SCREENING FOR SOURCE-SINK POTENTIALS IN SOME SWEET POTATO (*Ipomoea batatas*(L.)Lam.) LINES IN JOS – PLATEAU, NIGERIA.

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DECLARATION

I declare that this thesis contains the report of my original research work. As far as I know, this work has not been presented in any University for a higher degree.

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LIST OF ABBREVIATIONS AND SYMBOLS

ADGP	-	Adenosine diphosphateglucose
ANOVA	-	Analysis of Variance
b_i	-	Degree of response of source to sink
b_j	-	Degree of response of sink to source
cm	-	centimetre
CIP	-	International Potato Centre
CV	-	Coefficient of variability
CGR	-	Crop Growth Rate
DAP	-	Days After Planting
DM	-	Dry Matter
DMRT	-	Duncan's new Multiple-Range Test
g	-	gramme
$g/m^2/week$	-	gramme per squared metre per week
g/plant	-	gramme per plant
HI	-	Harvest Index
ha	-	hectare
I.I.T.A.	-	International Institute of Tropical Agriculture
$J/cm^2/day$	-	Joules per squared centimetre per day
kg	-	kilogramme
LAD	-	Leaf Area Duration
LAI	-	Leaf Area Index
m	-	metre
mm	-	millimetre
NAR	-	Net Assimilation Rate
NPK	-	Nitrogen, Phosphorus and Potassium
NRCRI	-	National Root Crops Research Institute
P.A.D.P.	-	Plateau Agricultural Development Programme
pH	-	Logarithm of the reciprocal of hydrogen concentration in moles per litre of a solution.
ppm	-	Parts per million
r	-	Simple correlation coefficient
RCBD	-	Randomized Complete Block Design
RTR	-	Root-Top Ratio
SE	-	Standard error of mean
2, 4-D	-	2,4 dichlorophenoxyacetic acid
t/ha	-	tonnes per hectare
TBR	-	Tuber Bulking Rate
$<$	-	Less than
$>$	-	Greater than
%	-	Percentage
*	-	Significant at 5% level of probability
**	-	Significant at 1% level of probability

ABSTRACT

Fourteen (14) sweet potato (*Ipomoea batatas*(L.)Lam.) clones, TIS.8441, Ex-Igbariam, TIS.86/0356, TIS.86/0306, TIS.2271, TIS.2532.OP.1.13, CIP 4400168, TIS.2544 Rusanya 1.5, TIS.82/0270.OP.1.85, TIS.82/0070.OP.120, TIS.8/637, NRCRI/UN/13, TIS.87/0087 and a farmer's variety(Dan-Mangu), were screened during the cropping seasons of 2000 and 2001, to evaluate their yield potentials under the Jos-Plateau environment. The randomized complete block design was used with four replications. On the basis of differences in vine length, number of branches per plant, total tuber yield, dry matter content, leaf size, leaf orientation and harvest index, six out of the fourteen clones, Ex-Igbariam, TIS.87/0087, TIS.2532.OP.1.13, CIP 4400168, TIS.86/0356 and TIS.2544 Rusanya 1.5, were selected for grafting study during the 2003 cropping season. Results of the studies revealed that tuberous root yield of the sweet potato clones varied with genotype and environment. Petiole length, number of branches per plant, number of tubers/m^2 and per plant and mean tuber weight were shown to have greatly influenced total tuber yield. Total dry matter accumulated increased with crop age and varied with genotype. The proportion of dry matter in the above-ground portion decreased while that of the tubers increased with crop age. In low-yielding clones, more dry matter was left in the leaves and stems than in the tubers. Results of the grafting study showed a high degree of graft-compatibility amongst the clones used. Both total and dry tuberous root yields were influenced by the size and activity of the source and the sink as well as the rate of translocation of assimilates from the former to the latter. Clones Ex-Igbariam and TIS.2544 Rusanya 1.5 had the highest source potential and the largest

sink capacity, respectively. While clone CIP 4400168 showed the greatest response of source to sink, clone TIS.2532.OP.1.13 demonstrated the greatest response of sink to source. Clones Ex-Igbariam and TIS.2544 Rusanya 1.5 ranked amongst the highest yielders. Clone CIP 4400168 appeared to have been limited in its yield potential by a poor sink capacity and slow rate of translocation of assimilates from the source to the sink. Selection of clones with large sink capacities and ideal degree of response of sink to source will, to some extent, lead to higher yield in the sweet potato.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND INFORMATION

Sweet potato (*Ipomoea batatas* (L.) Lam.) is a minor crop in most parts of Africa where it is regarded as a "backyard" crop or found at the fringes of other crops. In such instances, it is resorted to in times of famine and thus regarded as life-safer (Ifefo, 1979; Mallik, 1979; Chinaka, 1983). This situation is fast changing as the potential of the crop is now being realized (Alvarez, 1986; Enwezor *et al*., 1990). The food situation in Nigeria, for example, is influencing a shift towards sweet potato such that it is no longer a minor crop. Projections are that given its efficient biological production and low input requirements, the crop has a potential of overtaking yam (Nwokocha, 1992). This is more so that urban dwellers have acquired a taste for sweet potato fries as a breakfast menu.

1.2 CONCEPT/STATEMENT OF PROBLEM

Sweet potato production is influenced by many factors such as variety, spacing, pests and diseases, land preparation and propagation methods(Onwueme, 1978). The total dry matter of the tuberous roots of sweet potato depends on photosynthetic activity of the leaf canopy (source), the capacity of the plant to translocate assimilates to the tuberous root (sink) and the capacity of the tuberous root to accommodate or capture assimilates (Hahn and Hozyo, 1980). Increasing the activities of the source and the sink and maintaining them for long periods of time would lead to higher economic yield. Wilson (1972) noted that source strength and sink capacity consist of two major components, namely the size and activities of the source and sink. Clarification of the relative importance and relationships of these source – sink characteristics is the first priority in analyzing the physiology of yield in sweet potato. It has been hypothesized that evaluation of source potentials would be possible because sweet potato has a simple source-sink relationship and source can easily be exchanged by reciprocal grafting(Dahniya, 1979).

1.3 JUSTIFICATION

In sweet potato and other root crops, the tuberous roots which accumulate assimilates are the dominant sink and the shoot, mainly leaves, are the source. It is difficult to determine whether the source or the sink regulates production because in many cases the demand for photosynthates exerts a clear feed-back effect on photosynthetic activity (Dahniya, 1979).

Using reciprocal grafts between an inherently high-yielding sweet potato clone and a related species (*Ipomoea trifida*), which virtually produces no tuberous root, Hozyo and Park (1971), Hozyo and Kato (1973, 1976a) as well as Kato and Hozyo (1974, 1978) have demonstrated that dry matter yield production of the stock clone with good sink was much higher than of the related species with poor sink irrespective of the source, and that photosynthetic activity decreased when the related species was used as the stock. An active source coupled with a large tuberous sink capacity is desirable and there must be a balance between source potential and sink capacity to obtain higher economic yield.

An investigation into the source–sink relations in the locally available clones could result in selecting genotypes with a balanced source-sink potential that could lead to higher yields. Genotypes with large sink capacities can, therefore, be selected in breeding procedures with subsequent improvement by incorporating a large source potential, through reciprocal grafting.

1.4 GENERAL OBJECTIVES AND RESEARCH SCOPE

In view of the increasing potential of sweet potato as food for humans and a raw material for industries, the need to develop strategies aimed at evaluation and selection of clones with balanced source-sink potential that could result in sustainable yield has become imperative. This forms the main objective of this research with the following specific activities:

i) To screen 14 selected clones for their agronomic and physiological performance under the Jos-Plateau ecology.

ii) To make crosses between the selected clones in all possible combinations, using reciprocal grafting.

iii) To measure the source potential of each clone.

iv) To measure the sink capacity of each clone.

v) To estimate the degrees of response of source to sink and of sink to source.

1.5 DEFINITION OF SOME USEFUL TERMS

Annual. An annual is a plant that completes its life-cycle, that is the entire sequence from germination to dissemination of seeds and death, in one growing season.

Assimilate. This is the product of photosynthesis, which may be stored in the organ in which it is produced or exported to other parts of the plant where it is utilized.

Centre of Origin. The ancestral or native home of a cultivated plant species, where wild relatives of the species are now found and where one can find large amounts of natural varieties in the crop plant.

Clone. This is the population of plants generated from a single individual which maintains the same genotype.

Cultivar. A new breed of a cultivated crop plant resulting from a scientifically conducted breeding programme. It is also referred to as a variety.

Genotype. The hereditary make-up of an individual plant or animal which, together with the environment, controls the individual's characteristics such as type of flower, shape of leaf or colour of flower.

Grafting. The art of connecting two pieces of living plant tissues together in such a way that they unite and subsequently grow and develop as one composite plant.

Line. A cultivated variety that is propagated by seeds under certain specified conditions. It could also mean a group of individuals with a common ancestry, which when propagated by seeds, retains its characteristics.

Perennial. A plant that lives for more than two years and repeats the vegetative-reproductive change annually or biennially in new shoots produced by buds.

Scion. The short piece of detached shoot containing several dormant buds which, when united with the rootstock, comprises the upper portion of the graft and from which will grow the stem or branches, or both, of the grafted plant. It becomes the shoot system of the graft.

Sink. The organs in which assimilates produced by a source are stored. In cereals, the ear is the dominant sink after anthesis. In sweet potato and other root crops, the tuberous roots which accumulate assimilates are the dominant sink.

Source. The site from which a mineral or organic nutrient moves in the plant, whether it has been absorbed, manufactured or stored there. Young roots are sources of water and minerals, actively photosynthesizing leaves are sources of carbohydrates and organic nitrogen compounds such as amino acids, and senescent organs and storage sites within the plant are sources of many types of nutrient.

Stock. The lower portion of the graft, which develops into the root system of the grafted plant. It may be a seedling, a rooted cutting or a layered or micro-propagated plant. If the grafting is done high in a tree, as in top-working, the stock may consist of the roots, trunk and scaffold branches.

Translocation. The conduction of any dissolved substance from any part of a plant to any other part. Translocation occurs in the vascular tissue called phloem, whose functions are to ensure an efficient distribution of photosynthetic energy and carbon throughout the organism and in determining productivity, crop yield and the effectiveness of applied herbicides and other xenobiotic chemicals. Translocation is facilitated by direct vascular connection between the leaf source and the sink.

Tuberous Root. An underground organ formed from a root, swollen with food and capable of perennation. In sweet potato, for example, tuberous root develops as a result of secondary growth of the initial fibrous root system of the plant within the first 20-25 cm of the soil.

Yield. The weight of produce harvested from a single plant. Most commonly, yield is the quantity of produce harvested per unit of land area.

CHAPTER TWO

LITERATURE REVIEW

2.1. ORIGIN AND DISTRIBUTION

The sweet potato (*Ipomoea batatas* (L.)Lam.) originated in Central America or north-western South America (O'Brien, 1972). Apart from tropical America, the tropical Pacific Islands were another area of extensive sweet potato cultivation in ancient times. The introduction of sweet potato to Europe, Africa, Asia and North America occurred in more recent times (Onwueme, 1978). Columbus introduced it into Europe during his voyage of discovery, while subsequent Spanish and Portuguese explorers and traders introduced it into Africa and Asia. Today, the crop is grown in nearly all parts of the tropical and subtropical world, and in warmer parts of the temperate regions (Onwueme, 1978). In Nigeria, it is an important staple food, particularly in the Northern part from where the bulk of the country's production comes and in which it is even used to sweeten food in place of sugar.

Farm-gate yields range from 3-8 t/ha whereas potential yields of 20 tonnes and above are attainable (Nwokocha, 1992). The causes of low yields from the farmers have been summarized by the International Potato Centre (CIP) to be due mainly to use of inappropriate plant types in particular production systems. Therefore, there is ample room for the farmers' yields to double once improved production packages for sweet potato are extended and adopted (Nwokocha, 1992).

2.2 GENETICS AND CLASSIFICATION

Sweet potato is a hexaploid with a basic chromosome number (n) of 15 and a double chromosome number (2n) of 90. It is a dicotyledonous plant belonging to the family Convolvulaceae. The family includes about 45 genera and 1,000 species of which only *Ipomoea batatas* (L.)Lam. is of economic importance (Onwueme, 1978). A very large number of sweet potato clones have arisen through systematic breeding efforts, but an appreciable number of them have also arisen through natural hybridization and mutation (Onwueme, 1978).

On the basis of tuber texture after cooking, sweet potato clones fall into three categories:

a) Those with firm, dry, mealy flesh after cooking, e.g. Nemagold, Onokeo;

b) Those with soft, moist, gelatinous flesh after cooking, e.g. Centennial, Goldrush, Kandee, and

c) Those with very coarse tubers which are suitable only for animal feed or for industrial uses.

Sweet potato clones also differ from one another in the colour of tuber skin (white, brown, yellow or reddish-purple), colour of the tuber flesh(white or yellow), shape of the tuber, shape of leaves, depth of rooting, time of maturity, resistance to disease and several other vegetative characteristics.

Some of the clones recommended for various parts of the world include Centennial and Nemagold in the U.S.A.; Tucumana Morada and Brasilera Blanca in Argentina; Onokeo in Hawaii; Accessions 2342, 2291 and 2292 in Nigeria; La Catemaco and Dulce in Venezuela; A26/7 and T25 in the West Indies.

2.3 VEGETATIVE DEVELOPMENT

The stem cuttings that are used as planting material in the tropics are planted on mounds or ridges. New shoots and roots arise from the nodes of the cutting (Onwueme, 1978). The stems are thin and may be prostrate or climbing. Leaves are spirally arranged on the stem, without stipules. The petiole ranges in length from 5 to 30cm, with a groove on the upper surface. Laminae vary in shape between clones and may be large or small and erect or horizontal.

Adventitious roots develop at an early stage from the nodes at and near the attachment of the first expanded leaf (Togari, 1950). The total number of roots formed reaches a maximum 10 to 15 days after planting. Roots can be divided into four classes: young roots, fibrous roots, pencil-form and tuberous roots, depending on the primary cambial activity and the amount of lignifications of cells of the stele. Environmental conditions during early growth influence the proportion of roots that are formed in each class. The number of tuberous roots may be determined as early as 30 days after planting. Cool temperatures (22 to 24^{o}C) and an adequate supply of potassium lead to rapid activity in the cambium and little lignifications of the roots, a condition that favours the development of tubers (Onwueme, 1978).

Further development of the tuberous roots depends on an increase in both the number and size of cells in the stele and on the development of starch granules in the cells. The number of cells increases slowly until 40 days after planting, but then more rapidly from 40-60 days after planting. Most cells reach their maximum size at 60 days after planting.

The components of yield of sweet potato are determined in sequence by the events that have been described (Togari, 1950). These events include the initiation of tuberous roots, followed by cell division and expansion, which determines the size of the tubers. The synthesis of starch granules thereafter determines the density of starch in the cells. Changes in one component of yield under the influence of environment will often lead to adjustment by the plant in the components that are determined subsequently (Thomas *et al.*, 1971a).

Tuber formation in the field is influenced by the environment in the first 20 days after planting (20 DAP). Soil aeration increases the activity of cell division and expansion. Early in their development, respiration by the tuberous roots is rapid and accounts for about 25 percent of the whole plant respiration under normal condition. Lack of oxygen as a result of poor aeration can often check cell division and expansion in the tuberous root and may prevent the initiation and development of new tubers. When there is excess soil water, shoot growth may be good, but tuberization poor, resulting in excess top growth (Watanabe and Kodama, 1965; Watanabe *et al.*, 1966).

Potassium is needed for rapid cambial activity in the tuberous roots in which starch is stored. Thus, when potassium is added, the activity of the starch synthetase in sweet potato tubers increases, but when it is lacking, the enzyme activity can be extremely low. When adenosine diphosphate glucose (ADGP) is used as a donor of glucose, the enzyme activity is near to maximum (Murata and Akazawa, 1968, 1969).

Cool nights (20^{o}C) with long days seem to be critical requirements for the initiation and development of tuberous roots (Kim, 1961). Low temperatures increase cambial activity and lessen lignifications of the stele cells. The development of tuberous roots is more rapid at 25^{o}C than at 30^{o}C and no tuberous roots are formed at 10^{o}C and 15^{o}C (Spence and Humphries, 1972).

Light affects the development of tuberous roots (Hozyo and Kato, 1976b). Low light intensity decreases both the cambial activity and lignification and delays development. If the tuberous roots are exposed to light at an early stage, they will cease to develop due to lack of cambial activity or starch accumulation. Cell division and expansion and starch accumulation are resumed when the exposed tubers are again covered with soil.

Large amounts of soil nitrogen decrease cambial activity, but increase lignifications, favouring the production of non-tuberous roots (Togari, 1950). Stress (e.g. drought) causes tubers to develop slowly, but when the stress is removed they will continue to grow normally.

Cytokinins appear to play a role in the development of tubers by accelerating cell division and expansion (Hozyo, 1973). As roots develop, the cytokinin content in them increases almost in proportion to the increase in tuber weight.

2.4 DRY MATTER ACCUMULATION IN SWEET POTATO

The importance of aspects related to dry matter accumulation, such as crop growth rate, net assimilation rate and leaf area index as well as the distribution of assimilates, have been demonstrated by Haynes *et al*. (1967), Fujise and Tsuno, (1967) and Austin and Aung (1973).

In sweet potato, dry matter accumulates in the economically important part of the plant, the tuberous roots, while the stems and leaves are still growing.

2.4.1 Leaf Area

In sweet potato the leaves are the main source of assimilate for dry weight increase. The total dry weight of the crop, therefore, depends on the size of the leaf area developed, the rate at which it works and the length of time it persists.

Variations in the total leaf area of a plant depend on changes in the number of leaves and in their size. The number of leaves depends on the number of growing points, the length of time during which they produce leaves, the rate of leaf production during the period and the length of life of the individual leaf. Variation in leaf size may arise from effects on cell division, resulting in differences in cell number or cell expansion (Watson, 1952). Environmental factors affect cell division and expansion, resulting in change in number and size of leaves and ultimately in leaf area and leaf area duration.

In sweet potato the developmental sequence that gives rise to change in the leaf area with time is much simpler than in cereals. Sweet potato plants continue to produce new leaves until harvest. The change in leaf area depends almost entirely on the activity of apical meristems and on the growth and longevity of the leaves they produce (Hahn and Hozyo, 1984). To maintain the leaf area needed for continued production of dry matter, a portion of the current assimilation must be partitioned for the growth of new leaves after the growth of tubers has begun.

2.4.2 Leaf Area Index(LAI)

The ratio of the total area of the leaves of a crop to the ground area occupied by the crop is known as the leaf area index (Forbes and Watson, 1992).

Early in the life of an annual crop, LAI is very small. Interception of sunlight by the crop is poor with most of the light falling on bare soil. As the season progresses, LAI increases, light interception improves and the rate of dry matter production goes up.

However, as new leaves continue to be produced at the top of the crop canopy they begin to shade the older ones lower down. These older leaves, receiving less light, photosynthesize less but continue to respire as before. With further increase in LAI the shading of the lower leaves becomes so great that photosynthesis no longer exceeds respiration in these leaves, which cease to be net producers of dry matter. At this stage the lower leaves begin to senesce and die, so that they no longer form part of the productive leaf area of the crop. The continued production of new leaves at the top of the canopy balances the loss of old leaves at the bottom and LAI levels off.

In most crops LAI levels off at a value which gives about 95% interception of light and this value is known as the optimum LAI for the crop. In most dicotyledonous crops, the leaves of which tend to be broad and flat and held more or less horizontally, the optimum LAI is around 3. Cereals and grasses have narrower leaves which are held more vertically so that light penetrates further into the canopy. They tend to have higher values of optimum LAI, usually around 4 to 5(Forbes and Watson, 1992).

Optimum LAI for most crops is greater when the angle of the sun is higher, as light from overhead penetrates further into a canopy than light from an oblique angle. Also, high intensity light penetrates to lower levels in the canopy than does low-intensity light. Thus, optimum LAI is greater in tropical than in temperate latitudes, and in temperate latitudes it is greater in midsummer than earlier or later in the season.

The optimum LAI of sweet potato (3-4) is small compared with cereals (Norman *et al.*, 1995). The shoots are prostrate so that leaves are held in a narrow layer near the soil surface. There is, therefore, more mutual shading of leaves than in cereals. In Japan where the average solar radiation was 430 j cal. cm^{-2} day^{-1} the optimum LAI was reported to be 3.2 with a maximum dry matter production of 120 g m^{-2} $week^{-1}$ (Tsuno and Fujise, 1963). Kodama *et al.* (1970) and Enyi (1977) have reported the maximum crop growth rates of 150 and 163 g m^{-2} $week^{-1}$ when the LAI was 5.5 and 8.0, respectively.

Fertilizer and soil influence the size of the LAI of a crop (Tsuno and Fujise, 1963). Sweet potato clones show differences in responses to nitrogen fertilizer. Clones which develop a large leaf area show only a small response to nitrogen fertilizer, while those with a small leaf area show a large response. The application of nitrogen to clones with an already large leaf area may increase the LAI to more than the optimum so that crop growth rate decreases (Haynes *et al.*, 1967).

Similarly, the effect of variation in plant population will differ depending on the clones used. Close spacing may diminish the yield of clones with a large leaf area, but may increase the yield of those with only a small leaf area (Haynes *et al.*, 1967).

2.4.3 Leaf Area Duration(LAD)

The leaf area duration (LAD) of a crop is a measure of its ability to maintain leaf area throughout its life. It is the leaf area integrated over time. Watson (1952) noted that if Net Assimilation Rate (NAR) remained constant, dry matter production of different crops would be proportional to LAD. The decline in LAI of sweet potato is due to senescence and death of individual leaves in succession from the base of the stem upward during the period that follows the initiation of tuberous roots. High fertilizer application has been reported to reduce LAD (Yoshida *et al*., 1970).

2.4.4 Net Assimilation Rate (NAR)

The extent to which dry matter production can be increased by increase in leaf area depends on the effect this has on the rate of assimilation per unit leaf area (the net assimilation rate). When LAI is large, as it is on fertile soils, the NAR is correspondingly smaller because of mutual shading (Tsuno and Fujise, 1963).

The disposition in space of the assimilating surfaces influences light transmission within the canopy. When LAI is large, erect leaves would be expected to give an advantage. Tsunoda (1959) found that sweet potato clones that gave a good economic response to large fertilizer applications had relatively thick, small leaves.

2.4.5 Crop Growth Rate (CGR)

The rate of dry matter production per unit ground area in a crop at any time is referred to as the crop growth rate (CGR). It is the product of LAI and NAR. NAR and LAI are, therefore, regarded as components of dry matter yield production or photosynthetic systems.

Crop growth rate of sweet potato in the natural population is relatively low compared with other crops and C_3 plants (Murata *et al*., 1976). This is due to low photosynthetic activity per unit leaf area and to poor light interception by horizontally displayed thin layer of leaves.

Just as an increase in LAI can give improved yields, so, theoretically, can an increase in NAR and hence CGR(Forbes and Watson, 1992). A high CGR, then, whether resulting from high LAI or high NAR or a combination of both, tends to lead to high yield, especially when it is sustained over a long period.

2.4.6 Translocation and Partitioning of Dry Matter.

The pattern of translocation of assimilate from the leaves determines how dry matter is partitioned and what fraction of the product of photosynthesis is laid down in the economically important tuberous roots. Radioactive tracer experiment with ^{14}C shows that translocation is polarized towards the underground parts as soon as the tuberous roots are initiated. The rate of translocation increases as tuberous root development proceeds (Kato and Hozyo, 1974). Kato and Hozyo (1978) demonstrated that the rate of translocation towards the tuberous roots is 2.7 times faster than towards the shoot apex.

The harvested yield of a crop will depend on the total dry matter weight produced and the fraction of this which is laid down in the economically useful parts of the plant (the harvest index) (Forbes and Watson, 1992; Donald, 1962).

2.5 SOURCE-SINK RELATIONSHIPS

2.5.1 Source-Sink Relations in Crop Plants

The partition of assimilates between different parts of the crop plant is of great importance. For maximum rate of production of dry matter within the plant as a whole, it is important that as high a proportion of assimilates as possible be ploughed back into the leaf tissue which will further increase the productive capacity of the plant. Expenditure of dry matter on the rest of the plant (stems, petiole, and roots) should not be more than is required to support leaves in an efficient arrangement and supply sufficient mineral nutrients and water (Wareing and Patrick, 1975).

Normally, the regions of assimilate production, the leaves, are separate from the regions of assimilate consumption which are primarily growing regions and storage organs. However, a developing leaf may both produce and consume assimilates. The region of production of assimilates is referred to as the source. Wherever in the plant the products of photosynthesis are utilized is referred to as the sink (Beevers, 1969). The yield of a crop is, therefore, dependent on the production of assimilates (photosynthates) by a source and its accumulation in a sink.

Wilson (1972) observed that the terms source and sink are often used rather loosely and in several senses. In relation to the direction of transport, sources are regions that export assimilates while sinks import them. Because mature leaves tend to be associated with production and export of assimilates whereas other parts (roots, meristems, fruits and storage organs) tend to be associated with import and utilization of assimilates, the terms source and sink are applied in a morphological sense to particular parts of the plant.

