EFFECTS OF MORINGA (*Moringa Oleifera* Lam) LEAF EXTRACTS ON GROWTH AND YIELD OF MAIZE (*Zea Mays* L.)

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ABSTRACT

A field experiment was conducted during the 2016 cropping season at Kwadon area of Yamaltu-Deba L.G.A. of Gombe State, to assess the effect of fresh (*Moringa oleifera)* leaf extract (MLE) on the growth and yield of maize. Young moringa leaves were harvested and pounded, 20 g of the pounded leaves was mixed with 675ml of 80% ethanol and filtered, the extract was then diluted with distilled water at 1:32 ratio (v/v) and sprayed directly onto the plants. The frequencies of spray constitute the treatments as T1 (4-MLE sprays), T2 (3-MLE sprays), T3 (2-MLE sprays), T4 (1-MLE spray) and T5 (0- MLE spray), in a randomized complete block design (RCBD) and replicated four times. Data were collected on plant height; stem girth, number of leaves, cob length, cob girth, 1000 seed weight and yield. The data were subjected to Analysis of variance (ANOVA), while differences among the treatments were separated by Least Significant Difference (LSD). Results of the growth parameters indicated that 4 sprays produced the greatest height (172.50 cm), largest stem girth (2.60 cm), highest number of leaves (14.00) and widest leaf area (82.40 cm^2). Similarly, 4 sprays also produced yield parameters at ($P<0.01$) with highest cob length (20.5 cm), 1000 seed weight (415g) and yield (5253.23 kg/ha) while no spray gave the least. It can be concluded that the use of moringa leaf extract foliar spray improves the yield of maize. It was recommended that, farmers should adopt foliar application of moringa leaf extract four times for increases in yield of maize.

Keywords: *Aqueous ethanol, maize, growth, yield*

INTRODUCTION

Plant hormones (also known as phytohormones) are those substances that regulate plant growth, which, in the UK, are termed 'plant growth substances'. Plant hormones are not nutrients, but chemicals that in small amounts influence and promote the growth, development and differentiation of cells and tissues (Opik et al., 2005).

Plant hormones are signal molecules produced within the plant, and occur in extremely low concentrations. Hormones regulate cellular processes in targeted cells locally and other sensitive locations in the plant. Hormones also determine the formation of flowers, stems, leaves, the shedding of leaves, and the development and ripening of fruits. Plants, unlike animals, lack glands that produce and secrete hormones. Instead, each cell is capable of producing hormone. Plant hormones shape the plant, affecting seed growth, time of flowering, senescence of leaves, and fruits. They determine which tissues grow upward and which grow downward, leaf formation and stem growth, fruit development and ripening, plant longevity, and even plant death. Hormones are vital to plant growth, and, lacking them, plants would be mostly a mass of undifferentiated cells. So they are also known as growth factors or growth hormones or growth regulatory (Öpik et al., 2005). Maize (Zea mays L.) is one the most efficient crops which can give high biological yield as well as grain yield in a short period of time due to its unique photosynthetic mechanism. It ranks after wheat and rice as the third most important cereal crop in the world considering total area and production. Though quantitatively it is after wheat and rice, it is in the first position for its yield per unit area. Nigeria is the largest producer of maize in Africa, followed by South Africa. Annually, Nigeria produces about 8 million tonnes of this crop (Odusanya, 2018). However, low poor soil especially in the savanna is one of the major constraints to maize production (Omisore and Abayomi, 2016). Furthermore, most of the able farmers were abandoning farming or changing to other crops due to poor harvest in maize as a result of this,

there is need for plant growth enhancer that will boost growth, development and yield. Furthermore, the inadequate availability of fertilizer to most farmers aggravated the low yield syndrome. Hence the need to produce growth hormones using the common plant like (Moringa oleifera leaf extract) for farmers to enhance their yield and thus improve food security.

The Moringa leaf extract contain zeatin which is a plant hormone from the Cytokinins group. Zeatin obtained from moringa leaf juice was found effective in yielding a positive result in a variety of crops (Makkar and Becker, 1996). Therefore, the use of this moringa leaf extracts on crops to enhance growth and high yield becomes paramount. Plant hormones are used to increase yield because they influence every phase of plant growth and development. In addition, it is environmentally friendly in the sense that, it does not have any harmful effect to humans and other living organisms. Moringa is a common plant in households in this sub region, as its extracts can increase crop yields; farmers will embrace the technology and utilize the available resources with little or no cost. Furthermore, even though, chemical fertilizers were reported to improve crops yields they are scarce and when available they are beyond the reach of a poor resource farmer.

