POTENTIALS OF *Moringa oleifera* LEAF EXTRACT IN INCREASING MAIZE (*Zea mays* L.) PRODUCTIVITY IN NIGERIA

Williams, O.A., Ogunwande, O.A and Amao, A.O

Department of Sustainable Forest Management, Forestry Research
Institute of Nigeria, Jericho, Ibadan
Corresponding Author: Email: funmyrest@yahoo.com, funmiakaluhme@gmail.com

DOI: 10.29322/IJSRP.8.12.2018.p8438
http://dx.doi.org/10.29322/IJSRP.8.12.2018.p8438

Abstract

In averting the menace of the adverse effects caused by the application of inorganic fertilizer to agricultural crops, there is the need to adopt the use of organic yield enhancers. One of such is the use of *Moringa oleifera* leaves, known to be in abundant supply especially in the South west, Nigeria. This study was conducted in the screen house of the Department of Sustainable Forest Management (SFM), Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, located on the latitude $07^0$23'N and longitude $03^0$51'E. The objective was to evaluate the potential of Moringa leaf extract (MLE) and frequency of application on increased maize productivity. The five treatments included application of 25 ml aqueous MLE once (3 WAP), twice (3 and 6 WAP), thrice (3, 6, and 9 WAP), four times (3, 6, 9 and 12 WAP) and the control (no Moringa leaf extract) on maize plants at interval of 3 weeks and the experiment was monitored for 15 weeks. Significant differences at five percent level of probability were observed for the growth parameters and the yield components viz: vigour score, height, stem diameter, number of leaves, root length, shoot dry matter production, number and weight of cobs. The application of Moringa leaf extract (MLE) twice, thrice and/ or four times enhanced the growth and productivity of maize hence, farmer can adopt this method as a substitute for mineral fertilizer (NPK) in increasing maize productivity.

Keywords: Moringa leaf extract, Maize, inorganic fertilizer, growth and yield parameters

1.1 Introduction

Moringa is the sole genus in the flowering plant family Moringaceae made up of 13 species but the commonest one is *Moringa oleifera*. It is a tropical multipurpose tree and one of the world’s most used plants. It is a fast growing tree for human consumption, livestock forage, medicine, dye and water purification. It is grown traditionally as backyard trees or hedges. Its importance as medicine and nutritional values have been widely highlighted and documented. However, there are limited reports on the frequency of application of the Moringa leaf extract and its impact on maize productivity in Nigeria. Trials carried out by Foidl *et al*. (2001) and Fuglie (2008) have shown that Moringa is suitable for intense production of many crops due to its growth hormone activity. As a leguminous plant, Moringa fixes atmospheric nitrogen thus reducing the need for fertilizer application and as green manure can also help improve soil fertility. It can be grown as intercrop in association with other annual crops and the leaf extract can be used as foliar spray to increase plant growth. Moringa contains zeatin, a plant hormone derived from the purine adenine. It is a member of the plant growth hormone family known as cytokinins. These plant hormones help cell division, differentiation, growth, protect against oxidation and help in nutrient assimilation (Hwang *et al.*, 2012). Maize (*Zea mays* L.) is a very important staple food of great socio-economic importance in the sub-Saharan African of which Nigeria is inclusive with per capita kg year of 40 (IITA, 2007). Nigeria is currently the tenth largest producer of maize in the world and the largest maize producer in Africa (IITA, 2012; 2018). Fajemisin (1985), stated that maize has established itself as a very significant component of the farming system, in that it determines the cropping pattern of the predominantly peasant farmers. The fact that maize can produce higher yield within its short maturity period coupled with its ability to respond to good cultural practices, particularly fertilizer, has therefore made it to perform better than other cereals like sorghum and millet. It is a multipurpose crop that provides food for human, feeds for animals especially poultry and livestock and raw materials for industries. The use of maize has shifted primarily from domestic crop to industrial crop (Khaliq *et al*., 2004; Iken and Amusa, 2014).

