

## **RESPONSE OF TOMATOES (UC82B) TO THREE LEVELS OF DRIP IRRIGATION AND FERTIGATION UNDER TWO PLANTING CONDITIONS.**

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### **ABSTRACT**

Tomato seeds were sown into the nursery in October, 2007 and January, 2008 for the Green house (GH) and Open field (OF). Soil samples from the plots were analyzed for micro and macro elements. Poultry and horse manures (PM, HM) were also analyzed for nutrient status. Drip irrigation and fertigation structures were installed into the GH and OF in December, 2007 and January, 2008 respectively. SAR, RSP, EC, CEC, RSC, ESP of the soils, irrigation water and organic manure in solution (OMS) were determined. Tomato seedlings were transplanted into the GH in December, 2007 and OF in February, 2008. OMS was prepared at the rate of 4.2kg/ℓ and NPK at 0.6kg/ℓ. Three levels of drip irrigation and fertigation, once ( $W_1$ ), twice ( $W_2$ ) and thrice per week ( $W_3$ ) using NPK and PM for the GH and NPK with HM for the OF were adopted. Growth and nutrient uptake were determined. Results showed that EC, CEC, ESP, SAR and RSC values were within tolerant values. Plants under PM applied at  $W_2$  gave the highest yield (0.74t/ha) with significantly higher lycopene formation, vitamin C. was best under water application alone in the GH. Similarly, plants under  $W_3$  produced the highest yield for both lycopene and vitamin C. However, B-carotene was highest under HM for OF. Overall results showed that plants under PM +  $W_2$  in the GH had better yield than others. Similarly, lycopene formation was significantly best under PM in the GH which suggests the preference of GH tomato production over OF.

**Key words:** Drip irrigation, fertigation, organic manure in solution, Tomato yield

## INTRODUCTION

Tomato production is of vital importance in Nigeria, possibly due to its nutritional quality. This crop is considered a rapidly growing plant with gestation period of 90 to 180 days. World-wide, tomato production is accorded as high priority. Van Der Vossen et al., 2004 estimated tomato production in 2001 at 105 million metric tons from 3.9 million ha of land. Analysis of tomato production in the world market followed this trend: China-124,000 ha (Van Der Vossen et al., 2004). Interestingly, tomato production in the region of Africa was given as 300,000 ha, 40% less than the production potentials of India. This observation might not be unconnected with lack of effective Green house production facilities especially in Nigeria, a country endowed with abundant solar energy. Shankara et al., (2005), Wener (2000), described tomato as one of the most important vegetables worldwide with estimated production of 105 million tons of fresh fruits from about 3.9 million ha of land in 2001. Research has established that tomato is a good source of Vitamins A and C essential for bone formation, cell division and regulation of immune system while maintaining surface linings of eyes, respiratory, urinary and intestinal tracts. The National Horticultural Research Scientists (Afolayan et al., 2008) also confirmed that red tomato contained Lycopene in substantial quality, an anti-oxidant that contributes to protection

against carcinogenic substances in human systems. Notwithstanding the economic relevance of this crop together with its nutritional exceptional qualities, production is extremely low in Nigeria. The low tomato productivity in Nigeria could possibly be attributed to grossly inadequate availability of inputs like fertilizer, irrigation and GH facilities. However, Jagidish et al., 2005 reported that food production including vegetables such as tomato was boosted with the use of N fertilizer. He estimated that 50% of human population depend on this production input resulting into about 83 million metric tons of N. Unfortunately, 50% of this N applied for food production remained un-assimilated by plants (Tilman et al., 2002; Dobermann and Cassman, 2004) thereby constituting groundwater contamination, eutrophication, acid rain and ammonia redeposition, global warming and stratospheric ozone depletion with acute environmental pollution (Howarth et al., 1996, Van Derch et al., 2001). The menace characterized extensive use of minerals fertilizers as reported by various authors (Jagidish et al., 2005; Fageria and Baligar, 2005) necessitates consolidated research exploits in the use of organic manures as sustainable alternative N- sources. Organic manure is generally believed to be characterized with slow release of N thereby encouraging more effective uptake by plants, reducing N leaching or denitrification losses (Fageria and

