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Original Article

EVALUATION OF SOIL AMENDED WITH HOG-NOSED BAT (*CRASEONYCTERIS THONGLONGYAI*) MUCK ON THE IMPROVEMENT OF MINERAL ELEMENT CONTENTS OF FLUTED PUMPKIN (*TELFAIRIA OCCIDENTALIS*)

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ABSTRACT

With exception of fruits, leafy vegetables are major sources of mineral elements for maintenance of good health and prevention of diseases. The concentrations of minerals in vegetables are significantly influenced by physical and chemical properties of the soil. It is for this reason that pot experiment was conducted to evaluate the influence of different levels of *Craseonycteris thonglongyai* muck on the concentrations of some mineral elements (Mg, Cu, Na, Fe, Zn, Ca, and K) in the leaf of *Telfairia occidentalis*. The different levels of *C. thonglongyai* muck used for growing the vegetable were the Control (no application), 25, 50 and 75 g per 20 kg soil. Leaves of *T. occidentalis* were harvested at vegetative phase and the analyses of mineral contents were done using Atomic Absorption Spectrophotometer (AAS) for Fe, Zn, Cu, Ca and Mg; and Flame Photometer for Na and K. The results showed that the concentrations of Zn and Ca in *T. occidentalis* increased significantly ($P<0.05$) with increase application of *C. thonglongyai* muck except that the Zn content in the vegetable fertilized with 75 g of muck decreased significantly ($P<0.05$). While application of different levels of *C. thonglongyai* muck had no significant effect on Fe content in *T. occidentalis*, the concentration of K in the vegetable decreased significantly. Whereas, treatment with 25 g of the muck had no significant effect on the concentrations of Cu, Mg and Na, their contents were elevated significantly ($P<0.05$) when the vegetable was cultivated with 50 and 75 g *C. thonglongyai* muck. However, the concentrations of these minerals in the vegetable treated with 50 and 70 g were not significantly different from each other. The results of this present study conclude that application of moderate quantity of *C. thonglongyai* muck elevates the mineral contents in *Telfairia occidentalis*.

Keywords: *Telfairia occidentalis*, vegetative phase, *Craseonycteris thonglongyai* muck, mineral elements

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INTRODUCTION

Vegetables are widely consumed for health and nutritional benefits as they are one of major sources of micronutrients required for maintenance of good health and prevention of diseases. Some of these micronutrients include minerals, vitamins, amino acids and antioxidants and they play vital roles in nutrients metabolism and prevention of degenerative diseases (Musa, 2010).

Fluted pumpkin is a creeping plant that spread low across the ground with large lobed leaves, and extensive twisting tendrils (Christian, 2006; Ojiako and Igwe, 2008). The vegetable is one of the leafy vegetables that are grown across the low land humid Tropics in West Africa and the plant does well in loose and friable ample humus (Schippers, 2000). Nitrogen is vital for sufficient vegetation and should ideally be given in the form of manure (Schippers, 2000). Harvesting of *T. occidentalis* takes place 120 - 150 days after planting (Horsfall and Spiff, 2005). *T. occidentalis* is an important leafy vegetable in West African because of the high nutrient contents abound in it (Nkang *et al*., 2003). The leaves of *T. occidentalis* are widely eaten as they are good sources of micronutrient such as mineral elements (Fe, Mg, Cu, Ca, Zn K, Na and P), vitamins (such as vitamin C, β-carotene), fibres and fats (Schipper, 2000; Nkang *et al*., 2003; Christian, 2006; Ogbadoyi *et al*., 2011; Musa *et al*., 2011; Musa and Ogbadoyi, 2012).

