# Effect of early and late water stress on the growth and storage root yield of ten sweet potato genotypes

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## ABSTRACT

An experiment involving ten sweet potato (*Ipomoea batatas* (L.) Lam) genotypes was conducted at the Papua New Guinea (PNG) University of Technology, Lae during the 2005 - 2006 cropping season to evaluate their drought tolerance and yield potential under water stress conditions. Water stress prolonged beyond 35 days during the vegetative and storage root development stages affected the phenological developments of all genotypes. Total storage root yield in genotypes MUIB007, MUIB011, MUIB013, MUIB057, MUIB058 and B11 were comparatively highcompared to the other genotypes indicating early storage root formation and early maturity. Genotypes MUIB 005, MUIB 015, MUIB 034 and MUIB 035 with low to very low storage root yield were late maturing. At final harvest (146 DAP) significant (P≤0.05) storage root yield reduction from as little as 0.94 % in MUIB 058 to the highest of 58.51% in MUIB 011 were observed under the stressed condition compared to the corresponding storage root yield under irrigated condition. Similarly, the marketable storage root yield at the final harvest was significantly (P≤0.05) reduced in most genotypes compared to irrigated condition. Total storage root weights at 146 DAP under irrigated and stressed trials showed highly significant (P≤0.05) differences among the genotypes. Marketable storage root weight had strong significant positive correlation with total storage root weight both under irrigated (0.0.80**) and stress trial (0.58*). Similarly, vine weight had significant (P<0.01) positive correlation with leaf area (0.77) in the stress trial, but was negatively correlated to drought score (-0.20) and storage root dry matter (-0.69).

**Key words:** Water stress, growth and development, sweet potato genotypes.

## INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is a major root crop in Papua New Guinea (PNG) grown under rain-fed condition and is prone to water stress. The water stress can occur at any stage of the crop growth. The crop is very sensitive to water deficit, especially during early stages (prior to storage root formation) of crop growth affecting vine development and late stages during assimilate translocation (Indira and Kabeerathumma, 1988). Drought is often considered as the major limiting factor for sweet potato production in areas where it is grown under rain-fed conditions. Anselmo *et al*. (1998) and El Sharkawy and Cadavid (2002) reported genotypic variability among sweet potato cultivars in tolerating desiccation under severe moisture stress during vegetative and establishment stage, and in recovering from stress. Valenzuela *et al*. (2000) found that different cultivars may respond differently to limited quantities of soil water. Prolonged drought stress can significantly reduce the storage root yield and quality (El Sharkawy and Cadavid, 2002).

Rainfall is unevenly distribution in PNG. As such, it is important to find out the effect of both early water stress (i.e. stress at vegetative growth stage) and late water stress (i.e. stress at maturity stage) on sweet potato production under PNG lowlands condition so that farmers can adjust the time of planting to avoid water stress, otherwise that would adversely affect the yield and quality. The use of drought tolerant genotypes and better water management practices can

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improve the yield and quality of sweet potatoes. Selection of cultivars expressing superior characters that confer tolerance to water stress is of prime importance for the farmers of PNG. Therefore, this study was conducted to evaluate the effect of soil water stress prior to and after storage root initiation on the growth performance and yield of 10 sweet potato genotypes.

## MATERIALS AND METHODS

### Experimental Site

Two experiments were conducted at the Agriculture Department Farm of the PNG University of Technology (6$^o$ 41´S, 146$^o$ 98´E), Lae, PNG in 2006. The farm is situated at an elevation of 65 and is classified as having Lowland per humid climate (McAlpine *et al*., 1983).The site receives an average of 10 sunshine hours per day, minimum and maximum temperatures of 23 °C and 30 °C respectively; an average relative humidity (RH) of 77 %, and an annual rainfall of 4,700 mm.

### Soil type

Soil samples collected from the site were analyzed for texture using the "Glass Jar and Triangular Method" which showed that the soil is sandy loam. The soil is shallow, fertile, well drained with clay content of 45% in the surface and the soil pH was 4.5-5.2 indicating its acidic nature. The soil of the experimental site was previously cropped with taro (*Colocasia esculenta*), peanut (*Arachis hypogeae*) and maize (*Zea mays*) and then fallowed with Johnson grass (*Rottboelia exaltata*) and kunai (*Imperata cylindrica*) for five years. During previous cropping and the land preparation before planting, farm implements, including tractor mounted disc ploughs and harrows were used, hence may have disturbed the soil structure of the area .

