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EFFECT OF DIFFERENT SOIL FERTILITY AMENDMENTS ON OXALATE ACCUMULATION IN COCOYAM

Olatunde Kofoworola[1*]; Kolawole Adebayo[2]; Bada Babatunde[1]; Ojekunle Oluseyi[1] and Towolawi Taofik

[1]Department of Environmental Management and Toxicology, Federal University of Agriculture Abeokuta, Nigeria
[2]Department of Agricultural Extension and Rural Development, Federal University of Agriculture Abeokuta, Nigeria

ABSTRACT

The availability of cheaper food energy sources which compares favourably well with other high priced cereals is of utmost importance and should be encouraged. Cocoyam presents such an opportunity as it can compete with other contemporary root crops like cassava, yam and potatoes with respect to its proximate and mineral contents. It however contains anti-nutritive components which may limit its utilization. This study investigated the effect different soil fertility amendment options (Urea, NPK, Single phosphate and organic fertilizer) have on the oxalate content of cocoyam cormels. Oxalate contents (mg/Kg) of cocoyam tubers ranged between 63.30 – 79.27: Urea; 66.13 – 92.80: single phosphate; 66.53 – 99.83: NPK and 66.93 – 97.15: organic fertilizer. Application of the different types of fertilizers was observed not to have any influence on the total oxalate accumulation in cocoyam cormels. Similarly, varying the levels of each soil amendment used was also observed not to have a significant effect ($P<0.05$) on the potential of cocoyam to accumulate oxalates in the tubers indicating that oxalic acid accumulation in cocoyam may be an intrinsic property of the crop and not as a result of differences in the type of available nutrient ions present in the soil.

Keywords: Cocoyam, Anti-nutrients, Oxalates, Urea, Single phosphates, organic fertilizer

INTRODUCTION

Cocoyam unlike other root and tuber crops contains anti-nutritive components such as phytates, oxalates, saponins and cyanides which have the potential to bind calcium, zinc, iron and other minerals, thereby reducing their availability in the body (Babayemi, 2009). In addition, the tubers are generally perceived as food for the impoverished thereby limiting its research attention which threatens its utilization.

[1]The role of some agronomic, climatic and genetic factors in minimizing oxalate accumulation in forage plants has been discussed (Rahman and Kawamura, 2011). Research has indicated that oxalate accumulation in forage can be controlled by fertilizer application. Xu *et al.* (2006) observed that nitrate application resulted in higher oxalate accumulation in rice and some vegetable crops than did ammonium application. A recent nutrient solution study also suggested that similar effects of nitrate-N were also observed in forage plants

[1*]Corresponding Author: Email: olatundeka@funaab.edu.ng, TEL: +2349059360691

(Rahman *et al*., 2010b). In addition, experiments carried out with napier grass also showed that soluble oxalate content correlates highly with K concentration (Rahman *et al*., 2008b). However, the potential of soil amendment for reducing oxalic acid in cocoyam have not been exploited. Hence, this study assessed the effect of different soil amendment options on the accumulation of oxalates in cocoyam cormels.

MATERIALS AND METHODS

The experiment was carried using the 'Taro' variety *Colocasia esculenta* (L.) Schott which is the most cultivated from field observations. It was laid out in a randomized complete block design, with three replications (Fig 1). The tubers were grown in 25L buckets containing agricultural soils (sand: 78%, clay: 13%) with pH range of 6.84 – 6.9. Other soil parameters include organic carbon 4.04%, total nitrogen 0.38%, organic matter content 6.98%, available phosphorous 58.2 mg/Kg and exchangeable cations K, Na, Ca, Mg as 0.11, 0.16, 6.05 and 1.1cmol/Kg respectively.

Crops were treated to increasing rates of fertilizers: nitrogen supplied as 40% N-Urea, phosphorus (single superphosphate), 2:1:1 NPK and commercial organic fertilizers (Table 1). Leachates were collected in trays placed under perforated planting buckets and returned into buckets to minimize nutrient losses during watering.

