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Growth, yield and quality of selected sweet potato (*Ipomoea batatas [l.] Lam.),* lines under varying soil moisture conditions.

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Article Info

KEY WORDS

Vine length

Number of leaves

Tuber length

Tuber circumference

Tuber yield

Abstract

Sweet Potato (*Ipomoea batatas [L.]* has increasing potential as a food security crop in Kenya. However, its' production is relatively low compared to its potential production which is attributed to drought conditions alongside use of local landrace cultivars that are quite low yielding. A study was conducted at Meru University of Science and Technology in Kenya in 2020-2021 to assess the performance of selected improved sweet potato lines under varied watering regimes. Two selected sweet potato varieties were used; CIP 106988.1 (Naspot13) and CIP 112286.1 (Margarette), and a farmer-preferred variety Kemb-10. The varieties were subjected to three watering regimes (i) Severe stress (SS), 4 WAE (ii) Moderate Stress (MS), 9 WAE and (iii) well watered to maturity. A randomized complete block design in a split plot, with water treatment as the main plot and varieties as subplot with 3 replicates was used. There was no significant interaction between moisture treatments and varieties. Water treatments significantly ($p \leq 0.05$) affected vine length, number of leaves and tuber yield. Plants under severe stress had significantly lower vine length, branches and leaves. Under Moderate stress 9 WAE, plants experienced significant reduction in vine length, leaves and branches compared to the well watered. However, this reduction was less compared to severe stress. The reduced vine length and tuber yield is attributed to reduced cell division, elongation and assimilates partitioning. Tuber numbers correlated with leaves ($r = 0.63^*, 0.74^*$), and vine length ($r = 0.62^*, 0.76^*$). This positive correlation implies that if drought significantly reduces number of leaves and vine length, it reduces tuber yield indicating effect of drought on tuber yield can be estimated by measuring tuber length and number of leaves. Based on findings, ensuring the crop obtains enough moisture during the first nine weeks after planting is recommendable whereas Naspot13 is suitable for the area considering its higher productivity.

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Introduction

Sweet potato is the seventh most important food crop in the world in terms of production. Due to its' outstanding nutritional value and production potential per unit time, it has a high potential to sustain the increasing global population and minimize malnutrition and hunger (Afzal *et al.,* 2021). Sweet potatoes are considered among other major crops as plants that produce the most human-edible energy, as much as 194 MJ $ha^{-1}day^{-1}$ (Burbano-Erazo., *et al* 2020).

Sweet potatoes can be grown in a wide range of agro ecological zones including low rainfall areas and has low input demand. African farmers produce only about 14.39 million tones of sweet potatoes annually but most of the crop is cultivated for human consumption (Mishra *et al.,* 2019). Yield and quality of sweet potato depends on the availability of water in the soil, soil characteristics and other environmental factors. The quantity and quality of sweet potato tubers is strongly influenced by the availability of water (750 to 1000 mm) during the sweet potato growth period (Esan *et al*., 2018. Though sweet potato is generally considered a drought tolerant crop, leaf area, yield, and canopy reduce as water stress increases under deficit irrigation (Gibberson *et al*., 2016). A decrease in stomatal conductance during drought is also experienced, (Laurie *et al*., 2015). Stem length is reduced consequent to insufficient soil water (Li *et al.,* 2021). When water stress lasts over an extended period, it leads to low leaf area which eventually leads to yield reduction (Laurie *et al.,* 2015). Subsequent water stress leads to malformation and reduction in the number and tuber sizes. Irrigation at 60% moisture level field capacity could increase root yield by 24% (Daryanto *et al.,* 2016).

Sweet potato *(Ipomea batatas)* is an important food crop in Kenya, but farmers experience low production and thus their food and income security is threatened. The productivity of sweet potato varieties differs even in the same environmental conditions; therefore, selection of suitable sweet potato varieties based on environmental conditions is very important (Nugroho *et al.,* 2017).Kenya is the seventh largest African sweet potato producer with an average yield of 8.2 tons/ha against a potential of 50 tons/ha (Mukras, 2013). These low yields are attributed to use of local cultivars, drought and poor access to vines, field pests and diseases as well as postharvest storage, preservations, and utilization issues (Abidin *et al*., 2016).

Sweet potatoes in Kenya are produced in the Lake region (Western and Nyanza), Rift Valley, Coastal and Central Kenya with Lake Region leading in production. Climate change has led to scanty and unpredictable rains leading to rains either coming earlier or late in the season. Meru County has vast land affected by drought hence most regions are dry and receive rainfall of less than 700 mm/yr leading to crop failure. Adequate soil moisture through supply of timely irrigation is crucial for successful sweet potato crop performance. Sweet potato crop is sensitive to drought at the tuber initiation stage 50–60 days after planting. If drought occurs during tuber initiation and bulking, it could considerably reduce yield (Daryanto *et al*., 2017).