### Experimental Design

The experiment involved two adjacent trials with different watering treatments. Each trial consisted of ten genotypes with four replications arranged in a randomized complete block design with each of the treatment plots having dimensions of 3m x 5m.

#### a) Irrigated Trial

This trial received 1,172 mm of rain from the time of sowing to final harvest. During the days of no rain, overhead sprinkler irrigation of 400-560 mm was supplemented for the the short fall with two irrigations per week. What is the volume of water applied?

#### b) Early and Late Stress

Water stress was created by covering the entire experimental area by a temporary rain-out shelter. Before the construction of the Rain-out shelter, both trials irrigated and stress trials received similar amounts of water. A temporary Rain-Out shelter measuring 22 m x 26 m and 3.5 m high was built over the experimental plot after 60 days of growing under normal adequate well watered conditions in the same manner as the irrigated trial. Stress was imposed by excluding water and rain from the plot by pulling the clear plastic tarpaulin on top of the constructed building frame over the plot. The first stress lasted for 35 days from 61 – 95 days after planting (DAP). The second stress was applied during the storage root sinking stage towards maturity from 116 – 146 DAP. Stress was relieved after the respective duration by removing the rain-out shelter.

### Land Preparation and Cultural Details

The experimental sites for the two trials were fallowed with corn?? grass (*Rothboelia exaltata*) during the previous years and were ploughed and harrowed with the Massey Ferguson 4600 Tractor three weeks before planting. A compound fertilizer (12:12:17) was applied at the time of planting at 80 kg N ha$^{-1}$. Vine cuttings of 30 cm length for all genotypes were collected and planted on raised flat beds at 70 cm between rows and 50 cm between plants. A top dressing of 50 kg N ha$^{-1}$as ammonium sulphate was applied four weeks after planting. Weeds were controlled by frequent hand weeding until development of the full canopy to cover the ground.

### Data Collection

Data were collected on both below (storage roots) and above ground plant parts (i.e. vines, leaves, petioles) during each harvest at 60, 95, 116 and 146 DAP. At each harvest 6 plants were randomly harvested on every adjacent row excluding the guard rows. At each sampling, plant tops were cut 2-4 cm above ground level while storage roots were dug out using the manual garden fork. Samples were weighed fresh, and then dried in oven at 70°C for at least five days to have the dry weights.

### Vine Weight

Fresh vine weight and vine dry weights at each harvest from six randomly sampled plants were recorded. Vine dry weights were taken at each sampling occasions after drying the vines for four days in the oven at 50-60ºC.

**Total Storage root Weight**

Harvest was done at different days after planting to observe the tuber dry matter accumulation at progressive growth stages. During each harvest at 60, 95, 116 and 146 DAP, all storage root formed were counted, washed and weighed to obtain a total storage root weight for each of the treatment plot.

**Marketable Storage root Weights**

Marketable storage root number and weight were taken by separating the marketable from non-marketable storage roots. Marketable storage roots are storage root sizes ranging from medium to large and weigh more than 750 g and can be sold at market for consumption.

**Storage root Dry Matter**

Five hundred grams of fresh storage roots from each the genotypes during the respective harvest was sliced and dried in the oven at 50-60ºC for three days to measure storage root dry matter (SRDM). SRDM was then divided by the plot area ($m^2$) to calculate the dry matter production per unit area.

**Leaf Area (LA)**

Leaf area ($cm^2$) was measured before, during and after stress for all the genotypes. Fifty fully developed leaves were randomly collected from each plot. LA was measured using the portable Leaf Area Meter (Model: L1 3000A, Brand Name: LI-COR

**Drought Score**

Effect of water stress was visually assessed on a 1-5 scale following the Drought Evaluation System devised by International Rice Research Institute (IRRI, 1975) for rice. This system, was modified for sweet potato, where 1=leaves green; 2= dry tips on some leaves; 3= dead tips on most leaves; 4= dead tips longer than 5 cm; and 5= all leaves with dead tips longer than 8 cm.

**Statistical Analysis**

Data collected on total fresh storage root yield, marketable storage root yield and storage root dry matter were subjected to Analysis of variance (ANOVA). Least significant differences (LSD) and Duncan Multiple Range Test (DMRT) were used to determine the treatment mean differences for the selected parameters. Data on mean leaf area and fresh vine weight were graphed against date of harvest to determine the effect of water stress. Correlations coefficients analysis by Pearson (normal) or Spearman's rank among important characters were also calculated to investigate if various growth parameters were strongly dependent on each other.

