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WATER USE EFFICIENCY OF OKRA AMENDED WITH SAW-DUST UNDER DEFICIT IRRIGATION IN A CONTROLLED ENVIRONMENT.

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ABSTRACT

Enormous funds are spent annually on providing moisture for crop use throughout each planting cycle. The sharp depletion of moisture available for planting necessitates essential amendment measures, keenly focused on moisture conservation. A research trial consisiting of an experimental design of 12 samples arranged in a specific order to meet the research requirement. Treatment samples of soil–sawdust were mixed proportionally at (25%-75%, 50%-50%, 75%-25%, 100%-0%) with varying water application of (100%, 50% and 25%). Growth stages amongst samples were visible owing to variance in height and yield. The amended samples greatly conserved moisture through a wide margin by the difference in bucket weight. Rates of moisture conservation in amended samples correspondingly declined with a descending sawdust application; samples with greater sawdust application showed higher moisture conservation. The growth and yield of the amended samples to the leave-alone samples greatly varied. The leave-alone samples proved to be less moisture conservative, but showing high- moisture usage potential.

KEYWORDS: *Soil Amendment, Saw dust, Deficit Irrigation, Water Use Effectiveness, Okra, Control Environment*

INTRODUCTION

Excessive water use across several sectors pose a great challenge in drought seasons. The negative impact of climate change takes an extreme toll within the shores of Africa owing to global warming.

The extent of water shortage or scarcity varies around the world; the cost of energy required to make water available for agriculture, particularly irrigation purposes is general and could be escalating. Operators of irrigation systems must ensure that there is high return on the capital invested. Thus for this to be achieved, irrigation water application should take cognizance of the need to secure maximum output for each drop of water in terms of crop yield.

The intensity of irrigation operations requires that the soil water supply be kept at the optimal level to maximize returns to farmer. Alternatively, the soil ability to serve as a potential reservoir can be harnessed through appropriate amendment measures, high-frequency water management by drip irrigation minimize soil as a storage reservoir for water, provides at least daily requirements of water to a portion of the root zone of each plant, and maintains a high soil metric potential in the rhizophere to reduce plant water stress (Tiwari *et al.,* (1998); Singh and Rajput (2007); Al-Harbi *et al.,* (year?); Zotarelli *et al.,* (2009).

Soil Amendment is focused on enhancing soil performance through the modification of certain properties. Cocoa shells reportedly decayed more rapidly than peat, but still produced good soil physical conditions because the products of decomposition increased aggregation Richer *et al.,*(1949). Saw dust is an organic amendment, which expectedly should provide a wide range of improvement in crop production.

Deficit Irrigation (DI) is an optimization strategy in which irrigation is applied during drought-sensitive growth stages of a crop. Water restriction is limited to drought-tolerant and the physiological stages, often the vegetative stages and the late ripening period. DI maximizes irrigation water productivity, which is the main limiting factor (English, 1990). In other words, DI aims at stabilizing yields and at obtaining maximum crop water productivity rather than maximum yields Zhang and Oweis, (1999).

Physiological responses of plants generally vary with the severity and duration of the stress. The most sensitive processes are altered by a very mild stress and these changes intensify while additional processes become affected in accordance to their sensitivity to stress. Plants respond continuously to changes in available water, temperature, Light, Salinity, and other abiotic factors (Hasegawa *et al.,* (2000): Turnbull *et al.,* (2001); Chinnusamy *et al.,* (2004); Zheng *et al.,* (2004); Nixon *et al.,* (2005).

Historically, measurements of leaf or canopy temperatures have been used to evaluate the severity of water-deficit stress in plants Jackson *et al.,* (1988). Also, biomass accumulation and fruiting habit are common measures of field stress responses to water deficits (Burke *et al.,* (1985); Sharp and Davies (1989).

Much published research has evaluated the feasibility of deficit irrigation and whether significant savings in irrigation water are possible without significant yield penalties. Stegman (1982) reported that the yield of maize, sprinkler irrigated to induce a 30-40% depletion of available water between irrigations, was not statistically different from the yield obtained with trickle irrigation maintaining near zero water potential in the root zone. Ziska and Hall (1983) reported that cowpea had the ability to maintain seed yields when subjected to drought during the vegetative stage provided subsequent irrigation intervals did not exceed eight days. The work of Korte *et al.,* (1983), Eck *et al.,* (1987); Speck *et al.,* (1989), and many others, has shown that soybean is amenable to limited irrigation. Stegman *et al.* (1990) indicated that through short term water stress in soybean during early flowering may result in flower and pod drop in the lower canopy, increased pod set in the upper nodes compensates for this where there is a resumption of normal irrigation.

