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Influence of Pinching Back on the Growth and Yield Parameters of Sweet Potato Varieties in Southeastern Nigeria

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1 SUMMARY

The influence of pinching back on the growth and yield parameters of two varieties of sweet potato (*Ipomoea batatas* (L) Lam) bred by International Institute of Tropical Agriculture, Ibadan, Nigeria, was studied. The objective of this paper was therefore, to determine the effects of four pruning activities in a 4x2 factorial experiment arranged in a randomized complete block design in four replications. The four pruning times consisted of [zero pruning (0), 4, 8 and 12 weeks after planting (WAP)] on two sweet potato varieties [TIS 87/0087 (pink fleshed) and TIS 2498 (cream fleshed)]. Pinching back as early as 4WAP significantly (p=0.05) reduced the growth and yield parameters, but these were improved significantly later. The root tuber yield at 0WAP (5.06kg/plant) was >12WAP (4.58kg/plant) >8WAP (3.92kg/plant) >4WAP (3.73kg/plant). The coefficient of variation in variety TIS 87/0087 was significantly (p=0.05) >TIS 2498 in vine length/plant (7.61%), number of leaves/plant (14.95%), fresh pruning weight/plant (42.60%) and the root tuber weight/plant (64.58%).

2 INTRODUCTION

Some crops are primarily grown for their young leaves and tips for utilization by man as leafy vegetables in various forms for their beneficial micronutrient contents (Maundu *et al.*, 2009). For others, the young leaves and tips are secondary in importance, harvested and utilized as leafy vegetables. Pinching back is described as a pruning activity where pruning is limited to clipping out (harvesting) the tips of growing shoots for secondary use, not as a 'garden art'. Pinching back is a well-studied practice in cucumber (Humphries and Vermillion, 1994; Gobeil and Gosselin, 1990; Xo, 1999) and in melon (Pereira *et al.*, 2003). Sweet potato is widely grown mainly for its tuber, but its leaves are also important and it is a staple species for some communities (Maundu *et al.*, 2009). It is therefore important to investigate the effect of pinching back activities on the growth and yield of the primary product (root tubers) and secondly product (the leaves) of sweet potato, in view of the important role its root tubers and leaves play in human nutrition (CIP, 1998). Sweet potato (*Ipomoea batatas* (L) Lam) is a perennial food crop of the morning- glory family, Convolvulaceae, but widely cultivated as an annual crop in tropical and warmer temperate climates (Huaman, 2002). The crop has played a major role in the food economy of nations as one of the world's most valued root crops with sweetish edible and vitamin-enriched roots. It is cultivated over a range of environment in more than one hundred countries, and between latitude 40° N and S of the equator as well as between 2000-2300 m above mean sea level (Hahn, 1977, Kay, 1987, Onwueme and Sinha, 1991, James, 1994). In some areas, sweet potato is the major source of nourishment for the people (NRCRI, 1983; Bourke, 1985; SPC, 1986). It is one of the seven leading world food crops with annual production of about 122 million Mt yr^{-1}, ranking

