Effects of Land Preparation Methods on the Growth and Yield of Sweet Potato (*Ipomoea batatas* LAM)

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Abstract: Sweet potato (*Ipomoea batatas* LAM) is among the world's most important, versatile and under exploited food crops. Not much research has been carried out on the most suitable land preparation technique(s) for its production. This work was designed to assess the effects of land preparation methods on the performance of sweet potato and make recommendations on land preparation for optimal and sustainable production. The land preparation methods used in this experiment were ploughing and harrowing, ploughing harrowing and ridging, ridging, Slash and burn. The experiment was laid out in a randomized complete block design (RCBD) with three replicates. This gave a total of 15 plots. Each plot measured 3m X 4m ($12m^2$) with lm^2 between plot spacing. The size of each experimental plot was 26 m X 13 m, making a total land area of $338m^2$. Potato vines were planted at 50 cm within the rows and 100 cm between the rows. Growth parameters were measured between 4 and 14 weeks after planting (WAP). Data were collected on vine length, number of leaves and stem diameter. Yield parameters taken at harvest (14WAP) were number of roots, tuber length, tuber girth and fresh weight. The data were subjected to analysis of variance, correlation was carried out on the data and significant differences were separated using least significant difference (LSD). The results showed that at 5 and 6 WAP, ploughed harrowed and ridged plots produced the longest vines of 89.00cm and 143.58cm respectively. There was a significant correlation between vine length and tuber length 5 and 6WAP ($r^2 = 0.55$, P<O. 05 and $r^2 = 0.59$, P<0.05 respectively). Land preparation methods did not have significant effect on number of leaves but it did on stem diameter at 4 and 11WAP. There was a high negative, significant correlation between stem diameter 11WAP and root number. ($r^2 = - 0.466146$, PO 01). If sweet potato were to be produced for propagation and use of its vines or for forage, a combination of ploughing, harrowing and ridging method of land preparation is recommended. Slash and burn land preparation method is suggested only if the leaves are required for forage, vegetables or other purposes, as such the study recommends that the leaves should then be harvested at 7weeks after planting. If sweet potato is to be planted for the roots, the highest fresh yield of sweet potato was obtained in slash and burn land preparation method, so slash and burn land preparation method is recommended.

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Introduction

Sweet potato (*Ipomoea batatas* LAM) is among the world's most important, versatile and under exploited food crops (CIP, 2005). With Over 133 - l40 million tons of annual production (FAO, 2000, CIP, 2005) sweet potato currently ranks the fifth most important food crop in developing countries after rice, wheat, Maize and cassava. It is cultivated in over 100 developing countries and only in the last decade has sweet potato been given an intense, coordinated, global effort to realize its full potential as a Source of food and an income earner for millions of small scale farmers in developing areas Such as Africa, Asia and Latin America (CIP, 2005).

In sub-Saharan Africa, sweet potato is the third most important tuber crop after cassava and yam (Ewell and Mutuura, 1994). Although African farmers produce only about 9 million tons of sweet potato annually, most of it is cultivated for human consumption. Yields in Africa are quite low, between 4-5 Tons/ha which is about 1/3 of what the Asian farmers produce. This indicates a huge potential for future growth. In Africa the crop is grown on small scale, primarily to help ensure food security of the rural households (Ewell and Mutuura, 1994).

Sweet potato (*Ipomoea batatas* LAM) is a member of the convolvuaceae family and approximately 900 different species of convolvulaceae in 400 genera have been identified around the world (Purseglove, 1972; Yen, 1974). Austin (1988) recognized 11 spices in the section batatas, which includes sweet potato. It is however accepted that cultivated sweet potato originated in central America or tropical south America. Nishiyama (1971) and Martin and Jones 1972) suggested Mexico as a center of diversity of the batatas section in ipomoea.

The storage roots of sweet potato serve as a staple food, animal feed (Posas, 1989), and to a

limited extent raw material for industrial purpose. It can also be used as a starch source and for alcohol production (Collins, 1984) Sweet potato starch is used for the manufacturing of adhesives, textiles and paper sizing and in the confectionary and baking industries. In most parts of the tropics sweet potatoes is consumed boiled, baked, roasted or fried. Preparation practices vary according to the location. In Nigeria, roots are boiled unpeeled or roasted in the ash of a fire before being eaten or less commonly, the sweet potato is boiled or fried with other vegetables or root crops.

Planting of sweet potato on mounds is the most common practice in traditional agriculture. Essentially, the topsoil is gathered into more or less conical heaps at constant intervals in the field. Hoes with wide blades are used for the mound making. The size of each mound, the mean distance between mounds and the number of sweet potato cuttings planted on each mound vary from place to place. In general, the bigger the mound the greater the distance between mounds, and the greater the number of the cuttings that may be planted on each.