Source and sink can also be defined in metabolic terms since sources produce assimilates by photosynthesis and mobilization of stored materials while sinks utilize assimilates in respiration and growth.

Since the use of the terms in these different senses is liable to some confusion, Wilson (1972) suggested that sources and sinks should be defined in terms of losses and gains of a particular substance in a particular plant part.

The rate of growth of a sink such as a fruit or storage organ and the final size it can attain are determined, to a considerable extent, by the rate at which nutrients are supplied to it (Forbes and Watson, 1992). This supply must be controlled in some way if a balance of parts is to be maintained in the plant. The rate of supply of assimilates appears to be influenced by the rate at which the sources can produce the nutrients, the rate at which the nutrients can be translocated and the rate at which the sinks can utilize them.

Sources generally do not limit nutrient supply to sinks, except in the case of nitrogen, phosphorus and potassium which are often below optimum levels for plant growth in the soil. Carbohydrate sources, mainly leaves, are seldom limiting. Tobacco, for example, has been shown to have more photosynthetic capacity than it needs for most of its life (Forbes and Watson, 1992). Maize often contains large amounts of unutilized mobilizable carbohydrates in its stems at harvest. It appears, therefore, that it is the capacity of the sink itself that usually limits the rate at which it can receive nutrients. This is difficult to prove, because changes in the sink can have a pronounced feedback effect on the sources. An increase in the sink capacity often induces an increase in the strength of the source. In apple trees, for example, the rate of photosynthesis in leaves near developing fruits may be 50% greater than in more distant leaves. The direction of nutrients, then, is controlled largely by sink demand, rather than by the output of sources or the ability of the phloem to translocate.

Source-sink relations of plants can be altered by reducing leaf area through defoliation or shading, that is decreasing the source-sink ratio, or removing physiological sinks such as fruit, shoot apices and root tips, that is increasing the source-sink ratio (Wareing and Patrick, 1975).

When source-sink ratios of whole plants are decreased, net photosynthesis and net assimilation rates of the remaining leaves increase (Maggs, 1964, 1965; Sweet and

Wareing, 1966), suggesting that assimilate accumulation is operating below its maximum potential. Increasing source-sink ratios tends to reduce the rate of assimilate accumulation (Sweet and Wareing, 1966) and in some cases, the growth of the remaining sinks has been observed to increase (Maggs, 1963). This is the basis for the common practice of pruning trees to ensure a smaller number of fruits per tree (William, 1995). Partitioning the assimilate among a smaller number of fruits encourages the development of larger, more marketable fruits.

2.5.2 Source-Sink Relations in Sweet Potato

In any attempt to improve yield it is important to understand the relationships between the source of assimilates on the one hand and the sink in which the dry weight is accumulated as economic yield, on the other. Knowledge of these relationships is needed to determine which of the two, the source or the sink, limits yield and the probable steps needed to overcome the limitation.

In sweet potato and other root crops, the tuberous roots which accumulate assimilates are the dominant sink and the shoots, mainly leaves, are the source.

It is difficult to determine whether the source or the sink regulates the production of assimilates because in many cases, the demand for photosynthates exerts a clear feedback effect on photosynthetic activity (Dahniya, 1979).

Using reciprocal grafts between inherently high-yielding sweet potato clones and a related wild species, *Ipomoea trifida,* which produces virtually no tuberous roots, the effects of the tops (sources) and roots (sinks) on yield could be examined separately, in terms of the rate of growth in total dry matter, the rate of growth of tubers, and differences in photosynthetic efficiency (Hozyo and Park, 1971; Hozyo and Kato, 1973, 1976a; Kato and Hozyo, 1974, 1978). The studies showed that dry matter production by the improved clone with a large sink was much larger than that of the wild species with a poor sink, irrespective of the source. The rate of photosynthesis decreased when the wild species was used as stock. Histochemical analysis showed that the scion did not significantly affect the starch synthesis in the tuberous roots. It was concluded that it is primarily the characteristics of the sink and not of the source that determine the rate of photosynthesis and the total yield of dry matter.

Hozyo *et al.* (1971) have demonstrated that the early or late tuber- forming characteristics were determined by the root stocks (sinks) and not by the scions (sources). Clones with inherently large sink capacity will respond to differences in source more than those with poor sink capacity. Conversely, scions with a potentially high photosynthetic productivity are affected more than those of limited productivity by the capacity of the sink (Hahn, 1977b).

Hozyo and Kato (1976a) have shown that the tuber-developing ability affects translocation speed. As tuberous root developing ability decreased in the graft with *Ipomoea trifida* as stock, the translocation speed was reduced by one-third, and the translocation coefficient decreased by 43 fold compared to the graft with a clone as stock (Kato and Hozyo, 1978). This shows that sink also affects translocation, and has a regulatory mechanism in dry matter yield production.

Dry matter accumulation provides some indication of the competitive ability of a sink to attract assimilates relative to other sink regions. The resultant accumulation of dry matter by a sink within the competitive framework of a whole plant is described as mobilizing ability. The various growth and storage centres of the plant compete for assimilates. Each centre has a certain competitive or mobilizing ability whereby it can pull or attract assimilates against a similar effect of the other centres. The mobilizing ability of a sink is a measure of its ability to import assimilates and is given by the absolute growth rate of the whole plant or plant part under investigation (Wareing and Patrick, 1975).

The growing meristems and storage organs compete with one another for assimilates (Bunting, 1971). In sweet potato the competition between stems and leaves for the available supply of assimilates for growth continues for a comparatively large part of the duration of growth of the crop. There is, therefore, an advantage in early, rapid shoot growth before the growth of tubers begins, to minimize the internal competition between them (Murata *et al*., 1976). Once the shoots are formed, the aim then would be to see that most of the growth is in the tubers, limiting the growth of new shoots and leaves to only that which is needed to maintain LAD required for large yield.

There is an inverse relation between the growth of leaves and of tubers. As the tubers increase in size, branch and leaf production gradually ceases and the existing leaves senesce, with the result that total leaf area declines. Senescence results mainly from lack of substrate supply to potential growing parts of shoot and absorbing roots. This in turn probably results in decreasing the potential rates of photosynthesis and of tuberous root growth. Eventually, the rate of tuberous root growth will cease (Hahn and Hozyo, 1984).

High stem-leaf ratio at a later growth stage is an indication of excessive shoot growth for non-productive purpose which would result in lower light interception due to mutual shading, lower NAR, undesirable partitioning of photosynthates and death of lower leaves (Tsuno and Fujise, 1963).

2.6 BREEDING OF SWEET POTATO

Breeding of sweet potato, like in other crops, is generally aimed at higher yields, resistance to diseases and pests, shorter growing season, improved tuber quality, etc (Onwueme, 1978).

From available physiological information, it should be possible to alter the form or development of the plant by breeding and to modify the environment by cultural practices to increase yield (Watson, 1971). However, advances so far made in varietal improvement of sweet potato have been obtained mainly by selecting only for yield without taking account of physiological characteristics. Part of the problem is that yield formation is complex and it depends on the interaction of many factors.

Genes for yield do not exist (Grafius, 1959) and genetic control of yield is indirect, through control of many physiological and developmental processes that determine yield (Adams and Grafius, 1971; Thomas *et al*., 1971a, b; Grafius, 1978). The most practical approach to breeding for high yield would, therefore, seem to be to identify the physiological components that account for varietal differences in economic yield and acquire an understanding of their genetic control (Wallace *et al*., 1972).

Sadik (1973) screened ten thousand sweet potato clones and selected a number of genotypes with high photosynthetic efficiency. The variation in NAR between lines suggested that the NAR of existing clones could be increased through crossing and selection. Later, it was reported (IITA, 1973) that there were no differences in the dry matter yield or in its components, between groups selected for high and low photosynthetic efficiency. Hahn (1977a) noted that the crosses between genotypes with high photosynthetic efficiency did not produce progenies that were above average.

There appears to be little opportunity for increasing yield through increase of NAR alone (Hahn and Hozyo, 1984). However, there are striking differences between clones in shape, number and orientation of leaves. One rewarding approach would be to incorporate the best of these characteristics into improved varieties to give a better canopy structure while at the same time selecting for large NAR.

Grafting experiments have shown that there are differences between clones in the efficiency of the photosynthetic source and the capacity of the storage sink (Hozyo and Park, 1971; Hahn, 1977a; Dahniya, 1979; Hahn, 1982). Dahniya (1979) has suggested that it would be worth attempting to combine large source potential and large sink capacity of the varieties to increase yield further by making crosses between such varieties. However, in sweet potato the source is a more complex component than the sink, and it is affected by many factors both genetic and environmental. Therefore, screening for source potential is complicated and more difficult than for sink capacity (Hahn, 1982). Also, the sink characteristics influence photosynthesis and yield more than the source characteristics. It appears, therefore, that yield improvement in sweet potato can be achieved more easily by selecting for the sink capacity alone. Yield and sink capacity will then tend to increase simultaneously until they reach their limits set by photosynthetic capacity. Further progress will then require that both photosynthesis and sink capacities be increased in a more or less co-ordinated manner (Evans, 1975).

It is easier to study and understand physiologically and genetically each individual character influencing yield than it is to study yield formation as a whole. One approach is to select individual characteristics and then select parents for crosses on the basis of complementation of physiological components, aiming in this way the probability of finding superior segregates (Wallace *et al.*, 1972).

The key factors for success in the production of sweet potato include the maintenance of a large and active photosynthetic source in genetic material that can produce a large storage sink as well as the management of the source-sink relationship in a manner which favours early and rapid development of storage roots.

A major problem in the breeding of sweet potato is the degenerate sexual reproductive system occasioned by:

i) **Photoperiodically controlled flowering.** Photoperiodic control causes flowering to be extremely rare in the temperate regions. As such, sweet potato breeding in the temperate regions relies on artificially-induced flowering(Onwueme, 1978). This can be achieved by subjecting the plants to artificial short-day conditions, by grafting sweet potato onto species of *Ipomoea* that flower more readily, and by applying growth regulator (e.g. 2,4 dichloro-phenoxy-acetic acid at 500 ppm) that may sometimes promote flowering. Sweet potato flowers readily in the tropics, so that breeding work there can rely on naturally produced flowers.

ii) **Low pollen viability.** Certain clones produce large quantities of non-viable pollen. Fortunately, the problem is restricted to only a few clones (Onwueme, 1978).

iii) **Short flower life and slow rate of pollen tube growth.** The period of opening and receptivity of the flower is extremely short. Even where pollination does occur, fertilization may fail to occur before flower abscission. This is due to the slow rate of pollen tube growth. It has been demonstrated that flower abscission can be delayed by applying 2, 4-D at 100 ppm to the pedicels (Charles *et al.*, 1974). This allows enough time for pollen tube growth, and results in greater seed-set.

iv) **Incompatibility complexes.** Various kinds of incompatibility exist in sweet potato. Both self-incompatibility and cross-incompatibility are present, and each one limits the options open to breeding efforts (Onwueme, 1978).

v) **Seed set and seed dormancy.** Because of the foregoing factors, seed production by sweet potato is never plentiful. Worse still, the seeds produced germinate with extreme difficulty unless they are first scarified.

Vegetative propagation remains the most practical approach in sweet potato cultivation. Pieces of root, stem or tuber sprout easily, so that clonal multiplication can be achieved without difficulty.

In addition, tissue culture of tuber-pieces can result in even more rapid multiplication of clonal material (Onwueme, 1978). Even the petioles of excised leaves of sweet potato root readily if placed in a moist medium; however, they do not produce new shoot material and their use is confined to physiological experimentation.

The methods used in sweet improvement include:

a) **Selection of clonal material**. In the natural course of events, mutations arise fairly frequently in sweet potato plots. Some of these mutations can be observed as chimeras of the tuber, bud or vine. Vigilance is required to identify and propagate such mutant plants or parts. Only a few of the mutations give rise to superior characteristics. Once a superior mutant has been identified, it can be multiplied rapidly by vegetative means, so that it is not lost (Onwueme, 1978).

b) **Hybridization**. Hybrids are produced by controlled crossing, and selection is carried out on them. Sweet potato improvement through hybridization relies heavily on the sexual processes, with attendant difficulties already highlighted. On the other hand, any desirable individual that results can be multiplied and perpetuated with ease through vegetative propagation (Onwueme, 1978).

c) **Mutation breeding**. This involves treating the sweet potato material with artificial mutagens such as gamma rays and colchicine, growing the resulting mutants and selecting for desirable ones among them. The problem associated with mutation breeding include: **(i) Low viability:** Mutations are generally deleterious and recessive for the organisms, so that majority of them are of no practical value. Gustaffson (1954) estimated that less than one in 1000 mutants produced may be useful in plant breeding.

(ii) Mutations are kept at low frequency in the population by the action of natural selection since majority of them are deleterious to the organism. Even under optimal environmental conditions, many mutants appear less frequently than expected.

(iii) Mutant types are generally unable to compete equally with other wild type individuals.

Of all the methods highlighted, grafting, though laborious and expensive, appears to be the most practical approach in the improvement of sweet potato. One major limitation in grafting is that materials generated from the crosses cannot be multiplied through vegetative propagation (Onwueme, 1978).

CHAPTER THREE

MATERIALS AND METHODS

Trials were conducted between June and December in 2000 and 2001 at the Vom Garden of the Plateau Agricultural Development Programme (P.A.D.P.), Kuru, in Jos-South Local Government Area of Plateau State (1,293.2m above sea level). The trial site is located at latitude 09^{o}44'N and longitude 08^{o}47'E. The soil is ferrallitic cambisol developed from volcanic rocks (Enwezor *et al*., 1990) and had a cropping history of maize and potato. The total annual rainfall was 1611.9mm and 1171.8mm for 2000 and 2001, respectively (Appendices III and IV).

3.1 CLONE - SCREENING EXPERIMENT

3.1.1 Sources of Materials

The planting materials were procured from the National Root Crops Research Institute (NRCRI), Umudike, Abia State.

The clones used in the 2000 trial were:

TIS.8441
Ex-Igbariam
TIS.86/0356
TIS.86/0306
TIS.2271
TIS.2532.OP.1.13
CIP4400168
TIS.2544 Rusanya 1.5
TIS.82/0270.OP.1.85
TIS.82/0070.OP.120
TIS.8/637, and
NRCRI/UN/13.

In 2001, TIS.82/0270 .OP.1.85, TIS.82/0070.OP.120, TIS.8/637 and NRCRI/UN/13 were dropped, due to inadequacy of vines for planting, while clones TIS.87/0087 and a farmers' variety (Dan-Mangu) were added to the others.

3.1.2 Experimental Design

In both years the nett plot size measured $(3x3)m^2$, consisting of three 1m rows, each measuring 3m.

The clones were randomly distributed to all the plots. The Randomized Complete Block Design (RCBD) with four replications was used (Appendices I and II). The fourth replication was used for the growth analysis studies.

3.1.3 Cultural Practice

Land preparation, including ridging and plot mapping, was done manually on June 23 and 26 in 2000 and on June 26 and 27 in 2001.

Vine cuttings of about 30cm long were planted at inter-and intra-row spacings of 100 and 30cm, respectively, giving a total of 33,333 plants per hectare. Planting was done on June 28 and July 10 for 2000 and 2001 trials, respectively.

The plots were weeded manually at 29, 45 and 73 days after planting (DAP) in 2000. In 2001 the plots were weeded at 20 and 46 DAP and at 70 DAP they were earthed up. In both years the plots received a blanket application of 300g of NPK(15-15-15) fertilizer, equivalent of 50 kgN, 50 kg P_2O_5 and 50 kg K_2O per hectare at 45 DAP.

3.1.4 <u>Field Observations and Data Collection</u>

Field observations and data collection began at 59 DAP in 2000 and 77 DAP in 2001 and were continued weekly until 94 and 112 DAP for 2000 and 2001, respectively. Variations in sampling dates between 2000 and 2001 were due to circumstances beyond control.

3.1.4(a) <u>Vine Length</u>

Vine length was measured at 94 and 136 DAP in 2000 and 2001, respectively. Two vines were sampled from each plot and tagged for this purpose. Each vine was measured with a measuring tape from the base to the terminal leaf.

3.1.4(b) <u>Petiole Length</u>

Petiole length was measured at 131 DAP (2000 trial) and 134 DAP (2001 trial). Two plants were sampled from each plot. From each of the plants the petiole length of three leaves were measured from the stalk to the canopy, using the measuring tape.

3.1.4(c) <u>Number of Branches per Plant</u>

Branches were counted at 89 DAP for 2000 trial and at 98 DAP for 2001 trial. Two plant stands were sampled from each plot. The total number of primary branches (branches arising from the main stem) were physically counted and recorded.

3.1.4(d) Vigour Score

Plants were scored for vigour at 101 DAP and at 120 DAP in 2000 and 2001, respectively. The plants were scored based on their physical appearance using the International Potato Centre (CIP) scale of 0, 1, 2 and 3, as reported by Kwon-Ndung (1990).

Where: 0 = poor vigour
1 = fairly vigorous
2 = vigorous, and
3 = very vigorous.

3.1.5 Growth Analysis Measurement

Growth analysis measurement was commenced at 59 DAP in 2000 and at 77 DAP in 2001, and continued at weekly intervals until 94 DAP and 112 DAP, respectively. Parameters measured during these periods included LAI, LAD, CGR and NAR.

One plant was harvested from each plot in the growth analysis replication. The roots were thoroughly washed and the plants were separated into roots, stems and leaves. All plant parts were placed in separately labeled calico bags and dried in a moisture-extraction oven at 100^{o}C for 48 hours to obtain a constant weight.

3.1.5(a) Leaf Area Index (LAI)

Leaf area index was measured using the leaf-disc method (Watson, 1947) as modified by Bremner and Taha (1966) and reported by Ifenkwe (1975).

The method involves the removal of leaves from the sampled plant from each plot, determination of the total dry weight and of the area/weight relationship of a sub-sample taken from the mass of leaves with a punch of a known diameter. The cross-sectional area of the punch used in these studies was 1.1304cm^2. Fifty discs were taken from each sample and placed in envelopes for drying to constant weight in a moisture-extraction oven at 100^{o}C for 48 hours. The rest of the leaves along with the remains of the punched leaves were put into separate labeled calico bags and dried at the same temperature and time. Leaf area index was then calculated using the formula:

$$LAI = \frac{\text{Area of 1 disc} \times \text{No of discs} \times \text{Total leaf dry wt}}{\text{Dry wt of discs}} / \text{Land area occupied by sampled plant}$$

3.1.5(b) Leaf Area Duration (LAD)

This was calculated by summing up the individual LAI values over the whole growing season (Watson, 1947). Leaf area index being a pure number and time being measured in weeks, the leaf area duration was measured in weeks.

3.1.5(c) Crop Growth Rate (CGR)

The absolute crop growth rate was calculated on the basis of increase in dry weight of the plant parts over a fixed period, using the formula:

$$CGR = \frac{W_2 - W_1}{t_2 - t_1} \text{ g/m}^2\text{/week}$$ (Blackman and Black, 1955)

where: W_1 and W_2 = Total dry weight at times t_1 and t_2.

3.1.5(d) Net Assimilation Rate (NAR)

Net assimilation rate, defined as the rate of increase in dry weight per unit leaf area, was calculated from the data obtained on dry weights of plants using the method proposed by Gregory (1918) as cited by Watson (1947) and Mannan *et al.* (1992).

$$NAR = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\text{Log}_e L_2 - \text{Log}_e L_1}{L_2 - L_1}$$

Where W_1 and W_2 are the total dry weight of all parts at times t_1 and t_2, respectively; L_1 and L_2 are the leaf area at t_1 and t_2.

3.1.6 HARVESTING

Due to circumstances beyond control, plots were harvested at 150 DAP in 2000 and at 147 DAP in 2001.

The following data were taken at harvest:

3.1.6(a) Stand Count

At harvest, the total number of plant stands in each plot was counted and recorded.

3.1.6(b) Mean Number of Tubers per Plant

The total number of tubers harvested in each plot was divided by the number of stands at harvest to give the mean number of tubers per plant.

3.1.6(c) Mean Number of Tubers per m²

The total number of tubers harvested from each plot was divided by the nett plot size ($9m^2$) to obtain the mean number of tubers per m^2.

3.1.6(d) Mean number of Marketable Tubers per m²

All the tubers harvested from each plot were graded into marketable (above 50mm) and non-marketable (below 50 mm) tubers, using a 50 mm –grader.

The number of marketable tubers in each plot was divided by the nett plot size ($9m^2$) to give the mean number of marketable tubers per m^2.

3.1.6(e) Mean number of Non-marketable Tubers per m²

The total number of non-marketable tubers in each plot was divided by the nett plot size ($9m^2$) to obtain the mean number of non-marketable tubers per m^2.

3.1.6(f) Mean Tuber Weight (g)

All the tubers harvested from each plot were weighed and the weight was divided by the total number of tubers from the respective plot in order to obtain the mean tuber weight for each clone.

3.1.6(g) Dry Matter Percentage

Twenty (20) grammes of shredded fresh tubers were taken from the harvested tubers in each plot and dried in a moisture-extraction oven to constant weight at 100°C for 48 hours. The dry matter percentage (DM %) was then calculated as the ratio of the dry weight to the sample fresh weight and multiplied by 100, as follows:

$$DM\% = \frac{b}{a} \times 100$$

where a = sample fresh weight
b = dry weight of sample.

3.1.6(h) Total Tuber Yield (t/ha)

All the tubers harvested from each plot were weighed and the weight was converted to the equivalent in tonnes per hectare before the analysis.

3.1.6(i) Marketable Tuber Yield (t/ha)

Tubers above 50 mm were weighed and the weight was converted to tonnes per hectare to give the marketable tuber yield.

3.1.6(j) Non-marketable Tuber Yield (t/ha)

Tubers below 50mm were weighed and the weight was converted to tonnes per hectare.

3.2 GRAFTING EXPERIMENT

3.2.1 Raising of Nurseries

From the results of the trials conducted in 2000 and 2001, six clones namely Ex-Igbariam, TIS.87/0087, TIS.2532.OP.1.13, CIP 4400168, TIS.86/0356 and TIS.2544 Rusanya 1.5 were selected for the grafting experiment. Selection was based on differences in vine length, number of branches per plant, total tuber yield, dry matter content, leaf size, leaf orientation and harvest index(Table 1).

From each clone, 96 vines of about 20cm were planted in black polyethylene bags (15x18x24cm) filled with topsoil, manure and riversand in a potting ratio of 3:2:1, respectively. Planting was done on May 17, 2003 at the Federal College of Forestry, Jos. The plants were watered regularly until the rains were fully established.

3.2.2 Making the Various Grafts

Fourteen (14) days after planting (14 DAP), when the vines were rooted, all possible combinations of grafts of the six clones were made including six self-grafts. For each graft-combination in each of the six clones, sixteen (16) grafts were made, giving a total of 576 grafts.

The whip-grafting technique was used. The technique involves the use of scions and stocks of approximately the same diameter. In order to avoid physiological stress, the grafting was done either in the morning between 8.00am and 11.00am or in the evening (between 4.00pm and 6.00pm).

A diagonal cut was made in a young and actively growing sweet potato plant to be used as stock. A short actively growing sweet potato plant with three to four buds was selected and a matching diagonal cut was made with a grafting knife. The two pieces were slipped together and wrapped with polyethylene grafting tape so that there would be a union between the cambium layers of the stock and scion (see plates 1 and 2).

The grafted plants were kept under shade to keep them moist. Grafting lasted for about three (3) weeks (June 4 to June 23, 2003).

After the graft-union has been established, the plants were regularly pruned with a pair of secateurs to remove sprouts from the stock. Hand-weeding was carried out to keep the pots weed-free.

Seven (7) days after grafting, the number of successful grafts was counted and recorded. Success rate was then calculated as the number of successful grafts divided by the total number of grafts and multiplied by 100.

3.2.3. Transplanting of Successful Grafts to the Field

This phase of the trial was carried out at the Vom Garden of the Plateau Agricultural Development Programme (P.A.D.P.) located at Kuru in Jos-South Local Government Area of Plateau State (1,293.2m above sea level, latitude 09^{o} 44'N and longitude 08^{o}47'E). The site had a cropping history of potato, wheat and maize, respectively.

A composite soil sample collected from the site before planting was analysed, the results of which are shown in Table 2.

Table 2: Nutrient Status of Kuru Soil before Planting

Total N (%)	Soil pH	Available P (ppm)	Calcium (%)	Silica (%)	Potassium (%)	Magnesium (%)	Organic Matter (%)
0.44	6.10	0.08	0.13	98.65	29.42	5.37	13.30

3.2.4. Experimental Design

The nett plot size measured (2.0x6.0) m^2, consisting of four rows, each measuring (2.0x1.5) metres. The treatments, numbering 42, included 6 non-grafts, 6 self-grafts and 24 reciprocal grafts. These were randomly assigned to all the plots, using the Randomized Complete Block Design (RCBD) with four replications. The fourth replication was used for the growth analysis studies. Details of the layout are shown in Appendix III.

3.2.5 Cultural Practice

Land preparation, ridging and plot-mapping, was done manually on June 23-24, 2003. Just before field planting, the grafts were carefully removed from the polyethylene bags and the roots were pruned by means of a pair of secateurs. Root pruning was done to minimize the variation due to differences in dates of grafting and to induce the growth of strong new roots.

