Journal of Environmental Issues and Agriculture in Developing Countries
Volume 12, Number 1, April 2020
ISSN: 2141-2731
Published By
International Centre for Integrated Development Research, Nigeria
In collaboration with
Copperstone University, Zambia.

Effect of *Moringa oleifera* Leaf Extract and NPK (20:10:10) Fertilizer on the Yield of Sweet Potato, Soil Properties and Incidence of *Cylas formucarius* (Weevil) in Abuja, Nigeria

Roseline Imoh Joseph
Anyaegbu Polycarp Ozobia
Asala Shatu Wudiri

ABSTRACT

The study was conducted to determine the effect of Moringa oleifera and NPK (20:10:10) fertilizer on the yield of two varieties of sweet potato (IMOSO and kwara), soil properties and incidence of Cylas weevil in the production of sweet potato on the crop. Factorial treatment arrangement fitted into Randomized Complete Block Design with 3 replications was used. Results showed that the contents of some basic elements (N, P, K, Mg and Ca) were significantly enhanced especially in the plots that received Moringa leaf extract. Soil pH of the plots that received Moringa oleifera increased from 5.5 to 6.6 while those given NPK fertilizer decreased from 5.3 to 5.0 and control plots decreased from 5.4 to 5.0. Stand count of the stands per plot before harvest showed that stands amended with various treatments were higher than that of the control plots by 20% and 18% for Moringa extract and NPK respectively. Stands of variety, Kwara, that were amended with NPK and Moringa extract produced 51% more yield than the control in 2017 and 2018, while those of variety, IMOSO, produced 63% in 2017and 56% in 2018 over the control. While stands of sweet potato treated with Moringa extract produced significantly, ($p<0.05$) highest number of marketable roots, those that received NPK fertilizer produced highest roots followed by those on control plots In terms of severity of infection by Cylas weevils on the storage roots. Stands treated with Moringa extract showed very mild symptoms but roots from NPK fertilizer amended plots and the control plots showed severe symptoms of infection.
Keywords: *Moringa oleifera, NPK (20:10:10), Fertilizer, Sweet Potato, Soil Properties and Cylas formucarius*

INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] is one of the world's most important food crops, with annual production of 1.47 million tonnes (FAO, 2016). Of the staple food crops grown, including cassava, rice and maize, sweet potato is the

***Roseline Imoh Joseph, Anyaegbu Polycarp Ozobia and Asala Shatu Wudiri** are affiliated with the Department of Crop Science, University of Abuja, Abuja, Nigeria.*
***E-mail:** akroseline85@yahoo.com.*

crop with the highest potential for commercial exploitation (Kenneth, 2009). The crop is the fifth most important food crop after rice, wheat, maize and cassava (FAO, 1998) and an important food and vegetable crop that grows throughout the world, especially in the tropics and warm tropical areas for its edible tubers. According to Woolfe (1992), sweet potato is fed to livestock to support a domestic demand for protein as it provides significant amount of protein, vitamin, carbohydrate (about 75% of the total dry matter) and Iron (5.3% of daily energy requirement). Although, sweet potato is not usually regarded as source of protein, but it contributes 3.4% to total protein intake compared with 4.5%, 4.8% and 5.8% contributed by eggs, fish and cheese respectively (Woolfe, 1992).

Many studies have suggested that increasing consumption of plant foods like sweet potatoes decreases the risk of obesity, diabetes, heart disease and overall mortality while promoting a healthy complexion, increased energy, and overall lower weight (Ewell and Mutuura, 1991). In addition, sweet potato skin contributes significant amounts of fiber, potassium and quercetin, (Ewell and Mutuura, 1991).

One of the most limiting factors in sweet potato production has been lack of desirable varieties. Currently, the problem seems to have been taken care of by the production of high breeding Lines yielding lines capable of producing more than 30 tones ha-1, by Agricultural research Institutions such as National Root Crop Research Center Institute, Umudike. Unfortunately most of these high yielding varieties are highly susceptible to the weevil known as, *Cylas*. *Cylas*spp, is a very serious pest of sweet potato, especially the orange-fleshed varieties. They feed on the tubers of the sweet potato, leaving behind numerous small black holes on the affected tubers which render reduce qualities useless.