According to Onwueme (1978) in some parts of south western Nigeria, Mounds may attain heights of up to 1m. The distance between the mounds can be as much as 3m. On mounds of this size, 6 to 10 cuttings can be planted at various points on the sloping side of the mound. In most sweet potato growing areas of Africa smaller mounds of 50cm in height are more common and only 5 or 6 cuttings are planted on each mound. There are several advantages of high mounds; they provide a favorable seedbed for tuber development, and the largest yield of tubers per plant and the most uniformly shaped tubers are often obtained from mound plantings. A second factor that may contribute to the high yield on mound grown plants is that the process of mound making collects the rich topsoil and the entire depth of the mound consist of the more fertile topsoil. A third advantage of mounding is that it facilitates harvesting. In soils where the mater table is high, mounds also serve to keep most of the roots above the water table. besides all lt's advantages mounding has the major disadvantage of not being mechanizable. Mound making is an extremely tedious and labour consuming operation, which is very difficult to mechanize (Onwueme, 1978)

Planting on ridges is the most universally recommended method of growing sweet Potato It has been shown that the higher the ridges, the higher the yield up to a ridge height of 36cm (Edmond and Ammerman, I950) The optimum height of the ridge Will depend on the soil type and the cultivar being grown. A high ridge provides ample depth of loose fertiIe soil for root and tuber development and a high broad ridge is less readily washed away by rain during the cropping season. After the ridge has been made, actual planting of the cuttings on the ridge is done by opening up the soil at the crest of the ridge with a hoe.

Planting on ridges has several of the same advantages as planting on mounds In addition, it has the added advantage that ridge making can be completely mechanized. On slopes, ridging along the contour can help in erosion control The major disadvantage of ridge planting is that during the course of the season rains tend to wash soil away from the ridge-top thereby decreasing the height of the ridges.

The chemical composition of sweet potato tubers varies widely according to the cultivars, climatic conditions and degree of maturity and duration of storage. Table 1 shows the nutritional composition of 100g of sweet potato tubers. Hill *et al*. (1985), Woolfe (1992) and Nawale and Salvi (1983) reported that sweet potato shoots and tuberous roots provide energy, proteins, vitamins and minerals sufficient for both man and livestock.

The objectives of this study were to assess the effects of land preparation on the performance of sweet potato and to recommend a suitable land preparation method for optimal and sustainable sweet potato production.

Table1: Nutritional composition of sweet potato tuber

NUTRIENT	VALUE
Water	50-80 %
Protein	1.7 g
Food Energy	114Kcal
Protein / Calorie Ratio	15g / 1000 Kcal
Fats	0.4g
Ash	1.0mg
Ca	30 - 32 mg
P	47 - 49 mg
Fe	0.7 - 0.8 mg
Na	10 -13 mg
K	243-373 mg
Thiamie	0.09 mg
Riboflavin	0.06 mg
Niacin	0.6 mg
Ascorbic Acid	20-30 mg
Nicotinic Acid	0.9 mg
Carotene	1 -12mg
S	30 mg
Mg	24 mg

NOTE. Values are expressed per 100g of peeled tuber
Source. Scott *el at*. (2000)

Materials and Methods

This study was conducted on the experimental field of the Department of Agronomy, situated along Parry Road on the campus of the University of Ibadan, Nigeria. The plot size was 26 m X 13 m this making a total land area of 338m^2. There were 15 plots within this land area each measuring 3m X 4m (12 m^2).

Plants were spaced 50 cm within the rows and 100 cm between the rows. Particles size analysis was done using hydrometer method. And the soil type on the plot is sand silt clay. The experimental design used was randomised complete block design (RCBD) with 5 treatments replicated 3 times. Data collection commenced 4 weeks after planting, precisely on the 29"of June 2005. By this time vegetative parameters were fully established. Data was collected every week for the next 12 weeks till plants reached maturity at 4 months. Data was collected on vine length, using a tape measure graduated in centimeters (cm). Stem diameter was measured using a veneer calliper the stem diameter was taken between the soil surface and the Junction where the first branch intersects the stem. The number of leaves was taken by counting the individual leaves per Plant, while the number of branches was determined by counting branches. Data collected was subjected to analysis of variance and means of significantly different treatments was separated using least significant difference (LSD).