The grafts were planted out in the field on June 30, 2003. Each plot consisted of four plants, planted at a spacing of 2.0metres on ridges 1.5metres apart, giving a total of 13,333 plants per hectare. This was to allow sufficient room for proper assessment of each graft.

To keep the plots weed-free, they were manually weeded at 25 and 51 DAP followed by earthing up at 57 DAP. Hand-weeding was done at 87 DAP. Twenty-nine (29) days after planting, each plot received a blanket application of 240g of 15-15-15 (NPK) fertilizer, equivalent to 50kg/ha each of N, P_2O_5 and K_2O. The plots were continually pruned to remove any sprout from the stock or tuber from the scion, so that only the scions were allowed to produce leaves which served as the main organ of photosynthesis while the stock served as the organ of tuberous root formation.

3.2.6 Data Collection

Data collection was commenced at 21 DAP and ended at 150 DAP.

3.2.6(a) Establishment Rate

At 21 DAP, the number of successful grafts established after planting in the field was counted and recorded for each plot. The ratio of this to the total number of grafts transplanted and multiplied by 100 gave the establishment rate.

3.2.6(b) Growth Analysis Measurement

Growth analysis study was carried out at 45, 90 and 135 DAP. One plant was harvested from each plot in the growth analysis replication and separated into roots, stems, petioles and laminae. All plant parts were weighed fresh on the farm using the Camry weighing scale. They were then sub-sampled (30.0g) into separate labelled envelopes and dried in a moisture-extraction oven at 100^{o}C for 48 hours.

From the dry weight obtained, leaf area, crop growth rate (CGR), net assimilation rate (NAR), harvest index and dry matter content (DM%) were calculated as in 2000 and 2001 trials. Tuber bulking rate (TBR) was estimated as the rate of tuber increase per unit time.

$$TBR = \frac{b - a}{t_2 - t_1}$$

where a and b are fresh weights of tubers at times t_1 and t_2, respectively.

3.2.6(c) Dry Matter Accumulation and Partitioning

The total dry matter accumulated over time and its percentage distribution to the various parts (laminae, petioles, stems and roots) was calculated at each harvest.

3.2.6(d) Vigour Score

Plants were scored for vigour at 85 DAP, using the same scale as in the 2000 and 2001 trials.

3.2.6(e) Flowering Score

Flowering score was carried out at 114 DAP, using the scale of 0, 1, 2 and 3.

Where 0 – No flowering

1 – shy/scanty flowering

2 – Moderate flowering

3 – Profuse flowering.

3.2.6(f) **Pollen Fertility Test (%)**

Pollen fertility test was carried out at 120 DAP. Anthers from open flower buds were squashed in a drop of 5% glycerol-acetocarmine on a slide. After removing the debris, the slides were covered with cover-slips and left for about 18 hours before examination.

The pollen grains were observed under 25 different microscopic fields of view. Pollen grains which were filled with stained cytoplasm were considered to be fertile while the small, shrivelled, unstained ones were considered as sterile. Pollen fertility was then calculated as:

$$\text{Pollen Fertility (\%)} = \frac{\text{No. of Stained Pollens}}{\text{Total No. of Pollens observed}} \times 100$$

3.2.6(g) **Stand Count at Harvest**

At 145 DAP, the total number of plant stands in each plot was counted and recorded.

3.2.6(h) **Number of Branches per Plant**

The total number of primary branches (branches arising from the main stem) was physically counted and recorded at 147 DAP.

3.2.6(i) <u>Vine Length (cm)</u>

Vine length was measured at 147 DAP. One vine sampled from each plot the length of which was measured with a measuring tape from the base to the terminal leaf.

3.2.6(j) <u>Petiole Length (cm)</u>

Petiole length was measured at 150 DAP. Five (5) leaves were sampled from each plot and the length of the petiole was measured from the base of the stalk to the canopy.

3.2.6(k) <u>Dry Vine Yield(g)</u>

At harvest (150 DAP), one plant was sampled from each plot in each replication the top of which was harvested and weighed. Sub-samples (30.0g) were placed in well-labelled envelopes and dried in a moisture-extraction oven at 100^{o}C for 48 hours to obtain vine weight.

3.2.6(l) <u>Root-Top Ratio (RTR)</u>

After harvesting the top of each sampled plant, the tubers were also harvested and weighed. The ratio of the weight of the tubers to that of the top was calculated as the root-top ratio.

3.2.6(m) Tuber Length (cm)

Two(2) tubers were sampled from each plot, the length of each of which was measured, using a measuring tape.

3.2.6(n) Tuber Girth (cm)

The tubers used in the measurement of the length were also used for the measurement of the tuber girth. Tuber girth was measured at the widest portion of the tuber.

3.2.6(o) Mean Number of Tubers per Plant

The total number of tubers harvested in each plot was divided by the number of plant stands at harvest to obtain the mean number of tubers per plant.

3.2.6(p) Number of Large Tubers (>50mm) per Plant

The number of large tubers (tubers above 50mm) (see 3.1.6(d)) in each plot was divided by the number of plant stands at harvest to obtain the mean number of large tubers per plant.

3.2.6(q) Number of Small Tubers (<50mm) per Plant

The number of small tubers (tubers below 50mm) (see 3.1.6(e)) harvested in each plot was divided by the number of plant stands at harvest to obtain the mean number of small tubers per plant.

3.2.6(r) Mean Tuber Weight (g)

All the tubers harvested in each plot were weighed and the weight was divided by the total number of tubers from the respective plot in order to obtain the mean tuber weight of each cross.

3.2.6(s) Dry Matter Content (DM%) at Harvest

A sub-sample of two hundred (200) grammes of tubers was taken from the harvested tubers in each plot, shredded and dried in a moisture-extraction oven at $100^{o}C$ for 48 hours. Dry matter content was calculated as the ratio of the dry weight of the sample to the sample fresh weight and multiplied by 100.

$$DM\% = \frac{b \times 100}{a}$$

where a = sample fresh weight (g)

b = sample dry weight (g)

3.2.6(t) Total Tuber Yield (t/ha)

All the tubers from each plot were weighed and the weight was converted to the equivalent in tonnes per hectare before the analysis.

3.2.6(u) Dry Tuberous Root Yield (g/plant)

From the sample dry weight obtained in 3.2.6(s) above, the equivalent total dry weight was calculated from the total fresh weight of tubers in each in plot. The value so obtained was divided by the number of plant stands at harvest in each plot, to obtain the dry tuberous root yield per plant.

3.2.6(v) <u>Measurement of Source Potential</u>

The source potential of each clone was measured as the mean scion effect on the dry tuberous root yield when it was grafted on each of the other clones used as the stock.

3.2.6(w) <u>Measurement of Sink Capacity</u>

The sink capacity of each clone was measured as the mean stock effect on the dry tuberous root yield when it was grafted with each of the other clones as the scion.

3.2.6(x) <u>Degree of Response of Source to Sink</u>

The regression of a scion on the mean stock effects on dry tuberous root yield when it was grafted on a set of clones as stock measures the degree of response of source to sink capacities (Hahn, 1982).

3.2.6(y) <u>Degree of Response of Sink to source</u>

The regression of a stock on the mean scion effects on dry tuberous root yield when it was grafted with a set of varieties as scion measures the degree of response of sink to source potentials (Hahn, 1982).

3.3 DATA ANALYSIS

3.3.1 <u>Clone - Screening Experiment</u>

Data collected during the 2000 and 2001 trials were analysed separately and then pooled using the Analysis of Variance (ANOVA) to test the treatment effects for significance using the 'F' test as described by Snedecor and Cochran (1969).

Significance of mean difference was tested using the Duncan's New Multiple-Range Test (Steel and Torrie, 1960).

Simple correlation coefficient was computed to determine the relationship between total tuber yield and thirteen (13) attributes of sweet potato. The path coefficients were generated using the computer software known as the Startview(Version 95).

3.3.2 Grafting Experiment

Data collected during the 2003 grafting study were also analysed using the Analysis of Variance as in the 2000 and 2001 studies. Means were also separated using the Duncan's New Multiple Range Test.

CHAPTER FOUR

RESULTS

4.1.1 Vine Length

In the year 2000, clone TIS.82/0070.OP.120 produced the longest vines while clone TIS.86/0306 produced the shortest. However, in the year 2001, clone Ex-Igbariam produced the longest vines while TIS.8441 produced the shortest. Across both years, Ex-Igbariam had reasonably long vines. Although vines appeared to be generally longer in 2000 than in 2001, the differences were not significant (Table 3).

4.1.2 Petiole Length

In both 2000 and 2001 trials clone CIP 4400168 produced leaves with the longest petioles. The shortest petioles were observed in NRCRI/UN/13 in 2000 and in TIS.8441 in 2001. Across the two years, clone CIP 4400168 had significantly longer petioles than the other clones. Petioles were generally longer in 2000 than in 2001 (Table 3).

4.1.3 Mean Number of Branches Per Plant

In both years clone TIS.2271 produced the highest number of branches per plant. In the 2001 study, the clones did not differ significantly in the mean number of branches per plant. Again, number of branches per plant was higher in 2000 than in 2001 (Table 4).

4.1.4 Vigour Score

The highest mean vigour score of 3.0 was observed in clones TIS.2271 and CIP 4400168 in 2000, while the lowest score of 1.0 was observed in TIS.8441 and NRCRI/UN/13 (Table 4).

Table 3: Mean Vine and Petiole lengths of selected Sweet Potato Clones in 2000 and 2001

	Vine length (cm)			Petiole length (cm)		
Clone	**2000**	**2001**	**Pooled**	**2000**	**2001**	**Pooled**
TIS.8441	76.4^{de}	51.4^{e}	191.8^{b}	15.9^{cd}	5.0^{c}	31.2^{c}
Ex-Igbariam	120.3^{b}	137.9^{a}	387.4^{a}	16.3^{cd}	9.2^{b}	38.3^{bc}
TIS.86/0356	74.9^{de}	66.0^{de}	211.4^{b}	18.1^{bc}	12.5^{ab}	45.7^{bc}
TIS.86/0306	59.8^{e}	103.8^{bc}	245.5^{ab}	18.7^{bc}	10.4^{b}	43.8^{bc}
TIS.2271	74.9^{de}	76.0^{de}	226.6^{ab}	21.3^{b}	12.9^{ab}	51.3^{b}
TIS.2532.OP.1.13	103.0^{bc}	77.8^{de}	271.2^{ab}	16.5^{cd}	10.9^{b}	41.0^{bc}
CIP4400168	106.8^{bc}	88.0^{bcd}	292.2^{ab}	29.9^{a}	16.1^{a}	68.9^{a}
TIS.2544 Rusanya1.5	98.7^{bc}	81.1^{bcd}	166.5^{b}	16.5^{cd}	10.0^{b}	39.8^{bc}
TIS.82/0270.OP.1.85	95.2^{cd}	na	na	14.9^{cd}	na	na
TIS.82/0070.OP.120	154.2^{a}	na	na	15.2^{cd}	na	na
TIS.8/637	148.3^{a}	na	na	16.6^{cd}	na	na
NRCRI/UN/13	69.0^{e}	na	na	12.8^{d}	na	na
TIS.87/0087	na	73.3^{de}	na	na	11.4^{b}	na
Farmers' Variety	na	106.0^{b}	na	na	10.3^{b}	na
CV(%)	12.63	16.87	25.76	14.21	21.61	13.22

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's New Multiple-Range Test).

na = Not available

Table 4: Mean Number of Branches per plant and Vigour Score for selected Sweet Potato Clones in 2000 and 2001

	Mean No. of branches/plant			Vigour Score		
Clone	**2000**	**2001**	**Pooled**	**2000**	**2001**	**Pooled**
TIS.8441	2.8^{ab}	2.2^{a}	7.5^{b}	1.0^{e}	1.3^{b}	3.5^{c}
Ex-Igbariam	2.3^{b}	2.2^{a}	6.8^{b}	1.3^{e}	2.7^{a}	6.0^{abc}
TIS.86/0356	2.7^{ab}	1.8^{a}	6.8^{b}	2.7^{ab}	2.7^{a}	8.0^{ab}
TIS.86/0306	3.0^{ab}	1.8^{a}	7.3^{b}	2.0^{cd}	1.7^{ab}	5.5^{abc}
TIS.2271	4.0^{a}	3.0^{a}	10.5^{a}	3.0^{a}	2.7^{a}	8.5^{abc}
TIS.2532.OP.1.13	1.8^{b}	2.3^{a}	6.3^{b}	1.3^{e}	1.7^{ab}	4.5^{bc}
CIP4400168	2.5^{ab}	2.0^{a}	6.8^{b}	3.0^{a}	2.7^{a}	8.5^{a}
TIS.2544 Rusanya1.5	2.5^{ab}	2.0^{a}	6.8^{b}	2.7^{ab}	1.7^{ab}	6.5^{abc}
TIS.82/0270.OP.1.85	2.2^{b}	na	na	2.0^{cd}	na	na
TIS.82/0070.OP.120	2.2^{b}	na	na	2.3^{bc}	na	na
TIS.8/637	2.8^{ab}	na	na	2.3^{bc}	na	na
NRCRI/UN/13	1.7^{b}	na	na	1.0^{e}	na	na
TIS.87/0087	na	2.5^{a}	na	na	2.3^{ab}	na
Farmers' Variety	na	2.2^{a}	na	na	2.7^{a}	na
CV(%)	10.73	36.65	15.25	18.16	27.27	22.91

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's New Multiple-Range Test).

na = Not available

4.1.5 Leaf Area Index (LAI)

Table 5 shows the leaf area index of selected sweet potato clones at various periods of growth in the 2000 study. LAI increased with time in all the clones, and the peak period varied with genotype. In clones TIS.8/637, NRCRI/UN/13 and TIS.2544 Rusanya 1.5 the highest LAI values were observed at 73 DAP. In clones TIS.8441, Ex-Igbariam, TIS.2532.OP.1.13 and TIS.82/0070.OP.120, LAI peaked at 87 DAP. In clone TIS.86/0356 LAI increased throughout the sampling period.

In the 2001 study LAI also increased with time in all the genotypes. The highest LAI values were observed at 98 DAP in most genotypes (Table 6). Clone TIS.8441 had a very low LAI value. By 112 DAP, the LAI values in most of the clones had dropped.

4.1.6 Leaf Area Duration (LAD)

In the 2000 study LAD varied from 6.9 weeks in clone Ex-Igbariam to 40.2 weeks in CIP 4400168 (Table 7). In the 2001 study, the longest LAD of 28.9 weeks was observed in clone Ex-Igbariam while the shortest (5.1 weeks) was observed in TIS.8441.

Table 5: Leaf Area Index (LAI) of selected Sweet Potato Clones at various periods of Growth in 2000

	Growth Period (Days After Planting)					
Clone	**59**	**66**	**73**	**80**	**87**	**94**
TIS.8441	0.3	1.0	1.1	3.7	5.0	1.1
Ex-Igbariam	0.2	0.9	1.2	0.5	2.6	1.5
TIS.86/0356	0.4	1.0	2.8	2.4	3.4	3.8
TIS.82/0270.OP.1.85	0.3	0.9	0.4	2.6	0.4	1.8
TIS.86/0306	0.2	0.5	1.1	1.9	1.8	3.1
TIS.2271	0.6	0.6	2.0	3.1	1.6	2.7
TIS.2532.OP.1.13	0.4	0.4	1.4	1.4	2.0	1.2
CIP4400168	0.5	3.3	6.0	14.1	10.7	5.6
TIS.82/0070.OP.120	0.4	0.5	1.2	1.9	2.4	2.1
TIS.8/637	0.4	1.2	2.3	1.5	1.7	2.3
NRCRI/UN/13	0.3	0.5	2.2	2.0	0.4	3.4
TIS.2544 Rusanya 1.5	0.2	0.5	6.9	6.7	4.5	2.1
SE±	0.0	0.2	0.6	1.1	0.8	0.4

Table 6: Leaf Area Index (LAI) of selected Sweet Potato Clones at various periods of Growth in 2001

	Growth Period (Days After Planting)					
Clone	**77**	**84**	**91**	**98**	**105**	**112**
TIS. 8441	0.5	1.3	1.7	0.7	0.6	0.3
Ex-Igbariam	1.7	4.1	5.5	7.7	4.6	5.3
TIS.86/0356	1.3	3.5	7.1	3.3	3.3	2.4
TIS.86/0306	1.9	3.2	3.2	4.2	3.5	2.4
TIS.2271	1.9	3.4	4.4	3.3	3.9	2.1
TIS.2532. OP. 1.13	0.7	1.8	1.9	2.0	4.1	1.6
CIP4400168	1.4	2.9	5.0	5.3	3.7	3.1
TIS.2544 RUSANYA 1.5	0.8	2.0	2.4	3.9	1.1	2.5
TIS.87/0087	1.3	2.5	4.2	5.8	3.8	1.7
Farmers' Variety	1.3	1.7	3.4	4.4	3.3	4.3
SE±	0.2	0.3	0.5	0.6	0.4	0.4

Table 7: Leaf Area Duration (LAD) of selected Sweet Potato Clones in 2000 and 2001.

Clone	Leaf Area Duration (Weeks) 2000	2001
TIS.8441	12.2	5.1
Ex-Igbariam	6.9	28.9
TIS.86/0356	13.8	20.9
TIS.86/0306	8.6	18.4
TIS.2271	10.6	19.0
TIS.2532. OP. 1.13	6.8	12.1
CIP4400168	40.2	21.4
TIS.2544 RUSANYA 1.5	20.9	12.7
TIS.82/0270. OP. 1.85	6.4	na
TIS.82/0070.OP. 120	8.5	na
TIS.8/637	9.4	na
NRCRI/UN/13	8.8	na
TIS.87/0087	na	19.3
Farmers' Variety	na	18.4
SE±	2.7	2.0

na = Not available

4.1.7 Crop Growth Rate (CGR)

In both 2000 and 2001 CGR increased with duration of crop growth in all the clones used in the studies (Tables 8 and 9). In the 2000 study the peak CGR was observed at between 80 DAP and 87 DAP in most clones after which it dropped. In clones CIP 4400168, NRCRI/UN/13 and TIS.2544 Rusanya1.5, CGR continued to increase throughout the sampling period.

In 2001 study, the highest CGR in clones TIS.86/0356 and TIS.2271 was observed at 91 DAP while those of clones TIS.86/0306, CIP 4400168, TIS.2544 Rusanya 1.5 and TIS.87/0087 were observed at 98 DAP. Clones Ex-Igbariam and TIS.2532.OP.1.13 peaked at 105 DAP. Crop growth rate continued to increase throughout the growing season in the farmers' variety (Tables 8 and 9).

Table 8: Crop Growth Rate (gm^{-2} $week^{-1}$) of selected Sweet Potato Clones at Various Periods of Growth in 2000

	Growth Period (Days After Planting)				
Clone	**66**	**73**	**80**	**87**	**94**
TIS.8441	0.9	2.0	21.2	14.6	12.9
Ex-Igbariam	0.5	6.7	5.5	13.9	9.6
TIS.86/0356	3.8	2.4	11.6	15.5	5.8
TIS.82/0270.OP.1.85	3.1	4.2	8.2	11.9	12.0
TIS.86/0306	2.7	1.8	54.5	38.0	3.5
TIS.2271	1.4	2.2	12.7	1.8	2.8
TIS.2532.OP.1.13	3.7	0.0	2.3	10.4	9.3
CIP4400168	4.9	3.0	15.4	15.7	16.2
TIS.82/0070.OP.120	0.3	2.0	21.3	4.5	12.5
TIS.8/637	12.1	5.2	10.6	3.3	8.0
NRCRI/UN/13	2.3	4.3	3.7	7.0	23.9
TIS.2544 Rusanya 1.5	4.9	12.5	11.1	7.9	18.3
SE±	0.9	0.9	4.0	2.7	1.8

Table 9: Crop Growth Rate (gm^{-2} $week^{-1}$) of selected Sweet Potato Clones at various periods of Growth in 2001

	Growth Period (Days After Planting)				
Clone	**84**	**91**	**98**	**105**	**112**
TIS.8441	0.9	1.5	9.2	7.2	5.5
Ex-Igbariam	9.5	11.0	14.1	14.5	10.9
TIS.86/0356	7.0	22.7	18.2	9.3	2.4
TIS.86/0306	0.2	4.4	13.7	8.8	4.3
TIS.2271	4.2	9.0	5.8	7.2	5.9
TIS.2532. OP. 1.13	2.5	3.3	4.8	12.0	8.3
CIP4400168	3.3	1.2	11.6	3.4	2.5
TIS.2544 RUSANYA 1.5	2.6	5.9	11.2	8.6	3.4
TIS.87/0087	0.4	1.5	19.7	14.7	1.5
Farmers' Variety	5.0	3.2	6.4	7.9	15.6
SE±	0.9	2.1	1.6	1.1	1.4

4.1.8 Net Assimilation Rate (NAR)

Net assimilation rate varied with genotype and time in both years (Tables 10 and 11). In most clones NAR appeared to be higher at the early and later stages of growth. In clones TIS.82/0270.OP.1.85, NRCRI/UN/13 and TIS.2544 Rusanya 1.5, NAR increased throughout the growing period in the 2000 study.

In the 2001 study the NAR reached a peak at 91 DAP in clones TIS.86/0356, TIS.2271, CIP 4400168 and TIS.87/0087, while clones Ex-Igbariam, TIS.86/0306, TIS.2532.OP.1.13, TIS.2544 Rusanya 1.5 and the farmers' variety peaked at 84, 98, 105 and 112 DAP, respectively (Table 11). Clone TIS.8441 maintained a consistently higher NAR than the other clones at all sampling dates except at 105 DAP.

Table 10: Net Assimilation Rate (NAR) (gm^{-2} $week^{-1}$) ($x10^{-4}$) of selected Sweet Potato Clones at various Periods of Growth in 2000

	Growth Period (Days After Planting)				
Clone	**66**	**73**	**80**	**87**	**94**
TIS.8441	5.4	6.4	33.9	11.7	16.8
Ex-Igbariam	3.7	21.4	23.7	38.9	16.3
TIS.86/0356	19.8	4.6	15.1	18.6	5.2
TIS.82.0270.OP.1.85	19.5	23.9	23.0	33.3	42.0
TIS.86/0306	3.2	0.7	25.6	68.4	4.9
TIS.2271	7.6	6.2	16.5	2.7	4.5
TIS.2532.OP.1.13	32.9	0.2	5.5	20.8	20.5
CIP 4400168	11.3	2.1	6.2	4.7	6.5
TIS.82/0070.OP.120	2.2	8.0	46.9	7.2	18.8
TIS.8/637	56.9	10.4	19.1	6.9	13.6
NRCRI/UN/13	19.8	12.5	6.3	24.5	59.8
TIS.2544 Rusanya1.5	5.4	16.3	5.6	4.7	20.1
SE±	4.6	2.3	3.7	5.6	4.8

Table 11: Net Assimilation Rate (NAR) (gm^{-2} week^{-1}) (x10^{-4}) of selected Sweet Potato Clones at various Periods of Growth in 2001

	Growth Period (Days After Planting)				
Clone	**84**	**91**	**98**	**105**	**112**
TIS.8441	36.8	3.5	21.6	4.6	38.5
Ex-Igbariam	11.4	7.7	8.5	8.7	7.6
TIS.86/0356	10.5	13.6	12.7	9.3	2.9
TIS.86/0306	5.7	0.2	12.3	7.9	5.2
TIS.2271	5.5	8.1	5.2	6.5	6.5
TIS.2532. OP. 1.13	9.6	8.6	4.3	24.0	1.0
CIP4400168	5.3	10.4	0.8	2.7	2.5
TIS.2544 RUSANYA 1.5	6.5	8.9	12.3	12.9	10.2
TIS.87/0087	13.9	19.7	0.3	1.1	19.1
Farmers' Variety	1.0	10.3	5.8	2.9	14.0
SE±	3.1	1.7	2.1	2.1	3.6

4.1.9 Total Dry Matter Partitioning

In the 2000 trial, dry matter distribution in the leaves, stems and tubers increased up to 87 DAP in clone TIS.8441. Thereafter, there was a decline (Figure 1). Up to 66 DAP, about 69% of the DM was in the leaves, 21% in the stem and 10% in the tubers. At 94 DAP, 16% DM was in the leaves, 7% in the stem and 77% in the tubers. The trend was similar in 2001 but with even much lower values in the leaves (Figure 2).

In 2000 percentage of dry matter in leaves declined from 68.8 at 59 DAP to 43 at 94 DAP in clone Ex-Igbariam. Stem DM increased from 30.0% to 37.5% while tuber DM increased from 1.2% to 52.1% (Figure 3).

In 2001 DM in leaves was reduced from 63.3% at 77DAP to 28.2% at 94DAP. Stems appeared to remain stable at about 20% throughout whilst DM% of tubers increased from 17.3% at 77DAP to 52.5% at 112DAP (Figure 4).

In both 2000 and 2001 studies, dry matter of leaves, stems and tubers as well as total dry matter per plant increased with delay in harvesting in clone TIS. 86/0356; final DM was greater in 2000 than in 2001 (Figures 5 and 6).

