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THE EFFECT OF FERTILIZING TYPE ON SOME HEAVY METALS ACCUMULATION IN COCOYAM

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ABSTRACT

Little were known on heavy metal accumulation in plant due to fertilizing type. This study was carried out to assess the accumulation of some heavy metals in cocoyam leaves from farms fertilized with three fertilizing types -Garbage ash, Animal dropping, NPKand a control. Some heavy metals accumulation on the 16 week old leaves was analyzed using Atomic Absorption Spectroscopy (AAS). The results revealed that Cadmium (Cd), lead (Pb) and Zinc (Zn) were evenly accumulated in all the three fertilizing type and the control while Copper (Cu), Manganese (Mn) and Iron (Fe) were not. The range of the six heavy metals analyzed for the three fertilizing types and the control were within the normal range in plants. It can be concluded that the six heavy metals investigated fall within the normal range in plants for all the fertilizing types and control and none of the metals was present in phytotoxic concentration.

KEYWORDS: Heavy metals, fertilizing types, cocoyam, Atomic absorption spectroscopy, normal range.

INTRODUCTION

The use of garbage ash and animals dropping from animals such as pig and chicken is being considered as a replacement to NPK (nitrogen, phosphorous and potassium) as a fertilizing type. This probably is due to their availability and affordability without knowing the heavy metal accumulation effect in plants.

These garbage ash and animal dropping are known to contain paper, food wastes, metals, glass, ceramics, etc., that persist with densities greater than $6g/cm^3$ in the soil at environmentally hazardous levels (Amusan et al., 2005; Alloway, 1996). The uptake and accumulation of these heavy elements by plants either as mobile ions present in the soil saluting through the roots or through foliar absorption (Sawidis et al., 2001).

The uptake of these heavy elements by plant depends on some factors such as their solubility, the soil pH, the growth stages type of different species, type of fertilizer and soil (Sharma et al., 2006; Ismail et al., 2005).

The result of many studies revealed hazardous levels of some heavy metals in vegetables in daily meals due to high accumulation of heavy metals (Cheang and Nguyen, 2003; Dang and Chu, 2005; Ho Thi, 2007).

The use of organic wastes combined with or without inorganic fertilizer is considered as a good soil management practices in any agricultural production because it improves, plant quality and soil fertility (Esawy et al., 2009).

Garbage ash is often richer in metal contents after getting rid of the organic materials. After the processes of oxidation and corrosion, these metals will dissolve in precipitation water and leach into the soil from where they could be picked up by growing plants thereby entering the food chain (Ebong et al., 2008).

Pig foods are known to contain high concentration of copper and Zinc as growth promoters. Plant farms fertilized with pig droppings may, therefore be at risk from excessive uptake of these elements in agricultural region or Galicia (NW Spain) where intensive pig farming is a major source of meat, cattle's has been found to have high liver copper concentrations (Lipez et al., 2000).

Various levels of impurities which include heavy metals from the quality of raw materials used, NPK fertilizers usually we not pure and results in accumulation of heavy metals in soil, ground water and plants of which the toxic effects can be very harmful (Jadgedin et al., 1991; Gupta and Gupta, 1998).

In this study, Cd, Cu, Pb and Zn concentrations in three fertilizer types (Garbage ash, Pig dropping and NPK) and control were determined in four species of cocoyam (colocasiaesulenta, colocasiaantiguorumXanthosoniasagithifolium and Xanthosoniaundipes). The results obtained will provide a basis for an assessment of risks from heavy metal toxicity in the fertilizing types.

MATERIALS AND METHODS

SAMPLE CULTIVATION AND FERTILIZING

Cocoyams were cultivated on a piece of land at ESUT in Agbani of Nkanu West L.G.A. of Enugu State and fertilized with garbage ash, pig droppings, NPK (20:10:10) and the control. These were nurtured for four months before the leaves were harvested for analysis.

DIGESTION PROCEDURES

Samples (1g) were weighted in 50mL porcelain crucibles, charged on a hot plate with stepwise increasing temperature up to 350^0C for 4 hours and finally ashed in a muffle furnace at 550^0C for 1 hour. After cooling, ashes were dissolved with 20mL of deionized water, filtered and the filtrates made up to 50mL with deionized water (Zaprjanoval et al., 2006).

AAS HEAVY METAL ANALYSIS

The Buck 205s a high energy, micro-processor controlled single beam atomic absorption spectrophotometer was used for this study. All operating conditions are pre-loaded in the internal computer, including lamp setting secondary wavelengths, and alternate methods of analysis for over 60 elements by flame and hydride techniques.

The trace metals (Cd, Fe, Cu, Mn, Pb and Zn) in the sample solution were determined with aliquots of the digest.

RESULTS AND DISCUSSION

Table 1 shows the range, mean values and standard deviation for the total concentration of Cd, Cu, Pb, Ca, Fe, Zn and Mn in every fertilizer type tested. The results obtained can be contrasted with (FAO/ WHO, 1976). In all cases, all the fertilizing types, the values were within the normal range in

plants (Table 2). Fe, Ca, Zn and Mn values were high; however, it is among the essential micro-nutrients.