Inorganic fertilizers were applied at one month and three months after planting while commercial organic fertilizers were properly incorporated into soils 15 days before planting to allow for integration. During planting, nematicides were placed in planting holes to control nematodes that may cause root rots. Planting pots were maintained weed free by hand pulling throughout the duration of the experiment. Cocoyam cormels were harvested at 9-month maturity and analyzed for Oxalates.

Figure 1: Field trials to investigate the effect of fertilizer modification on Oxalate accumulation in cocoyam.

Table 1: Fertilizer treatments

Amendment	Experimental variations (kg/ ha of soil)			
	A	B	C	D
Urea	60	120	180	240
Single phosphate	14	28	42	56
NPK(2:1:1)	300	600	900	1200
Organic fertilizer	300	600	900	1200

Oxalate determination

Oxalate contents of cocoyam were determined in powdered subsamples using the method of Chinma and Igyor 2007. About 1g of sample was weighed into 100ml conical flask. 75ml 3M H_2SO_4 was added and stirred for 1hr with a magnetic stirrer. This was filtered using a Whatman No 1 filter paper. About 25ml of the filtrate was then taken and titrated while hot against 0.05M $KMnO_4$ solution until a faint pink color persisted. The oxalate content was then calculated by taking 1ml of 0.05m $KMnO_4$ as equivalent to 2.2mg oxalate.

Data Entry and Analysis

Data obtained from analysis were subjected to descriptive statistics. Separation of means was assessed using the ANOVA tool in the IBM SPSS statistical package 21.

RESULTS AND DISCUSSION

The oxalate content of cocoyam cormels harvested from soils amended with different soil amendment options are presented in Table 2. Application of the different types of fertilizers was observed not to have any influence on the total oxalate accumulation in cormels indicating that oxalic acid accumulation in cocoyam may be an intrinsic property of the crop and not as a result of differences in the type of available nutrient ions present in the soil. This observation is in agreement with Rahman *et al*., 2010 who reported that the total oxalate accumulation in Napier grass, a forage crop is not affected by Nitrogen and potassium fertilization.

Variations in the levels of Nitrogen (Urea) applied to the crops had no significant influence on oxalate accumulate in the cocoyam cormels (Figure 1a). This observation is similar to the findings of Kipnis and Dabush (1988) and Rahman *et al*. (2010) where nitrogen applied as ammonium nitrate and urea respectively had no effect of oxalate accumulations in Napier grass.

Some studies (Ji and Peng, 2005; Xu *et al*., 2006) have reported an increase in oxalate content of rice and vegetables with the application of nitrogen in form of nitrates. It has been suggested that nitrates in soil releases hydroxyl ions (OH^{-1}) which stimulates the dissociation of hydrogen ions (H^{+1}) ions to neutralize intracellular pH leaving carboxyl ions to uptake available cations (Ca, Na and Mg)(Allen *et al*., 1988). Urea however produces ammonium ions which acidify the cytoplasm (Schubert and Yan, 1997), which may inhibit the synthesis of oxalates.

Table 2: Total Oxalate concentration in cocoyam as affected by fertilizer application

	Oxalate accumulation(mg/kg)				
	Control	N - Urea	Phosphorous	NPK	Organic Fertilizer
Range	63.30– 3.33	63.30 – 79.27	66.13 – 92.80	66.53 – 99.83	66.93 – 97.15

Analysis of cocoyam cormels also showed that oxalate accumulation was not affected by phosphorous fertilizer application. Adebooye and Oloyede (2007) also observed that oxalate contents in *Trichosanthes cucumerina* were not affected by Phosphorous levels. Organic fertilizers and the compound fertilizer NPK were also observed not to have any effect on the oxalate contents of cormels.

Figure 2 illustrates the oxalate content of cormels grown with varying concentrations of each amendment. Increasing or reducing the levels of these nutrients (N- Urea, P, NPK and organic fertilizers) had no influence on the potential of cocoyam to accumulate oxalates in the tubers (figure 2).

