

EFFECTS OF PROGRESSIVE EDIBLE LEAF AND TUBER
REMOVAL ON YIELD AND DEVELOPMENT OF TWO DUAL
PURPOSE SWEET POTATO (Ipomoea batatas (L.)
Lam.) CULTIVARS

BY

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DECLARATION

I, Florence James Teri, do hereby declare to the Senate of the Sokoine University of Agriculture that this thesis is my own original work and that it has not been submitted in whole or in part, for a degree award in any other University.

Date: 18.6.86

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Signature

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ABSTRACT

Two dual purpose sweet potato (*Ipomoea batatas* (L) Lam.) cultivars "Bangi" and "Simama" differing in shoot morphology were subjected to differential leaf and tuber harvest combination under field conditions at Morogoro. The aim was to find out the effect of leaf and tuber harvesting combinations on tuberous and edible leaf yield, plant development and the adaptability of the cultivars to two tuber harvesting methods. Either edible leaves, edible tubers or both leaves and tubers were progressively removed. The control treatment consisted of a single final tuber harvesting without leaf or tuber removal. Leaf and tuber harvesting treatments were imposed monthly commencing at 77 and 99 days from planting respectively. Sample plants for the determination of dry matter distribution with time in leaves, stems and roots were taken three times at monthly intervals starting at 75 days from planting.

The erectophile cv "Simama" gave a significantly higher total yield (4.4 t/ha) and fresh edible leaves (1.09 t/ha) over the procumbent cv "Bangi". In cv "Bangi" progressive removal of both leaves and tubers gave 2.6 t/ha tubers above control and 0.6 t/ha above

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control where only tubers were progressively harvested. Progressive removal of leaves in cv "Banggi" had 2.4 t/ha below control. In cv "Simama" progressive harvesting of both tubers and leaves gave 1.8 t/ha fresh tubers above control and 1.5 t/ha above control where only tubers were progressively removed. Where only leaves were progressively harvested, tuber yields were 0.6 t/ha above control. Progressive harvesting of both tubers and leaves yielded 3.1 t/ha fresh tubers more in cv "Simama" than cv "Banggi" and 1.04 t/ha fresh edible leaves. Removal of leaves resulted in an increase of 6.9 t/ha fresh tubers and 1.4 t/ha edible leaves in cv "Simama" over cv "Banggi". In plants where only tubers were removed cv "Simama" had 3.6 t/ha over cv "Banggi". The progressive method of tuber harvesting had an overall higher tuberous yield compared to single method but the number of pig tubers was high.

During the first 10 weeks of growth, per cent dry matter distribution in leaves was about 50 of the total plant dry matter in all the treatments. But 15 weeks later dry matter in roots had increased to an average of 34.1 per cent. Nineteen weeks after planting the proportion of dry matter in roots was significantly

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higher than that in leaves or stem. Final dry matter distribution in roots was higher in the treatments whose tubers were harvested once in both cultivars. Leaf picking affected the performance of cv "Banggi" but not cv "Simama". Combination of progressive removal of both leaves and tubers gave highest fresh tuber yield in both cultivars. Sink rather than source seem to be more important in sweet potato yield, but the performance of the two cultivars showed that a good source is also important.

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1. INTRODUCTION

The sweet potato, Ipomoea batatas (L.) Lam., originated in Central America or North-West South America where it must have been cultivated for thousands of years (Cobley and Steele 1975, Onwueme 1978). The plant is a perennial herb, but treated as an annual in cultivation. It has vine-like trailing or twinning stems, one to five metres long with latex in all its parts. The sweet potato has been fully described as a crop by Acland (1971), Edmond (1971), Cobley and Steele (1975) and Onwueme, (1978).

Sweet potato is one of the most important food crop throughout the tropical, sub-tropical and at least half of the temperate zone (Miller and Hernandez, 1970). It is the sixth most important food crop in the world. Annual production is about 1.4×10^7 t from 1.5×10^7 ha (FAO, 1977). In East Africa and other parts of Africa sweet potatoes are gradually replacing yams because they give a quicker return with less work involved (Purseglove, 1957).

Tuberous roots and leaves are eaten. The roots are used mainly as a source of carbohydrates. The leaves used as relish are a good source of minerals and protein. The roots and leaves have substantial amounts

of vitamins, particularly, pro-vitamin A. Consumption of sweet potato tender shoots and leaves is popular in areas like Philippines, Indonesia, Thailand and Malaysia (Anon. 1976, Villareal et al. 1979). Sweet potato greens are particularly important in West Africa and varieties have been developed that are used only for the leaves (Martin and Ruberte, 1979). Recently at the Asian Vegetable Research and Development Centre (Anon. 1983) a variety with tender light green leaves has been developed for use as a leafy vegetable. The leaves could help alleviate nutritional problems such as night blindness, scurvy and anaemia among the inhabitants of the tropics (Villareal et al. 1982). Some selected varieties at Ukiriguru, Tanzania have shown good potential in high fresh tuber yield and yield of the tops^{per} unit area (Msabaha, 1979). The varieties had fresh tops yield ranging from 16.7 to 44.1 metric tons per hectare whereas the fresh tuber yield ranged between 26.7 and 40.0 metric tons per hectare in six months. Nutritive values for tuber and leaves has been described by Onwueme (1978).

The sweet potato is also important as an animal feed (Hahn, 1980; Selleck, 1982). In the villages, roots are chopped or cooked by the farmer before being

fed to the animals. Where more sophisticated technology is available, roots are processed into chips before being fed to the animals. It is also used as a raw material for industrial purposes (Selleck 1982, Hahn 1980).

As a tuberous starchy crop, the sweet potato combines a very high tuber yield potential (de Vries et al. 1967, Rehm 1982) with leafiness (Hahn 1977, Dahniya 1979). The crop has a tremendous capacity to produce dry matter per unit of land and time. The calorie production from the edible root of sweet potato in Japan is 2.94×10^7 Kcal/ha (Murata et al., 1976). This is an average root yield of 2.1×10^7 Kcal/ha in five months; a value almost five times that of rice which has an average yield of 4.5×10^3 kg/ha in Japan (Murata et al., 1976).

The crop is grown over a wide range of environmental conditions and can produce considerable crop on land of low fertility (Hahn 1977a, Hahn and Hozyo 1980). It requires low production inputs compared with other food crops and is less vulnerable to adverse conditions such as drought and heavy storm (Hahn 1980).

In Tanzania and East Africa as a whole cassava

and sweet potato are the most important root crops (Acland, 1971, FAO, 1982). Sweet potato is however more widely distributed. The tubers constitute much of the main diet of peoples over much of Tanzania (Anon. 1967); and tender leaves are a popular green vegetable (Msabaha 1979). The crop is used as a buffer against famine for once established, the plant will subsist through adverse conditions. Major sweet potato growing areas in Tanzania are shown in Appendix 1.

In order to supply both tuberous roots and leaves, most subsistence farmers practise progressive harvest of either leaves, tuberous roots or both throughout the cropping cycle. Leaves or tubers are harvested as needed allowing ample time for formation of new tubers and leaves on the same plant. The process is repeated until no more leaves or tubers can be harvested. Earthing up the vines after harvesting the tubers induces successive crops to develop. This periodic or progressive harvesting technique is most suitable in subsistence farming. It is not wasteful and it does not require storage facilities. It acts as a means of storage and maintains the crop in a more or less perennial state. Acland (1971) reported that in some parts of East Africa the crop has been maintained in

field for as long as six years. The method of progressive harvesting is common in Eastern Africa (MacDonald, 1963, Aldrich, 1963), West Africa (Dahniya, 1980), Papua New Guinea (Kimber, 1972, Rose 1979, Onwueme 1978) and Asia (Gonzales et al., 1977, Villareal et al., 1982).

Most research attention has been directed towards tuberous root yield in response to defoliation. Virtually no published data exists on reciprocal effects of tuber and leaf removal on yield and plant development. Dahniya (1979) reported that detopping reduced tuberous yield by up to 48% and individual tuber size was reduced by increased detopping frequency in agreement with findings of Gonzales et al. (1977). Villareal et al. (1979) noted however that the decrease in tuber yield in response to frequent leaf removal depend upon variety. Rose (1979) observed the effect of progressive tuber removal on tuber yield and noted that although total tuber yield increased, marketable tubers decreased.

