Greener Journal of Agricultural Sciences
ISSN: 2276-7770; ICV: 6.15
Vol. 2(6), pp. 246-250, October, 2012

http://gjournals.org/GJAS

Research Article

Assessment of Some Handling Practices on Cow Dung: Calcium and Magnesium Content and Total Microbial Population in the Northern Guinea Savanna of Nigeria

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ARTICLE INFO

Article No.: *09031256*
DOI: *10.15580/GJAS.2012.6.09031256*

Submitted: *03/09/2012*
Accepted: *20/09/2012*
Published: *30/10/2012*

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Keywords:
cow dung, handling practices, calcium, magnesium, microbial population, Northern Guinea Savanna, Nigeria

ABSTRACT

The handling practices of cow dung were examined in two (2003 and 2004) seasons to determine their effects on the Calcium and Magnesium content and the microbial population in Northern Nigeria. The experiment consisted of four treatments (surface heaped uncovered, surface heaped covered and pit covered) and a control (untreated). The results revealed that, subjecting the cow dung to different handling practices significantly ($P < 0.05$) increased values of Calcium and Magnesium and the total bacterial and fungal populations, compared to the control. At termination of composting of the cow dung, the heaped uncovered method gave significantly ($P < 0.05$) higher values of Calcium and Magnesium in the two years, while after field storage, it was the heaped covered method that gave significantly ($P < 0.05$) higher values of the Calcium and Magnesium for the two years. In each case where the nutrient content (Ca and Mg) was high, the microbial population of bacteria and fungi was also high. It is therefore concluded that, the high Calcium and Magnesium content of cow dung was directly related to the high population of bacteria and fungi. It is therefore recommended based on this work, that cow dung should be used immediately after composting using the heaped uncovered method, while the heaped covered method is recommended if it is to be used after field storage..

INTRODUCTION

Organic matter (OM) is considered as the life of soil as well as a storehouse of plant nutrients (Reddy and Reddi, 1992). It plays important roles in maintaining soil fertility and productivity. Organic matter acts as a good source and reservoir of primary, secondary, and micro nutrients for crop production, also preventing leaching of these nutrients. Manure is also an important source of humus and has a beneficial long-term effect on the structure and carbon-economy of the soil. It also improves the cation exchange capacity of soil (Buckman and Brady, 1980). Karim *et al.,* (1980) have observed that, organic matter status of the soil is in critical position, and if the present rate of degradation is continued, in the near future our soil will become unfertile. As a result, either no or very less quantity of OM will remain in the soil, which will not be sufficient for the soil itself, due to poor management and intensive manipulation of soil organic matter it's content is reduced day by day. The ever decreasing OM content in our soils is causing nutritional imbalance including micronutrient deficiency. Although conserving nutrients is a very important aspect of manure management, it is a mistake to regard manure as just a vehicle for nutrients. Moreover, farmyard manures contain hormones, vitamins, and anti-biotin, and their stimulating effects on root growth and on the growth of micro-organisms (yeast cultures) has been demonstrated experimentally (Sauerlandt and Tietjen, 1970; Fulhage, 2000). A lot of work has been done on the conservation of nutrients in manure, but most of the times the attention has always been on N P K (Muller-samann and Kotschi, 1997; Camberato *et al*., 1996; Fulhage, 2000), while Ca and Mg are not given adequate attention. Most workers have also reported the reduction in nutrient content in manure before application to the field, due to the storage and handling methods among other factors (Flaig *et al*., 1978; Muller-samann and Kotschi, 1997; Camberato *et al*., 1996; Fulhage, 2000). Considering the important roles that Ca and Mg play in the soil and in the crop, it is very important that this aspect is given adequate attention.