## RESULTS

**Total Storage root Fresh Weight**

At 60 DAP harvest, just before the imposition of water stress; the genotypes differ widely in terms of storage root yield. Genotypes B11, MUIB 005, MUIB 035, MUIB 013 and MUIB 015 had comparably higher yield than the rest of the genotypes in the irrigated trial. In the stress trial (before imposition of the stress) MUIB 057, MUIB 013, MUIB 011 and MUIB 058 performed better than the rest of the clones.

At the second harvest of 95 DAP, 35 days after the imposition of water stress (61 DAP – 95 DAP), all the genotypes responded differently to water stress. Total storage root yield decreased in all the genotypes compared to the corresponding yield under the irrigated condition except for MUIB 013, MUIB 034 and MUIB 058, where they had the higher storage root yield. Under irrigated condition, MUIB 035 had the highest storage root yield of 475.5 g and the lowest being 130 g in MUIB 013. But under the stress trial, B11 had the highest yield of 285 g and the lowest of 110 g with MUIB 011. The overall mean storage root yield of the genotypes under the stress trial was 1.98% lower than the corresponding genotype mean under the irrigated condition and this difference in means was not significant.

At 116 DAP (i.e. 21 days)_ after the withdrawal of water stress by removing the rainout shelter and re-watering, the genotypes showed high variability in terms of recovery and storage root production. Almost all the genotypes had reduced storage root yield compared to the corresponding yield under the controlled condition except for MUIB 007, MUIB 034, MUIB 057 and MUIB 058, where these genotypes had higher storage root yield than under the irrigated condition. Overall, the mean storage root yield under the stressed condition was 12.18% lower than the corresponding mean storage root yield under the irrigated condition and that difference was significant at $P \leq .05$.

At the final harvest of 146 DAP, just after the second water stress (96 - 146 DAP), almost all the genotypes were affected with reduction in storage root yield ranging from as little as 0.94% in MUIB 058 to the highest of 58.51% in MUIB 011 compared to the corresponding yield under the controlled condition. However, MUIB 007, MUIB 013 and MUIB 034 recorded higher storage root yield by 1.73%, 38.22% and 15.42%, respectively. The overall mean storage root yield under the stressed condition (early + late) was 26.53% lower than the mean under the irrigated condition and this difference was significant ($P \leq 0.01$).

Treatment mean comparisons of the total storage root weights for the ten genotypes under stress and irrigated condition at maturity (146 DAP) are shown in Table 1. Significant differences in treatment means for storage root weights were observed in both the trials. Under the stressed condition, fewer variations were observed among the genotypes in terms of total storage root weight. MUIB 034 had the highest yield of 2,679.5 g and the lowest being 1,045 g in case of MUIB 011. The difference of the means was significant at $P<0.05$ . Again, the storage root weights of MUIB 034, MUIB 007, MUIB 035 and MUIB 005 did not differ significantly from MUIB 013, MUIB 057, MUIB 058, MUIB 015 and B 11.

Wider variations in terms of total storage root weights were observed under the irrigated condition (Table 1). B 11 produced the highest storage root yield of 3836.8 g and that was not significantly different from MUIB 035 and MUIB 005; but was significantly higher than MUIB 013, the lowest yielding genotype and MUIB 058, MUIB 034, MUIB 007, B 11, MUIB 057 and MUIB 015. Moreover, the mean yield differences among MUIB 057, MUIB 011, MUIB 007 and MUIB 034 were also insignificant.

## Marketable Storage root Weight

It was noted that none of the genotypes produced any marketable storage roots until 116 DAP, as a result, Table 2 shows only the marketable storage root yield at 116 and 146 DAP.

At harvest 116 DAP, marketable storage root yield ranged from 234.8 g in MUIB 058 to 2033.2 g in B 11 under the irrigated condition. However, under the stressed trial, most of the genotypes had higher marketable storage root yield compared to the corresponding irrigated condition except for MUIB 013, MUIB 011 and B 11. The mean marketable storage root yield for the stress trial was 56.20% higher than the corresponding mean under the irrigated condition and this difference in means was significant ($P \leq 0.05$).