The concentrations of nutrients in *Telfairia occidentalis* like other vegetables depend on the nutrient contents and composition of the soil. *Craseonycteris thonglongyai* muck is one of the organic fertilizers used to amend the soil in order to improve plant growth and development (Emerson and Roark, 2007). The muck is a highly effective fertilizer due to exceptional high contents of nitrogen, phosphorus and potassium which are essential nutrients for plant growth. *C. thonglongyai* muck also contains some microorganisms whose activities in soil help to recondition the soil for proper nutrient uptake by plant (Emerson and Roark, 2007; Musa *et al*., 2016). Despite the use of the muck for growing vegetables such as *T. occidentalis*, there is paucity of information on the effect of the muck on the nutrient contents in the vegetable. It is against this background that this present study was designed to evaluate the influence of different levels of *Craseonycteris thonglongai* on the uptake and bioaccumulation some mineral elements (Mg, Cu, Na, Fe, Zn, Ca, and K) in the leaf of *Telfairia occidentalis*.

MATERIALS AND METHODS

Study area

Pot experiment was conducted in the experimental farm of the Faculty of Agriculture, Ibrahim Badamasi Babangida University Lapai, Niger State, Nigeria. Lapai is situated in the Southern Guinea Savanna region, on latitude 8^{o} 49'N and longitude 6^{o} 41'E. The raining season of Lapai occurs between April – October with mean annual rainfall of 1334 mm. The peak rainfall of between 300-330 mm is usually recorded in August and September, while the maximum mean monthly temperature of Lapai (30-40^{o}C) is usually March and the minimum (22.3^{o}C) in August.

Collection of *Craseonycteris thonglongyai* muck and seeds of *Telfairia occidentalis*

The *C. thonglongyai* muck used for this study was collected into a polythene sack from a cave in Faso village of Edati Local Government Area of Niger State,

Nigeria while the seeds of *T. occidentalis* were obtain from the Teaching and Research Farm of Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State.

Collection of soil sample and analysis

Soil samples used for the present experiment were collected from 3 different positions in the main campus of Ibrahim Badamasi Babangida University, Lapai. The surface soil (0-20 cm) was collected, mixed and sieved to remove wreckage. The physical and chemical properties of the *C. thonglongyai* muck and soil sample were analysed according to the method of Juo (1979).

Manure treatment and application

The *C. thonglongyai* muck was collected in the dry form and ground into powder. The fine particles of the muck were applied to cultivate *T. occidentalis* in pot experiment at four different levels, which are; control (No application), 25, 50 and 75 g per 20 kg soil.

Experimental design, planting and nursery management

Experimental design adopted for this study was Complete Randomizes Design (CRD) to evaluate the effect of *C. thonglongyai* muck on the concentrations of some mineral elements in *T. occidentalis.* Each treatment had 10 pots replicated 3 times and this gave a total of 120 pots for the experiment.

Two seeds of *T. occidentalis* were planted in a polythene bag filled with 20.00 kg of top soil (0-20 cm) and after germination; the seedlings were thinned to one plant per pot.

The seedlings were watered twice daily (morning and evening) using watering can and weeded regularly. The experimental area and the surroundings were kept clean to prevent harbouring of pest. The pots were lifted from time to time to prevent the roots of the plant from growing out of the container (Musa *et al.*, 2016).

Plant tissue analysis

The mineral elements in the leaves of *Telfairia occidentalis* were analysed according to the method of Ezeonu *et al*. (2002), the concentrations of Ca, Cu, Fe, Mg and Zn were determined with Atomic Absorption Spectrophotometer (AAS) while Flame Photometer was used to evaluate the concentrations of Na and K in the samples.

Data Analysis

Analysis of variance (ANOVA) was performed using SPSS statistical package to determine the variation between different levels of *C. thonglongyai* muck on the concentrations of some mineral elements in the leaves of *T. occidentalis*. The DUNCAN's Multiple Range Test (DMRT) was used for comparison means and significant difference was accepted at values of $p < 0.05$.

RESULTS

Physical and Chemical Properties of Soil

Table 1 showed the results of physical and chemical properties of soil used for pot experiment. The texture class of the soil is sandy loam which indicates that the water holding capacity is moderate. Total nitrogen, CEC (cation exchange capacity), organic carbon, Ca, K and K of the soil were low while the Mg content was moderate; however, the available phosphorus of the soil was high. The pH of the soil showed that the soil is slightly acidic.

