Research Article

Effect of Moringa Extract on Growth and Yield of Tomato

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ABSTRACT

Trials were carried out to evaluate the effect of *Moringa oleifera* leaf extract as a growth hormone on growth and yield of tomato (*Lycopersicon esculentum*L var. Rodade).

In the greenhouse, five treatments were used: the control, where only water was added (M0), second control where ethanol 80 % was added (ME), moringa extract applied once at 2 weeks from emergence (M1), moringa extract applied at 2 and 4 weeks from emergence (M2), and moringa extract applied every 2 weeks to maturity,starting from two weeks from germination (M3).The same treatments were adopted in the field except the ME which was considered unnecessary after observing the results of the greenhouse experiment. Results showed that moringa extract increased growth and yield of tomato in both greenhouse and field. Moringa extract significantly increased above ground dry matter yield (DM), root dry matter weight and plant height for the crop. Yields obtained at MI, M2 and M3 were increasing in ascending order from M1. The study recommends the application of extract at M3.

Key words: *Moringaoleifera* leaf extract, growth hormone, tomato

ABBREVIATIONS

AN	**ammonium nitrate**
DM	**dry matter**
EC	**emulsifiable concentration**
FAO	**food and organization**
SSP	**single super phosphate**
TEB	**total exchangeable bases**
WP	**wettable powder**

INTRODUCTION

Vegetables are important crops for additional supply of human nutritional requirements. Temu and Temu (2005) described vegetables, which include tomatoes as high-value crops which have high nutritive value. In particular, they are high in vitamins, minerals and fibre. But according to reports by Stock (2004), half of the Sub Saharan countries were designated by FAO as having short supply of these crops. One of the constraints to sustained production of tomatoes in this region is lack of hormonal application. This leads to poor plant growth and increased disease pressure which results in decline in agricultural food production.

Plant hormones can be used to increase yield per unit area because they influence every phase of plant growth and development. Traditionally, there are five groups of growth regulators which are listed: auxins, gibberellins, abscisic acid, ethylene and cytokinins (Prosecus, 2006).Cytokinins enhance food production. Zeatin is one form of the most common forms of naturally occurring cytokinin in plants. Fresh *Moringa oleifera* leaves have been shown to have high zeatin content. Moringa leaves gathered from various parts of the world were found to have high zeatin concentrations of between 5 mcg and 200 mcg/g of leaves(El Awady, 2003).

Moringa leaf extract was sprayed onto leaves of onions, bell pepper, soya beans, sorghum, coffee, tea, chili, melon and maize and was shown to increase yields of these crops (Fuglie, 2000). If moringa extract can increase yields, then the potential benefit to the smallholder farmers in Africa would be great. The effect of moringa extract on other crops is unknown.

The objective of the current study is to test effect of moringa extract on growth and development of tomato. The hypothesis of this research was application of moringa extract tomato (*Lycopersicon esculentum* L. var. Rodade) can increase the growth and yield of the crop.

MATERIALS AND METHODS

The effect of applying moringa extract on three crops was evaluated in the greenhouse and in the field at Africa University (AU) during the 2006-2007 rainy season. The soil used was loamy orthoferralitic soils, 7E (Nyamapfene, 1991).

Greenhouse Experiment

12 black polythene bags containing 10 kg of soil each were used to establish tomato plants.Fertilizer rates used were:

105 kg N/ha (1.38 g AN /10 kg soil), 240 kg P2O5/ha (5.74 g SSP/10 kg soil), and 75 kg K2O/ha (0.68 g sulphate of potash/10 kg soil). (AN=34.5 % N, SSP=18 % P2O5 and Sulphate of Potash=50 % K2O5).
The design was a Randomized Complete Block Design (RCBD) with three replicates.

Treatments

1. Control-with no moringa extract added (M0).
2. Control- 80 % ethanol sprayed at every 2 weeks, starting from 2 weeks after emergence (ME).
3. Moringa extract sprayed at 2 weeks after emergence (M1).
4. Moringa extract sprayed at 2 weeks and 4 weeks after emergence (M2)
5. Moringa extract sprayed 2 weeks after emergence and after every two weeks thereafter (M3)

The alcohol control was added to establish if its use in the extract had any effect on the growth of the plants.
The seed was directly sown into the pots at a depth of 1.5 cm. Four seeds were planted per pot. The plants were thinned to two plants per pot two weeks after emergence. Water was applied according to the requirements of each crop. All pots were kept weed free. Pests were controlled using dimethoate 40 % EC applied at 10 ml per 10 litres of water sprayed after every 2 weeks to control red spider mites. Carbaryl 85 % WP was applied at 20 g per 10 litres to control leaf eating pests and copper oxychloride at 50 g per 10 litres of water to control early blight (*Alternaria solani*) and other fungal diseases which attack the crop. The two latter pesticides were applied after every 7 days.