During the final harvest at 146 DAP i.e. after the impositions of second water stress at 116 DAP, most of the genotypes had reduced marketable storage root yield compared to the irrigated condition. However, MUIB 007, MUIB 034, MUIB 057 and MUIB 058 had higher yield compared to the same under irrigated condition. Marketable storage root yield ranged from the lowest of 565.4 g in MUIB 058 to the highest of 2769.2 g in B 11 in the irrigated trial, but under the stressed condition, the lowest marketable yield of 492.8 g was produced by MUIB 013 and the highest of 1585.5 g by MUIB 035.

The mean marketable yield of the genotypes under the stress trial (early + late) was reduced by 20.88% from the corresponding mean under the irrigated condition and this difference in means was significant ($P \leq 0.05$).

## Vine Weight

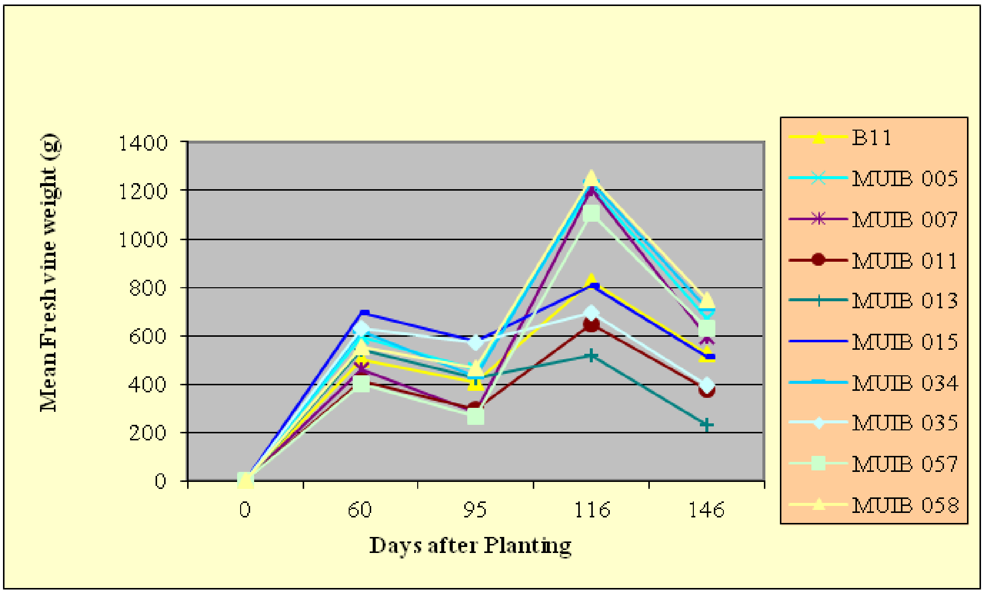
In the stress trial, the vine weights of all the genotypes increased steadily during the early growth phase (up to 60 DAP). With the imposition of water stress at 61 DAP, the vine weights of all the genotypes reduced drastically even though the genotypes differed in their responses. After 95 DAP, with the withdrawal of water stress by removing the rain-out shelter and re-watering, all the genotypes recovered and vine weights increased quite dramatically. Fresh vine weights of all the genotypes dropped sharply again with the imposition of late water stress on 116 DAP. On the contrary, vine weights for all the genotypes increased steadily under the irrigated watered condition even though differed significantly in the mean fresh vine weights.

## Storage root Dry Matter (TDM)

The total dry matter for the 10 genotypes under irrigated and stressed condition is presented in Table 3. At 60 DAP before the imposition of stress, the mean TDM of the two trials did not differ significantly. MUIB 013 had the highest TDM both under the stress and controlled condition at 95, 116 and 146 DAP harvest.

The average TDM reduction under the stressed condition at 95, 116 and 146 DAP were 7.40%, 11.63% and 7.96%, respectively compared to the means under the irrigated condition and these reductions in TDM were significant at $P \leq 0.01$.