Plant development is affected by removal of tubers and leaves. Austin and Aung (1972), and Austin et al. (1970) noted that there is a high correlation between the development of the tops and the storage

root weight. Also the increase in sweet potato storage root weight followed a linear growth pattern with time. Thus the objectives of this study were:

- (a) To compare the yielding capacity of both tubers and leaves from progressive and single harvested plants.
- (b) To determine the adaptability of two morphologically contrasting sweet potato cultivars to the progressive methods of harvesting.
- (c) To determine reciprocal influence of either leaf or tuberous root removal on yield and plant growth in two dual purpose sweet potato cultivars.

2. LITERATURE REVIEW

The sweet potato can be harvested either progressively or once over. The progressive, periodic or peacemeal method involves the removal of tubers as they mature. The plant and its ridge or mound are given minimum disturbance in so doing. The single or once over method of sweet potato harvesting involves removal of all the crop at maturity. Normally, in subsistence farming the tops are removed, then either forks or sticks are used for removing the tubers.

In most parts of the tropics, harvesting is done by hand and tubers are harvested progressively (Aldrich, 1963; MacDonald, 1963; Acland, 1971; Onwueme, 1978). This system has been evolved to give a continuous supply of food over a period of time (Aldrich 1963, Kimber 1972).

Once harvested the sweet potato tuber deteriorates very quickly (Gooding and Campbell 1964). It was reported by MacDonald (1963) that though sweet potato occupies large acreages in the tropics, it has not become a major food because of storage problem. Therefore, the progressive method of harvesting acts as a means of storage (Kimber, 1972). Most frequently, all

the tubers on a given plant do not reach maturity at the same time. The method therefore allows harvesting to be done at a time when a reasonable number of tubers are mature (Onwueme 1978). The method is particularly useful in the long maturing varieties which take up to six months to give reasonable crop. Because of the delayed tuber formation those varieties can be safely left in the ground for a longer period. Aldrich (1963) and Rose (1979) noted that within limits, yield per hectare increases the longer the crop remains in the ground. In the tropics where mechanical harvesting is not common, the method is useful because of high labour requirement. An experiment in Uganda showed that harvesting requires 40% of total labour (Aldrich, 1963). Austin (1970) reported that for the future of the sweet potato industry, the harvesting labour problem which is approximately 33% of total labour must be solved.

The progressive method of harvesting sweet potatoes however, places a heavy reliance on earthing up the vines. It is feasible where rainfall and favourable temperatures are available all the year round (Onwueme, 1978). If the crop is left in the ground too long, the tubers become fibrous, unpalatable and are prone to attack by the sweet potato weevil and

Rose (1979) compared the single and progressive methods of tuber harvesting and found that progressive harvesting yielded less than single harvesting. She also found out that tuber yield and bulking rate were higher in progressive than in single harvesting.

The yield of a crop is dependent on the production of photosynthates by a source and the degree of accumulation in a sink (Dahniya, et al., 1982). In sweet potato the roots which accumulate assimilates are the predominant sink. The shoots, mainly leaves, which produce assimilates, are the source (Hahn, 1982). Investigations by Hahn (1977b) with reciprocal grafts of sweet potato revealed that varieties with large sink capacities had a greater response of sink to source. Those with large source potentials showed greater response of source to sink. Humphries (1967) reported that tuber yield after tuber initiation depends both on the capacity of the shoot system to produce assimilate and on the development of the tubers to produce a sink for such assimilate.

Economic yield of sweet potato may be limited by either photosynthetic source potential or tuberous root sink capacity (Hahn 1977b). With sweet potato in the

tropics which has not been subjected to much improvement the sink may be more limiting on tuberous yield than source activity (Hahn 1977a). However Loomis and Rapoport (1976) reported that if nutrients and water are not limiting, source activity is usually the most limiting part of the system. It was further concluded by Evans (1975) that source-sink and transport systems are relatively well balanced in most crop plants to the side of source limitations.

Photosynthesis is closely related to source and sink. From the reciprocal graft between cultivated sweet potato, Ipomoea batatas, and its related species Ipomoea trifida, Hozyo and Park (1971) and Hozyo (1977a) reported that photosynthetic activity was higher when cultivated sweet potato with higher sink was used as a stock. Based on these results, Hozyo and Park (1971) and Spence and Humphries (1972) support the view that the rate of photosynthesis depends on the demand of sink for photosynthates.

There is ample evidence that assimilates accumulate in the leaves of plants that lack adequate 'sinks'. Nosov (1959) observed that removing cotton bolls halved photosynthetic activity of the leaves in 24 hours. Kiesselbach (1948) similarly found that

removing maize flowers decreased fodder yield by 27 per cent. Experiments in which size of sink is changed also support the idea that sink capacity and photosynthesis are positively correlated. Burt (1964) found that removing potato tubers 21 days after they formed slowed the net assimilation rate. He suggested assimilation by the leaves in bright light may be restricted by their ability to use or store products of photosynthesis.

Nosberger and Humphries (1965) confirmed that removing tubers depressed net assimilation rate of potato plants and increased carbohydrate content of stems and leaves. Tsuno and Fujise (1965) pointed out that exposing tubers to light inhibit growth. This results in treated plants photosynthesizing less and their leaves to have more starch. They detected no change in the diurnal course of photosynthesis. They concluded that the rate of movement from the leaf and not the accumulation of carbohydrates controls rate of photosynthesis.

During the early growth a leaf will require carbohydrates from other parts of the plant for its development. Once a leaf is fully expanded it is no longer capable of importing assimilates even when placed in darkness (Rabideau and Burr, 1945; Aronoff, 1955; Doodson et al. 1964 and Williams, 1964). The amounts

of translocate to the leaf rises up to the maximum expansion of the leaf, then declines as the rate of growth decreases and its own photosynthetic system comes into full operation. Ultimately, the amount of labelled imports falls to a very low level which is reached at the time when growth in length of leaf ceases. It was reported by Evans and Wardlaw (1966) that it is not until a leaf has reached between one third and half of its final area that the carbohydrate produced through its own photosynthesis are adequate for its own growth requirements. Then export of assimilates commences.

Austin and Aung (1972) measured growth during field development of Ipomoea batatas cultivars. They observed that attainment of maximum vegetative top growth preceded storage root development. Also, a high degree of correlation was observed between the development of the top and storage root weights. Dry matter distribution in leaves, stems and roots were found to change linearly with time and cultivar (Austin et al., 1970).

Tuber development is defined as the qualitative changes in growth which take place in the sweet potato root system in the course of the transformation of

potentially tuberous roots into mature tuber (Wilson, 1962); which occurs during the eighth to twelfth weeks. The tuberization process is recognised by the formation of uniformly thickened string roots. Lowe and Wilson (1974) found that 92 - 100 per cent of final tuber length was established by 16 weeks after planting.

Development of tuber involves a series of qualitative changes in growth, the most important of which appears to be the relative activity of cell division and cell expansion versus cell lignification (Wilson, 1982). Such relative activity leads to either tuber initiation or the generation of alternative root types such as pencil roots. It delimits the tuber stalk, defines the length of the tuber and later determines its rate of lateral growth to give rise to tubers of different shape.

Light, dry, and compact soil (Akita et al., 1960), water logged soil conditions (Togari, 1950) gibberellin and long days (McDavid and Alamu, 1980) are known to encourage lignification and frustrate tuber development. Alternatively, dark conditions (Akita et al., 1960; Fujise and Tsuno, 1967), high potassium supply (Tsuno and Fujise, 1967), well aerated soil conditions, low temperature (Togari, 1950 and Kim 1961), short days and

kinetin (Spence and Humphries, 1972; McDavid and Alamu, 1980) have been shown to encourage tuber development.

Wilson (1982) defined tuber growth as the quantitative changes in the size and weight of tubers which take place in the course of transformation of sweet potato tuberous roots into mature tubers. According to Hozyo (1970) there is a close relationship between photosynthetic activity and tuberous root growth.

Leaf harvesting has been reported to have some detrimental effect on tuberous root yield of sweet potato. Dahniya (1980) compared effects of harvesting shoots of two varieties of sweet potato 'TIS 2154' and 'TIS 2328'. Harvesting the crop for shoots led to a reduction in tuber yield. The reduction was 48% in var. 'TIS 2328' and 31% in var. 'TIS 2154'. Harvesting the shoots at the base led to a reduction of 62% for var. 'TIS 2328' and 50% for var. 'TIS 2154'. Similar results were reported by Gonzales et al. (1977) who found that topping the sweet potato plants reduced tuberous root yield. Highest tuber yield was obtained where no topping was done. Bartolini (1982), however noted that timing of the leaf harvesting is important.