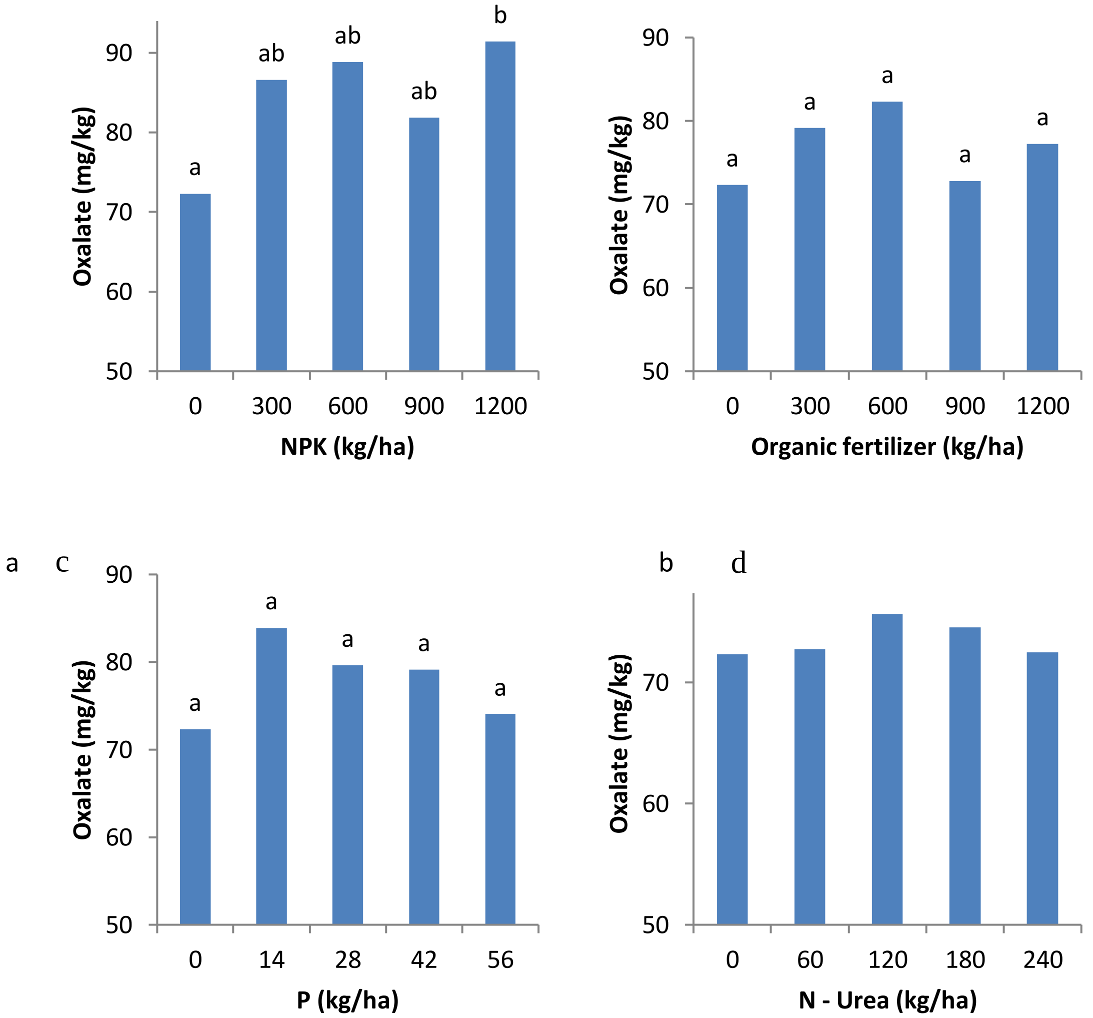

Figure 2(a-d): Effect of varying fertilizer concentration on oxalate accumulation in cocoyam

CONCLUSION

Application of the different types of fertilizers was observed not to have any influence on the total oxalate accumulation in cocoyam cormels similarly, varying the levels of each soil amendment used was also observed not to have a significant effect on the potential of cocoyam to accumulate oxalates in the tubers indicating that oxalic acid accumulation in cocoyam may be an intrinsic property of the crop and not as a result of differences in the type and abundance of available nutrient ions present in the soil.

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