In spite of the great potentials of maize both as industrial and domestic crop several problems have constrained its maximum production. The major constraint to increased maize production is low soil nitrogen and the non-availability of mineral fertilizer at the right time of farming to augment the soil nutrient deficiency and even when available most peasant farmers cannot afford it (Abera *et al*. 2005, Farhad *et al*., 2009). Furthermore, concerns over the negative environmental impacts of mineral fertilizers have increased the need to develop alternative strategies that will help alleviate or minimize the use of such inorganic fertilizers. It is therefore imperative that alternatives sustainable climate-smart Agroforestry practices should be developed to improve and enhance maize productivity.

2.1 Materials and methods

2.1.1 Study area

The study was carried out in the screen house of the Department of Sustainable Forest Management (SFM), Forestry Research Institute of Nigeria (FRIN), Jericho, Ibadan, Nigeria. FRIN is located on the latitude $07^0$23'N and longitude $03^0$51'E with the main total rainfall of 1548.9 mm, falling in approximately 90 days. The mean maximum temperature was 31.9^0C, minimum 24.2^0C and the relative humidity was 71.9% (FRIN, 2014).

2.1.2 Experimental Procedure

The experiment consisted of five treatments viz: Spraying of maize seedlings with Moringa leaf extract at only 3 Weeks after planting (WAP); 3 and 6 WAP; 3,6 and 9 WAP and 3,6,9 and 12 WAP and the control(No spraying with leaf extract) laid out in a Complete Randomized Design replicated five times. The maize variety PVA SYN3 F2 was sourced from the International Institute of Tropical Agriculture (IITA), Ibadan. Two seeds were planted in each polythene pots containing 4 kg of soil top soil. Leaves of 40 day old Moringa were collected and grounded in water at ratio 1kg of Moringa leaves to 1 liter of water. The extract was squeezed out of the paste using microfilament cloth. This was further diluted in the ratio 1 to 10. 25 ml of the extract was sprayed on each of the maize plants at 3 WAP, 3 and 6 WAP, 3,6 and 9 WAP and 3, 6, 9 and 12 WAP according to specifications. All these were replicated 5 times arranged in a Complete Randomized Design (CRD) lay out. Watering was done when necessary. Data were collected at 3 weeks interval on the vigour score, height, stem diameter, number of leaves, dry matter production, number and weight of cobs of the maize plants till 15 WAP.

2.1.3 Leaf extract analysis

Analysis of the Moringa leaf extract was carried out using the procedures described by Ryan *et al.*, (2001) using flame photometer

2.1.4 Data analysis

The data collected on the growth and yield parameters of the maize plants were then subjected to one-way Analysis of Variance (ANOVA) to compare the effect of the different treatments on the growth and yield of the maize plants. Means found to differ significantly were separated using Duncan Multiple Range Test (DMRT) procedure. Results were summarized in tables.

3.0 Results and Discussion

3.1 Composition of Aqueous Moringa Leaf Extract (MLE)

The composition of the aqueous MLE analysis indicated it as an organic productive nutrient carrier for both growth and yield productivity (Table 1)

Table 1: Nutrient composition of the aqueous MLE

Nutrient	Percentage (%)
Nitrogen	4.10

Phosphorus	1.20
Potassium	1.83
Calcium	14.1
Magnesium	0.11
Sodium	1.22
Organic carbon	12.2
C:N	2:8

3.2 Influence of Application Frequencies of MLE on Growth Parameters

3.2.1 Influence of frequencies of MLE on crop vigour score (CVS) of maize

There were no significant differences in the growth parameters of the maize plants at 3 WAP, this indicates that there was still enough food reserves in the endosperm of the maize planted coupled with the effects of 30kg/ ha NPK applied at 2 WAP to all the maize plants. Fiodl, (2001) suggested that for effective use of MLE, the necessary agronomic requirements must be provided for the specific crops. The nutrients at this stage were still sufficient and available to meet the growth requirements of the seedlings (Oaks, 1997; Bettey *et al*.,2000). (Table 2)

