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DETERMINATION OF SIGNIFICANT FACTOR AND T -STATISTICS OF SOIL MOISTURE AND TEMPERATURE FOR EFFECTIVE IRRIGATION MANAGEMENT

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ABSTRACT

A study was conducted at the Experimental farm of the Department of Agricultural and Bio-environmental Engineering, Yaba College of Technology, Epe Campus Nigeria which lies on latitude 60. 58' N, and longitude 30. 96'E. Tomato crop (Eva F1 variety developed in the Teaching Research Farm) was used due to its advantage over other species. Therm 500 Digital soil thermometer was used to measure soil temperature, soil moisture, and pH level. The readings were taken at three different depths of 20 cm, 40 cm, and 60 cm respectively based on the root depth of tomatoes which is 60 cm. Data were analyzed using two different statistical software of Microsoft Excel and XL Compare analytical tools. Microsoft Excel was used to analyze the soil moisture and temperature raw data generated for the different depths of 20 cm, 40 cm, and 60 cm for sixty days. XL Compare statistical tool was used to carry out a comparative analysis between soil moisture and temperature data. The finding indicated that soil temperature increases with a decrease in soil moisture content, and they were significantly different at p = 0.02. The significant factor of soil temperature was greater than that of soil moisture which means that more attention is to be paid to soil temperature in irrigation management as this will enable curb or reduce the incident of crop failure due to soil heat influx.

Keyword: T- Statistics, Significant factors, Soil moisture, Soil temperature, and Irrigation management

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INTRODUCTION

Proper management of irrigation water has become an issue that need to be handled with all senses of professionalism in the face of the decline of water resources due to the incident of climate change. However, statistical analysis output of soil moisture and temperature data will enhance a better understanding of how best irrigation scheduling can be applied. Dependence of soil temperature on soil moisture as verse versa, enhances a better understanding of the interactions between land surface and atmosphere whereby adequate knowledge of the estimation of soil moisture and surface temperature is needed. Corrado., (2014) reported that soil moisture is significant in water and energy cycle. Soil temperature generates heat that affects the biophysical properties of soil as related to the amount of heat supplied down the soil profile (Brownmang *et al*., 2018). However, soil as the main receiver of atmospheric temperature stores heat during the day and release the same to the atmosphere during the night (Grietal *et al*., 2003; Zhou *et al*., 2007). Activities of some enzymes are

regulated by moderate temperature which inadvertently increases the microbial activities and enhance crop production (Aruna and Rao., 2017). Furthermore, soil temperature impacts and ensures soil aggregate stability, soil structure and moisture content (Postolos, 2014).

Soil temperature also enhances water uptake, nutrient uptake, root growth, and flowering and yields increase (Pregistzer and King., 2005). Water viscosity is affected by soil temperature as well as the nutrient transport around the root zone of plants (Midori *et al*., 2013). There are many ways soil temperature can be managed ranging from the incorporation of mulching materials into the soil, carrying out of tillage operation, drainage of the water logged areas, etc (Raphael *et al*., 2020).

Among other factors that affect soil moisture include precipitation, temperature, soil characteristics, plant type and irrigation. Soil moisture, as well as soil temperature dictates when water should be applied to the field. When soil moisture is high, it will lower the soil temperature which will invariably lead to water logged if the increase in moisture persists. Hence, the objective of this study is to determine between soil temperature and moisture as the most significant parameter in irrigation scheduling.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Department of Agricultural and Bio-environmental Engineering, School of Engineering, Yaba College of Technology, Epe Campus Nigeria which lies on latitude 60. 58' N, and longitude 30. 96'E.

Layout of drip irrigation system

Four split-plot design was prepared for the experiment with each plot having 3 laterals and 15 emitters which means that the four plots having 60 emitters. The field layout has the following components; a water tank of 2000 litres capacity, the filter, the mainline was a pipe of 6 m length and 1-inch (25 mm) diameter which made from polyvinylchloride (PVC); the lateral lines were made of polyvinyl chloride also with 1/2-inch (12.5mm) diameter, 6 m length, and 0.6 m laterals spacing with 60 cm spacing along the laterals, and the five gate valves were used; the first valve was connected to the water tank; while the other four were connected to each sub-main line.

Tomatoes as chosen crop

Tomato (*Lycopersicon esculent um*) belongs to the family of Solanaceae. There are many varieties of tomatoes in Nigeria but for the sake of this research, Eva FI is chosen. Eva F1 is a variety developed in the Teaching Research Farm (TRF) of the School of Agriculture and Agricultural Technology, Federal University of Technology, Akure. Eva F1 is reported to be five times bigger than commonly available tomatoes in Nigerian markets, and it is capable of producing paste more than four times more than the common tomatoes. The tomato was chosen for this project based on these comparative advantages over other crops as thus; it has a processing value; it is a fast-moving commodity; it is readily available; and takes almost three months to become ripe, juicy, and yummy, and a period that is believed to be lengthened enough for the study of soil temperature.