Plant hormone induced growth and yield by altering photosynthetic distributive pattern within the plants. Foliar application of moringa extracts as a plant growth hormone were reported to enhance growth of almost all crops and increase in yield by 25-30 per cent (Martin, 2000 and Fuglie, 2008). Foidl et al. (2001) reported accelerated growth of young plants, increase in stem diameter and larger leaves with Moringa oleifera leaf extract. Muhammad et al. (2011) reported increased growth parameters of sesame with foliar application of moringa (root, shoot and seed extracts). Foliar application of aqueous extract of moringa and coconut milk water were found to significantly affect pawpaw seedlings height, girth diameter, number of leaves and plant vigour (Muhammad and Kwada, 2015).

Crop yield is a quantitative character of which many characters depend on it (Muhammad et al., 2012). An effective yield improvement is a simultaneous improvement of physiological yield parameters alongside with sound agronomic practices, plant height, number of leaves per plant were earlier reported to significantly affect sesame yield (Muhammad et al., 2010). An aqueous extract of moringa was found to significantly influence yield and yield components such as number of branches, number of fruits per plant and fruit weight of tomato (Muhammad, 2015). Therefore, there is the need to explore a synergy with plant growth hormone to minimize fertilizer use and obtain optimum maize yield. Thus, the objective of the study was to evaluate the effect of moringa leaf extract on the growth and yield of maize.

MATERIALS AND METHODS

The research was conducted at Kwadon located between latitude 90^0 .30 and 12^0 .30N and longitude 8^0. 45 and 11^0 .45E and has an average elevation of 380 meters above sea level in the Northern Guinea Savannah ecological zone of Nigeria during the 2016 cropping season. Experimental design used was randomize complete block design (RCBD). The size of the experimental field was 45m x 21m, which was divided into four blocks, each block measuring 45m x 5.25m. On each block, there were five experimental plots of 9m x 5.25m in dimension. Five treatments were randomly allocated to each of the block and were replicated four times.

Moringa seeds were planted directly on the field, which also served as demarcation between one plot and the other. As the plants were growing, new shoots were harvested at 35 days of emergence. An amount of 20g of young moringa leaves were harvested and pounded before mixing with 675ml of 80% ethanol as suggested by Makkar and Becker (1996). The suspension was stir using a homogenizer to help maximize the amount of the extract. The solution was then filtered by wringing the solution using a mutton cloth. The solution was also, re-filtered using No. 2 Whitman filter paper as recommended by Fuglie (2000). The extract was then diluted with distilled water at 1:32 ratio (v/v) and sprayed directly onto the plants. The extract was used within five hours from cutting and extracting to avoid occurrence of fermentation. The solution was applied per plant by foliar application (Fuglie, 2000). The hormone extract was applied by foliar spray using hand sprayer for uniform application as follows:

Treatment 1(T1): The Moringa leaf extract foliar spray was applied four times (4):

1. First application :10 days after germination
2. Second application: 45 days after seed emergence
3. Third application: at tasselling stage
4. Fourth application: at silking stage.

Treatment 2 (T2): The Moringa leaf extract foliar spray was applied three times:

1. First application :10 days after germination
2. Second application: 45 days after seed emergence
3. Third application: at tasselling

Treatment 3 (T3): The Moringa leaf extract foliar spray was applied twice (2):

1. First application :10 days after germination
2. Second application: 45 days after germination

Treatment 4 (T4): The Moringa leaf extract foliar spray was applied once (1):

1. One application :10 days after germination

Treatment 5 (T5): No Moringa leaf extract treatment was applied (control), but distilled water was sprayed in order to attest whether there is influence of distilled water in either of the treatment.

The land was cleared of shrubs, stumps and ploughed with mould board. The soil was tilted in order to provide good seed germination and root growth, the seeds were sown on the ridges. The seeds were dressed with Apron star 52 DS at one sachet/4 kg of seeds to prevent seeds and seedlings from insects and fungal infestation. Manual sowing was carried out using hand hoe, 2 seeds/hole at a spacing of 75cm by 25 cm. Manual weed control was carried out using a hand hoe at 3 and 6 weeks after sowing (WAS). Basal application of 200 kg/ha NPK 20:10:10 fertilizer was applied at planting. This was followed by split application of 100 kg urea per hectare by side dressing at four and six weeks after sowing. 4m x 4m quadrant was marked out from each of the plots where yield components such as cob length, 1000 seed weight and total grain yield were taken. Data collected were subjected to analysis of variance (ANOVA) using Genstat Discovery Edition 2013 software program, where the F-test showed significance, treatment means were separated using the least significant difference (LSD).

