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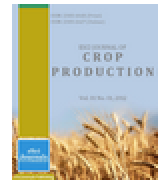

VINE PRODUCTION OF SWEET POTATO (*IPOMEA BATATAS*) IN A SCREEN HOUSE AS AFFECTED BY MULCH APPLICATION UNDER MOISTURE STRESSED CONDITION

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A B S T R A C T

Abundance of vines is produced every season after harvest of sweet potato. Vine scarcity has however been identified as one of the important constraints limiting production at the beginning of the season, when needed most. A study was carried out in a screen house of the College of Plant Science, University of Agriculture Abeokuta; between December 2011 and March, 2012 to evaluate vine production of Sweet potato (*Ipomea batatas*) as influenced by mulch application under moisture stressed condition. The experiment was a 2x2x2 factorial arrangement in a completely randomized design and replicated four times. The factors were two varieties of sweet potatoes irrigated at 2 or 3 weeks interval (2 or 3 weeks between successive irrigation) with or without mulch application. Delaying successive irrigation by three weeks did not significantly reduce growth of mulched sweet potato till the fourth week. Mulch application significantly enhanced irrigation, stem elongation and vine production by about 22%. Mulching produced similar advantage that irrigating at 2 weeks interval had over irrigating at 3 weeks interval. TIS 86/0356 produced significantly more number of cuttings than TIS 87/0087. Priced sweet potato vines can be kept alive till the following season by farmers, by mulching and irrigating every 14 or 21 days. It will be of immense benefit to growers especially in regions with shortage of water due to marked dry periods.

Keywords: Irrigation intervals, moisture stress, sweet potato, vine production.

INTRODUCTION

Sweet potato (*Ipomea batatas*) is a tuber crop widely grown in different parts of the world. It is an important food crops in tropical and sub-tropical regions of the world particularly in Asia, Africa, and the Pacific (Osiru *et al*., 2009, Amante and O'Sullivan, 2012). No continent depends as much on root and tuber crops in feeding its population as does Africa and sweet potatoes is one of the important sources of food in the tropics (FAO, 2012).The highest producer of sweet potato in the world is China; in Africa Uganda is the highest producer and followed closely by Nigeria and in 2001 both countries contributed up to 3.6% of the world's production (Amante and O'Sullivan, 2012). Within the African cropping systems, sweet potato has several advantages. It produces food in a relatively short time, gives reliable yields in sub-optimal growth conditions, requires lower labour inputs (appropriate for vulnerable households) than other staples, serves as an alternative food source for urban populations, facing increasing prices of cereals, provides a potential option to reduce vitamin A deficiency (Andreas *et al*.,2009). Sweet potato is used in diverse ways in Asia and Africa and this contribute in the improvement of local economies. Aside from being a subsistence crop, it makes a large contribution to livestock production in many areas; it's used industrially for starch and other processed goods is more localized, but expanding (Amante and O'Sullivan, 2012). In a few countries in Africa where there is a bimodal rainfall pattern, for example, Kenya, Rwanda and Uganda, sweet potato makes an important contribution to household food security and is also gaining importance as a cash crop sold as fresh roots on urban markets (Andreas *et al*., 2009). In Nigeria it is an important revenue earner and employer of labour for rural people who are engaged in production of sweet potato (Gbigbi, 2011), and it surpasses other root crops in terms of agronomic potentials, diversification into other food, feed and industrial uses (Tewe *et al.,* 2003).

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Constraints to production of sweet potato in Uganda the leading African producer, as highlighted by Yanggen and Naguja (2006) include pests and diseases, drought, vine scarcity, lack of capital, high labour requirements, poor yields, low prices, destruction of crops by animals, lack of land and crop rotting. Of all the highlighted problems, the third most important constraint mentioned by farmers was the availability of vines. Vines cannot be preserved for long without losing its quality. According to Nabiswa and Wesonga (2009), cuttings cannot be kept for more than seven days, beyond which condition that leads to large reduction in storage root yield sets in. Storing vine cuttings for 1 - 3 days does not affect the final yield. In Africa, inappropriate agronomic practices, lack of virus-clean material, limited yield potential of land races, and sweet potato weevil have been identified as major constraints (Andreas *et al.*, 2009). In Uganda, principal sources of vines for farmers are 46% from their previous crop, 31% from friends and neighbours and only 14% are purchased (Yanggen and Naguja, 2006). Some of the challenges associated with sweet potato production in Nigeria as with other root and tuber crops include low prices of the crops and their products (Tewe *et al.,* 2003). Lacks of capital to boost production and unavailability of improved materials have also been reported (Gbigbi, 2011).

