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SOIL CHEMICAL QUALITY AND TOMATO PERFORMANCE AS INFLUENCE BY MORINGA (*Moringa oleifera)* EXTRACTS AT MINNA NIGERIA.

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ABSTRACT

The production of tomato in Nigeria is beset with varying problems arising from low yield and poor value of fruits. A pot experiment was carried out in the screen house of the Federal University of Technology Minna, Nigeria to evaluate the impact of *Moringa oleifera* (Moringa) leaf extract on soil chemical properties and tomato performance. The treatment consisted of three concentrations of moringa leaf extract, which were 1:10, 1:20, and 1:30, applied at one, two and three weeks interval after transplanting. The treatments were laid out in a Completely Randomized Design (CRD), replicated four times. Data collected were plant height, number of leaf, days to flowering, number of fruits and fruit weight. Results showed that the texture of the soil was sandy loam and the soil was slightly acidic in water (pH 6.3) with low organic carbon (3.30g kg^{-1}). It was concluded that plant height, fruit weight of tomato were significantly influenced by the application of Moringa leaf extract. Application of 1:30 at two weeks after transplanting improved the growth and yield parameter of tomato variety assessed and exchangeable potassium of the soil.

Keywords: Moringa leaf extract, concentrations, tomatoes and Minna

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) which belongs to the family Solanaceae is a relevant yearly vegetable crop which can be eaten raw without been cooked and used as an important part in salad and various African dishes. Other forms in which tomato is utilized are in puree or paste. When modified, it can be a good source of mineral, fibre, vitamins (Frusciante *et al.,* 2007). Tomato production in Nigeria is ranked 16th globally, this represents 10.8% of Africa's and 1.2% of the world's production of tomatoes. Tomato is one of the most relevant vegetables crop, with priority next to potato (Rice *et al* 1987). It is a crop of high worth having high nutritional value according to report by (Temu and Temu 2005). Stock (2004) reported that a limiting factor in tomato production in Sub-Saharan countries is the absence of hormonal application. Hormonal application involves, the use of plant hormones such as auxins, gibberellins, ascorbic acid, ethylene and cytokinin which are growth regulators (Prosecus, 2006) to increase yield per unit area due to their influence on every developmental stage in the life cycle of plant. Zeatin is included as a form of cytokinin naturally occurring in plant. A high amount of Zeatin has been shown to be present in fresh *Moringa oleifera* (Moringa) leaves (El-Awady, 2003).

The leaf of Moringa is a potential source for Vitamins A and C, iron, calcium, riboflavin, beta-carotene, and phenolic acid (Nambiar*et al*, 2005). The Moringa plant contains all essential amino acids; the leaves and oil of Moringa possess strong natural antioxidants (Njoku and Adikwu, 1997). Siddhuraju and Becker (2003) reported that antioxidant properties present in the solvent extract of Moringa leaves reduced potassium ferricyanide and donate hydrogen and scavenge radicals. Moringa leaves gathered from varying locations were found to have

high Zeatin concentrations of 5mcg/g and 200mcg/g of leaves (El-Awady, 2003). Moringa leaf extract used as an organic bio fertilizer was sprayed onto the leaves of pepper, sorghum, soya beans, onions, coffee, tea, chilli, melon and maize have been concluded to increase yield of the crops (Fuglie, 2000). Fuglie (2000) concluded that Leaf extract accelerated growth of young plants, improved resistance to pests and diseases, increased leaf area and the number of roots, produce more and larger fruits which resulted into generally increased yield from 20% to 35%. Foliar application of Moringa leaf extract (MLE) expedites growth of plant, elevates plant resistance to stress and improves better produce of crop (Fuglie, 1999; Foidl *et al.*, 2001). Extract gotten from plant of some trees and crop improved growth and yield (Ahmed and Nimer, 2002; Farooq *et al.*, 2008).

The objective of this study is to determine the impact of varying concentration of Moringa leaf extract (MLE) on the growth, yield of tomato and the properties of soil organic carbon, total nitrogen, available phosphorous and exchangeable potassium.

MATERIALS AND METHODS

Study site:

The experiment was conducted in the Screen house School of Agriculture and Agricultural Technology of the Federal University of Technology Minna (Latitude 09 ° 31 N; Longitude 06° 27[1] E), in the southern Guinea Savanna of Nigeria. The climate of the experimental location is sub-humid with mean annual rainfall of about 1284mm. The physical features consist of gently undulating high plains developed on basement complex rocks.

Treatments and Experimental design.

