growth} = 0.00559 \text{ (No of branches)} - 0.24223 \text{ (Total dry matter)} + 0.87852 \text{ (vine length)} + 0.41169 \text{ (No. of leaves)} \quad (2)$$

The first principal component explain 60.9% of the total variation in the p-variates. The second principal component explain 31.58% of the total variation in the p-variates. The first and second principal component explain 92.48% of the total variation in the p-variates. Which reduces the dimensionality of the original data as shown in Table 1.

The first Principal component that explain the total variation in the original p-variates for the yield characters is:

$$P_1Y_{yield} = -\ 0.21710 \text{ (tuber dry matter)}\ \ 0.00022 \text{ (No. of tubers)} - 0.97615 \text{ (tuber fresh weight)} - 0.00060 \text{ (yield/plot)} \quad (3)$$

The first principal component explain 93.65% of the total variation in the p-variates as in Table 2.

The above component as shown that the total dry matter and vine length of sweet potato are the most important variable in growth character. Also, the tuber fresh weight is the most important variable in the yield characters of sweet potatoes. This is in conformity with the findings of Muhammed (2001).

CONCLUSION

In explaining the growth parameters for sweet potatoes (*Ipomodea batatas* L.), from the components in Eq. 1, total dry matter is having the highest coefficient and the vine length the highest in Eq. 2. Therefore, in explaining the growth parameters for *Ipomodea batatas* L., both the total dry matter and vine length explain most of the variation in growth parameters. Likewise in Eq. 3 the tuber fresh weight is shown to have the highest coefficient, which indicates that it is the parameter with the most variance in explaining the yield of sweet potatoes.

REFERENCES

Aitken, A.C., 1937. The evaluation of the latent roots and vectors of a matrix. Proc. Roy. Soc. Edn., 57: 269-307.

Anonymous, 2001. Annual Abstract of Statistics, National Bureau of Statistics, Abuja.

Essa, J.A. and W.L. Nieuwoudt, 2003. Socio-economic dimensions of small-scale agriculture: A principal components analysis. Development Southern Africa, Number 1, March , pp: 67-73.

FAO, 2004. Roots, tubers, plantains and bananas in human nutrition. Food and Agriculture Organization of the United Nations.

Genstat, 1913. Genstta 6 Release 3 Reference manual Oxford University Press Oxford, 1913.

Hotelling, H., 1933. Analysis of a complex statistical variables into principal components. J. Edu. Psychol., 24: 417-441, 498-520.

Muhammed, B.A., 2001. Productivity of two sweet potato (*Ipomoea batatas* L.) varieties as affected by varying rates of organic anjd inorganic fertilizer. M.Sc. Thesis: Unpublished

Richard, A. J. and D.W. Wichern, 1974. Applied Multivariate Statistical Analysis. 3rd Edn. Eastern Economy Edition.