The study is intended sought to achieve the following objectives:

(a) To determine the effect of *Moringa oleifera* leaf extract son in the control of *Cylas* weevil in sweet potato production.

(b) To compare the effects of the plant extract and chemical fertilizer on the soil properties and the yield of two varieties of sweet potato used in this study,.

(c) To determine whether the plant extract would be suitable alternatives to chemical fertilizer and

(d) To compare the response of the hybrid line (IMOSO) of the sweet potato and the local variety (kwara) of the sweet potato to the applied plant extract and NPK fertilizer.

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MATERIALS AND METHODS

The study was conducted in 2017 and 2018 cropping seasons at the Teaching and Research farm, Faculty of Agriculture, University of Abuja, Abuja, Nigeria. Abuja, the Federal Capital Territory, is located in the Guinea Savannah of Nigeria. The raining season begins from April and ends in October, and the average day temperature is 28°C to 30°C in the dry season and can be as high as 40°C or more especially in Gwagwalada area. Its annual rainfall ranges from 1100 mm to 1130 mm, humidity of 14% at the period of planting, and wind of 10 km/h North East. Its soil is clay loam with a quick moisture regime (Afisol soil). The sweet potato vines used in the study was sourced from National Root Crop Research Institute, Umudike and Potato Farmers Association, Abuja, Nigeria. The two varieties used in this study include; are IMOSO and KWARA respectively.

The breeding lines (IMOSO) is an Orange fleshed sweet potato, very high yielding and has been under Pre–Release evaluation for recommendation to farmers in Nigeria. The two varieties constitute factor A (KWARA-A1 and IMOSO-A2) while the *Moringa* extract constituted Factor B 0 ml-B1,50 ml-B2 and 100 ml-B3) and NPK20:10:10 C (0 kg-C1, 100 kg-C2 and 300 kg-C3). The study was a 2x3x3 factorial experiment fitted into a Randomized Complete Block Design with 3 replications. Plot size was 3 m x3 m and planting spacing was 1m x 0.3m giving a population of 33333.33 stands per hectare. Plant population per plot was 30 stands and inter plot spacing was 1m. During plating, 2/3 of the length of each vine (20 cm long) was inserted into the soil, at an angle of 60^{o}. The soil around the vine was firmly pressed to ensure proper contact of the vine with the soil for easy establishment. First weeding was done three weeks after planting using hoes while treatments were applied four weeks after planting.

The fertilizer NPK 20:10:10 was applied at the rate of 100 and 300 kg per hectare with no fertilizer as control. In plots receiving 100 kg/ha, each ridge received 0.03 kg of fertilizer while those given 300 kg/ha, each ridge received 0.09 kg fertilizer. For stands treated with Moringa leaf extract, the application was by spraying of the entire plant right from the tip of the plant, to its base, which was done 21 days after planting. Two times weeding was done before the vines leaves covered the ground surface to suppress weeds. Samples of the *Cylas formutaris* were collected from the infected storages roots during the harvest for identification. Data collected were:

i. Stand count at harvest,
ii. Mean marketable (>150 g) root weight (kg/plot),
iii. Mean unmarketable root weight (kg/plot),