Data collection

Data were generated directly from the field. Therm 500 Digital soil thermometer was used to measure soil temperature, soil moisture, and pH level. The readings were taken at three different depths of 20 cm, 40 cm, and 60 cm respectively based on the root depth of tomatoes which is 60 cm. The 0-10 cm was assumed to be a direct interface between the soil temperature and atmospheric temperature, hence it was not considered.

Data Analysis

Data were analyzed using two different statistical software of Microsoft Excel and XL Compare analytical tools. Microsoft Excel was used to analyze the soil moisture and temperature raw data generated for the different depths of 20 cm, 40 cm, and 60 cm for sixty days both morning and evening before irrigation. Reading was also taken after irrigation to know the difference in soil temperature and moisture before and after, but data taken after the irrigation was not presented in this paper. Hydraulic parameters were evaluated based on Omofunmi *et al*.,2019.

XL Compare statistical tool was used to carry out a comparative analysis between soil moisture and temperature data for 20 cm, 40 cm, and 60 cm depths for sixty days. The critical factor was generated also but not presented in this paper.

T- Statistic

The t- statistic is the ratio of the departure of the estimated value of a parameter from its hypothesized value to its standard error which can be expressed as shown below: $T\beta i = \beta i - \beta o / Se(\beta i)$ .... (1) (Kothari ***et al***, 2004) Where, βi, βo and Se are estimator, non- random and Standard Error respectively. T- test was to determine significance of regression determinants and also if no hypothesis is to be supported or rejected, which is similar to Z- test (Kothari *et al*., 2004).

RESULTS

Tables 1-4 below show the relationship that exists between soil temperature and soil moisture at different depths for bed 1 to bed 4. The T- statistics for soil temperature and soil moisture in all the beds at various depths revealed the same pattern and trends. While soil temperature and soil moisture for all the beds at various depths manifest almost the same significant and critical factors showing the level of dependence that exists between the soil temperature and soil moisture. The values for significant factors of soil temperature (S_T) and soil moisture (S_M) were XL compared and the results were shown below;

Table 1. T-Statistics and Significance Factor of Soil Temperature and Soil Moisture at Bed 1

S/No.	Soil Temperature			Soil Moisture		
	T Stat	F	Significance F	T Stat	F	Significance F
20 cm	-0.61	0.33	1.04	-0.65	0.34	1.30
40 cm	-0.63	0.90	0.56	-0.71	1.01	0.68
60 cm	-0.85	0.63	0.44	-0.78	0.74	0.90

Table 2.T-Statistics and Significance Factor of Soil Temperature and Soil Moisture at Bed 2

S/No.	Soil Temperature			Soil Moisture		
	T Stat	F	Significance F	T Stat	F	Significance F
20 cm	-0.92	0.90	0.48	-0.85	0.89	0.50
40 cm	-0.95	0.89	0.36	-0.90	0.90	0.38
60 cm	-0.95	0.91	0.35	-0.91	0.89	0.37

Table 3. T-Statistics and Significance Factor of Soil Temperature and Soil Moisture at Bed 3

S/No.	Soil Temperature			Soil Moisture		
	T Stat	F	Significance F	T Stat	F	Significance F
20 cm	-0.97	0.93	0.34	-0.87	0.89	0.46
40 cm	-1.11	1.44	0.32	-0.95	0.88	0.38
60 cm	1.10	1.42	0.32	-1.00	0.86	0.38

Table 4. T-Statistics and Significance Factor of Soil Temperature and Soil Moisture at Bed 4

S/No.	Soil Temperature			Soil Moisture		
	T Stat	F	Significance F	T Stat	F	Significance F
20 mm	-1.09	1.74	0.27	-1.00	1.65	0.32
40 mm	-1.02	1.22	0.35	-1.20	1.11	0.36
60 mm	-1.18	1.82	0.32	-1.15	1.66	0.34

DISCUSSION

The outcome of XL comparison of significant factors of soil temperature (S_T) and soil moisture (S_M) shows that soil temperature and soil moisture are inseparably dependent which means that the treatment given to one will affect the other just like an increase in soil temperature leads to decrease in soil moisture and increase in soil aeration (Broadbent, 2015; Allison, 2005). Meanwhile, soil temperature has a higher significant factor than soil moisture with 0.02 which is regarded as statistically significant (i.e.

P is less than 0.05). With this result, it is advisable to pay more attention to soil temperature in irrigation scheduling because is mostly affected by heat and other environmental factors (Brownmang *et al.*, 2018; Gercek *et al*., 2017; Grietal *et al*.,2003), and coupling with the fact that global average surface temperature has been on the increase for the past ten decades (Crowley., 2000 and Alli *et al*., 2019).

CONCLUSION

The significant factor of soil temperature was greater than that of soil moisture. Their trend statistics and critical factors are of little or no difference which shows that strong dependence exists between soil temperature and soil moisture. It is advisable to pay more attention to soil temperature in irrigation scheduling because the soil is mostly affected by heat and other environmental factors.

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