Cotton shows complex responses to deficit irrigation because of its deep root system, its ability to maintain low leaf water potential and to through osmosis regulate leaf-tugor pressure, also called conditioning. Thomas *et al.,* (1976) found that plants that suffered a gentle water stress during the vegetative period showed higher tolerance of water deficit imposed later as a result of adaptations to existing soil water status. Grimes and Dickens (1977) reported that both early and late irrigations lowered cotton yields. However, water stress during vegetative growth, causing leaf water potential less than critical midday value of -1.6 MPa, adversely affected the final yield Grimmes and Yamada (1982).

Based on data from a Coordinated Research Program (CRP) on crop yield responses to deficit irrigation Kirda *et al.,*(1999b), conducted under the auspices of the soil and water management and crop nutrition section of the Joint FAO/IAEA Division of nuclear techniques in food and agriculture, Vienna. A wide range of field crops (Including cotton, wheat, sugar beet, soybean, sugar cane, potato, and maize) were the subject of four years of field experiments.

Crop yield response data from deficit irrigation were fitted to the following linear equation used by stalwart *et al.,* (1977);

$$\frac{Y}{Y_m} = 1 - k_y\left[1 - \frac{ET_a}{ET_m}\right] \quad ....(1)$$

The crop yield response factor gives an indication of whether the crop is tolerant of water stress. A response factor greater than unity indicates that the expected relative yield decreases for a given evapotranspiration deficit is proportionately greater than the relative decrease in evapotranspiration Kirda *et al.,* (1999a). For example, soybean yield decreases proportionately more where evapotranspiration deficiency takes place during flowering and pod development rather than during vegetative growth.

The design of irrigation schemes doesn't consider limitations of the available water supply. However, in arid and semi-arid regions, increasing municipal and industrial demands for water obviously necessitates major changes in irrigation management and scheduling, to increase the efficiency of water use in agriculture.

This experiment considered deficit irrigation, varying water application rate, and sawdust amendment in managing and conserving water at the same time.

MATERIALS AND METHODS

The materials employed in the research included screen house, twelve perforated buckets, soil (well drained sandy loam), water, saw-dust, okra seeds, measuring cylinder, measuring scale, electric oven, electronic scale. The screen house was a wooden structure with a gabble roof having a dimension of 10ft by 10ft, with polythene as the roof covering material, a combination of both polyethene and wire netting as side coverings, and an polythene framed entrance (door) of 5ft by 3inches.

The species of okra is *Abelmoschus esculentus* sourced from The Ministry Of Agriculture, Asero, Abeokuta Ogun State.

The buckets were perforated using a pillar drill coupled with a 5mm drill bit, just before saw dust samples were introduced sterilization occurred, spanning for 24hrs under a constant temperature of 85°C. A representative soil sample was obtained to calculate moisture content, aimed to project the soil holding capacity, and the amount needed to stay within deficit bounds. The samples of sawdust and sand were weighed using a camry scale on (Gram basis) gravimetric, to ascertain defined percentages of sand-sawdust at (50%-50%; 75%-25%; 100%-0%). The buckets were tagged with alphanumeric labels, duly arranged correspondingly in rows and columns alphanumerically, and well-spaced in the controlled environment for thorough study; seed viability test was carried out just before planting, seed density eventuates 3 seeds per bucket, with extra 2 seeds to forestall seed dormancy. The samples were monitored closely, keenly to observe changes in color, plant stress, wilting effects and growth stages. Readings were collected on a two-day interval. The irrigation schedule did vary between samples. Treatments irrigated at field capacity 100% (A1 B1 C1 D1); Treatments at 75% (A2 B2 C2 D2); Treatment at 50% (A3 B3 C3 D3). This implies that for every column there were three varying water application and for every row, equal amount of water was applied. These were all laid in Randomized Complete Block Design (RCBD) in the screenhouse.