RESULTS

Physical and chemical properties of the soil at the experimental Site

The result of the physical and chemical analysis of the soil in the experimental site is presented in Table 1. The textural class of the soil was clay loam with pH slightly acidic. The organic matter, organic carbon and total nitrogen were relatively low. The CEC, Exchangeable bases and the available phosphorus moderate.

Effect of moringa leaf extract on growth parameters of maize

The result in Table 2 shows that there was a highly significant ($P<0.01$) effect of treatments on maize plant height at 4 and 8 WAS, and a significant ($P<0.05$) effect at harvest. Plants on T1 were tallest at 4 and 8 WAS and at harvest with 77.25cm, 159.80cm and 172.50cm, respectively, at all the sampling periods, while those on T5 were shortest (39cm, 108.50cm and 117.80cm, respectively).

The results on Table 3 revealed that there was highly significant ($P<0.01$) difference among the treatment means for maize stem girth at weeks 4 and 8 WAS and at harvest. Treatment T1 had the highest values at 4 and 8 WAS and at harvest with1.53cm, 2.52cm and 2.60cm, respectively followed by T2 then T3 and T4, while treatment T5 was the least (1.08cm, 1.70cm and 1.90cm, respectively).

Results on Table 4 show a highly significant ($P<0.01$) difference among the treatment means for number leaves per plant at 4 and 8WAS, and significant ($P<0.05$) difference at harvest. Treatment T1 had the highest number of leaves at 4 and 8 WAS and at harvest with values11.5, 13.75 and 14.00, respectively whereas; lowest leaves were recorded in T5 with 7.25, 9.00 and 10.00, respectively.

The result on Table 5 shows a highly significant ($P<0.01$) difference among the treatment means in respect to leaf area per plant at 4 and 8 WAS and at harvest. Treatment T1 had the highest leaf area of 21.86cm^2, 30,49cm^2 and 82.40 cm^2 respectively, at 4 and 8 WAS and at harvest while T5 had least with leaf area values of 9.30cm^2, 12.75cm^2 and 49.34 cm^{2}respectively. Table 6 shows that there was a highly significant ($P<0.01$) effect of treatment on cob length, T1 had the highest effect (20.50 cm) followed by T2 (19.00 cm), while T5 recorded the lowest (16.50 cm). Similarly, 1000 grain weigh showed significant

P<0.01) effect by treatments, T1was the heaviest (415g), followed by T2 then T3, while T4 and T5 were statistically similar and recorded the least effect (Table 6). The effect of moringa extracts on yield per hectare was highly significant (P<0.01), T1 recorded the highest yield per hectare (5253.23kg), followed by T2, while T5 had lowest yield (3105.40kg).

DISCUSSION

The result of physical and chemical properties of the experimental site indicated that the soil was low in fertility and could be referred for crop hormone growth enhancer application to boost the productivity of maize. The results on growth parameters indicated highest values with T1 (four times sprays). This is due to the fact that hormones promote growth, development and differentiation of cells and tissues in plants. This finding is in consonance with that of Muhammad *et al.* (2011) who reported increased growth parameters of sesame with foliar application of moringa (root, shoot and seed extracts). Furthermore, foliar application of aqueous extract of moringa and coconut milk water were found to significantly affect pawpaw seedlings height, girth diameter, number of leaves and plant vigour (Muhammad and Kwada, 2015). Foidl *et al.* (2001) reported accelerated growth of young plants, increase in stem diameter and larger leaves with *Moringa oleifera* extract.

The result of yield parameters revealed that the yield increased as the frequency of moringa leaf extract increased. This is because hormone enhances formation and development of flowers and ripening of fruits. Hormones also enhance growth and yield by altering photosynthetic distributive pattern within the plants. This may be connected with the increase in height, as the plant increased in height more leaves may be found which may increase surface area for the absorption of solar radiation and consequently, more assimilate which is then partitioned to the developing region of the plant, resulting in high yields. These findings were supported by Price (1985) who reported an increase in growth and yield of crop due to use of moringa extract. The findings were also in line with that of Muhammad (2015) who found that an aqueous extract of moringa significantly influence yield and yield components such as number of branches, number of fruits per plant and fruit weight of tomato (Muhammad, 2015).