Land preparation methods

The land preparation methods used in the experiment included:

1. Ploughing 2. Ploughing and harrowing 3. Ploughing, harrow and ridging 4. Ridging and slash and burn.

A Massey Ferguson T l00 tractor was used for the ploughing and the harrowing on the experimental site. Harrowing was done two days after ploughing. Ridging was done manually using a hoe. Slashing was done using a cutlass. Planting was done on 29th may 2005 using the standard method described by Onwueme (1978), Ngeze (2000). The length of the planting material, in this case stem cuttings, was 30 cm, were planted.

Data Collection

Data collection commenced 4 weeks after planting, precisely on the 29"of June 2005. By this time vegetative parameters were fully established. Data were collected every week for the next 12 weeks till plants reached maturity at 4 months. Vine length was measured using a tape (in cm). Stem diameter was measured using a veneer calliper; the stem diameter was taken between the soil surface and the Junction where the first branch intersects the stem. The number of leaves was taken by counting the individual leaves per Plant, while the number of branches was determined by counting branches.

Results and Discussion

Effects of land preparation methods on vine length

Table 2 shows the effects of land preparation methods on the growth of sweet potato vine length. There were significant effects of land preparation methods on vine length at 5 WAP and 6 WAP (table 2). At 5 WAP plants from ploughed harrowed and ridged plots produced the longest vines of 89.00 cm, which was not significantly different from the lengths of vines on plants on ploughed and harrowed plots, with vine length of 72.75 cm. Plants from plots ploughed alone produced 57.92 cm, which was the shortest However, plant vine lengths on treatments, ploughing and harrowing, ploughing, harrowing and ridging and ridging with values of 72.75 cm, 89 00 cm. 85 75 cm, respectively were not significantly different from each other. Plant vine lengths on treatments ploughing and harrowing, slash and bum and ploughing with plant vine lengths of 72.75 cm, 64.17 cm and 57. 92 cm respectively were not significantly different from each other this trend continued up till 6 WAP as plants on treatment ploughing harrowing and ridging produced the longest vines which were not significantly different from plant vine lengths produced under ridging and ploughing and harrowing with vine lengths of 143.58 cm, 132.33 cm, 114.83 cm respectively. Vine lengths obtained for ploughing and harrowing, slash and bum and ploughing were also not significantly different from each other with lengths of 114.83 cm, 93.00 cm, and 88.50 cm respectively. There was significant correlation between vine length and tuber length at weeks 5 and 6 (r^2= 0.55, P<O. 05 and r^2=0.59, P<0.05 respectively).

Effects of land preparation methods on number of leaves

There was no significant effect of land preparation on number of leaves, but there was a trend observed in Fig. 1. Between 4 and 5 weeks after planting, plants under treatment slash and bum, produced the highest number of leaves. This trend continued till 9weeks after planting. At 9 weeks after planting, plants under treatment ridge started to produce the highest number of leaves. At 10 weeks after planting, plants under treatment ploughing, harrowing and ridge started to produce the highest number of leaves and had the highest number of leaves till 14WAP, even though these differences were not significantly different from other treatments.

Effects of land preparation methods on stem diameter

Significant effects of land preparation methods on stem diameter were observed at 4 WAP and 11 WAP (table 3). At 4 weeks after planting, plants grown On treatment ridging gave the highest stem diameter which was not significantly different from the stem diameter of plants grown on treatments ploughing and harrowing, slash and bum, ploughing, harrowing and ridging, and ploughing were not significantly different, with stem diameters of 0.63 cm, 0.60 cm, 0.54 cm and 0.50 cm respectively. The stem diameters of plants grown on treatments slash and bum, ploughing, harrowing and ridging and

ploughing were not significantly different with values of 0.5 4cm, 0.50 cm and 0.41 cm respectively.

Table 2. Means of vine length of sweet potato from 4WAP to 14WAP for different treatments.

TREATMENTS / WEEKS AFTER PLANTING (WAP)	PLOUGHING	PLOUGHING +HARROWING	PLOUGHING + HARROWING +RIDGING	RIDGING	SLASH +BURN
4	27.33	32.92	37.25	46.25	38.17
5*	57.92b	72.75ab	89.00a	85.75a	64.17b
6*	88.50b	114.83ab	143.58a	132.33a	93.00b
7	117.67	172.25	194.33	143.33	116.08
8	161.08	190.50	266.50	187.67	125.17
9	118.33	212.08	306.33	193.42	163.42
10	195.50	236.60	320.08	244.83	175.75
11	204.58	250.75	342.75	258.25	227.58
12	224.25	261.83	357.00	271.67	201.58
13	228.33	266.33	362.75	274.00	206.08
14	229.92	268.75	363.83	278.58	209.17

*means on the same rows with similar alphabets are not significantly different (P<0.05)