Table 1: Physical and chemical properties of the soil (0 – 20 cm) used for pot experiment

Parameters	Values
Sandy (g kg-1)	95.27
Silt (g kg-1)	5.97
Clay (g kg-1)	0.38
Textural class	Sandy loam
pH (H_2O)	6.72
pH ($CaCl_2$)	5.97
Organic carbon (g kg-1)	4.64
Total nitrogen (g kg-1)	0.18
Available phosphorus (mg kg-1)	51.90
Na^+ (cmol kg-1)	0.23
K^+ (cmol kg-1)	0.07
Mg^{2+} (cmol kg-1)	1.42
Ca^{2+} (cmol kg-1)	1.18
Acidity (cmol kg-1)	0.15
CEC (cmol kg-1)	2.97
EC(cmol kg-1)	1.32

CEC = Cation exchange capacity, EC = Exchangeable cation. Values represent means of triplicate determinations

Table 2: Physical and chemical properties of the *Craseonycteris thonglongyai* muck

Parameters	Values
Sandy (g kg-1)	72.15
Silt (g kg-1)	18.56
Clay (g kg-1)	10.30
Textural class	Loam
pH (H_2O)	7.66
Organic carbon (g kg-1)	32.50
Total nitrogen (g kg-1)	7.60
Available phosphorus (mg kg-1)	8744.30
Na^+ (cmol kg-1)	3.18
K^+ (cmol kg-1)	12.90
Mg^{2+} (cmol kg-1)	3.84
Ca^{2+} (cmol kg-1)	2.84
Acidity (cmol kg-1)	1.32
CEC (cmol kg-1)	22.91
EC(cmol kg-1)	3690

CEC = Cation exchange capacity, EC = Exchangeable cations. Values represent means of triplicate determinations.

Physical and Chemical Properties of *Craseonycteris thonglongyai* muck

Result of physical and chemical properties of *C. thonglongyai* muck used for experiment indicated that it is slightly basic in H_2O with very high organic carbon content. The total nitrogen, potassium, magnesium and sodium and available phosphorus were very high while calcium was low (Table 2).

Concentration of mineral elements in *Telfairia occidentalis* treated with *Craseonycteris thonglongyai*

The results showed that the concentrations of Zn and Ca in *T. occidentalis* increased significantly ($P < 0.05$) with application of different levels of *C. thonglongyai* muck except that the Zn content in the vegetable amended with 75 g of muck decreased significantly ($P < 0.05$). The mean

values of Zn in *T. occidentalis* recorded for control, 25, 50 and 75 g of *C. thonglongyai* muck per 20 kg soil were 0.97 ± 0.04, 1.15 ± 0.08, 1.17 ± 0.13 and 0.70 ± 0.18 respectively, while the corresponding values for Ca were 291.26 ± 66.84, 331.41 ± 18.19, 363.10±9.94 and 351.06 ± 22.94, respectively (Table 3).

Similarly, application of different levels of *C. thonglongyai* muck had no significant ($P > 0.05$) effect on Fe content in *T. occidentalis*, however, the concentration of K in the vegetable decreased significantly ($P < 0.05$) with the application of different levels of *C. thonglongyai* muck (Table 3).

Whereas, treatment with 25 g of the muck had no significant effect on the concentrations of Cu, Mg and Na in *T. occidentalis*, the concentrations of these parameters were elevated significantly ($P < 0.05$) when the vegetable was cultivated with 50 and 75 g *C. thonglongyai* muck. However, the concentrations of these minerals in *T. occidentalis* treated with 50 and 70 g did not differ significantly from each other (Table 3).

