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Effect of different *Moringa oleifera* extracts and fruit peels on the growth of *Solanum scabrum*

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ABSTRACT

There is a continuous search for natural and safe sources of plant nutrients to replace inorganic fertilizers. *Moringa oleifera* is one of such alternatives that have been investigated to ascertain its effect on the growth and yield of other crops. Other sources need to be explored. This study investigated the effect of *Moringa oleifera* extracts and a mixture of orange and banana peels on the growth and vegetable yield of *Solanum scabrum* Mill, an underutilized, highly nutritious and medicinal leafy vegetable. Leaf, shoot and leaf residue *Moringa* extracts were applied to different sets of four weeks old seedlings. The two fruit peels were mixed thoroughly and applied to the soil around another set of plants. Growth parameters were compared with plants to which NPK or no fertilizers had been added (control). All *Moringa* extracts significantly improved growth performance of *S. Scabrum* seedlings when compared with the control. Some growth parameters especially leaf area and shoot height were enhanced by fruit peel extracts but did not translate to higher plant dry weight. NPK fertilized plants outperformed plants treated with *Moringa* leaf extracts by only approximately 10% increase in growth parameters where applicable. Fruit peels appear to be promising as bioorganic fertilizers.

Keywords: Bio-organic fertilizers, indigenous leafy vegetable, African nightshade.

INTRODUCTION

Vegetables are cheap sources of minerals, vitamins, and fiber in many African diets which are majorly carbohydrate staples. They are included in meals mainly for their nutritional value. They can also be used to augment meals for the sick and convalescence because of their medicinal properties. One of such vegetables is *Solanum scabrum* Mill. It is commonly called Ogunmo in the Southwestern part of Nigeria, also known as garden huckleberry, black nightshade or African nightshade. It belongs to the family *Solanaceae*. It is one of the indigenous underutilized vegetables in Southwest Nigeria. It can be differentiated from other members of the Genus (*Solanum*) by its rapidly growing broad leaves and big purple berries (Abukutsa-Onyango and Karimi, 2005).

In Africa, *Solanum scabrum* is cultivated as a leaf vegetable. The leaf extract can be used to treat diarrhea, certain eye

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infections and jaundice in children. Raw fruits are also used to treat stomach ulcers when chewed and swallowed (Musyimi et al., 2012). Helping women improve the production of more nutritious, high-value products such as vegetables will not only increase family income but also promote ground-level nutrition by increasing the amount of healthy food available for home consumption (Idowu et al., 2014).

Fertility of the soil is important if successful cultivation is to be achieved, making the application of fertilizers and manures to soil imperative. The dependency on the use of inorganic fertilizers as a source of plant nutrients by farmers and their high cost is associated with land and soil degradation and environmental pollution (Phiri, 2010). In recent years, the use of organic fertilizers or biostimulants that can be applied in agriculture to improve quali-quantitative crop yields has encountered increasing interest. Biostimulants are gaining importance also for their possible use in organic and sustainable agriculture, to avoid excessive fertilizer applications (Tarantino et al., 2015). *Moringa oleifera* is a source of such bio-organic substances, being investigated to ascertain its effect on growth and yield of crops. Extracts from *M. oleifera* has been reported by many authors (Abdalla, 2013; Anyaegbu, 2014; Aslam et al., 2016) as growth enhancer. Investigations carried out on the effect of different formulations of fruit peels also revealed that they increased fertility of soil and soil microorganisms and that most of the fruit peels contain potassium, vitamins, minerals and some essential elements which enhance the growth of plants (Mercy et al., 2014; Omoni et al., 2015). High dry matter content (low moisture) has also been obtained for *C. sesamoïdes* and *J. tenella* under organic fertilization (cowpat) (Sossa-Vihotogbe, 2013). The objective of this study was to investigate the effect of banana and orange fruit peels and different *M. oleifera* extracts on the growth of *S. scabrum*.