Unavailability of improved varieties adapted to local environments that meet consumer preferences is another challenge facing sweet potato production. Vines used by farmers to propagate the crop are obtained from fellow farmers which are landrace varieties; therefore, there is limited access to improved varieties. Research on sweet potato has resulted in cultivars that have good attributes that are adapted to the local conditions. Some of the varieties released by the International Potato Centre (CIP) possess outstanding attributes that include; high yielding, high dry matter content early maturity period, drought resistant, tolerant to various diseases and have improved nutritional content (Ngailo *et al.,* 2017). Resultantly, these being new varieties, their performance under varied soil moisture regimes have not been published. Additionally, different varieties respond differently to varied soil moisture regimes, therefore the study aimed at evaluating the growth, yield and quality of selected sweet potato lines in varied soil moisture in the Meru region.

Materials and Methods

Experimental site characteristics and Experimental time

The study was carried out in Meru University of Science and Technology farm located 15km north east of Meru town along Meru-Maua Road. The altitude of the area is 1582 M above sea level. The area receives an average rainfall of around 1324 mm per annum which occurs during March-April and October-January seasons. The average annual temperature for the area is 21°C. The soils in the study area are deep well drained red clay soils. The experiment was conducted in two seasons. In season one planting was done on January 2021 and harvesting was carried out on May 2021. The experiment was repeated in September-January 2022 season (season two) where planting took place on September 2021 and harvesting done on January 2022.

Experimental design and treatments

The treatments consisted of three sweet potato

a) CIP 112286.1 (Margarete b) CIP 106988.1 (Naspot 13) c) Kemb 10

Plate 1: *Photos of the Sweet Potatoes Varieties*

varieties and three watering levels. Two varieties were obtained from the international potato centre (CIP) namely; CIP 106988.1(Naspot 13), CIP 112286.1 (Margarete) and a farmer preferred variety; (Kemb 10) was obtained from one of the prominent farmers. Photos of the varieties are as shown in Plate: 1 below. Vines multiplication was carried out in the University farm. The three watering levels were: well watering to establishment, 30 days after planting (severe stress, SS), well watering to root initiation, 60 days after planting, (moderate stress, MS) and well watering to maintain soil moisture above 70% field capacity to maturity (2 weeks to harvesting).

The Experimental design was a split plot in a randomized complete block design with 3 replications. The watering levels were allocated to main plots and the sweet potato lines were allocated to the sub-plots. The site was marked out into three blocks of 3 plots each. Each block measured 6.4m x 4.6m and the plot size from which growth and yield attributes were estimated measured 1.8 m x 1.2 m. Plots were separated by a path of 0.5m while blocks separated by a path of 1 m. The field size measured 21.2m by 4.6m with 27 sub- plots. The cuttings were spaced at 60 cm x 40 cm, to give 9 plants per unit and a total of 243 plants.

Land preparation and planting

Experimental sites were cleared manually, ploughed and harrowed once to a depth of 20cm to eradicate perennial weeds and soil pests. Soil samples (0-30 cm depths) were collected from the sites and analyzed for physico-chemical properties to determine the baseline fertility status of the trial sites using standard procedures (IITA, 1982). Mounds were made using hoes to accelerate penetration and expansion of tubers. Vines with uniform length (25cm) with lower leaves removed were obtained from the tip by use of a sharp sterilized knife. The vines were then dipped into a rooting hormone (ABA) to encourage uniform rooting.

The vines were planted by inserting to half their length slanting at an angle of 45°. Below is a photo of newly planted sweet potato vines.

Plate 2: *A photo of newly planted sweet potato crops*

Management Practices

The vines were misted regularly for faster establishment. Water management was done through monitoring of soil moisture content every two days by means of a moisture meter. Crops were covered by a clear polythene sheet during rainfall episodes. Manual weeding at intervals of 4 weeks after planting was done. Earthing up to fill the cracks to prevent attack from sweet potato weevil was carried out the same time as weeding operation.

Data Collected

Data on vine parameters

a) Vine length

Vine length was measured from the mount to the tip of the longest vine from one plant per plot selected randomly. The measurement was done using a tape measure in centimeters and recorded. Vine length data was collected at an interval of 2 weeks just after the crop establishment for a period of 3 months.

b) Number of leaves

The number of fully developed leaves was counted from one plant selected randomly from each plot and the data recorded. Counting was done manually at two weeks interval for a period of 2.5 months. However, during the first season Jan-May 2021, there was extreme growth and increase in the number of leaves hence counting became tedious and data collection stopped at 2 months after the differences were clear.

c) Number of branches

The number of branches of the primary branch was counted manually and the data recorded. Counting was done at an interval of two weeks, 2 weeks from establishment for a period of 3 months.

