**Effect of Poultry Manure, Moringa and Neem Leaf Extracts on the Varietal Performance of Tomato (*Solanum Lycopersicum* L.)**

**ABSTRACT**

Pot experiment was carried out in a hoop-house at the Teaching and Research Farm of Rivers State University from August 2020 -February 2021 cropping season to evaluate the agronomic performance of three Tomato (*Solanum lycopersicum* L) varieties (Jos, Beef and RVF) to the exogenous applications of Moringa leaf extract (MLE), Neem leaf extract (NLE) and poultry manure (PM). The MLE and NLE were applied at 30ml of 0, 5 and 10 litres concentrations with 20t/ha PM singly and in all possible combinations, in a Completely Randomized Design (CRD) in three replications. The tested parameters were percentage emergence, days to 50% flowering and fruiting, plant height, number of branches, leaves, flowers, fruit, and fruit weight. The results showed that applications of MLE, NLE (priming and foliar spray) and PM had significant (p≤0.05) effects on tested parameters over the control at all growth stages and on fruit yield, but the combination of these treatments gave a better performance. Among the MLE treatments, both sole and combined applications, MLE5 gave a better performance on growth parameters such as plant height (149.08cm), number of leaves (145.74) and number of branches (34.92), than MLE10, plant height (143.85cm), no of leaves (143.66), and number of branches (34.40) while MLE10 was superior in terms of yield and yield related parameters such as number of flowers (24.44), number of fruit (21.37) and fruit weight (6.90 t/ha). NLE 10 gave a better growth and yield performance than NLE 5. The combination of MLE, NLE and PM gave a better performance on growth and yield than their single applications and the control. However, the combination effect of MLE10+NLE10+PM exhibited larger number of flowers, more number of fruits as well as heaviest fruits. Plants treated with Moringa and Neem leaf extracts recorded zero pest infestation when compared to the PM alone and the control treatment. Among the varieties, Jos variety treated with MLE, NLE and PM single and in all combinations recorded the best and highest values in all growth and yield parameters, followed closely by RVF, while Beef variety was the least. The significant effect of MLE, NLE and PM on the agronomic performance of the three tomato varieties suggests that, MLE, NLE and PM can be used as a source of nutrient to grow tomato plants.

Keywords- Moringa leaf extract, Neem leaf extract, Poultry Manure, Tomato , Varietal Performance

**INTRODUCTION**

**Background of the Study**

Tomato (*Solanum lycopersicum* L.) is known as the most popular home garden vegetable and the world's second most consumed vegetable after potatoes (*Solanum tuberosum* L.) (USDA, 2017).

It belongs to the family Solanaceae, which includes several other commercially important species. Tomato is a popular tropical crop that provides numerous nutritional as well as health values which are beneficial to human. Tomato contains carotenoids (Van den berg *et al.,* 2000), which are the main source of lycopene, the red coloring pigment in tomato. Tomato is considered as one of the world's most important food crops (Frusciante *et al*., 2000), as well as one of the most researched and commercially available vegetables. Its cultivation, however, is mostly limited to cool-mild and dry areas, with some exceptions in hot and dry seasons (Hanson *et al*, 2001; IFPRI/PBS, 2007).Commercial tomato cultivation in Nigeria is limited to the savannah agro-ecology of the north and a few damp savannah agro-ecologies of the south. (Umeh *et al,* 2002). Nigeria, having a population of roughly 160 million people and a tomato production of 1,701,000 tons per year, produces only 5 percent of what China produces and 12 percent of what the United States produces (FAO, 2008), and the demand for fresh tomatoes in Nigeria exceeds supply, especially during the off-season (Tijani, 2001).

According to IFPRI/PBS(2007), one of the factors that limits production of tomato in Nigeria is the limitation of production to a specific season, which results in times of excess and shortage, resulting in high price of fresh fruits, as well as the cultivation of exotic varieties that are not well adapted to local environmental conditions. Poor seed quality, soil fertility, fertilizer usage, insufficient land, poor transportation infrastructure, and insect and disease issues, especially during the wet season, are all potential limits to tomato production (Afolabi and Ayide, 2001), necessitating the development of different agronomic practices that a farmer can easily adopt to improve tomato growth and fresh fruit yields.

Poultry manure has shown to significantly boost the growth and fruit yields of crops such as okra as reported by Ashraf *et al.* (2016), Ali *et al.* (2014), and Tiamiyu *et al.* (2012), leading to an increase in its use as a source of nutrients by farmers. Poultry manure is a very cheap and effective source of nutrient, especially nitrogen but ready availability remains an important issue since large amounts must be applied to give optimum yield (Mathew *et al*., 2017). Plant residues such as: banana peels (Jonathan *et al*., 2012), *Senna siamea, Leucaena leucocephala* and *Gliricidia sepium* (Akande *et al.,* 2010; Olujobi and Ayodele, 2013), sea weeds (Khan *et al*., 2009), *Moringa oleifera* (Fahey, 2005) are sources of nutrients needed to improve crop production.

Moringa (*Moringa olifera* L.) belongs to the Moringaceae family. It is one of such alternatives, being investigated to ascertain its effect on growth and yield of crops and thus can be promoted among farmers as a possible supplement or substitute to inorganic fertilizers (Phiri, 2010). Moringa leaves are high in Zeatin, a naturally occurring cytokinin, as well as other substances including ascorbates, vitamin E, and phenolics, which make the leaf extract a natural plant growth enhancer (Nagar *et al*., 2006). Moringa leaves were used to make a plant growth spray that enhanced crop production by 20 to 35 percent. Foliar application causes plants to live long, have stronger and heavy roots, stems, and leaves, produce more fruit, and improve production by 20 to 35 percent, according to (Foidle *et al.,* 2001) and highlighting the possibility of using it as a foliar spray to help young plants develop faster in numerous trials, Moringa leaf extract (MLE) demonstrated to be an excellent plant growth enhancer (Nouman *et al*., 2011). Makkar *et al.* (2007) found the moringa leaves as a source of plant growth factors, antioxidants, β- carotene and vitamin C. Moringa leaf extract was studied by Siddhuraju and Becker (2003) for its antioxidant qualities, and it was shown to be effective in: “(1) reducing potassium ferricyanide, (2) scavenge superoxide radicals, (3) prevent the peroxidation of lipid membranes in liposomes, (4) donate hydrogen and scavenge radicals”.

According to Sayed, Salem & Ali (2011), neem plant products have been utilized in agriculture to stimulate seed germination, improve soil quality, and protect diverse crop species from numerous insect classes. The neem leaves contain good quantities of flavonoids, steroids, carbohydrates, glyco­sides, antiquinone, terpenoides and alka­loids (Raphael, 2012). Alkaloids such as phnenolic and saponins, which also have antioxidant effects, protect plants from diseases. Neem leaves, seed cake, leaf seed, and bark extracts have been proven to improve various chemical features of soils when used as organic fertilizers. Neem products include insecticides, pesticides, fumigants, fertilizers, manures, compost, urea coating agents, and soil conditioners (Hossain *et al*., 2008; Subbalakshmi *et al*., 2012). Particularly, soil pH, total nitrogen, ammonium nitrogen exchangeable bases micronutrients, and electrical conductivity have all improved as a result of using neem products (Aduloju, Adelana, and Shuaib, 2013; Elnasikh *et al.,*  2011). The chemical composition of the different parts of the neem plant employed as soil amendments is responsible for these differences in soil fertility (Solomon, Okon, and Umoetok, 2008; Elnasikh *et al*., 2011); which are sometimes richer in some mineral components than farmyard manure or sewage sludge. Apart from hormone, medicinal plant extracts contain saponins and polyphenols which could be the active compounds causing the effect on growth and yield of crop plants (Andresen and Cedergreen, 2010).

The demand for agricultural techniques that is sound, ecologically compatible, and environmentally friendly, capable of providing enough food for the growing human populations while also preserving soil quality and improving the quality and quantity of agricultural produce is increasing rapidly (Ruso *et al*., 2012; FAOSTAT, 2017). Therefore, this study was carried out to evaluate the effects of Poultry Manure, Moringa and Neem leaf extract preparations on the agronomic performance and insect pest management of three tomato varieties in Port Harcourt.