The pots were filled with 10 kg of soil. There were 10 treatments which are: To =Control, T1-1:10/1 WAT, T2- 1:20/1 WAT, T3- 1:30/1 WAT, T4- 1:10/2 WAT, T5- 1:20/2 WAT, T6- 1:30/2 WAT, T7- 1:10/3 WAT, T8- 1:20/3 WAT, T9- 1:30/3 WAT.

The experiment was laid out on a Completely Randomized Design (CRD). Each treatment was replicated 4 times.

Agronomic practices.

Tomato seed (UC 82 B) was sown by broadcasting method on a nursery bed, water was applied on a daily basis. Three seedlings were transplanted into the pots at three Weeks after Emergence (WAE). The seedlings were later thinned to one seedling per pot at one week after transplanting (WAT). One, two and three WAT moringa leaf extract was applied by foliar application using hand sprayer to the required pots. Weeding was done by hand pulling at 2 and 5 WAT.

Soil sampling and analysis:

Surface soil (0 - 15 cm) samples were collected at the Teaching and Research Farm, Federal University of Technology Minna along diagonal transects. Each was bulked together. The soil sample collected was air dried, gently crushed and sieved with 2 mm opening sieve. 10 kg of the soil samples were weighed into the pots using a weighing balance. 50 g of the soil samples was taken for initial characteristics of the soil. After harvesting, soil was sampled in each pot for some chemical analysis using the procedure described by Agbenin (1995).

Soil particle size distribution was determined by the hydrometer method. Soil pH was determined in a 1:2.5 soil to water ratio with a pH meter, while the organic carbon was determined using the Walkley-Black wet oxidation method; total nitrogen by the micro Kjeldahl method. Exchangeable bases were extracted with neutral 1 N NH_4OAC extraction. Na and K in the extract was determined using Flame photometry while the Ca and Mg was determined using the Na-EDTA titration. Exchangeable acidity was determined by Titrimetric method and phosphorus was extracted using Bray P-1 method and the concentration was determined Colorimetrically using Atomic absorption spectrophotometer.

Preparation of moringa leaf extract:

The leaves of *Moringa oleifera,* was collected and washed properly to reduce dust and soil particles attached to the leaves after collection, it was dry at room temperature free from dust and well ventilated to aid drying process, after which the leaves was milled into powdered moringa. 20 g of Moringa leaves was mixed with 675 ml of 80 % ethanol (Makkar and Becker, 1996). The suspension was stirred using a hand stirrer. The solution was thenfiltered by wringing the solution using a mutton cloth. The solution were re-filtered using No. 1Whatman filter paper as described by Fuglie (2000), the extract was diluted with distilled water at 1:10, 1:20, 1:30 ratio (v/v)and then 25 ml of each dilution was

sprayed directly unto plants at 1WAT, 2 WAT and 3WAT .

Growth and yield parameters;

The height of tomato was measured from the base of the plant to the top of the plant using a metre rule and recorded as plant height at 2, 4, 6 and 8 WAT. The number of leaf was recorded by counting the well-established leaves at 2, 4, 6 and 8 WAT. The number of days to flowering was calculated from date of sowing to the date when the flower appears on each pot.The number of fruits established per plant was recorded. The fruit weight established per plant was obtained using a top loading electronic weigh balance and recorded in grams (g).

Statistical analysis:

Data collected was subjected to Analysis of Variance (ANOVA). Treatment means were compared using Student Newman Keuls (SNK) at 5% level of probability.

RESULTS

Some soil physical and chemical properties

The results obtained from the physical and chemical properties of the soil used for the experiment prior to sowing is shown in Table 1. The textural class of the soil was sandy loam. The soil sample showed a high proportion of sand 788 g kg^{-1}, the soil was slightly acidic in water and low in organic carbon, available phosphorus and high nitrogen content (Esu, 1991).

Table 1: Some physical and chemical properties of soil prior to sowing.

Parameter	Value
Sand (gkg^{-1})	788
Silt (gkg^{-1})	80
Clay (gkg^{-1})	132
Textural class	Sandy loam
pH (H_2O)	6.3
Organic carbon (g kg^{-1})	3.30
Available phosphorus (mg kg^{-1})	9
Total nitrogen (g kg^{-1})	0.58
Exchangeable bases (cmol kg^{-1})	
Ca^{2+}	4.12
Mg^{2+}	2.40
K^{+}	0.34
Na^{+}	0.23
Exchangeable Acidity (cmol kg^{-1})	0.12

Effect of moringa leaves extract on plant height and number of leaves of tomato

The effect of moringa leaf extract on the plant height of tomato at different growth stage is shown in Table 2. At 2 WAT, pots treated with 1:20/1WAT, 1:10/2WAT and 1:30/2WAT (27.30cm, 27.03cm and 27.30cm respectively) were significantly taller ($p<0.05$) than other treatments. At 4, 6, and 8 WAT, all pots treated with moringa leaves extract had significantly taller plant than control except 1:20/1WAT at 8 WAT.