Data on tuber yield

a) Tuber length

Harvesting of the sweet potato crop was done 5 months after planting. Harvesting was done by digging out the tubers from the mounds for each individual plant. Tuber length was measured using tape measure on one tuber of one plant selected randomly from each plot. The measurement was made from the edible ends of the sweet potato tuber.

b) Tuber circumference

Data on tuber circumference was taken from one tuber of one plant per plot selected randomly. Data was taken around the thickest part of the sweet potato tuber using a tape measure and recorded.

c) Number of tubers

On harvesting the data on the number of market sized tubers was taken. The data was obtained from one plant of the nine selected randomly from each plot. The tubers were manually counted and recorded.

d) Tuber weight

The total marketable tubers from one plant selected randomly per plot was taken and weighed by use of an electronic balance to obtain the tuber weight in kilograms.

Data Analysis

All the data obtained from the experiments was subjected to analysis of variance (ANOVA) using a Statistical Agricultural software (SAS 2005) and treatment means were separated using the Least Significant Difference (LSD) at the 5% level of significance. Pearson correlation was done to establish the relation between different growth and yield parameters.

Results and Discussion

Effect of watering level and variety on soil moisture status

There was no significant interaction between watering levels and lines on the soil moisture in both seasons. Under well watered conditions, the soil moisture was generally maintained above 18 and 16 during season one and two respectively, which was equivalent to 85.7% and 76.1% field capacity. This was similar to moderate stress treatments in the first 6 weeks and 3 weeks for the severe stress treatments. After these periods, well watered treatment maintained significantly higher soil moisture followed by moderate stress treatments (Fig. 1a and c). At the termination of the treatments, the soil moisture for moderate stress had declined to 11 and 10 in season one and two, respectively. The soil moisture at severe stress was significantly lower at 8 and 3 for season one and two, respectively. The soil moisture did not significantly differ between the varieties. All the three varieties responded similarly to moisture stress levels. The varieties did not significantly differ on how they utilized soil moisture. At severe stress, flowering was observed in some plants. See Figure 1.

Effect of watering level and variety on vegetative growth.

Vine length

There were no significant interactions between watering level and variety on vine length. Plants grown under well watered conditions had significantly longer vines than plants under severe stress from 6 weeks after establishment. At this point the soil moisture levels were 18 and 16 (85.7% and 76.1% field capacity) for season one and two respectively before the moisture content started declining (Fig. 1a & c). At this time, moderate stress had not been established. Plants under well watered conditions had significantly longer vines than those under moderate and severe stress 8 weeks after establishment in season one and two (Fig. 1a & c) after moisture levels fell below 11 and 12 equivalent to 52.4 and 61.9% field capacity in season one and two, respectively. Naspot 13 and Kemb 10 had significantly longer vines at 8 and 6 weeks after establishment for season one and two, respectively. Initially from week 12 for season one and two respectively, Naspot had significantly longer vines than the other two varieties while Margarette had the shortest. At 14 weeks, the vine lengths of plants grown under moderate water stress was about 17.7 (84.4% field capacity) of those well watered, while that under severe stress was about 60% of the well watered. Margarette vine length was about 70.4% of Naspot variety. The greater vine length of