**MATERIALS AND METHODS**

**Study Area**

This research was carried out in the Hoop House of the Rivers State University Teaching and Research Farm, Nkpolu-Oroworukwo, Port Harcourt. The study location lies in the humid tropical zone of the Southern Nigeria. It lies between latitude 4.5oN and longitude 7.0oE with an elevation of 18m above sea level. The climate of the area is tropics, with 2 seasons; wet (rainy) and the dry seasons. The mean annual rainfall in Port Harcourt ranges from about 3,000mm to 4,500mm, annual temperature ranges from 22oC to 29oC while relative humidity varies from 75% and 95%. Port Harcourt soils are of Coastal Plain Sands. These soils have been found to range from sand to sandy loam in the surface soil horizon, with pH values of between 4.0 and 5.8 in water (Ayolagha and Onuegbu, 2002). The vegetation consists of tropical and mangrove swamp forest (Uko *et al*., 2013).

**Collection and analysis of soil samples before cultivation**

Top soil (0-15 cm) samples were randomly collected from cultivated farm, bulked to form a composite sample; air dried and sieved using a 2mm mesh size. The routine analyses as described in Udo *et al*. (2009) for physical and chemical properties were carried out on the soil sample. 10 kg of the soil sample were measured into plastic containers that were perforated at the base.

**Sources and Collection of Tomato Seeds, Poultry Manure, Moringa and Neem Leaves**

Three tomato varieties (Jos, Beef and Roman VF) were obtained from two locations (Agricultural Development Program, Ministry of Agriculture and Fruit Garden) all in Port Harcourt. Poultry manure, Moringa and Neem leaf were sourced from the Rivers State Teaching and Research Farm.

**Preparation and Applications of Poultry Manure, Moringa and Neem Leaf Extracts**

**Poultry manure**

Poultry manure was air-dried and finely crushed. 0.089kg (89g) of the poultry manure was weighed and added to poly pots filled with 10kg soil 2 weeks before planting.

**Moringa and Neem Leaf Extracts**

Fresh leaves of moringa and neem were washed with tap water and then shade dried for seven days at room temperature 2± 270C. The dried leaves were milled into uniform powder. 500g from each of the dried powered plant samples were weighed and soaked in 5 and 10 litres of water respectively, stirred for 30 minutes and left for 24 hours. The extracts were filtered through cheese cloth about two times to separate the residues from the solution, a method adopted from Sale *et al*., 2015. Moringa and neem leaf extracts were sprayed at the rate of 30ml for each plant at two weeks interval, starting from two weeks after germination to fruit maturity.

**Tomato Seed preparation and planting**

The tomato seeds were soaked in each plant extracts at 30ml for 4 hours and then air dried before planting (Deepti *et al*., 2016).Seeds of each tomato varieties were planted at four seeds per pot with sizes 30 X 30cm filled with 10kg of soil perforated at the base. The distance between each pot was 35 X 35cm while distance between treatments was 40 X 40cm.

**Experimental Design**

The experiment (hoop-house pot experiment) was laid out as Completely Randomized Design (CRD) with twelve treatments replicated three times. The treatments consist of milled moringa and neem leaves mixed in 0, 5 and 10 litres of water rates of concentrations and 20t/ha poultry manure singly and in all possible combinations and control.

**Data Collections and Statistical Analysis**

Data were collected on Percentage Emergence (%), Number of Days to 50% flowering, Number of Days to Fruiting, plant height, number of leaves and number of branches at intervals of two (2) weeks from 6 WAP (weeks after planting). Harvesting of fresh fruits begins at 10 WAP which was done in 4 days interval. The Level of pest infestation, number of fruits per plant was counted and the fresh fruit weight per plant was recorded. All data obtained for each character were subjected to analysis of variance (ANOVA) and the treatment means were separated by Fisher’s Least Significant Difference (LSD) at 5% probability.

**RESULTS**

**Physical and Chemical Properties of the Soil. PM. MLE and NLE before Planting**

The pre-cropping soil properties and some chemical properties of PM, NLE and MLE used for the experiment before treatment application is shown in Table 1. The soil was a very strongly acidic (pH=4.97) sandy loam containing 1.17% O.C, 14% N, 2.02% OM, and 0.18 Mg/kg Available P. While exchangeable K, Na, Ca and Mg were 4, 6, 0.6, and 1 cmol/kg respectively.

The chemical analysis of the Poultry Manure as presented in Table 1 showed that the manure had a pH value of 7.20 which is neutral, 36.80% organic matter organic carbon was 8.30%, 2.5% total nitrogen, available P 6.90 Mg/kg, While P, K, Na, Ca and Mg were 0.09, 0.12, 3.09 and 1.57 Cmol/kg respectively. The chemical analysis of the dried Neem leaf showed that the pH was slightly acidic (6.4), 12.3% organic carbon, 21.58% organic matter, 3.00% total nitrogen, 6.00% P, 2.75% total K, 1.46% Ca and 0.91% Mg. The pH of moringa leaf was slightly acidic (6.37), 4.51% total nitrogen, exchangeable K (9.98 mgkg), 4.51 cmol/kg Ca, 7.10 cmol/kg P.

**Table 1: Chemical and Physical properties of Soil, Poultry Manure, dried Neem and Moringa leaf samples.**

|  |  |
| --- | --- |
| **Parameters** | **Soil** |
| pH | 5.67 |
| Organic Carbon (%) | 1.17 |
| Total Nitrogen (%) | 0.14 |
| Available Phosphorus (Mg/kg) | 0.18 |
| Potassium (k) (Cmol/kg) | 4 |
| Sodium (Na) (Cmol/kg) | 6 |
| Calcium (Ca) (Cmol/kg) | 0.6 |
| Magnesium (Mg) (Cmol/kg) | 1 |
| Organic Matter (%) | 2.02 |
| ECEC (Cmol/kg) | **-** |
| **Physical Characteristics** |  |
| Sand (%) | 85.8 |
| Silt (%) | 10.4 |
| Clay (%) | 3.8 |
| Textural class | Sandy Loam |

**Agronomic performance of Tomato Varieties to Poultry Manure, Moringa and Neem Leaf Extracts preparation.**

**Percentage Emergence %**

The percentage emergence of the various treatments and tomato varieties taken at 7 days after planting is presented in table 2. The percentage emergence varied among the varieties. Jos (87.83%) recorded the highest values in terms of percentage emergence 7 days after planting followed closely by RVF (86.44%). Beef variety recorded the least value (83.55%) table 2.

Improved germina­tion percentage was recorded in all the treat­ments. Germination percentage ranged from 62.86 to 99.07% (Table 3). The highest seedling emergence was obtained from the combination of MLE and NLE when compared to the sole applications of this treatment, PM and the control. However, the combination effect of MLE 10 + NLE 10 + PM (99.07%) was superior to other treatments, singly and combined. The control treatment recorded the least value of percentage emergence (62.86%). Between the two levels of MLE and NLE, applications of MLE 10 and NLE 10 applied alone or in combination recorded the highest seedling emergence than MLE 5 and NLE 5 (Table 3),

The results in Table 4 showed that the interaction of treatments and varieties had a significant effect on the percentage emergence of tomato. This effect indicates that the varieties responded differently to the treatments. The highest value was obtained from varieties treated with MLE 10 + NLE 10 + PM with a value of (100%) and the least value was obtained from the control (62.34%). Jos and RVF varieties significantly recorded the highest seedling emergence than Beef across all treatments, singly and in all possible combinations.

**Days to 50% Flowering**

Results of the study presented on Table 2 indicate that, there was significant difference among the varieties used in respect to the number of days to 50% flowering. Jos variety was the earliest to attain 50% flowering (55.53 days), followed closely by RVF (57.75 days) with Beef variety recording the highest number of days to 50% flowering (59.53 days).

The effect of PM, MLE and NLE on tomato varieties on Table 3 showed that the application of MLE + NLE + PM recorded the lowest number of days to 50% flowering and was significantly different from the sole applications of these treatments and the control. The highest values were observed in the control treatment (68.00 days). There was no difference between MLE 5 + NLE5 + PM and MLE 10 + NLE 10 + PM. However, there was significant difference between the two levels of MLE and NLE sole and in combination with PM. MLE 5 (58.66 days) and MLE 5 + PM (55.25 days) was higher than MLE 10 (56.66 days) and MLE 10 + PM (53.66 days). Also NLE 5 (60.66 days) and NLE 5 + PM (56.66 days) were higher than NLE 10 (58.18 days) and NLE 10 + PM (55.25 days) Table 3.