(a) Early + Late stress




(b) Irrigated Trial

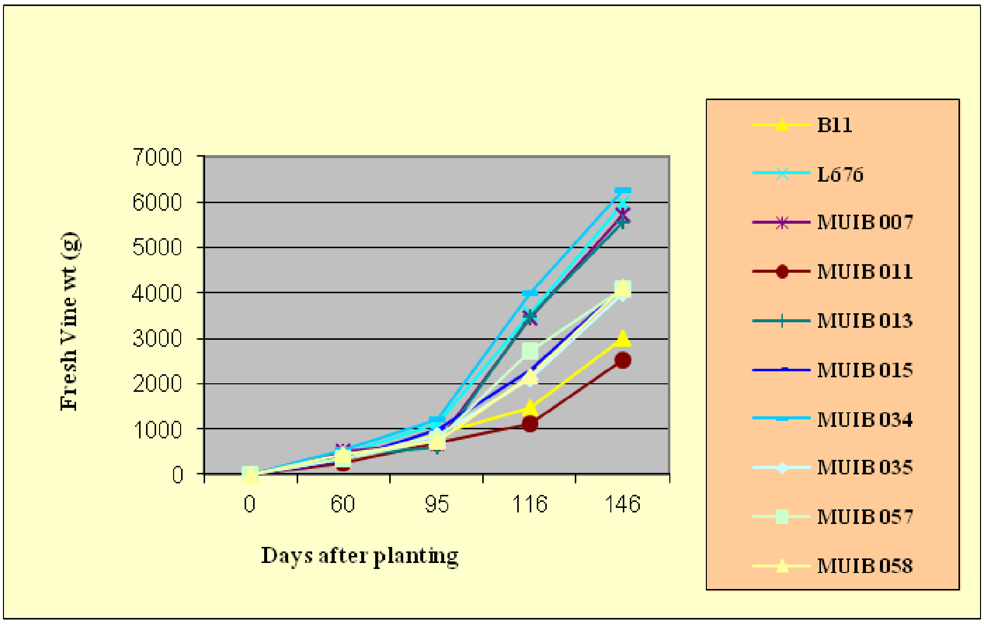
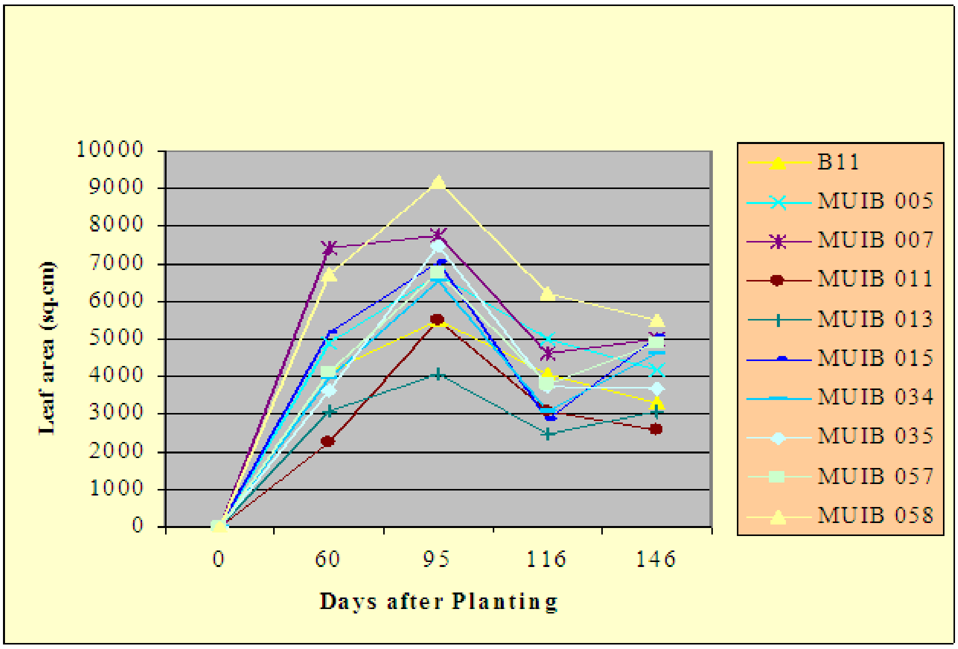



**Figure 1**. Mean Fresh Vine Weight (grams) in (a) Early and Late Stress and (b) Irrigated trials.

**Leaf Area**

In the stress trial, imposition of water stress at 61 DAP for 35 days (up to 95 DAP) did not show any impact, the LA was markedly reduced for all the genotypes from 95 to 116 DAP. The imposition of the second stress at 116 DAP did not have any LA reduction, rather leaf area increased for all the genotypes though the increase was smaller than at 0 – 95 DAP. In contrast, under the control trial, leaf area for all the genotypes increased steadily until 116 DAP and then reduced until the final harvest at 146 DAP drastically even though the individual genotypes differed in terms of leaf area.