thirteenth globally in production value among agricultural commodities (Collins, 1995; FAO, 2005). It ranks second in world root and tuber crop production after potato and second after cassava in importance in Africa (CIP, 1994). About 80% of the world's sweet potato is cultivated in China and virtually 98% are cultivated in developing countries between 1995 and 1997. China's sweet potato harvest topped 117 million Mt per year, which is 85% of the world's total harvest. With the breakup of the Soviet Union, China became the world's largest producer (Martin, 1994, Theberge, 1985, CIP, 1994, 1998, Ikeorgu, 2000). Sweet potato is a dependable and flexible crop with a great potential to feeding the hungry people in the tropical world, as it can be left in the ground and harvested piecemeal as needed or harvesting everything at once and preserved for food security (CIP, 1998). It has long been known as a calamity crop, especially suited for emergency situations, a versatile and hardy source of subsistence and therefore a solid base for agricultural reconstruction after disasters like typhoons, drought have occurred (CIP, 1998). As a life - saver, the Japanese used it when typhoons demolished their rice fields, just as much as it kept millions from starvation in famine-plagued China in 1960s (CIP, 1998). In Uganda, when a virus ravaged cassava crops in the 90s, the rural communities depended on its high food value. The crop is easy to cultivate under different agro-ecologies with little fertilizer input and produces a high volume of roots per hectare, matures fast has good keeping qualities and is affected by few pests and diseases. It tastes nice and is an excellent source of vitamin C (50%), vitamin A (10%), vitamin B_1 (21%), vitamin B_2 (8%), calcium (14%), Iron (12%), Niacin (12%), energy (13%), protein (13%) and some magnesium, potassium and Zinc (raw or cooked). The young leaves and tips are always a good food source (whether in emergency or not), providing 167% vitamin C, 120% vitamin A, 8% vitamin B_1, 23% vitamin B_2, 56% calcium, 19% Iron, 10% Niacin, 17% protein and 2% energy (cooked) (Terry, 1987, Shiotani *et al*., 1991; SPC, 1986; CIP, 1998, Yang and Keding, 2009). Sweet potato also offers other useful subsidiary uses as animal feeds, producing a high carbohydrate feeding stuff for cattle, pigs and poultry. The starch is used in textile, paper, cosmetics, food-manufacturing, pharmaceutical industries and for preparation of alcohol, adhesive, glucose and sweet potato flour for bread and pastry making (Villarreal *et al*., 1979, NRCRI, 1983, Kay, 1987, Rehm and Espig, 1991, Martin, 1994, CIP, 1998). Sugar syrup resulting from its starch has a dextrose equivalent of 28.30 kcal and has the potential for producing sugar syrup of 32.34 kcal digestible energy (Tewe *et al*., 2003). Despite the name 'sweet' it may be a beneficial food for diabetics as preliminary studies on animals have revealed that it helps to stabilize blood sugar levels and to lower insulin resistance (FAO, 2005). The roots boiled, roasted and eaten in form of fries and crisps as food, and 15-30% sweet potato flour blended with wheat flour used for baking bread. It yields about 60% industrial starch in Japan and used as a sweetener in local drinks in Nigeria (Collins, 1993, Agbo and Ene, 1994). A patented bread of about $17 per loaf made of 100% sweet potato produced and marketed as "hypoallergenic" in USA for people who cannot tolerate grain breads and flours (Collins, 1993). Singh *et al*., (1987) recommended a mixture of soybean and sweet potato as weaning food. The vines and leaves are useful dry forage during scarce grazing periods while the young shoots serve as vegetables for human consumption in some West African countries like Guinea, Sierra-Leone and Liberia (Abindin, 2004). In Eastern Africa (Uganda), it is called "cilera adama" (protector of the children) alluding to the vital role it plays in thousands of villages where people depend on the crop to combat hunger and vitamin A deficiency disease (CIP, 1998).

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3 MATERIALS AND METHODS

Field experiments were conducted in 2009 and 2010 on the research farm of the Department of Crop Production and Landscape Management, Ebonyi State University, Abakaliki, Southeastern Nigeria located at latitude 06° 19´ 407´´ N, longitude 08° 07´ 831´´ E and an altitude of about 447m above sea level. It has a pseudo-bimodal rainfall pattern from April to November. The total average annual rainfall received in the area is about 1700-2060 mm. The zone receives abundant sunshine during the day with a maximum mean daily temperature ranging between 27°C-31°C all through the year. The humidity is high with the lowest levels during the dry season. The soil is a shallow hydromorphic type with unconsolidated parent material (shale residuum) within 1m of the soil surface, classified as *Dystric leptosol* (Anikwe *et al*., 1999).

Experimental design: The design of the experiment was a 4x2 factorial in a randomized complete block design (RCBD) in four replications covering an area of 585m^2 (65m x 9m). Factor A, consisted of 4 pruning times [zero pruning (0), 4, 8 and 12 weeks after planting (WAP)], while factor B, was two sweet potato varieties [TIS 87/0087 (pink fleshed) and TIS 2498 (cream fleshed)] bred by International Institute of Tropical Agriculture (IITA), Ibadan, the vines were supplied by the National Root Crop Research Institute (NRCRI), Umudike, Nigeria. Eight treatment combinations arose from the design. The 128 ridges of four metres, were manually constructed one meter apart with the West Africa dwarf hoe (the large blade type) arranged into 32 plots of four ridges each, unto which the eight treatment combinations were randomly applied in each replicate.

