GLADSTONE ROAD AGRICULTURAL CENTRE
CROPS RESEARCH REPORT NO. 27

THE IMPACT OF DIFFERENT WEATHER CONDITIONS ON GROUND COVER DEVELOPMENT AND TUBER YIELD OF SWEET POTATO

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ABSTRACT

The purpose of this study was to evaluate the effect of different weather conditions on canopy development and tuber yield of sweet potato. This study combined statistical data from the Meteorological Department of The Bahamas with the percentage of ground cover, or canopy development, over time. The trial was conducted on two occasions, from November 2007 to June 2008 and from October 2011 to May 2012 at the Gladstone Road Agricultural Centre, and studied the impact of rainfall, sunshine duration and mean maximum and minimum temperatures on four sweet potato varieties. The results of this field study affirm that weather conditions do influence sweet potato canopy development and subsequent tuber yield. The canopy development and yield responses will be useful for the development and management of sweet potato production systems.

Canopy development in sweet potato grown at the Gladstone Road Agricultural Centre during 2008

Introduction:

The sweet potato (*Ipomoea batatas* (L.) Lam.) is a perennial crop that is cultivated over a wide range of climatic conditions from the tropic to the temperate zones of the world. Crop growth and yield is determined by many factors such as crop variety, soil conditions, agronomic practices and climatic conditions (Kays, 1985). Under favourable conditions, the sweet potato roots will develop into economically viable storage organs (Wilson and Lowe, 1973). The sweet potato is of particular importance in developing countries because of its adaptability to adverse conditions such as high temperatures, low soil fertility and drought (Yencho *et al.*, 2002). Annually, worldwide production of the sweet potato exceeds 104 million tonnes, harvested from approximately eight million hectares (FAOSTAT, 2011). Most of this production comes from China (more than 80 million tonnes) and other Asian countries, including Indonesia, Japan and Korea. Total sweet potato production for the Caribbean region is in excess of 700 thousand tonnes, with The Bahamas contributing 900 tonnes to that figure.

Climate and weather influence crop production. Climate is a long-term average weather condition that either directly or indirectly controls or affects agricultural production (Akpenpuun and Busari, 2013). That is to say, the long-term average temperature and the total solar radiation and rainfall over a crop's growing season can be described as the climate. It is the climate that, in the absence of any weather extremes, determines the actual yields for a given region (Hollinger and Angel, 2009). The day-to-day variability of temperatures, solar radiation and rainfall across the landscape can be described as weather. Weather extremes at critical periods of a crop's development can have dramatic influences on productivity and yields.

The impact of climate on crop production and the response of various crop species to the climatic environment has been well documented (Yong, 1962; Sajjapongse and Wu, 1989; Gunadi and Harris, 2000; Korkmazk and Dufault, 2001; Kumar *et al.*, 2006; Lewthwaite, and Triggs, 2012; Akpenpuun and Busari, 2013). Climatic conditions such as temperature, solar radiation and rainfall influence the rate of development of a crop (Dennett, 1984). Crop growth and yields are negatively affected by deficits in water supply and extreme temperatures, which can result in physical damages, physiological disruptions and biochemical changes (Fahad *et al.*, 2017).

Rainfall is perhaps the most important climatic condition essential for crop production. Without water, plants are unable to carry out vital physiological functions, such as photosynthesis, respiration and transpiration. The amount of rainfall affects moisture levels in the ground, which also affects yields. The development of the sweet potato canopy can be severely restricted by the lack of irrigation water which, in turn, affects the tuber yield (Lewthwaite and Triggs, 2012). According to Dennett (1982), the rate of water loss from a short green crop, completely covering the ground and amply supplied with water, depends solely on meteorological factors, primarily solar radiation.

Solar radiation is essential for plant growth and development. Plants absorb sunlight through the leaves, as an energy source to carry out photosynthesis. The amount of sunlight that a crop is able to capture depends upon the leaf surface area. With a fully developed canopy, a crop's ability to capture sunlight is maximised. Monteith (1977) was able to demonstrate that the total dry matter yields of crops were directly related to the amount of solar radiation intercepted by these crops. McDavid and Alamu (1980) demonstrated the effects of sunshine duration on sweet potato, showing that long days promoted canopy development and slowed down tuber growth. They observed the opposite effect for short day lengths, which encouraged flowering and tuber development and reduced shoot growth in the sweet potato.

The mean maximum and minimum temperatures are the average temperatures occurring during the day and night, respectively. Both temperatures play important roles in the growth and development of plants. Day temperatures in their optimum limits help the photosynthesis process in the presence of sunlight while higher night temperatures support the respiration process, which is the reverse process of photosynthesis. Dry matter accumulation takes place when photosynthesis is greater than respiration, which supports plant growth and development. When respiration is greater than photosynthesis, the development process of plants is slowed down (Rasul, *et al*,. 2011). On the other hand, extreme minimum temperatures may affect the night time plant respiration rates which can potentially reduce biomass accumulation during the growth stage of plants and hence reduce the crop's yield (Hatfield and Prueger, 2015).