At 6 WAP and throughout the life cycle of the maize plants, differences among the vigour of maize plants treated with MLE at various frequencies were highly significant (≤0.05) compared to the control with no leaf extract (Table 2). At the early stage about 4 WAP of maize growth, the endosperm reserves becomes exhausted and the differences in their canopy size, colour and general appearance are as a result of the differences in their abilities to produce assimilates (Revilla *et al.*, 1999), hence the need for additional nutrients for optimum maize productivity. At 6, 12, and 15WAP, maize plants treated with MLE twice, thrice and fourthly had significantly higher CVS than those treated once and the ones in the control(no MLE application) However, the CVS of maize plants in which MLE was applied once were significantly higher than those of control.

Table 2: Influence of frequencies of MLE on crop vigour score (CVS) of maize

	CVS			
Frequency	6	9	12	15
Once	6.6[b]	7.2[a]	6.2[b]	6.4[b]
Twice	7.6[a]	7.4[a]	8.0[a]	7.6[a]
Thrice	7.8[a]	8.0[a]	8.0[a]	7.6[a]
Four times	7.4[a]	7.6[a]	7.8[a]	7.2[a]

Control	5.4[c]	5.6[b]	4.6[c]	4.4[c]

3.2.2 Influence of frequencies of MLE application on the height of maize plants

The height of the maize plants in which MLE was applied once, twice, thrice and fourthly were significantly different from those of the control (Table 3). At 12 and 15 WAP**,** the heights of the maize plants treated with MLE once and control were highly suppressed compared to those treated with MLE twice, thrice and four times. Maize plants treated with MLE twice, thrice and four times had significantly taller plants than those treated once with MLE and control. This result corroborates with the findings of Mvumi, *et al*. (2013) and Abdalla (2015) that there was improved growth of maize with the increasing frequencies of MLE and this was suggested to be due to the presence of the abundant zeatin in the MLE. However, the application time plays a very significant role as the maize reaches the reproductive stage of tasseling, silking and kernel formation and grain filling (6 to 12WAP) to maturity. At 12 WAP, the mean values were 166.34, 163.0, 162.48, 146.5, 122.48 and at 15 WAP: 166.80, 165.68, 164.08, 148.60 and 122.0 for four times, thrice, twice, once and control respectively. At 9 WAP, all treated maize plants had taller plants than the control. Abdel (2016) also reported that Moringa extract significantly increased the plant height, number of leaves per plant, neck diameter and yield parameters of garlic.

3.2.3 Influence of frequencies of MLE application on the Leaf number

Significant differences were also observed in the number of maize leaves treated with MLE compared with the control especially at 12 and 15 WAP (Table 3). The mean values were 12.4, 11.6, 11.6, 10.8 and 7.2 at 12 WAP; 11.8, 11.6, 10.0 and 7.0 at 15 WAP for four times, thrice, twice, once and control respectively. Higher number of leaves on the maize plants treated with MLE twice, thrice and four times may be as a result of the presence of growth hormones in the MLE that helps in the metabolic processes. This report corroborates those of Gingula *et al. (2005)* that increased leaf area and photosynthetic capacity was associated with increase nitrogen on the cells and tissue growth. Adequate growth factors supply can help delay leaf senescence in maize thereby maintaining the leaf green pigment and functionality for a longer period. Cytokinins are vital hormones found in MLE and have been reported to cause increased cell division by stimulating the process of mitosis. Increased mitosis results in plant growth and the formation of shoots and buds as well as development of fruits and seeds (Schmulling, 2002). Werner *et al.(* 2001) also reported that cytokinin deficient plants developed stunted shoots with smaller apical meristem. The leaf cell production was only 3 to 4 % of the wild type

ISSN 2250-3153

indicating an absolute requirement of cytokinin for leaf growth. Berchtold *et al*. (1993) observed higher senescence in plots of maize low in nutrients rate. Leaf senescence greatly affects photosynthetic capacity, dry natter production and allocation in plants (Gingula *et al*.2005). The reduction in the leaf number observed at 6 and 9 WAP on maize plants sprayed once and the control however, suggested that the maize plants might have been under inadequate nutrient supply and therefore failed to support their own energy requirements because of reduction in net photosynthesis due to senescence.) The presence of the growth hormones in the treated plants may therefore be responsible for the higher number of leaves as cytokinins delay senescence (Sanjay *et al*., 2013; Abosede and Ayodeji, 2018).