Topping is detrimental to tuberous root production when done beyond two months from planting. According to Wilson (1974) rapid root formation and development takes place at this time. Villareal et al., (1979b) observed that frequent harvesting of leaves reduce tuber yield, but the degree of reduction differs with variety. Some varieties were found to yield 15 tons per hectare of fresh tubers and 14 tons per hectare of fresh tips while others had 1 ton per hectare fresh tubers and 14 tons per hectare fresh tips (Villareal, 1979b). However, frequent or continuous topping increase yield of the toppings (Bartolini, 1982; Dahniya et al., 1980); and Dahniya (1979) noted that topping sweet potato plants twice at the base resulted in higher shoot yield.

MATERIALS AND METHODS

A 2 x 4 factorial field experiment in a randomized complete block design was conducted at Sokoine University of Agriculture, Horticultural Unit, Morogoro, Tanzania. The experiment was conducted between March and September 1983. Weather conditions for the period is shown in Appendix II. The treatments were arranged in four randomized blocks, one factor being the two cultivars, and the other a combination of leaf and tuber harvesting.

The field was ploughed and harrowed during March 1983. Plot size was 5.4 x 3.9 metres and total number of plots was 32. Three metres were allowed between replications and two metres between plots. Each plot consisted of seven ridges, 5.4 metres long, 30 cm wide and 35 cm high. Eighteen cuttings each 30 cm long were planted 30 cm apart along the ridge on 28th March, 1983. The cuttings were dipped in a 5% DDT solution as a measure against the sweet potato weevil. The crop was rainfed (Appendix II) and plots were weeded twice. No chemical spray was done.

The area used for the experiment has been fallow

for three years. Soil analysis data is shown in Appendix III. No fertilizers or manure were applied. Planting was done by women. Aldrich (1963) and Acland (1971) reported that womenfolk are most familiar with day to day management of sweet potato plots in the tropics. They are able to distinguish and name each variety and give some information about their characteristics. They also are the ultimate harvesters of leaves for cooking.

One of the cultivars used was 'BANGI', a local cultivar with small narrow leaves which have purple veins. The cultivar is procumbent in habit and tubers are white-fleshed (Plate 1a). The other cultivar 'SICAMA', is an erectophile local cultivar with medium size leaves which have green veins. The stem is thicker compared with that of cv 'Bangi' and tubers are yellow-fleshed (Plate 1b). Both cultivars were collected from a nearby village where they are commonly grown.

Beginning at 75 days from planting, three plants were taken randomly from each plot three times at a monthly interval. These plants were separated into edible leaves, leaves, stem and roots and tubers. These were oven dried to a constant weight and weighed. Stand count was done before harvest operations.



Plate 1a: Mature plant of sweet potato cv 'Bangsi'.



Plate 1b: Mature plant of sweet potato cv 'Simama'.

Monthly leaf and tuber harvesting treatments were imposed 77 and 99 days from planting respectively. The leaf and tuber harvest operations were done three times. At each tuber harvesting operation digging sticks were used. All mature tubers were carefully removed. The presence of cracks on the side of the ridge was used as an indication that sizeable tubers were present, and digging was done at that spot. The rest of the plant was given minimum disturbance and earthing up was done. A sample from each progressively harvested tubers was taken and oven dried for moisture content determination. Final tuber harvest for the progressively harvested treatments was done 180 days from planting. The single harvested treatments were harvested 141 days from planting.

At each tuber harvesting operation, tubers were graded into marketable, (tubers $> 100\text{g}$), and pig tubers or culls, (tubers $\leq 100\text{g}$); following the method by Rose (1979). The tubers were then counted and weighed. Edible leaves picked and weighed immediately to avoid weight loss. At the two final single and progressive tuber harvesting operations, the tops (branches and leaves) were weighed. Data were analysed according to the standard method of analysing factorial experiments as described in Steel and Torrie, (1960).

RESULTS

Total edible leaf yield, total tuber yield, marketable tubers and pig tuber percentage for cv 'Bangsi' are shown in table 1a. Edible leaf yield was reduced by progressive removal of leaf and tuber when compared to leaf removal alone without periodic tuber harvesting. Progressive harvesting of both leaves and tubers promoted highest tuber yield/ha and increased both tuber number/plant and tuber weight. Progressive tuber harvesting alone also resulted in higher tuber yield compared to the once-over tuber harvesting method when leaves were left unpicked by increasing tuber number/plant but not tuber weight. Progressive leaf removal alone was detrimental to total and marketable tuber yield and to tuber weight. The control plants had lowest tuber number per plant and highest marketable tuber weight. Progressive harvesting of tubers alone resulted in highest number of marketable tubers/plant. Progressive leaf picking alone increased percentage of pig tubers.

Total edible leaf yield, total tuber yield marketable and pig tuber percentage for cv 'Simama' are shown in table 1b. Total edible leaf yield was highest where tubers were harvested once over. Periodic

Table 1a: Edible leaf, total and marketable tuber yield of sweet potato cv 'Bangli' subjected to reciprocal progressive (periodic) leaf and tuber harvesting regimes.

Treatment combination	Total tubers			Marketable tubers			Total pig tubers %	
	Fresh leaf (t/ha)	Tuber no./plant	Fresh wt. (t/ha)	Fresh tuber wt. (g)	Tuber No./plant	Fresh yield (t/ha)		Fresh tuber wt. (g)
Leaves in tact, tubers harvested once-over (control)	-	1.52 de	7.1 ed	152.8ab	0.58f	5.85e	329.61	17.00 ns
Progressive leaf harvesting tubers harvested once-over	1.64bc	1.51e	4.7d	101.7b	0.65f	5.7e	188.3b	22.80 ns
Progressive harvesting of both leaves and tubers	1.59c	2.1cde	8.7abcd	158.9a	1.12def	6.29de	189.9b	13.60 ns
Progressive harvesting of tubers only	-	2.2acd	7.7bcd	111.3ab	1.15dcf	6.52de	186.1b	14.93 ns

Figures on each column followed by the same letter are not statistically significant using Duncan's New Multiple-range test.

ns = not significant

Table 1b: Edible leaf, total and marketable tuber yield of sweet potato cv 'Simama' subjected to reciprocal progressive (periodic) leaf and tuber harvesting regimes.

Treatment combination	Fresh leaf (t/ha)	Total tubers			Marketable tubers			Total pig tubers %
		Tuber No. /plant	Fresh wt. (t/ha)	Fresh tuber wt(g)	Tuber No. /plant	Fresh yield (t/ha)	Fresh tuber wt(g)	
Leaves intact, tubers harvested once-over (control)	-	2.1cd	11.0abcd	177.0a	1.28c	9.95abc	265.1ab	15.45 ns
Progressive leaf harvesting, tubers harvested once-over	2.78a	2.3abc	11.6ab	157.9ab	1.31cd	9.62abcd	234.4b	11.90 ns
Progressive harvesting of both leaves and tubers	2.63ab	2.0ab	12.8a	150.9ab	1.86ab	11.07a	185.0b	12.18 ns
Progressive harvesting of tubers only	-	3.5a	11.3abc	122.1ab	2.04a	10.37ab	190.3b	13.36 ns

Figures on each column followed by the same letter are not statistically significant using Duncan's New Multiple-range test.

ns = not significant

removal of both leaves and tubers resulted in highest total tuber yield/ha. Removal of leaves alone had a superior effect over that of tuber removal alone with respect to total yield. Progressive removal of both tubers and leaves resulted in lowest tuber weight but had highest tuber number/plant. Marketable tuber weight and tuber number/plant were increased by progressive tuber removal alone or leaves and tubers together. Leaf removal alone promoted the highest proportion of pig tubers.

Total edible leaf and tuber yields were significantly higher in cv 'Simama' compared with 'Bangi'. Similarly tuber number/plant for both total and marketable tubers was higher in cv 'Simama' than in cv 'Bangi'. Both cvs had highest total tuber yields in plants whose tubers and leaves were progressively harvested. The control plants had highest marketable tuber weight in both cultivars. The cvs did not differ significantly in the percentage pig tubers. Total number of pig and marketable tubers were higher in cv 'Simama' than in cv 'Bangi' (Appendix VII). In both cvs progressive harvesting of tubers had higher number of pig tubers than single tuber harvesting method.

