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Use of Processed Waste Feathers as Source of Organic Nutrients for Maize Production

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Abstract

Management of waste feathers in Nigeria is of great concern due to large quantities generated daily. Over 30,000 birds slaughtered daily by two poultry industries in Ibadan Southwest generate 4980kg of feathers ending up in dumpsites polluting the environment. Feathers contain 91% fibrous protein which can be processed and released as soil nutrients to increase food production. Eighty grams of waste chicken feathers were processed into mulch by washing, sun-drying and grinded into bits, then pasted with 27g of glycerol and air-dried. Farmland was cleared and made into sixty four 30cm-diameter heaps arranged into two groups A and B with four replications each having eight heaps. Maize was planted in every heap while feather mulch was applied to group B. Group A (control) had no mulch applied. Watering was done *ad libitum*. Lengths of leaves and stem were measured at 4 days interval using flexible tape. Maize cobs were weighed after harvesting (65 days) and mean for each group obtained. Data were analysed using ANOVA. Results showed that maize in group B had 196.47±4.61cm and 105.82 ±2.44cm as mean lengths of leaves and stem respectively as against 165.43±1.57cm and 78.43±2.56cm respectively for the control. These represented 18.76% and 34.92% significant increase ($p<0.05$) in mean lengths of leaves and stem respectively over control. Yield of maize showed 22% significant increase ($p<0.05$) in mean cob weight at 0.275±0.03kg over control at 0.225±0.03kg. Application of feather mulch caused significant increase in growth and production of maize by releasing additional nutrients into the soil. It is therefore recommended that processed waste feathers be used as alternative source of organic nutrient for maize production as means of sustainable waste management.

Keywords:
Chicken feathers, Feather mulch,
Organic nutrient

Introduction

The burden of solid waste management is of particular concern in many cities of the world due to rural-urban migration and globalization. The contribution of waste feathers to the quantity of solid wastes generated world-wide has been on the increase since there is a rise in the consumption of chickens all over the world. Around 24 billion chickens are killed per year across the world which is

discarding four billion pounds of poultry feathers. In the United states alone, more than 8 billion broiler chickens are produced yearly (Barone, 2004), and the poultry industry discards 2 million tons of chicken feathers as wastes annually (Schmidt and Barone, 2004).

In Nigeria, solid waste generation has also been on the increase and waste feathers contribute to this burden. Poultry chickens form major source of cheap animal protein for the population. Several festive seasons celebrated almost every month of the year also make demand for poultry products very high. In Ibadan, two poultry industries in Oluyole estate slaughter over 30,000 chickens per day and therefore generate large amount of poultry feather wastes. These poultry feathers are usually disposed of in landfills where they constitute environmental problems because they are not easily biodegradable in the soil. The use of waste feathers for making organic mulch has not yet been well documented in Nigeria.

Feathers are the covering of poultry and birds forming between 6-9% of the total weight of a chicken. They are composed of about 91% protein, 8% water and 1% lipids (Schrooyen, 1999). Feathers are composed mainly of Carbon (46%), Nitrogen (13.5%), Phosphorus (0.5%), Magnesium (0.12%) and other microelements like Zinc and Manganese (Chojnacka *et al*, 2006). The type of protein in feathers is called Keratin which is characterized by a high percentage of the sulphur-containing diamino-acid cystine, acting as a cross-linking point between protein chains (Krimm, 1995).

This feature of a high-level of interchain cross linking through cystine gives the keratins, especially the hard keratin, their characteristics of toughness, durability and resistance to degradation. Most of the manure and waste produced by the poultry industry is currently applied to agricultural land. When managed correctly, land application is a viable way to recycle the nutrients such as nitrogen (N), phosphorus (P) and potassium (K) in manure. However, pollution and nuisance problems can occur when manure is applied under environmental conditions that do not favour agronomic utilisation of the manure-borne nutrients (Sharpley *et al*., 2007 and Kaiser *et al*., 2009). When processed, waste feathers can be transformed into useful protein-based mulching films which become more easily degradable and able to release available nutrients into the soil.