The interaction between PM, MLE, NLE and varieties significantly (P = 0.05) affected the number of days to 50% flowering when compared to the control. There was significant difference between the varieties, Jos variety treated with PM, MLE and NLE singly and in combined applications recorded the lowers number of days to 50% flowering, followed by RVF while Beef recorded the highest number of days to 50% flowering across all treatments.

**Number of Days to Fruiting**

The number of days to fruiting varied among the varieties (Table 2). Jos variety recorded the lowest number of days to fruiting (68.71 days), followed by RVF (71.21 days) with Beef variety recording the highest number of days to 50% fruiting (73.04 days), Table 2.

The combined application of MLE, NLE and PM recorded the lowest number of days to fruiting and was significantly different from the sole applications of these treatments and the control. The highest number of days to fruiting was observed in the control treatment (85.00 days). There was no significant difference between the combination of MLE 5 + NLE5 + PM and MLE 10 + NLE 10 + PM. However, there was significant difference between the two levels of MLE and NLE singly and in combination with PM. The result presented on Table 4 showed that the interaction between PM, MLE, NLE and varieties significantly (P = 0.05) affected the number of days to fruiting. There was significant difference between the varieties, Jos variety treated with PM, MLE and NLE sole and in combined applications recorded the lowest number of days to fruiting (63.00 days), followed by RVF (64.00%) while Beef recorded the highest number of days to fruiting (66.00 days) across all treatments (Table 4).

**Table 2: Effect of Tomato Varieties on Percentage Emergence, Number of Days to Flowering and Fruiting**

|  |  |  |  |
| --- | --- | --- | --- |
| **VARIETIES** | **PE** | **DTF** | **DTFR** |
| JOS | 87.83a | 55.53c | 68.71c |
| RVF | 86.44b | 57.75b | 71.21b |
| BEEF | 83.55c | 59.53a | 73.04a |
| LSD(0.05) | 0.06 | 0.07 | 0.07 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), PE = Percentage Emergence, DTF = Days to 50% Flowering, DTFR = Number of Days to fruiting, LSD = Least Significant Difference, RVF = Roman VF.

**Table 3 Effect of Treatments on Percentage Emergence, Number of Days to Flowering and Fruiting**

|  |  |  |  |
| --- | --- | --- | --- |
| TREATMENTS | PE % | DTF | DTFR |
| CON | 62.86l | 68.00a | 85.00a |
| PM | 71.27k | 64.66b | 78.67b |
| MLE 5 | 81.50i | 58.66d | 71.67d |
| MLE 10 | 87.03g | 56.66f | 69.67e |
| NLE 5 | 71.27j | 60.66c | 73.67c |
| NLE 10 | 82.40h | 58.18e | 71.67d |
| MLE 5 + PM | 92.50e | 55.25g | 68.48f |
| MLE 10 + PM | 96.27c | 53.66h | 66.67h |
| NLE 5 + PM | 89.83f | 56.66f | 69.67e |
| NLE 10 + PM | 93.50d | 55.25g | 68.07g |
| MLE 5 + NLE 5 + PM | 97.20b | 51.33i | 64.33i |
| MLE 10 + NLE 10 + PM | 99.07a | 51.33i | 64.33i |
| LSD(0.05) | 0.12 | 0.14 | 0.14 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litres concentrations), NLE (5 & 10) = Neem leaf extract(5 & 10 litres concentrations), PE = Percentage Emergence, DTF = Days to 50% Flowering, DTFR = Number of Days to fruiting, LSD = Least Significant Difference.

**Table 4: Interaction Effect of Treatments on Percentage Emergence, Number of Days to**

**Flowering and Fruiting**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TREATMENTS** | **VAR** | PE | DTF | DTFR |
| CON | JOS | 62.34n | 68.00a | 85.00a |
|  | BEEF | 63.90m | 68.00a | 85.00a |
|  | RVF | 62.34n | 68.00a | 85.00a |
| PM | JOS | 72.20k | 62.00e | 76.00d |
|  | BEEF | 69.40l | 67.00b | 81.00b |
|  | RVF | 72.20k | 65.00c | 79.00c |
| MLE 5 | JOS | 86.10f | 56.00m | 69.00j |
|  | BEEF | 77.80i | 61.00f | 74.00e |
|  | RVF | 80.60h | 59.00h | 72.00f |
| MLE 10 | JOS | 94.40d | 54.00o | 67.00l |
|  | BEEF | 83.30g | 59.00h | 72.00f |
|  | RVF | 86.10f | 57.00l | 70.00i |
| NLE 5 | JOS | 80.60h | 58.00j | 71.00g |
|  | BEEF | 75.00j | 63.00d | 76.00d |
|  | RVF | 77.80i | 61.00f | 74.00e |
| NLE 10 | JOS | 86.10f | 55.44n | 69.00j |
|  | BEEF | 77.80i | 60.56g | 74.00e |
|  | RVF | 83.30g | 58.56i | 72.00f |
| MLE 5 + PM | JOS | 94.40c | 52.56q | 65.44n |
|  | BEEF | 88.80e | 57.44k | 71.00g |
|  | RVF | 94.40c | 55.78m | 69.00j |
| MLE 10 + PM | JOS | 97.20b | 51.00r | 64.00p |
|  | BEEF | 94.40c | 56.00m | 69.00j |
|  | RVF | 97.20b | 54.00o | 67.00l |
| NLE 5 + PM | JOS | 94.40d | 54.00o | 67.00l |
|  | BEEF | 86.10f | 59.00h | 72.00f |
|  | RVF | 94.40d | 57.00l | 70.00i |
| NLE 10 + PM | JOS | 94.40c | 52.56q | 65.11o |
|  | BEEF | 94.40d | 57.44k | 70.56h |
|  | RVF | 94.40c | 55.78m | 68.56k |
| MLE5 + NLE5 + PM | JOS | 97.20b | 50.00s | 63.00q |
|  | BEEF | 97.20b | 53.00p | 66.00m |
|  | RVF | 97.20b | 51.00r | 64.00p |
| MLE10 + NLE10 + PM | JOS | 100.00a | 50.00s | 63.00q |
|  | BEEF | 97.20b | 53.00p | 66.00m |
|  | RVF | 100.00a | 51.00r | 64.00p |
| LSD0.05 |  | 0.32 | 0.24 | 0.24 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litres concentrations), NLE (5 & 10) = Neem leaf extract(5 & 10 litres concentrations), PE = Percentage Emergence, DTF = Days to 50% Flowering, DTFR = Number of Days to fruiting, LSD = Least Significant Difference, VAR = Varieties.

**Growth Parameters**

The results presented in Table 5 indicates that, there was significant difference among the varieties used in respect to the growth parameters; plant height, number of leaves and branches at 6, 8 and 10 weeks after planting (WAP). However, as the week after planting (WAP) progressed, the value recorded for each variety increased. The Jos type had the best performance in these growth parameters at 6, 8, and 10 WAP, while the Beef variety had the least performance.

The effect of PM, MLE and NLE on tomato varieties on Table 6 showed that, the combination of MLE + NLE + PM produced the highest plant heights, number of leaves and branches at 6, 8 and 10 WAP when compared to the sole applications of this treatments and the control. The control treatment recorded the least plant height (72.9). However, the combination effect of MLE 5 + NLE 5 + PM was superior to other treatments, singly and combined applications. The single and combined applications of MLE 5 recorded highest plant height, number of leaves and branches at 6, 8 and 10 WAP than MLE 10, while NLE 10 sole and combined recorded the highest plant height, number of leaves and branches than NLE 5 at 6, 8 and 10 WAP (table 6)

The results presented on Table 7 shows that the interactions between PM, MLE and NLE and varieties significantly (P = 0.05) affected the plant height, number of leaves and branches at 6, 8 and 10 WAP. The interaction effect of PM, MLE and NLE (applied singly and in combination) and varieties at 6, 8 and 10 WAP indicates that varieties Jos and RVF significantly produced the highest plant heights, number of leaves andmore number of leaves. While Beef variety produced lowest plant height, number of leaves and branches. However, the combination of MLE 5 + NLE 5 + PM produced the highest plant height, number of leaves and branches across all three varieties while the lowest plant heights, number of leaves and branches were recorded in the control treatment across all three varieties. The data recorded also showed that the interaction between the treatments (PM, MLE and NLE) and varieties were effective as the WAP increased (Table 7).