The yield pattern for both cvs when subjected to progressive tuber and/or edible leaf harvesting is shown in table 2. Edible leaf yield decreased with each successive harvest. Cultivar 'Simama' yielded more leaves on the first and second harvest than cv 'Bangi'. There were no differences in leaf yield in the third harvest. Harvesting both leaves and tubers progressively decreased edible leaf yield in either cultivar and the differences were more manifested in the first harvest. With respect to successive tuber yields, cv 'Simama' out yielded cv 'Bangi', but yields became almost equal in the third harvest. In both cultivars, there was a significant reduction in the second tuber harvest and an increase in the final tuber harvest. Progressive harvesting of tubers and leaves significantly depressed tuber yield in the second harvest but increased it in the third.

The effect of reciprocal progressive removal of tubers or leaves in time on percent dry matter re-distribution in the whole plant is shown in Fig. 1-4. Both cultivars had equally high leaf dry matter prior to the first leaf and tuber harvesting. Increased leafiness was evident in cv 'Simama' where either both tubers and leaves or tubers alone were progressively

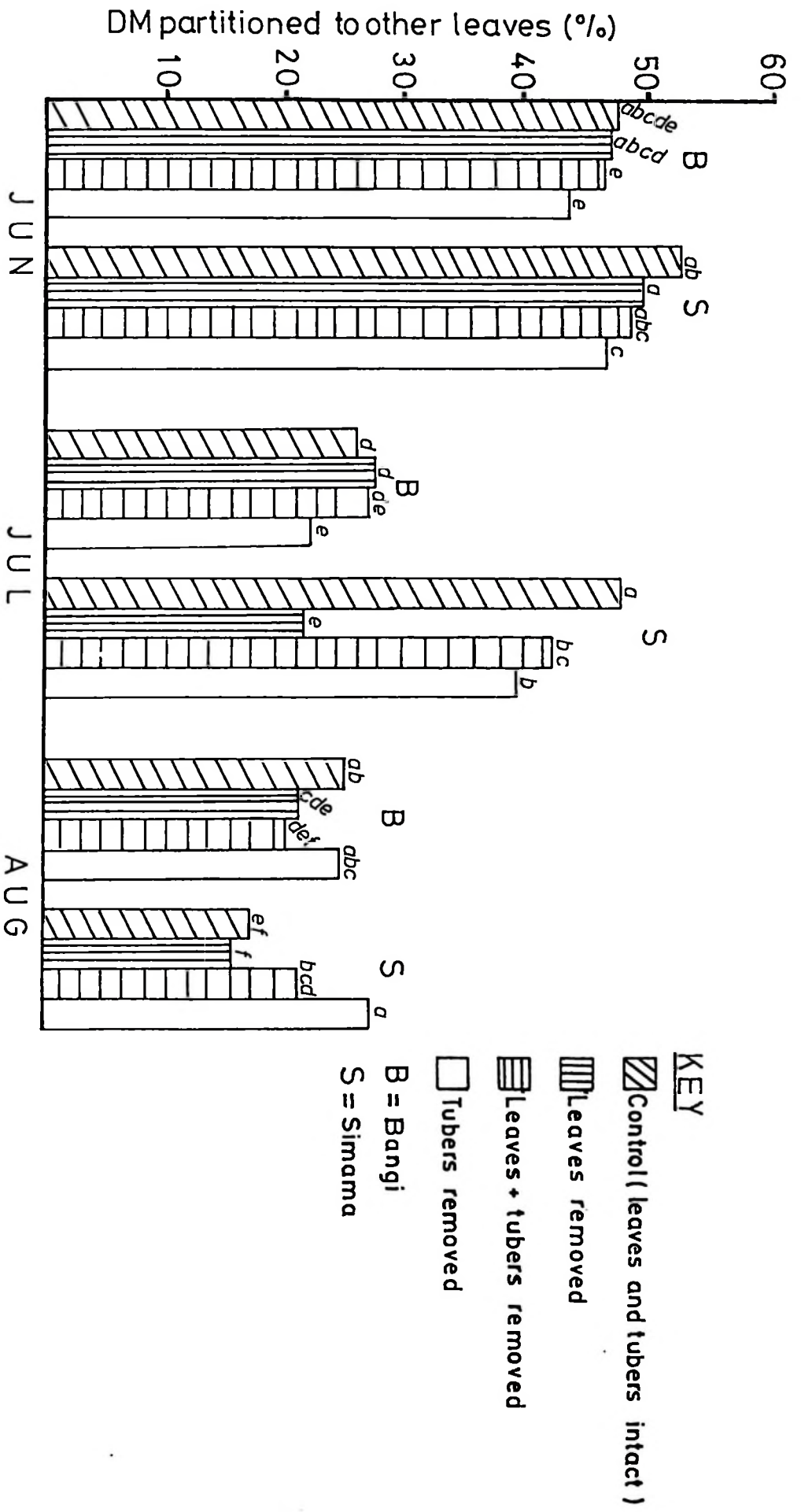


Fig.2. Dry matter (DM) partitioned to other leaves as percentage of total plant DM of sweet potato cultivars 'Bangi' and 'Simama' subjected to different harvesting regimes at different dates. (Bars with similar letters (for both CVs each month) are not significantly different using Duncan's new multiple - range test).

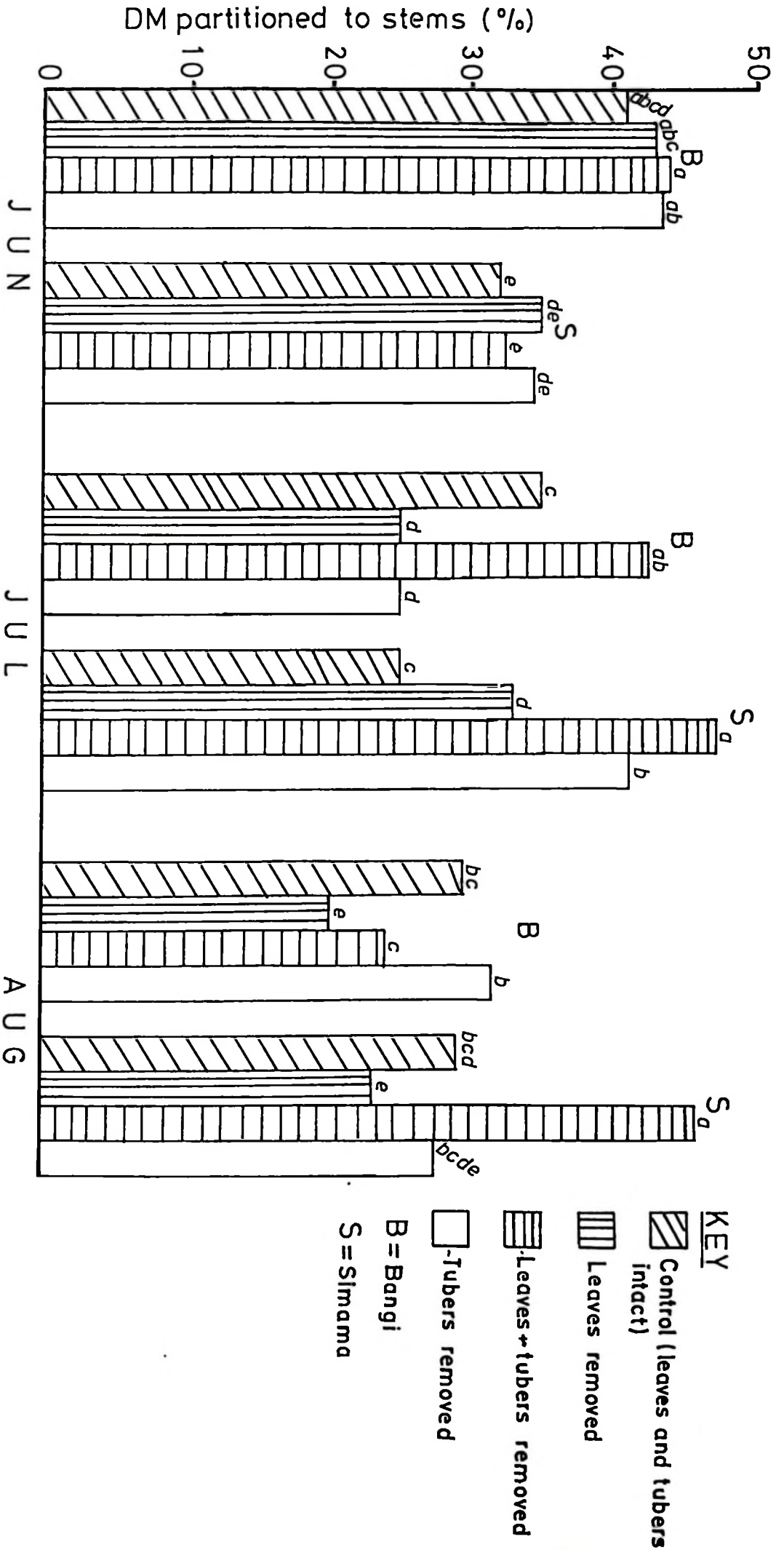


Fig.3. Dry matter (DM) partitioned to stems as percentage of total plant DM of sweet potato cultivars 'Bangi' and 'Simama' subjected to different harvesting regimes at different dates. (Bars with similar letters (for both CVs each month) are not significantly different from each other using Duncan's new multiple - range test)