Maize (*Zea mays*) is an important cereal crop and a major source of carbohydrate in human diet in the developing world and also used as animal feed worldwide. Early season maize is planted as cash crop in mixture with other crops and is harvested first from the mixture and sold as fresh maize to urban dwellers. Expansion in the cultivation of the early season maize crop in the humid Tropical Rainforest agro-ecology of Southwest Nigeria is limited by lack of appropriate technologies for preservation of the fresh harvest. The large gap between demand and supply has necessitated expansion of cultivation into the second or late rainy season in the Southwest Nigeria. In developing countries maize is a major source of income to many farmers (Tagne *et al*., 2008). Maize has great nutritional value as it contains about 72% starch, 10% proteins, 4.8% oil, 8.5% fibre, 3% sugar and 1.7% ash (Chaudhary, 1993).

Maize is nitro positive and needs ample quantity of nitrogen (N) for attaining high yield. Nitrogen deficiency is a key factor for controlling maize yields (Alvarez and Grigera, 2005). It is therefore, imperative to use an optimum amount of nitrogen through suitable and efficient source.

Hence the objective of this study was to employ a more economically sustainable method of handling waste feathers by converting the resource in poultry feathers into organic mulch which releases nutrients into the soil. This goal is to make the "waste" a renewable resource that can be utilized and not discarded. This will ultimately increase crop yield and also reduce the waste-burden, thereby promoting food security and environmental sustainability to meet the Millennium Development Goals.

Materials and Methods

The maize seeds used for the project were the Downey Mildew Resistance – Early Streak Resistance – Yellow (DMR-ESR-Y) maize seeds and were obtained from the grains store of I.A.R. &T., Ibadan. Waste poultry feathers were obtained from Zartech Industries, Oluyole Estate, Ibadan. The project was carried out at the Federal College of Animal Health and Production Technology, Moor plantation, Ibadan between March – May, 2013. The farmland was located at the Research Farm beside the breeder farm of the college.

Processing of feather into mulch

Pre-Treatment Stage: This involved washing the feathers in mild "omo" detergent prepared by dissolving 10 grammes of detergent in 1 litre of water. The detergent solution was used to remove traces of fat and dirt from the waste feathers, then properly rinsing in water, then air-drying the feathers. Afterwards, the fibers were taken to the mill at Aleshinloye market waste recycling plant for grinding.

Grinding of Feathers

Dried feathers were grounded in a well-cleaned thirty horse-power grinding machine at Aleshinloye Waste Recycling Plant, Ibadan, into tiny fragments until almost powdered state was obtained. Grinding breaks the feather fibres into small bits thereby exposing the cross linkage to weaken the bonds and allow the feathers degrade faster.

Mixing of Feather with Glycerol

The mixing ratio for glycerol to feather-fibers was 1:3 by mass. Hence, 80g of the feather fiber was measured and placed in a large crucible, and then 27g of glycerol was added. The feather-glycerol mixture was properly mixed into a paste for about 15 minutes until the fibers became sticky. The glycerol was to act as a plasticizer in the mixture.

Making of the Feather Film

The sticky feather-glycerol mixture was transferred unto an aluminum foil and sandwiched between the foil, then pressed into flat film and allowed to cool to room temperature.

Fig. 1: Collection and bagging of waste

Fig. 2: Feather waste after grounding

Fig. 3: Processed feather waste

Farm preparation

The farmland was cleared and made into 64 heaps of 30cm diameters each. The heaps were randomly divided into two groups A and B, with four replicates each having 8 heaps per replicate. Two seeds of maize were planted in each heap and pruned to one after germination to avoid overcrowding. On day 11 after planting, 20g of moist processed waste feather mulch was applied by ring method to each heap in group B while control group A had no mulch application. Manual weeding was done every five days to avoid nutrient competition while watering was done daily.

Measurements taken

Growth of maize was measured by taking the length of leaves and length of stem every four days using flexible measuring tape. Measurement was taken until 65 days when maize cobs were harvested. Maize cobs were also weighed for the two groups using a measuring scale, and mean weights recorded for every replicate. Data collected were analysed using the analysis of variance (ANOVA) test (SAS 2003) and the means were separated by Duncan multiple range test (Duncan, 1955).