CONCLUSION

From the foregoing results, it could be concluded that Moringa leaf extract could increase growth parameters and yield of maize, thus enhancing higher productivity of the crop to ensure food security in Nigeria.

RECOMMENDATION

Based on the findings of this work, it is suggested that farmers in the study area should adopt foliar application of moringa leaf extract four times at different growing and developing stages for increase growth and yield of maize. The use of moringa leaf extract a as growth enhancer could improve the productivity of small and large scale farmers. Finally, further research is also recommended on other crops at different dimensions.

Table 1: Physical and Chemical Properties of the Soil at the Experimental Site

Parameters	Values
pH water	6.50
Exchangeable bases (cmol/kg)	
Calcium	2.43
Magnesium	1.50
Sodium	0.80
Potasium	1.16
CEC	7.45
Zinc (mg/kg)	4.76
Available P (mg/kg)	8.55
Organic C (%)	0.85
Organic matter (%)	1.87
Total N (g/kg)	0.67
Sand (%)	60.00
Silt (%)	20.00
Clay (%)	20.00
Textural class	Sandy-Clay loam

Table 2: Effect of (*Moringa oleifera*) leaf extract on maize plant height (cm)

Treatment	4 WAS	8 WAS	Harvest
T1	77.25	159.80	172.50
T2	67.25	148.50	157.80
T3	58.75	141.00	145.00
T4	48.25	128.50	134.20
T5	39.00	108.50	117.80
P of F	<0.01	<0.01	0.03
LSD	5.374	10.41	21.56

LSD= Least significant difference, P of F= Probability value of F-test, WAS= Weeks after sowing,
TI= Four MLE spray, T2= Three MLE spray, T3= Two MLE spray, T4= One MLE spray, T5= Zero MLE spray

Table 3: Effect of (*Moringa oleifera*) leaf extract on maize stem girth (cm)

Treatment	4 WAS	8 WAS	Harvest
T1	1.53	2.52	2.60
T2	1.35	2.33	2.40
T3	1.25	2.10	2.12
T4	1.15	1.90	1.95
T5	1.08	1.70	1.90
P of F	<0.01	<0.01	<0.01
LSD	0.13	0.12	0.32

LSD= Least significant difference, P of F= Probability value of F-test, WAS= Weeks after sowing,
TI= Four MLE spray, T2= Three MLE spray, T3= Two MLE spray, T4= One MLE spray, T5= Zero MLE spray

Table 4: Effect of (*Moringa oleifera*) leaf extract on maize number of leaves/plant

Treatment	4 WAS	8 WAS	Harvest
T1	11.50	13.75	14.00
T2	10.25	12.25	12.25
T3	9.25	11.25	11.75
T4	8.25	9.75	10.75
T5	7.25	9.00	10.00
P of F	<0.01	<0.01	0.02
LSD	0.345	1.02	1.54

LSD= Least significant difference, P of F= Probability value of F-test, WAS= Weeks after sowing,
TI= Four MLE spray, T2= Three MLE spray, T3= Two MLE spray, T4= One MLE spray, T5= Zero MLE spray

Table 5: Effect of (*Moringa oleifera*) leaf extract on maize plant leaf area/plant (cm^2)

Treatment	4 WAS	8 WAS	Harvest
T1	21.86	30.49	82.40
T2	17.94	24.07	62.50
T3	14.81	20.08	57.58
T4	12.11	15.39	53.02
T5	9.30	12.75	49.34
P of F	<0.01	<0.01	<0.01
LSD	1.608	2.394	8.06

LSD= Least significant difference, P of F= Probability value of F-test, WAS= Weeks after sowing,
TI= Four MLE spray, T2= Three MLE spray, T3= Two MLE spray, T4= One MLE spray, T5= Zero MLE spray

Table 6: Effect of (*Moringa oleifera*) leaf extracts on the yield parameters and yield of maize

Treatment	Cob length (cm)	1000 GW	Yield/plot (g)	Yield (kg/ha)
T1	20.50	415.00	525.32	5253.23
T2	19.00	370.00	473.14	4731.38
T3	17.75	334.80	368.10	3680.95
T4	17.50	304.80	340.87	3408.73
T5	16.50	295.50	310.54	3105.40
P of F	<.001	<.001	<.001	<.001
LSD	1.16	19.85	24.27	242.67

LSD = Least significant difference, P of F= Probability value of F-test, WAS= Weeks after sowing, TI= Four MLE spray, T2= Three MLE spray, T3= Two MLE spray, T4= One MLE spray, T5= Zero MLE spray

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