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THE MICROCLIMATE AND LEAF AREA INDEX OF YAM PLANT IN THE GUINEA SAVANNA ECOLOGICAL ZONE OF NIGERIA.

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Abstract: The amount of light leaf intercepts and hence plant production is mainly the function of its leaf area index (LAI). Experimental research farm was set up at the National Centre for Agriculture Mechanization (NCAM) kilometer 12 Ilorin – Idofian road for two yam growing seasons of 2007/2008 and 2008/2009 to examine the effect of the micro climate of yam plant on its LAI. Climatic data generated from daily records include minimum and maximum temperature, rainfall amount, number of rain day, evaporation, soil temperature at soil depth intervals of 5cm, 10cm, 20cm, and 30cm, soil moisture at soil intervals of 0-15cm and 15 – 30cm. Three yam plants were randomly sampled once every four weeks from 30 weeks after planting (WAP) and 50WAP. Yam LAI calculated using Watson (1952) formula. Since LAI measurement was carried out on monthly basis, climatic data generated were also tabulated and partitioned on monthly basis. Correlation was used to study strength of relationship. Yam leaf developed vigorously between 34WAP and 38WAP. A strong negative relationship is established between LAI and thermal indices while positive relationship of varying magnitudes exist between LAI and moisture indices. Soil temperature at 10cm and 20cm appeared to be most critical for yam LAI. Farmers in the study area are advised to improve on material used for mulching yam beds to reduce the scorching effect of sun.

INTRODUCTION

The growth of food output has not kept pace with Nigeria demographic growth. Climate has been recognized as the determinant of agriculture in Nigeria (Adefolalu, (1999), Ayoade, (2004) and Olanrewaju, (2012). Thus concerted efforts have been made by researchers to bridge the gap between population growth and food requirement with climate in focus in Nigeria. These include the works of Olaniran, (1983), Odjugo, (2003), Okoloye and Ojo (2007) and Musa and Aliyu (2011) among others. For instance, Odjugo (2003) carried out analysis onthe effectiveness of traditional techniques (of preparing yam beds such as hole, ridge, mound,of regulating the themal condition of the yam beds e.g mulching and different orientations) of on-farm microclimate improvement of mid-western Nigeria. Mound tillage system was found to exhibit low moisture content at all soil depths throughout the year.Soil moisture was higher in mulched than unmulched treatment and highest in NE/SW orientation. At all depths soil temperature was highest in mound and lowest in hole tillage system.The E/W orientation with higher temperature produced bigger yam tubers. In the final analysis the mound tillage system produce the highest number of economic tubers. Okoloye and Ojo (2007) examined the sustainable industrial crop production and climate extremes in Nigeria. They found out that the performance of agricultural sector in terms of industrial crop production is constrained by weather and climate extremes, rampant incidence of pests and diseases infestation amidst other factors. Musa and Aliyu (2011) investigated the effects of climate on food production in Kano region of Nigeria and concluded that the climatic characteristics of Kano region of high sunshine, light rainfall with low relative humidity have restricted the faming activities to the production of mainly grains and cereals.Rainfall was found most crucial during the planting and growing season, humidity during the period of maturing and floating while sunshine was found most critical during the ripening and harvesting period. This present research work is an extension of these studies.

Understanding processes involve in plant growth is fundamental to crop production. Crop micro climate can be improved upon to enhance such productivity. For instance the role of green leaf in both physical and biological process of plant cannot be over emphasized. Leaf area index (LAI) has been recognized by Fageria et al (2006) as the major determinant of light interception and transpiration and hence a strong indicator of crop production and an important yield factor for field grown crops. The importance of LAI as a factor in estimating yields for crops was emphasized by Pierce and Edward (1994). Based on their findings, the production of dry matter correlates very well with LAI. Thus this present work aimed at examining the effect of micro climate on LAI of yam plant with the intent of increasing yam production in the study area. Yam is a tuber of a tropical plant and constitutes one of the major food crops in Nigeria. Yam tuber is used extensively for human consumption, animal feed, raw material for manufacturing drugs etc. To enhance its production there is need for an improved understanding of the impact that the yam growing environment exerts on the basic processes of yam growth. The above assertion is further corroborated by Nairn et al (2012) that frequent information on crop growth is vital for adequate characterization of crop production.