iv. Mean number of marketable roots per plot,
v. Mean number of unmarketable roots per plot,
vi. Mean root with *Cylas* weevil incidence (i.e. total number of roots with *Cylas* weevil),
vii Mean root with *Cylas* weevil severity score, where
1 = All tubers clean of *Cylas* damage across the plot
2 = <20% of each tuber in the plot damaged
3 = 21 – 50% of each tuber in the plot damaged
4 = 51 – 80% of each tuber in the plot damaged by *Cylas*
5 = >80% of each of the tubers in a plot damaged
viii. Mean sweet potato virus disease (SPVD) incidence (i.e. total number with SPVD in a plot at 10 weeks after planting).
ix. Mean SPVD severity score at 10 weeks after planting,
where:
1. = No visible SPVD symptoms on all plants in the plot
2. = Very mild symptoms on infected plants
3. = Moderate symptoms on infected plants
4. = Severe symptoms on infected plants and
5. = Very severe symptoms on infected plants (plants are stunted, leaves shriveled)
x Soil analysis data.
Data collected were subjected to analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Table 1 showed the proximate analysis of the *Moringa oleifera* fresh leaves used in the study per 100 gram. Meanwhile the fertility status of the experimental site determined before the commencement of the experiment is shown on Table 2.The result indicates that the soil fertility was relatively poor, which may be attributed to the continuous cropping in the area as indicated by the cropping history. The site was under one year fallow following a two-year maize trial. Nwaka (2012) and Esu (2010) classified the soil in the area as Alfisols, well drained and strongly acidic giving credence to the pre-planting soil analysis that showed a soil pH value of 5.4. However, after the experiment, post-harvest soil analysis showed that the status of some basic elements, (N, P, K, Mg and Ca) was significantly enhanced especially in the plots that received *Moring*a extract (Table 3). Percent nitrogen and phosphorus were relatively higher in plots that were given NPK fertilizer than other treatments. The large concentration of soil phosphorus in the NPK amended plots may be due the immobilization of the element due to low soil pH. Soil pH was significantly improved with the application of *Moringa* extract. The pH of the plots that received *Moringa* extracts increased from 5.5 to 6.7 irrespective of varieties of sweet potato. Enhanced pH values tend to increase the Cation Exchange Capacity of the soil. Under this situation the basic cations are significantly available to the plant for their nutrition. Thus, the enhanced performance of the varieties of potato that were given *Moringa* extract might partly be due to improved soil pH. *Moringa* has been reported to significantly improve soil fertility if used as a green manure (Davis, 2000).

In control plots, the pH decreased from 5.3 to 5.0. Inorganic fertilizers are known to increase the hydrogen ion concentration in the soil thereby reducing the soil pH drastically. Owolabi *et al*. (2003) further added that at lower pH values potatoes can suffer from aluminum and other heavy metal ion toxicity, as well as restricted P or Mo availability. In this study, the values of sodium ions increased as the soil pH decreased (Table 4), giving credence to the reports of Onwuka *et al*. (2009) and Owolabi *et al.* (2003). Concentration of sodium ions is known to be detrimental to crop growth and development. The physical properties of the soil remained fairly the same even after the trial.

Figure 3 showed the yield and yield component of the selected varieties of sweet potato as influenced by *Moringa* leaf extract and NPK fertilizer. Stand count of the stands per plot before harvest showed that stands amended with with *Moringa* and NPK were higher than that of the control plots by 20% and 18%, respectively. Thus crop survival was better in plots amended with *Moringa* extract than others. Phiri (2003) reported that *Moringa oleifera* leaves have high zeatin content. Zeatin is a plant growth hormone from the cytokines group. It plays an important role in cell division and cell elongation (Taiz and Zeiger, 2000), thus influencing improvement in crop growth and yield (Prince 1985).

Generally, application of the various treatments significantly ($P>0.05$) improved the root yield of the varieties of potato used in this study. High root dry matter (DM) content (25.5% and above) is preferred in the Sub Saharan Africa especially in Nigeria because of the various food preparations that sweet potato is generally used for. When compared with the yield from control plots, plots amended with *Moringa* extract produced 74% more root yield than the control and NPK fertilizer by 70%. The stands of sweet potato, irrespective of varieties, treated with *Moringa* leaf extract produced significantly ($p<0.05$) greater number of marketable roots than those that received NPK fertilizer and those on the control plots. In Zambia, Moringa has been reported to increase crop growth and yield, (Foidl *et al*., 2001). *Moringa* accelerates rate of young plants, strengthens plants, prolongs life span, increases number of roots, stems and leaves, produces

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more and large fruits and generally increased yield by 20 – 35% (Fugile, 2000). Irrespective of varieties used, 100 ml *Moringa* rate and 100 kg NPK fertilizer rate gave the optimum yield for Sweet potato production under study.