(a) Early + Late stress




(b) Irrigated Trial

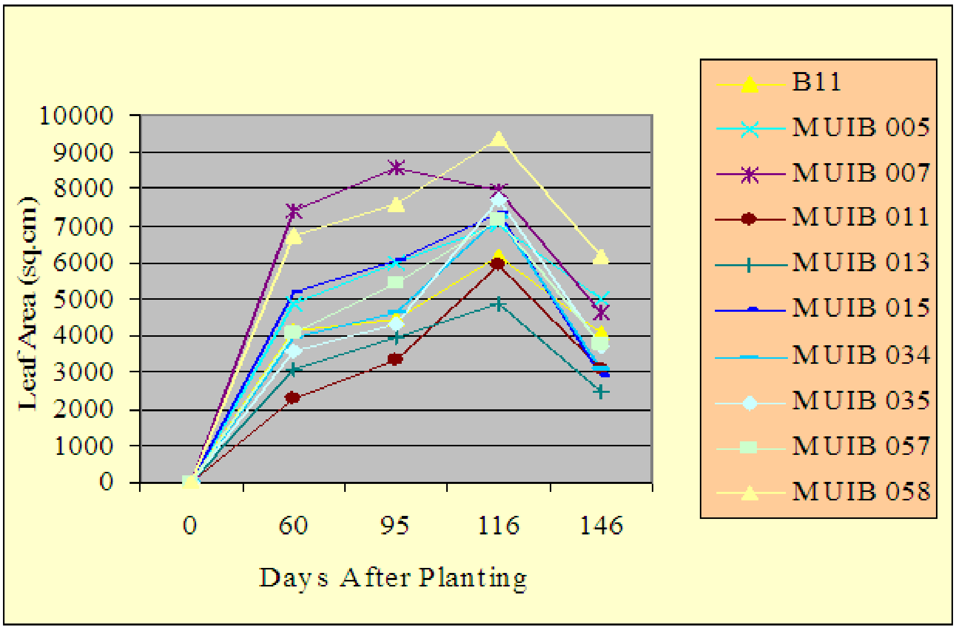



**Figure 2**. Mean Leaf area ($cm^2$) of ten genotypes from 0 – 146 DAP in (a) Early + Late Stress and (b) Irrigated Trials

Table 1: Total Storage root weight (tonnes per hectare) at 60, 95, 116 and 146 DAP under stressed and irrigated trials.

| Genotypes | Days after planting (DAP) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 60 | | 95 | | 116 | | 146 | |
| | Irrigated | Early + Late stress | Irrigated | Early + Late stress | Irrigated | Early + Late stress | Irrigated | Early + Late stress |
| B11 | 18.5 | 26.0 | 22.2 | 19.0 | 19.6 | 11.3 | 25.6**a** | 11.2**ab** |
| MUIB 005 | 19.1 | 22.7 | 20.0 | 13.7 | 13.8 | 9.2 | 23.5**ab** | 15.6**a** |
| MUIB 007 | 11.9 | 27.8 | 17.1 | 13.3 | 9.6 | 10.6 | 16.0**cde** | 16.3**a** |
| MUIB 011 | 17.9 | 31.7 | 15.8 | 7.3 | 8.2 | 5.1 | 16.8**cde** | 7.0**b** |
| MUIB 013 | 17.9 | 32.7 | 8.7 | 11.2 | 6.4 | 4.0 | 9.6**f** | 13.2**ab** |
| MUIB 015 | 17.4 | 16.4 | 14.5 | 12.7 | 12.1 | 8.1 | 20.5**bc** | 11.2**ab** |
| MUIB 034 | 13.2 | 18.9 | 12.6 | 17.4 | 10.1 | 13.1 | 15.5**de** | 17.9**a** |
| MUIB 035 | 19.5 | 20.2 | 31.7 | 13.8 | 15.4 | 9.6 | 24.4**ab** | 16.1**a** |
| MUIB 057 | 15.9 | 35.5 | 12.8 | 8.7 | 9.1 | 10.7 | 18.1**cd** | 13.2**ab** |
| MUIB 058 | 10.0 | 31.7 | 10.3 | 15.9 | 6.1 | 8.9 | 12.9**ef** | 12.8**ab** |
| Mean±SE | 16.1 | 26.4** | 16.6 | 13.3ns | 10.3 | 9.0* | 18.3* | 13.4** |

*, ** significant at P ≤ 0.05 and P ≤ 0.01, respectively.