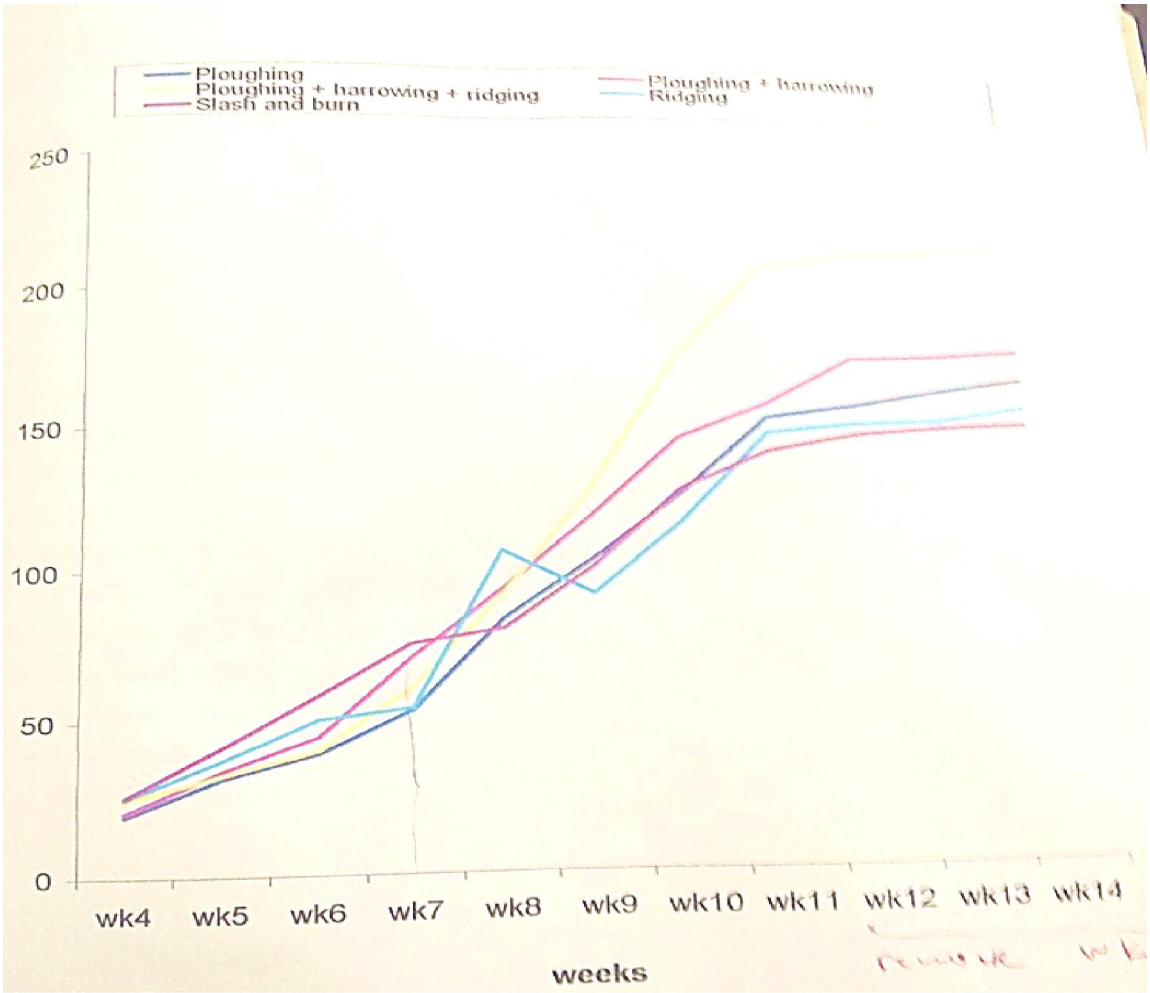

Figure 1. Effects of treatments on number of leaves

Table 3. Effects of land preparation methods on stem diameter of sweet potato vines

TREATMENTS / WEEKS AFTER PLANTING (WAP)	PLOUGHING	PLOUGHING +HARROWING	PLOUGHING + HARROWING +RIDGING	RIDGING	SLASH +BURN
4	0.413b*	0.60a	0.50ab	0.63a	0.54ab
5	0.59	0.62	0.53	0.52	0.62
6	0.62	0.63	0.55	0.53	0.67
7	0.71	0.72	0.59	0.63	0.69
8	0.71	0.73	0.71	0.67	0.74
9	0.71	0.78	0.74	0.69	0.73
10	0.87	0.88	0.77	0.73	0.80
11	0.99a	0.97a	0.71b	0.86ab	0.86ab
12	1.02	1.03	0.83	0.94	0.99
13	1.02	1.03	0.83	0.95	1.00
14	1.02	1.04	0.84	0.96	1.00