In this study the range of Cd in all the fertilizing types, the control, garbage ash, pig droppings and NPK (0.00 – 0.05, 0.00 – 0.09, 0.02 – 0.07 and 0.00 – 0.04 ppm) and the mean (0.015, 0.033, 0.038 and 0.015ppm), were within the normal range and could be considered very safe as fertilizing types. The Cd concentration was within the minimum and maximum required standard range in plants. Cadmium and lead are of additional problem, because they can cause problem to human health and plant, the concentrations in this study are not directly phytotoxic (Peiknenburg et al., 2000).

As can be seen in (Table 1), some of the level of the six heavy metals studied appears to fall within the normal range for plants in all the fertilizing types. Although some of these concentrations in the three fertilizing types investigated were not very high to presume imminent serious pollution problem.

The statistics employed at probability level, reveals that the cocoyam samples precluded any formal attempt at correlating the concentration of heavy metals found in them with the concentration before planting. It revealed that Cd and Zn were evenly accumulated in all the three fertilizing types while Cu, Pb, Mn, Fe and Ca were not.

The magnitude and accumulation of trace heavy metals will vary depending on the ability of foliar uptake of each species. Thus, in the cocoyam samples fertilized with NPK were found to have more Mn revealing that the NPK fertilizer probably were contaminated with Mn. Various studies have shown that anomalously large concentration of heavy metals in plant can be caused by contamination with anthropogenic emission and not soil composition (Binns and Lynch, 1998), but through foliar uptake (Peiknenburg et al., 2000).

Therefore, the possibility that the concentration of heavy metals found in the cocoyam samples were not caused by the fertilizing types used.

Also wastes from domestic activities (ash) are used as farm manure and with increasing industrialization and consumerism on the part of the town's population; this waste can probably be a source of heavy metals. Therefore, it was necessary to investigate the levels of trace metals in the dumps (refuse) and the ashes from them since most of the rural famers use them as manures, to ascertain their exact health and environmental risks, so as to identify a strategy for utilization of the

wastes generated in the rural areas, because of the significance of 'farm status interaction' effect and fertilization practice (Pasquine, 2006).

The practice of using ashes (wastes) as manures could be significant, although it has associated environmental problems (Sweet, 1999), like the problem of waste disposal. It contributes to rural pollution and health risks, yet it has great potential because it can be very rich as farm nutrient.

Table 1: Result of Heavy Metal Concentration (ppm) in the analyzed samples

Fertilizer Sample	Cadmium (Cd)	Copper (Cu)	Lead (Pb)	Manganese (Mn)	Iron (Fe)	Zinc (Zn)
Control						
Range	0.00-0.05	10.00-0.30	0.00-0.00	0.74 – 2.58	0.91 – 1.24	2.04 – 4.50
Mean	**0.015**	**0.15**	**0.000**	**1.595**	**11.023**	**2.723**
SD	0.02	0.13	0.00	0.95	0.16	1.19
Garbage Ash						
Range	0.00 – 0.09	0.10 – 0.50	0.00 – 0.00	1.09 – 2.05	1.02- 6.23	1.81 – 5.35
Mean	**0.033**	**0.275**	**0.000**	**1.628**	**2.503**	**2.988**
SD	0.04	0.21	0.00	0.42	2.49	1.63
Animal Dropping						
Range	0.02 – 0.07	0.00 – 0.01	0.00 – 0.01	0.30 – 1.10	4.06 – 6.15	1.55-3.00
Mean	**0.038**	**0.025**	**0.025**	**0.668**	**5.095**	**2.463**
SD	0.02	0.05	0.05	0.33	0.86	0.64
NPK						
Range	0.00 – 0.04	0.00 – 0.00	0.00 – 0.000	0.60 – 3.01	4.26 – 5.18	1.57-2.95
Mean	**0.015**	**0.000**	**0.000**	**1.36**	**4.738**	**2.090**
SD	0.02	0.00	0.00	1.14	0.46	0.62
Normal range in plants (FAO/WHO, 1976 and Keith, 2007)	< 2.4	2.5	0.30 - 0.50	14 - 100	400 - 500	20 - 100

Key: Range: For total population number (4)

Mean: Average

SD: Sample Standard deviation.

By disposing it to the farms can be very rich as farm nutrient. By disposing wastes on farm lands beside the house as cheap supply of nutrient, farmers obtain a good yield yearly while alleviating the waste disposal problem at the same time.

Animal manure as an alternative to chemical fertilizer is cheaper, easily accessible and available and has sustainability effects on soil properties such as bulk density (Fawole et al., 2010); soil moisture content (Adeleye et al., 2010); water holding capacity and other soil physical properties (Fawole et al., 2010).

Plate 1: Cocoyam photo print unfertilized 'control'

Plate 2: Cocoyam photo print fertilized with 'NPK'

Plate 3: Cocoyam photo print fertilized with 'Animal dropping'

Plate 4: Cocoyam photo print fertilized with 'Garbage ash'

CONCLUSION

With the use of animal manure and garbage ash our farms can grow good crops without using inorganic fertilizer, thereby taking advantage of the growing garbage size and the animal manure which are abundant. These organic wastes which presently constitute environmental problem can be converted to wealth by using them as organic fertilizers that is free of heavy metals concentration.

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