In terms of severity of infection by *Cylas* weevils on the storage roots, stands on plots that received *Moringa* treatments showed very mild symptoms while those on plots that received NPK fertilizer treatments and the control plots showed severe symptoms of infestation (Table 3). Fugile (2001) reported that *Moringa* extracts improved resistance to pests and diseases.

Fig 1: *Cylas formicarius C*

Figure 2: Storage damage caused by *Cylas* spp

Table 1: Proximate analysis of Moringa fresh leaves and dry leaf powder Per 100 gram of the edible portion.

Components	Fresh leaves	Leaf powder	Bark powder
Moisture (%)	75.0	7.5	45.4
Calories	92	205	35
Protein (g)	6.7	27.1	5.8
Fat (g)	1.7	2.3	0.8
Carbohydrate (g)	13.7	38.2	5.3
Fiber (g)	0.9	19.2	23.3
Ca (mg)	440	2,003	1,221
Cu (mg)	1.1	0.57	0.87
Fe (mg)	7.0	28.2	19.8
K (mg)	259	1,324	456

Mg (mg)	24	368	25
P (mg)	70	204	136
S (mg)	137	870	23

Table 2: Pre-planting soil Physico-chemical properties in the study area.

Parameters	before planting
pH in water (1:2.5)	5.0
% organic matter	0.52
Total Nitrogen	0.43
P (ppm)	10.3
K (Cmol kg-1)	0.47
Mg (Cmol kg-1)	2.38
Na (Cmol kg-1)	1.44
Clay (%)	36.6
Silt (%)	16.9
Sand	41

Table 3: Severity of infestation of Cylas weevil on the Storage roots of the Selected Sweet Potato

Varieties	M/NPK	Application	No. of Roots with Cylas weevil/plot	Severity Score
Kwara	00	10	4	
Kwara	0	100	10	4
Kwara	0	300	5	4
Kwara	50	0	4	2
Kwara	50	100	4	2
Kwara	50	300	4	3
Kwara	100	0	4	2
Kwara	100	100	3	2
Kwara	100	300	5	2
Imoso	0	0	11	4
Imoso	0	100	4	3
Imoso	0	300	6	2
Imoso	50	0	6	2
Imoso	50	100	4	2
Imoso	50	300	8	3
Imoso	100	0	4	2
Imoso	100	100	4	2
Imoso	100	300	4	2

Key: M- Moringa
Mean SPVD severity score at 10 weeks after planting
where:

1.= No visible SPVD symptoms on all plants in the plot
2.= Very mild symptoms on infected plants
3.= Moderate symptoms on infected plants
4.= Severe symptoms on infected plants and
5.= Very severe symptoms on infected plants (plants are stunted, leaves shriveled)