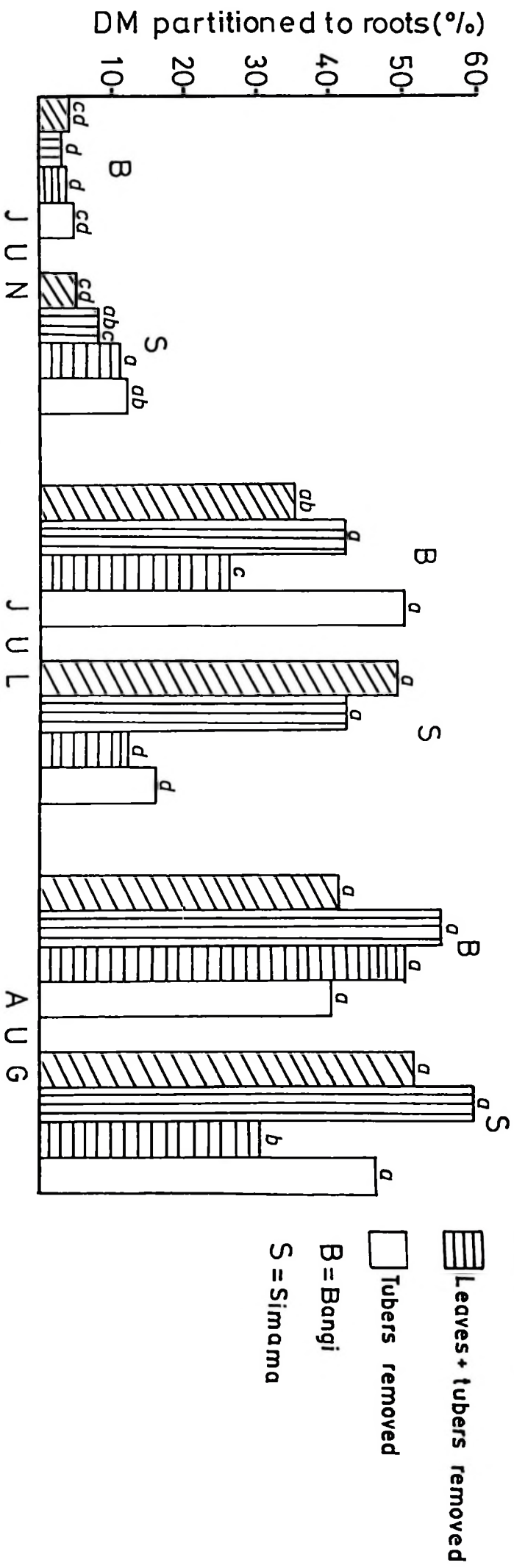


Fig.4. Dry matter (DM) partitioned to roots as percentage of total plant DM of sweet potato cultivars 'Bangi' and 'Simama' subjected to different harvesting regimes at different dates. (Bars with same letters (for both CVs each month) are not significantly different using Duncan's new multiple-range test)

removed compared with when only leaves were picked or plants were left undisturbed. For cv 'Bangi', the removal of tubers suppressed leaf growth for the sample harvested in July while other harvesting regimes showed little differences. There was a general decline in leafiness towards the final sample taken in August in both cultivars except in cv 'Bangi' when tubers alone were progressively removed. In cv 'Simama' progressive leaf and tuber, or tuber removal promoted leafiness.

Dry matter partitioned to the roots was the lowest prior to the first harvesting but cv 'Simama' had twice the root dry weight of cv 'Bangi'. Cultivar 'Bangi' partitioned relatively more dry matter to the stem. Differences in dry matter partitioning to roots was concomitant in July and August. While progressive tuber or leaf harvesting increased root dry matter in cv 'Bangi', removal of either tubers alone or both leaf and tuber significantly, suppressed it in cv 'Simama' resulting in diverting dry matter to the tops. In samples taken in August, dry matter partition in roots was highest in cv 'Bangi' in plants whose leaves or both leaves and tubers were progressively harvested. Where leaves were intact and tubers either harvested once or progressively, dry matter partitioning to roots was lower but higher

amount of dry matter was partitioned to stems. The rate of dry matter partitioning to roots for cv 'Simama' was highest where leaves were progressively picked and in the control. Progressive harvesting of tubers thus favoured dry matter partition to roots in this cultivar. Progressive removal of both leaves and tubers had lowest dry matter partitioned to roots in cv 'Simama' in the final sample but highest dry matter in stem than all the treatments in both cultivars. Total dry matter partitioned to roots was significantly higher in cv 'Simama' than cv 'Bangi'.

Figure 5 shows per cent moisture content of the tubers of the two cultivars which were harvested progressively. In cv 'Bangi' there was little variation in per cent moisture content with time for tubers whose both leaves and tubers were harvested. There was a reduction in moisture content of tubers harvested in August and September compared to those harvested in July where only tubers were harvested progressively. Per cent moisture for cv 'Simama' was lowest where tubers and leaves were harvested progressively in tubers harvested in July. There was no increase in moisture content for the tubers harvested in July and August where only tubers were harvested.

The bulking rates of the tubers which were progressively harvested and average final bulking rate for all the treatments is shown in table 3. Lower bulking rate was evident in the first harvested tubers in cv 'Bangi' compared with cv 'Simama'. This was more pronounced in the treatment where only tubers were progressively harvested. In the second harvest bulking rate in this treatment increased but still cv 'Simama' had a higher bulking rate where both tubers and leaves, and tubers only were progressively harvested. Bulking rates for the final progressively harvested tubers were more or less similar except in cv 'Simama' where a reduction in bulking rate was evident in the treatment where only tubers were progressively harvested. The overall average final bulking rate for single and progressively harvested tubers showed some variation between and within cultivars. Cultivar 'Simama' had an overall higher bulking rate compared with cv 'Bangi'. Highest bulking rate for cv 'Simama' occurred where leaves were progressively harvested and tubers harvested once-over, followed by the control. Similar treatment in cv 'Bangi' had lowest bulking rate. Harvesting leaves and tubers progressively had highest bulking rate per day in cv 'Bangi'.

Table 3: Bulking rate (gm/day) of the progressively harvested tubers and final bulking rate (gm/day) of all the treatments.