3.2.4 Influence of frequencies of MLE application on the stem diameter

Significant differences were observed on the stem diameter of maize plants treated with the MLE at the various frequencies (Table 3). At 9 WAP, maize plants treated with MLE twice had significantly thicker stem diameter than those treated thrice, four times, once and the control. The mean values of the stem diameter follow the order 9.51>9.02>8.94>8.0>6.75 respectively. At 12 and 15 WAP however, all maize plants treated with MLE four times, thrice and twice had significantly thicker stem than those treated once and the control. The mean values order were 10.80>10.33>10.31>8.32 for 12 WAP and 11.34>10.91>10.34>8.72>7.09 at 15 WAP respectively. This could be due to the presence of the zeatin. Photosynthetic rate, leaf surface area, size of the sink will all increase with increased growth nutrients consequently resulting in higher vigour, height, number of leaves and stem diameter. A similar report was observed with the work done by Maishanu *et al*., 2017 where they reported that MLE treated *Vigna unguiculata* had thicker stem than those treated with urea and the control(untreated). This further corroborates the report of Fuglie *et al*., 2001 that the zeatin in MLE can boost crop productivity in the range of 10-45%.

Table 3: **Influence of frequencies of MLE application on the growth parameters assessed on maize plants**

	Height				No of leaves				Stem diameter			
Frequency	6	9	12	15	6	9	12	15	6	9	12	15
Once	108.08^{b}	137.12^{a}	146.5^{b}	148.6^{b}	8.6^{b}	10.8^{b}	10.8^{a}	10.0^{a}	8.23^{ns}	8.0^{c}	8.32^{b}	8.72^{b}
Twice	109.34^{b}	143.22^{a}	162.48^{a}	164.08^{a}	9.2^{ab}	11.8^{a}	11.6^{a}	11.6^{a}	8.11^{ns}	9.51^{a}	10.31^{a}	10.34^{a}
Thrice	109.12^{b}	142.02^{a}	163.0^{a}	165.68^{a}	9.2^{ab}	10.8^{a}	11.6^{a}	11.6^{a}	7.37^{ns}	9.02^{b}	10.33^{a}	10.91^{a}

Four times	127.48^{a}	136.12^{a}	166.34^{a}	166.8^{a}	9.6^{a}	10.2^{c}	12.4^{a}	11.8^{a}	7.94^{ns}	8.94^{b}	10.80^{a}	11.34^{a}
Control	96.58^{b}	112.72^{b}	122.48^{c}	120.4^{c}	6.8^{c}	6.6^{d}	7.2^{b}	7.0^{b}.	6.3^{ns}	6.74^{d}	6.63^{c}	7.09^{c}

Means±SE with different alphabet in columns are significantly different from each other ($p\leq0.05$)

3.2.5 Influence of frequencies of MLE application on the Root length and dry matter production

Significant differences were observed on the root length and dry matter production at 15 WAP. Root length of the maize plants in the various treatments follow the order: 73.8>69.7>67.0>64.5>38.3 and the dry matter production: 41.4>39.87>38.2>36.5>21.1 for four, thrice, twice, once and control respectively (Fig. 1 and 2). These results may be due to the increasing level of the cytokinins at the various frequencies (Werner *et al*.., (2001). Cytokinin combine with auxin to elongate the roots while adequate supply delays leaf senescence thus increasing photosynthetic capacity, dry matter production and allocation to economic parts (Aluko and Fischer, 1989, Gingula *et al*., 2005).