Treatment mean comparisons of total storage root weight (t / ha) at 146 DAP. Means followed by the same letters in the column are not significantly different at p ≤ 0.05 (DMRT)

Table 2: Marketable storage root yield (tonnes/hectare) for ten sweet potato genotypes at 116 and 146 days after planting under irrigated and stressed Trials

| Genotypes | Days after planting | | | |
|---|---|---|---|---|
| | 116 | | 146 | |
| | Irrigated | Early + Late stress | Irrigated | Early + Late stress |
| B11 | 13.6 | 10.7 | 18.5 | 10.0 |
| MUIB 005 | 5.2 | 17.7 | 9.7 | 8.9 |
| MUIB 007 | 2.4 | 7.2 | 5.8 | 8.1 |
| MUIB 011 | 5.9 | 4.2 | 10.5 | 4.0 |
| MUIB 013 | 3.7 | 2.5 | 5.8 | 3.3 |
| MUIB 015 | 4.9 | 5.6 | 9.7 | 4.1 |
| MUIB 034 | 3.8 | 7.2 | 8.6 | 8.8 |
| MUIB 035 | 7.1 | 8.7 | 11.6 | 10.6 |
| MUIB 057 | 4.3 | 10.9 | 7.2 | 8.6 |
| MUIB 058 | 1.6 | 6.9 | 3.8 | 5.8 |
| Means ± SE | 5.2 | 8.2* | 9.1 | 7.2* |

*, **, significantly different at p ≤ 0.05 and p ≤ 0.01, respectively.

Table 3.Storage root dry matter (tonnes / hectare) for ten sweet potato genotypes at60, 95, 116 146 days after planting

| Genotypes | Days after planting (DAP) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 60 | | 95 | | 116 | | 146 | |
| | Irrigated | Early + Late stress | Irrigated | Early + Late stress | Irrigated | Early + Late stress | Irrigated | Early + Late stress |
| B11 | 4.55 | 4.42 | 9.24 | 8.57 | 9.35 | 8.68 | 11.07 | 10.40 |
| MUIB 005 | 3.91 | 4.09 | 8.89 | 8.22 | 9.46 | 8.12 | 10.10 | 9.43 |
| MUIB 007 | 4.33 | 3.99 | 9.01 | 8.35 | 9.62 | 8.28 | 10.33 | 9.67 |
| MUIB 011 | 4.57 | 4.50 | 8.97 | 8.30 | 9.41 | 8.74 | 11.21 | 9.88 |
| MUIB 013 | 4.20 | 4.08 | 10.65 | 9.99 | 11.12 | 10.45 | 12.95 | 12.29 |
| MUIB 015 | 4.23 | 4.25 | 9.17 | 8.50 | 9.63 | 8.29 | 10.21 | 9.54 |
| MUIB 034 | 4.51 | 3.98 | 9.04 | 8.38 | 9.38 | 8.05 | 10.42 | 9.08 |
| MUIB 035 | 3.96 | 3.57 | 8.37 | 7.70 | 9.70 | 8.36 | 10.62 | 9.96 |
| MUIB 057 | 4.08 | 4.17 | 9.29 | 8.62 | 10.16 | 8.82 | 11.09 | 9.76 |
| MUIB 058 | 3.99 | 4.21 | 9.19 | 8.53 | 9.65 | 8.31 | 10.91 | 10.25 |
| Means±SE | 4.23 | 4.19 ns | 9.18 | 8.49** | 9.75 | 8.61** | 10.89 | 10.03** |

ns = non-significant;

*, **, significantly different at P ≤ 0.05 and P ≤ 0.01, respectively.

Correlation coefficients among leaf area, drought score, marketable storage root weight, total storage root weight, storage root dry matter and vine weights for the two trials at the final harvest (146 DAP) are presented in Table 4. Marketable storage root weight had a strong significant (P<0.01) positive correlation with total storage root weight for the irrigated (0.80) and stressed conditions (0.60, P<0.05), respectively.

Similarly, vine weight had a significant (P<0.01) positive correlation with leaf area (0.80) in the stress trial, but was negatively correlated to drought score (-0.1994) and storage root dry matter (-0.6852). Storage root dry matter had a significant positive correlation (0.46*) with drought score but was negatively correlated to leaf area (-0.4506), marketable storage root yield (-0.4890) and total storage root weight (-0.2357) even though none of them was significant.