Many of the physiological processes in the development of the sweet potato are influenced by temperature. Sweet potato thrives best in temperatures ranging between 15ºC and 35ºC, while lower and higher temperatures outside of this range adversely affect tuber yields (Romero and Baigorria, 2008). The sweet potato prefers warm day and night time temperatures for optimum growth and development. As temperature decreases, there is some temperature at which a plant stops developing. This temperature is called the "base temperature" and it varies from crop to crop. Night time temperatures below 13°C have been shown to slow down growth in sweet potato (Carey *et al.*, 2007). In many sweet potato varieties, growth is completely inhibited at temperatures below 15°C.

The sweet potato is a vigorous growing plant and can establish a complete canopy in as little as six weeks (Onwueme, 1978). A healthy sweet potato canopy is essential for the optimal production and profitability of the sweet potato crop. In their research on weed control in sweet potato, Tenaw, *et al*., (2011) found that sweet potato varieties with a vigorous, spreading growth habit were better able to compete with weeds and required less weeding than those with an erect or intermediate growth habit. While close spacing may contribute to rapid development of a complete canopy, increasing plant density decreases stem length and total number of branches per plant, presumably due to an increase in competition for nutrients and irradiance (Somda and Kays, 1990b).

A better understanding of the relationship between crop canopy development and weather conditions can provide useful information about a crop's potential within a given area. Monteith (1977) describes the efficiency of crop production as the ratio of energy output (carbohydrate) to energy input (solar radiation). Temperature and water supply, he adds, are the main climatic constraints on efficiency. An important element in the production of high yielding, good quality sweet potatoes is a uniform canopy of healthy, vigorous plants. It is important to assess the weather and climatic factors affecting plant growth and development, as a better understanding of their interactions with agricultural parameters could help increase crop productivity (Goswami, *et al*., 2006).

Objectives:

This study examined the impact of different weather conditions on ground cover development and yield of four sweet potato varieties.

Materials and Methods:

The results of this study was derived from field experiments carried out on two occasions at the Gladstone Road Agricultural Centre, New Providence, from November 2007 to June 2008 and from October 2011 to May 2012. Two-node cuttings of sweet potato were rooted in polystyrene trays containing a potting mixture. The plantlets were propagated under greenhouse conditions until they produced a well-developed root system and at least two fully expanded leaves. After a brief hardening-off period, the plants were transplanted to 200-ft long field plots, in a 4 x 32 factorial design with three replications, using four varieties over a period of thirty two weeks. Measurements of ground cover and final tuber yields were determined from the actual area of each plot, which, according to Romani *et al*., (1993), provides a good estimate of true yield. This is also supported by Neppl *et al*., (2003) whose study indicated that interactions of centre row with border row were insignificant.

The usual cultural practices were observed to ensure an even stand of plants in the experimental plots. The sweet potato varieties were grown under rain-fed conditions. Fertiliser was applied at a rate of 250 kg per hectare (220 lb per acre) one month after planting, then again at three months after planting. Before each application of fertiliser, the plots were weeded and cultivated. The four sweet potato selections used in this study and some of their characteristics are listed in table 1.

Table 1. Characteristics and origin of plant material used in the experiment.

VARIETY	SOURCE	DESCRIPTION
Antigua (King's Crown)	Antigua and Barbuda	Early maturing, bushy, erect plant.
CI001	Cat Island	Late maturing, vigorous, spreading plant
Six Weeks	New Providence	Early maturing, bushy, semi-erect, tending to spread
Solomon	Cat Island	Late maturing, up to ten months, vigorous, spreading plant.

The percentage ground cover over the period of growth was determined for the four sweet potato varieties according to the method outlined by Gunadi and Harris (2000). Essentially, a 70 x 50 cm frame was divided with nylon wires into 100 rectangles and held over the sweet potato crop at three designated sites per plot. The number of rectangles that were more than 50% filled with green leaf gave the percentage of ground cover. The percentage ground cover was recorded at weekly intervals for thirty two weeks from the 5 November 2007 to 9 June 2008 for the first experiment and from 3 October 2011 to 6 May 2012 for the second experiment.

At the end of the 2008 experiment, twelve plants of each of the four varieties were randomly selected from each of four plots and harvested, to determine the total number of tubers, number of marketable tubers, total tuber weights and weight of marketable tubers. During 2012, only six plants were harvested at random from each of four plots for the four varieties.

During the first conducting of the experiment in 2007-2008, the mean monthly maximum and minimum temperatures were 28.9°C and 21.4°C, respectively. The total rainfall for the period was 395.2 mm. Mean monthly sunshine duration for the period was 8.7 h. Weather data (Tables 2 and 3) on sunshine duration, maximum and minimum temperatures and rainfall for the period under study were obtained from the Meteorological Department of the Commonwealth of the Bahamas.