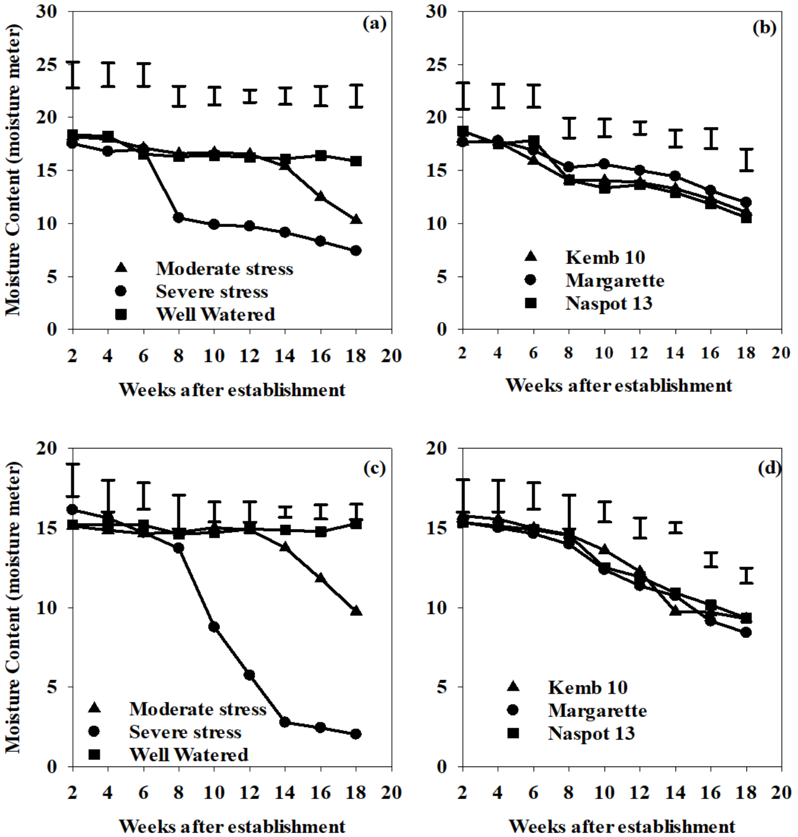

Figure 1: *Soil moisture treatment status on sweet potato vegetative growth and tuber yield at M.U.S.T Farm during January-May 2021 (Figure: a & b) and September 2021-January 2022 (Figure c & d)*

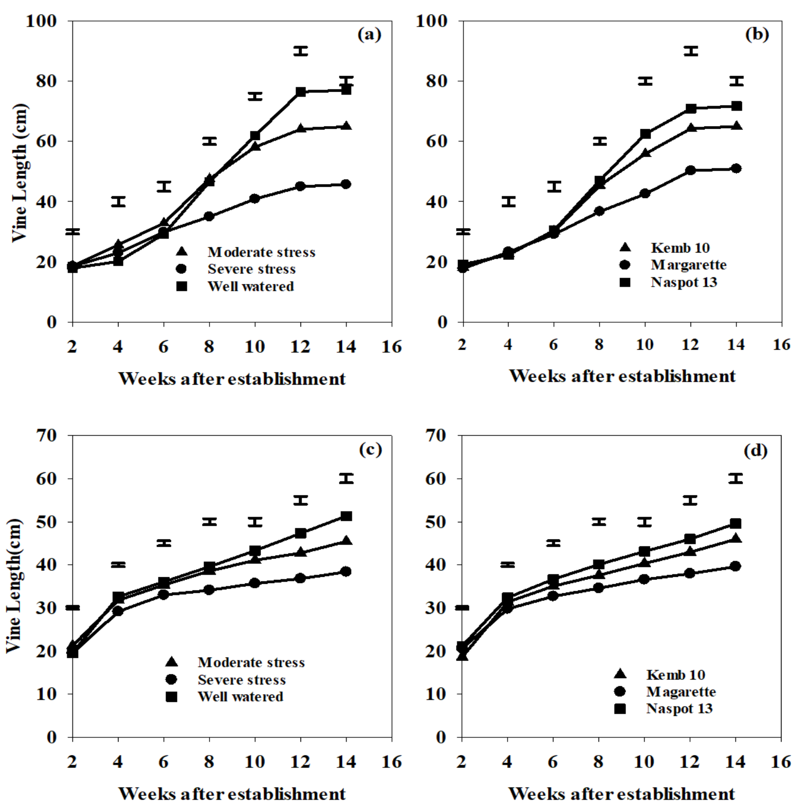

Figure 2: *Effect of Soil Moisture treatment and variety on sweet potato vine length grown at M.U.S.T Farm during January-May 2021 (Figure: a & b) and Sep 2021-January 2022 (Figure: c & d).*

well watered plants could be attributed to the role of water in growth and development of a plant, especially more cell division followed by cell elongation. The reduced vine length in plants under both severe and moderate water stress indicates reduction in cell division and elongation. The net photosynthesis in water deficit plants is reduced (Seleiman *et al.*, 2021) thereby contributing to reduced vegetative growth. The results here obtained are in agreement with, Laurie *et al.*, 6459 who reported a decrease in vine length of plants subjected under moisture stress levels of 100% (control), 60% (mild stress) and 30% (severe stress) field capacity. He found the largest reduction in stem length (67%) at 30% irrigation treatment. Correspondingly, Gajanayake *et al.*, 2016 as well observed a decreasing trend in vine length, 3.2 cm $plant^{-1}$, under water deficit levels of (100, 60, 40, and 20%) field capacity. Saqib *et al.*, 645[1] obtained similar results of reduced vine growth parameters in sweet potato plants subjected to deficit irrigation who recorded the highest vine length of 274cm at 7days irrigation interval followed by 14 and 21days. The maximum vine length obtained in this study (80cm) is not comparable to the results obtained by Saqib *et al.*, 2017, who obtained a length of 274cm. Water stress reduces stem extension of sweet potato cultivars; however, the severity of this reduction is reported to differ with different cultivars (Mbayaki, C. W., & Karuku, G. N. 2021).