Preparation of moringa extract

Moringa plants were planted through direct seeding in the field at Africa University farm to raise plants with appropriate leaf ages to use for deriving the extract. As the plants were growing, new shoots were harvested at 35 days after emergence. An amount of 20 g of young moringa leaves was mixed with 675 ml of 80 % ethanol as suggested by (Makker and Becker, 1996). The suspension was stirred 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 re-filtered using No. 2 Whatman filter paper. Using a method developed by Fuglie (2000), the extract was diluted with distilled water at a 1:32 ratio (v/v) and then sprayed directly onto plants. The extract was used within five hours from cutting and extracting (if not ready to be used, the extract or the solution prepared was stored at 0 ^{0}C and only taken out when needed for use). An amount of 25 ml (application rate) of the solution was applied per plant in the greenhouse.

Statistical Analysis of Data

Analysis of variance (ANOVA) was done using Genstat, version 4.2.

Field experiment

The crop was planted in plots which were 1.8m long by 1.8m wide, giving an area of 3.24 m^2. The chemical characteristics of the soil used were the same as that presented in Table 2. The crop evaluated was tomato (cultivar Rodade) .The following treatments were applied:
1. Control-no moringa extract added (M0).
2. Moringa extract sprayed at 2 weeks after transplanting (M1).
3. Moringa extract sprayed at 2 weeks and 4 weeks after transplanting (M2).
4. Moringa sprayed after every 2 weeks up to physiological maturity, starting from two weeks after transplanting (M3).

The control in which ethanol 80 % (ME) was applied alone was not included. It was proved not significantly different from water during the greenhouse experiment in which both the ethanol 80 % (ME) and water (M0) were used as controls during the test for the crop. Otherwise, the treatments applied were the same with those applied in the greenhouse.

The design was a RCBD with three replicates.

Fertilizer rates used

The fertilizer rates used at planting were equivalent to those used in the greenhouse experiment except the following additions or changes.

The rate of 34.5 kg N/ha (32.4 g AN/plot) was used on the top dressing of tomato mixed with the same amount of sulphate of potash (1:1 ratio) by weight (Gilmour, 1983). The crop was top-dressed 2 times at 3 weeks interval starting from marble size stage.

All the other agronomic operations were similar to those described in the greenhouse study. The crop was planted in the nursery and then transplanted after four weeks. The spacing used was 60 cm inter-row x 30 cm in-row.

Moringa extract

Moringa extract for the field experiment was prepared and applied as described for the greenhouse experiment.

Data Analysis

Analysis of variance (ANOVA) was done using Genstat, version 4.2.

Table 1. Chemical characteristics of the soil used at Africa University (AU) during the 2006-2007 in greenhouse and field trials

			----------Nutrient level in the soil----------				
pHCa	Mg	K	TEB	P	Total N		
	(Ca Cl_2 scale)	----------me %----------				(ppm)	(%)
	5.1	8.57	5.15	0.70	14.42	18.5	0.12

Table 2. Mean shoot and root dry matter yield and plant height at 49 days after planting for tomato plants treated with moringa extract in the greenhouse.

Treatment	DM (g/pot)	Root dry weight (g/pot)	Height (cm)	Number of stems
M0	32.8	10.1	33.7	2.00
ME	33.1	9.7	28.7	2.33
M1	38.0	15.4	51.7	2.33
M2	41.4	26.8	64.3	3.33
M3	46.4	30.7	84.0	3.33
Mean	38.40	18.4	52.5	2.60
SE±	4.42	6.8	8.1	0.92
P	*	*	***	(NS)
$LSD_{(0.05)}$	8.33	12.8	15.3	-
CV (%)	11.50	37.0	15.5	35.50

*, **, *** Significant at P=0.05, P=0.01, P=0.001 respectively, NS=Not significant at P=0.05. M0=control-with no moringa added, ME=control-80 % ethanol sprayed

every 2 weeks starting from 2 weeks after mergence, M1=moringa extract sprayed 2 weeks after emergence, M2=moringa extract sprayed at 2 weeks and 4 weeks after emergence, M3=moringa extract sprayed 2 weeks after emergence and after every two weeks thereafter.

Table 3. Mean fresh fruit weight (tha^{-1}) and number of stem branches for tomato plants treated with moringa extract in the field.