Table 2. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of November 2007 to June 2008, courtesy of the Meteorological Department of the Bahamas.

Month	Total rainfall (mm)	Mean monthly radiation (h)	Mean maximum temperature (ºC)	Mean minimum temperature (ºC)
November 2007	**61.0**	**8.1**	**27.9**	**20.8**
December2007	**53.3**	**7.8**	**28.0**	**21.1**
January 2008	**58.4**	**6.9**	**26.1**	**18.4**
February 2008	**38.1**	**8.8**	**28.2**	**20.1**
March 2008	**12.7**	**8.1**	**28.2**	**20.5**
April 2008	**20.3**	**10.0**	**28.8**	**21.4**
May 2008	**41.4**	**10.8**	**31.6**	**23.7**
June 2008	**110.0**	**9.1**	**32.7**	**25.0**

Note: Monthly mean values have been rounded up to the nearest tenth

The mean monthly maximum and minimum temperatures for the second conducting of the experiment (2011-2012) were 28.0ºC and 20.7ºC, respectively. The total rainfall for the same period was 1873.6 mm. Mean monthly sunshine duration for the period was 7.7 h.

Table 3. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of October 2011 to May 2012, courtesy of the Meteorological Department of The Bahamas.

Month	Total rainfall (mm)	Mean monthly radiation (h)	Mean maximum temperature (ºC)	Mean minimum temperature (ºC)
October 2011	**232.7**	**5.5**	**30.4**	**23.9**
November 2011	**20.1**	**8.1**	**28.2**	**21.6**
December 2011	**22.9**	**7.0**	**26.9**	**19.8**
January 2012	**6.6**	**8.0**	**26.1**	**17.8**
February 2012	**44.2**	**8.1**	**27.2**	**19.2**
March 2012	**62.2**	**9.3**	**27.8**	**20.1**
April 2012	**326.1**	**8.9**	**27.9**	**20.3**
May 2012	**222.0**	**6.8**	**29.7**	**22.8**

Note: Monthly mean values have been rounded up to the nearest tenth

Statistical Analyses:

All experimental results were analysed using Instat+™ v3.37 and ASSISTAT. Instat is an interactive statistical package, copyright © 2005, Statistical Services Centre, University of Reading, UK. All rights reserved. ASSISTAT, Version 7.7 beta (2015), website – http://www.assistat.com, by Fransisco de Assis Santos e Silva, Federal University of Campina-Grande City, Campina Grande, Brazil.

Results Experiment 2008

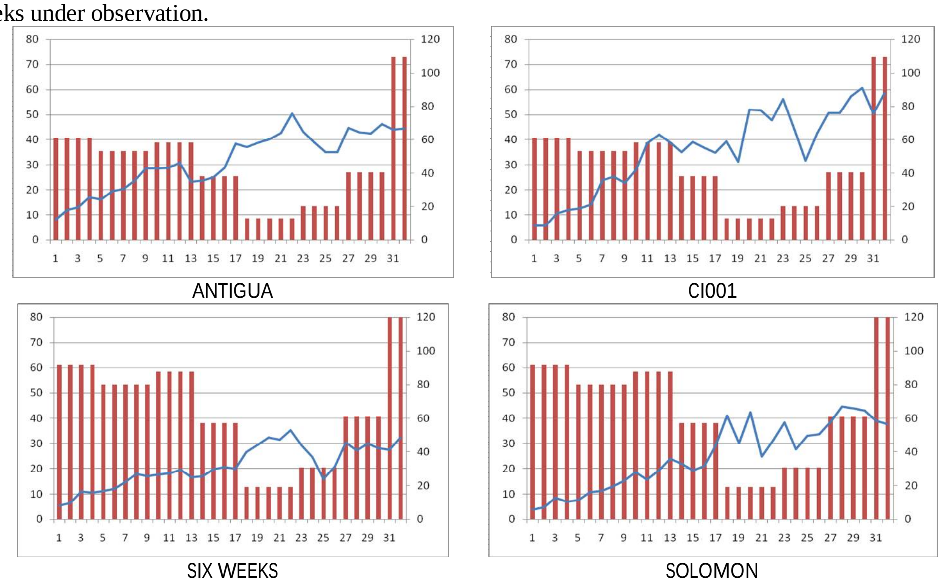
For the year 2008, the analysis of variance (Table 4) was performed on arc sine transformations of the ratio of the number of filled rectangles to the total number of rectangles found within the frame used to measure the percentage ground cover, in order to present a more normalised distribution of the experimental errors.

Table 4. Analysis of variance of arc sine transformation of percentages of ground cover for experiment conducted during 2008. Error mean square has 127 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. ns indicates differences between means not significant.