Table 3: Effect of different levels of *Craseonycteris thonglongyai* muck on concentrations of some mineral elements in *Telfairia occidentalis*

Mineral elements (mg kg^{-1})	Levels of *Craseonycteris thonglongyai* muck (g)			
	Control (0)	25	50	75
Cu	0.53 ± 0.01^{a}	0.72 ± 0.016^{a}	0.95 ± 0.09^{b}	1.13 ± 0.021^{b}
Zn	0.97 ± 0.04^{b}	1.15 ± 0.08^{c}	1.17 ± 0.13^{c}	0.70 ± 0.18^{c}
Fe	5.02 ±0.91^{a}	5.64 ± 0.14^{a}	6.53 ± 0.33^{a}	4.48 ± 0.51^{a}
Ca	291.26 ± 66.84^{a}	331.41 ± 18.19^{b}	363.10±9.94^{b}	351.06 ± 22.94^{b}
Mg	44.04 ± 3.84^{a}	45.20 ± 0.96^{a}	53.14 ± 1.96^{ab}	66.03 ± 0.08^{b}
Na	18.00 ± 2.00^{a}	22.00 ± 2.00^{a}	50.00 ± 5.20^{b}	52.00 ± 8.00^{b}
K	204.00 ± 12.00^{b}	99.00 ± 15.00^{a}	90.00 ± 10.00^{a}	90.00 ± 0.00^{a}

Mean values across the same row with different superscript are significantly different ($p < 0.05$).

DISCUSSION

The increase in the contents of Ca, Cu, Zn, Mg and Na in the leaf of *T. occidentalis* with application of *C. thonglongyai* muck corroborate submissions of Arisha *et al*. (2003), Masarirambi *et al*. (2010), Funda *et al*. (2011) and Mofunanya *et al*. (2015) who observed that organic fertilizers elevate the concentrations of mineral elements in vegetables. Arisha *et al*. (2003) put forward that organic fertilizers stimulate many species of microorganisms, increase the microbial activity of soil and stimulate the plant growth and nutrients uptake. Similarly, Magkos *et al*. (2003) observed high concentrations of mineral elements in organic vegetables. Masarirambi *et al*. (2010) stressed that the elevation in the concentrations of Zn, Fe and Ca in *Lactuca sativa* produced by bounce back compost is due to the balanced quantity of nutrients in the bounce back compost. It, therefore, follows that the increase in the concentrations of Ca, Cu, Zn, Mg and Na in the leaf of *T. occidentalis* with application of *C. thonglongyai* muck implies a direct interaction between nutrient contents of the soil and bioaccumulation of nutrients by the vegetable. This may be due to fact that *C. thonglongyai* muck, which is organic manure, contains some microorganisms. The activity of these microorganisms with high nutrient content of the muck may increase the organic matters and soil biological interactions that are able to recondition the soil for nutrients uptake and promote plant health (Musa *et al*., 2016). This observation agrees with the reports of Mofunanya *et al*. (2015) to the effect that organic manure increased mineral contents in *Amaranthus spinosus*. There is also a strong fact that the muck of *C. thonglongyai* acts as fungicide in the soil, by degrading fungi along with other organic materials and thereby reconditions soil, keeping the plant in good health and free of disease (Musa *et al*. 2016; Heldt, 2005). Plants with good health and diseases free with sufficient nutrients in the soil have been associated with high nutrients uptake from the soil for metabolic and physiological and activities.

The insignificant effect of the muck on the concentration of Fe and the decrease in the concentration of K in *T. occidentalis* following application of *C. thonglongyai* muck which is in contrary with the above observation may perhaps put forward that the influence of *C. thonglongyai* muck on the uptake of minerals from the soil could depend on the mineral element under investigation among other factors.
However the significant reduction in the concentration of Zn in *T. occidentalis* fertilized with 75 g of *C. thonglongyai* muck may suggest that even though organic fertilizers enriched the soil and promote plant growth and improve nutrients uptake, excess application could alter the physico-chemical properties of soil that may adversely reduce the uptake of the some nutrients. Therefore, it will be appropriate to applied moderate amount of organic manure in growing vegetables for optimum nutrients uptake from the soil. In this present study, 50 g of *C. thonglongyai* muck per 20 kg soil may be suitable for growing *T. occidentalis* for optimal uptake of the minerals from the soil.

CONCLUSION

The results conclude that moderate application of *C. thonglongyai* muck for the cultivation of *T. occidentalis* could improve the uptake and accumulation of mineral elements in the vegetable. This practice may go a long way in alleviating

the public health problems associated with micronutrients deficiency which is prominent in West African.

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