Treatment	Fresh fruit weight (tha^{-1})	No. of stems/plant
Control-no moringa extract added (M0)	13.22	4.00
Moringa extract sprayed at 2 weeks after transplanting (M1)	18.98	6.67
Moringa extract sprayed at 2 weeks and 4 weeks after transplanting (M2)	24.34	7.67
Moringa extract sprayed every 2 weeks up to physiological maturity, starting from two weeks after transplanting (M3)	31.88	10.00
Mean	22.11	7.08
SE±	2.55	1.05
P	***	**
$LSD_{(0.05)}$	5.10	2.11
CV (%)	11.50	14.90

, * Significant at P=0.01, P=0.001 respectively.

RESULTS

Greenhouse

The two control treatments were also not significantly different from M1 Table 1. There was no significant difference in dry matter yield between applying one moringa spray at 2 weeks after germination and applying at 2 and 4 weeks after germination. Applying the extract at 2 and 4 weeks and at every two weeks significantly ($p<0.05$) increased dry matter yield by 26 % and 41 % respectively. M1 had no significant effect on root weight, but M2 and M3 significantly increased root weight by 66 % and 162 % respectively. All the moringa treatments significantly increased plant height. Height was significantly increased by 53 % when moringa extract was applied once at 2 weeks, 90 % when moringa was applied at 2 and 4 weeks (M2) and by 149 % when moringa was applied every two weeks up to harvest (ME). There was no significant difference in the number of stem branches.

Field

The control fresh fruit weight and number of stem branches for tomato plants (Table 4) was lower than the treatment where one spray (M1) was added. All moringa extract treatments significantly ($p<0.05$) increased fresh fruit weight and number of stem branches of the tomato plants. Applying moringa extract spray at 2 weeks after transplanting (M1), spraying at 2 weeks and 4 weeks after transplanting (M2) and spaying every 2 weeks up to physiological maturity (M3) increased fruit weight by 43 %, 84 % and 141 % respectively. M1, M2 and M3 significantly increased the number of stem branches by 66 %, 91 % and 150 % respectively.

DISCUSSION

In the greenhouse experiment done, application of moringa extract significantly increased dry matter yield, root dry weight and plant height of tomato plants. Allmoringa extract treatments increased tomato plant height.The percentage increases in yields for root weight in the greenhouse through moringa extract application at M3 was 162

%. In the greenhouse, the height of the crop gave the most response to the extract in comparison to the other parameters. The highest increase was obtained with the highest moringa extract treatment (M3).In field, all moringa extract treatments increased fresh fruit weight and number of stem branches. The percentage increases for fruit yield through moringa extract application at M3 was 150 %.The applications of M1 to M3 gave yield increases which ranged from 20-150 %. The highest frequency of moringa application (M3) gave the highest yield. The percentage increase in yield at M3 was 141 %.

El Awady (2003) pointed out that in moringa, there is zeatin hormone in very high concentrations of between 5 mcg and 200 mcg/g of material. Fuglie (2000) confirmed that this cytokinin (CK) related hormone increases crop yields when sprayed as an extract from fresh moringa leaves.

CONCLUSION

Moringa leaf extract increases growth and yields of tomatoes. From the results of both the greenhouse and field experiments, it may be concluded the higher the frequency of moringa application, the greater the increase in plant height, dry matter and yield of the crop. The study recommends the application of extract at M3.

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REFERENCES

Adandonon A (2004). Damping-off and Stem rot of Cowpea in Benin caused by Sclerotiumrolfii.University of Pretoria.

Ark PA and Thompson JP(1959). Control of certain diseases of plants with antibiotics from garlic (Allium sativum L.). Plant Dis. Rep. 43:276-282.

Fuglie LJ (2000). New Uses of Moringa Studied in Nicaragua: ECHO's Technical Network Site-networking global hunger solutions. ECHO, Nicaragua.

Gilmour JG (1983). Horticultural Handbook.Agritex, Zimbabwe.

Makkar HPS and Becker K (1996). Nutritional value and antinutritional components of whole and ethanol extracted *Moringaoleifera* leaves. *Animal Feed Scinec and Technology* 63, 211-228.

Nyamapfene K (1991). The Soils of Zimbabwe.Nehanda Publishers, Zimbabwe, pp 28-30.

Prosecus P (2006). Biosynthesis-Plant Hormones and Growth Regulators: Chemistry and Biology. Biosynth Ag. Co., Switzerland.

Stock RF (2004). Africa South of the Sahara: a Geographical Interpretation. Guilford Press, New York.

Temu AE &T emu AA (2005). High Value Agricultural Products for Small holder Markets in Sub-Saharan Africa: Trends, Opportunities and Research Priorities. International

Workshop on How can the poor benefit from the growing markets for high value agricultural products? 3-5 October 2005. International Center for Tropical Agriculture, Cali, Colombia.