Number of leaves

There were no significant interactions between watering level and variety on number of leaves. During season one and two, plants grown under well watered conditions had significantly higher number of leaves than plants under severe stress from 6 weeks after establishment when the moisture stress fell below 71.4% field capacity (Figure 1a &c). Plants under well watered conditions, 18 and 16 (85.7% and 76.1% field capacity) had significantly more leaves than those under moderate and severe stress starting from 6 weeks after establishment in season one and two respectively (Fig. 3 a

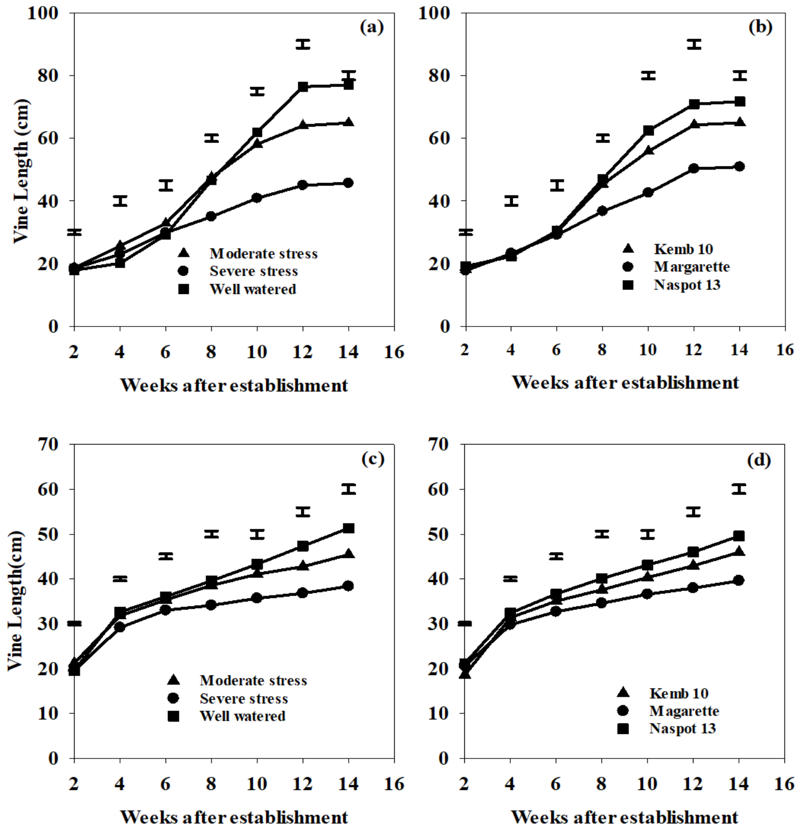

Figure 3: *Effect of soil moisture treatment on sweet potato number of leaves grown at M.U.S.T Farm during January-May 2021 (Figure: a & b) and September 2021-January 2022 (Figure: c & d).*

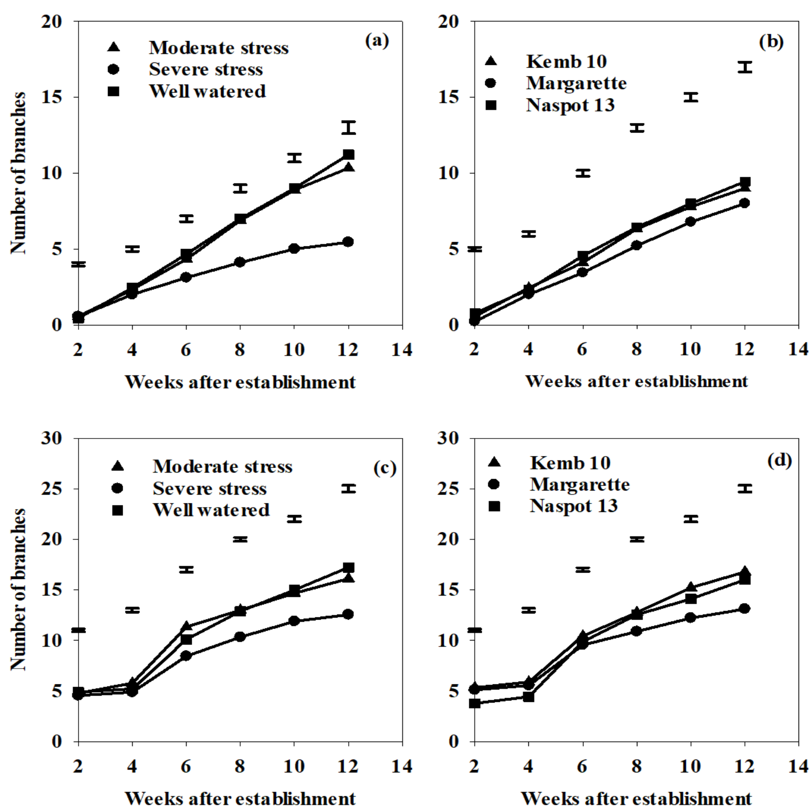

Figure 4: *Effect of soil moisture treatment and variety on sweet potato number of branches grown at M.U.S.T Farm during January-May 2021 (Fig: a & b) and September 2021-January 2022 (Fig: c & d).*