		--------Significance levels--------
Source	df	Arc sine transformation of number of filled rectangles/100 rectangles
Week	31	**
Variety	3	**
Variety x Week	93	**
Std Err		0.47

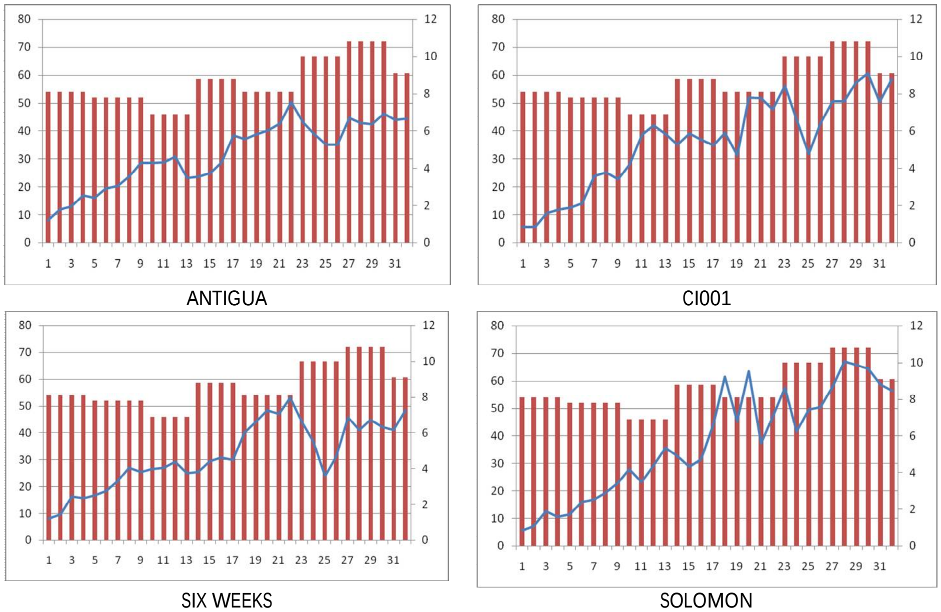
The distribution of rainfall during the growth and development of ground cover of the four sweet potato varieties is displayed in Figure 1. Canopy development steadily increased between the wet period between week 1 and week 17, for all four sweet potato varieties. There was a significant reduction in the amount of rainfall recorded during March of 2008 (Table 2), which coincides with the period between week 18 and week 22 of the experiment. This reduction in rainfall resulted in a dramatic reduction in canopy development, occasioned by a significant loss of leaf by week 23. A steep decline in the percentage of ground cover was noted for the individual responses of three of the sweet potato varieties (Figure 1), namely: 'Antigua', 'CI001' and 'Six Weeks'. The 'Solomon' sweet potato variety responded with alternating increases and decreases in canopy development over the same period. This behaviour might be attributed to a greater sensitivity to changing weather conditions.

Fig. 1. Arc sine transformation of percentage ground cover over 32 weeks of growth of four sweet potato varieties (2008). Response to rainfall over the period. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the total rainfall (red column graphs). Horizontal axis shows the number of weeks under observation.



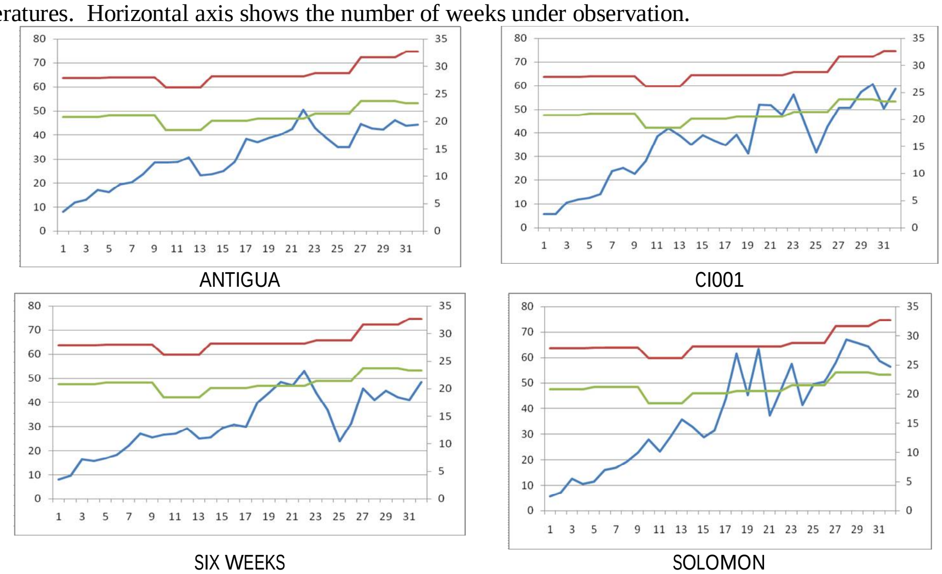
An early decline in the percentage of ground cover at week thirteen for all four sweet potato varieties (Figure 2) coincided with a decrease in the hours of solar radiation (Table 2). As the mean monthly radiation increased during the latter half of the experimental period, there was a steady increase in the percentage of ground cover.