Table 2 Effect of moringa leaf extract on plant height of tomato

	Plant height (cm)			
Treatments	2 WAT	4 WAT	6 WAT	8 WAT
Control	16.20^{b}	32.70^{b}	55.28^{b}	76.25^{c}
1:10/1WAT	21.45^{ab}	47.40^{a}	68.23^{a}	83.16^{bc}
1:20/1WAT	27.30^{a}	54.83^{a}	77.40^{a}	90.34^{ab}
1:30/1WAT	22.18^{ab}	50.93^{a}	73.40^{a}	90.42^{ab}
1:10/2WAT	27.03^{a}	52.40^{a}	72.73^{a}	90.53^{ab}
1:20/2WAT	22.80^{ab}	48.45^{a}	67.85^{a}	86.87^{ab}
1:30/2WAT	27.30^{a}	54.00^{a}	77.45^{a}	92.51^{ab}
1:10/3WAT	25.13^{ab}	51.75^{a}	72.90^{a}	86.94^{ab}
1:20/3WAT	24.85^{ab}	55.75^{a}	72.48^{a}	87.79^{ab}
1:30/3WAT	24.85^{ab}	54.68^{a}	76.45^{a}	96.36^{a}
SE±	0.80	1.40	1.32	1.13

Means with the same letter(s) in a column are not significantly different at 5 % level of probability using Student Newman Keuls (SNK) WAT: Weeks after transplanting.

The effect of moringa leaf extract on the number of leaves of tomato at different growth stage is shown in Table 3. Treatment 1:20/3WAT had the highest number of leaves which was significantly ($p<0.05$) different from the control at 2 and 4 WAT but similar to other treatments at 4 WAT. No significant effect was observed between the treatments applied at 4 WAT except 1:20/3WAT. At 6 and 8 WAT, there was response to moringa leaf extract irrespective of the concentration applied as compared with the control pot.

Table 3: Effect of moringa leaf extract on the number of leaves of tomato

	Number of Leaves			
Treatments	2 WAT	4 WAT	6 WAT	8 WAT
Control	18^{b}	33^{b}	50^{b}	68^{b}
1:10/1WAT	24^{a}	43^{ab}	63^{a}	80^{a}
1:20/1WAT	26^{a}	49^{ab}	69^{a}	85^{a}
1:30/1WAT	22^{ab}	46^{ab}	67^{a}	85^{a}
1:10/2WAT	25^{a}	48^{ab}	68^{a}	84^{a}
1:20/2WAT	23^{ab}	43^{ab}	64^{a}	80^{a}
1:30/2WAT	27^{a}	51^{ab}	73^{a}	91^{a}
1:10/3WAT	25^{a}	46^{ab}	67^{a}	83^{a}
1:20/3WAT	27^{a}	52^{a}	71^{a}	82^{a}
1:30/3WAT	25^{a}	51^{ab}	72^{a}	89^{a}
SE±	0.60	1.37	1.33	1.16

Means with the same letter(s) in a column are not significantly different at 5 % level of probability
WAT: Weeks after transplanting.

Effect of moringa leaf extract on number of days to flowering, number of fruits and fruit weight of tomato and some soil chemical properties

Effect of moringa leaf extract on number of days to flowering was shown in Figure 1. Treatments 1:20/1WAT, 1:30/ 1WAT and 1:10/ 2 WAT flower earlier than other treatments but were not significantly different from one another. Treatments1:10/ 3 WAT produced the highest number of fruits and the lowest was recorded on the control (Figure 2). Treatments 1:30 irrespective of the time of application produced the heaviest fruit weight which was significantly different from other treatments. Treatments 1:10/ 1 WAT,1:20/ 1 WAT, 1:10/ 2 WAT and 1:20/ 2 WAT were not significantly from treatment 1:10/ 3 WAT and 1:20/ 3 WAT (Figure 3).Pots treated with 1:30/1WAT had highest nitrogen content which was significantly different ($p<0.05$) from other treatments. 1:20 / 2WAT and 1:30 /2WAT recorded high amount of organic carbon and exchangeable potassium. There was no significant different between the treatments on available phosphorous (Table 4.).