**Table 5: Effect of Tomato Varieties on Plant Height,Number of Leaves and Branches at 6, 8 and 10 WAP**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **6WAP** |  |  | **8WAP** |  |  | **10WAP** |  |  |
| **VARIETIES** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** |
| JOS | 24.79a | 47.31a | 9.65a | 54.25a | 82.45a | 18.37a | 113.90a | 119.34a | 28.06a |
| RVF | 22.42b | 44.73b | 8.42b | 49.50b | 80.01b | 17.05b | 104.40b | 116.53b | 26.71b |
| BEEF | 22.15c | 44.10C | 8.29b | 49.24b | 79.34c | 16.85b | 103.53c | 116.22b | 26.34c |
| LSD(0.05) | 0.17 | 0.29 | 0.20 | 0.32 | 0.31 | 0.24 | 0.60 | 0.53 | 0.24 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), WAP= Weeks after planting, PH = Plant Height, NOL= Number of leaves, NOB = Number of Branches, LSD = Least Significant Difference, RVF = Roman VF.

**Table 6: Effect of PM, MLE and NLE on Plant Height,Number of Leaves and Branches at 6, 8 and 10 WAP.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **6WAP** |  |  | **8WAP** |  |  | **10WAP** |  |  |
| **TREATMENTS** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** |
| CON | 17.19j | 24.52j | 3.67i | 36.79j | 42.77k | 7.51i | 72.90k | 71.88k | 10.88j |
| PM | 18.74i | 32.33i | 5.59h | 40.47i | 65.92j | 12.03h | 84.34j | 97.25j | 18.25i |
| MLE 5 | 21.21f | 41.30f | 8.41e | 46.41f | 76.37g | 17.48e | 97.84f | 112.37g | 27.55f |
| MLE 10 | 20.26g | 40.04g | 7.59f | 43.59g | 74.11h | 16.62f | 92.35g | 109.11h | 26.66g |
| NLE 5 | 19.52h | 38.85h | 6.96g | 42.00h | 71.96i | 15.88g | 87.05i | 106.18i | 25.96h |
| NLE 10 | 20.13g | 39.52g | 7.56f | 43.25g | 73.51h | 16.51f | 90.74h | 108.48h | 26.55g |
| MLE 5 + PM | 25.86c | 52.89c | 10.67b | 57.79c | 92.00c | 19.96b | 122.54c | 132.25c | 30.77c |
| MLE 10 + PM | 24.95d | 50.81d | 10.04c | 54.91d | 89.63d | 19.44c | 117.05d | 128.96d | 29.92d |
| NLE 5 + PM | 24.02e | 49.67e | 9.37d | 53.04e | 86.66f | 18.62d | 112.92e | 124.74f | 28.74e |
| NLE 10 + PM | 24.94d | 50.59d | 9.96c | 55.42d | 88.70e | 19.37c | 116.64d | 127.70e | 29.81d |
| MLE 5 + NLE 5 + PM | 30.59a | 62.48a | 13.00a | 30.59a | 103.48a | 22.92a | 149.08a | 145.74a | 34.92a |
| MLE 10 + NLE 10 + PM | 30.09b | 61.52b | 12.70a | 30.09b | 102.11b | 22.70a | 143.85b | 143.66b | 34.40b |
| LSD(0.05) | 0.35 | 0.57 | 0.40 | 0.63 | 0.62 | 0.47 | 1.19 | 1.06 | 0.49 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litres concentrations), NLE (5 & 10) = Neem leaf extract(5 & 10 litres concentrations), WAP= Weeks after planting, PH = Plant Height, NOB = Number of branches = NOL= Number of leaves, NOB = Number of, LSD = Least Significant Difference.

**Table 7: Interaction Effect of Treatments on Plant Height, Number of leaves and Branches**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **6WAP** |  |  | **8WAP** |  |  | **10WAP** | |  |
| **TREATMENTS** | **VAR** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** | **PH** | **NOL** | **NOB** |
| CON | JOS | 17.35o | 24.33v | 3.56n | 36.58v | 42.22u | 7.44r | 72.13s | 71.66t | 10.66w |
|  | BEEF | 16.92o | 24.78v | 3.78n | 37.71u | 43.00u | 7.66r | 73.42s | 72.11t | 11.33w |
|  | RVF | 17.28o | 24.44v | 3.67n | 36.07w | 43.11u | 7.44r | 73.15s | 71.88t | 10.66w |
| PM | JOS | 20.02k l | 35.00s | 6.33kl | 43.04qr | 68.55r | 12.88p | 89.34op | 101.44q | 19.66u |
|  | BEEF | 18.01n | 30.22u | 5.11m | 39.02u | 63.77t | 11.44q | 81.43r | 96.55r | 17.44v |
|  | RVF | 18.17n | 31.78t | 5.33m | 39.36t | 65.44s | 11.77q | 82.26r | 93.77s | 17.66v |
| MLE 5 | JOS | 22.88i | 44.56k | 9.44fgh | 49.78l | 79.55l | 18.66fghi | 104.57k | 115.55l | 28.77klmn |
|  | BEEF | 20.11k | 39.33no | 7.78j | 44.22op | 74.55n | 16.77lm | 93.44n | 110.55m | 26.88qr |
|  | RVF | 20.62k | 40.00n | 8.00j | 45.24no | 75.00n | 17.00kl | 95.51m | 111.00m | 27.00q |
| MLE 10 | JOS | 21.90j | 42.56l | 8.89hi | 46.74m | 76.55m | 17.88ij | 98.82l | 111.55m | 28.00nop |
|  | BEEF | 19.43l m | 38.56op | 6.89kl | 41.93s | 72.66o | 15.88no | 88.84p | 107.66no | 25.88st |
|  | RVF | 19.45l m | 39.00op | 7.00k | 42.09r | 73.11o | 16.11mn | 89.40op | 108.11no | 26.11r |
| NLE 5 | JOS | 20.60k | 41.22m | 8.22ij | 44.09pq | 74.22n | 17.00kl | 91.34o | 108.22n | 27.22pq |
|  | BEEF | 18.96m | 37.11r | 6.22l | 40.93t | 70.33q | 15.22o | 84.86q | 105.00p | 25.22t |
|  | RVF | 18.98m | 38.22pq | 6.44kl | 40.98st | 71.33pq | 15.44no | 84.95q | 105.33p | 25.44st |
| NLE 10 | JOS | 21.58j | 42.44l | 8.89hi | 46.18mn | 76.44m | 17.77jk | 97.02lm | 111.44m | 27.88op |
|  | BEEF | 19.37m | 37.44qr | 6.78kl | 41.76st | 72.66o | 15.77no | 87.51p | 106.33op | 25.77st |
|  | RVF | 19.43l m | 38.67op | 7.00k | 41.82st | 71.44p | 16.00mno | 87.71p | 107.66no | 26.00st |
| MLE 5 + PM | JOS | 27.03e | 54.67e | 12.11c | 55.69i | 93.66f | 21.88c | 127.13f | 133.66e | 32.66e |
|  | BEEF | 25.11g | 51.67fg | 9.89f | 56.22hi | 90.66gh | 18.77fgh | 119.35h | 130.77fg | 29.11ijklm |
|  | RVF | 25.43g | 52.33f | 10.00ef | 57.07gh | 91.66g | 19.22f | 121.13gh | 132.33ef | 30.55fg |
| MLE 10 + PM | JOS | 26.15f | 52.56f | 10.89d | 57.42g | 91.22gh | 20.66d | 121.73g | 130.66fg | 31.22f |
|  | BEEF | 24.26h | 49.89hi | 9.56fgh | 53.60j | 88.77ij | 18.55fghij | 114.15i | 127.88hij | 28.88jklm |
|  | RVF | 24.43h | 50.00h | 9.67fg | 53.71j | 103.44b | 19.11fg | 115.28i | 128.33hi | 29.66hij |
| NLE 5 + PM | JOS | 25.34g | 51.33g | 10.00ef | 60.07f | 88.88i | 19.33ef | 119.93gh | 126.33j | 29.44ijk |
|  | BEEF | 23.34i | 48.67j | 9.00gh | 51.69k | 88.33ij | 18.22hij | 109.37j | 123.88k | 28.33mno |
|  | RVF | 23.36i | 49.00ij | 9.11gh | 51.73k | 85.66k | 18.33ghij | 109.46j | 124.00k | 28.44lmno |
| NLE 10 + PM | JOS | 26.14f | 52.33f | 10.67de | 57.71g | 86.00k | 20.11de | 121.42g | 129.33gh | 30.44fgh |
|  | BEEF | 24.28h | 49.67hi | 9.56fgh | 54.02j | 90.33h | 18.88fgh | 113.97i | 126.77ij | 29.22ijkl |
|  | RVF | 24.37h | 49.78hi | 9.67fg | 54.53j | 87.77j | 19.11fg | 114.53i | 127.00ij | 29.77ghi |
| MLE5 + NLE5 + PM | JOS | 34.75a | 63.89a | 13.78a | 77.51a | 88.00ij | 23.66a | 164.67a | 147.22a | 35.66a |
|  | BEEF | 28.00d | 61.33cd | 12.56bc | 66.42c | 104.88a | 22.55bc | 140.73c | 144.44bcd | 34.22cd |
|  | RVF | 29.00c | 62.22bc | 12.67bc | 66.96c | 102.33cd | 22.55bc | 141.84c | 145.55ab | 34.88abc |
| MLE10 + NLE10 + PM | JOS | 33.75b | 62.89b | 13.11ab | 75.08b | 103.22bc | 23.11ab | 158.68b | 145.00bc | 35.11ab |
|  | BEEF | 27.98d | 60.56d | 12.44bc | 63.39e | 101.11e | 22.44bc | 135.28e | 142.66d | 33.77d |
|  | RVF | 28.52c d | 61.11d | 12.56bc | 64.49d | 101.77de | 22.55bc | 137.60d | 143.33cd | 34.33bcd |
| LSD0.05 |  | 0.602 | 0.99 | 0.69 | 1.10 | 1.07 | 0.82 | 2.05 | 1.83 | 0.84 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litres concentrations), NLE (5 & 10) = Neem leaf extract(5 & 10 litres concentrations), WAP= Weeks after planting, PH = Plant Height, NOL= Number of leaves, NOB = Number of Branches, LSD = Least Significant Difference, VAR = Varieties.