Figure 7 shows dry matter distribution in clone TIS.82/0270. OP.1.85 in 2000 trial. The proportion of DM in the leaves and stems was reduced from 83.8% at 59DAP to 36.4% at 94DAP, whereas the %DM in the tubers increased from 16.2% at 59DAP to 63.6% at 94DAP.

In clone TIS.86/0306, the percentage of DM in leaves, stems and tubers were 56.2, 16.9 and 26.8, respectively, at 59 DAP. At 94DAP the percentages were 24.3, 9.4 and 66.3 for leaves, stems and tubers, respectively. A similar trend was observed in 2001 (Figures 8 and 9).

Dry matter partitioning in clone TIS.2271 for 2000 and 2001 studies is shown in Figures 10 and 11, respectively. The proportion of dry matter in the leaves and stems decreased with time whereas that of the tubers increased.

The percentage of DM in the leaves, stems and tubers at 94DAP was 26.2, 12.9 and 60.9, respectively in 2000 compared with 24.9, 19.7 and 55.5 for the same organs at 112DAP in 2001.

The patterns of dry matter distribution in clone TIS.2532.OP.1.13 in both 2000 and 2001 trials are shown in Figures 12 and 13. In the 2000 study, the proportion of dry matter accumulation in the tubers was much lower than in the leaves and stems at the early stages of growth. But at the later stages, the distribution of dry matter in the tubers was higher than in the leaves and the stems.

In 2000 the proportion of DM in leaves dropped from 62.8% at 59DAP to 36.9% at 94DAP, whilst in the stem it dropped from 31.4% to 15.5%. In the tubers there was an increase from 5.8% to 47.6%. In 2001 the drops in the leaves and stems were greater and the increase in DM% in the tubers was as high as 67.6 at 112DAP.

In clone CIP 4400168, the proportion of DM in the leaves was quite high at the beginning and at the end. At 94DAP there was as much DM in the leaves as in the tubers. The leaves and stems contributed about 63% of DM in comparison with 37% DM in the tubers at the final harvest.

In 2001, the percentage of DM in the tubers at the final harvest (45.0%) was less compared with 55.0% in the leaves and stems (Figures 14 and 15).

Figure 16 shows the pattern of dry matter distribution in clone TIS. 82/0070.OP.120 in 2000 study. A prominent feature was the decrease in the proportion of DM in the leaves and stems with time in favour of tuberous root development.

In clone TIS.8/637, the percentage of DM in the leaves and stems was about 51.0 at 59 DAP and the equivalent value at 94DAP was 70.8% compared with 29.2% in the tubers (Figure 17).

Figure 18 shows the dry matter distribution in different parts of clone NRCRI/UN/13 over time. Leaf DM was quite high at 59DAP and decreased from 78.5% to 28.9% at 94 DAP. Stem DM averaged about 18% throughout the sampling period. Tuber DM was extremely low at 59 DAP (1.3%), but increased to about 44.7% at 94DAP. Thus, more dry matter was left in the leaves and stems than in the tubers by 94DAP.

In TIS.2544 Rusanya 1.5, the proportion of DM in leaves and stems at 94DAP was 47.5% compared with 52.5% in the tubers at the same time in 2000. In 2001, the figures were 44.0% (for stems and leaves) and 56.0% (for tubers). Total dry matter increased with time in both years (Figures 19 and 20).

Figure 21 shows the DM distribution in clone TIS.87/0087 in 2001. Dry matter percentage in the leaves dropped from 53.4 at 77DAP to 17.4 at 112 DAP. Stem dry matter averaged about 10% throughout the sampling period. Tuber DM increased from about 35% at 77 DAP to about 73% at 94DAP. The DM percentage of leaves and stems constituted about 27.5% of the total DM. Most of the DM developed was transferred to the tubers at the end of the season.

The distribution of dry matter with time in the farmers' variety is shown in Figure 22. Dry matter in the leaves dropped from 60.5% at 77DAP to 19.4% at 94DAP. The DM in the stems averaged about 16.2%. The DM in the tubers increased from 25.6% at 77DAP to 67.9% at 112 DAP. The leaves and the stems constituted about 32.2% of the total DM at 112 DAP. Total dry matter increased with time throughout the sampling period.

4.1.10 Total Dry Matter

Tables 12 and 13 show the effects of genotype and time on the total dry matter in sweet potato in 2000 and 2001 trials, respectively. Generally, total dry matter increased with time in all clones in both years of the study. In the 2000 study, the peak total DM was observed at 87DAP in most clones with CIP 4400168 maintaining a consistently higher DM than the other clones throughout the sampling period.

In 2001 peak DM accumulation occurred at between 91 and 105DAP in most clones except TIS.8441 and the farmers' variety, which continued to increase up to the end of the growing season (112DAP). Clone TIS.87/0087 reached a peak DM early at 91DAP. Clones Ex-Igbariam and CIP4400168 reached their peak DM at 98 DAP, while clones TIS.86/0356, TIS.86/0306, TIS.2271 and TIS.2532.OP. 1.13 reached their peak DM at 105DAP. In all clones except TIS.8441 and CIP4400168 there was a tendency for the DM to drop by 112DAP.

4.1.11 Harvest Index (HI)

Harvest index increased with time in all the clones in the two years of study (Tables 14 and 15), and the peak period varied with genotype. In 2000, clone Ex-Igbariam peaked earlier than the other clones, most of which peaked at 94DAP. In 2001, TIS.8441 peaked at 91DAP, while Ex-Igbariam had its highest harvest index at 98DAP. Clones TIS.2271, TIS.2544 Rusanya 1.5 and the farmers' variety peaked at 105DAP while the rest of the clones peaked at 112DAP.

4.1.12 Mean Number of Tubers per Plant

The highest mean number of tubers per plant was observed in clone TIS.2271 in the 2000 trial, while the lowest was observed in clone NRCRI/UN/13 (Table 16).

In 2001, clone Ex-Igbariam had the highest mean number of tubers per plant, with TIS.2544 Rusanya 1.5 producing the lowest. Although mean number of tubers per plant was generally higher in 2000 than in 2001, across both years there was no significant difference (Table 16).

4.1.13 Number of Tubers per M^2

The highest number of tubers/m^2 was produced by clone TIS.2271 in 2000, while NRCRI/UN/13 produced the lowest (Table 16). In 2001, Ex-Igbariam exceeded other clones in the mean number of tubers/m^2; TIS.2544 Rusanya 1.5 produced the lowest. Number of tuber/m^2 was generally higher in 2000 than in 2001.

Table 16: Mean Number of Tubers per plant and per m² in selected Sweet Potato Clones in 2000 and 2001

	Mean No. of Tubers/plant			Mean No. of Tubers/m²		
Clone	**2000**	**2001**	**Pooled**	**2000**	**2001**	**Pooled**
TIS.8441	3.8^{bcd}	2.4^{cd}	9.4^{a}	6.8^{cde}	5.9^{b}	19.1^{a}
Ex-Igbariam	5.3^{b}	4.4^{a}	14.6^{a}	6.5^{de}	10.7^{a}	25.9^{a}
TIS.86/0356	4.3^{bcd}	2.1^{d}	9.5^{a}	12.0^{b}	5.4^{b}	26.1^{a}
TIS.86/0306	3.9^{bcd}	3.2^{bc}	10.7^{a}	9.0^{bcd}	7.5^{b}	24.7^{a}
TIS.2271	7.0^{a*}	2.7^{bcd}	14.5^{a}	19.3^{a}	6.5^{b}	38.8^{a}
TIS.2532.OP.1.13	2.8^{de}	2.5^{cd}	8.1^{a}	3.9^{ef}	6.2^{b}	15.3^{a}
CIP4400168	4.7^{bc}	2.6^{bcd}	10.9^{a}	9.6^{bcd}	6.2^{b}	23.7^{a}
TIS.2544 Rusanya1.5	3.3^{cde}	2.0^{d}	8.0^{a}	9.0^{bcd}	1.5^{c}	15.8^{a}
TIS.82/0270.OP.1.85	3.8^{bcd}	na	na	8.0^{cd}	na	na
TIS.82/0070.OP.120	5.1^{b}	na	na	10.4^{bc}	na	na
TIS.8/637	4.1^{bcd}	na	na	8.2^{cd}	na	na
NRCRI/UN/13	2.1^{e}	na	na	2.4^{f}	na	na
TIS.87/0087	na	2.7^{bcd}	na	na	6.7^{b}	na
Farmers' Variety	na	3.4^{b}	na	na	6.0^{b}	na
CV(%)	19.92	17.50	24.85	21.75	24.07	49.88

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

na = Not available

4.1.14 Number of Marketable Tubers

The highest number of marketable tubers per m^2 was observed in clone TIS.86/0356 in 2000 (Table 17). In 2001, clone TIS.87/0087 produced the highest number of large tubers per m^2. Clones NRCRI/UN/13 and TIS.2544 Rusanya 1.5 produced the lowest number of marketable tubers/m^2 in 2000 and 2001, respectively (Table 17). Generally, number of marketable tubers was higher in 2000 than 2001.

4.1.15 Number of Non-Marketable Tubers

Clone TIS.2271 produced the highest number of non-marketable tubers/m^2 in 2000; the lowest number was observed in NRCRI/UN/13 (Table 17).

In 2001, clone Ex-Igbariam yielded the highest number of small tubers, with the lowest observed in TIS.2544 Rusanya 1.5 (Table 17).

Table 17: Mean Number of Marketable (>50mm) and Non-Marketable (<50mm) Tubers per m² in selected Sweet Potato Clones in 2000 and 2001

	No. of Marketable Tubers/m²			No. of Non- Marketable Tubers/m²		
Clone	**2000**	**2001**	**Pooled**	**2000**	**2001**	**Pooled**
TIS.8441	3.9^{bcd}	0.3^{de}	6.4^{ab}	2.9^{cde}	5.6^{b}	12.7^{a}
Ex-Igbariam	2.5^{def}	0.9^{bc}	5.2^{ab}	4.4^{bcd}	9.8^{a}	21.2^{a}
TIS.86/0356	6.8^{a*}	1.4^{ab}	12.3^{a}	5.2^{bc}	4.0^{b}	13.8^{a}
TIS.86/0306	4.5^{b}	1.1^{bc}	8.5^{ab}	4.6^{bcd}	6.4^{b}	16.3^{a}
TIS.2271	4.9^{b}	1.0^{bc}	8.8^{ab}	14.5^{a}	5.5^{b}	30.0^{a}
TIS.2532.OP.1.13	1.9^{ef}	0.7^{cd}	4.0^{b}	2.0^{de}	5.6^{b}	11.4^{a}
CIP4400168	2.8^{cde}	0.7^{cd}	5.3^{ab}	6.1^{b}	5.6^{b}	17.4^{a}
TIS.2544 Rusanya1.5	3.9^{bcd}	0.2^{e}	6.2^{ab}	4.0^{bcde}	1.3^{c}	7.9^{a}
TIS.82/0270.OP.1.85	3.6^{bcd}	na	na	4.0^{bcde}	na	na
TIS.82/0070.OP.120	4.2^{bc}	na	na	6.3^{b}	na	na
TIS.8/637	4.1^{bc}	na	na	4.2^{bcd}	na	na
NRCRI/UN/13	1.2^{f}	na-	na	1.2^{e}	na	na
TIS.87/0087	na	1.7^{a}	na	na	5.1^{b}	na
Farmers' Variety	na	1.0^{bc}	na	na	5.5^{b}	na
CV(%)	23.63	32.97	41.71	30.89	25.92	58.69

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple-Range Test).

na = Not available

4.1.16 Number of Graded Tubers

Table 18 shows the graded number of tubers per m^2 and their percentage distribution. On the average, the proportion of non-marketable tubers produced in 2000 was not different from that of the marketable tubers in most clones. In 2001, the proportion of non-marketable tubers was much higher than that of marketable tubers (Table 19).

Table 18: Graded Tubers/m² in selected Sweet Potato Clones in 2000

	Graded tubers/m²		
Clone	**>50mm**	**<50mm**	**Total**
TIS.8441	3.9(57.35)	2.9(42.65)	6.8
Ex-Igbariam	2.5(36.23)	4.4(63.77)	6.9
TIS.86/0356	6.8(56.67)	5.2(43.33)	12.0
TIS.86/0306	4.5(50.56)	4.4(49.44)	8.9
TIS.2271	4.9(25.26)	14.5(74.74)	19.4
TIS.2532. OP. 1.13	1.9(48.72)	2.0(51.28)	3.9
CIP4400168	2.8(31.46)	6.1(68.54)	8.9
TIS.2544 RUSANYA 1.5	3.9(49.37)	4.0(50.63)	7.9
TIS.82/0270.OP.1.85	3.6(47.37)	4.0(52.63)	7.6
TIS.82/0070.OP.120	4.2(40.00)	6.3(60.00)	10.5
TIS.8/637	4.1(49.40)	4.2(50.60)	8.3
NRCRI/UN/13	1.2(50.00)	1.2(50.00)	2.4
Mean	(45.20)	(54.80)	

·Figures in parentheses are percentage of number of tubers of the total number/m².

Table 19: Graded Tubers/m² in selected Sweet Potato Clones in 2001

	Graded tubers/m²		
Clone	**>50mm**	**<50mm**	**Total**
TIS.8441	0.3(5.08)	5.6(94.92)	5.9
Ex-Igbariam	0.9(8.41)	9.8(91.59)	10.7
TIS.86/0356	1.4(25.93)	4.0(74.07)	5.4
TIS.86/0306	1.1(14.67)	6.4(85.33)	7.5
TIS.2271	1.0(15.38)	5.5(84.62)	6.5
TIS.2532. OP. 1.13	0.7(11.11)	5.6(88.89)	6.3
CIP4400168	0.7(11.29)	5.5(88.71)	6.2
TIS.2544 RUSANYA 1.5	0.2(13.33)	1.3(86.67)	1.5
TIS.87/0087	1.7(25.76)	4.9(74.24)	6.6
Farmers' Variety	1.0(16.39)	5.1(83.61)	6.1
Mean	(14.74)	(85.26)	

▪Figures in parentheses are percentage of number of tubers of the total number/m².

4.1.17 Mean Tuberous Root Weight

Clone NRCRI/UN/13 produced tubers that were bigger than those produced by the other clones in 2000 (Table 20). In 2001, TIS.87/0087 produced the biggest tubers, while TIS.2544 Rusanya 1.5 yielded the smallest tubers. Tubers were generally bigger in 2000 than in 2001 study. Clone TIS.86/0356 produced tubers which were significantly bigger than the other clones across the two years (Table 20).

4.1.18 Dry Matter Percentage (DM%)

Dry matter percentage was significantly higher in clone NRCRI/UN/13 than in other clones in 2000 trial. The lowest DM% of 11.7 was observed in clone TIS.86/0356 (Table 21).

In the 2001 study, the highest DM% of 40.0 was observed in clone TIS.2271, with the lowest (31.2) in clone TIS.87/0087 (Table 21). Dry matter content was generally higher in 2001 than in 2000.

Table 20: Mean Weight of Tubers in selected Sweet Potato Clones in 2000 and 2001

	Mean Weight of Tubers (g)		
Clone	**2000**	**2001**	**Pooled**
TIS.8441	216.7^{abc}	40.0^{c}	385.1^{ab}
Ex-Igbariam	195.4^{bcd}	59.2^{c}	381.8^{ab}
TIS.86/0356	241.1^{abc}	134.0^{a}	562.7^{a}
TIS.86/0306	245.0^{abc}	72.5^{bc}	476.4^{ab}
TIS.2271	93.4^{d}	64.7^{c}	237.1^{b}
TIS.2532.OP.1.13	245.8^{abc}	68.8^{bc}	471.9^{ab}
CIP4400168	142.9^{cd}	57.6^{c}	300.8^{ab}
TIS.2544 Rusanya1.5	149.4^{cd}	43.7^{c}	289.6^{ab}
TIS.82/0270.OP.1.85	215.0^{abc}	na	na
TIS.82/0070.OP.120	169.5^{cd}	na	na
TIS.8/637	287.8^{ab}	na	na
NRCRI/UN/13	304.2^{a}	na	na
TIS.87/0087	na	152.2^{a}	na
Farmers' Variety	na	96.6^{b}	na
CV(%)	26.71	21.64	28.70

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's New Multiple-Range Test).

na = Not available

Table 21: Dry Matter Percentage in selected Sweet Potato Clones in 2000 and 2001

	Dry Matter Percentage(%)		
Clone	**2000**	**2001**	**Pooled**
TIS.8441	26.2^{c}	37.2^{a}	95.2^{ab}
Ex-Igbariam	26.7^{c}	39.7^{a}	99.6^{ab}
TIS.86/0356	11.7^{e}	31.3^{a}	64.5^{b}
TIS.86/0306	16.1^{de}	33.3^{a}	74.0^{ab}
TIS.2271	18.6^{cde}	40.0^{a}	87.7^{ab}
TIS.2532.OP.1.13	37.0^{b}	35.5^{a}	108.8^{a}
CIP4400168	24.5^{cd}	36.8^{a}	92.0^{ab}
TIS.2544 Rusanya1.5	25.1^{cd}	34.2^{a}	88.9^{ab}
TIS.82/0270.OP.1.85	20.1^{cde}	na	na
TIS.82/0070.OP.120	19.6^{cde}	na	na
TIS.8/637	15.0^{e}	na	na
NRCRI/UN/13	48.5^{a*}	na	na
TIS.87/0087	na	31.2^{a}	na
Farmers' Variety	na	37.8^{a}	na
CV(%)	19.84	15.61	17.09

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's New Multiple-Range Test).

na = Not available

4.1.19 Total Tuber Yield

The highest tuber yield of 28.9t/ha was produced by clone TIS.86/0356 in 2000 while the lowest (7.2t/ha) was observed in NRCRI/UN/13 (Table 22). In 2001, clone TIS.87/0087 produced the highest total yield of 10.1t/ha while TIS.2544 Rusanya 1.5 yielded the lowest (0.7t/ha). Total tuber yields were generally higher in 2000 than in 2001 (Table 22).

4.1.20 Marketable Tuber Yield

Again, the highest marketable tuber yield of 25.9t/ha was produced by clone TIS.86/0356 in 2000 with the lowest (6.9t/ha) in NRCRI/UN/13 (Table 23). Similarly, clone TIS.87/0087 had the highest marketable tuber yield of 5.9t/ha while clone TIS.2544 Rusanya 1.5 had the lowest yield of 0.3t/ha in 2001. Across both years, clone TIS.86/0356 produced the highest tuber yield (Table 23).

4.1.21 Non-Marketable Tuber Yield

Clone TIS.2271 had the highest non-marketable tuber yield of 5.4 t/ha in 2000, and NRCRI/UN/13 produced the lowest (0.3t/ha) (Table 23).

In 2001 trial, the highest non-marketable tuber yield of 4.3t/ha was observed in TIS.87/0087 and the lowest (0.4t/ha) was observed in TIS.2544 Rusanya 1.5 (Table 23).

Table 22: Total Tuber Yield in selected Sweet Potato Clones in 2000 and 2001

	Total Tuber Yield(t/ha)		
Clone	**2000**	**2001**	**Pooled**
TIS.8441	13.2^{efg}	2.4^{de}	23.5^{b}
Ex-Igbariam	12.6^{fg}	6.2^{bc}	28.3^{ab}
TIS.86/0356	28.9^{a}	7.2^{b}	54.2^{a}
TIS.86/0306	21.1^{bc}	5.7^{bc}	40.2^{ab}
TIS.2271	18.0^{cd}	4.7^{bcd}	34.0^{ab}
TIS.2532.OP.1.13	9.1^{gh}	4.4^{bcd}	20.2^{b}
CIP4400168	13.7^{def}	3.8^{cd}	26.2^{ab}
TIS.2544 Rusanya1.5	13.3^{efg}	0.7^{e}	21.1^{b}
TIS.82/0270.OP.1.85	17.0^{cdef}	na	na
TIS.82/0070.OP.120	17.4^{cde}	na	na
TIS.8/637	22.4^{b}	na	na
NRCRI/UN/13	7.2^{h}	na	na
TIS.87/0087	na	10.1^{a}	na
Farmers' Variety	na	5.8^{bc}	na
CV(%)	15.23	31.31	37.59

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple - Range Test).

na = Not available

Table 23: Marketable (>50mm) and Non-Marketable (<50mm) Tuber Yields in selected Sweet Potato Clones in 2000 and 2001

	Marketable Tuber Yield (t/ha)			Non-Marketable Tuber Yield(t/ha)		
Clone	**2000**	**2001**	**Pooled**	**2000**	**2001**	**Pooled**
TIS.8441	12.2^{de}	0.4^{e}	18.9^{b}	1.7^{bcd}	2.0^{cd}	5.7^{a}
Ex-Igbariam	10.5^{def}	2.2^{cd}	19.1^{b}	1.9^{bcd}	4.0^{ab}	8.9^{a}
TIS.86/0356	25.9^{a}	4.5^{ab}	45.7^{a}	3.0^{bc}	2.7^{abc}	8.5^{a}
TIS.86/0306	18.3^{bc}	3.2^{bc}	32.3^{ab}	2.8^{bc}	2.5^{abc}	7.9^{a}
TIS.2271	12.6^{d}	2.1^{cd}	22.1^{ab}	5.4^{a}	2.6^{abc}	11.9^{a}
TIS.2532.OP.1.13	7.8^{ef}	2.3^{cd}	15.1^{b}	1.3^{cd}	2.1^{bcd}	5.1^{a}
CIP4400168	10.5^{def}	1.4^{de}	17.9^{b}	3.2^{bc}	2.4^{abc}	8.4^{a}
TIS.2544 Rusanya1.5	11.1^{def}	0.3^{e}	17.1^{b}	2.2^{bc}	0.4^{d}	4.0^{a}
TIS.82/0270.OP.1.85	14.8^{cd}	na	na	2.2^{bc}	na	na
TIS.82/0070.OP.120	13.9^{d}	na	na	3.5^{b}	na	na
TIS.8/637	20.6^{b}	na	na	1.9^{bcd}	na	na
NRCRI/UN/13	6.9^{f}	na	na	0.3^{d}	na	na
TIS.87/0087	na	5.9^{a}	na	na	4.3^{a}	na
Farmers' Variety	na	3.1^{cd}	na	na	2.7^{abc}	na
CV(%)	18.14	34.35	43.63	40.82	40.22	41.85

Means followed by the same letter(s) within the same column are not significantly different at 5% level of probability (Duncan's new Multiple - Range Test).

na = Not available

4.1.22 Graded Tuber Yield

Table 24 shows the effect of genotype on graded tuber yield in sweet potato in 2000. The proportion of marketable tuber yield of the total tuber yield was generally higher than that of non-marketable tubers in all genotypes. In 2001, clones TIS.86/0356, TIS.86/0306, TIS.2532.OP.1.13, TIS.87/0087 and the farmers' variety had a higher proportion of marketable tuber yield than the non-marketable yield (Plates 5 and 13). On the other hand, the proportion of non-marketable tuber yield in clones TIS.8441, Ex-Igbariam, TIS.2271, CIP4400168 and TIS.2544 Rusanya 1.5 was higher than that of the marketable tuber yield (Table 25; Plates 3, 9 and 11).

The proportion of large tubers (>50mm) was between 70 and 96% in 2000 whilst the smaller tubers (<50mm) constituted from 4-30%. In 2001 the larger tubers constituted about 17-63% whilst the smaller tubers constituted about 38-83%.

Table 24: Graded Tuber Yield in selected Sweet Potato Clones in 2000

	Graded tuber yield (t/ha)		
Clone	**>50mm**	**<50mm**	**Total**
TIS. 8441	12.2(87.77)	1.7(12.23)	13.9
Ex-Igbariam	10.5(84.68)	1.9(15.32)	12.4
TIS. 86/0356	25.9(89.62)	3.0(10.38)	28.9
TIS. 86/0306	18.3(86.73)	2.8(13.27)	21.1
TIS. 2271	12.6(70.00)	5.4(30.00)	18.0
TIS. 2532. OP. 1.13	7.8(85.71)	1.3(14.29)	9.1
CIP4400168	10.5(76.64)	3.2(23.36)	13.7
TIS. 2544 RUSANYA 1.5	11.1(83.46)	2.2(16.54)	13.3
TIS. 82/0270.OP.1.85	14.8(85.06)	2.2(14.94)	17.0
TIS. 82/0070.OP.120	13.9(79.89)	3.5(20.11)	17.4
TIS. 8/637	20.6(91.56)	1.9(8.44)	22.5
NRCRI/UN/13	6.9(95.83)	0.3(4.17)	7.2
Mean	(84.75)	(15.25)	

Figures in parentheses are percentage of graded tuber yield of the total tuber yield.