Planting and plot maintenance: The 2009 and 2010 experiments were carried out in a field cleared, ridged and planted in June and May respectively when the rainfall stabilized. Vine cuttings with at least 4 nodes or 6cm long each planted in a slanting position made an angle of 45° with the crest of the ridges. Eight plant stands per ridge resulted from a plant spacing of 45cm on ridges made one meter apart, to give a total plant population of 256 per block. A blanket application of NPK (10:10:10) fertilizer was made 2WAP at the rate of 400kg/ha to augment the native soil fertility. Two manual weeding times sustained the crop growth at 3WAP and 6WAP before harvesting since the growing plant vines and leaves inhibited further weed growth.

Measurements and data Analysis: Fresh and dry weights of the young shoots at 60cm long from the terminal buds clipped from the four innermost stands within the two middle ridges in each plot using a top loading weighing balance were taken. The clipped materials were sun dried to a stable weight before taking the final dry weight. Sixty centimetres of the growing tips were young enough as leafy vegetable for human consumption, but the size exceeds it if for animal feed. At each pruning, leaves are counted, vine lengths measured and recorded. Harvesting of the roots and recording of weights were at 18WAP. All data collected were statistically analyzed using the analysis of variance (ANOVA) procedure according to Steel and Torrie (1980), while mean separation for detecting significant differences between means was performed using Fishers least significant difference (F-LSD=LSD) as illustrated by Obi (1986).

4 RESULTS AND DISCUSSION

The practice of pinching back in sweet potato production significantly (p=0.05) affected all the growth and yield parameters measured in these experiments (Table 1). The removal of a good chunk of the photosynthetically active portion of the growing plant as early as 4WAP had a suppressing effect on the vine length (109.5cm/plant) as against later pinching backs at 8WAP (143.5cm/plant), 12WAP (183.5cm/plant) and at zero pruning (0WAP) (218.5cm/plant). Also affected in that order, were the number of leaves/plant (141.0, 170.0,

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237.0 and 264.5) and the weight of root tuber yield/plant (3.73kg, 3.92kg, 4.58kg and 5.06kg). Also affected too in the same order was the pruning weight/plant (fresh and dry weights). This agrees with Crowder and Chedda (1982), who indicated that forage species in a grassland, had varied yields with pruning dates of the plants. In addition, Nwinyi (1992) and Dahniya *et al.* (1985) reported that removal of sweet potato vines reduced the supply of photosynthates during the remainder of the plant's growth with eventual reduction in root yield. However, pinching back should be with an intention made a priori to the action: root and vegetable production or root and forage production. The higher root yield at 12WAP and zero pruning (0WAP) agreed with the report of Ahn (1993), that the root tuber initiation occurs at about 50-60 days after planting which approximates 7-9WAP, such that pruning done after this time may not have serious depressing effect on the root yield. Uddin *et al.* (1994), An *et al.* (2003), Kiozya *et al.* (2001) and Nwokocha *et al.* (2000), observed that defoliation had a depressing influence on root tuber production in sweet potato.

Table 1: Main effects of pruning time on the growth and yield parameters of sweet potato plants

Parameters					
Pruning time	Vine length cm/plant	Number of leaves/plant	Pruning weight/ plant (g)		Weight of root yield (kg)
			Fresh	Dry	
4WAP	109.5	141.0	284	190	3.73
8WAP	143.5	170.0	407	250	3.92
12WAP	183.5	237.0	540	350	4.58
0WAP	218.5	264.5	-	-	5.06
F-LSD (p=0.05)	37.20	54.20	1.06	0.80	1.42

Key: 0WAP = zero pruning. No pinching back at any week after planting

The two varieties were not significantly (p>0.05) different in much of their growth parameters, but the weight of root yield per plant and the pruning weight were significantly (p=0.05) different (Table 2). Variety TIS 87/0087 did better than TIS 2498 on vine length/plant (7.61%), number of leaves/plant (14.95%), fresh pruning weight/plant (42.60%) and weight of root tuber/plant (64.58%). Beside the high productivity of the pink-fleshed variety (TIS 87/0087), it is the preferred species, based on the beta-carotene content, considered as a vitamin A precursor (Baker, 1970). Estimated 100-250 million pre-school children alone were affected by severe vitamin A deficiency (Fritschel, 2000). The deficiency of vitamin A is the cause of night blindness being the first stage in a set of increasingly severe eye problems as well as the cause of an impaired resistance to infections (Benson, 2004), which consumption of sweet potato can solve. With sustained high yield potential of sweet potato, "hidden" hunger reduction can be achieved as envisaged in the slogan of the 1996 World food summit "food for all" (Messer *et al.*, 2001) and utilized as a calamity crop (CIP, 1998).