**Yield and Yield Components**

**Number of Flowers Per Plant**:

The effect of variety on number of flowers, fruits and weight of fruits were presented on Table 8. There was significant difference (P = 0.05) among varieties used in number offlowers, fruits and weight of fruits.

Data regarding number of flowers per plant given in Table 8 revealed that varieties had a significant variation (P<0.05) for the number of flowers. The highest average number of flowers, fruits and fruit weight were produced by Jos and the lowest number of flower, fruits and fruit weight were produced by Beef (15.08). In the result presented on Table 9 the effect of PM, MLE and NLE were effective on number of flowers, fruits and fruit weight as the result showed significant difference among the treatments. The highest number of flower, fruits and fruit weight was obtained from the treatment combination of MLE, NLE and PM when compared to the sole applications of this treatments and the control. However, the highest values were obtained from the combination of MLE 10 + NLE 10 + PM with a value of (flower; 21.37) and the least value were obtained from the control (3.48). Treatment applications of sole and combined applications of MLE 10 recorded highest number of flowers, fruits and fruit weight than MLE 5, while NLE 10 recorded the highest number of flowers, fruits and fruit weight than NLE 5 (table 9).

The results in Table 10 showed that the interaction of treatments and varieties had a significant effect on the number of flowers, fruits and fruit weight. This effect indicates that the varieties responded differently to the treatments. Jos varieties significantly produced more flowers, fruits and fruit weight than RVF and Beef across all treatments singly and combined. However, maximum number of flowers, fruits and fruit weight were observed in the treatment combination of MLE 10 + NLE 10 + PM across all three varieties while the control treatment recorded the lowest number of flower, fruits and fresh fruit weight across all three varieties.

**Plants Damaged by Pests and Diseases:**

There was no significant difference among the varieties used in respect to pest and disease leaf infestation. However, the number of plants damaged by pests and diseases (leaf infested) was higher in the control treatment than other treatment applications. Plants damaged by pests and diseases were observed in plants treated with sole application of PM (0.41) and the control (0.67), while treatment applications of MLE and NLE, singly and combined recorded zero number of damages. The interaction effect of treatments and varieties in Table 10 shows that Beef variety under the control treatment recorded the highest number of plants damaged by pest and diseases (0.89) followed by RVF (0.67) with Jos recording the least (0.44).

**Table 8: Effect of Varieties on Yield Parameters and Pest Infestation of Tomato**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Varieties** | **NOFL** | **NOFR** | **FW kg t/ha** | **PAD** |
| **JOS** | 16.60a | 13.19a | 3.36a | 0.07a |
| **RVF** | 15.79b | 12.33b | 3.17b | 0.08a |
| **BEEF** | 15.08c | 11.30c | 3.01c | 0.11a |
| **LSD(0.05)** | 0.27 | 0.26 | 0.07 | 0.09 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), NOFL = Number of Flowers, NOFR = Number of Fruit, FW =, Fruit Weight t/ha, PAD = Pests and Diseases, LSD = Least Significant Difference, RVF = Roman VF.

**Table 9: Effect of Treatments on Yield Parameters and Pest Infestation of Tomato.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| TREATMENT | NOFL | NOFR | FW kg t/ha | PAD |
| CON | 8.70j | 3.48k | 0.66j | 0.67a |
| PM | 10.62i | 5.70j | 1.15i | 0.41b |
| MLE 5 | 13.33g | 9.59g | 2.04g | 0.00c |
| MLE 10 | 14.74f | 11.37f | 2.53f | 0.00c |
| NLE 5 | 10,89i | 7.88i | 1.67h | 0.00c |
| NLE 10 | 12.14h | 8.92h | 1.93g | 0.00c |
| MLE 5 + PM | 10.07d | 14.81d | 3.75d | 0.00c |
| MLE 10 + PM | 20.11c | 16.70c | 4.39c | 0.00c |
| NLE 5 + PM | 16.60e | 13.40e | 3.40e | 0.00c |
| NLE 10 + PM | 17.63d | 14.55d | 3.65d | 0.00c |
| MLE 5 + NLE 5 + PM | 22.66b | 19.51b | 6.10b | 0.00c |
| MLE 10 + NLE 10 + PM | 24.44a | 21.37a | 6.90a | 0.00c |
| LSD(0.05) | 0.54 | 0.53 | 0.13 | 0.19 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litresconcentrations), NLE (5 & 10) = Neem leaf extract (5 & 10 litres concentrations), NOFL = Number of Flowers, NOFR = Number of Fruit, FW = Fruit Weight t/ha, PAD = Pests and Diseases, LSD = Least Significant Difference.