Table 25: Graded Tuber Yield in selected Sweet Potato Clones in 2001

	Graded Tuber Yield (t/ha)		
Clone	**>50mm**	**<50mm**	**Total**
TIS. 8441	0.4(16.67)	2.0(83.33)	2.4
Ex-Igbariam	2.2(35.48)	4.0(64.52)	6.2
TIS. 86/0356	4.5(62.50)	2.7(37.50)	7.2
TIS. 86/0306	3.2(56.14)	2.5(43.86)	5.7
TIS. 2271	2.1(44.68)	2.6(55.32)	4.7
TIS. 2532. OP. 1.13	2.5(54.35)	2.1(45.65)	4.6
CIP4400168	1.4(40.00)	2.4(60.00)	3.8
TIS. 2544 RUSANYA 1.5	0.3(42.86)	0.4(57.14)	0.7
TIS. 87/0087	5.9(57.84)	4.3(42.16)	10.2
Farmers' Variety	3.1(53.45)	2.7(46.55)	5.8
Mean	(46.40)	(53.60)	

▪Figures in parentheses are percentage of graded tuber yield of the total tuber yield.

4.1.23 Correlation Analysis

Table 26 shows the correlation matrix between thirteen attributes and with total tuber yield using the data pooled over two years (2000 and 2001). Petiole length, mean number of branches per plant, mean number of tubers/m^2 and per plant as well as mean tuber weight were positively correlated with total tuber yield. Petiole length was significantly correlated with mean tuber weight and mean number of tubers per plant. Harvest index and petiole length were negatively correlated. Mean number of tubers per plant and per m^2 were highly correlated with mean number of branches per plant. Leaf area index, leaf area duration and mean number of tubers per m^2 were positively correlated with vigour whereas vigour and NAR were negatively correlated. Leaf area duration, total dry matter and net assimilation rate were significantly correlated with leaf area index. Net assimilation rate and total dry matter were highly correlated with leaf area duration. Mean tuber weight and NAR were positively correlated with CGR. Net assimilation rate and mean number of tubers/m^2 were positively correlated with mean tuber weight and mean number of tubers/plant, respectively.

The direct and indirect influences of the thirteen attributes on total tuber yield are shown in Table 27 and Fig. 23. Leaf area index showed the highest direct influence on total tuber yield while mean tuber weight showed the least. Other attributes which showed low direct influences appeared to have influenced tuber yield through indirect paths.

Table 27: Path Analysis showing the Direct and Indirect Influences of thirteen (13) Attributes on Total Tuber Yield of Sweet Potato.

Pathways of Association	Direct Effect Path Coeff.(p)	%	Indirect Effect Path Coeff.(pxr)	%	Correlation Coefficient
1. Vine Length					
a) Direct Effect (P_1 Y)	-0.113	74.34			
b) Indirect Effect via					
Petiole Length(P_2 $Yr_{1\ 2}$)			0.041	26.97	
No. of Branches/plant (P_3 $Yr_{1\ 3}$)			0.050	32.89	
Vigour(P_4 $Yr_{1\ 4}$)			-0.051	33.55	
Leaf Area Index (P_5 $Yr_{1\ 5}$)			-0.282	185.53	
Leaf Area Duration (P_6 $Yr_{1\ 6}$)			0.016	10.53	
Crop Growth Rate (P_7 $Yr_{1\ 7}$)			0.103	67.76	
Net Assimilation Rate (P_8 $Yr_{1\ 8}$)			-0.140	92.11	
Mean No. of Tubers/m^2 (P_9 $Yr_{1\ 9}$)			0.006	3.95	
Mean Tuber Weight (P_{10} $Yr_{1\ 10}$)			-0.003	1.97	
Mean No. of Tubers/plant (P_{11} $Yr_{1\ 11}$)			0.171	112.50	
Total Dry Matter (P_{12} $Yr_{1\ 12}$)			0.093	61.18	
Harvest Index (P_{13} $Yr_{1\ 13}$)			-0.043	28.29	
c) Total Effect					-0.152
2. Petiole Length					
a) Direct Effect (P_2 Y)	0.520	82.54			
b) Indirect Effect via					
Vine Length(P_1 $Yr_{2\ 1}$)			-0.009	1.43	
No. of Branches/plant (P_3 $Yr_{2\ 3}$)			-0.085	13.49	
Vigour(P_4 $Yr_{2\ 4}$)			0.382	60.63	
Leaf Area Index (P_5 $Yr_{2\ 5}$)			-0.614	97.46	
Leaf Area Duration (P_6 $Yr_{2\ 6}$)			0.021	3.33	
Crop Growth Rate (P_7 $Yr_{2\ 7}$)			-0.094	14.92	
Net Assimilation Rate (P_8 $Yr_{2\ 8}$)			0.016	2.54	
Mean No. of Tubers/m^2 (P_9 $Yr_{2\ 9}$)			-0.236	37.46	
Mean Tuber Weight (P_{10} $Yr_{2\ 10}$)			0.029	4.60	
Mean No. of Tubers/plant (P_{11} $Yr_{2\ 11}$)			0.332	52.70	
Total Dry Matter (P_{12} $Yr_{2\ 12}$)			0.487	77.30	
Harvest Index (P_{13} $Yr_{2\ 13}$)			-0.119	18.89	
c) Total Effect					0.630

3. No. of Branches/plant				
a) Direct Effect (P_3 Y)	-0.188	33.51		
b) Indirect Effect via				
Vine Length(P_1 $Yr_{3\,1}$)		0.030	5.35	
Petiole Length (P_2 $Yr_{3\,2}$)		0.236	42.07	
Vigour(P_4 $Yr_{3\,4}$)		0.286	50.98	
Leaf Area Index (P_5 $Yr_{3\,5}$)		0.131	23.35	
Leaf Area Duration (P_6 $Yr_{3\,6}$)		-0.007	1.25	
Crop Growth Rate (P_7 $Yr_{3\,7}$)		-0.090	16.04	
Net Assimilation Rate (P_8 $Yr_{3\,8}$)		0.099	17.65	
Mean No. of Tubers/m^2 (P_9 $Yr_{3\,9}$)		-0.392	69.88	
Mean Tuber Weight (P_{10} $Yr_{3\,10}$)		0.009	1.60	
Mean No. of Tubers/plant (P_{11} $Yr_{3\,11}$)		0.399	71.12	
Total Dry Matter (P_{12} $Yr_{3\,12}$)		0.054	9.63	
Harvest Index (P_{13} $Yr_{3\,13}$)		-0.008	1.43	
c) Total Effect				0.561
4. Vigour				
a) Direct Effect (P_4 Y)	0.865	322.76		
b) Indirect Effect via				
Vine Length(P_1 $Yr_{4\,1}$)		0.007	2.61	
Petiole Length (P_2 $Yr_{4\,2}$)		0.230	85.82	
No. of Branches/plant (P_3 $Yr_{4\,3}$)		-0.062	23.13	
Leaf Area Index (P_5 $Yr_{4\,5}$)		-0.707	263.81	
Leaf Area Duration (P_6 $Yr_{4\,6}$)		0.035	13.06	
Crop Growth Rate (P_7 $Yr_{4\,7}$)		-0.001	0.37	
Net Assimilation Rate (P_8 $Yr_{4\,8}$)		-0.313	116.79	
Mean No. of Tubers/m^2 (P_9 $Yr_{4\,9}$)		-0.293	109.33	
Mean Tuber Weight (P_{10} $Yr_{4\,10}$)		-0.011	4.10	
Mean No. of Tubers/plant (P_{11} $Yr_{4\,11}$)		0.164	61.19	
Total Dry Matter (P_{12} $Yr_{4\,12}$)		0.431	160.82	
Harvest Index (P_{13} $Yr_{4\,13}$)		-0.077	28.73	
c) Total Effect				0.268

5. Leaf Area Index (LAI)			
a) Direct Effect (P_5 Y)	-1.264	8426.67	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{5\ 1}$)	-0.025	166.67	
Petiole Length (P_2 $Yr_{5\ 2}$)	0.253	1687.67	
No. of Branches/plant (P_5 $Yr_{5\ 3}$)	0.020	133.33	
Vigour(P_4 $Yr_{5\ 4}$)	0.484	3226.67	
Leaf Area Duration (P_6 $Yr_{5\ 6}$)	0.050	333.33	
Crop Growth Rate (P_7 $Yr_{5\ 7}$)	0.031	206.67	
Net Assimilation Rate (P_8 $Yr_{5\ 8}$)	-0.307	2046.67	
Mean No. of Tubers/m^2 (P_9 $Yr_{5\ 9}$)	-0.058	386.67	
Mean Tuber Weight (P_{10} $Yr_{5\ 10}$)	-0.007	46.67	
Mean No. of Tubers/plant (P_{11} $Yr_{5\ 11}$)	0.049	326.67	
Total Dry Matter (P_{12} $Yr_{5\ 12}$)	0.829	5526.67	
Harvest Index (P_{13} $Yr_{5\ 13}$)	-0.070	466.67	
c) Total Effect			-0.015
6. Leaf Area Duration (LAD)			
a) Direct Effect (P_6 Y)	0.053	73.61	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{6\ 1}$)	-0.034	47.22	
Petiole Length (P_2 $Yr_{6\ 2}$)	0.204	283.33	
No. of Branches/plant (P_3 $Yr_{6\ 3}$)	0.024	33.33	
Vigour (P_4 $Yr_{6\ 4}$)	0.574	797.22	
Leaf Area Index (P_5 $Yr_{6\ 5}$)	-1.202	1669.44	
Crop Growth Rate (P_7 $Yr_{6\ 7}$)	0.036	50.00	
Net Assimilation Rate (P_8 $Yr_{6\ 8}$)	-0.362	502.78	
Mean No. of Tubers/m^2 (P_9 $Yr_{6\ 9}$)	-0.074	102.78	
Mean Tuber Weight (P_{10} $Yr_{6\ 10}$)	-0.014	19.44	
Mean No. of Tubers/plant (P_{11} $Yr_{6\ 11}$)	0.030	40.54	
Total Dry Matter (P_{12} $Yr_{6\ 12}$)	0.763	1059.72	
Harvest Index (P_{13} $Yr_{6\ 13}$)	-0.070	97.22	
c) Total Effect			-0.072

7. Crop Growth Rate (CGR)			
a) Direct Effect (P_7 Y)	-0.376	78.66	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{7\ 1}$)	0.031	6.49	
Petiole Length (P_2 $Yr_{7\ 2}$)	0.129	26.99	
No. of Branches/plant (P_3 $Yr_{7\ 3}$)	-0.045	9.41	
Vigour(P_4 $Yr_{7\ 4}$)	0.003	0.63	
Leaf Area Index (P_5 $Yr_{7\ 5}$)	0.105	21.97	
Leaf Area Duration (P_6 $Yr_{7\ 6}$)	-0.005	1.05	
Net Assimilation Rate (P_8 $Yr_{7\ 8}$)	0.413	86.40	
Mean No. of Tubers/m^2 (P_9 $Yr_{7\ 9}$)	-0.056	11.72	
Mean Tuber Weight (P_{10} $Yr_{7\ 10}$)	0.030	6.28	
Mean No. of Tubers/plant (P_{11} $Yr_{7\ 11}$)	0.056	11.72	
Total Dry Matter (P_{12} $Yr_{7\ 12}$)	0.170	35.56	
Harvest Index (P_{13} $Yr_{7\ 13}$)	0.023	4.81	
c) Total Effect			0.478
8. Net Assimilation Rate (NAR)			
a) Direct Effect (P_8 Y)	0.589	164.99	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{8\ 1}$)	0.027	7.56	
Petiole Length (P_2 $Yr_{8\ 2}$)	0.014	3.92	
No. of Branches/plant (P_3 $Yr_{8\ 3}$)	-0.032	8.96	
Vigour (P_4 $Yr_{8\ 4}$)	-0.459	128.57	
Leaf Area Index (P_5 $Yr_{8\ 5}$)	0.660	184.87	
Leaf Area Duration (P_6 $Yr_{8\ 6}$)	-0.033	9.24	
Crop Growth Rate (P_7 $Yr_{8\ 7}$)	-0.264	73.95	
Mean No. of Tubers/m^2 (P_9 $Yr_{8\ 9}$)	0.035	9.80	
Mean Tuber Weight (P_{10} $Yr_{8\ 10}$)	0.034	9.52	
Mean No. of Tubers/plant (P_{11} $Yr_{8\ 11}$)	0.057	15.97	
Total Dry Matter (P_{12} $Yr_{8\ 12}$)	-0.316	88.52	
Harvest Index (P_{13} $Yr_{8\ 13}$)	0.045	12.61	
c) Total Effect			0.357

9. Mean No. of Tubers/m^2			
a) Direct Effect (P_9 Y)	-0.513	81.43	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{9\ 1}$)	0.001	0.16	
Petiole Length (P_2 $Yr_{9\ 2}$)	0.240	38.10	
No. of Branches/plant (P_3 $Yr_{9\ 3}$)	-0.144	22.86	
Vigour(P_4 $Yr_{9\ 4}$)	0.495	78.57	
Leaf Area Index (P_5 $Yr_{9\ 5}$)	-0.143	22.70	
Leaf Area Duration (P_6 $Yr_{9\ 6}$)	0.007	1.11	
Crop Growth Rate (P_7 $Yr_{9\ 7}$)	-0.041	6.51	
Net Assimilation Rate (P_8 $Yr_{9\ 8}$)	-0.040	6.35	
Mean Tuber Weight (P_{10} $Yr_{9\ 10}$)	0.005	0.79	
Mean No. of Tubers/plant (P_{11} $Yr_{9\ 11}$)	0.482	76.51	
Total Dry Matter (P_{12} $Yr_{9\ 12}$)	0.308	48.89	
Harvest Index (P_{13} $Yr_{9\ 13}$)	-0.027	4.29	
c) Total Effect			0.630
10. Mean Tuber Weight			
a) Direct Effect (P_{10} Y)	0.058	7.65	
b) Indirect Effect via			
Vine Length(P_1 $Yr_{10\ 1}$)	0.006	0.79	
Petiole Length (P_2 $Yr_{10\ 2}$)	0.264	34.83	
No. of Branches/plant (P_3 $Yr_{10\ 3}$)	-0.030	3.96	
Vigour (P_4 $Yr_{10\ 4}$)	-0.163	21.50	
Leaf Area Index (P_5 $Yr_{10\ 5}$)	0.158	20.84	
Leaf Area Duration (P_6 $Yr_{10\ 6}$)	-0.013	1.72	
Crop Growth Rate (P_7 $Yr_{10\ 7}$)	-0.195	25.73	
Net Assimilation Rate (P_8 $Yr_{10\ 8}$)	0.343	45.25	
Mean No. of Tubers/m^2 (P_{10} $Yr_{10\ 10}$)	-0.048	6.33	
Mean No. of Tubers/plant (P_{11} $Yr_{10\ 11}$)	0.162	21.37	
Total Dry Matter (P_{12} $Yr_{10\ 12}$)	0.260	34.30	
Harvest Index (P_{13} $Yr_{10\ 13}$)	-0.044	5.80	
c) Total Effect			0.758

11. Mean No. of Tubers/plant					
a) Direct Effect (P_{11} Y)	0.573	90.81			
b) Indirect Effect via					
Vine Length(P_1 $Yr_{11\,1}$)			-0.034	5.39	
Petiole Length (P_2 $Yr_{11\,2}$)			0.302	47.86	
No. of Branches/plant (P_3 $Yr_{11\,3}$)			-0.131	20.76	
Vigour(P_4 $Yr_{11\,4}$)			0.247	39.14	
Leaf Area Index (P_5 $Yr_{11\,5}$)			-0.107	16.96	
Leaf Area Duration (P_6 $Yr_{11\,6}$)			0.003	0.48	
Crop Growth Rate (P_7 $Yr_{11\,7}$)			-0.037	5.86	
Net Assimilation Rate (P_8 $Yr_{11\,8}$)			0.059	9.35	
Mean No. of Tubers/m^2 (P_9 $Yr_{11\,9}$)			-0.432	68.46	
Mean Tuber Weight (P_{10} $Yr_{11\,10}$)			0.016	2.54	
Total Dry Matter (P_{12} $Yr_{11\,12}$)			0.223	35.34	
Harvest Index (P_{13} $Yr_{11\,13}$)			-0.051	8.08	
c) Total Effect					0.631
12. Total Dry Matter					
a) Direct Effect (P_{12} Y)	1.060	265.00			
b) Indirect Effect via					
Vine Length(P_1 $Yr_{12\,1}$)			-0.010	2.50	
Petiole Length (P_2 $Yr_{12\,2}$)			0.239	59.75	
No. of Branches/plant (P_3 $Yr_{12\,3}$)			-0.010	2.50	
Vigour (P_4 $Yr_{12\,4}$)			0.352	88.00	
Leaf Area Index (P_5 $Yr_{12\,5}$)			-0.988	247.00	
Leaf Area Duration (P_6 $Yr_{12\,6}$)			0.038	9.50	
Crop Growth Rate (P_7 $Yr_{12\,7}$)			-0.060	15.00	
Net Assimilation Rate (P_8 $Yr_{12\,8}$)			-0.176	44.00	
Mean No. of Tubers/m^2 (P_9 $Yr_{12\,9}$)			-0.149	37.25	
Mean Tuber Weight (P_{10} $Yr_{12\,10}$)			0.014	3.50	
Mean No. of Tubers/plant (P_{11} $Yr_{12\,11}$)			0.120	30.00	
Harvest Index (P_{13} $Yr_{12\,13}$)			-0.030	7.50	
c) Total Effect					0.400

13. Harvest Index				
a) Direct Effect (P_{13} Y)	0.165	62.98		
b) Indirect Effect via				
Vine Length(P_1 $Yr_{13\ 1}$)		0.029	11.07	
Petiole Length (P_2 $Yr_{13\ 2}$)		-0.376	143.51	
No. of Branches/plant (P_3 $Yr_{13\ 3}$)		0.009	3.44	
Vigour (P_4 $Yr_{13\ 4}$)		-0.406	154.96	
Leaf Area Index (P_5 $Yr_{13\ 5}$)		0.533	203.44	
Leaf Area Duration (P_6 $Yr_{13\ 6}$)		-0.023	8.78	
Crop Growth Rate (P_7 $Yr_{13\ 7}$)		-0.053	20.23	
Net Assimilation Rate (P_8 $Yr_{13\ 8}$)		0.160	61.07	
Mean No. of Tubers/m^2 (P_9 $Yr_{13\ 9}$)		0.083	31.68	
Mean Tuber Weight (P_{10} $Yr_{13\ 10}$)		-0.015	5.73	
Mean No. of Tubers/plant (P_{11} $Yr_{13\ 11}$)		-0.178	67.94	
Total Dry Matter (P_{12} $Yr_{13\ 12}$)		-0.190	72.52	
c) Total Effect				-0.262
Residual	0.145			

4.2 GRAFTING EXPERIMENT

4.2.1 <u>Success Rate</u>

Table 28 shows the success rate (%) of all possible grafts including reciprocals and self-grafts of six sweet potato clones. The lowest success rate of 93.3% was observed when clone Ex-Igbariam was self-grafted or when it was used as stock in combination with clones TIS.87/0087 and CIP 4400168 as scions or as scion in combination with clones TIS.2532.OP.1.13 and TIS.2544 Rusanya 1.5 as stocks. All other grafts had 100.0% success rate.

4.2.2 <u>Establishment Rate</u>

Establishment rate ranged from 50.0% in the graft-combination involving clones TIS.2532.OP.1.13 as stock and Ex-Igbariam as scion to 100.0% in thirteen (13) different grafts (Table 29). All self-grafts except that for clone TIS.86/0356 had the highest establishment rate (100.0%).

Clone Ex-Igbariam had the highest mean stock effect of 98.8% while clones TIS.2532.OP.1.13 and CIP 4400168 had the lowest (86.3%) and the difference was significant at P=0.05. Clone CIP 4400168 had the highest mean scion effect of 98.8% while the lowest (82.1%) was observed in clone Ex-Igbariam and the difference was highly significant (P=0.01).

4.2.3 Leaf Area

In all but two crosses (Ex-Igbariam X CIP 4400168 and TIS.2532.OP.1.13 X TIS.2544 Rusanya 1.5), leaf area increased up to 90 DAP after which it decreased (Table 30). Cross CIP 4400168 X Ex-Igbariam maintained the highest leaf area at 45 and 90 DAP; at 135 DAP, the highest leaf area of 17.5×10^3 cm^2 was observed in the graft-combination involving clones Ex-Igbariam as stock and CIP 4400168 as scion.

4.2.4 Crop Growth Rate (CGR)

The effect of grafting on crop growth rate at different stages of growth is shown in Table 31. In all but crosses Ex-Igbariam X CIP 4400168, CIP 4400168 X TIS.86/0356, TIS.2544 Rusanya 1.5 X Ex-Igbariam, TIS.544 Rusanya 1.5 X TIS.2532.OP.1.13 and TIS.2544 Rusanya 1.5 X CIP 4400168, CGR increased with time up to 90 DAP and thereafter decreased.

4.2.5 Net Assimilation Rate(NAR)

With the exception of crosses Ex-Igbariam X CIP 4400168, TIS.87/0087 X CIP-4400168, CIP 4400168 X TIS.86/0356, TIS.86/0356 X Ex-Igbariam, TIS.2544- Rusanya 1.5 X Ex-Igbariam and TIS.2544 Rusanya 1.5 X TIS.2532.OP.1.13, net assimilation rate increased with time up to 90 DAP and thereafter decreased (Table 32). In graft-combinations where CGR was observed to have increased up to 135 DAP, NAR also increased.

4.2.6 <u>Tuber Bulking Rate</u> (TBR)

Tuber bulking rate increased with time up to 90 DAP in many grafts (Table 33). When clones Ex-Igbariam and TIS.2544 Rusanya 1.5 were used as stocks, tuber-bulking rate increased up to 135 DAP in nearly all their graft combinations. The highest tuber bulking rates of 1.5 and 20.9g/day were observed in self-grafts of clones TIS.86/0356 and TIS.2532.OP.1.13 at 45 DAP and 90 DAP, respectively. At 135 DAP, however, cross TIS.2544 Rusanya 1.5 X CIP 4400168 had the highest tuber-bulking rate of 18.0g/day.

4.2.7 <u>Harvest Index</u> (HI)

Table 34 shows the harvest index of grafts of six sweet potato clones at different periods of growth. Harvest index increased up to 135 DAP in the self-grafts of clones Ex-Igbariam and TIS.87/087 as well as in grafts Ex-Igbariam X TIS.87/087, Ex-Igbariam X TIS.2532.OP.1.13, TIS.87/0087 X CIP 4400168 and TIS.87/0087 X TIS.86/0356. Harvest index remained fairly constant in grafts Ex-Igbariam X CIP 4400168, TIS.2532.OP.1.13 X CIP 4400168 and TIS.2532.OP.1.13 X TIS.2544 Rusanya 1.5. In the self-graft of clone TIS.87/0087 as well as graft TIS.87/0087 X Ex-Igbariam, HI reached a plateau from 90 DAP. Harvest index increased up to 90 DAP after which it declined in grafts Ex-Igbariam X TIS.2544 Rusanya 1.5 and TIS.87/0087 X TIS.2544 Rusanya 1.5.

4.2.8 <u>Dry Matter Content</u> (DM%)

In all but five grafts (Ex-Igbariam X TIS.2532.OP.1.13, Ex-Igbariam X TIS.86/0356, TIS.2532.OP.1.13 X TIS.86/0356, TIS.86/0356 X TIS.86/0356 and TIS.86/0356 X CIP 4400168), dry matter content increased up to the end of the growing season (Table 35). Except at 45 DAP, graft-combinations involving clone Ex-Igbariam as stock had the highest dry matter content.

4.2.9 Total Dry Matter Accumulation and Partitioning

Table 36 shows total dry matter accumulated and its distribution amongst the various parts of grafts of six sweet potato clones. In many graft-combinations, total dry matter increased with time throughout the growing season. Total dry matter accumulated in graft-combinations with clone CIP 4400168 as scion was generally higher than that involving the other clones.

Generally, the proportion of dry matter left in laminae, petioles and stems decreased with delay in harvesting in all grafts, whereas that of the tubers increased. Whether clone CIP 4400168 was used as stock or scion, the proportion of dry matter in the laminae, petioles and stems was much higher than that partitioned to the tubers. On the other hand, dry matter distribution in the tubers was much higher at the end of the growing season when clone TIS.87/0087 was used as stock compared to the other clones.

Table 37 shows distribution of dry matter amongst the different parts of the six clones when they were planted without grafting. A similar pattern of distribution as seen in the graft-combinations was observed. However, less dry matter was partitioned to the tubers when the clones were not grafted than when they were grafted, the only exception being clone TIS.86/0356.

4.2.10 Vigour Score

The highest mean vigour score of 3.0 was observed in the graft-combination of clones TIS.86/0356 as stock and TIS.2544 Rusanya 1.5 as scion, while the lowest (1.3) was observed in the graft involving TIS.87/0087 as stock and TIS.2544 Rusanya 1.5 as scion (Table 38). There was no significant difference amongst the mean stock or mean scion effects (Table 38).

4.2.11 Flowering Score

The highest mean flowering score of 2.0 was observed in the self-graft of clone TIS.2532.OP.1.13 while the lowest value of 0.0 was observed in the graft involving clones TIS.2544 Rusanya 1.5 as stock and CIP 4400168 as scion (Table 39).

Clone TIS.2544 Rusanya 1.5 had the highest mean scion effect on flowering score while clone CIP 4400168 had the lowest and the difference was highly significant. There was no significant difference in the mean stock effect (Table 39).