Table 4: Effect of moringa leaf extract on some soil chemical properties

Treatments	TN (g kg^{-1})	OC (g kg^{-1})	AP (mg kg^{-1})	EK (cmol kg^{-1})
Control	0.1075^{c}	2.50^{b}	8^{a}	0.795^{b}
1:10/1WAT	0.1100^{bc}	3.33^{ab}	10^{a}	0.313^{b}
1:20/1WAT	0.1100^{bc}	3.00^{ab}	8^{a}	0.305^{b}
1:30/1WAT	0.1250^{a}	2.70^{ab}	10^{a}	0.295^{b}
1:10/2WAT	0.1125^{bc}	3.33^{ab}	9^{a}	0.348^{b}
1:20/2WAT	0.1125^{bc}	4.20^{a}	10^{a}	0.438^{b}
1:30/2WAT	0.1125^{bc}	3.24^{ab}	9^{a}	1.880^{a}
1:10/3WAT	0.1100^{bc}	3.42^{ab}	10^{a}	0.465^{b}
1:20/3WAT	0.1100^{bc}	3.33^{ab}	8^{a}	0.278^{b}
1:30/3WAT	0.1200^{ab}	3.51^{ab}	10^{a}	0.463^{b}
SE±	0.011	0.113	0.244	0.110

Means with the same letter(s) in a column are not significantly different at 5% level of probability using Student Newman Keuls (SNK). WAT- Weeks after transplanting, TN- Total Nitrogen, OC- Organic Carbon, AP- Available Phosphorus, EK- Exchangeable Potassium

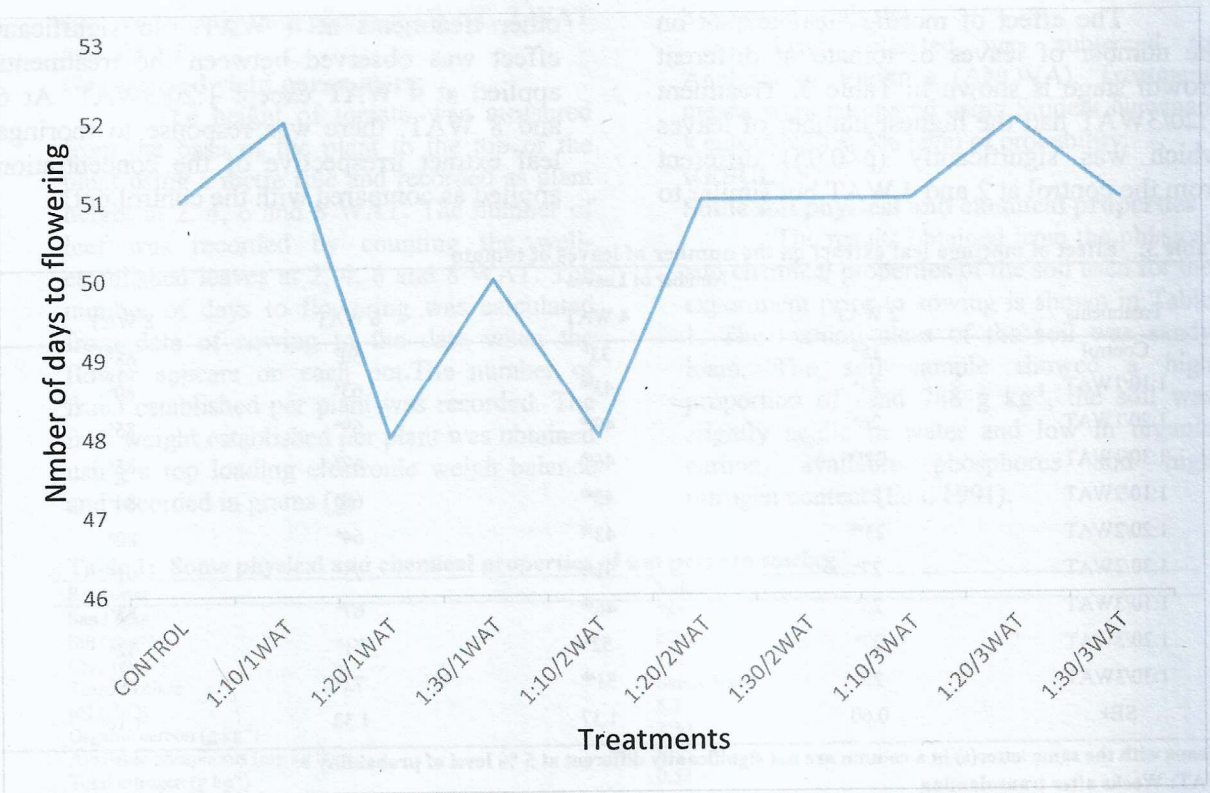

Figure 1: The effects of moringa leaf extract on number of days to flowering of tomato