Balligar,2005).Shoji et al.,2001 and Shoji and Kanno, 1994 confirmed that slow release of N facilities reduction in N fertilization rates that contribute to conservation of air and water quality.Irshad et al.,2002; Clark et al.,1998;Chang et al., 1993 and Ma et al.,1999 reported the preference of organic manure over conventional inorganic fertilizers. They documented reports from the studies comparing soils of organically and conventional inorganically managed farming systems and confirmed that higher soil organic matter and total N were obtained from organically managed farming systems with more improved nitrogen use efficiency (NUE). It is generally accepted that organic manure is a reservoir of both nitrogen and beneficial micro organisms. Result of analysis carried out by Afolayan et al., 2008 indicated that cow, horse, pig and poultry manures were capable of producing 11.54%CH<sub>4</sub>, 5.32% CO<sub>2</sub>, 0.06%N<sub>2</sub>O, 11.42%CH<sub>4</sub>, 16.42%CO<sub>2</sub>, 0.14%N<sub>2</sub>O; 11.12%CH<sub>4</sub>, 16.62% CO<sub>2</sub>, 0.13%N<sub>2</sub>O, 15.51%CH<sub>4</sub>, 7.88%CO<sub>2</sub>, 0.14%N<sub>2</sub>O respectively. These gases when allowed to diffuse into the air could constitute nuisance and aggravate global warming. However, conversion of these wastes into compost has been reported to prevent production of CH<sub>4</sub> and other obnoxious gases (USEPA, 2003). Similarly, organic manure in solution as fertigation is capable of circumventing the production of those gases in sufficient quality with negative on effect global warming. Much

work had been done on fertigation and tomato production in developed countries (Hartz, 2005; Garcia et al., 2000; Holmes and Schnitzler, 1997, little is reported in Nigeria especially as related to tomato production. This study however aims at investigating the response of tomatoes (UC82B) to three levels of drip irrigation and fertigation under two planting conditions.

## **MATERIALS AND METHODS**

This experiment was conducted at the National Horticultural Research Institute (NIHORT) experimental field, Ibadan. Ibadan lies between longitude 3° 50<sup>1</sup> and 3°52<sup>1</sup>E and latitudes 7°23<sup>1</sup> and 7°28<sup>1</sup>N with an altitude of 168m above mean sea level. Seeds of tomato were planted into the nursery on 27<sup>th</sup> October, 2007 for the GH experiment and 3<sup>rd</sup> January, 2008 for the OF. The GH was filled with top soil and was allowed to stabilize before physical and chemicals properties analyzed for nutrient status. The soil was sterilized before planting to prevent microbial action with potential soil-borne pathogens. Irrigation water sample was analyzed as appropriate before utilizing same for experimentation. Poultry manure (PM) and horse manure (HM) were analyzed for major nutrient composition at solid and solution states. Drip irrigation and fertigation systems were installed in the GH and OF on 14<sup>th</sup> Decmber, 2007 and 15<sup>th</sup> January, 2008 respectively. The drip lines were flushed and

cleaned with water to ensure clog-free orifice. Emitter discharge was determined by citing empty milk tins at discharge points operated at 45° throttling of pressure valve and allowed to run for 60 seconds at three replications of 1.7ℓ/h and 2.7ℓ/h for GH and OF respectively. PM used for fertigation in the GH and HM utilized for OF fertigation were dissolved in water and sieved with BS40 standard sieve size (159 μmm) until a soluble

solid content of 4.2 kg was achieved in both cases. Indices of salinity potential status of the solutions were determined. Sodium adsorption ratio (SAR), Exchangeable sodium percentage (ESP), Cation exchange capacity (CEC), Electrical conductivity (EC), Residual sodium carbonate (RSC) were determined empirically equations i v as follows :