**Table 10: Interaction effect of treatments and varieties on yield parameters and pest infestation of tomato**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TREATMENTS** | **VAR** | **NOFL** | **NOFR** | **FW kg t/ha** | **PAD** |
| CON | JOS | 8.66t | 3.44u | 0.65t | 0.44bc |
|  | BEEF | 8.77t | 3.55u | 0.67t | 0.89a |
|  | RVF | 8.66t | 3.44u | 0.65t | 0.67ab |
| PM | JOS | 11.00rs | 6.00t | 1.20s | 0.44bc |
|  | BEEF | 10.33s | 5.33t | 1.12s | 0.44bc |
|  | RVF | 10.55s | 5.77t | 1.15s | 0.33c |
| MLE 5 | JOS | 14.55lm | 11.55n | 2.42mn | 0.00d |
|  | BEEF | 12.66op | 7.88rs | 1.73qr | 0.00d |
|  | RVF | 12.77nop | 9.33opq | 1.96pq | 0.00d |
| MLE 10 | JOS | 15.88k | 12.88lm | 2.83l | 0.00d |
|  | BEEF | 13.66mn | 9.77op | 2.24no | 0.00d |
|  | RVF | 14.66l | 11.44n | 2.51m | 0.00d |
| NLE 5 | JOS | 11.55qr | 8.44qr | 1.74qr | 0.00d |
|  | BEEF | 10.33s | 7.22s | 1.58r | 0.00d |
|  | RVF | 10.77rs | 8.00rs | 1.68r | 0.00d |
| NLE 10 | JOS | 13.44no | 10.11o | 2.12op | 0.00d |
|  | BEEF | 10.66rs | 7.66rs | 1.68r | 0.00d |
|  | RVF | 12.33pq | 9.00pq | 1.98p | 0.00d |
| MLE 5 + PM | JOS | 18.88gh | 15.77g | 3.94h | 0.00d |
|  | BEEF | 17.44j | 14.00jk | 3.64ij | 0.00d |
|  | RVF | 17.77ij | 14.66hij | 3.66ij | 0.00d |
| MLE 10 + PM | JOS | 20.66e | 17.55ef | 4.56f | 0.00d |
|  | BEEF | 19.44fg | 15.55gh | 4.20g | 0.00d |
|  | RVF | 20.22ef | 17.00f | 4.42fg | 0.00d |
| NLE 5 + PM | JOS | 17.00j | 14.00jk | 3.50j | 0.00d |
|  | BEEF | 15.88k | 12.55m | 3.26k | 0.00d |
|  | RVF | 16.88j | 13.66kl | 3.44jk | 0.00d |
| NLE 10 + PM | JOS | 18.44hi | 15.44ghi | 3.80hi | 0.00d |
|  | BEEF | 16.88j | 13.66kl | 3.52j | 0.00d |
|  | RVF | 17.55ij | 14.55ijk | 3.63ij | 0.00d |
| MLE5 + NLE5 + PM | JOS | 23.55c | 20.55c | 6.33d | 0.00d |
|  | BEEF | 21.66d | 18.44e | 5.90e | 0.00d |
|  | RVF | 22.77c | 19.55d | 6.06e | 0.00d |
| MLE10 + NLE10 + PM | JOS | 25.55a | 22.55a | 7.21a | 0.00d |
|  | BEEF | 23.22c | 20.00cd | 6.60c | 0.00d |
|  | RVF | 24.55b | 21.55b | 6.90b | 0.00d |
| LSD0.05 |  | 0.93 | 0.91 | 0.23 | 0.33 |

Note: Means that do not share same letter on the same column are significantly different at fishers least significant difference (0.05), CON= Control, PM=Poultry manure, MLE (5 & 10) = Moringa leaf extract (5 & 10 litres concentrations), NLE (5 & 10) = Neem leaf extract(5 & 10 litres concentrations), NOFL = Number of Flowers, NOFR = Number of Fruit, FW =, Fruit Weight t/ha, PAD = Pests and Diseases, LSD = Least Significant Difference, VAR = Varieties.

**DISCUSSION**

The role of exogenous application of Moringa and Neem leaf extracts in combination with poultry manure in improving tomato physiological performance was examined in this experiment.The physical properties of the soil before cultivation showed that the soil was sandy loam (Table 1). Tomato grows well on most mineral soils that have proper water holding capacity and aeration, and is free of salt but prefers deep, well drained, sandy loam soils (Shankara *et al*., 2005). The pH value of the soil (pH=5.67) was within the pH range of 5.5-6.8 considered as suitable for optimum performance of tomato and other vegetables (Shankara *et al*., 2005).

The results of the study showed that all growth and yield parameters of the treated tomato varieties were enhanced following the application of PM, MLE and NLE. From previous studies, MLE, NLE, and PM are high in nutrients and can be utilized as both soil and foliar treatment (Mark, 2010; Fahey, 2005; Annette, 2012). All the growth and yield parameters were found to be increased as the week after planting increased. The differences in growth and yield parameters may have resulted probably as a result of differences in plant nutrients in the rates or level of concentration of the treatments applied.

The results in Table 2 to 9, showed that the application of PM increased all vegetative growth characters (plant height, number of branches per plant and leaves per plant) at 6, 8 and 10 weeks after planting (WAP), and yield characters (percentage emergence, 50% flowering, number of days to flowering and fruiting, total number of flowers, fruits, and average fresh fruit weight) per plant. The result is in line with those obtained on tomato by Alaa El-Din (2000), Agyeman *et al.* (2014); on Squash by Shehata, (2001) and Shehata, (2004). The advantages or the significant effect of poultry manure observed in this study is also similar to those reported by other researchers (Mehdizadeh *et al.*, 2013; Oyewole *et al*., 2012; Adekiya and Agbede, 2009; Olaniyi and Ajibola, 2008). This significant effect of poultry manure on growth and yield of tomato in this study may possibly be explained by the fact that the poultry manure improved the soil physical, chemical, and biological properties and provided the macro and micro-nutrient requirements of the plants (Abou *et al*., 2005), thereby increasing yield.The decomposition of the PM in the soil added more available nutrients and liberated the fixed nutrients as a result of the produced organic acids. The superior effect of PM over the untreated (control) plants can be attributed to its richness in nutrients.

In addition, of N, other macronutrients such as S, P and K as well as micronutrients which are found in poultry manure are more readily available for plant growth. Also, organic manure improving soil properties, thus offering suitable nutrients for vigorous vegetative growth, which reflected in the fresh weight per plant.

Application of NLE significantly increased the vegetative growth and yield character of tomato varieties. Maximum vegetative growth and yield related parameters per plant were higher in NLE 10 over NLE 5 at 6, 8 and 10 WAP across all varieties (Tables 2-10). From the observation in tables 8-10, the treatment with Neem aqueous extract at 5 and 10 litres concentration both single and in combination with MLE and PM produced higher yield over the control. The results also agree with the findings of Subbalakshmi *et al.* (2012) that Neem application on crops helps to increase the yield.

The performance of Neem leaf extract concentrations to improve tomato growth and yield characteristics in this study could be attributed to the high levels of N, P, K, Ca, and Mg delivered to the plants, as well as the availability of potential growth hormones in suitable amounts (Kasarkar and Barge, 2016), and this is reflected in the significant increase of the growth and yield over the control. The significant increase in the growth and yield parameters confirms the ability of plant residues to compete favorably with inorganic fertilizers as sources of nutrients (Olujobi and Ayodele, 2013). In comparison to the control, all growth indices increased, indicating that compounds having some qualities of hormone can stimulate or change biomass allocation in plants (Andresen and Cedergreen, 2010). Similarly, the effect of foliar spray of neem leaf extract also fell in line with that of Mishra and Mishra (2002). who reported that treatment containing Azadirachtin significantly reduced the attack of okra pests and increased yield. The results showed that use of neem products as bio-pesticides is highly effective against insects.

The application of MLE alone and in combination with PM and NLE had profound and significant effect on the performance of tomato plants. Maximum vegetative growth (plant height, number of leaves and number of branches) were recorded under foliar applications of MLE 5. Conversely, the yield related parameters (number of days to 50% flowering, number of days to fruiting, number of flowers, number of fruits and average fresh fruit weight) per plant where higher by foliar application of MLE10.This could be due to the greater nutritional needs of the reproductive phase, which are met by using macro and micronutrients contained in MLE (Azra, 2011). Plant response to MLE, could be said to be dependent on both plant growth stages and MLE levels (as higher response was seen during vegetative growth on plants treated with MLE 5 while higher response was seen on the reproductive stages on plants treated with MLE 10). This response is in line with those observed by Azra (2011), that MLE 30 (30 times diluted MLE) was more effective in tomato yield than MLE 20 and MLE 10 spray. Aluko (2016) also observed an increase in the concentrations of Moringa leaf extract as foliar spray improved pepper fruit yield. Aluko *et al*. (2017) also reported an increase in growth and yield of Okra at different rates of application which is in line with the results obtained in this study. The increase in vegetative growth and yield parameters by sole applications of MLE also agrees with report of Azra (2011) that foliar applications of MLE increased growth and yield of tomato, pea and wheat. Kowthar *et al.* (2017) and Yusuff *et al.* (2019) also reported that foliar application of Moringa extract had significant effect on number of days to flowering in Okra and *Narcissus tazetta.* Moringa leaf extracts have been observed to accelerate tomato, peanut, corn, and wheat growth at the early stages of vegetative growth, improve pests and disease resistance, and produce more and larger fruits, increasing output by 20 to 35 percent (Fuglie, 2000). The significant effects of MLE shows that the presence of Zeatin in Moringa leaf improves vegetative growth and yield in crops as observed by Fuglie (2008), El- Award (2003) and Nagar *et al.* (2006), which shows that substances with hormone like properties can stimulate the effect of biomass allocation in plants.