Treatment combinations	JULY		AUGUST		SEPTEMBER		Average final bulking rate (gm/day)
	Fresh wt. (kg)	Bulking rate (gm/day)	Fresh wt. (kg)	Bulking rate (gm/day)	Fresh wt. (kg)	Bulking rate (gm/day)	
CV 'Bangri', leaves intact, tubers harvested once-over (control)	-	-	-	-	-	-	235.18
Progressive leaf harvesting, tubers harvested once-over	-	-	-	-	-	-	154.18
Progressive harvesting of both tubers and leaves	1.57	15.8	1.20	9.25	6.11	35.9	252.94
Progressive harvesting of tubers only	1.21	12.2	2.38	18.3	5.43	30.1	200.38
CV 'Simama', leaves intact, tubers harvested once-over (control)	-	-	-	-	-	-	366.52
Progressive leaf harvesting, tubers harvested once-over	-	-	-	-	-	-	386.31
Progressive harvesting of both tubers and leaves	6.57	64.3	2.56	19.6	6.20	34.4	335.17
Progressive harvesting of tubers only	6.85	69.2	3.02	23.2	3.58	19.8	306.50

Leaf and tuber harvest indices, shoot to root ratio of the two cultivars at different growing periods is shown in Appendix IV. Tuber harvest index 75 days after planting was very low in both cultivars, but more pronounced in cv 'Bangi'. Leaf harvest index was high in both cultivars, while shoot to root ratio was also high particularly in cv 'Bangi'. After 105 days, shoot to root ratio for both cultivars was reduced drastically in all the treatments except where both leaves and tubers, and tubers alone were progressively harvested in cv 'Simama'. The same treatments had lowest tuber harvest index. Tuber harvest index at 135 days was higher than leaf harvest index for both cultivars. Leaf harvest index for cv 'Bangi' was higher than that of cv 'Simama'. Shoot to root ratio was higher in cv 'Simama' where both leaves and tubers, or tubers alone were harvested progressively.

5. DISCUSSION

The erectophile cv 'Simama' had 62 per cent more total fresh tuber yields than cv 'Bangsi'. This was highly significant ($P < 0.05$). The difference in yielding abilities show inherent cultivar differences in yield. The erectophile leaf posture could have given cv 'Simama' an advantage in intercepting more light, thus higher photosynthetic rate. Donald (1968) reported that near vertical leaves will permit adequate illumination of a greater area of leaf surface than will occur in a canopy of long horizontal or drooping leaves. In such canopies the upper leaves will be overlit and the lower leaves harmfully shaded. This was further clarified by Evans (1973) who found that canopies with more vertically inclined leaves have a higher photosynthetic rate than horizontal leaves. Tanner et al., (1966) have likewise found a strong association between high yield and erect leaves among barley, wheat and oat varieties. Cowling (1964) and Chapman and Cowling (1965) reported that vertical leaf display, and by inference photosynthesis might be directly involved in sweet potato yield. Cultivar 'Simama' had broader leaves, and as reported by Tsuno and Fujise (1964) varieties with broader leaves have higher photosynthetic

efficiency.

Cultivar 'Simama' had shorter, thicker semi-trailing stems. This has been found to be of an advantage in many crops. The high yielding varieties of rice in Japan and Taiwan have erect leaves together with short sturdy erect stems (Donald 1968). Cultivar 'Bangi' had longer and thinner stems compared with cv 'Simama'. Chapman and Cowling (1965) noted that there is some relationship between vine growth and yield and that mutual shading was an important factor in yields of sweet potato varieties. Training the vines by artificially altering the leaf distribution improved yields significantly. The shorter stems in cv 'Simama' had a further advantage of shortening the distance from source to sink. This is in agreement with findings of Wardlaw (1965) that distance from source of photosynthates to sink affects the rate of translocation of photosynthates. Morphologically, cv 'Simama' approaches features of the ideotype stipulated by Donald (1968).

The higher tuber yields in cv 'Simama' could have also been attributed to this cultivar having a better sink capacity. Hahn (1977b, 1982) showed that varieties with greater source potentials have greater responses of source to sink. Similarly varieties with large sink capacities had greater responses of sink to

source. In this study it was easier to differentiate the cultivars by the appearance of the plant's leaves (source) than the roots (sinks). But Evans (1975) suggested that it is easier for a plant breeder to identify, evaluate and select for sink efficiency (yield) than for source efficiency (photosynthetic capacity). Hahn (1982) reported that no successful attempt has been made to screen sweet potato for source potential. Furthermore, limitations due to sink activity and transport capacity can easily be demonstrated like removal of developing fruits or girdling (Neales and Incoll 1966, Humphries 1967). Also treatments which increase storage capacity can be demonstrated. Grafting experiments with several sweet potato varieties by Borger et al., (1936) suggest that tuber sizes and starch content are largely independent of the characteristics of the above ground parts. Thus, yield must be largely sink determined, as also in the case of reciprocal grafts between sugar beets (Thorne and Evans 1964) and between high and low yielding sweet potato varieties (Hozyo and Park 1971, Kato and Hozyo 1972, Hozyo 1977). It has been inferred (Wilson, 1967, Hozyo, 1970, 1977) that yield is determined primarily by the root stock rather than the foliar portion of the

sweet potato, based on the fact that the influence of stock on plant production is apparently predominant. However, Hahn (1977) suggested that for good yields in sweet potato selection for source and sink should be done together. Cultivar 'Simama' in this case seems to have both good source potential and sink capacity.

Progressive harvesting of leaves alone had lowest total tuber yield in cv 'Bangi'. The same treatment in cv 'Simama' had second best highest yields. It has been observed by Dahniya (1979, 1980) Dahniya et al., (1981), Gonzales et al., (1977), and Villareal et al., (1979b) that leaf picking reduces tuber yields drastically. Leaf picking has also been found to reduce tuber yields and plant vigour in cassava (Montaldo and Montilla, 1976, Montaldo and Ezumah, 1979, Dahniya, 1980, Dahniya et al. 1981). The results obtained in this study are to some extent contrary to the above findings in cv 'Simama' but are in agreement for cv 'Bangi'. The lower yields in cv 'Bangi' where only leaves were progressively harvested showed that leaf picking was detrimental to tuber yield. Possibly the cultivar had low ability in regenerating new leaves. The low leaf area in this cultivar could not cater for the tubers as well as the developing new leaves. This

supports the views of Hahn (1977b) that although sink could be more limiting to yield, both photosynthetic source potential and storage sink capacity can be rate limiting. In cv 'Simama' the remaining leaves could cater for the tubers as well as developing new leaves.

Highest tuber yields were obtained in the treatments where both leaves and tubers were progressively harvested in both cultivars. Removal of leaves did not affect tuberous yield. The young leaves which were picked are also carbohydrate sinks. They require photosynthates for their growth (Rabideau and Burr, 1945, Aronoff 1955, Doodson et al. 1964, Williams, 1964). The photosynthates which would have been translocated to these young leaves were transferred to the roots. Removal of tubers reduced a carbohydrate sink (Rose 1979). This being a trailing perennial earthing up the vines induced the initiation of new tubers at the nodes (Onwueme 1978). These new tubers, together with the remaining small tubers which were left after progressive harvesting and the development of new leaves provided enough carbohydrate sink for the photosynthates being manufactured by older leaves.

The control in cv 'Simama' had lowest yields and in cv 'Bangsi' the yields of the control was second

lowest. These results are in contrast with the findings of Dahniya (1980, 1981), Bartolini (1982), Gonzales et al. (1977) who obtained highest tuber yields in the control. This reflects the dual nature of the cultivars used. Leaf and tuber harvesting did not reduce yields, thus rendering these cultivars suitable for subsistence farmers.

Reasonable yields were obtained where only tubers were progressively harvested in both cultivars. These yields were not as high as the ones obtained in plants whose both tubers and leaves were progressively harvested. Though removal of tubers reduced a carbohydrate sink (Rose 1979), some new tubers were being formed, and the older leaves had to cater for a succession of new leaves, remaining small tubers, and newly forming tubers. Possibly the leaves could not provide enough carbohydrates for the multiple sinks. It is also plausible that the removal of the major carbohydrate sink, in other words, reducing tuber growth (Tsuno and Fujise, 1964) made the plants divert carbohydrates to the tops and slow down photosynthesis, a form of feedback sink controlled inhibition.

The single method of tuber harvesting had an overall insignificantly lower tuber yields compared with

progressive method. Comparable results were obtained by Rose (1979) who noted that progressive harvesting of tubers gave higher tuber yields in the two cultivars studied. Aldrich (1963) also noted that the method results into higher yields. The significantly higher yields ($P \leq 0.05$) of marketable tubers in the progressively harvested plants are also in agreement with the findings of Rose (1979). Progressive harvesting of tubers had higher number of pig tubers (Appendix VI). Comparable results were obtained by Rose (1979) who reported that removal of the big tubers effectively altered the ultimate size of eventual tubers to the extent that they could not attain marketable size, thus resulting in high proportion of pig tubers. Higher yields in the progressively harvested plants could have been contributed by time factor and the nature of the sweet potato plant whereby new leaves were added to the canopy.