METHODOLOGY

The study of the fundamentals of yam plant-climate relationship was carried out for two consecutive yam grown seasons. The experimental yam plot was sited at the National Centre for Agriculture Mechanization (NCAM) located at kilometer 12, Ilorin-Idofian road (figure 1). The response of yam leaf development and hence LAI to variation in climate was examined. A plot of 100 heaps measured 13 meters by 10 meters was prepared manually with hoe and mulched. This method of yam bed preparation is preferred because Odjugo (2003) observed a better yam yield from mound tillage in the mid-western Nigeria while Olanrewaju (2012) also recorded a better yam yield from the mulched-mound tillage system in the study area. The plot was examined for its variation in micro climate and leaf area development from the commencement leaves formation through the period when yam tubers were harvested. The reference station was cited in Niger River Basin Authority Area located about 25 kilometers from NCAM.

Yam planting seasons of years 2007/2008 and year 2008/2009 were used. Whole yam seeds were planted because from Onwueme (1978) findings, whole tuber seeds yield better than setts.

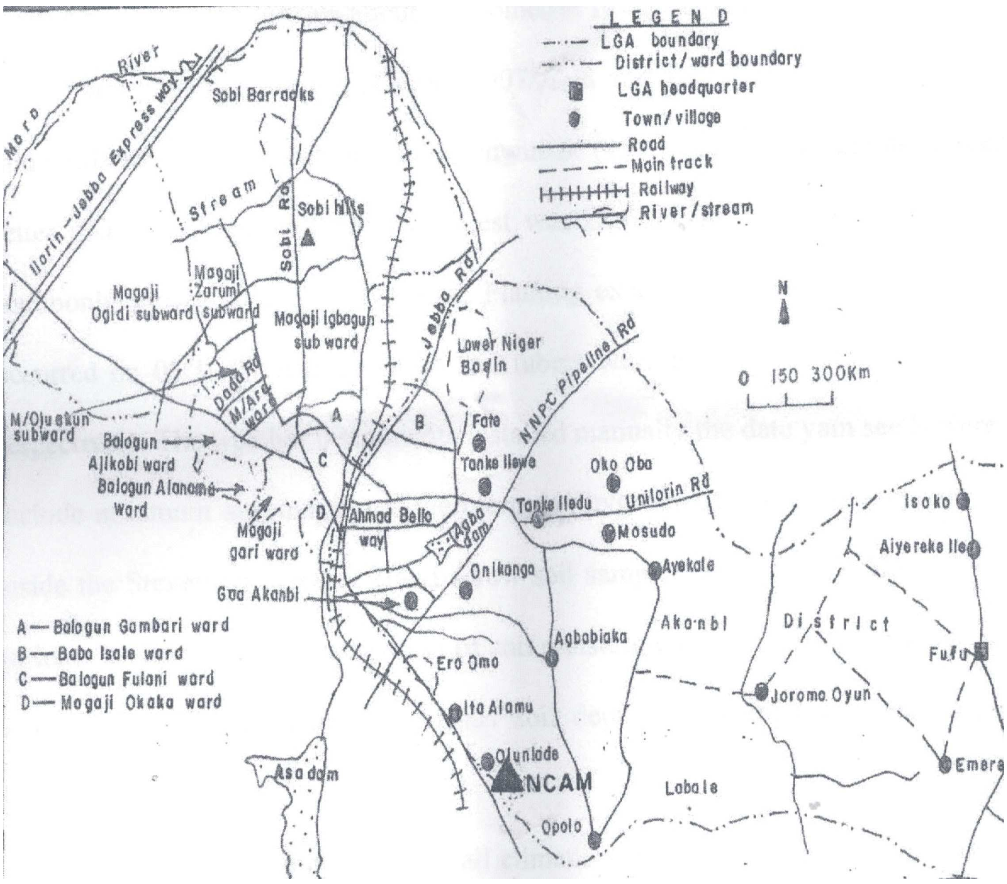

Figure 1: The Map of Ilorin South Local Government Area Showing NCAM the study area.

The cultivar of interest was D.rotundata which constitutes the most commonly grown species in the area. Planting exercise for each yam growing season occurred on 07/10/07 and 21/10/08 and tubers were harvested 26/09/08 and 28/09/09 respectively. The weather observing instruments were installed the day yam seeds were planted. Theseinclude minimum and maximum thermometer, hygrometer, evaporimeter (all were kept inside the Stevenson screen). Hand screw soil auger was use to take soil sample at various depths for the determination of soil moisture content. Also soil thermometers for the measuring soil temperature at various soil depths of interest and rain gauge were installed.