The responses of tomato varieties to treatment combinations of MLE and NLE as foliar spray plus PM at 20t/ha were reflected in the growth parameters and fruit yield of tomato presented in tables 2-10. The use of organic and inorganic fertilizer mixture to improve crop production as observed by Akande *et al.* (2010) and Olujobi and Ayodele (2013) is similar to the response of MLE + PM, NLE + PM, and MLE + NLE + PM which would ensure steady release of nutrients. The integrated application of MLE, NLE and PM gave higher yield compared to the application of these sources alone. Havlin *et al.* (2004) had advocated the integrated approach to nutrient management in crop production for better performance.

The poor growth and yield performance of tomato in the control treatment was consistent with the fact that the soil was very low in nutrient contents. This observation was supported by Arapitsas (2008) who had reported poor growth and yield responses of crops in an unfertilized soil.

In the present study, Jos variety performed competitively better and responded better to the treatments applied more than the Roma VF and Beef varieties in all of the parameters measured. Jos variety treated with single or combinations of MLE, NLE and PM recorded the highest values in both vegetative and reproductive stages throughout the sampling period, followed closely was RVF while Beef recorded the lowest values. The difference in growth and yield between the three varieties could be due to their distinct growth habits (Agyeman *et al.,* 2014), genetic makeup of the individual variety and adaptability to the soil as well as the nutrient contents of the plant extracts under study. The choice of varieties and the application rates of either organic or inorganic fertilizers can help improve tomato yields.

Plants damaged by pests and diseases (leaf infested) were only observed on the control treatment and the sole application of PM. The non-infestations of pests on plants treated by MLE and NLE could be attributed to reports that Moringa and Neem extracts possess pesticidal and insecticidal properties (Habib *et al*., 2015; Mishra and Mishra, 2002). The use of Neem and Moringa leaf extracts in this study may have given the crop some immunity, reducing yield loss and, as a result, supporting the crop's increased productivity and yield.

**Conclusion**

Crop productivity is affected by many factors and these factors limit plant growth and development. Foliar application of antioxidants, PGRs, herbs, botanicals, and certain nutrient sources to plants improves biotic and abiotic stress tolerance, resulting in a higher economic return.

The application of MLE and NLE gave significant effect on growth and yield of tomato. The pronounced effects of MLE and NLE observed in yield performance of tomato in this study was found to be concentration dependent because 10 litres diluted MLE and NLE proved more effective as compared to 5 litres concentration.

The results from the analysis showed that the application of MLE, NLE and PM singly and all possible combinations had significant effect on the performance of the three tomato varieties. MLE, NLE, and PM performed better than the control at all growth stages. MLE 10 + NLE 10 priming outperformed all other priming treatments employed in the study, resulting in more fruits as well as maximum yields per plant.

The integrated application of MLE + NLE + PM gave the best performance, but the combination of MLE10 + NLE10 + PM was found to be more superior to other combinations and single treatments.

In all of the parameters assessed in this experiment, the Jos variety performed competitively better and responded better to the treatments applied than the RVF and Beef varieties, based on the results recorded.The genetic makeup of the individual varieties, as well as their adaptation to the environment, soil and the nutrient contents of the plant extracts under study could be the reason for the differences observed among the varieties.

In conclusion, foliar application of MLE and NLE singly or in combination with PM was found to be effective in improving growth and yield of tomato. 10 litres concentration of MLE and NLE was found to be optimum dose in yield of tomato in the pot experiment. Also, plant extract formulations such as those tested in this experiment can be a useful tool for sustainable crop production, either for stand-alone treatments or in combination with other nutrient sources in conventional agricultural systems.

**References**

Abou El-Magd, M. M., Hoda, A. M., & Fawzy, Z. F. (2005). Relationship growth, yield of Broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers (Brassica oleracea var. italicaplenck). *Annuals of Agricultural Science, 43*(2), 791-805.

Adekiya, A. O &Agbede, T. M. (2009). Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer. *Emirates Journal of Food and Agriculture, 21*(1), 10-20.

Aduloju, M. O., Adelana, F. Y, & Shuaib, O. M. (2013). Studies of the potentials of neem and albizia pruning as soil amendment. *Global Journal of Bio-science and Biotechnology, 2*(40), 467 470.

Afolabi, C. A., & Ayinde, I. A, (2001). ‘Economics of Tomato Production in Yewa North L.G.A of Ogun State, Nigeria’ in Agro-Science Journal of Tropical Agriculture, Food, Environment and Extension 2(1), 17-23

Agyeman, K., Osei-Bonsu, 1., Berchie1, J. N., Osei1, M. K., Mochiah, M. B., Lamptey, J. N., Kingsley, O, &Bolfrey-Arku, G, (2014). Effect of Poultry Manure and different combinations of Inorganic Fertilizers on Growth and Yield of Four Tomato Varieties in Ghana. Science and Education Centre of North America ISSN 2291-4471 E-ISSN 2291-448X

Akande, M. O., Oluwatoyinbo, F. I., Makinde, E. A., Adejoju, A. S. & Adepoju, I. S. (2010). Response of okra to organic and inorganic fertilization. *Nature of Science*, 8: 261 - 266.

Alaa El-din A. S. (2000). Influence of mulching and organic manures on growth and yield of tomato and cucumber. M. Sc. Thesis Faculty of Agric., Minia University, Egypt.

Ali, M. B., Lakun, H. I., Sani, S. M., & Adamu, H. M. (2014). Effect of organic manure and sowingdate on the growth and yield of okra(Abelmoschus esculentus Moench) in SamaruZaria,Nigeria. *International Journal of Agronomy and Agricultural Research (IJAAR)*, *5*(5), 111-117.

Aluko, M. (2016). Moringa leaf extract on the growth and yield of pepper (*Capsicum annuum*). APRN Journal of Agricultural and Biological Science. 11 (3): 106-109.

Andresen, M & Cedergreen, N, (2010). Plant growth is stimulated by tea-seed extract; Anew natural growth regulator. Horticultural Science, 45; 1848-1853.

Annette F. (2012). Moringa: Tree helps in Niger’s food crisis. Australia: The World Today/ABC News. Retrieved 13 August 2013.

Ashraf, I., Ahmad, I., Nafees, M., Yousaf, M. M., & Ahmad, B. (2016). A review on organic farming for sustainable agricultural production. Pure and Applied Biology, 277-286.

Ayolagha, G. A. &Onueghu, B. A. (2002). Soils of Rivers State and their uses in Land and People of Rivers State

Azra, Y (2011). Exploring the Potential of Moringa (*Moringa oleifera*) Leaf Extract as a Natural Plant Growth Enhancer. Ph.D. Thesis, University of Agriculture, Faisalabad, Pakistan.

Deepti, P., Swati, N., Poonam, K., Yogesh, K. N & Chauhan, J. S. (2016). Effect of Seed Priming with some Plant Leaf Extract on Seedling Growth Characteristics and Root Rot Disease in Tomato. International Journal of Agriculture System (IJAS).

El- Award A, (2003). Moringa Tree: Nature’s Pharmacy.

Elnasikh, M. H., Osman, A. G, & Sherif, A. M. (2011). Impact of neem seed cake on soil microflora and some soil properties. *Journal of Science and technology, 12*(1), 144-150.

FAOSTAT, (2017), “Production – Crops – Area harvested/ Production quantity – Tomatoes –2014”, *FAO Statistics online database*, Food and Agriculture Organization, Rome, [www.fao.org/faostat/en](http://www.fao.org/faostat/en)

Frusciante, L., Barone A., Carputo D., Ercolano M. R., della Rocca F & Esposito S, (2000), Evaluation and use of plant biodiversity for food and pharmaceuticals Evaluation and use of plant biodiversity for food and pharmaceuticals. Fitoterapia, 7: S66-S72

Fugile L. J (2000). New uses of Moringa studied in Nicaragua: ECHO’s Technical Network Site-networking global hunger solutions. ECHO, Nicaragua.