Emerging evidences have shown that availability of vines at time of planting is a major constraint that must be overcome if production will be encouraged and improved in Nigeria. Vines are often produced in excess at the time of harvest and scarce at planting. Preservation of these stems has always been a constraint thus, the vicious cycle of scarce planting material continues. A major requirement for preservation of this planting material is moisture availability since most parts of the sweet potato growing zones in Nigeria experience marked dry period; this is not different from what is experienced in eastern and southern Africa (Andreas *et al.*, 2009). Preservation is possible close to the river bed or in lowland, however since availability of lowland is not always guaranteed, effort must be directed to preserving the vines under the prevailing environmental conditions. In Uganda, lack of commercial vine distribution has been linked to a situation when farmers are unable to obtain vines from their own production essentially due to drought, prolonged dry season or a lack of access to a water source to maintain a vine nursery during the dry season (Yanggen and Naguja, 2006). A meaningful way of vine preservation must be that which will require little amount of water and/or reduce the frequency of irrigation and the attendant drudgery. One of the cultural methods that have been employed over the ages in conservation of moisture is mulch application. Amongst other advantages, mulch application reduces direct sun shine on the soil thus, reduce evaporative loss of moisture and suppress weeds. The aim of this study is therefore to evaluate the vine production of sweet potato under different irrigation intervals in a moisture stress condition, with or without mulch application.

The study seeks to address the following objectives:

1. To determine the reasonable intervals between successive irrigation for preservation of vines of sweet potato in a drought situation.
2. To evaluate vine production of sweet potato under two continuous moisture stress conditions.
3. To evaluate the ameliorative effect of mulching on growth of sweet potato under two moisture stress conditions.

MATERIALS AND METHODS

The experiment was carried out in a screen house of the College of Plant Science, University of Agriculture Abeokuta; between December 2011 and March, 2012. The experiment was a 2x2x2 factorial arrangement in a completely randomized design and replicated four times. The factors were two varieties of sweet potatoes irrigated at 2 or 3 weeks interval (2 or 3 weeks between successive irrigation) with or without mulch application. The field capacity of the soil used for the experiment was determined by adding known volume of water to 1 Kg sample of the soil until saturation and collecting the excess water until draining ceased. The quantity of water retained was then deduced by subtraction. 7.5 kg of the soil was weighed into 32 plastic buckets, 8 of which were arranged per replication to represent the 8 treatments. 2.1 litres of water was then added per pot to irrigate to field capacity. The two varieties of sweet potato used had some contrasting characteristics. TIS 87/0087 (white fleshed) had leaves with larger surface area and leaf margin was entire, TIS 86/0356 (orange fleshed) had smaller leaves with serrated margin. Two 30 cm cuttings of sweet potatoes stem were planted per pot and 50g of dried *Panicum maximum* was used as mulch material per pot according to the experimental design (*Panicum maximum* is a common weed in the locality). After the initial watering before planting, subsequent irrigations were done at 2 or 3 weeks interval; resulting in 6 and 4 numbers of irrigations for the 2 and 3 weeks interval respectively, from planting to termination of the experiment. Vine length was measured fortnightly as from 4 weeks after planting. At 11 weeks after planting the vine length, fresh weight and number of 20 cm cuttings per plant were measured. Data collected were subjected to analysis of variance (ANOVA) using Genstat3 Discovery Edition. Significant means were separated using the Least Significant Difference (LSD).

RESULTS

Effects of irrigation interval and mulch application on vine length, vine weight and number of cuttings per plant of sweet potato varieties: The growth response (as measured by vine length) of the two sweet potato varieties to weeks between successive irrigation and mulch application is presented in Table1. Irrigation at two weeks intervals consistently led to the production of significantly longer vines ($p<0.05$) at 6, 8 and 10 weeks after planting (WAP) relative to that produced when the period between successive irrigation was increased to three weeks. Similarly, the results showed that mulch application significantly increased vine length at 4, 6, 8 and 10 WAP.

The result also revealed a significant interactive effect of irrigation intervals and mulch application on vine length at 4 WAP. TIS 86/0356 consistently had longer vine length than TIS 87/0087 as from 6 WAP; this was significant at 10 and 11 WAP (Table 1).

Table1. Effect of intervals between irrigation and mulch application on vine length of two varieties of sweet potato.