$$\begin{aligned}
 \text{SAR} &= \frac{\text{Na}^+}{\frac{\text{Ca}^{2+} + \text{Mg}^{2+}}{2}} \dots\dots\dots (i) \\
 \text{ESP} &= \frac{100 (0.01475\text{SAR} - 0.0126)}{1 + (0.01475\text{SAR} - 0.0126)} \dots\dots\dots (ii) \\
 \text{CEC} &= ? (\text{Ca}^{2+} + \text{Mg}^{2+} + \text{K}^+ + \text{Na}^+) \text{ meq/100g} \dots\dots\dots (iii) \\
 \text{EC} &= ? \frac{\{\text{cations (meq/?)}\}}{10} \dots\dots\dots (iv) \\
 \text{RSC} &= (\text{HCO}_3^- + \text{CO}_3^{2-}) - (\text{Mg}^{2+} + \text{Ca}^{2+}) \text{ meq/100g} \dots\dots\dots (v)
 \end{aligned}$$

Seedlings of tomato were transplanted into the GH on 17<sup>th</sup> December, 2007 and OF on 6<sup>th</sup> February; 2008. The plant spacing was 0.3m by 0.75 on a plot size of 2.77m x 0.3m. Drip irrigation and fertigation treatments using water (control), NPK (20-10-10) and PM in solution at 1.7ℓ/h, water 1.8ℓ/h (NPK) and 1.86 ℓ/h (PM) were applied as treatment under the GH using randomized complete block

design with three replicates. Similarly, water (control), NPK and HM in solution at the rate of 1.7ℓ/h (water), 1.8ℓ/h (NPK) and 2.7ℓ/h (HM) were applied under the same experimental design with GH until the crop reached maturity. Growth parameters of the crop such as plant height, number of branches, stem diameter, number of flowers, and fruit yield were determined using appropriate methods (Afolayan et al., 2008). The

meteorological elements during the period of experiment were processed. Data generated were analyzed for analysis of variance (ANOVA) after sufficient processing using Scientific Analytical software (SAS) of 1996.

## RESULTS AND DISCUSSIONS

Figs 1 and 2 show the technical presentation of the two systems (GH, OF). The systems were installed to fit into the topography of the landscapes. Physiochemical properties of the water used for drip irrigation and the water extracts of poultry and horse manures are shown in Table 1. HM recorded the highest mean value of pH at 7.5 and the highest N-value (1.68%) indicating manure with better possibility for soil condition amelioration. Table 2 shows the physical and chemical status of the soil after experimentation. The pH values of the manure followed this trend: HM decreases from 7.5 to 6.2, water 2 from 7.0 to 6.9, water 1, from 6.5 to 6.3 while PM increases from 5.3 to 6.4. This observation is expected in view of continuous breakdown of toxic materials initially present in the PM together with addition of water to dissolve the manure for fertigation. Table 3 reflects the proximate analysis of the sampled plants after harvest. Plants under OF produced the higher mean values of Lycopene with plants under water 1, the highest value of vitamin C (36.20) and plants under NPK, the highest in terms of B-carotene.

This trend occurs possibly because of the healthy interaction between insolent radiation and the soil moisture reverence to better exposure of OF plants- based to higher temperatures. Table 4 shows the salinity status of the soil and organic fertilizer in solution in the GH. Results obtained revealed low levels of salinity showing the values are within crop tolerant level (Sharma and Sharma, 2002). Growth parameters and fruit yield of tomato under GH and OF are presented in Table 5. Plants under the GH +watering thrice per week ( $G_1W_3$ ) recorded the highest mean plant height (119 cm) followed by  $G_2W_3$  and  $G_1W_1$ , the least. Similarly, biomass production was the best under  $G_2W_2$  (740.8t/ha). However, the highest fruit yield was recorded under  $G_3W_3$ . It is observed that results obtained under OF were very lower in yield to GH which suggests superiority of GH tomato production to OF. Overall results showed that GH condition was more profitable and sustainable than OF with  $G_2W_3$ , the best.

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