Mean monthly and annual of all climate variables measured were obtained from the observed daily records. Data collected includes minimum and maximum temperature (^{O}C), rainfall (mm), number of rain days, relative humidity (%), soil temperature (^{O}C) at depth intervals of 5cm, 10cm, 20cm and 30cm, soil moisture (%) at different depth intervals of 0-15cm and 15-30cm. These soil depth intervals are the major zones of yam root and tuber development. To measure the physiological parameters of yam plant destructive method was used. Three yam plants were randomly sampled once every four weeks. Sampling commenced 30 Weeks After Planting (WAP) when yam leaves started to develop. This exercise ran through 50 WAP when yam tubers were harvested. Yam leaf area was calculated based on Watson (1952) formula as stated underneath.

$$LAI = \frac{\text{Leaf area per plant}}{\text{Ground Area}}$$

Yam plants uprooted were taken to the laboratory where all leaves were plucked and measured using leaf area meter. Ground area is obtained using tape and all measurements were in cm. Since LAI measurement was carried out on monthly basis, climate data generated were also tabulated and partitioned on monthly basis. Correlation analysis was used to study strength of relationship. This helped shed light on the micro climatic variables to which yam leaf is most sensitive and how to improve upon the supply of such to enhance yam productivity in Kwara State Nigeria.

RESULTS AND DISCUSSION

Leaf Area (La) and Leaf Area Index (LAI)

An increase in the development of La was witnessed between 30 WAP through 38 WAP but the development was most vigorous between 34 WAP and 38 WAP (See table 1 below).

Table 1: Leaf Area

Parameters(cm)	30 WAP)	34 WAP	38 WAP	42WAP	46 WAP	50 WAP
Mean LeafArea (La)	1054	20163	31652	29973	24381	1600
Mean Yam Stand Area	304	4356	5623	5625	5021	4800
Leaf Area Index (LAI)	3.46	4.62	5.62	5.31	4.85	0.33

Source: Fieldwork computation (2009)

Table 2: Effect of Climate on LAI

		Soil Temperature (Oc)				Soil Moisture %)							
WAP	LAI	5cm	10cm	20cm	30cm	0-15cm	15-30C	Rainfall (mm)	Rain Day	R.H(%)	Evap. (mm)	Mini Temp(^{oc})	Maxi Temp (^{oc})
30	3.46	35.30	33.19	31.71	29.83	6.64	8.95	127.3	8	58	6.0	25.02	33.24
34	4.62	33.36	30.28	29.42	27.75	16.12	18.53	248	14	65.45	3.0	24.9	34.0
38	5.62	32.12	29.42	28.37	26.66	17.7	20.17	220	14	60	3.0	22.35	30.43
42	5.31	32.10	29.61	28.0	27.46	20.99	23.97	126	11	76	2.5	22.34	29.8
46	4.85	29.94	28.27	27.00	26.0	20.55	23.45	78.5	12	78	2.0	22.31	29.32
50	0.33	33.58	31.54	30.91	28.27	21.55	24.43	220	16	80	2.0	22.3	30.13

Source: Fieldwork Computation (2009)

A gradual decline in La development witnessed between 42 WAP and 46 WAP paved way to a sharp fall through 50 WAP when yam tubers were harvested. The implication of these findings is that yam leaf reaches its fullest and broadest size at 38 WAP and almost maintains this status through 42 WAP and 46 WAP. It can then be concluded that yam leaf develops with vigour within 3 months in the study area. The drastic decline in LAI at 50 WAP can be associated with the rapidity at which yam plant loses its leaves at senescence stage.