The number of tubers per plant and weight per individual tuber are regarded as components of tuberous root yield (Dahniya et al., 1981). The data obtained on individual tuber weight for total and marketable tuber yields are in agreement with results obtained by Dahniya (1980) who found that zero topping resulted in

highest individual tuber weight. However, where no leaf picking was done tuber number per plant was not highest, contrary to findings of Banniya (1980). This is attributed to the tuber harvesting method in which progressive harvesting and earthing up the vines had higher yields and higher tuber number compared to the single harvest method, thus leading to correspondingly higher tuber number per plant in both cultivars.

During the first ten weeks, per cent dry matter partition to the leaves was higher than that of roots or stem. Partition to roots was very low. After 15 weeks the amount of dry matter in leaves and stem declined gradually while that of roots increased. Lowe and Wilson (1973) found that 92 - 100% of the final tuber length was established by 16 weeks after planting; thus during the period between 10 and 15 weeks tuber development was taking place. Normally, in sweet potato, early growth is dominated by shoot and fibrous root growth, but it is without competition from storage organs (Loomis and Rapoport, 1976). Once tuberization had begun the competitive effects on shoot growth may be quite dramatic, even to the extent that shoot growth may be completely suppressed. Similarly, Hozyo (1970) found that stems and leaves were temporary accumulative

organs of photosynthates during early days of sweet potato growth. These photosynthates were later translocated to roots. Thus the observed dry matter distribution pattern in these cultivars is in agreement with established information on sweet potato developmental physiology.

The samples taken 19 weeks after planting revealed that most treatments had high percent dry matter in roots, however the cultivars differed significantly ($P \leq 0.05$) in dry matter partitioning in roots. The high dry matter in roots at the later part of the growing period agrees with observations by Leopold and Kriedemann (1975) that great bulk of the tuber filling activity occurs very near the end of growth season.

The dry matter partitioning pattern obtained in this study also agree with those of Austin and Aung, (1972) who reported that dry matter distribution in the leaves, stems and roots change linearly with time. Maximum vegetative growth precedes storage root growth. Thus when rapid increases in storage root weights occurred vegetative top weights remained constant or declined. As observed by Austin and Aung, (1973), final amount produced depend on cultivar. In this study cv

'Simama' showed a significantly greater final dry matter accumulation in roots than cv 'Bangi'.

Harvesting tubers progressively significantly affected the final dry matter accumulation in roots for both cultivars. The treatments where leaves were progressively harvested gave significantly lower percent dry matter partition in leaves as would be expected (Gonzales et al., 1977, Dahniya 1980, Dahniya et al., 1981).

The frequency of leaf picking during this study of one month interval was the same as that of Dahniya (1980) and Bartolini (1982) of four weeks. Only in the first leaf harvest did cv 'Simama' give significantly higher leaf yields than cv 'Bangi'. Leaf yields were reduced in both cultivars as the age of the crop advanced. More dry matter was being diverted towards roots as the age of the plants increased. Hozyo (1977) reported that the property of root thickening exerts an influence on the distribution of dry matter to each organ as well as dry matter production. Therefore, in cultivars of Ipomoea batatas most of photosynthates are finally translocated to tuberous roots.

The yields of the edible leaves were very low compared with the ones obtained by Dahniya (1980), Bartolini (1982), Villareal et al., (1979b) or Gonzales

et al., (1977). In this study only the young leaves with their petioles were picked while the other researchers picked the tips including part of the stem which induces more branching and hence more leaves. Some of the cultivars used by Villareal (1979b) or others (Anon.1983) were specifically developed for leaf picking or dual in nature.

The yields of tubers from the first and second harvest period differed significantly ($P \leq 0.05$) between the two cultivars, with cv 'Simama' giving higher yields. Cultivar 'Bangsi' gave higher yields in the final harvest. Yields in cv 'Simama' support those obtained by Rose (1979). The final harvest in cv 'Bangsi' was highest and this shows that it is late maturing.

In cv 'Bangsi' and 'Simama' removal of tubers and leaves reduced bulking rate, in agreement with findings of Burt (1964, 1966); and Nosberger and Humphries (1965) who reported that removal of tubers leads to lower rates of net assimilation rate; and that bulking rate is some function of number of growing tubers and the amount of leaf area. Removal of tubers alone however gave contrary results to the above because it improved bulking rate.

Leaf removal in these treatments had little or no

effect on bulking rate, in agreement with Humphries (1969).

Final bulking rates for the progressive and single harvested treatments showed similar trends as total tuber yield in cv 'Bangsi'. Highest bulking rate occurred where both tubers and leaves were removed, and lowest where only leaves were removed. This is in contrast with results obtained by Humphries (1969) that leaf removal have no effect on bulking rate. Cultivar 'Simama' behaved differently where leaves and not tubers were disturbed, bulking rate was highest and where tubers were disturbed, bulking rate was lower, indicating that tuber removal results in reduction of bulking rate in support of the views of Moorby and Milthorpe (1965) and Burt (1964, 1966). The cv 'Simama' can be described as being unnecessarily leafy with respect to its tuber yielding potential while cv 'Bangsi' appears to be insufficiently foliated on a profusely tuberizing procumbent frame.

SUMMARY AND CONCLUSIONS

The two cultivars studied differ in their response to single and progressive tuber harvesting. In both cultivars, progressive harvesting had higher total tuber yield compared with single harvesting method. Cultivar 'Banggi' had an average of 5.6 t/ha more fresh tuber yield in the progressively harvested plants and cv 'Simama' had an average of 1.5 t/ha more fresh tubers.

Cultivar 'Banggi' had an overall low tuber yields compared with cv 'Simama'. However, the progressive harvesting of tubers gave higher tuber yields in this cultivar. Cultivar 'Banggi' is thus more suitable for the progressive tuber harvesting method than the single method. The cultivar appears to be late maturing and therefore more suitable for progressive harvesting.

Progressive harvesting of both leaves and tubers resulted in highest fresh tuber yield in both cultivars. Though cv 'Banggi' had lower yields, both cultivars are well suited to a combination of progressive leaf and tuber harvesting. Leaf harvesting alone affected tuber yields in cv 'Banggi' drastically. It seems this cultivar is not tolerant to leaf picking. Progressive harvesting of tubers alone gave reasonably high yields in both cultivars, though cv 'Simama' performed better.

Thus, where a farmer is just interested in progressive harvesting of only tubers, cv 'Sinama' is most suitable. These cultivars can be harvested progressively without a significant reduction of tuber yield.

Dry matter distribution in the plant parts increased linearly with time. Progressive harvesting of tubers affected dry matter increase in roots of both cultivars but more in cv 'Sinama'. Progressive harvesting of only leaves resulted in highest dry matter distributed to the roots in both cultivars. In cv 'Bangi' progressive removal of both leaves and tubers had no effect on dry matter distribution in roots but in cv 'Sinama' dry matter distribution in roots was affected drastically. However, the same treatment gave highest tuber yield in this cultivar. In both cultivars, final dry matter distribution in roots was affected by progressive removal of tubers but not the final tuber yield. Total per cent dry matter distribution in roots in both cultivars was similar but yields were different, and by comparison cv 'Bangi' is a lower yielding cultivar.

Results in this experiment suggest that in sweet potato sink could be more limiting to tuber yield than

source. However, a combination of good source and sink gives best yields. For a subsistence farmer, cv 'Sinama' is better because of early maturity, higher tuber and leaf yields and its ability to give higher yields where both tubers and leaves are harvested. Leaf and tuber palatability however, may not coincide with its high yield potential.