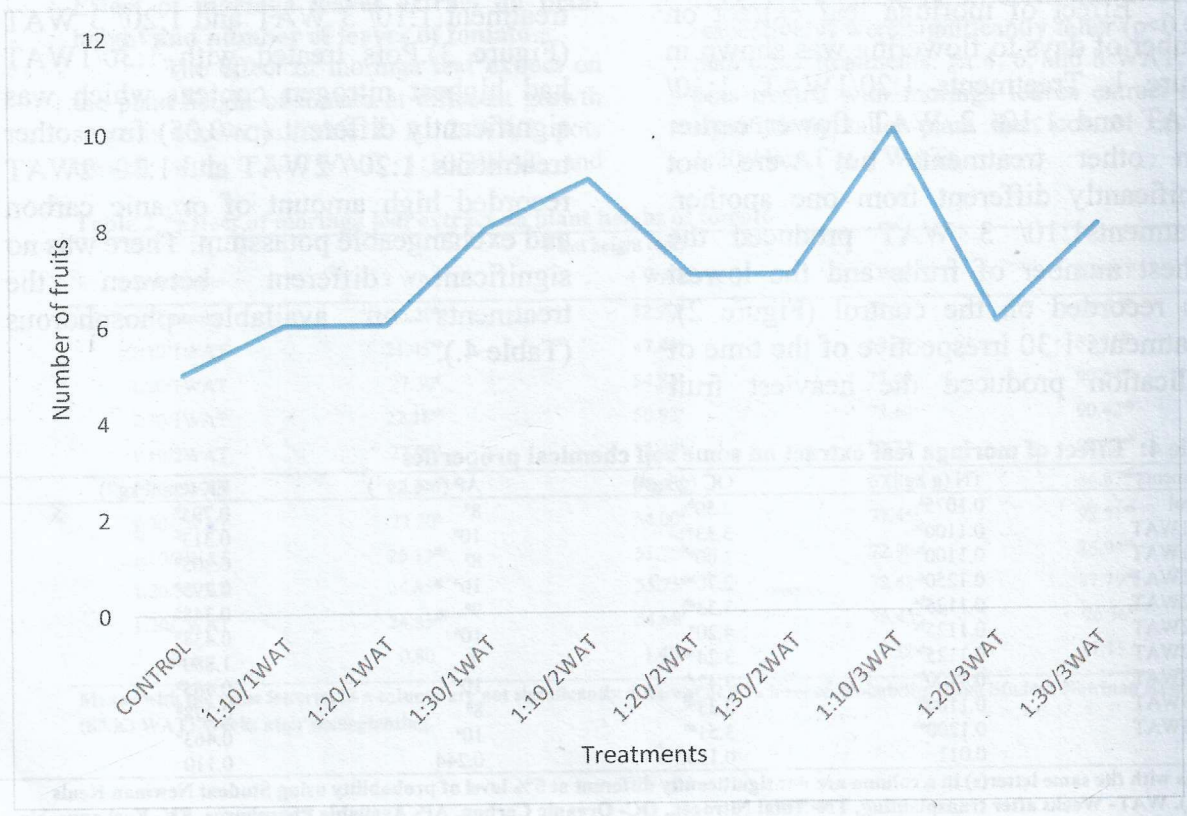

Figure 2: The effects of moringa leaf extract on number of fruits per pot of tomato