Data was analysed as follows:
Evaporation rate was calculated using:

$$ET(01) = W_{i-1} - W_i \quad ....(2)$$

Where:
ET(01) is Evapotranspiration (mm)
W_{i-1} and W_i is Weights of pots a day *i-1* and I respectively

Moisture at field capacity for all samples was calculated using:

$$MC\% = \frac{w_2 - w_3}{w_3 - w_1} * 100 \quad ....3$$

Microsoft excel package was used to analyze the data. Analysis of variance tool (ANOVA) and Excel graphs was also used to spatially interpret the obtained data.

RESULTS AND DISCUSSION

The result of water loss between samples and variation in height are shown below in Figures 1-5. While Tables 1-2 gives the analysis of variance for the work. It could be observed that plants grows faster in the specimen with 100% soil than in those amended with sawdust and the higher the percentage of the sawdust amendment the lower the growth of the plant from analysis of variance, soil amendment significantly affected the plant growth. On the other hand, reducing the percentage of irrigation water applied did not show a noticeable difference in the growth of the plant between 100% and 50% water application, whereas a slight difference was noticed when the irrigation water was reduced to about 25% analysis of variance shows that irrigation levels had no significant effect on plant height.. Furthermore water loss was the highest with specimen without amendment at reduces with the increase in the level of amendment. From the analysis of variance irrigation level for all samples had no significant but sawdust amendment had a significant effect on the water loss.

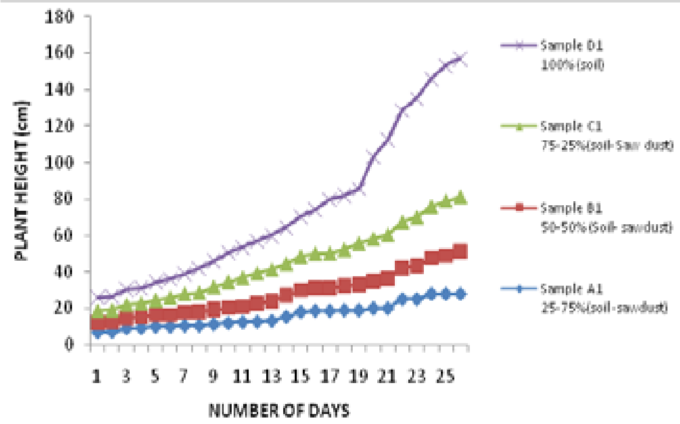

Figure 1: Relationship of Plant Height To Days For All Samples With 100% Irrigation.