Fig. 2. percentage ground cover over 32 weeks of growth of four sweet potato varieties (2008). Response to sunshine duration over the period. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the sunshine duration (red column graphs). Horizontal axis shows the number of weeks under observation.



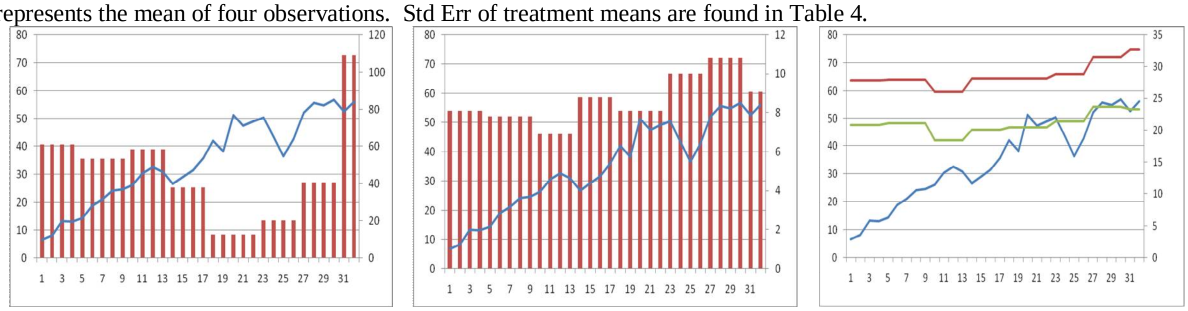
Growth of the sweet potato canopy was greatest at high temperatures. A pronounced dip in the mean maximum and minimum temperatures during the week nine to week eleven (Figure 3) was observed. This temperature dip resulted in a decline in the percentage of ground cover, which affected all four sweet potato varieties in varying degrees. As average minimum temperatures increased through the growing period, the sweet potato canopy was less affected by dips in temperatures.

Fig. 3. Percentage ground cover over 32 weeks of growth of four sweet potato varieties. Response to mean maximum and minimum temperatures over the period. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the maximum (red line graphs) and minimum (green line graphs) temperatures. Horizontal axis shows the number of weeks under observation.



Though the analysis of variance results showed significant interactions between sweet potato variety and time (weeks) for the arc sine transformation of the percentage of ground cover (Table 4), the composite responses for the four sweet potato varieties were plotted on the graphs in Figure 4, in order to provide a general response of the sweet potato over the 32 weeks. The values were based on the averaged means of the four sweet potato varieties.

Fig. 4. Composite response of climatic effects of rainfall, sunshine duration and maximum and minimum temperatures on canopy coverage development of four sweet potato varieties, during 2008. Each data point for composite canopy coverage represents the mean of four observations. Std Err of treatment means are found in Table 4.



Rainfall Sunshine duration Mean maximum and minimum temperatures

The analysis of variance (ANOVA) of the yield responses (Table 5) for the four sweet potato varieties showed a statistical significance for number of marketable tubers per plant, total tuber weights per plant and weight of marketable tubers per plant at a 1.0 % level of confidence. This indicates that the average performances for these varieties, with respect to yield components, varied significantly. The total number of tubers per plant showed no significant difference.

Table 5. Analysis of variance (ANOVA) for total number of tubers, number of marketable tubers, total tuber weights and weight of marketable tubers among four sweet potato varieties, harvested after 32 weeks. Standard error is for each treatment mean. Error mean square has 191 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. NS indicates differences between means not significant.

		-----------------Significance levels---------------------			
Source	df	Total number of tubers per plant	Number of marketable tubers per plant	Total weight of tubers per plant (kg)	Weight of marketable tubers per plant (kg)
Varieties	3	ns	**	**	**
Error	188				
Std. Err		0.26	0.12	0.05	0.04

The mean values for the yield components of the four sweet potato varieties are displayed in Table 6. The total yield per plant and marketable yield per plant in kilogrammes were highest for the variety ‘Six Weeks’ and lowest for the variety ‘Solomon’. There was no significant difference in yield between the bush type variety, ‘Antigua’, and the moderately spreading variety, ‘Six Weeks’, which gave similar yields, as indicated in Table 6. Both of these varieties were significantly earlier in root tuber maturity than any of the other two varieties, based upon the marketable yields. The varieties ‘CI001’ and ‘Solomon’, both late maturing and vigorously spreading plants, gave the lowest yields, performing well below ‘Six Weeks’ and ‘Antigua’. Yields were generally low for the late maturing varieties among the four sweet potatoes evaluated. The average weight of tubers is an important factor that affects the quality and percentage of marketable tubers. The highest weight of tubers per plant was produced by the variety ‘Six Weeks’ followed by ‘Antigua’. These weights were significantly higher than the other two sweet potato varieties.