4.2.12. Pollen Fertility

The total number of anthers observed varied from 11 in the self-graft of clone TIS.87/0087 to 641 in the self-graft of clone Ex-Igbariam. Pollen fertility ranged from 50.7% in the cross involving clones CIP 4400168 as stock and TIS.2544 Rusanya 1.5 as scion to 100.0% in the self-graft of clone TIS.87/0087 (Table 40).

4.2.13. **Mean Stand Count at Harvest**

Mean stand count at harvest varied from 1.7 in the graft involving clones TIS.2532.OP.1.13 as stock and Ex-Igbariam as scion to 4.0 in grafts Ex-Igbariam X Ex-Igbariam, TIS.2544 Rusanya 1.5 X TIS.87/0087, TIS.2532.OP.1.13 X TIS.2532.OP.1.13, Ex-Igbariam X CIP 4400168, TIS.87/0087 X CIP 4400168, CIP 4400168 X CIP 4400168, CIP 4400168 X TIS.2544 Rusanya 1.5 and TIS.2544 Rusanya 1.5 X TIS.2544 Rusanya 1.5 (Table 41).

The mean scion effect on stand count was significantly higher in clone CIP 440068 than in the other clones. There was no significant difference in the mean stock effects(Table 41).

A significant interaction of stock and scion on stand count was observed. Whereas clone TIS.2544 Rusanya 1.5 had the highest mean stock effect on stand count, clone CIP 4400168 had the highest mean scion effect (Table 41).

4.2.14. **Mean Number of Branches per Plant**

The highest mean number of branches per plant (3.7) was observed in the graft between clone Ex-Igbariam (stock) and clone CIP 4400168 (scion); the lowest was observed when clone TIS.2544 Rusanya 1.5 was grafted as scion onto clone TIS.87/0087 as stock (Table 42). There was no significant difference in mean stock or mean scion effects (Table 42).

4.2.15 Mean Vine Length

The longest vines were produced in the graft involving Ex-Igbariam as stock and TIS.2532.OP.1.13 as scion. The self-grafts of clone TIS.87/0087 produced the shortest vines (Table 43). Clone TIS.2544 Rusanya 1.5 had the highest mean stock effect on vine length while clone TIS.87/0087 had the lowest, and the difference was highly significant (P=0.01). The mean scion effect in clone TIS.2532.OP.1.13 (176.8cm) was significantly higher (P=0.01) than that observed in clone TIS.86/0356 (101.6cm) (Table 43).

4.2.16 Mean Petiole Length

Table 44 summarises the effect of grafting on mean petiole length in six sweet potato clones. Clones Ex-Igbariam as stock and CIP 4400168 as scion produced leaves with the longest petioles (12.7cm), while the shortest petioles (3.2cm) were observed in the graft-combination of clones TIS.2532.OP.1.13 as stock and TIS.86/0356 as scion.

Clone Ex-Igbariam had the highest mean stock effect, although this was not significantly different from the other clones. The mean scion effect in clone CIP 4400168(10.9cm) was significantly different from the other clones (Table 44).

4.2.17 Dry Vine Yield

The highest dry vine yield of 238.5g/plant was produced in the self-graft of clone CIP 4400168, with the lowest in the graft involving TIS.87/0087 as stock and TIS.86/0356 as scion (Table 45). The mean stock effect and the mean scion effect in clone CIP 4400168 were significantly higher (P=0.01) than in the other clones. Clones TIS.87/0087 and TIS.86/0356 had the lowest mean stock and mean scion effects on dry vine yield, respectively (Table 45).

4.2.18 Root-Top Ratio(RTR)

Root-top ratio of grafts of six sweet potato clones is shown in Table 46. The graft-combination of clones TIS.87/0087 as stock and TIS.86/0356 as scion resulted in the highest root-top ratio of 14.1, while the self-graft of clone CIP 4400168 resulted in the lowest root-top ratio of 0.7.

The highest mean stock effect of 6.6 was observed in clone TIS.87/0087 with the lowest in clone CIP 4400168 and the difference was highly significant (Table 46). The mean scion effect in clone TIS.86/0356 (4.6) was significantly higher than in the other clones.

4.2.19 Tuber Length

The longest tubers were produced when clone Ex-Igbariam as stock was combined with clone TIS.2532.OP.1.13 as scion. The combination of clones TIS.87/0087 (stock) and TIS.86/0356(scion) resulted in the production of the shortest tubers (Table 47).

Clone CIP 4400168 had a significantly higher mean stock effect (P=0.05) on tuber length than the other clones. There was no significant difference in the mean scion effects (Table 47).

4.2.20 Tuber Girth

The largest tubers, with a mean tuber girth of 24.1cm, were produced in the graft-combination of clone TIS.2544 Rusanya 1.5 as stock and clone CIP 4400168 as scion; combination of clones Ex-Igbariam (stock) and TIS.86/0356 (scion) resulted in the production of the smallest tubers with a mean tuber girth of 11.0cm (Table 48).

The highest mean stock effect on tuber girth (19.2cm) was observed in clone TIS.2544 Rusanya 1.5 and this was significantly different (P=0.05) from the other clones. Clone CIP 4400168 had the highest mean scion effect on tuber girth (19.4cm), which was significantly different (P=0.01) from the other clones (Table 48).

4.2.21 Mean Number of Tubers per Plant

Mean number of tubers produced per plant is shown in Table 49. The self-graft of clone Ex-Igbariam resulted in the highest mean number of tubers per plant (7.4); the combination of clones TIS.2532.OP.1.13 (stock) and TIS.86/0356 (scion) resulted in the production of the lowest number of tubers per plant. The self-grafts of clones Ex-Igbariam, TIS.87/0087 and TIS.2544 Rusanya 1.5 ranked amongst the highest producers of tubers per plant.

Clone TIS.2544 Rusanya 1.5 had the highest mean stock effect on the number of tubers produced per plant (4.8) and this was significantly different (P=0.01) from the other clones. Clone Ex-Igbariam had the highest mean scion effect, although this was not statistically different from the other clones.

4.2.22 Mean Number of Large Tubers (>50mm) per Plant

The highest number of large tubers per plant was observed in the self-graft of clone Ex-Igbariam, the graft-combinations of clones TIS.2544 Rusanya 1.5 (stock) and TIS.2532.OP.1.13(scion) as well as clones TIS.2532.OP.1.13 (stock) and TIS.2544 Rusanya 1.5(scion). The lowest number of large tubers per plant was produced in the graft-combination of clones Ex-Igbariam as stock and TIS.86/0356 as scion (Table 50).

The highest mean stock effect of 0.5 was observed in clone TIS.2544 Rusanya 1.5 with the lowest in clone TIS.87/0087 and the difference was significant at 5% level of probability. The mean scion effect on number of large tubers per plant was significantly higher (P=0.01) in clones Ex-Igbariam, TIS.2532.OP.1.13 and CIP 4400168 than in the other clones (Table 50).

A significant interaction of stock and scion on number of large tubers was observed. The highest mean stock effect was observed in clone TIS.2544 Rusanya 1.5 whereas clones Ex-Igbariam, TIS.2532.OP.1.13 and CIP 4400168 had the highest mean scion effect (Table 50).

4.2.23. Mean Number of Small Tubers (<50mm) per Plant

Mean number of small tubers produced per plant is shown in Table 51. The self-graft of clone Ex-Igbariam produced the highest number of small tubers while the lowest was observed in the graft-combination of clones CIP 4400168 (stock) and TIS.2532.OP.1.13(scion).

Clones Ex-Igbariam and TIS.2544 Rusanya 1.5 had a significantly higher mean stock effect (2.2) on number of small tubers than the other clones. Interaction of stock and scion on mean number of small tubers per plant was significant at 5% level of probability. The highest mean stock effect was observed in clones TIS.2544 Rusanya 1.5 and Ex-Igbariam, followed by TIS.87/0087. On the other hand, the highest mean scion effect was observed in clone Ex-Igbariam and this was followed by clones TIS.87/0087 and TIS.86/0356(Table 51).

4.2.24 Mean Tuberous Root Weight

Mean tuberous root weight was significantly higher in the graft-combination of clones TIS.2532.OP.1.13 (stock) and CIP 4400168 (scion) than in the other grafts (Table 52). The combination of clones Ex-Igbariam (stock) and TIS.86/0356 (scion) resulted in the production of tubers with the lowest mean tuberous root weight of 68.1g.

The highest mean stock effect of 207.1g was observed in TIS.2532.OP.1.13 while the lowest (115.2g) was observed in TIS.87/0087. Clones CIP 4400168 and TIS.86/0356 had the highest and the lowest mean scion effects, respectively. Differences in the mean stock and mean scion effects were highly significant (P=0.01)(Table 52).

4.2.25 Dry Matter Content(DM%)

The highest DM% of 35.6 was observed in the graft-combination of clones Ex-Igbariam (stock) and TIS.2532.OP.1.13(scion) and this was significantly different from the lowest DM% (22.2) observed when clone TIS.87/0087 as stock was combined with clone TIS.86/0356 as scion (Table 53).

Clone Ex-Igbariam produced tubers with both the highest mean stock effect(33.3%) and the highest mean scion effect(30.7%) on dry matter content and this was significantly different from the other clones (Table 53).

Clone TIS.87/0087 had the lowest mean stock effect while clone TIS.86/0356 had the lowest mean scion effect. There was no interaction between stock and scion.

4.2.26 Total Tuber Yield

The self-grafts of clones Ex-Igbariam, TIS.87/0087, TIS.2532.OP.1.13 and TIS.2544 Rusanya 1.5 ranked amongst the highest yielders. The lowest tuber yield of 6.3t/ha was observed in the graft between clone TIS.2532.OP.1.13 as stock and clone TIS.87/0087 as scion (Table 54).

Clone TIS.2544 Rusanya 1.5 had a very large sink capacity with a mean stock effect of 28.5t/ha. Clone CIP 4400168 had a very good source potential with a mean scion effect of 24.6t/ha; clone TIS.86/0356 had the lowest mean scion effect (source potential) of 12.3t/ha. Differences in mean stock and mean scion effects were significant (Table 54).

A significant stock and scion interaction on total tuber yield was observed. Whereas clone TIS.2544 Rusanya 1.5 had the highest mean stock effect, clone CIP 4400168 had the highest mean scion effect on tuber yield (Table 54).

4.2.27 Dry Tuberous Root Yield

Table 54 shows dry tuberous root yield of grafts of six sweet potato clones. Like total tuber yield, the self-grafts of clones Ex-Igbariam, TIS.2544 Rusanya 1.5, TIS.87/0087 and TIS.2532.OP.1.13 produced very high dry tuberous root yields of 352.3, 210.5, 197.9 and 181.2g/plant, respectively. The lowest dry tuberous root yield of 62.5g/plant was produced when clone TIS.2532.OP.1.13 as stock was grafted with clone TIS.87/0087 as scion.

Again, clone TIS.2544 Rusanya 1.5 showed a very large sink capacity with a mean stock effect of 225.8g/plant while clone TIS.87/0087 showed the smallest sink capacity. Clone Ex-Igbariam with a mean scion effect of 244.8g/plant demonstrated a very good source potential while clone TIS.86/0356 showed a poor source potential with a mean scion effect of 99.3g/plant. There was no interaction between source and sink.

4.2.28 **Response of Sink to Source and of Source to Sink**

The b_j and b_i values were computed, as shown in Table 55. The bj values(response of sink to source) were plotted against the respective sink capacities (Figure 24). Although clone TIS.2544 Rusanya 1.5 showed a very large sink capacity, clone TIS.2532.OP.1.13 showed the highest response of sink to source with a regression co-efficient of 2.00, and was followed by clone Ex-Igbariam. Clone TIS.87/0087 showed the lowest response of sink to source.

The b_i values, which measure the degree of response of source to sink, were plotted against the respective source potentials (Figure 25). Although clone Ex-Igbariam had the highest source potential with respect to dry tuberous root yield, clone CIP 4400168 showed the highest response of source to sink, with a regression coefficient of 1.65. This was followed by clones TIS.2532.OP.1.13 and TIS.2544 Rusanya 1.5. Clone TIS.87/0087 showed the lowest response of source to sink (Table 55).

The dry tuberous yields of the self-grafts were plotted against the respective source potentials (mean scion effects) and sink capacities (mean stock effects). Figure 26 shows that clone TIS.86/0356 had a low tuber yield and that source potential and sink capacity of this clone were different. Clones CIP 4400168, TIS.2532.OP.1.13 and TIS.87/0087 had medium tuber yields and their source potentials and sink capacities were not very different. Clone Ex-Igbariam had the highest dry tuberous root yield, followed by clone TIS.2544 Rusanya 1.5. Their source potentials and sink capacities were also quite different.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

Vine-length varied with genotypes in both years of experimentation. Generally, vines were longer in 2000 than in 2001. Kumar *et al*. (1993), Chandra and Tiwari (1987) and Nair and Nair (1992) had reported a similar observation. Leopold and Kriedman (1975) noted that variations in vine length might be due to the inherent genetic make-up of the varieties, which influences the morphological expression through the activities of endogenous Gibberellin level. Nawale and Salvi (1983) observed that high rainfall, coupled with less sunshine hours and high humidity might be responsible for excessive shoot growth.

Like vine length, petiole length varied with genotypes in both 2000 and 2001 trials, and petioles were generally longer in 2000 than in 2001. Clone CIP 4400168 produced petioles which were longer than those of the other clones in both years. Variations in petiole length could be attributed to the differences in climatic and edaphic conditions, as reported by Stell *et al*. (1965) and Chandra and Tiwari (1987).

The significant positive correlation of petiole length with total tuber yield in the present study confirmed the observations of Chandra and Tiwari (1987), Hrishi and Nair (1973), Thamburaj and Muthukrishnan (1976) and Kamalan *et al*. (1977). Naskar *et al*. (1986) noted that selection based on length of tubers and length of petiole appeared to be most desirable for improving sweet potato yield.

Mean number of branches per plant was generally higher in 2000 than in 2001 and varied from one genotype to another. Clone TIS.2271 maintained the highest number of branches per plant. This agrees with Kumar *et al*. (1993) who reported variation in the mean number of branches per plant. Similarly, Chandra and Tiwari (1987) reported that the number of branches produced by a plant is primarily a genetic character and that it is influenced by Indole Acetic Acid (IAA) in the plant as well as prevailing environmental conditions.

Mean number of branches and tuber yield were positively correlated. Naskar *et al*. (1986) also reported a high positive correlation between number of branches and tuber yield. Number of branches contributes to the total dry matter produced by the plant, which may in turn lead to a higher yield.

Plants appeared more vigorous in 2000 than in 2001, although variations amongst genotypes with respect to vigour were not very wide compared with the other characters examined. The positive relationship observed between vigour and total yield indicate that plants that grow vigorously had a tendency to produce more assimilates to be made available for tuberous root development in sweet potato.

Results of the grafting study showed that in most graft-combinations leaf area increased with the age of the plant up to 90 DAP, after which it decreased. Irrespective of whether clones Ex-Igbariam and CIP 4400168 were used as stock or scion graft-combinations involving them resulted in a very high leaf area. The results indicate that variations in total leaf area of a plant depend on the number and/or size of the leaves. Whereas clone Ex-Igbariam had fewer but larger leaves, clone CIP 4400168 had many but narrower leaves. These clones had relatively high source potentials and could, therefore, be exchanged with clones that have poor source potentials through reciprocal grafting.

Results of 2000 and 2001 studies indicate that LAI increased with time in all the clones and that the peak period varied with genotype. Genotypes that peaked earlier were observed to produce less tuber yield than those that maintained high LAI values over a longer period. In clone TIS.86/0356, LAI increased throughout the sampling period and the clone ranked as one of the highest yielders in both years. Forbes and Watson (1992) observed that to increase yield in many crop plants, it might be necessary not only to increase LAI but to also maintain the increased value throughout the growing period. However, increasing LAI beyond the optimum may lead to undue competition between the shoot and the root system. This may explain the negative correlation of LAI with tuber yield in the present study.

In both years leaf area duration varied with genotypes, being highest in clones CIP 4400168 and Ex-Igbariam in 2000 and 2001, respectively. Clones with shorter LAD appeared to have lower yields than those with longer durations. Watson (1952) noted that if net assimilation rate remained constant, dry matter production of different crops would be proportional to leaf area duration. Forbes and Watson (1992) noted that in crops such as sugar beet, which maintain LAI at around optimum levels for longer periods of time than cereals, yield is related not simply to LAI at any one time but to the product of LAI and the time for which it is maintained.

In both 2000 and 2001 trials, crop growth rate increased with the age of the plant in all the clones. It also varied with genotype, being higher in the high- than in the low-yielding ones, especially in the 2001 trial. In the grafting study of the 2003, CGR and NAR increased with the crop age up to 90 DAP and thereafter decreased. In graft-combinations where CGR increased throughout the growing season, NAR also increased. Forbes and Watson (1992) noted that a high CGR, whether resulting from a high LAI or NAR or a combination of both, tends to lead to high yields in most crop plants, especially cereals, where mutual shading is low.

Net assimilation rate varied with genotype and time in both 2000 and 2001 studies. In most clones it appeared to be higher at the early and later stages of growth. Forbes and Watson (1992) have reported that as the cropping season progresses, light interception improves and the rate of dry matter production goes up. But due to mutual shading, photosynthesis no longer exceeds respiration in the older leaves, which then cease to be net producers of dry matter. Tsuno and Fujise (1963) also observed that when LAI is large, as it is in fertile soils, NAR is correspondingly smaller because of mutual shading.

The results of dry matter partitioning in clone TIS.8441 in both years showed that the clone has a good sink, even though its capacity as reflected in the final yield, appeared to have been limited by its poor source. Hahn (1977b) and Namo and Christopher (2002) observed that sweet potato clones with high source potential show greater responses of source to sink than those whose source potentials are poor.

In clone Ex-Igbariam, only half of the total dry matter produced at the end of the growing season was in the tubers in both 2000 and 2001 trials. This may suggest that this clone is a medium yielder.

In both years dry matter of leaves and stems as well as total dry matter per plant increased with delay in harvesting in clone TIS. 86/0356 and the final DM was greater in 2000 than in 2001. However, the proportion of dry matter in the leaves and the stems decreased with delay in harvesting with a corresponding increase in the proportion left in the tubers. By 94 DAP and 112 DAP in 2000 and 2001, respectively, leaves and stems contributed about 37% of the total dry matter in 2000 and 31% in 2001 while tubers accounted for 63% and 69%, respectively. These results indicate that TIS86/0356 has a high sink capacity.

In clone TIS.82/0270.OP.1.85, the proportion of DM in the leaves and stems was reduced from 83.8% at 59DAP to 36.4% at 94 DAP, whereas DM% in the tubers increased from 16.2% at 59DAP to 63.6% at 94 DAP. This suggests that the clone has a good sink capacity coupled with a good source potential as reflected in its total tuber yield in the 2000 trial.

In both years a higher proportion of dry matter was distributed to the tubers than in the stems and leaves in clone TIS.86/0306, and the clone ranked as one of the high yielders in both years. This would indicate that the clone had a good source as well as a good sink.

A look at the distribution pattern of dry matter in clone TIS.2271 shows that the proportion of dry matter in the leaves and the stems decreased with time whereas that of the tubers increased in both years. The clone ranked amongst medium yielders in both years, indicating that both its source potential and sink capacity were fairly good.

While the proportion of dry matter in the leaves and stems dropped with time, that of the tubers increased with delay in harvesting in both years of experimentation in clone TIS.2532.OP.1.13. However, its total tuber yield was not as high as might be expected, perhaps, due to its poor source potential.

The leaves and stems contributed about 63% of DM compared with 37% DM in the tubers at the final harvest in clone CIP4400168 in 2000 trial. In 2001, the %DM in the tubers at the final harvest was 45.0 compared with 55.0 in the leaves and stems. The results indicate that the apparently high source potential of CIP4400168 was limited by its poor sink capacity as reflected in the final tuber yield in both years.

A prominent feature in the dry matter distribution pattern in clone TIS.82/0070.OP.120 in the 2000 trial was the decrease in the proportion of DM in the leaves and stems with time in favour of tuberous root development. Results of the final tuber yield indicate that this clone could be ranked amongst the high-yielding ones.

In clone TIS.8/637, the proportion of dry matter in the leaves and stems at the final harvest (70.8%) was much higher than in the tubers (29.2%). This would indicate that the yielding ability of the clone might have been hampered by a poor sink capacity.

In clone NRCRI/UN/13, more dry matter was left in the leaves and stems than in the tubers by 94 DAP in 2000, resulting in a very low yield. The clone was most likely limited by a poor sink capacity.

Although total dry matter increased with time in both years in clone TIS.2544 Rusanya 1.5, the proportion of dry matter in the leaves and stems was as much as in the tubers. This may suggest that the clone has fairly good source potential and sink capacity.

The dry matter distribution pattern in TIS.87/0087 in 2001 indicated that most of the dry matter developed was transferred to the tubers at the end of the season. Its ability to capture assimilates and retain same over time might be responsible for its high-yield performance as reflected in the total tuber yield in 2001.

In the farmers' variety the leaves and the stems constituted about 32.2% of the total DM at 112 DAP while tubers alone constituted about 67.9%. The clone ranked second best in total tuber yield in 2001. While it may be expected that clones with a good source potential like CIP4400168 would have produced high tuberous root yields, this was not always the case in these studies. Dahniya (1979) observed that it is difficult to determine whether the source or the sink regulates tuberous root production because in many cases the demand for photosynthates exerts a clear feed-back effect on photosynthetic activity. Hozyo *et al*. (1971) showed that late tuberous root developing abilities of sweet potato clones were determined by their stocks and not by scions. Hozyo and Park (1971), Hozyo and Kato (1973) and Hozyo (1973) have demonstrated that the root-developing ability affects the photosynthetic activity in the source, and concluded that the clones with large sink capacity showed greater responses of source to sink than clones with poor sink capacities. Hahn (1977b) observed that clones with greater source potential showed greater response of source to sink, but that sink capacity affects yields more than the source potential. Hozyo and Kato (1976a) and Kato and Hozyo (1978) have demonstrated that the tuber – developing ability affects translocation speed and that sink has a regulatory mechanism in dry matter yield production. It thus implies that to maximize tuberous yield production in sweet potato there has to be a balance between source potential and sink capacity.

Results of the grafting experiment indicate that total dry matter accumulated increased with the age of the plant throughout the growing season in nearly all the grafts. Total dry matter in graft-combinations with clone CIP 4400168 as scion was generally higher than those involving the other clones. The proportion of dry matter in laminae, petioles and stems decreased whereas that of the tubers increased with time in all the crosses.

Whether clone CIP 4400168 was used as stock or scion, the proportion of dry matter in the above-ground portions was much higher than that left in the tubers. Conversely, in clone TIS.87/0087, dry matter accumulated in the tubers was much higher at the end of the growing season.

The results showed that clone CIP 4400168 did not only demonstrate a poor sink capacity, but the translocation speed in grafts involving the clone was rather slow. Hozyo and Kato (1976a) have shown that the tuber-developing ability affects translocation speed and that sink not only affects translocation, but has a regulatory mechanism in dry matter yield production.

Evans (1975) noted that the pattern of assimilate distribution is determined by the photosynthetic efficiency on the one hand, and the strength and proximity of the various sinks, modified to some extent by the pattern of vascular connections. The pattern of vascular connections can, therefore, be restrictive in spite of dominance by the sink, because many crops show little lateral movement of assimilate out of the phloem.

Less dry matter was partitioned to the tubers when the clones were planted without grafting than when they were grafted before planting. Dahniya (1979) noted that the high tuber production in sweet potato grafts was likely due to the higher crop growth rate and tuber bulking rate.

Harvest index increased with crop age in all the clones investigated in 2000 and 2001 studies, and the peak period varied with genotype. Clones that peaked early (e.g. Ex-Igbariam and TIS.8441) in 2000 appeared to be early maturing, whereas late-maturing clones, like TIS. 86/0306, TIS.2271, CIP4400168, NRCRI/UN/13 and TIS.2544 Rusanya 1.5 peaked much later. The same trend was observed in the 2001 study, when TIS.8441 and Ex-Igbariam peaked earlier than the rest of the clones. Results of grafting study showed that harvest index increased throughout the growing season in nearly all graft-combinations. Crosses involving clone TIS.87/0087 as stock had the highest harvest index at each harvest time except at 45 DAP.

Harvest index has been defined as the fraction of the total dry matter that is stored in the harvestable plant parts (Donald, 1962). Forbes and Watson (1992) defined harvest index or utilizable fraction as the ratio of yield to above-ground biomass, ignoring roots, the weight of which is very difficult to measure. Harvest index is a useful measure in comparing varieties of one crop, or in comparing the performance of one variety under different conditions, while utilizable fraction is a more meaningful basis for comparison of different types of crop.

In the current study, harvest index was negatively, albeit non-significantly, correlated with total tuber yield. This observation contrasts with the findings of Singh and Stoskopf (1971) and Ogunbodede (1988) who reported a high positive correlation between harvest index and grain yield in cereals as well as seed yield in cowpea, respectively. The non-significant correlation observed in the present study might have been due to the keen competition between the shoot and root for assimilates long after the commencement of tuberization. Under such circumstances, Wareing and Patrick

(1975) noted that the shoot seemed to have advantage over the root system. Breeders have used harvest index as an important criterion in the search for higher-yielding genotypes (Johnson and Major, 1979).