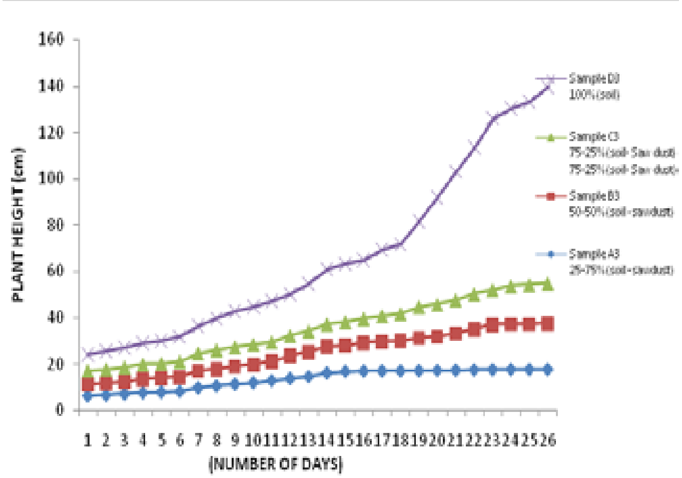

Figure 3: The Relationship Of Plant Height To Days At 25% Irrigation

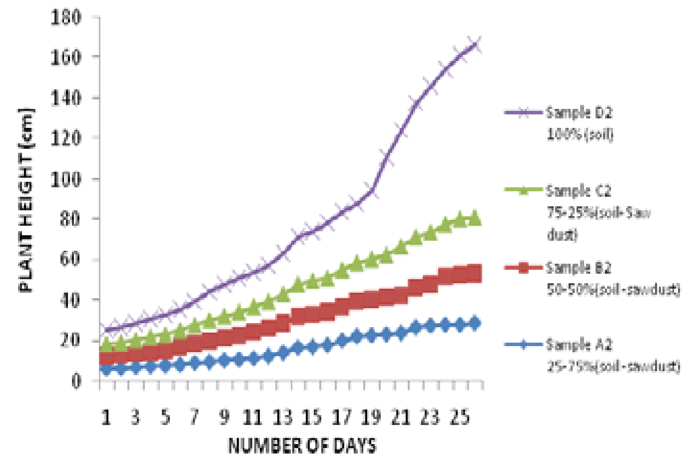

Figure 2: Relationship Of Plant Height To Day At 50% Irrigation

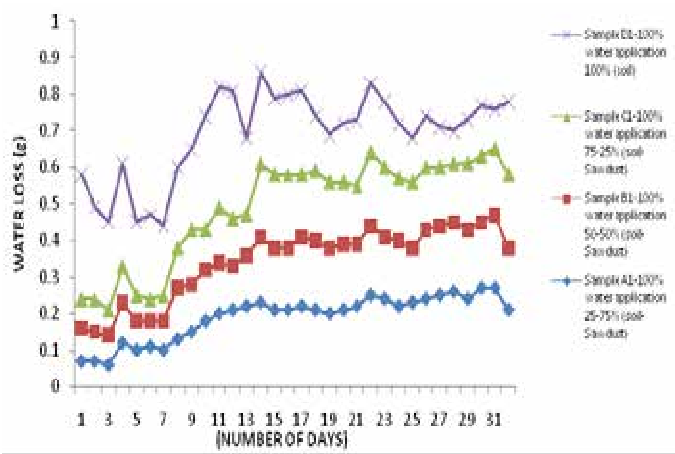

Figure 4: Water Loss to Days at 100% Irrigation Level

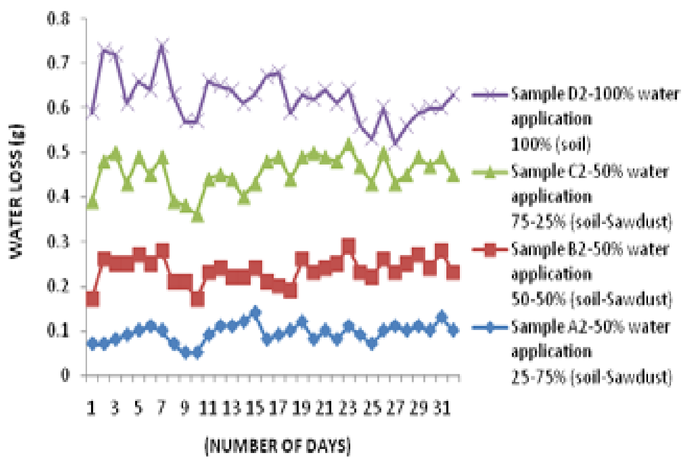

Figure 5: Water Loss to Days at 50% Irrigation Level

Table 1: Effect of Irrigation and Sawdust Amendment on Plant Height
ANOVA: Two-Factor Without Replication

Source Variation	Sum Of Squares	Degree of Freedom	Mean Sum Of Squares	F-Ratio	P-Value	F –crit
Irrigation level	67.67847	2	33.83923	0.365089	0.708556	5.143253
Sand-Sawdust	1558.976	3	519.6588	5.606561	0.035609	4.757063
Error	556.1257	6	92.68762			
Total	2182.781	11				

Table 2: Effect of Soil Amendment on Water Loss at Different Irrigation Rate.
ANOVA: Two-Factor Without Replication

Source of Variation	Sum Of Squares	Degree Of Freedom	Mean Sum Of Squares	F-Ratio	P-value	F crit
Irrigation level	0.03185	2	0.015925	2.82553	0.136571	5.143253
Sand-saw dust	0.014158	3	0.004719	4.837358	0.520806	4.757063
Error	0.033817	6	0.005636			
Total	0.079825	11				

CONCLUSION

Sawdust amendment conserved moisture but barely released moisture for crop utilization. Okra performed excellently well without amendment at all irrigation levels. It was generally observed that treated plants grow faster than those amended with sawdust and the higher the percentage of the sawdust amendment the lower the growth of the plant. Soil amendment therefore significantly affected the plant growth. Contrary, a reduction in percentage of irrigation water applied did not show noticeable difference in the growth of the plant between 100% and 50% water application, whereas a slight difference was noticed when the irrigation water was reduced to about 25%.

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