Table 6. Mean values of tuber yield responses assessed 32 weeks after planting four sweet potato varieties (2008).

Variety	**Total number of tubers/plant**	**Number of marketable tubers/plant**	**Total weight of tubers/plant (kg)**	**Weight of marketable tubers/plant (kg)**
Antigua	6.7ab	2.31a	0.98b	0.66a
CI001	7.25a	0.96b	1.11ab	0.25b
Six Weeks	5.96ab	2.27a	1.32a	0.85a
Solomon	5.54b	0.02c	0.28c	0.01c

The t-test at a level of 5% probability was applied. For each variety, means within columns bearing different lowercase letters differ significantly at 5% level of confidence.

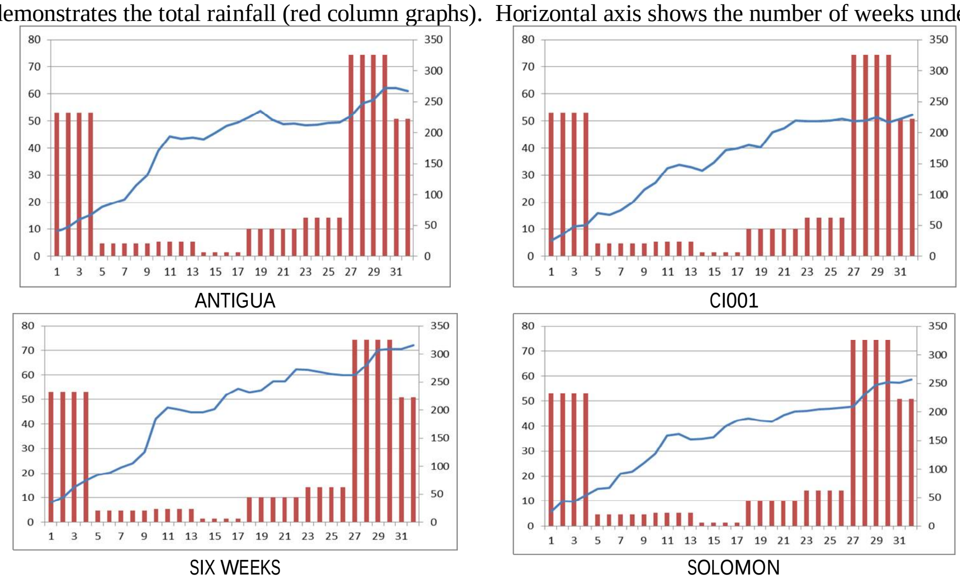
Results Experiment 2012

For the year 2012, as with the previous experiment, the analysis of variance (Table 7) was performed on arc sine transformations of the ratio of the number of filled rectangles to the total number of rectangles found within the frame used to measure the percentage ground cover, in order to present a more normalised distribution of the experimental errors.

Table 7. Analysis of variance of arc sine transformation of percentages of ground cover for experiment conducted during 2012. Error mean square has 256 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. ns indicates differences between means not significant.

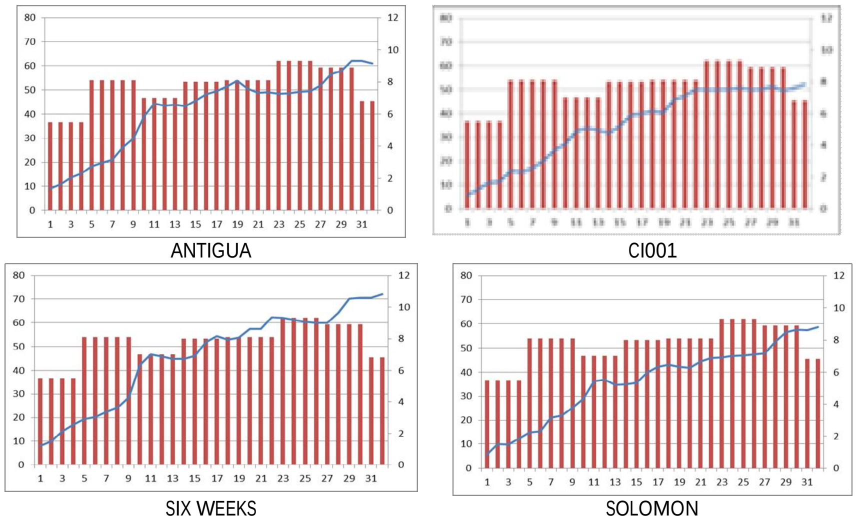
		--------Significance levels--------
Source	df	Arc sine transformation of number of filled rectangles/100 rectangles
Week	31	**
Variety	3	**
Variety x Week	93	**
Std Err		0.8

Fig. 5. percentage ground cover over 32 weeks of growth of four sweet potato varieties. Response to rainfall over the period.. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the total rainfall (red column graphs). Horizontal axis shows the number of weeks under observation.