Fuglie L. J (2008). New Uses of Moringa Studied in Nicaragua: ECHO's Technical Network Site networking global hunger solutions. ECHO, Nicaragua: 1-7.

Hanson, P., Chen, J. T., Kuo, C.G., Morris, R, & Opena, R.T. (2001). Tomato production. Suggested cultural practices for tomato.

Havlin, J. L., Beaton, J. D., Tisdale, S. L. & Nelson, W. L. (2004). Soil fertility and fertilizer: an introduction to nutrient management. Pearson Education. India, 2004: 106-153.

Hossain M. B., Poehling H. M., Thoming G., &Borgemeister B. E (2008). Effects of soil application of neem (Neem Azaal ® - U) on different life stages of *Liriomyzasativae* (Dipteraagromyzidae) on tomato in the humid tropics. Journal of Plant Diseases and Protection.115(2):80–87.

IFPRI/PBS, (2007). Accessing the potential economic impact of genetically modified crops in Ghana([http://www.ifpri.org/publication/assessing-potentialeconomic- impact-genetically-modified-crops-ghana3](http://www.ifpri.org/publication/assessing-potentialeconomic-%20impact-genetically-modified-crops-ghana3))

Jonathan, W. C., Wong, D. J., Lee & Jaya Nair. (2012). An evaluation of aerobic and anaerobic composing of banana peels treated with different inoculums for soil nutrient replenishment. In Advances in Biological Waste Treatment and Bioconversion Technologies. Eds: Jonathan, W. C., Wong, D. J., Lee and Jaya Nair. Bioresource Technology. 126: 375-382

Khan, W., Rayirath, U. P & Subramanian, S*.* (2009). Seaweed extracts as biostimulants of plant growth and development. Journal of Plant Growth Regulation. 28 (4): 386-399.

Kowthar, G. E., Rawia, A. E., Abeer, N. S & Samia, A. S. E. (2017). Evaluation of using *Moringa oleifera* on controlling weeds. Effect of leaf and seed water extracts of *Moringa oleifera* on broad and grassy weed associated *Narcissus tazetta*L. Agricultural Engineering International: CIGR Journal, Special issue: 45–52.

Makkar, H. P. S & Becker, K, (1996). Nutritional value and anti-nutritional components of whole and ethanol extracted of *Moringa oleifera* leaves. *Anim*al *Feed Sci*ence and *Technology*., 63, 211–228. TOO OLD

Makkar, H. P.S., Francis G & Becker K, (2007). Bioactivity of phyto chemicals in some lesser-known plants and their effects and potential applications in livestock and aquaculture production systems. Animal 1: 1371-1391.

Mark, O. (2010). MoringaceaeMartinov. Drumstick Tree Family.Flora of North America, 1993. Flora of North America, North of Mexico 7: 167 – 169.

Matthew, A., Olufemi, J. A., Ayo, S. G & Ifedayo, H. O, (2017). Comparative effects of Varying Rates of Moringa Leaf, Poultry Manure and NPK Fertilizer on the Growth, Yield and Quality of Okra (*Abelmoschus esculentus* L. Moench) *International Journal of Environment, Agriculture and Biotechnology (IJEAB), ISSN: 2456-1878.*

Mehdizadeh, M., Darbandi, E. I., Naseri-Rad, H., &Tobeh, A. (2013). Growth and yield of tomato (*Lycopersicon esculentum* Mill.) as influenced by different organic fertilizers. *International Journal of Agronomy and Plant Production, 4*(4), 734-738.

Nagar P. K, Lyer R. I & Sircar P. K (2006). Cytokinins in developing fruits of Moringa pterigospermaGaetn. Physical plant, 55: 45–50.

Nouman, W., Siddiqui, M.T., Basra, S.M.A., Farooq, H., Zubair, M & Gull, T, (2013).Biomass production and nutritional quality of *Moringaoleifera* as field crop. *Turk*. *J*. *Agric*. For, 37, 410–419.

Olaniyi, J. O & Ajibola, A. T. (2008). Effects of inorganic and organic fertilizers application on the growth, fruit yield and quality of tomato (*Lycopersiconlycopersicum*).*Journal of Applied Bio sciences, 8*(1), 236-242.

Olujobi, O. J. & Ayodele, O.J. (2013). Growth and yield of okra (*Abelmoschus esculentus*) in response to tree lrgume manure and urea fertilizer. IJAFS 4(12): 502-509

Oyewole, C. I., Opaluwa, H, &Omale, R. (2012). Response of tomato (*Lycopersicon esculentum*): Growth and yield, to rates of mineral and poultry manure application in the Guinea Savanna agro-ecological zone in Nigeria. *Journal of Biology, Agriculture and Healthcare, 2*(2), 44-56.

Raphael, E. (2012). Phytochemical constitu­ents of some leaves extract of Aloe vera and *Azadirachtaindica*plant species. Global Advanced Research Journal of Environmental Science and Toxicology, 1: 014-017.

Ruso A., Carrozza G. P., Vettori L., Felici C., Cinelli F &Toffanin A (2012). Plant beneficial microbes and their application in plant biotechnology innovation in biotechnology, Dr. Eddy C. Agbo (ed), ISBN: 9789565100966. International Technology Paper.57–72.

Sale, F. A., Fadipe, T. F. & Adah, H. (2015). Effect of neem extract preparations and nutrient sources on performance of okra (*Abelmoschus esculentus*) plant. Nigerian Journal of Agriculture, Food and Environment. 11(2):221-225

Shankara, N., Joep van Lidt, J., Marja, G., Martin, H. & Barbara, D. (2005). Cultivation of Tomato: Production, Processing and Marketing. Digigrafi, Netherlands.

Shehata, M. N. (2004). The effect of chemical, organic and Bio-fertilizers on growth and yield of squash (*Cucurbita pepo*L.). M. Sc. Thesis Faculty of Agric., Minia University, Egypt.

Shehata, S.M. (2001). Effect of some organic wastes application on growth, chemical contents and yield of squash plant. J. Agric. Sci. Mansoura Univ., 26 (9): 5695 - 5704.

Siddhuraju, P & Becker, K, (2003). Antioxidant properties of various solvent extracts of total phenolic constituents from three different agro-climatic origins of drumstick tree *(Moringa oleifera* Lam.). *Journal of Agriculture and Food Chemistry*., 15, 2144–2155.

Solomon, M. G., Okon, P. A., &Umoetok, S. B. A. (2008). Effects of neem extracts on soil properties, microbial populations and leaf area of fluted pumpkin (*Telfairiaoccidentalis*). *Research Journal of Agronomy, 2*(1), 12-17.

Subbalakshmi L, Muthukrishnan P, & Jeyaraman S, (2012). Neem products and their agricultural applications. Journal of Biopesticides; 5:72-76.

Tiamiyu, R. A., Ahmed, H. G., &Muhammad, A. S. (2012). Effect of sources of organic manure on growth and yields of okra (Abelmoschus esculentus L.) in Sokoto, Nigeria. *Nigerian Journal of Basic and Applied Sciences*, *20*(3), 213-216

Tijani, A. A., Ayanwale, A. O. S &Baruwa, O. I, (2001). Profitability and constrains of tomato production under tropical conditions. International Journal of vegetable science Vol. 16, page 128-134.

Udo, E. J, Ibia, T. O, Ogunwale, J. A, Ano, A. O. R. S &Esu, I. E (2009). Manual of soil, plant and water Analysis.

Umeh, V. C, kuku, F. O. Nwanguma, E. I, Adebayo, O. S & Manga (2002). A survey of the insect pests and Farmers practices in the cropping of tomato in Nigeria. Tropicultural Paper 181-188.

USDA, (2017). *Economic Research Service*, United States Department of Agriculture. U.S. Per Capita Loss-Adjusted Vegetable Availability Data.

Van d. B., Faulks H, R., Fernando H. G., Hirschberg J., Olmedilla B., Sandmann G., Southon S, and Stahl, W, (2000). The potential for the improvement of carotenoid levels in foods and the likely systemic effects. Journal of the Science of Food and Agriculture: Vol. 80, (7): 880–912.