Results and Discussion

Results showed from tables 1and 2 that there was significant increase ($p< 0.05$) in the mean lengths of leaves and stem of maize planted with processed waste feathers (group B) over control group A. On day 64, mean length of leaves in group B was 196.47±4.61cm as against 165.43±1.57cm in control group A, while mean length of stem in group B was 105.83±2.44cm against 78.43±2.56cm in control group A. These increases represent 18.7%in mean length of leaves and 34.9% in mean length of stem over the control.

Table 1: Mean Length of Maize Leaves

Days	Group A (cm) Control	Group B (cm) with Processed feather	±SEM
8	9.77 [b]	10.13 [a]	0.392
12	16.40 [b]	19.63 [a]	0.525
16	27.27 [a]	24.83 [b]	0.698
20	39.50 [b]	52.17 [a]	2.012
24	53.50 [b]	58.63 [a]	0.983
28	66.17 [a]	67.50 [a]	0.607
32	74.83 [b]	81.17 [a]	1.370
36	84.67 [a]	86.87 [a]	1.949
40	97.00 [b]	100.50 [a]	0.665
44	106.33 [b]	114.80 [a]	1.401
48	111.80 [b]	123.13 [a]	2.026
52	122.87 [b]	140.50 [a]	2.575
56	145.10 [b]	157.90 [a]	2.146
60	152.40 [b]	176.33 [a]	3.500
64	165.43[b]	196.47[a]	4.613

[ab]*Means on the same row with different superscripts differ significantly ($p<0.05$)*

Mean weight of maize cobs after harvest in group B also showed significant increase ($p< 0.05$) at 0.275±0.03kg over that of control group A at 0.225±0.03kg. This represents 22% increase in weight of cobs in group B over group A. Application of processed waste feathers to the soil in group B was effective in improving the growth of maize as shown by the significant increase in mean length of leaves, mean length of stem and mean weight of cobs taken. The processed waste feathers were able to release additional nutrients into the soil over the planting period. These additional nutrients contributed to the improved growth observed in group B. Processed waste feathers proved to be effective in improving maize production.

Table 2: Mean Length of Maize Stem

Days	Group A (cm) Control	Group B (cm) with Processed feather	±SEM
8	1.77[b]	2.17 [a]	0.117
12	3.40 [a]	3.00 [b]	0.335
16	4.40 [b]	4.53 [a]	0.247
20	12.47 [a]	12.34 [a]	0.236
24	13.37[b]	15.40[a]	0.904
28	19.40 [a]	18.67 [a]	0.441
32	29.53[a]	27.00[b]	1.627
36	30.23[b]	35.57 [b]	2.025
40	56.97[b]	62.60 [a]	1.012
44	63.57[b]	66.87 [a]	0.672
48	64.67[b]	73.53 [a]	2.236
52	68.87 [b]	81.60 [a]	0.885
56	69.37[b]	83.73 [a]	2.439
60	73.10[b]	100.07 [a]	5.242
64	78.43[b]	105.83[a]	4.170

[ab]*Means on the same row with different superscripts differ significantly ($p<0.05$)*

Table 3: Mean Cob Weights

Mean Weight of Cobs	Group A (kg) Control	Group B (kg) with Processed feather	+SEM
Replicate 1	0.25[b]	0.30[a]	0.1472
Replicate 2	0.25 [b]	0.30 [a]	0.0882
Replicate 3	0.20 [b]	0.25 [a]	0.0882
Replicate 4	0.20 [b]	0.25 [a]	0.0882
Mean	0.225[b]	0.275[a]	0.0330

[ab]*Means on the same row with* different superscripts differ significantly ($p<0.05$)

Conclusion

The study shows that application of processed waste feathers brought about an increase in the growth and production of maize crop. It is therefore recommended that processed waste feathers can be used as an alternative source of organic nutrient for maize production.

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