Table 4. Correlation coefficients of various yield parameters measured under different soil moisture conditions at harvest

**Correlations (Pearson)**

| | **DROUGHT** | **Leaf area** | **MARKETTUBwt** | **TOTtub.wt** | **TUBER DM** |
|---|---|---|---|---|---|
| LEAF | 0 | | | | |
| | (-.2611) | | | | |
| MARKTTub.wt | 0 | -0.2249 | | | |
| | (-0.0337) | (0.1236) | | | |
| TOTTub.wt | 0 | 0.1046 | 0.7984** | | |
| | (0.1936) | (0.4400*) | (0.5791*) | | |
| TUBERDM | 0 | -0.3870 | -0.1561 | -0.5705 | |
| | (0.4600*) | (-0.4506) | (-0.4485) | (-0.2357) | |
| VINEwt | 0 | 0.0445 | -0.4890 | -0.3231 | -0.1111 |
| | (-0.1944) | (0.7671**) | (0.4146) | (0.3985) | (-0.6852) |

Values in the parenthesis are the correlation coefficients for the stress trial and without parenthesis are correlation coefficient for unstressed (control) trial.
*, **, correlation coefficients are significantly different at $p \leq 0.05$ and $p \leq 0.01$, respectively.
The characters use for the correlations included; MARKTTub.wt – Marketable storage root weight; TOTTub.wt – Total storage root weight; STORAGE ROOTDM – Storage root dry matter; VINEwt – vine weight.

## DISCUSSION

Sweet potato is quite sensitive to water stress. As sweet potato is grown under rain-fed condition, intermittent water stress may occur at any growth stage. The effects become more severe on storage root yield when drought is prolonged (Gomes and Car 2001). Water stress decreased storage root dry matter production and this decrease may in turn reduce total storage root weight, leaf area and vine weight. Low storage root dry matter is due to prolonged water stress at early vegetative stage and late bulking stage. Gomes and Carr (2001) reported that storage root dry matter was reduced in sweet potato clones due to low radiation interception caused by leaf area index. Increased leaf death and drought score also contributed to reduced storage root dry matter. (Saraswati *et al.,* 2001)

The results from the current experiments showed interactions between watering treatments and the storage root yield at final harvest (146 DAP). The early stress (ES) that occurred during vegetative stage had significant effect on the early growth and development stage. However, stress during the sinking stage towards maturity period did not have much effect on storage root yield in some genotypes. Even some genotypes increased storage root yield during the stress at maturity. This was attributed to early storage root formation. Early stress during vegetative stage was not important in some genotypes; however, when stress was prolonged at 116 DAP, storage root yield declined drastically (Wamala and Akanda, 2010). This has shown that genotypes differ greatly in their agronomic responses in terms of growth and development, dry matter production, storage root yield, leaf area and drought score as affected by water stress (Taufatofua, 1994; Indira and Kabeerathumma, 1988).

Storage root yield declined with reduction in moisture caused by prolonged water stress in the early + late stress. It was observed that drastic storage root yield decline at 146 DAP on genotype B11 and MUIB 011 was related to damage by sweet potato weevil during the stress period. Other factor that also contributed to low storage root yield on genotype B11 was due to stealing of storage roots. Storage root yield of late maturing genotypes was lowest, mainly due to low storage root filling percentage affected by water stress (Gomes and Car, 2001). Severe water stress delayed storage root bulking of all genotypes at least 12 days. Marketable storage root number and storage root weight per plant was reduced more than other yield component in water stress treatment. (Taufatofua, 1994).Storage root yield in some genotypes was reduced during early and late stress. These findings were consistent with Saraswati *et al.* (2002).

Storage root weights of some genotypes were significantly lower in ES than under irrigated condition. Storage root dry matter 60-95 DAP was low due to insufficient availability of assimilates and source limitation to fill the storage roots. Alternatively, stress during storage root bulking and development may have restricted potential storage root size in drought tolerant lowland genotypes.

Storage root yield in both ES and ELS condition, stored assimilates available for translocation to fill the storage roots was low due low TDM at late vegetative growth stage (Wamala and Akanda, 2010). The second stress period resulted in little dry matter production between 90 –146 DAP under the stressed condition. The limited assimilates supply during storage root bulking (current and translocated assimilate) resulted in lower storage root weight and low storage root number per plant in ELS than in ES in all genotypes.

## CONCLUSION

Storage root yield and dry matter production declined with the reduction in available water. Reduced dry matter production under stress was associated with decreased moisture availability and water use. Genotypic differences in storage root weight, vine weight and leaf area were shown among the genotypes in growth.

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