and c, and 1a and c), a period when the soil moisture

fell below 85.7% and 76.1% field capacity in season one and two, respectively. Kemb 10 and Naspot 13 had significantly higher number of leaves at 6 and 4 weeks after establishment for season one and two respectively. Starting from week 8 and 10, Naspot had higher but comparable number of leaves to Naspot 13 while Margarette had the lowest during for season one and two respectively (Fig. 2b and d)

The leaf production of sweet potato declined in both moderate and severe stress treatments when soil moisture fell below 18 and 16 (85.7% and 76.1% field capacity). This appears to be the threshold below which moisture stress significantly reduces leaf initiation resulting in lower number of leaves. Based on varieties, Margarette had the least number of leaves with Naspot 13 having the highest number of leaves. Naspot and Kemb 10 had similar number of leaves, however; Kemb 10 was seen to have broader leaves than Naspot 13. Reductions in leaf number and leaf area are closely related to soil water deficits. (Sánchez-Blanco *et al.,* 2019) The significant decline in the number of leaves under severe stress conditions could be as a result of water stress affecting the growth and dry matter partitioning. A reduction in new leaf initiation was observed soon after water stress was imposed. Water stress that set early in the growing season, SS, and MS after planting, reduced the number of leaves by 42.4% and 32.5% respectively. The results here obtained from the study disagrees with Gibberson *et al.,*2020 who realized that sweet potato leaves per plant was not responsive to levels of irrigation under irrigation levels of 100, 90, 80 and70% moisture content field capacity.

Number of branches

There were no significant interactions between watering level and variety on number of branches. Plants grown under well watered conditions had significantly higher number of branches than those under moderate and severe stress starting from 6 weeks after establishment under a moisture content of 18 and 16 (85.7% and 76.1% field capacity) in season one and two respectively (Fig. 4 a and c, and 1a and c). The treatment under moderate stress (MS) had similar number of branches to the one that was well watered throughout. The three varieties had similar number of branches, (Fig. 4b & d). Naspot 13 and Kemb 10 had comparable number of branches though Naspot 13 had more secondary branches than the other two varieties. Naspot 13 and Kemb 10 had significantly higher number of branches at 6 and 8 weeks after establishment for season one and two respectively. Starting from week 10, for season one and two, Naspot had higher but similar number of branches to Kemb 10 while Margarette had the lowest. (Fig. 4b and d)

The results obtained from the study agrees with Saqib *et al.,* who obtained similar results of reduced number of branches in sweet potato plants subjected to irrigation intervals of 7, 14, and 21 days whereby he observed maximum number of branches per plant (10.4) which was noted in 7 days irrigation interval and the lowest numbers of branches (6.3) per plant with 21 days interval.

Effect of water level and variety on tuber characteristics and yield.

Tuber Length

There were no significant interactions between moisture treatments and varieties on sweet potato tuber length. Plants grown under well watered conditions had significantly longer tubers than plants under severe stress at moisture level of 18 and 17 (85.7 and 80.9% field capacity) in both season one and two respectively (Table 1). At this time, moderate moisture stress had not been established Naspot 13 and Kemb 10 had significantly longer tubers for both season one and two. There were significant differences with Kemb 10 and Naspot 13 having longer tubers than Magarrete during season one and two (Table 1). Naspot 13 and (Kemb 10) performed relatively well in both seasons in terms of tuber length. Both Naspot 13 and Kemb 10 are high yielding varieties. Naspot 13 produced relatively shorter tubers (market size) than Kemb 10. Sweet potato yield parameters (tuber length, tuber diameter, number and fresh weight of marketable tubers per plant) are directly linked with vegetative growth, especially in summer crop, Saqib *et al*., 645[1] . As vegetative growth reduced due to moisture stress, tuber yield also declined. Inadequate watering has been shown to reduce photosynthesis and efficient partitioning of assimilates resulting to low yields, Parthasarathi *et al.,* 2018. The same results were obtained by Saqib *et al.,* 2017 who reported a decline in tuber length under water stress conditions. Who recorded a maximum Storage root length of (19.64 cm) when the plants were irrigated after every 7 days interval and a minimum of (14.87 cm) when the plants were irrigated after 21 days interval.