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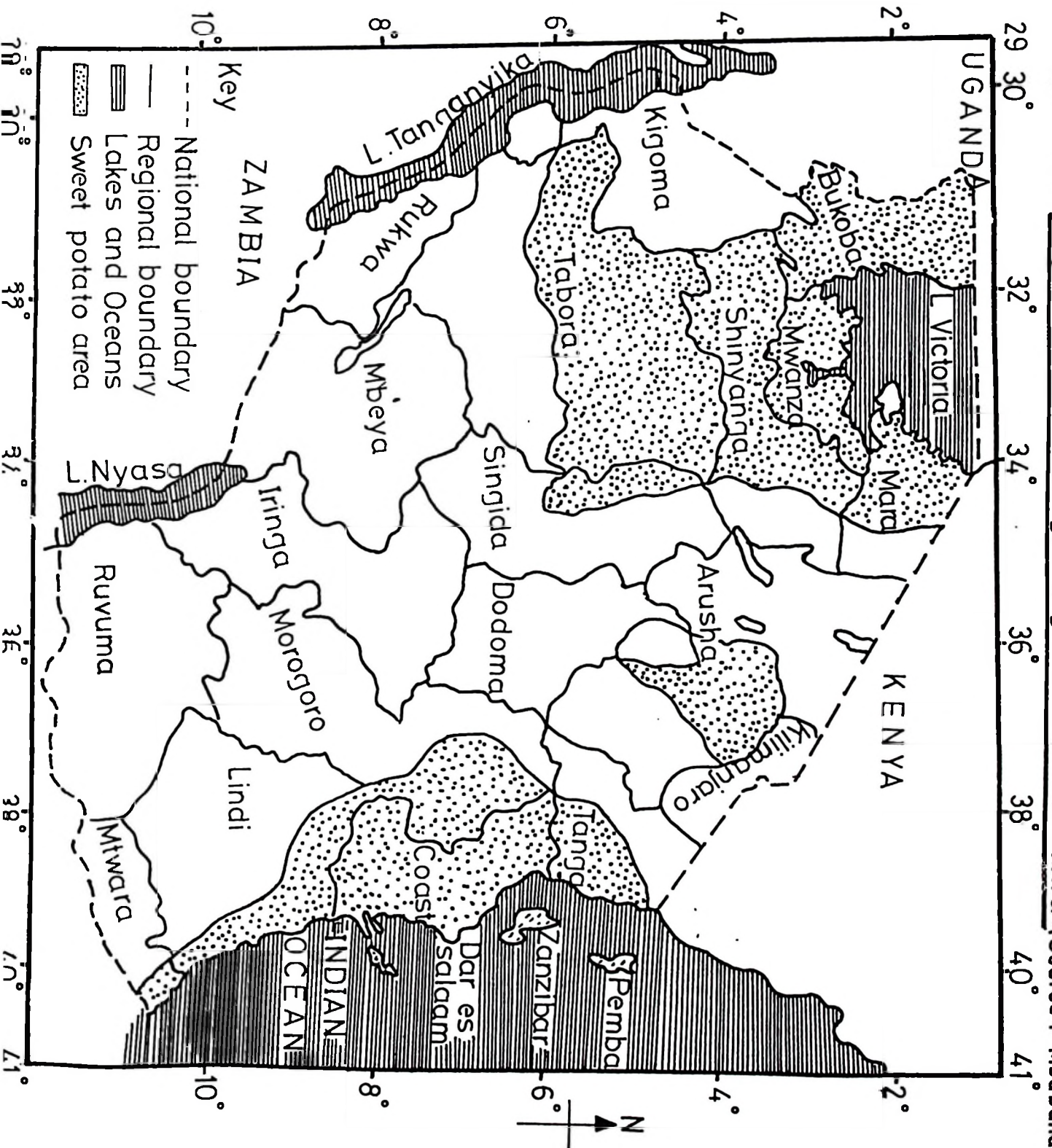
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Appendix 1. Major sweet potato growing areas in Tanzania. (Source : Msabaha 1979)



Appendix II: meteorological data during the experimental period (Morogoro 525m
asl 5 42'S).

Total	March	April	May	June	July	August	September
Total precipitation(cm)	109.5	115.8	142.5	24.6	54.2	2.2	7.3
mean max temp. ($^{\circ}$ C)	33.4	30.8	29.3	28.7	28.4	28.0	30.2
mean max temp. ($^{\circ}$ C)	21.7	21.7	17.5	16.9	15.9	16.3	16.9
mean relative humidity (%)	57.0	65.0	65.0	59.0	50.0	48.0	39.0
Sunshine(hours)	6.0	5.4	5.8	0.97	6.7	5.24	7.7
Radiation (mj)	19.22	14.03	13.24	12.07	14.24	12.97	17.59

Source: Morogoro Meteorological Station.

Appendix III: Edaphological data at experimental site

Depth (cm)	PH	Organic carbon (%)	Total N	Exch H	Phos-phorus um	Sodi-um me/100g	Pota-ssium me/100g	Calcium me/100g	Magne-sium	Zinc ppm/1g	Total CFC	Base satu-ration %	Soil texture
0 - 30	8.3	0.72	0.113	5.90	19.3	0.119	0.641	3.6	4.17	2.25	14.430	59.11	Sandy Clay-loam

Appendix IV: Shoot to root ratio, tuber harvest index, leaf harvest index of sweet potato cultivars 'Bangli' and 'Simama' at different dates.

Treatment combinations	June (75 days)			July (105 days)			August (135 days)		
	Shoot to root ratio	Tuber harvest index	Leaf harvest index	Shoot to root ratio	Tuber harvest index	Leaf harvest index	Shoot to root ratio	Tuber harvest index	Leaf harvest index
<u>Cv 'Bangli'</u> , leaves intact tubers harvested once-over (control)	26.70	0.04	0.55	1.82	0.35	0.30	1.40	0.42	0.29
Progressive leaf harvesting tubers harvested once-over	32.0	0.03	0.54	1.36	0.42	0.32	0.79	0.56	0.24
Progressive harvesting of both leaves and tubers	28.54	0.03	0.52	2.77	0.27	0.31	0.98	0.51	0.25
Progressive harvesting of tubers only	20.70	0.05	0.52	1.02	0.50	0.25	1.45	0.41	0.28
<u>Cv 'Simama'</u> , leaves intact tubers harvested once-over (control)	16.85	0.06	0.62	1.04	0.49	0.26	0.94	0.52	0.20
Progressive leaf harvesting tubers harvested once-over	10.73	0.03	0.56	1.37	0.42	0.25	0.69	0.59	0.17
Progressive harvesting of both leaves and tubers	7.60	0.12	0.56	7.26	0.12	0.41	2.30	0.30	0.24
Progressive harvesting of tubers only	7.45	0.12	0.53	5.28	0.16	0.45	1.16	0.46	0.29

Appendix V: Dry matter (Dm) partitioned to leaves, stem and root (gm/plant) of sweet potato cultivars 'Bangi' and 'Simama' subjected to differential periodic (progressive) leaf and or tuber harvesting regimes.

Treatment combination	JUNE			JULY			AUGUST		
	Leaf	Stem	Root	Leaf	Stem	Root	Leaf	Stem	Root
	Cv 'Bangi', leaves intact tubers harvested once-over	5.82	4.34	0.38	12.71	15.01	16.16	26.84	27.68
Progressive leaf harvesting tubers harvested once-over	6.93	5.56	0.39	10.33	8.29	13.68	16.46	13.68	37.92
Progressive harvesting of both leaves and tubers	7.52	6.37	0.49	6.29	8.83	5.46	16.45	15.76	32.88
Progressive harvesting of tubers only	7.27	6.19	0.65	6.95	77.04	13.74	19.62	22.27	28.77
Cv 'Simama', leaves intact tubers harvested once-over	12.63	9.51	1.67	27.27	26.57	51.88	21.35	31.70	56.34
Progressive leaf harvesting tubers harvested once-over	22.79	14.32	3.44	22.16	29.91	38.00	14.54	19.41	49.56
Progressive harvesting of both leaves and tubers	16.12	9.42	3.36	24.64	28.29	7.29	14.24	26.97	17.89
Progressive harvesting of tubers only	21.63	14.04	4.8	38.10	36.07	14.15	18.51	16.42	30.00



Appendix VI: Yield of vines, mean number of tubers, mean number of marketable and pig tubers as affected by progressive leaf and or tuber harvesting regimes.

Treatment combinations	Total No. of tubers	No. of marketable tubers	No. of pig tubers	Yield of vines (t/ha)
<u>Cv 'Banggi', leaves intact tubers harvested once-over (control)</u>	54.25	20.75	33.50	18.06
Progressive leaf harvesting tubers harvested once-over	53.50	23.00	30.50	21.15
Progressive harvesting of both leaves and tubers	72.00	37.00	35.00	12.60
Progressive harvesting of tubers only	78.25	41.50	36.25	13.83
<u>Cv 'Sinama', leaves intact tubers harvested once-over (control)</u>	72.75	44.25	28.50	25.75
Progressive leaf harvesting tubers harvested once-over	86.25	48.00	38.25	19.87
Progressive harvesting of both leaves and tubers	114.50	70.75	43.50	15.07
Progressive harvesting of tubers only	108.50	63.75	44.75	11.93