The highest mean number of tubers per plant was produced by clones TIS.2271 in 2000 and Ex-Igbariam in 2001, while clones NRCRI/UN/13 and TIS.2544 Rusanya 1.5 produced the lowest in 2000 and 2001, respectively. Mean number of tubers per plant was generally higher in 2000 than in 2001, suggesting that tuber number varies with genotype and environment. Chandra and Tiwari (1987) as well as Nair and Nair (1992) reported variations in the number of tubers per plant with genotypes. Wellensiek (1929) and Mes and Menge (1954) observed that the production of higher tuber number per plant might be due to higher tuber stimulus occasioned by environmental conditions.

Clones NRCRI/UN/13 and TIS.87/0087 produced the largest tubers in 2000 and 2001, respectively; tubers were generally larger in 2000 than in 2001. Kumar *et al*. (1993) observed that genotypes differ significantly with respect to their stability for tuber weight. Chandra and Tiwari (1987) reported that tuberous root girth and fresh weight per tuber are responsible for maximum yield in sweet potato, and that the importance of number of tubers per plant, tuber girth and mean tuberous root weight for increasing yield is greater compared to the other parameters. In this study, fresh weight per tuber and total tuber yield were positively correlated.

Mean tuberous root weight was significantly higher in cross TIS.2532.OP.1.13 (stock) X CIP 4400168 (scion) than in the other crosses in the grafting experiment in 2003. The highest mean stock effect of 207.0g/tuber was observed in clone

TIS.2532.OP.1.13, while CIP 4400168 showed the highest mean scion effect of 203.1g/tuber. The result demonstrates that to obtain large tubers, a good source coupled with a large sink capacity is necessary. Clones CIP 4400168 and TIS.2532.OP.1.13 showed very good source and sink potentials, respectively.

Dry matter percentage varied with genotype in 2000 and 2001, but the variations were more pronounced in 2000 than in 2001 trial. Dry matter content appeared to have been influenced by tuber size. Dry matter percentage and mean tuberous root weight were inversely correlated with total tuber yield. Ifenkwe *et al*. (1974) reported that large tubers tended to have lower dry matter content than the smaller ones.

Results of the grafting study in 2003 indicated that DM% increased up to the end of the growing season and that the highest DM% was observed in graft-combinations involving clone Ex-Igbariam as stock. The results demonstrate that the longer it takes to harvest sweet potato, the higher the dry matter content will be. In other words, the moisture content of the sweet potato tubers decreases as the cropping season progresses. Clone Ex-Igbariam, which maintained a consistently high DM% in this study, could be preferred to the other clones as root stock, especially if the tubers produced are to be used for industrial processing.

The highest tuber yields were observed in clones TIS.86/0356 in 2000 and TIS.87/0087 in 2001, while clones NRCRI/UN/13 and TIS.2544 Rusanya 1.5 had the lowest yields in 2000 and 2001, respectively. Yields were higher in 2000 than in 2001. Chandra and Tiwari (1987), Fielding and Ryder (1995), Sen and Goswami (1990) as well as Nawale and Salvi (1983) also reported variations in tuber yield with genotypes.

Haynes and Wholey (1971) noted that sweet potato crops show a high degree of variability in both total and marketable tuber yields. Carpena *et al*. (1980) noted that tuber yield in sweet potato is very sensitive to environmental changes. A variety that gave an experimental yield of as high as 60t/ha in one season was reported to have produced less than 10t/ha in another season. Nwokocha (1992) noted that if sweet potato was grown on the same soil continually or on a soil on which another tuber crop had previously been cultivated, yield could be reduced. This may explain the drastic reduction in tuber yields between 2000 and 2001; the site that was used for the 2001 trial was also used for the cultivation of sweet potato in 2000.

In the 2000 study large tubers constituted about 85% of the total tuber yield while small tubers constituted about 15%. In 2001 the proportion of small tubers (54%) was higher than that of the large tubers (46%). The results show that large tubers contribute more to the total tuber yield in sweet potato than the small tubers. Selection for maximum tuber yield could, therefore, be aimed at clones that produce large tubers.

Results of the grafting study of six sweet potato clones in 2003 showed that there were differences in the source potentials and sink capacities of the clones. Clone TIS.2544 Rusanya 1.5 had a large sink capacity but a poor source; CIP 4400168 had a very high source potential but a poor sink. The results further demonstrate that a clone with a large sink capacity may be limited by a poor source potential. The self-graft of clone TIS.2532.OP.1.13, for example, ranked amongst the highest yielders, but when it was grafted with clone TIS.87/0087 (with a poor source) as scion, the lowest total tuber yield of 6.3t/ha was observed.

The need to balance photosynthetic area and storage root capacity to maximize yield may explain the significant interaction of stock and scion on total tuber yield in the present study. Evans (1975) noted that the production of more assimilates without a corresponding large storage capacity would not increase yield, and that the presence of a large storage capacity without adequate and translocatable assimilate would merely result in harvestable organs that fail or are drastically reduced in size.

Both success and establishment rates during the grafting study were high, ranging from 93.3 to 100.0% for success rate and from 50.0 to 100.0% for establishment rate. The high rate of success in this study indicates that the six clones used showed a high degree of graft-compatibility. The stem diameters of both the stock and the scion were carefully selected to ensure a good match. This allowed for faster healing and recovery of the grafted plants. Also related to grafting success could have been the succulent nature of the stems which facilitated speedy recovery after grafting. Kehr *et al*. (1955) noted that carrying out grafting during a period of rainy or cloudy weather avoids excessive sun-drying of the scions before union takes place. In this study, grafting was carried out in June either in the morning (8.00 – 11.00am) or in the evening (4.00 – 6.00pm), during which time the rains had been fully established in Jos and the intensity of the sun was minimal.

Dahniya (1979) observed that variation in percentage graft success in cassava might be associated with graft-incompatibility resulting from the presence of hydrocyanic acid in the stem tissue. Hartman and Kester (1975) quoted Gur as having observed that the presence of hydrocyanic acid leads to a lack of cambial activity in the graft union with pronounced anatomical disturbance in the phloem and xylem. The phloem tissue is gradually destroyed at and above the graft union and conduction of water and materials is reduced in both the phloem and xylem.

In graft – combinations involving clones Ex-Igbariam or TIS.2544 Rusanya 1.5 as stock, tuber-bulking rate increased throughout the growing season, indicating, perhaps, that these clones have large sink capacities or high translocation rates. Evans (1975) noted that more assimilates without adequate storage capacity would not increase yield, whereas adequate storage capacity without corresponding increase in assimilate would merely result in fruits that fail or are shriveled. The need to balance photosynthetic area and storage capacity has, therefore, been highlighted (Moorby and Milthorpe, 1975).

Flowering score was significantly higher in the self-graft of clone TIS.2532.OP.1.13 than in the other crosses. Clone TIS.2544 Rusanya 1.5 had the highest mean scion effect while clone CIP 4400168 had the lowest. There was no significant difference in the mean stock effect.

Grafting of hard-blooming clones like CIP 4400168 onto easy-blooming clones like TIS.2532.OP.1.13 tended to enhance flowering on the former. Stino and Hassan (1952) made a similar observation and reasoned that a strong flowering stimulus synthesized by the leaves of the easy-blooming varieties was transmitted upwards. However, Kehr *et al*. (1955) noted that a blooming stimulus in the sweet potato was not transmitted across a graft union, or that if transmitted at all, it was not in sufficient amounts to promote flower production.

Results of the study show that pollen fertility ranged from 50.7% in cross CIP 4400168 (stock) x TIS.2544 Rusanya 1.5 (scion) to 100.0% in the self-graft of clone

TIS.87/0087. Pollen fertility appeared to be influenced more by the nature of the root-stock than by the scion. The grafting of clone TIS.2544 Rusanya 1.5 (an easy-blooming clone) onto CIP 4400168 (a hard-blooming clone), for example, resulted in a low pollen fertility.

The highest dry vine yield of 238.5 g/plant was produced in the self-graft of clone CIP 4400168, with the lowest in cross TIS.87/0087 (stock) x TIS.86/0356 (scion). The results indicate that most of the dry matter accumulated in clone CIP 4400168 during the growing season was left in the above-ground parts, as compared to clone TIS.87/0087. The finding also confirms clone CIP 4400168 as having a poor sink capacity. Moorby and Milthorpe (1975) observed that in a tuber crop with a large sink capacity, after tuber initiation the growth of tubers assumes a competitive advantage over the production of new leaves.

The highest root-top ratio of 14.1 was observed in cross TIS.87/0087 (stock) x TIS.86/0356 (scion) while the lowest value of 0.7 was observed in the self-graft of clone CIP 4400168. Again, clone TIS.87/0087 was shown to have a large sink capacity, capturing the greater proportion of the assimilates produced during the growing season. In clone CIP 4400168 most of the dry matter produced was left unconverted so that the top was heavier than the underground portion (tubers) at the end of the growing season. Hozyo and Park (1971) have demonstrated, through reciprocal grafting between high and low-yielding sweet potatoes, that yield is largely sink-determined.

Clone Ex-Igbariam as stock when combined with clone TIS.2532.OP.1.13 as scion produced tubers which were significantly longer than those produced in the other graft-combinations. The largest tubers were produced in the graft involving clones TIS.2544 Rusanya 1.5 (stock) and CIP 4400168 (scion). The highest mean stock effects on tuber length and tuber girth were observed, respectively, in clones CIP 4400168 and TIS.2544 Rusanya 1.5. Clone CIP 4400168 showed the highest mean scion effect on tuber girth. Tuber length, tuber girth and mean number of tubers per plant are believed to be the major components of total tuber yield in sweet potato and appeared to have been influenced by the size and activity of the sink and the source in this study. The interaction of stock and scion on number of tubers per plant shows that source and sink sizes can easily be exchanged through reciprocal grafting in order to increase yield through the increase in number and size of tubers.

Like total tuber yield, clone TIS.2544 Rusanya 1.5 showed a very large sink capacity with a mean stock effect on dry tuberous root yield of 225.8 g/plant, while clone TIS.87/0087 showed the lowest sink capacity (107.6 g/plant). Clone Ex-Igbariam with a mean scion effect of 244.8 g/plant showed a very high source potential; a poor source potential of 99.3 g/plant was observed in clone TIS.86/0356.

Although clone TIS.2544 Rusanya 1.5 showed a very large sink capacity, clone TIS.2532.OP.1.13, with a regression coefficient of 2.00, showed the highest response of sink to source. Clone TIS.87/0087 (b_j=0.31) showed the lowest response of sink to source.

Clone CIP 4400168 (b_i=1.65) showed the highest response of source to sink, even though clone Ex-Igbariam had the highest source potential with respect to dry tuberous root yield. Dahniya (1979) and Hahn (1982) demonstrated that the variety with the largest sink capacity showed the greatest response of sink to source while the variety with the highest source potential showed the greatest response of source to sink. Results of the present study, which concurred with Li and Kao (1990), suggest that the clones with high source potential or large sink capacity do not necessarily have high response of source to sink or of sink to source. It means that the photosynthetic capacity of a clone with a high source potential is unlikely to be altered by the change of the sink capacity. The discrepancy between Hahn's results and this study is possibly due to the different growth periods used. The growth period of Hahn's experiment was 3 months whereas in the present study the growth period was 5 months (July to November, 2003).

CONCLUSION

Results of the trials in 2000 and 2001 indicate that the tuberous root yield of sweet potato varies with genotype and environment. Leaf Area Index (LAI), Leaf Area Duration (LAD) Crop Growth Rate (CGR) and Net Assimilation Rate (NAR) all varied with genotype and time. Crop growth rate was higher in the high than in the low-yielding clones.

Total dry matter, number of tubers per plant and per m^2, mean tuberous root weight as well as final stand count were related to the total tuber yield. Results of dry matter accumulation and partitioning showed that the proportion of dry matter in the leaves and stems decreased with time while that of the tubers increased. In low-yielding clones like CIP 4400168 and NRCRI/UN/13, more dry matter was left in the above-ground portions than in the tubers at the end of the growing season. Such clones appeared to have been limited by poor storage root capacities. It would appear that source potential, sink capacity and the rate of translocation of assimilates from the leaf source to the storage root are limiting factors in the yield potential of sweet potato.

Results of the grafting experiments conducted in 2003 showed that the six sweet potato clones used exhibited a high degree of graft-compatibility. Tuber bulking rate (TBR) appeared to be a function of the storage-root capacity and/or the rate of translocation of photosynthates from the leaf-source to the storage roots.

Harvest index, total dry matter and dry matter content increased up to the end of the growing season in nearly all grafts. Dry matter accumulation in grafts involving clone CIP 4400168 was generally higher than in the other clones. The proportion of dry matter accumulated in the laminae, petioles and stems decreased while that of the tubers increased with the age of the plant. More dry matter was translocated to the tubers when the clones were grafted before planting. The tuber-developing ability of the clones would have been influenced by photosynthetic efficiency, the size and strength of the storage sinks as well as the pattern of vascular connections.

Flowering in sweet potato is believed to be influenced by a flowering stimulus synthesized by the root-stock and transmitted upwards to the scion. The present study indicates, however, that this might not always be so, as evidenced when clone CIP 4400168 (a hard-blooming clone) was grafted onto clone TIS.2544 Rusanya 1.5(an easy-blooming clone) as scion, the result of which was poor flowering.

Tuber length, tuber girth, number of tubers per plant and mean tuberous root weight were influenced by the size and activity of the sink and/or the source. Both total and dry tuberous root yields were shown to be influenced by the photosynthetic area, storage-sink capacity and the rate of translocation of assimilates from the former to the latter. Clone TIS.2532.OP.1.13 showed the highest response of sink to source, even though clone TIS.2544 Rusanya 1.5 had the largest sink capacity. Similarly, whereas clone Ex-Igbariam had the highest source potential with respect to dry tuberous root yield, CIP 4400168 showed the highest response of source to sink. The study shows that the size and activity of the source and the sink as well as the rate of translocation of assimilates from the former to the latter, occasioned by the pattern of vascular connections, are determinant factors in the yield potential in sweet potato.

RECOMMENDATIONS

The study recommends further screening of more locally available clones in different environments. Studies on seed-setting and viability should be undertaken in order to explore the possibility of propagating sweet potato through true potato seeds (TPS). This could result in exchange of genetic materials through hybridization.

SUMMARY OF FINDINGS

Fourteen (14) sweet potato clones, TIS.8441, Ex-Igbariam, TIS.86/0356, TIS.86/0306, TIS.2271, TIS.2532.OP.1.13, CIP 4400168, TIS.2544 Rusanya 1.5, TIS.82/0270.OP.1.85, TIS.82/0070.OP.120, TIS.8/637, NRCRI/UN/13, TIS.87/0087 and a farmers' variety, were screened during the cropping seasons of 2000 and 2001 to evaluate their yield potentials under the Jos-Plateau ecology. In both years the nett plot size measured (3x3)m^2, consisting of three 1m rows each measuring 3 metres. Randomized complete block design with four replications was used. Six out of the fourteen clones, Ex-Igbariam, TIS.87/0087, TIS.2532.OP.1.13, CIP 4400168, TIS.86/0356 and TIS.2544 Rusanya 1.5, were selected for grafting experiment during the 2003 cropping season. Results of the studies revealed that tuberous root yield of sweet potato varies with genotype and with environment. The major factors that influence yield in the sweet potato include leaf area index, leaf area duration, crop growth rate, net assimilation rate, harvest index, tuber bulking rate, final stand count, number of tubers per plant and per unit area and mean tuberous root weight. Total dry matter accumulated increased with the age of the plant and varied with genotype.

The proportion of dry matter in the above-ground portion decreased while that of the tubers increased as the growing season progresses. In low-yielding clones, however, more dry matter was left in the leaves and stems than in the tubers. Results of the grafting experiment showed a high degree of graft-compatibility amongst the clones used. Both total and dry tuberous root yields were influenced by the size and activity of the leaf source and the storage sink as well as rate of translocation of assimilates from the former to the latter. Clones Ex-Igbariam and TIS.2544 Rusanya 1.5 had the highest source potential and largest sink capacity, respectively. However, while clone CIP 4400168 showed the greatest response of source to sink, clone TIS.2532.OP.1.13 showed the greatest response of sink to source. The studies showed that the size and activity of the source and the sink, as well as the rate of translocation of assimilates from the former to the latter are the major limiting factors to the yield potentials in sweet potato. The high-yielding genotypes generally partitioned more photosynthates to the tuberous root than the low-yielding ones. Therefore, selection for clones with large sink capacities and ideal degrees of response of sink to source is possible. In other words, selection for a large sink will, to a certain extent, lead to improvement of translocation capacity and hence higher yield in sweet potato.

CONTRIBUTION TO KNOWLEDGE

Screening for source-sink potentials in some sweet potato clones was undertaken in order to select genotypes with a balanced source-sink relation which could lead to higher yield. The results obtained confirmed some earlier observations made while some offered contrary views to earlier reports. The patterns of dry matter distribution in the clones used in this study showed that the proportion of dry matter in the leaves and stems decreased with the age of the plant while that of the tubers increased. In low-yielding clones, however, this was not the case; a greater proportion of dry matter was left in the above-ground portion than in the tubers, thus corroborating the findings of Mannan *et al*. (1992). The study also revealed the beneficial effect of grafting on the partitioning of dry matter in favour of tuberous root development, as more dry matter was partitioned to the tubers when the clones were grafted than when they were not.

Leaf area index, leaf area duration, crop growth rate and net assimilation rate all varied with genotype and were observed to be generally higher in the high than in the low-yielding clones (Forbes and Watson, 1992). The negative correlation between harvest index and total tuber yield observed in this study contrasted with the observation by Singh and Stoskopf (1971) and Ogunbodede (1988). In the present study, however, the relationship was not significant.

Grafting of hard-blooming clones like CIP 4400168 onto easy-blooming clones like TIS.2532.OP.1.13 enhanced flowering, as observed by Stino and Hassan (1952). There were, however, a few exceptions, as reported by Kehr *et al.* (1955). The study revealed that pollen fertility is influenced by the nature of the root-stock. Tuber-bulking rate, number of tubers per plant, root-top ratio, tuber length, tuber girth and mean tuberous root weight were shown to have been influenced by the size and activity of the storage root. Dry matter content and tuber-size were negatively related as reported by Ifenkwe *et al.* (1974).

The following observations on relationship between source potentials and sink capacities are among the contributions to knowledge in the present study. Both total and dry tuberous root yields were shown to have been influenced by the photosynthetic area, storage sink capacity and the rate of translocation of assimilates from the leaf-source to the storage root. However, whereas Dahniya (1979) and Hahn(1982) reported that a clone with a high source potential or large sink capacity showed the greatest response of source to sink or of sink to source, the present study made a contrary observation. For example, although clone Ex-Igbariam had the highest source potential, CIP 4400168 showed the greatest response of source to sink. On the other hand, clone TIS.2532.OP.1.13 showed the greatest response of sink to source, even though clone TIS.2544 Rusanya 1.5 had the largest sink capacity.

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APPENDIX III. Field Layout for 2003 Grafting Experiment

REPLICATE ONE			REPLICATE TWO		
	GRAFT COMBINATION			GRAFT COMBINATION	
PL. No	STOCK	SCION	PL. No	STOCK	SCION
1	EX-IGBARIAM	TIS.87/0087	1	TIS.2544 Rusanya 1.5	EX-IGABRIAM
2	TIS.2532.OP.1.13	TIS.2532.OP.1.13	2	TIS.86/0356	CIP 4400168
3	TIS.87/0087	CIP 4400168	3	TIS.2532.OP.1.13	TIS.86/0356
4	TIS.2532.OP.1.13	TIS.87/0087	4	TIS.87/0087	EX-IGABRIAM
5	CIP 4400168	TIS.2532.OP.1.13	5	TIS.87/0087	TIS.2532.OP.1.13
6	CIP 4400168	CIP 4400168	6	CIP 400168	TIS.2532.OP.1.13
7	TIS.2544 Rusanya 1.5	TIS.2544 Rusanya 1.5	7	EX-IGABRIAM	NON-GRAFT
8	CIP 4400168	TIS.86/0356	8	EX-IGBARIAM	CIP 4400168
9	TIS.86/0356	NON-GRAFT	9	TIS.87/0087	TIS.2544 Rusanya 1.5
10	TIS.87/0087	TIS.2532.OP.1.13	10	TIS.2532.OP.1.13	NON-GRAFT
11	TIS.86/0356	TIS.2544 Rusanya 1.5	11	CIP 4400168	NON-GRAFT
12	TIS.2544 Rusanya 1.5	EX-IGBARIAM	12	TIS.86/0356	TIS.2532.OP.1.13
13	TIS.86/0356	EX-IGBARIAM	13	TIS.2544 Rusanya 1.5	CIP 4400168
14	TIS.87/0087	TIS.2544 Rusanya 1.5	14	TIS.2544 Rusanya 1.5	TIS.86/0356
15	TIS.86/0087	EX-IGBARIAM	15	EX-IGBARIAM	TIS.86/0356
16	EX-IGBARIAM	CIP 4400168	16	EX-IGBARIAM	TIS.2544 Rusanya 1.5
17	EX-IGBARIAM	TIS.2544 Rusanya 1.5	17	TIS.86/0356	EX-IGBARIAM
18	TIS.2532.OP.1.13	EX-IGBARIAM	18	TIS.232.OP.1.13	CIP 4400168
19	TIS.86/0356	CIP 4400168	19	TIS.87/0087	TIS.87/0087
20	TIS.87/0087	TIS.87/0087	20	TIS.86/0356	TIS.86/0356
21	CIP 4400168	NON-GRAFT	21	TIS.2544 Rusanya 1.5	TIS.2532.OP.1.13
22	TIS.2544 Rusanya 1.5	TIS.86/0356	22	TIS.87/0087	CIP 4400168
23	EX-IGBARIAM	NON-GRAFT	23	TIS.87/0087	TIS.86/0356
24	TIS.2532.OP.1.13	TIS.2544 Rusanya 1.5	24	EX-IGBARIAM	EX-IGBARIAM
25	TIS.2544 Rusanya 1.5	NON-GRAFT	25	TIS.2544 Rusanya 1.5	NON-GRAFT
26	TIS.2544 Rusanya 1.5	TIS.87/0087	26	TIS.2532.OP.1.13	TIS.2544 Rusanya 1.5
27	CIP 4400168	EX-IGBARIAM	27	TIS.86/0356	TIS.87/0087
28	TIS.2532.OP.1.13	CIP 4400168	28	TIS.2532.OP.1.13	EX-IGBARIAM
29	TIS.2532.OP.1.13	TIS.86/0356	29	TIS.2532.OP.1.13	TIS.2532.OP.1.13
30	CIP 4400168	TIS.87/0087	30	EX-IGBARIAM	TIS.2532.OP.1.13
31	TIS.2532.OP.1.13	TIS.2532.OP.1.13	31	TIS.86/0356	TIS.2544 Rusanya 1.5
32	CIP 4400168	TIS.544 Rusanya 1.5	32	TIS.2544 Rusanya 1.5	TIS.87/0087
33	TIS.2532.OP.1.13	NON-GRAFT	33	CIP 4400168	TIS.86/0356
34	TIS.86/0356	TIS.86/0356	34	CIP 4400168	EX-IGBARIAM
35	EX-IGBARIAM	TIS.2532.OP.1.13	35	TIS.87/0087	NON-GRAFT
36	TIS.86/0087	TIS.86/0356	36	TIS.2532.OP.1.13	TIS.87/0087
37	TIS.86/0356	TIS.87/0087	37	CIP 4400168	TIS.87/0087
38	EX-IGBARIAM	TIS.86/0356	38	EX-IGBARIAM	TIS.87/0087
39	TIS.86/0356	TIS.2532.OP.1.13	39	TIS.2544 Rusanya 1.5	TIS.2544 Rusanya 1.5
40	TIS.2544 Rusanya 1.5	CIP 4400168	40	TIS.86/0356	NON-GRAFT
41	EX-IGBARIAM	EX-IGBARIAM	41	CIP 4400168	CIP 4400168
42	TIS.87/0087	NON-GRAFT	42	CIP 4400168	TIS.2544 Rusanya 1.5