MATERIALS AND METHODS

Experimental plants

Seeds of *Solanum scabrum* were collected from Faculty of Agriculture, Obafemi Awolowo University,Ile-Ife, Osun State (7^0 31' N; 4^0 31' E). The seeds were treated with Ceiber-Plus (a fungicide) to prevent fungal attack, germinated and utilized in this experiment. The treated *Solanum scabrum* seeds were planted by broadcasting them onto top soil contained in nursery bowls. The seeds were watered twice daily. Emergence of seedlings occured one week after planting. Two weeks after germination, the seedlings were transplanted into plastic pots (22.1 cm and 22.5 cm in diameter and depth respectively) filled near the brim with top soil. Each pot contained four plants and was arranged in a completely randomized design.

The experimental treatments included N.P.K (20:10:10) 200 kg ha^{-1}, Fruit peels of orange and banana, aqueous solution of *Moringa* leaves, Solid extracts (leaf residue) of *Moringa* leaves, solution from soaked *Moringa* barks and cut branches, and the control (without any treatment). Fruit peels were sun dried. The dried fruit peels were prepared by powdering each individually and then sieved. 40 g each was taken from the orange and banana fruit peel powder and mixed thoroughly. The mixed fruit peel was then applied to the base of each plant at the rate of 200 kg ha^{-1} every 2 weeks. All *Moringa* treatments were based on Anyaegbu (2014). The aqueous solution of *Moringa* leaves was prepared by pounding 200 g of *Moringa* leaves in a mortar. Two liters of water was added to this, stirred properly for about 5 min, allowed to soak for 30 min and then filtered using a sieve. The plants were treated every week with 25 ml of extract. The solid substance left after filtration was also

kept as experimental treatment (leaf residue). Each plant received 2 g of the leaf residue of *Moringa* around it 2 cm away from the base of the plant and in 10 cm radius, every 2 weeks. For the bark and cut branches decoction, the bark of the stem and fresh, newly developing branches were cut into bits, 2 g of the stem bark and 2 g of the branches were soaked in 2 L distilled water for 48 hours before use. The plants were treated every week with 25 ml of extract. No treatment was applied to the control plants. All plants were watered daily. Sampling was carried out by destructive analysis on a weekly basis starting from the first week after the application of the treatments (Three weeks after germination).

Statistical analysis

Data collected include, shoot height, root length, number of leaves, leaf area, plant fresh and dry weight. Analysis of variance was carried out on SAS software and means were separated using LSD Fisher test at 0.05 confidence limit.

RESULTS

Results presented in Table 1 show that fruit peels significantly enhanced the shoot height of *S. scabrum* plants as compared with untreated plants (50.6% taller) and more than plants from soil supplemented with different *M. oleifera* extracts. It was only 16.2% lower than plants in which NPK was applied by the 5th week of treatment. The highest percentage increase in shoot height from *M. oleifera* treated plants was from *Moringa* leaf residue (39.7%).

Number of leaves was also significantly enhanced by the application of fruit peels being significantly higher (23.7% increase) than plants in which NPK and *Moringa* treatments were applied. By the 5th week of growth, leaf area of plants in which soils were treated were significantly higher than plants from untreated soils; fruit peels (33%), *Moringa* leaf residue (MR) (44%), *Moringa* shoot extract (MSE) (46%), *Moringa* leaf extract (MLE) (60%) and NPK (68%).

Though significantly higher than untreated plants, lack of nitrogen also translated to significantly lower plant fresh weight by the application of fruit peels as compared with NPK and *M. oleifera* treated plants. Plant dry weight was also significantly reduced by the application of fruit peels compared with both untreated and other treated plants. Yield of leafy vegetables is quantified in terms of biomass, therefore among the organic treatments, *Moringa* leaf residue stimulated the highest enhancement of biomass (56%) in *S. scabrum* plants although there was no significant difference between all the *Moringa* treatments.

Root length was only significantly enhanced by fruit peels by the second week of analysis. However, by the fifth week of analysis, the root length of plants treated with fruit peels was not significantly different from the control plants.