Effect of Climate on LAI of Yam Plant

Responses of yam leaf development to its micro climate expressed by LAI are reflected in Table 2 above. The period between 36 WAP and 38 WAP that witnessed rapid increment in LAI also observed a decline in soil temperature with a corresponding rise in soil moisture at all depths. This period also observed increase in rainfall amount and frequency, decline in evaporation, minimum and maximum temperature. The range for minimum temperature was between 22.35^{0}CC and 24.9oc and between 30.43^{0}C and 34.25^{0}C for maximum temperature. However, it appear variation in soil temperature could no longer explain pattern of variation observed in soil moisture content for the period between 42 and 50 WAP that recorded low LAI. Decline in soil temperature during this period did not bring about increase in soil moisture. For instance a slight decline in soil moisture from 20.99% to 20.55% and from 23.97% to 23.45% was observed at soil intervals of 0.15cm and 15-30cm respectively. Again at 50 WAP when soil temperature was raised at all soil depths considered (33.58^{0}C at 5cm, 31.54^{0}C at 10cm, 30.91^{0}C at 20cm and 28.27^{0}C at 30cm), soil moisture was as high as 21.55% and 24.43% at soil depth intervals of 0-15cm and 15-30cm respectively.

The above observation might be resulted from sudden increase in rainfall amount from 78.5mm to 220mm received coupled with high relative humidity and low evaporation rate which characterized the aerial micro climate of the farm site during this period.

It appears leaf development which is enhanced by increase in rainfall amount, rainfall frequency, soil moisture at all depths between 30 WAP and 38 WAP is inhibited between 42 and 50 WAP in the guinea savanna ecological zone of Nigeria.

Result of Correlation Analysis

The correlation between LAI and each element of both aerial and sub-aerial microclimate of yam plant is displayed in Table 3 below.

Table 3: Results of Correlation Analysis

Generally, a negative relationship of varying degree is established between LAI and soil temperature at various soil depths considered. Based on all the levels of negative relationship observed, soil temperature at 20cm soil depth showed the strongest negative relationship of -0.74 with LAI followed by soil temperature at 10cm soil depth (-0.6). They are significant at 0.01 level of confidence. It appears soil temperature at 10cm and at 20cm soil depths are most crucial for yam LAI. Soil moisture at various levels considered displayed a weak positive relationship which is not significant with LAI. The implication of this is that soil moisture does not have to be too high for yam leaf to develop in size. Considering the relationship between aerial microclimate of yam plant and LAI, positive relationship significant at 0.05 level of confidence was established between rainfall amount, number of rain day and LAI. Positive relationship which is not significant also existed between LAI and relative

Table 3: Result of Correlation Analysis

	Soil Temp. at various Depths				Soil Moisture %		Aerial Micro Climate					
LAI	5cm	10cm	20cm	30cm	0-15cm	15-30c	Rain fall (mm)	Rain day	Relative Humidity (%)	Evap. (mm)	Mini Temp (oc)	Maxi Temp (oc)
	-.046	-0.6**	-0.74**	-0.50**	0.04	0.048	0.57*	0.53*	0.37	0.04	0.32	-0.66**

*Significant at 0.05 level ** Significant at 0.01 level

Source: Author's Field Work 2009

humidity, evaporation and minimum temperature. The implication of this is that high rainfall amount favours yam leaf enlargement in the study area. Conversely, a strong negative relationship significant at 0.01 level of confidence was established between maximum temperature and LAI. Increase in maximum temperature inhibits yam leaf enlargement. Excessive heat experience in the area often results in the burning of yam vine at the base which in turn causes yam leaf to wilt.

SUMMARY AND CONCLUSION

The study investigates the effects of yam microclimate on its LAI. To achieve this objective, experimental yam plot was set up at NCAM located at kilometer 12 Ilorin-Idofian road. Responses of yam leaf development to the microclimate were monitored for two yam growing seasons. The relationship between LAI and various elements of both the aerial and sub aerial micro climate of yam plant was established. Yam leaf developed with vigour between 34 WAP and 38 WAP. Soil moisture fluctuated with soil temperature between 30WAP and 38 WAP but not for the period between 42 WAP and 50WAP that recorded decline in LAI. Soil moisture dropped a little with a decline in soil temperature at all depths considered. The result of the correlation established negative relationships between LAI and all thermal indices but minimum temperature. However, all moisture indices displayed positive relationships with rainfall amount and number of rain day having the strongest impacts.

Conclusion can be drawn for guinea savanna ecological zone that increase in yam leaf size and hence LAI is enhanced by low soil temperature mostly at 10cm and 20cm soil depths and rainfall that is well spread. Based on this fact, yam farmers in the study area need to seek for alternate mulching materials or improved on the existing one for effective regulation of the thermal condition of yam bed thus boosting its moisture condition.

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