	Vine length (cm)				
Treatments	**4 WAP**	**6 WAP**	**8 WAP**	**10 WAP**	**11 WAP**
Irrigation intervals					
2 weeks	33.7	47.2	59.9	69.9	73.3
3 weeks	33.7	38.9	50.0	58.9	60.0
LSD	NS	5.03	6.35	7.57	8.79
Mulch					
With mulch	35.6	46.8	60.4	68.5	70.0
Without mulch	31.8	39.2	49.6	60.3	63.4
LSD	**3.01**	**5.03**	**6.35**	**7.57**	NS
Variety					
TIS 87/0087	33.9	42.5	54.3	59.6	59.8
TIS86/0356	33.5	43.6	55.7	69.3	73.5
LSD	NS	NS	NS	**7.57**	8.79
Interactions					
I x M	**4.26**	NS	NS	NS	NS
V x M	NS	NS	NS	NS	NS
I x M x V	NS	NS	NS	NS	NS

WAP = weeks after planting NS= not significant

The percentage increase/decrease in vine length as influenced by irrigation intervals and mulch application as shown in Table 2. The decrease in vine length was negligible (<0.1%) by extending the irrigation interval by one week (from 2 to 3 weeks) at 4 WAP. However extending irrigation interval by one week led to decrease in percentage vine length by 21.3, 19.8 and 18.7 percent at 6, 8 and 10 WAP respectively. Similarly, mulch application increased vine length by 11.9, 19.4, 21.8 and 13.4 percent at 4, 6, 8 and 10 WAP respectively.

Table3 shows the effect of different treatments on generation of cuttings that are of plant-able size (20 cm) per plant. Number of cuttings per plant varied significantly between the two varieties, with TIS 86/0356 generating more cuttings per plant than TIS 87/0087. Irrigating at two weeks interval led to the production of significantly more fresh weight than irrigating at 3 weeks interval. Similarly mulch application significantly enhanced the fresh weight of the plant at 11 WAP (Table 3). TIS 86/0356 had significantly more number of cuttings than TIS 87/0087, fresh plant weight of TIS 87/0087 was higher than that of TIS 86/0356, the difference was however not significant ($p>0.05$).

Table2. Percentage decrease in vine length as influenced by irrigation intervals and mulch application.

	Vine length (cm)			
Treatments	**4 WAP**	**6 WAP**	**8 WAP**	**10 WAP**
Irrigation intervals				
2 weeks	33.7	47.2	59.9	69.9
3 weeks	33.7	38.9	50.0	58.9
Percentage decrease	0.09	21.3	19.8	18.7
Mulch				
With mulch	35.6	46.8	60.4	68.5
Without mulch	31.8	39.2	49.6	60.3
Percentage decrease	11.9	19.4	21.8	13.4

WAP = weeks after planting.

Table3. Effect of intervals between successive irrigation and mulching on number of cuttings per plant and fresh weight of potato.

Treatments	Cuttings per plant	Plant fresh weight (g)
Irrigation intervals		
2 weeks	4.6	32.7
3 weeks	3.8	23.8
LSD	NS	6.99
Mulch		
With mulch	4.6	33.2
Without mulch	3.8	23.2
LSD	NS	6.99
Variety		
TIS 87/0087	3.6	30.7
TIS86/0356	4.7	25.8
LSD	0.96	NS
Interactions		
I x M	NS	NS
V x M	NS	NS
I x M x V	NS	NS

WAP = weeks after planting NS= not significant

The effect of irrigation intervals, mulch application and crop variety on percentage increase/decrease in number of cuttings per plant and fresh plant weight is presented in Table 4. The results revealed that increasing irrigation interval from 2 to 3 weeks led to a corresponding decrease in both number of plant-able size cuttings and fresh plant weights by22% and 37% respectively; similarly mulch application also led to 22% increase in number of cuttings generated per plant. On the other hand plant fresh weight was enhanced by up to 43% by mulch application.

TIS 86/0356 generated about additional 30% cuttings relative to TIS 87/0087. However, with respect to fresh weight, TIS 87/0087 produced about 19% more than TIS 86/0356 (Table 4).

Interactive effect of irrigation and mulch application on vine length: Table 5 presents the interactive effect between irrigation intervals and mulch application on vine length of sweet potato. The result shows that at 4 WAP, mulch application had significantly more beneficial effect on vine length elongation at 3 weeks irrigation intervals relative to 2 weeks irrigation intervals. This is because mulch application did not significantly increase vine length when only two weeks was allowed between successive irrigation; thus vine length produced at 2 weeks irrigation intervals with or without mulching as well as that generated at 3 weeks interval with mulch application ranked same (Table 5).

Table4. Percentage decrease/increase in cuttings per plant and fresh weight of plant as influenced by irrigation intervals, mulch application and sweet potato varieties.

Treatments	Cuttings per plant	Plant fresh weight (g)
Irrigation intervals		
2 weeks	4.6	32.7
3 weeks	3.8	23.8
% decrease	21.6	37.4
Mulch		
With mulch	4.6	33.2
Without mulch	3.8	23.2
% decrease	21.6	43.1
Variety		
TIS 87/0087	3.6	30.7
TIS86/0356	4.7	25.8
% increase/decrease	29.6	19.0

Table5. Interactive effect of irrigation intervals and mulch application on vine length of sweet potato at 4WAP.