Table 1: The effect of different *M. oleifera* extracts and fruit peels on the growth parameters of *S. scabrum.*

	SH	RL	NL	LA	PFW	PDW
WEEK1						
CRL	5.05^{b}	3.75^{c}	5.75^{ba}	3.38^{b}	0.55^{bc}	0.07^{b}
BIO	6.82^{a}	4.75^{bc}	5.50^{b}	4.36^{ba}	0.35^{c}	0.03^{c}
MR	6.38^{ba}	6.61^{ba}	6.25^{ba}	6.19^{a}	0.84^{ba}	0.09^{b}
MSE	7.11^{a}	6.14^{ba}	6.37^{ba}	2.86^{b}	1.07^{a}	0.06^{bc}
MLE	7.62^{a}	6.77^{a}	5.85^{ba}	4.33^{ba}	0.63^{bc}	0.07^{b}
NPK	6.25^{ba}	7.71^{a}	7.12^{a}	3.75^{ba}	1.18^{a}	0.14^{a}

WEEK 2						
CRL	11.05^{c}	7.46^{b}	8.75^{bc}	6.61^{c}	3.28^{b}	0.27^{c}
BIO	19.14^{a}	15.09^{a}	9.37^{bc}	12.75^{ba}	3.97^{b}	0.26^{c}
MR	11.04^{c}	5.60^{b}	8.25^{c}	8.92^{bc}	3.37^{b}	0.37^{bc}
MSE	12.84^{bc}	9.09^{b}	10.00^{ba}	8.42^{bc}	5.11^{b}	0.49^{ba}
MLE	11.95^{bc}	9.21^{b}	8.12^{c}	6.53^{c}	3.34^{b}	0.26^{c}
NPK	14.57^{b}	8.51^{b}	10.87^{a}	13.93^{a}	7.57^{a}	0.65^{a}
WEEK 3						
CRL	16.56^{c}	19.31^{ba}	10.75^{ba}	8.88^{d}	6.25^{cd}	0.83^{ba}
BIO	24.77^{ba}	14.92^{b}	13.25^{a}	16.93^{cb}	8.17^{cb}	0.67^{b}
MR	25.19^{a}	18.11^{ba}	10.75^{ba}	20.66^{b}	3.31^{d}	0.37^{b}
MSE	23.42^{ba}	22.09^{a}	13.00^{a}	15.41^{cb}	11.33^{b}	1.41^{a}
MLE	20.27^{bc}	20.12^{ba}	9.25^{b}	13.01^{cd}	5.45^{cd}	0.72^{b}
NPK	27.63^{a}	24.55^{a}	10.87^{ba}	29.71^{a}	18.90^{a}	1.47^{a}
WEEK 4						
CRL	25.07^{d}	18.59^{b}	12.00^{ba}	15.38^{c}	12.27^{cbd}	0.96^{cd}
BIO	34.76^{cb}	18.26^{b}	10.87^{b}	20.86^{cb}	7.15^{d}	0.79^{d}
MR	39.87^{b}	23.23^{ba}	14.12^{a}	23.20^{cb}	11.07^{d}	0.78^{d}
MSE	35.76^{cb}	24.06^{ba}	12.50^{ba}	24,82^{b}	9.70^{b}	2.07^{b}
MLE	30.95^{cd}	27.05^{a}	11.87^{ba}	24.47^{b}	15.23^{cb}	1.56^{cb}
NPK	49.95^{a}	28.10^{a}	13.37^{ba}	44.36^{a}	41.45^{a}	3.12^{a}
WEEK 5						
CRL	29.06^{d}	14.51^{c}	10.87^{d}	17.35^{c}	14.41^{c}	1.43^{cb}
BIO	58.84^{b}	17.49^{bc}	22.62^{a}	25.98^{cb}	26.97^{cb}	0.53^{c}
MR	48.22^{c}	26.59^{a}	15.87^{cb}	30.98^{b}	34.49^{b}	3.26^{b}
MSE	44.70^{c}	24.69^{a}	13.25^{cbd}	31.92^{b}	30.33^{b}	2.85^{b}
MLE	46.55^{c}	21.81^{ba}	12.75^{cd}	43.52^{a}	34.50^{b}	2.81^{b}
NPK	70.25^{a}	21.11^{a}	17.25^{b}	54.53^{a}	64.50^{a}	6.32^{a}

(Similar letters within columns are not significantly different at p> 0.05 using Fisher's Least Significant Difference).
Key: CRL= Control; BIO= Banana and orange fruit peels; MR= *Moringa* leaf residue; MSE= *Moringa* bark and branch extract; MLE = *Moringa* leaf extract; NPK= NPK 20:10:10; SH= Shoot Height; RL= Root Length; NL= Number of Leaves; LA= Leaf Area; PFW= Plant Fresh Weight; PDW= Plant Dry Weight.