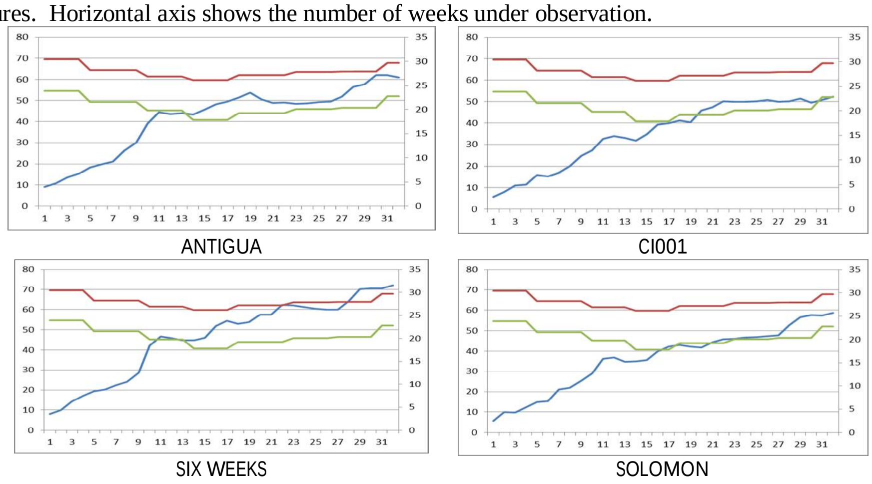
Rainfall for the months of November and December of 2011 was very low, with a significant drop in precipitation recorded during January of 2012. During this twelve week period, from week five to week seventeen (Fig. 5), there was a general decline in ground coverage development among the individual responses of each sweet potato variety as seen in Figure 6.

Fig. 6. percentage ground cover over 32 weeks of growth of four sweet potato varieties. Response to sunshine duration over the period. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the sunshine duration (red column graphs). Horizontal axis shows the number of weeks under observation.



The four sweet potato varieties, in general, responded positively to increases in solar radiation, with minor dips in percentage ground cover during periods of low radiation (Fig. 6).

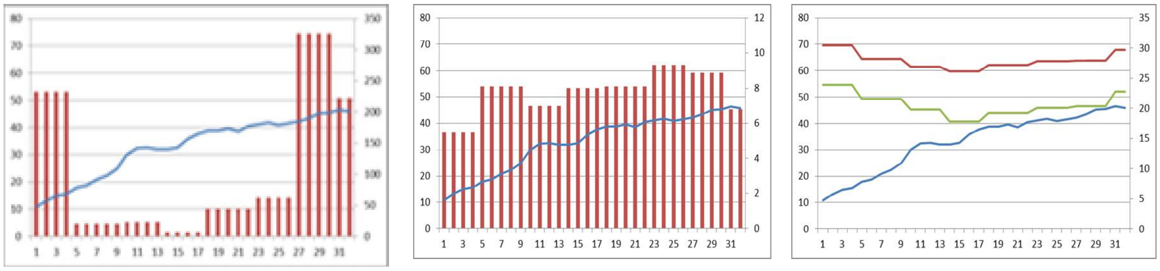
Fig.7. percentage ground cover over 32 weeks of growth of four sweet potato varieties. Response to mean maximum and minimum temperatures over the period. Primary vertical axis on left of graphs illustrate the percentage ground coverage (blue line graphs), while secondary vertical axis at right demonstrates the maximum (red line graphs) and minimum (green line graphs) temperatures. Horizontal axis shows the number of weeks under observation.



As the average minimum temperatures increased through the growing period, the sweet potato canopy was less affected by fluctuations in temperatures (Fig. 7).

Though the analysis of variance results showed significant interactions between sweet potato variety and time (weeks) for the percentage of ground cover (Table 7), the composite responses for the four sweet potato varieties were plotted on the graph in Figure 5, in order to compare the general responses. The values were based on the averaged means of the four sweet potato cultivars.

Fig. 8. Composite response of climatic effects of rainfall, sunshine duration and maximum and minimum temperatures on canopy coverage development of four sweet potato varieties. Each data point for composite canopy coverage represents the mean of four observations. Std Err of treatment means is found in Table 3.



Rainfall | Sunshine duration | Mean maximum and minimum temperatures

The analysis of variance (ANOVA) of the yield responses (Table 8) for the four sweet potato varieties showed a statistical significance for total number of tubers, number of marketable tubers, total tuber weights and weight of marketable tubers at a 1.0 % level of confidence. This indicates that the average performances for these varieties, with respect to yield components, varied significantly.