Treatment	Vine length (cm)	
Irrigation intervals	With mulch	Without mulch
2 weeks	34.4	33.3
3 weeks	36.8	30.3
LSD	**4.26**	

Effect of irrigation intervals, mulch application and crop varieties on tuber yield of sweet potato: Although there were evidences of tuber initiation in few pots, neither harvestable nor measurable tubers were produced under the irrigation regime within the period of this study.

DISCUSSION

Effect of irrigation intervals, mulch application and crop varieties on vine length of sweet potato: In this study, the significant interactive effect observed between irrigation intervals and mulch application on vine length at 4 WAP, despite the non-significant response to irrigation intervals alone, suggests that application of mulch when irrigation intervals was increased from 2 to 3 weeks within this period (1-4WAP), adequately conserved moisture for up to one week, that is without reducing the growth of the plant. This suggests that provided enough moisture was applied at planting and with adequate mulching, subsequent irrigation can commence 21 days later without leading to significant reduction in the growth of the vine. This could be attributed to the fact that sweet potato is naturally considered to be moderately drought tolerant (Valenzuela *et al.,* 2000). However beyond 4 WAP, consistent increase in vine length by shortening of the intervals between successive irrigation by one week (from 3 to 2 weeks) suggests that moisture demand of the plant cannot be adequately met by as long as 21 days between successive irrigation without sacrificing some growth. Sweet potato has been reported to be sensitive to water deficits, particularly during the establishment period including vine development (Indira and Kabeerathumma 1988). Reduction in growth was a coping strategy by the plant as a measure to reduce the surface area exposed for more transpiration and loss of moisture. Effect of mulch application was also reduced over the growing period. This can be attributed to increase plant mass beyond moisture conserved by mulch application. This implies that as from the fourth week after planting, mulch application can only complement irrigation. The fact that percentage increase of both vine length and number of cuttings were enhanced by mulch application by up to 22%; and also extending period between successive irrigation by one week (from 2 to 3 week) similarly leading to up to 22% reduction in vine length and number of plant-able cutting as from 6 WAP suggests that as the plant grows more rapidly as from 4 WAP, mulch application adequately prolonged moisture availability after irrigation by up to one week under this irrigation regime. Varietal difference observed in vine length and number of cutting produced, with TIS 86/0356 producing longer vines and generating more number of cuttings than TIS 87/0087 could be attributed to the differences in the morphology of the varieties. Larger surface area of the leaves of TIS 87/0087 exposed it to more stress under drought condition, while the natural smaller leaves of TIS 86/0356 could be one of the reasons for better vine elongation under the same stress condition. One of the adaptive features of plants growing in drought condition is reduction in leaf size to reduce loss of moisture through transpiration.

The fact that no measurable tubers were produced in this trial suggests that the soil moisture regime in this trial was not sufficient to support tuber formation. Sweet potato is sensitive to water deficit stress (Ekanayake and Collins, 2004) and can affect storage root initiation (Indira and Kabeerathumma, 1988). Water stress in sweet potato has been shown to result in low root yield and quality defects (Carey *et al*., 1997; Ekanayake *et al*., 1988). This also implies that the preservation of vines in this study cannot be attributed to food stored in the underground portion and the irrigation regime maintained in this study can only maintained the vine and more water will be needed for tuber production.

SUMMARY AND CONCLUSIONS

In this study, delaying successive irrigation by three weeks after planting did not reduce growth of mulched sweet potato measured at the fourth week. Mulching did not significantly enhance growth within the first four weeks provided intervals between successive irrigation are kept at two weeks. Implying that if irrigation is to be done at two weeks intervals, mulching may not be needed till the fourth week. Mulch application enhanced growth and led to generating of more planting materials by 22%. Mulching produced similar advantage that irrigating at 2 weeks interval had over irrigating at 3 weeks interval. Sweet potatoes varieties with bigger leaves might be more severely affected by moisture stress.

In conclusion delaying successive irrigation of sweet potato by three weeks after planting will not reduce growth within the first four weeks if mulch was applied and provided water was applied to field capacity at planting in a sandy loam soil. Priced sweet potato vines can be kept alive by farmers by applying irrigation water every 14 or 21 days. Mulch application will enhance irrigation, growth and vine production by about 22%. The effect of this cultural practice could reduce the frequency of irrigation when the objective is to preserve sweet potato vine for future use, especially in regions with shortage of water due to marked dry periods.

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