* Means on the same rows with similar alphabets are not significantly different (P<0.05)

At 11 weeks after planting, plants on treatment ploughing gave the highest stem diameter that was similar statistically to ploughing and harrowing, slash and bum and ridging with stem diameters of 0.99 cm, 0.97 cm, and 0.86 cm respectively. Stem diameters of plants grown on treatments slash and bum, ridging and ploughing, harrowing and ridging were also similar statistically, with stem diameters of 0.86 cm, 0.86 cm and 0.71 cm respectively. There is a high negative significant correlation between stem diameter at week 11 and root number. (r2= - 0.66146, p=0.01).

Effects of land preparation methods on number, length, girth and fresh weight of sweet potato roots

Effects of land preparation methods on number of sweet potato root(s)

There were significant effects of land preparation methods on number of roots as shown in table 4. The highest number of roots was gotten from sweet potato Vines grown on treatment ploughing harrowing and ridging. The mean number of roots was 2.33 this number of roots was statistically similar to number of roots of vines grown on treatments ridging, slash and bum and ploughing and harrowing, with number of roots of 2.25, 2.17, and 1.91 respectively. Sweet potato vines grown on treatments ploughing and harrowing and ploughing were similar with number of roots of 1.91 and 1.25 respectively.

Effects of land preparation methods on tuber length

There were significant effects of land preparation methods on tuber length, with the longest tuber length recorded for sweet potato vines grown on plots with ploughing harrowing and ridging (table 4). Mean length was 14.79cm and this was not significantly different from the tuber lengths of sweet potato vines grown on treatments ploughing and harrowing and ridging with lengths of 14.18cm and 12.05 cm respectively. Tuber lengths of sweet potato vines grown on plots with ridging, ploughing and slash and bum were not significantly different from each other with root lengths of 12.05 cm, 10.78 cm and 10.65 cm respectively. Table 4 shows the effects of land preparation method on tuber length.

Table 4. Effects of land preparation methods on number, length, girth and fresh weight of sweet potato roots

TREATMENTS / PLANT PART	PLOUGHING	PLOUGHING +HARROWING	PLOUGHING + HARROWING +RIDGING	RIDGING	SLASH +BURN
Number of Roots	1.25b*	1.92ab	2.33a	2.25a	2.17a
Tuber Length(cm)	10.78b	14.18a	14.79a	12.05ab	10.65b
Tuber Girth (cm)	12.64	12.44	13.54	15.11	16.47
Fresh Weight (g)	478.7	762.7	763.7	766.0	1085.3

* Means on the same rows with similar alphabets are not significantly different (P<0.05)

In the new dispensation, Agriculture strives not only to feed the population but also to conserve agricultural resources that are constantly being depleted. In this study, the soil conserving methods used by farmers that plant Sweet potato were compared to see which land conserving method best affects the performance of sweet potato and see which land preparation method is most sustainable and will produce optimally. Onwueme and Sinhar (1999) argued that mounds, ridges and planting on the flat are

commonplace; which of course corroborates the need to adequately prepare the land before planting sweet potato, as confirmed by results of this study. Ridge making however can be mechanized; and mechanization is progressively replacing manual mound making as the most common land preparation method for sweet potato. This experiment agrees with Onwueme and Sinhar because the longest vine length at 5WAP and 6WAP were from land preparation method: ploughing, harrowing and ridging. This method also gave the highest leaf yield even though it was not significantly different from the other treatments. This is probably because ploughing, harrowing and ridging method gives the loosest soil for easy root growth and development. Even though this method gave the highest yield in some instances it was not significantly different from slash and burn, which is cheaper and more easily adaptable for the farmer. Slash and burn gave the highest sweet potato fresh root yield. There was also positive and significant correlation between vine length and tuber length at 5 and 6 WAP. This shows that the longer the vine length at 5 and 6 WAP the longer the roots will be. This is so because the longer the vines the more leaves they will carry and the more dry matter they will produce. This is in line with Chua and Kays, 1982 and Wilson, 1982 who argued that root size has to do with accumulation of photosyntates that consists mainly of starch.

Conclusion

The study shows that the more the number of leaves the more the dry matter the crop will produce. The highest fresh yield of sweet potato root was obtained in slash and bum. It is recommended that slope positions should be considered in subsequent studies as this affects the efficiency of land preparation systems. The recommended method of land preparation if sweet potato is grown for its leaves is ploughing, harrowing and ridging, but if its leaves are going to be harvested before 9 weeks after planting slash and bum is recommended.

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