Tuber Circumference

There were no significant interactions between moisture treatments and varieties on sweet potato tuber circumference. Plants grown under well watered conditions; 18 and 17 moisture equivalent to 85.7 and 80.9% field capacity had significantly thicker tubers than plants under severe stress in both season one and two respectively (Table 1 and Fig.1a & c). Plants under well watered conditions had significantly thicker tubers than those under moderate and severe stress. (Table1). Under moderate and well watered conditions same tuber thickness was obtained. Naspot 13 and Kemb 10 had significantly thicker tubers for both season one and two compared to Margarette. (Table1). Naspot 13 and Kemb 10 performed relatively well in terms of tuber circumference perhaps because they are high yielding varieties. Naspot 13 produced relatively thicker tubers (market size) than Kemb 10 which had very thick tubers. In terms of varieties, Naspot 13 and Kemb 10 had equivalent tuber circumferences. The observed high sweet potato tuber yields were probably due to varietal genetic characteristics. The observed yield reduction in sweet potato subjected to water stress in this study was probably the result of reduced rates of photosynthesis and inefficient partitioning of assimilates. The results here obtained agrees with Abdalla *et al.,* 2020 who reported a decrease in the tuber circumference of plants subjected to water stress in their early period of development by 26 and 48%, at water deficit at 2 and 3 months after planting respectively. A study by Saqib *et al.,* 2017, showed that sweet potato yield parameters (tuber length, tuber circumference, number and fresh weight of marketable tubers per plant) were directly linked to vegetative growth. As vegetative growth decreased owing to moisture stress, tuber yield was also reduced.

Number of marketable Tubers

There were no significant interactions between moisture treatments and varieties on number of tubers. Plants grown under well watered conditions, 18 and 17 (85.7 and 80.9% field capacity) in both season one and two respectively, had significantly higher number of tubers than plants under severe stress (Table 1 and Fig.1a & c). At this time, moderate stress had not been established. Plants under well watered conditions had significantly more tubers than those under moderate and severe stress, 52.3 and 33.3%

	Season one			Season 2		
	Tuber length	*No. of tubers*	*Tuber circumference*	*Tuber length*	*No. of tubers*	*Tuber circumference*
Moderate stress	18.4a	2.78b	12.72a	16.0a	2.44a	13.98a
Severe stress	11.2b	2.33b	10.92b	10.8b	2.2a	9.1b
Well watered	22.08a	3.67a	13.31a	21.8a	3.88b	14.7a
LSD	1.833	0.791	1.492	1.52	0.97	2.752
P Value	0.001	0.0001	0.00232	0.0002	0.0055	0.0002
Kemb 10	24.35a	3.47a	15.75a	20.17a	3.55a	14.34a
Margarette	12.74c	2.33b	7.83c	11.8b	2.48b	9.76b
Naspot 13	21.76b	3.77a	13.36b	18.8a	3.7a	13.66a
LSD	1.833	0.791	1.492	1.52	0.868	2.752
P Value	0.0001	0.0003	0.00002	0.0001	0.0003	0.00002
CV	9.097	9.458	2.358	7.716	8.055	2.684

Means within a column followed with the same letter are not significantly different at P<0.05. LSD-Least Significant Difference; CV- Coefficient Variability

Table 1: *Effect of soil moisture treatment and variety on sweet potato number of tubers, tuber length, tuber diameter and tuber fresh weight grown at M.U.S.T Farm during Jan-May 2021 and Sep 2021-Jan 2022.*

field capacity respectively (Table1). Naspot 13 and Kemb 10 had significantly more tubers. There were significant differences, with Kemb 10 and Naspot 13 having higher number of tubers than Magarete during both season one and two (Table 1). Naspot 13 and (Kemb 10) performed relatively well in terms of tuber numbers. Naspot 13 and kemb 10 produced more tubers than Margarette possibly because they are high yielding. Naspot 13 produced more market-sized tubers than Kemb 10 which produced extremely big-sized tubers but less in number. Regarding varieties, Margarette had the least number of tubers with Naspot 13 having the highest number of tubers. According to Gajanayake *et al.*, 645^0, the crop is sensitive to drought at tuber initiation and bulking stage 50–60 days after planting. If droughts occur during this stage, it could considerably reduce yield. The results of this study conform with the findings by Abdallah *et al.,* 6464, who observed fewer tubers in sweet potato plants; 41% and 23%, subjected to water stress than those well watered throughout the growing season. The results of this study are also in agreement with those by Saqib *et al.,* 2017 who reported decreased number of tubers under water stress condition of plants subjected to water stress.