*Table 8. Analysis of variance (ANOVA) for total number of tubers, number of marketable tubers, total tuber weights and weight of marketable tubers among four sweet potato varieties, harvested after 32 weeks. Standard error is for each treatment mean. Error mean square has 95 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. NS indicates differences between means not significant.

		----------------Significance levels--------------------			
Source	df	Total number of tubers per plant	Number of marketable tubers per plant	Total Weight of tubers per plant (kg)	Weight of Marketable tubers per plant (kg)
Varieties	3	*	*	**	**
Error	92				
Std. Err		0.4	0.16	0.07	0.07

The mean values for the yield components of the four sweet potato varieties are displayed in Table 9. The total marketable yields of tubers per plant were highest for the varieties 'Antigua' and 'Six Weeks' with no significant difference between the two. The variety 'Solomon' produced the least amount of marketable tubers per plant.

Table 9. Mean values of root yield responses of four sweet potato varieties, assessed 32 weeks after planting (2012).

Variety	**Total number of tubers per plant**	**Number of marketable tubers/plant**	**Total weight of tubers/plant (kg)**	**Weight of marketable tubers/plant (kg)**
Antigua	7.08a	4.17a	1.75a	1.54a
CI001	7.38a	2.7b	1.01b	0.63b
Six Weeks	4.58b	2.88b	1.71a	1.49a
Solomon	4.83b	1.4c	0.53c	0.26c

The t-test at a level of 5% probability was applied. For each variety, means within columns bearing different lowercase letters differ significantly at 5% level of confidence.

Discussion:

The results of this study demonstrate the impact of different weather conditions on sweet potato canopy development and subsequent tuber yield. Ground cover development in the sweet potato can be related to variety, as the variation in growth and yield was significant. Lowe and Wilson (1974) reported great variability in total dry matter production among different sweet potato varieties. Martin and Cramer (1985) reported on the variation in sweet potato responses to abiotic stresses, such as drought, flooding and shading. Crop biomass accumulation is reduced during periods of atmospheric drought (Tanner and Sinclair, 1983).

In this study, some differences were observed in the individual responses to the varying weather conditions. Generally, there was a steady increase in the ground cover development over the growth period. There were fluctuations in the individual responses, occurring after periods of reduction in rainfall, solar radiation and maximum and minimum temperatures. Overall, the late-maturing varieties were more sensitive to variable weather patterns than the early-maturing varieties, establishing the early varieties as more suitable for year round production.

In a study on climate effects on sweet potato, Sajjapongse and Wu (1989) found that subjecting sweet potato to cool weather during its root formation stage, and to warm weather in late April and May, during its root enlargement stage, enhanced root formation and stimulated root enlargement, resulting in higher yields. Temperature fluctuations combined with short day length stimulates tuber development, but inhibits foliage growth (Yong, 1962). The sweet potato is a short day plant that needs light for maximum development. However, the growth of the tubers appears not to be influenced by photoperiod alone. It is probable that fluctuations in temperature, together with short days, favour the growth of tubers and limit the growth of foliage (Yong, 1962).

In several early studies, Sakr (1943) reported faster vine growth at 21˚C to 25˚C compared to 10˚C to 15˚C growth temperature conditions, while Harter and Whitney (1962) observed slower growth of sweet potato at 15˚C compared to plants grown at higher temperatures. These results are similar to the findings of this study at various temperatures for the sweet potato varieties. Harter and Whitney (1962) also reported that sweet potato plants failed to survive when exposed to temperatures below 12˚C, and growth increased from 15˚C to 35˚C and then suppressed at 38˚C, which is similar to our observations.

A decrease in canopy coverage, (Somda and Kays, 1990a) suggests that leaf loss is the result of inadequate light within the canopy. Jefferies and Mackerron (1993) found that drought reduced both the rate of canopy expansion and the maximum leaf area index achieved. Also, different genotypes differed both in the maximum leaf area index achieved and in the duration the canopy was maintained.

For this study, the sweet potato tuber yields were significantly higher during the 2012 trial in comparison to the trial of 2008. Nearly five times the amount of rain fell during 2012 than in 2008 (Tables 2 and 3). The heavy rains during the 2018 trial encouraged vegetative growth, which in turn affected tuber yields (Lewthwaite and Triggs, 2012).

Conclusion:

The results of this field study affirm that weather conditions do influence sweet potato canopy development and subsequent tuber yield. Rainfall is the weather condition having the greatest impact on crop growth and tuber yield. The canopy development and yield responses will be useful for the management and improvement of sweet potato production systems. Further studies are required to explore in greater detail the impact of weather and climate conditions on additional parameters of the sweet potato, using other varieties with improved yield potential.

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