DISCUSSION

Fruit peels significantly enhanced the shoot height of *S. scabrum* plants. This could be as a result of the fact that dried banana and orange peels are very rich in potassium and calcium (Assa et al., 2013; Kadir et al., 2016). Potassium promotes the movement of water and nutrients between cells. It also strengthens stems and calcium is required for cell wall formation. Leaf extracts of *M. oleifera* have been reported to accelerate growth of young plants and strengthen plants (Fuglie, 2000). *M. oleifera* leaf and twig extracts have also been reported to significantly enhance the height of *Eruca vesicaria* plants (Abdalla, 2013).

Yeh et al., (2000) reported that phosphorus deficient plants grew slowly with fewer leaves, smaller individual leaf size and total leaf area. Banana and orange peels are very rich in phosphorus (Assa et al., 2013; Kadir et al., 2016). This could have accounted for faster development of leaves translating to higher number of leaves by the application of fruit peels. *Moringa* leaf and twig extracts have been reported to contain crude proteins (43.5%) and growth promoting hormones like auxins and cytokinins (Makkar and Becker, 1996; Moyo et al., 2011). This could be implicated in the significantly higher leaf area from *M. oleifera* treated plants as compared

with fruit peels which lack nitrogen since proteins are essential for the formation of the protoplasm, while growth hormones favored rapid cell division, cell multiplication and enlargement (Abdalla, 2013).

Significantly lower plant fresh weight by the application of fruit peels as compared with NPK and *M. oleifera* treated plants may be as a result of high moisture content in NPK treated plants. Sossa-Vihotogbe (2013) reported that high dry matter content (low moisture) was obtained for *C. sesamoïdes* and *J. tenella* under organic fertilization. *M. oleifera* treatment is also an organic treatment but had higher fresh weight. The fact that the high fresh weight also translated to high dry weight suggests that it is not only an issue of moisture content but the development of biomass. Higher biomass is obtained in plants when there is availability of Nitrogen which is reflected in the NPK treated plants. *Moringa* leaves have also been reported to contain growth enhancing properties (Anyaegbu, 2014). In most cropping soils plant-available nitrogen is present in insufficient quantities to allow plants to achieve maximum yields. This is not only because nitrogen is required in relatively large amount by plants but also because nitrogen is highly mobile within the soil plant-atmosphere cycle (Gbenou et al., 2018). The rate of nutrient release is also a factor to consider. Makinde and Ayoola, (2010) reported low dry matter in *S. radiatum* leaves as a result of slow release of nutrients by organic fertilizers.

The result shows the ability of *Moringa* extracts to enhance the growth of roots. Root lengths of *Moringa* treated plants were longer though not significantly different from those of plants treated with NPK. A combination of *Moringa* extracts and fruit peels will likely bring about a synergistic effect that will enhance growth of *Solanum scabrum* plants. This needs to be investigated.

Conclusion

The present study confirms that these plant materials (*Moringa* extracts and fruit peels) can be effective in stimulating the growth of plants. *Moringa* extracts consistently increased plant biomass across the weeks. The formulation of fruit peels utilized show some benefits on some of the growth parameters but could not enhance leaf yield. Therefore, further studies are needed to determine sources of nitrogen (probably *Moringa* extracts) that may be suitable as additives to banana and orange peels in order to enhance their effectiveness as bio-organic fertilizers.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

AMAS designed the project, was involved in evaluation and interpretations and wrote the final draft of the manuscript. Other authors managed data collection, were involved in evaluation and interpretations and wrote the initial drafts of the manuscript.

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