Tuber Yields

There were no significant interactions between moisture treatments and varieties on sweet potato tuber yields. However, plants grown under well watered conditions; 18 and 17 (85.7 and 80.9% field capacity), had significantly higher tuber yield than plants under severe stress in both season one and two respectively (Table 1). Plants under well watered conditions had significantly higher tuber yield than those under moderate and severe stress. Under severe and moderate stress same number of kilograms per plant was obtained (Table1). Naspot 13 and Kemb 10 had significantly heavier tubers for both season one and two. There were significant differences, with Kemb 10 and Naspot 13 having higher tuber yield than Magarete in both season one and two (Table 1). Margarette had the least tuber yield with Kemb 10 having the highest tuber weight. Severe stress and moderate stress reduced tuber yield by 31.1 and 30.9% respectively. The reduction is similar perhaps because at the time moderate stress was established, 60 days after establishment tuber initiation and bulking had not started. According to Abdallah *et al.,* 2020, fewer tubers are realized in sweet potato plants subjected to water stress than those watered throughout the growing season.

Naspot 13 and Kemb 10 were superior in their performance perhaps because they are high yielding varieties than the Margarette variety. The results of this study are in agreement with those by Abdallah *et al.,* 6464 who reported decreased tuber weight at 96± and 70% under water stress condition of plants subjected to water stress. Laurie *et al.,* 2015 also obtained the same results.

Tuber Yields

Water stress levels	Season one (kg/plant)	Season 2 (kg/plant)
Moderate stress	2.75a	2.75a
Severe stress	2.55a	2.63a
Well watered	3.68b	3.84b
LSD	1.28	1.16
P Value	0.0003	0.0002
Kemb 10	3.86a	3.38a
Margarette	2.36b	2.02b
Naspot 13	3.55a	3.22a
LSD	1.78	1.16
P Value	0.0002	0.0002
CV	17.88	16.66

Table 2: *Effect of soil moisture treatment and variety on sweet potato tuber yields grown at M.U.S.T Farm during Jan-May 2021and Sep 2021-Jan 2022.*

Relation of vine length and number of leaves to number of tubers

The relationships among the vine length and the number of leaves to the number of tubers of sweet potato represented by coefficients of their correlations are shown (Table 2). Number of tubers was positively and significantly correlated with vine length in both seasons. All these correlations were significant (*p* =¬ 4.445). The correlation between vine length and number of leaves confirmed the expectation that number of tubers will decrease when the plant is experiencing a decline in both vine length and the number of leaves.

Season	Parameter	
	Vine Length	Number of Leaves
1	0.621*	0.632*
2	0.763*	0.744*

* indicates significant correlation

Table 3: *Pearson correlation coef⁶icients when comparing number of tuber with vine length and number of leaves in season one (Jan-May 2021) and season two (Sep 2021-Jan 2022)*

The results of Laurie *et al.,* (2015) indicated similar findings in sweet potato, though the correlation was not as strong. Significant and positive correlation were found between yield and stem length where he obtained r=0.526 and 0.406 for both trials.

From the experiment a strong correlation between number of tubers and number of leaves was observed in the two seasons, indicating the effect that number of leaves and vine length has on the root production of the sweet potato plant. Tuber numbers correlated with number of leaves (r = 0.63*, 0.74*), and vine length (r = 0.62*, 0.76*). This suggests a positive correlation between number of leaves and vine length with tuber yield. This therefore means that if drought significantly reduces the number of leaves and vine length, it will consequently reduce tuber yield. It implies the effect of drought on tuber yield can be estimated by simply measuring tuber length and number of leaves.

These results correlate with the findings of Adubasim *et al.*, 2017 who also found a significant correlation between tuber yield and number of leaves in sweet potato.

Conclusion

It's concluded that varieties tested responded similarly to water deficit, with larger vegetative and yield reductions at severe stress. Naspot 13 and Kemb 10 showed yield stability by having more tuber numbers, tuber size (circumference and length) and tuber yield across seasons. From the experiment, it can be concluded that sweet potato optimum yield is largely dependent on adequate watering especially during the early stages of development. Water stress can reduce sweet potato yields especially if it occurs at the tuber initiation and bulking stage; 60 days after planting. Measurement of vegetative parameters (number of leaves, branches and vine length) related well to root yield (tubers) and can therefore be used as drought screening tools in the future. Consequently, ensuring the crop obtains enough moisture during the first 60 days (tuber initiation stage) after planting to escape water stress for enhanced crop establishment and bulking is recommendable. Additionally, Naspot 13 is more suitable for the area considering its higher growth and yield. However, based on soil moisture perhaps there is no variety to recommend as all the varieties utilized moisture similarly since they were no significant differences between the varieties. The correlations obtained indicated that the optimum yield is very much dependant on upholding maximum number of leaves and vine length.

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