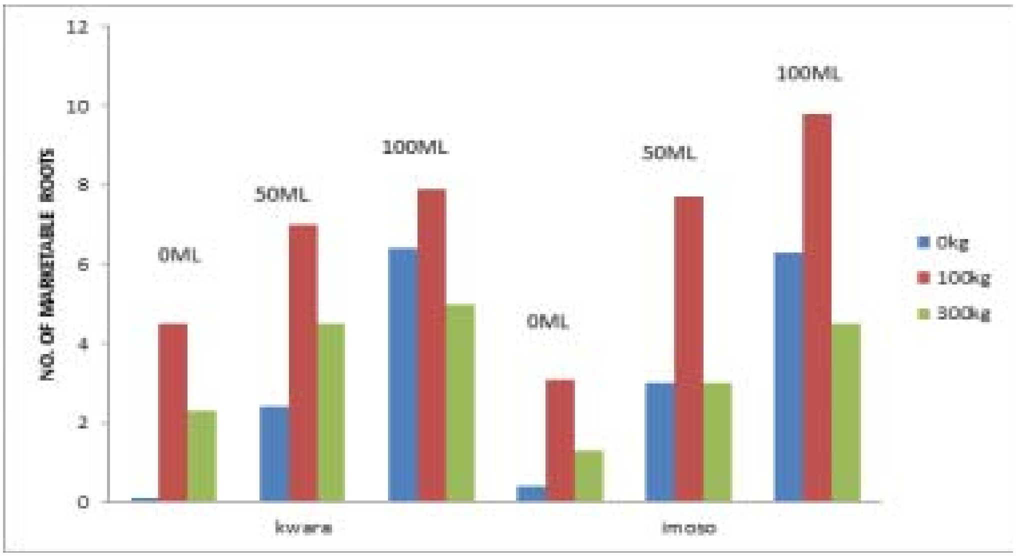

Fig 3: Mean Number of Marketable Roots per Plant of the sweet potato varieties as influenced by *Moringa* extract and NPK fertilizer.

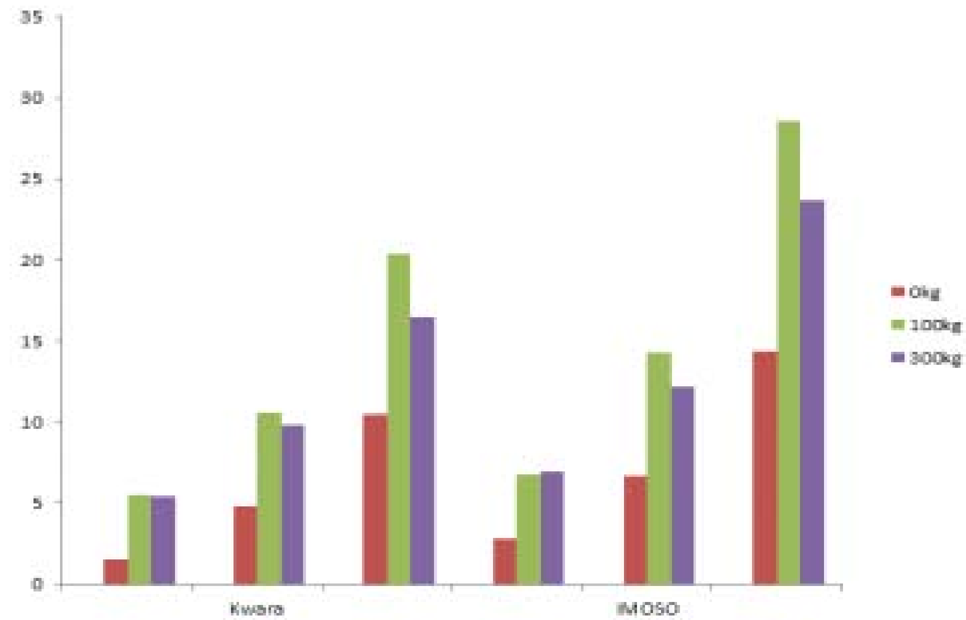

Fig 4: Root yield of Kwara and IMOSO varieties of sweet potato as influenced by NPK fertilizer and Moringa extract

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Table 4a: Post Harvest Soil Chemical Properties as influenced by *Moringa oleifera* Leaf extract and NPK (20:10:10) Fertilizer in Selected Sweet Potato Production in 2017.