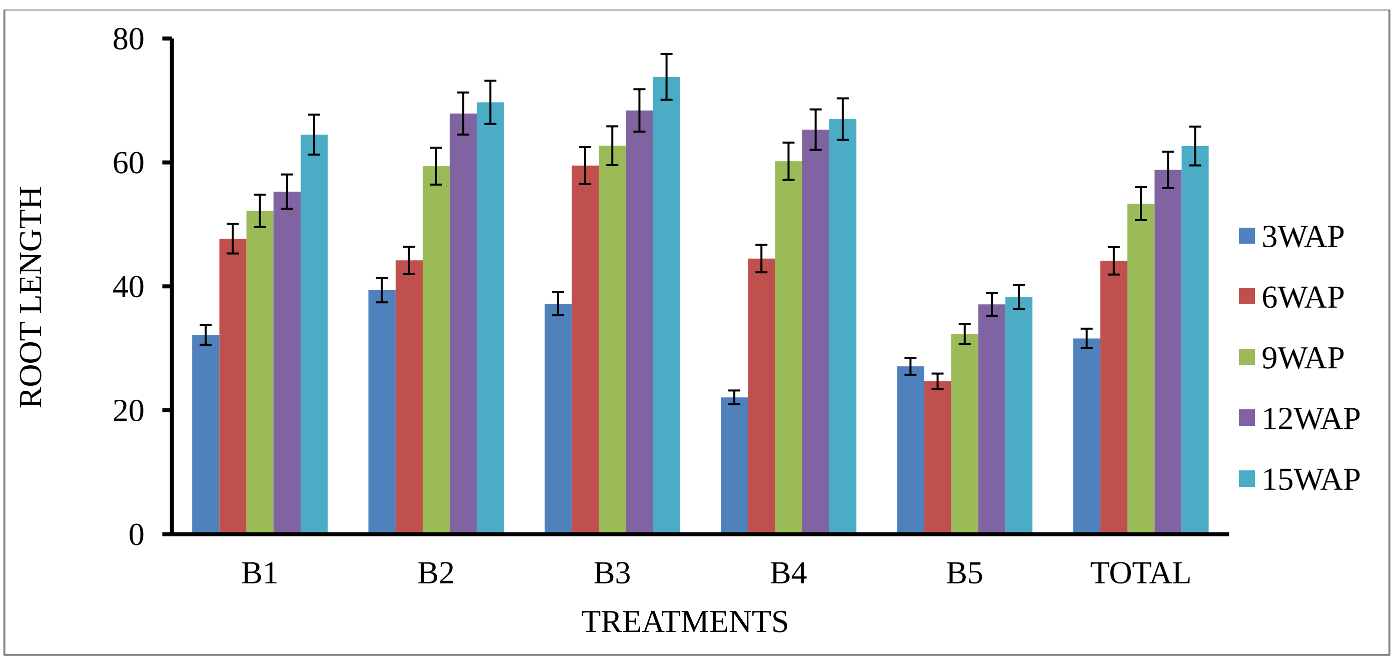

Fig. 1: Influence of frequencies of MLE application on the Root length

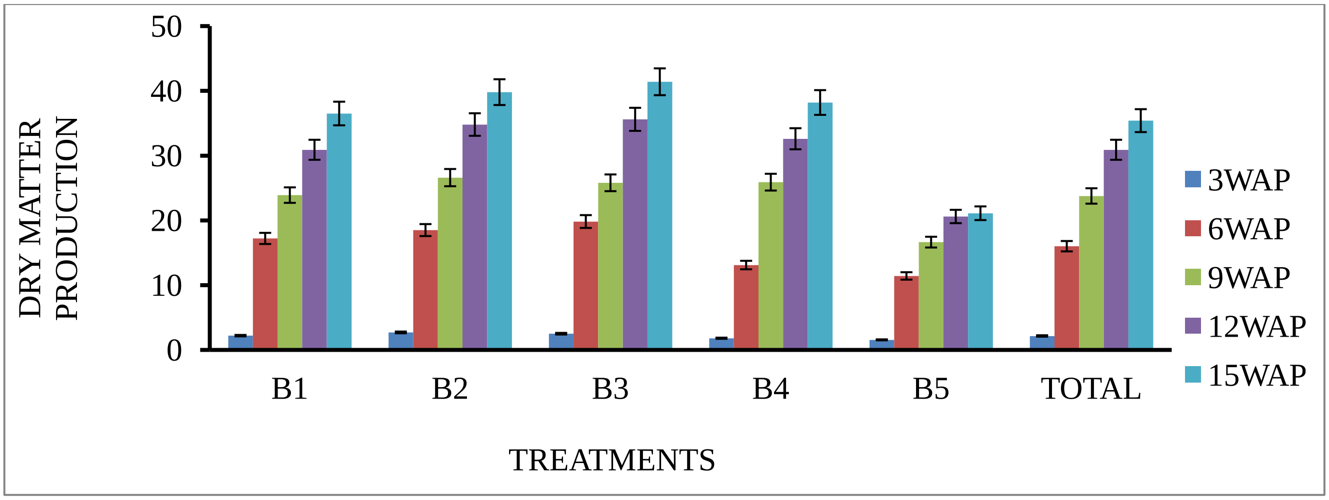

Fig. 2: Influence of frequencies of MLE application on the dry matter production

3.2.6 Effect of MLE application on number and weight of cobs

Significant differences were also observed on the number and weight of cobs harvested from the maize plants treated with MLE at the various frequencies (Table 4). All the maize plants treated with MLE at various frequencies produced higher number than the control while maize treated with MLE four times, thrice and twice had significantly higher cob weight (158.68, 151.44, 147.20) than those treated once and those in the control (113.20, 36.1) respectively . However, those treated with MLE once also had cobs weight bigger than those in the control (Table 4). These results agreed with those of Sanjay *et al*.,(2013) and Utietians *et al*., (2013); they recorded higher yields on pea and garden egg when treated with MLE respectively. Plants with high early seedling vigour, height and number of leaves are expected to establish faster by maximizing the use of available water, nutrients and solar energy thereby increasing the photosynthetic ability of the plant. This will result into more dry matter accumulation, which may be partitioned to the sink with consequent increased grain yield (Adetimirin, 2006). The complementary effect of the MLE with the minimum nitrogen applied provided the necessary growth requirements for the growth and establishment of the treated maize plants with resultant higher number and weight of cobs. Makkar *et al*.,(2007)and Chang *et al*., (2007) reported that the application of MLE on stem and leaves led to increased yield. Furthermore, Anyaegbu (2014), reported that the application of MLE increased the availability of micro and macro nutrients in the soil for plant uptake.

Table 4: Effect of MLE application on number and weight of cobs

Treatment	Number of cobs	Weight of cobs(g)
Once	1.2a	113.2b

Twice	1.8a	147.20a
Thrice	1.8a	151.44a
Four times	1.6a	148.68a
Control	0.4b	36.10c

Means±SE with different alphabet in columns are significantly different from each other (p≤0.05)

4.1 Conclusion

The results from this study indicated that foilar application of Moringa leaf extract on maize plants had significant effects on both the growth and yield components of maize plants. The application of MLE twice and thrice (3 and 6 WAP, 3, 6 and 9 WAP), especially at the critical stage prior to flowering and grain filling will enhance the productivity of maize plants and reduce the use of inorganic fertilizer that is not always available or too expensive for the poor resource farmer. Moringa grows fast, tolerates drought and thrives in many soils as well as seen growing almost everywhere in the country. The potentials of Moringa as high nutrients carrier especially the growth hormones components can therefore be harnessed and applied either as mulch, improved fallow or foliar spray to enhance and improve maize production and soil nutrient status. Necessary collaborations should therefore be intensified among the government, farmers, institutions, extension workers and NGOs to promote and impart such technology through On-farm demonstrations or trials, agricultural based radio programs and seminars.

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