APPENDIX III Continued

REPLICATE THREE			REPLICATE FOUR		
GRAFT COMBINATION			GRAFT COMBINATION		
PL. No	STOCK	SCION	PL. No	STOCK	SCION
1	EX-IGBARIAM	CIP 4400168	1	EX-IGBARIAM	TIS.2532.OP.1.13
2	TIS.2544 Rusanya 1.5	TIS.87/0087	2	CIP 4400168	CIP 4400168
3	TIS.86/0356	TIS.86/0356	3	TIS.86/0356	TIS.86/0356
4	TIS.87/0087	TIS.2544 Rusanya1.5	4	CIP 4400168	NON-GRAFT
5	CIP 4400168	EX-IGBARIAM	5	EX-IGBARIAM	TIS.86/0356
6	TIS.86/0356	EX-IGBARIAM	6	EX-IGBARIAM	EX-IGBARIAM
7	TIS.2544 Rusanya 1.5	EX-IGBARIAM	7	TIS.2532.OP.1.13	TIS.2532.OP.1.13
8	TIS.86/0356	TIS.87/0087	8	TIS.87/0087	TIS.2544 Rusanya 1.5
9	TIS.86/0356	TIS.2532.OP.1.13	9	TIS.87/0087	CIP 4400168
10	CIP 4400168	CIP 4400168	10	TIS.87/0087	TIS.2532.OP.1.13
11	TIS.2532.OP.1.13	EX-IGBARIAM	11	TIS.2544 Rusanya 1.5	NON-GRAFT
12	TIS.86/0356	CIP 4400168	12	TIS.87/0087	TIS.86/0356
13	TIS.86/0356	TIS.2544 Rusanya 1.5	13	TIS.2532.OP.1.13	CIP 4400168
14	EX-IGBARIAM	EX-IGBARIAM	14	TIS.2532.OP.1.13	EX-IGBARIAM
15	EX-IGBARIAM	TIS.87/0087	15	TIS.86/0356	TIS.2544 Rusanya 1.5
16	TIS.87/0087	NON-GRAFT	16	TIS.86/0356	NON-GRAFT
17	EX-IGBARIAM	TIS.2544 Rusanya 1.5	17	EX-IGBARIAM	TIS.2544 Rusanya 1.5
18	EX-IGBARIAM	NON-GRAFT	18	CIP 4400168	TIS.86/0356
19	CIP 4400168	NON-GRAFT	19	TIS.86/0356	TIS.87/0087
20	TIS.2544 Rusanya 1.5	NON-GRAFT	20	EX-IGBARIAM	CIP 4400168
21	TIS.87/0087	EX-IGBARIAM	21	TIS.87/0087	EX-IGBARIAM
22	TIS.2544 Rusanya 1.5	TIS.2544 Rusanya 1.5	22	TIS.2532.OP.1.13	TIS.86/0356
23	TIS.2532.OP.1.13	TIS.87/0087	23	TIS.87/0087	NON-GRAFT
24	TIS.2532.OP.1.13	TIS.2544 Rusanya 1.5	24	CIP 4400168	EX-IGBARIAM
25	TIS.86/0356	NON-GRAFT	25	EX-IGBARIAM	TIS.87/0087
26	TIS.2532.OP.1.13	TIS.86/0356	26	CIP 4400168	TIS.2532.OP.1.13
27	CIP 4400168	TIS.87/0087	27	TIS.2544 Rusanya 1.5	TIS.86/0356
28	CIP 4400168	TIS.2544 Rusanya 1.5	28	TIS.2544 Rusanya 1.5	CIP 4400168
29	TIS.2532.OP.1.13	NON-GRAFT	29	TIS.2544 Rusanya 1.5	EX-IGBARIAM
30	TIS.2532.OP.1.13	CIP 4400168	30	TIS.2532.OP.1.13	NON-GRAFT
31	TIS.2544 Rusanya 1.5	TIS.2532.OP.1.13	31	TIS.2544 Rusanya 1.5	TIS.2532.OP.1.13
32	EX-IGBARIAM	TIS.86/0356	32	TIS.86/0356	TIS.2532.OP.1.13
33	CIP 4400168	TIS.2532.OP.1.13	33	TIS.2544 Rusanya 1.5	TIS.2544 Rusanya 1.5
34	TIS.2532.OP.1.13	TIS.2532.OP.1.13	34	CIP 4400168	TIS.2544 Rusanya 1.5
35	CIP 4400168	TIS.86/0356	35	EX-IGBARIAM	NON-GRAFT
36	TIS.87/0087	TIS.86/0356	36	TIS.2532.OP.1.13	TIS.2544 Rusanya 1.5
37	TIS.87/0087	CIP 4400168	37	CIP 4400168	TIS.87/0087
38	TIS.2544 Rusanya 1.5	CIP 4400168	38	TIS.2532.OP.1.13	TIS.87/0087
39	TIS.87/0087	TIS.2532.OP.1.13	39	TIS.86/0356	EX-IGBARIAM
40	TIS.2544 Rusanya 1.5	TIS.86/0356	40	TIS.86/0356	CIP 4400168
41	TIS.87/0087	TIS.87/0087	41	TIS.2544 Rusanya 1.5	TIS.87/0087
42	EX-IGBARIAM	TIS.2532.OP.1.13	42	TIS.87/0087	TIS.87/0087

Appendix IV: Meteorological Data for year 2000

	CLIMATIC FACTOR					
	RAINFALL[1]	RELATIVE[1]	TEMPERATURE(°C)[1]		SOLAR RADIATION[1]	SUNSHINE[2]
MONTH	(mm)	HUMIDITY(%)	MAXIMUM	MINIMUM	(J/cm²/day)	HOURS
JAN	0.0	20.48	27.76	12.15	17.86	7.6
FEB	0.0	14.24	27.61	13.07	17.31	5.4
MAR	5.9	25.73	30.10	16.83	18.79	5.8
APR	56.5	60.56	31.26	19.06	16.24	6.7
MAY	192.2	71.19	28.35	18.72	16.77	6.6
JUN	402.0	72.36	24.57	17.69	12.89	4.9
JUL	180.5	76.58	23.46	17.01	9.93	3.8
AUG	485.0	78.93	24.39	16.35	12.39	4.2
SEP	259.9	69.97	25.04	16.60	15.14	8.3
OCT	29.9	57.35	26.12	16.19	17.22	6.5
NOV	0.0	20.60	28.28	13.24	20.18	8.6
DEC	0.0	21.90	28.55	11.19	18.64	7.4
TOTAL	1611.9	589.89	325.49	188.10	193.36	75.8
MEAN	1 34.33	49.16	27.12	15.68	16.11	6.32

Appendix V: Meteorological Data for year 2001

	CLIMATIC FACTOR					
	RAINFALL[1]	RELATIVE[1]	TEMPERATURE(°C)[1]		SOLAR RADIATION[1]	SUNSHINE[2]
MONTH	(mm)	HUMIDITY(%)	MAXIMUM	MINIMUM	(J/cm²/day)	HOURS
JAN	0.0	15.23	28.05	9.91	19.79	8.1
FEB	0.0	12.46	28.85	13.18	19.52	7.2
MAR	0.0	14.58	31.93	17.33	20.82	7.2
APR	68.2	54.00	29.74	18.20	15.62	5.1
MAY	172.7	69.39	27.47	18.43	15.86	5.5
JUN	201.1	76.30	24.79	16.85	14.63	5.2
JUL	200.8	80.55	23.74	16.57	11.90	5.0
AUG	340.7	83.70	23.10	16.67	12.44	4.1
SEP	185.8	84.50	25.51	16.62	14.23	5.1
OCT	2.5	86.77	26.60	14.76	19.07	5.5
NOV	0.0	17.70	28.46	12.42	19.68	8.5
DEC	0.0	16.00	28.48	12.61	19.48	6.7
TOTAL	1171.8	611.18	326.72	183.55	203.04	73.2
MEAN	97.65	50.93	27.23	15.30	16.92	6.10

Source: [1] Irish Potato Programme, Kuru, Plateau State
(Lat. 09°44′N, Long. 08°47′E, Altitude 1,293.2m amsl)

[2] Department of Geography and Planning, University of Jos, Jos, Nigeria
(Lat. 09°57′N, Long. 08°53′E, altitude 1,159m amsl)

APPENDIX VI: Meteorological Data for Year 2003

CLIMATIC FACTOR

MONTH	RAINFALL[1] (mm)	REL. HUMIDITY[1] (%)	TEMP. (°C)[1] MAX	MIN	SOLAR RADIATION[2] J/cm²/day	SUNSHINE[2] HOURS
JAN	0.0	18.90	29.12	11.47	16.0	7.9
FEB	0.0	12.60	31.20	14.18	19.2	8.5
MAR	0.0	44.40	31.83	15.49	19.0	5.8
APR	65.6	64.30	29.57	18.13	13.1	3.5
MAY	212.5	66.19	29.73	17.27	18.2	3.9
JUN	196.8	79.69	25.10	16.28	14.1	2.2
JUL	178.1	81.73	24.96	16.02	12.9	2.0
AUG	320.5	81.74	24.29	15.75	12.2	1.9
SEPT	220.5	74.10	26.05	15.70	15.6	2.2
OCT	32.3	63.00	26.82	15.22	17.9	3.2
NOV	5.1	32.43	29.17	12.57	17.2	4.4
DEC	0.0	21.46	28.46	10.31	16.9	4.2
TOTAL	1231.4	640.54	336.30	178.39	192.3	49.7
MEAN	102.6	53.38	28.03	14.87	16.0	4.1

SOURCE: [1] Irish Potato Programme, Kuru, Plateau State.
(Lat. 09°44′N, Long. 08°47′E, Altitude 1,293.2m amsl)

[2] Department of Geography and Planning, University of Jos, Jos, Nigeria.(Lat. 09°57′N, Long. 08°53′E, Altitude 1,159m amsl)

Appendix VIIa: Analysis of Variance for Vine Length in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	34826.82				
Treatment	11	31423.35	2856.67	18.47**	2.26	3.18
Replication	2	1068.42	534.21	3.45*	3.44	5.72
Error	22	3403.47	154.70			

Appendix VIIb: Analysis of Variance for Vine Length in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	20365.19				
Treatment	9	16092.42	1788.05	8.46**	2.46	3.60
Replication	2	469.58	234.79	1.11	3.55	6.01
Error	18	3803.19	211.29			

*1 Significant at P = 0.05

** Significant at P = 0.01

Appendix VIIIa: Analysis of Variance for Petiole Length in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	1%
Total	35	799.80				
Treatment	11	629.84	57.26	9.03**	2.26	3.18
Replication	2	30.40	15.20	2.39	3.44	5.72
Error	22	139.56	6.34			

Appendix VIIIb: Analysis of Variance for Petiole Length in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	1%
Total	29	319.85				
Treatment	9	215.00	23.89	4.34**	2.46	3.60
Replication	2	5.78	2.89	0.53	3.55	6.01
Error	18	99.07	5.50			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix IXa: Analysis of Variance for Mean Number of Branches per plant in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	27.19				
Treatment	11	12.36	1.12	1.67	2.26	3.18
Replication	2	0.04	0.02	0.03	3.44	5.72
Error	22	14.79	0.67			

Appendix IXb: Analysis of Variance for Mean Number of Branches per plant in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	17.80				
Treatment	9	3.30	0.37	0.65	2.46	3.60
Replication	2	2.85	1.43	2.20	3.55	6.01
Error	18	11.65	0.65			

Appendix Xa: Analysis of Variance for Vigour Score in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	21.89				
Treatment	11	17.89	1.63	11.64**	2.26	3.18
Replication	2	0.89	0.45	3.21	3.44	5.72
Error	22	3.11	0.14			

Appendix Xb: Analysis of Variance for Vigour Score in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	14.80				
Treatment	9	8.13	0.90	2.50*	2.46	3.60
Replication	2	0.20	0.10	0.28	3.55	6.01
Error	18	6.47	0.36			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XIa: Analysis of Variance for Mean Number of Tubers per plant in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	68.69				
Treatment	11	52.50	4.77	6.90**	2.26	3.18
Replication	2	0.98	0.49	0.71	3.44	5.72
Error	22	15.21	0.69			

Appendix XIb: Analysis of Variance for Mean Number of Tubers per plant in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	24.45				
Treatment	9	14.24	1.58	6.54**	2.46	3.60
Replication	2	5.86	2.93	12.21**	3.55	6.01
Error	18	4.35	0.24			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XIIa: Analysis of Variance for Mean Number of Tubers per m² in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	677.52				
Treatment	11	597.21	54.29	14.91**	2.26	3.18
Replication	2	0.19	0.10	0.03	3.44	5.72
Error	22	80.12	3.64			

Appendix XIIb: Analysis of Variance for Mean Number of Tubers per m² in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	220.37				
Treatment	9	134.16	14.91	6.48**	2.46	3.60
Replication	2	44.89	22.45	9.76**	3.55	6.01
Error	18	41.32	2.30			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XIIIa: Analysis of Variance for Total Number of Marketable Tubers per m² in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	88.26				
Treatment	11	70.86	6.44	8.47**	2.26	3.18
Replication	2	0.72	0.36	0.47	3.44	5.72
Error	22	16.68	0.76			

Appendix XIIIb: Analysis of Variance for Total Number of Marketable Tubers per m² in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	8.29				
Treatment	9	5.62	0.62	6.89**	2.46	3.60
Replication	2	1.05	0.53	5.89*	3.55	6.01
Error	18	1.62	0.09			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XIVa: Analysis of Variance for Total Number of Non-Marketable Tubers per m² in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	427.48				
Treatment	11	371.61	33.78	14.62**	2.26	3.18
Replication	2	5.06	2.53	1.10	3.44	5.72
Error	22	50.81	2.31			

Appendix XIVb: Analysis of Variance for Total Number of Non-Marketable Tubers per m² in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	187.86				
Treatment	9	118.03	13.11	6.79**	2.46	3.60
Replication	2	35.01	17.51	9.07**	3.55	6.01
Error	18	34.82	1.93			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XVa: Analysis of Variance for Mean Tuberous Root Weight in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	207032.13				
Treatment	11	126261.65	11478.33	3.69**	2.26	3.18
Replication	2	12327.30	6163.65	1.98	3.44	5.72
Error	22	68443.18	3111.05			

Appendix XVb: Analysis of Variance for Mean Tuberous Root Weight in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	43786.28				
Treatment	9	38014.24	4223.80	14.48**	2.46	3.60
Replication	2	520.37	260.19	0.89	3.55	6.01
Error	18	5251.67	291.76			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XVIa: Analysis of Variance for Dry Matter Percentage in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	3945.15				
Treatment	11	3426.56	311.51	13.66**	2.26	3.18
Replication	2	16.99	8.50	0.37	3.44	5.72
Error	22	501.60	22.80			

Appendix XVIb: Analysis of Variance for Dry Matter Percentage in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	865.83				
Treatment	9	268.86	29.87	0.96	2.46	3.60
Replication	2	38.92	19.46	0.65	3.55	6.01
Error	18	558.05	31.00			

* Significant at P = 0.05

** Significant at P = 0.01

Appendix XVIIa: Analysis of Variance for Total Tuber Yield in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	1344.26				
Treatment	11	1193.74	108.52	17.92**	2.26	3.18
Replication	2	17.26	8.63	1.42	3.44	5.72
Error	22	133.26	6.06			

Appendix XVIIb: Analysis of Variance for Total Tuber Yield in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	265.76				
Treatment	9	182.85	20.32	7.97**	2.46	3.60
Replication	2	37.08	18.54	7.27**	3.55	6.01
Error	18	45.83	2.55			

* Significant at P = 0.05
** Significant at P = 0.01

Appendix XVIIIa: Analysis of Variance for Marketable Tuber Yield in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	1141.23				
Treatment	11	995.30	90.48	14.52**	2.26	3.18
Replication	2	8.87	4.44	0.71	3.44	5.72
Error	22	137.06	6.23			

Appendix XVIIIb: Analysis of Variance for Marketable Tuber Yield in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	106.35				
Treatment	9	81.66	9.07	10.08**	2.46	3.60
Replication	2	8.42	4.21	4.68*	3.55	6.01
Error	18	16.27	0.90			

* Significant at P = 0.05
** Significant at P = 0.01

Appendix XIXa: Analysis of Variance for Non-Marketable Tuber Yield in 2000

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	35	77.28				
Treatment	11	53.65	4.88	4.88**	2.26	3.18
Replication	2	1.61	0.81	0.81	3.44	5.72
Error	22	22.02	1.00			

Appendix XIXb: Analysis of Variance for Non-Marketable Tuber Yield in 2001

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	29	60.48				
Treatment	9	30.52	3.39	3.20*	2.46	3.60
Replication	2	10.91	5.46	5.15*	3.55	6.01
Error	18	19.05	1.06			

* Significant at P = 0.05

** Significant at P = 0.01

APPENDIX XX. Analysis of Variance for Establishment Rate of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	38.92				
Treatment	35	20.25	0.58	2.19**	1.65	2.03
Replication	2	0.17	0.09	0.35	3.15	4.98
Stock(St)	5	3.86	0.77	2.96*	2.37	3.34
Scion(Sc.)	5	5.64	1.13	4.35**	2.37	3.34
St x Sc	25	10.75	0.43	1.65	1.70	2.12
Error	70	18.50	0.26			

APPENDIX XXI. Analysis of Variance for Vigour Score of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	56.67				
Treatment	35	16.00	0.46	0.87	1.65	2.03
Replication	2	3.73	1.87	3.53*	3.15	4.98
Stock(St)	5	2.00	0.40	0.75	2.37	3.34
Scion(Sc.)	5	3.00	0.60	1.13	2.37	3.34
St x Sc	25	11.00	0.44	0.83	1.70	2.12
Error	70	36.94	0.53			

* Significant at P=0.05
** Significant at P=0.01

APPENDIX XXII. Analysis of Variance for Flowering Score of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	21.21				
Treatment	35	13.05	0.37	3.29**	1.65	2.03
Replication	2	0.22	0.11	0.97	3.15	4.98
Stock(St)	5	0.95	0.19	1.68	2.37	3.34
Scion(Sc.)	5	9.95	1.97	17.43**	2.37	3.34
St x Sc	25	2.23	0.09	0.79	1.70	2.12
Error	70	7.94	0.11			

APPENDIX XXIII. Analysis of Variance for Stand Count at Harvest of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	82.92				
Treatment	35	41.59	1.19	2.03**	1.65	2.03
Replication	2	0.23	0.12	0.20	3.15	4.98
Stock(St)	5	2.64	0.53	0.90	2.37	3.34
Scion(Sc.)	5	11.86	2.37	4.02**	2.37	3.34
St x Sc	25	27.09	1.08	1.83*	1.70	2.12
Error	70	41.10	0.59			

* Significant at P=0.05
** Significant at P=0.01

APPENDIX XXIV. Analysis of Variance for Mean No. of Branches/plant of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	60.92				
Treatment	35	19.59	0.56	1.02	1.65	2.03
Replication	2	2.73	1.37	2.49	3.15	4.98
Stock(St)	5	4.64	0.93	1.69	2.37	3.34
Scion(Sc.)	5	2.42	0.48	0.87	2.37	3.34
St x Sc	25	12.53	0.50	0.91	1.70	2.12
Error	70	38.60	0.55			

APPENDIX XXV. Analysis of Variance for Vine Length of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	311954.78				
Treatment	35	174619.61	4989.13	2.72**	1.65	2.03
Replication	2	9133.85	4566.93	2.49	3.15	4.98
Stock(St)	5	57404.84	11480.97	6.27**	2.37	3.34
Scion(Sc.)	5	84201.01	16840.20	9.20**	2.37	3.34
St x Sc	25	33013.76	1320.55	0.72	1.70	2.12
Error	70	128201.32	1831.45			

* Significant at P=0.05
** Significant at P=0.01

APPENDIX XXVI. Analysis of Variance for Petiole Length of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	749.14				
Treatment	35	486.68	13.91	3.84*	1.65	2.03
Replication	2	8.76	4.38	1.21	3.15	4.98
Stock(St)	5	40.12	8.02	2.22	2.37	3.34
Scion(Sc.)	5	294.24	58.85	16.26**	2.37	3.34
St x Sc	25	152.32	6.09	1.68	1.70	2.12
Error	70	253.70	3.62			

APPENDIX XXVII. Analysis of Variance for Dry Vine Yield of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	561683.65				
Treatment	35	323835.03	9252.43	2.74**	1.65	2.03
Replication	2	1219.35	609.68	0.18	3.15	4.98
Stock(St)	5	130273.64	26054.73	7.71**	2.37	3.34
Scion(Sc.)	5	101443.19	20288.64	6.00**	2.37	3.34
St x Sc	25	92118.20	3684.73	1.09	1.70	2.12
Error	70	236629.27	3380.42			

* Significant at P=0.05

** Significant at P=0.01

APPENDIX XXVIII. Analysis of Variance for Root-Top Ratio of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	1071.37				
Treatment	35	689.14	19.69	3.63**	1.65	2.03
Replication	2	2.83	1.42	0.26	3.15	4.98
Stock(St)	5	366.81	73.36	13.54**	2.37	3.34
Scion(Sc.)	5	100.60	20.12	3.71**	2.37	3.34
St x Sc	25	221.73	8.87	1.63	1.70	2.12
Error	70	379.37	5.42			

APPENDIX XXIX. Analysis of Variance for Tuber Length of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	1375.75				
Treatment	35	526.74	15.05	1.26	1.65	2.03
Replication	2	9.61	4.81	0.40	3.15	4.98
Stock(St)	5	194.69	38.94	3.25*	2.37	3.34
Scion(Sc.)	5	98.71	19.74	1.65	2.37	3.34
St x Sc	25	233.34	9.33	0.78	1.70	2.12
Error	70	839.40	11.99			

* Significant at P=0.05
** Significant at P=0.01

APPENDIX XXX. Analysis of Variance for Tuber Girth of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	1587.20				
Treatment	35	758.79	21.68	1.84*	1.65	2.03
Replication	2	4.06	2.03	0.17	3.15	4.98
Stock(St)	5	172.88	34.58	2.94*	2.37	3.34
Scion(Sc.)	5	500.73	100.15	8.50**	2.37	3.34
St x Sc	25	265.18	10.61	0.90	1.70	2.12
Error	70	824.35	11.78			

APPENDIX XXXI. Analysis of Variance for Mean Number of Tubers/plant of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	310.40				
Treatment	35	144.20	4.12	1.78*	1.65	2.03
Replication	2	4.09	2.05	0.88	3.15	4.98
Stock(St)	5	56.22	11.24	4.84**	2.37	3.34
Scion(Sc.)	5	7.40	1.48	0.64	2.37	3.34
St x Sc	25	80.58	3.22	1.39	1.70	2.12
Error	70	162.11	2.32			

* Significant at P=0.05

** Significant at P=0.01

APPENDIX XXXII. Analysis of Variance for Number of large Tubers/plant of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	5.00				
Treatment	35	2.63	0.0751	2.38**	1.65	2.03
Replication	2	0.16	0.0800	2.53	3.15	4.98
Stock(St)	5	0.49	0.0980	3.10*	2.37	3.34
Scion(Sc.)	5	0.72	0.1440	4.56**	2.37	3.34
St x Sc	25	1.42	0.0568	1.80*	1.70	2.12
Error	70	2.21	0.0316			

APPENDIX XXXIII. Analysis of Variance for Number of Small Tubers/plant of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	17.18				
Treatment	35	9.71	0.2774	2.61**	1.65	2.03
Replication	2	0.02	0.0100	0.09	3.15	4.98
Stock(St)	5	3.99	0.7980	7.50**	2.37	3.34
Scion(Sc.)	5	1.02	0.2040	1.92	2.37	3.34
St x Sc	25	4.70	0.1880	1.77*	1.70	2.12
Error	70	7.45	0.1064			

* Significant at P=0.05

** Significant at P=0.01

APPENDIX XXXIV. Analysis of Variance for Mean Tuberous Root Weight of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	855350.08				
Treatment	35	371002.97	10600.08	1.55	1.65	2.03
Replication	2	6730.39	3365.20	0.49	3.15	4.98
Stock(St)	5	127154.63	25430.93	3.73**	2.37	3.34
Scion(Sc.)	5	144595.29	28919.06	4.24**	2.37	3.34
St x Sc	25	99253.05	3970.12	0.58	1.70	2.12
Error	70	477616.72	6823.10			

APPENDIX XXXV. Analysis of Variance for Dry Matter Content of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	2677.31				
Treatment	35	1450.63	41.45	2.52**	1.65	2.03
Replication	2	77.21	38.61	2.35	3.15	4.98
Stock(St)	5	833.02	166.60	10.15**	2.37	3.34
Scion(Sc.)	5	233.27	46.65	2.84*	2.37	3.34
St x Sc	25	384.34	15.37	0.94	1.70	2.12
Error	70	1149.47	16.42			

* Significant at P=0.05

** Significant at P=0.01

APPENDIX XXXVI. Analysis of Variance for Total Tuber Yield of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	15326.96				
Treatment	35	9075.23	259.29	3.00**	1.65	2.03
Replication	2	192.89	96.45	1.11	3.15	4.98
Stock(St)	5	2198.11	439.62	5.08**	2.37	3.34
Scion(Sc.)	5	1426.43	285.29	3.30*	2.37	3.34
St x Sc	25	5450.69	218.03	2.52**	1.70	2.12
Error	70	6058.84	86.55			

APPENDIX XXXVII. Analysis of Variance for Dry Tuberous Root Yield of Grafts of Six Sweet Potato Clones

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	Computed F	Tabular F 5%	Tabular F 1%
Total	107	1196510.73				
Treatment	35	565304.63	16151.56	1.89*	1.65	2.03
Replication	2	33817.81	16908.91	1.98	3.15	4.98
Stock(St)	5	134682.28	26936.46	3.16*	2.37	3.34
Scion(Sc.)	5	217066.58	43413.32	5.09**	2.37	3.34
St x Sc	25	213555.77	8542.23	1.00	1.70	2.12
Error	70	597388.29	8534.12			

* Significant at P=0.05
** Significant at P=0.01