Variety	*Moringa* extract	NPK	CEC	pH	Org.C	N	P	K	Mg	Ca	Na	Sand	Silt	Clay
					g/kg/ha		PPM	Cmol/kg		%				
Kwara	0	0	2.61	5.0	1.3	0.4	20.20	0.07	0.7	1.6	1.41	50	14	38
Kwara	0	100	3.8	5.0	1.1	0.6	26.30	0.09	1.4	1.3	1.31	50	15	38
Kwara	0	300	4.2	5.0	0.8	1.1	26.8	1.02	1.0	1.2	1.32	50	16	37
Kwara	50	0	4.6	5.5	2.0	1.3	18.4	1.14	1.43	1.8	0.81	48	14	38
Kwara	50	100	5.4	5.5	2.6	1.8	20.1	1.16	1.31	1.5	0.92	50	15	36
Kwara	50	300	5.9	5.4	1.4	2.0	23.1	1.20	1.30	1.3	1.01	49	14	37
Kwara	100	0	4.4	6.6	2.6	2.1	20.3	1.02	1.56	2.1	0.76	50	14	38
Kwara	100	100	5.2	5.8	1.7	2.4	22.6	1.21	1.35	1.8	0.93	50	14	38
Kwara	100	300	6.6	5.6	1.5	2.6	22.9	1.22	1.32	1.6	0.93	49	16	37
Imoso	0	0	3.2	5.4	1.3	0.3	18.4	0.07	0.7	1.4	1.36	50	15	36
Imoso	0	100	3.7	5.3	1.8	0.6	22.6	0.09	1.31	1.2	1.22	48	16	38
Imoso	0	300	4.2	5.2	0.6	1.2	24.3	0.09	1.20	1.0	1.27	49	14	37
Imoso	50	0	4.4	5.6	1.4	1.6	21.2	1.04	1.61	1.8	0.86	50	16	38
Imoso	50	100	5.3	5.5	2.1	2.0	23.9	1.11	1.84	1.6	0.96	48	15	37
Imoso	50	300	5.8	5.3	1.7	2.2	24.3	1.15	1.33	1.4	1.14	50	16	37
Imoso	100	0	4.5	6.7	2.6	1.7	21.2	1.11	1.62	2.2	0.67	50	14	38
Imoso	100	100	5.6	6.4	2.2	2.3	25.6	1.20	1.41	1.6	0.88	48	16	38
Imoso	100	300	6.7	6.0	1.4	2.6	25.8	1.23	1.38	1.4	1.05	50	15	37

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Table 4b: Post harvest soil chemical properties as influenced by Moringa oleifera leaf extracts and NPK (20:10:10) fertilizer in sweet potato production in 2018

Varieties	Moringa extract	NPK	CEC	PH	Org	N% g/kg/ha	P	K	Mg Ppm	Ca	Na	Sand	Silt	clay
Kwara	0	0	211	5.0	1.2	0.3	20.10	0.05	0.7	0.6	1.33	48	16	38
Kwara	0	100	3.7	4.8	1.0	0.5	26.20	1.01	1.3	1.5	1.33	50	16	38
Kwara	0	300	4.1	4.6	0.7	1.0	26.7	1.14	1.1	1.7	1.33	50	16	38
Kwara	50	0	4.5	5.4	1.9	1.2	18.3	0.91	1.33	1.9	0.18	48	15	38
Kwara	50	100	5.3	5.4	2.5	1.7	20.0	1.16	1.30	2.1	0.72	48	16	38
Kwara	50	300	5.8	5.3	1.3	1.9	23.0	1.16	1.30	2.1	0.72	48	16	38
Kwara	100	0	5.0	6.5	2.5	2.0	20.2	1.01	1.32	2.1	0.62	48	16	38
Kwara	100	100	5.1	5.7	1.6	2.3	22.5	1.21	1.35	2.3	0.68	48	16	38
Kwara	100	300	6.5	5.5	1.4	2.5	22.8	1.25	1.34	2.3	0.61	48	16	38
Imoso	0	0	5.1	5.3	1.2	0.2	18.3	0.08	1.26	0.6	1.34	50	16	38
Imoso	0	100	5.6	5.2	1.7	0.5	22.5	0.97	0.68	1.2	1.21	48	16	38
Imoso	0	300	5.2	5.1	0.5	1.1	24.2	1.11	1.31	1.2	1.31	48	16	38
Imoso	50	0	5.3	5.5	1.3	1.5	21.1	0.96	1.25	1.3	0.85	48	16	38
Imoso	50	100	5.2	5.4	2.0	1.9	23.8	1.04	1.51	1.7	0.75	48	16	38
Imoso	50	300	5.7	5.2	1.6	2.1	24.2	1.13	1.34	2.1	0.75	48	16	38
Imoso	100	0	5.4	6.6	2.5	1.6	21.1	1.05	1.35	2.1	0.68	48	16	38
Imoso	100	100	5.5	6.3	2.1	2.2	25.5	1.22	1.37	2.3	0.61	48	16	38
Imoso	100	300	6.6	5.9	1.3	2.5	25.7	1.25	1.41	2.3	0.60	48	16	38