Table 2: Main effects of variety on the growth and yield parameters of sweet potato plant

Parameters					
Variety	Vine length cm/plant	Number of leaves/plant	Pruning weight g/plant		Weight of root yield (kg)
			Fresh	Dry	
TIS 87/0087	169.75	217.25	482	241	5.53
TIS 2498	157.75	189.00	338	232	3.36
CV%	7.61	14.95	42.60	3.88	64.58
F-LSD (p=0.05	Ns	ns	0.75	Ns	1.71

CV= coefficient of variation.

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The effect of variety and pruning time on the fresh pruning weight (g) per plant was significantly (p=0.05) different among the three pruning times with the highest pruning weight in the 12WAP for both varieties (Table 3). Obtaining the highest fresh pruning weight 610g (TIS 87/0087) and 470g (TIS 2498) is as expected, because the vines had longer time to branch out and lengthen more than in early days after planting, as evident in Table 1 and reported by Crowder and Chedda (1982).

Table 3: Effect of variety and pruning time on the fresh pruning weight (g) of sweet potato plant

	Pruning Time				
Variety	4WAP	8WAP	12WAP	0WAP	Mean
TIS 87/0087	317	520	610	-	482
TIS 2498	250	293	470	-	338
Mean	284	407	540	-	

F-LSD (p=0.05) = 0.75 for comparing two variety means
= 1.06 for comparing two pruning time means
= 0.53 for comparing two variety x pruning time means
Key: 0WAP = zero pruning. No pinching back at any week after planting

Delayed pinching back time (12WAP) or zero pinching back (0WAP) did not disturb the process of photosynthesis at the time of root tuber initiation, which translated to the significantly (p=0.05) high root weight obtained (Table 4). At 12WAP, TIS 87/0087 produced 5.53kg/plant of root tubers, while, TIS 2498 produced 3.62kg/plant, which agreed with the observations of Ahn (1993). When there was no pinching activity (0WAP), the root tuber yield of the pink-fleshed variety was 6.69kg/plant and the cream fleshed variety was 4.42kg/plant. This result corroborates the observations of Uddin *et al.* (1994), Kiozya *et al.* (2001) and Nwokocha *et al.* (2000) that defoliation had a depressing effect on root tuber production in sweet potato and the converse is true in this case.

Table 4: Effect of variety and pruning time on the root tuber weight (kg/plant) of sweet potato plant

	Pruning Time				
Variety	4WAP	8WAP	12WAP	0WAP	Mean
TIS 87/0087	4.93	4.98	5.53	6.69	5.53
TIS 2498	2.53	2.85	3.62	4.42	3.36
Mean	3.73	3.92	4.58	5.56	

F-LSD (p=0.05) = 1.71 for comparing two variety means
= 1.42 for comparing two pruning time means
= 1.21 for comparing variety x pruning time interactions means
Key: 0WAP = zero pruning. No pinching back at any week after planting

5 CONCLUSION

Influence of pinching back activity on sweet potato root tuber yield and fresh pruning weight (as leafy vegetable production) for human consumption was determined in Abakaliki, Southeastern Nigeria. Early pruning (4WAP) depressed pruning weight and root tuber yield per plant, while delayed or zero pruning (0WAP) yielded more root tuber and fresh pruning vegetables for human consumption. It is therefore important to practice pinching back at 12WAP for dual purposes (source of vegetable and root tubers), 4WAP, when need for vegetables weighs more and 0WAP, when need for staple weighs more. Due to its high productivity and its high provitamin A beta-carotene content, the pink

fleshed variety (TIS 87/0087) is highly recommended as a veritable crop for fighting hunger and vitamin A deficiency over the cream fleshed variety, in Africa. Moreover, the versatility, flexibility and dependability of sweet potato crop make it command a leading role in warding off hunger in the tropical world.

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