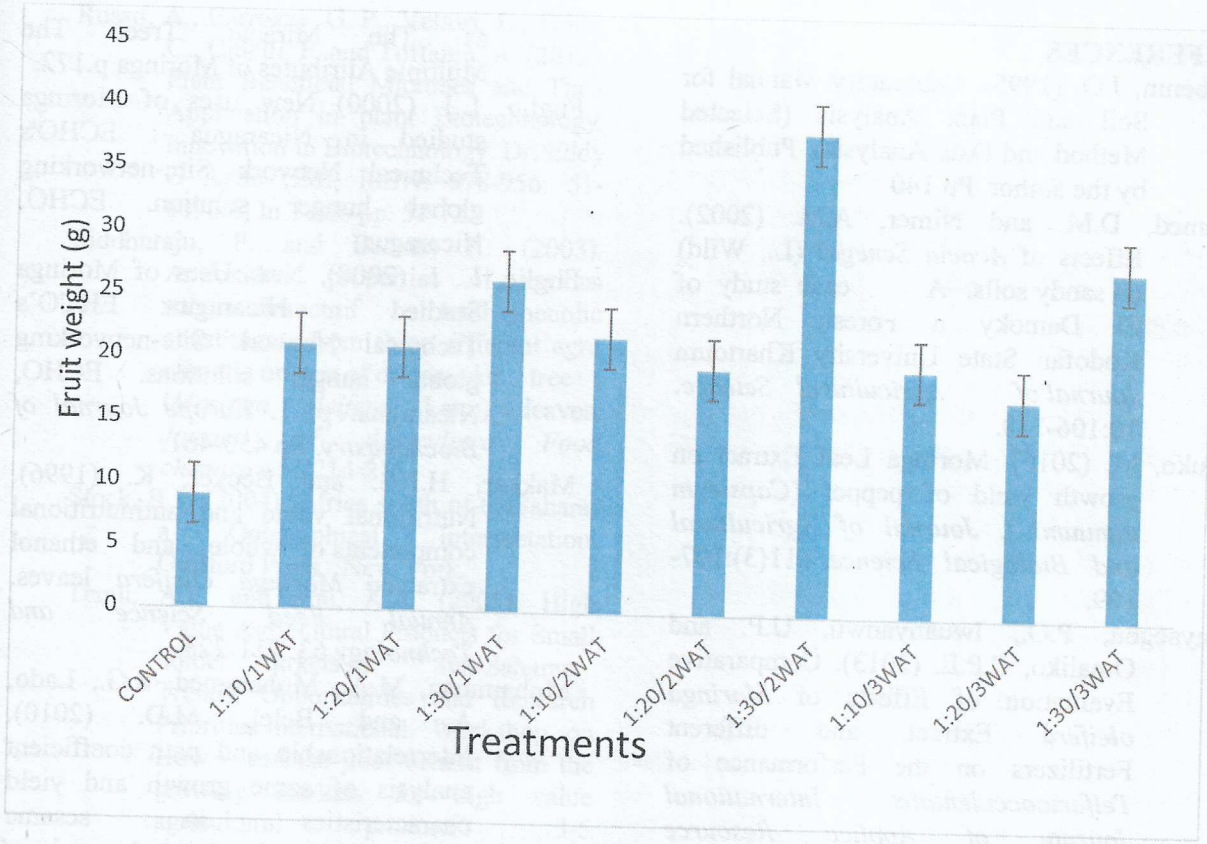

Figure 3: The effects of moringa leaf extract on fruit weight of tomato

DISCUSSION

The moringa leaf extract increased the plant height and fruit weight of tomato, this may be as a result of the moringa leaf extract been able to absorb the leaf epidemics and then transported to other plant parts through the conducting tissues of the plants such as the phloem and xylem. There was a response of tomato to the foliar application of moringa leaf extract which indicates that moringa leaf extract can indeed increase yield and growth of plant. Similar results were reported by Aluko (2016) who observed that moringa leaf extract influence the growth parameters of *Capsicum annuum*. Fuglie (2008) also reported that application of moringa leaf extract increased yield of any crop by 25 to 30%.Treatments 1:30 irrespective of the time of application produced the heaviest fruit weight which was significantly different from other treatments. Similarly, Anyaegbu*et al.*, (2013) also reported an increase in the yield and yield components of *Telferia occidentalis* using moringa leaf extract. Now the need for sound and ecological compatible and eco-friendly method in agriculture, capable of providing enough food for the increasing human population; in keeping soil quality and improving the quality and quantity of agricultural produce (Russo *et al.*, 2012). In many households of Nigeria, the uses of moringa were reported to have increased seed germination, growth and yield of crops (Foidl *et al*, 2001; Muhamman *et al.*, 2010; Phiri and Mbewe, 2010).

CONCLUSION

From the result of this study, application of moringa leaf extract 1:30 at two weeks after transplanting improved the growth and yield parameters of tomato and exchangeable potassium. Therefore for the production of tomato (*Solanum lycopersicumL.*) in pot experiments, the application of Moringa Leaf Extract 1:30 at two weeks after transplanting is recommended.

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