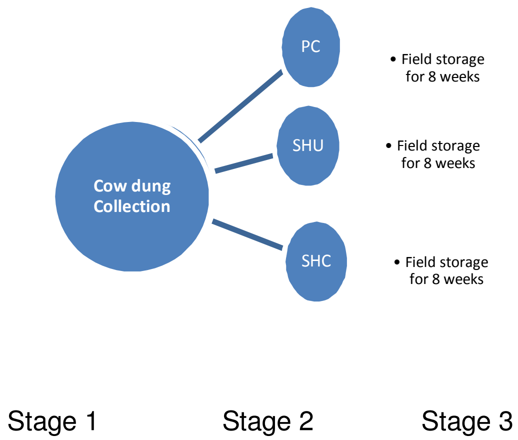
Microbiologists (Fauci and Dick, 1994; Ndiaye *et al*., 2002) have used microbiological analyses of soils, as indices of soil fertility and land use. Incorporating large amounts of livestock waste and other agricultural waste into surface soil alters the microbial population of the soil quantitatively and qualitatively (Mendes, 1999). The data on soil microorganisms in several tropical soils are very limited and grossly inadequate (Ayanaba and Sanders, 1981). Most of the available reports did not consider the effects of some soil properties, cropping history and system and waste disposal on the microbial population (Isirimah *et al*., 2006). In their work Isirimah *et al*., (2006), reported crop residues and animal waste incorporated into the soil for different land use, affected the rate of organic matter decomposition as indicated by the population of microorganisms. A measure of the size of the soil microbial biomass is of importance in studies of nutrient cycling in soils and has been used as an ecological maker (Smith and Paul, 1990). The soil organic matter dynamics and nutrient cycling are closely related through, the microbially – driven processes of nutrient immobilization and mineralization from soil organic matter (Duxbury *et al*., 1989). Soil microbes play a key role in these processes because of their ability to serve as a source and sink of soil nutrients and as a "driving force" of nutrient availability (Coleman *et al*., 1983). Therefore, the study of soil microbial dynamics is important in the development of management strategies, to reverse declining organic matter content and fertility of agricultural soils (Collins *et al*., 1992). The objectives of this study are to assess effects, of different cow dung manure handling practices on the Ca, Mg content and the total microbial population of bacteria and fungi in the Northern Guinea Savanna of Nigeria.

MATERIALS AND METHODS

Cow dung collection and handling practices in the field

The cow dung that was used for these experiments in years 2003 and 2004, were collected from the National Animal Production Research Institute (NAPRI), Shika-Zaria. The cow dung collected was subjected to three different handling practices, including control practice making a total of four treatments.

For the two years (2003 and 2004) fresh cow dung was collected early in the morning from pens and heaped. The cow dung was then mixed thoroughly with a shovel with the aim of harmonizing it. After mixing the cow dung, it was then subjected to the various handling schedules as outlined below. (i) Cow dung was placed in a pit of 2 x 2 m and 75 cm deep and covered with a polythene sheet. (ii) Cow dung was heaped on the ground surface and covered with a polythene sheet and (iii) Cow dung was heaped on the ground surface and left uncovered. The collection of the cow dung and its distribution to the three different handling practices, was repeated for 2-3 consecutive days as described above until enough cow dung was gathered. The cow dung was then allowed to decompose for four weeks (one month) without any disturbance, before it was removed and stored in the field for eight weeks (two months). The control (untreated) treatment was not composted or stored in the field, but was collected immediately after the thorough mixing and oven dried and stored for analysis.



Stage 1= Cow dung Collection
Stage 2= Composting for four weeks under different handling methods
Stage 3= Field storage (exposure) time before use in the field for 8 weeks.
Figure 1 Diagrammatic Presentation of Experimental Set up

Cow dung sampling

Samples were collected at three different stages. First, fresh cow dung samples (untreated) were taken after mixing thoroughly, before subjecting them to any handling practice for analysis. Secondly, samples were taken after composting the cow dung under three different handling practices for four weeks (already discussed above), but before taking them to the field. The third sampling of the cow dung was done after field storage (8 weeks) at the time of incorporation into the soil. Samples were all carefully processed and kept for analysis.

Cow dung chemical and microbial analysis

Cow dung samples were analyzed using the wet oxidation method (Juo, 1979). Calcium and magnesium, were determined by using the Atomic Absorption Spectrophotometer as described by (Juo, 1979). Soil-dilution plate technique and media was used for microbial analysis as described by (Isirimah *et al*., 2006). The inoculated plates were incubated at ambient temperature (30 ^{o} C) for seven days and colonies of bacteria and fungi were counted.

Data analysis

The data collected were subjected to analysis of variance (ANOVA) and significant means were separated using the DMRT at 5 % level of significance.

RESULTS AND DISCUSSION

Calcium

The total Ca content of the heaped uncovered and heaped covered methods gave significantly higher values than the control method in year 2003, but they were not significantly different from the pit covered method at the end of four weeks composting (Table 1). In year 2004 and the pooled data, they both maintained a similar pattern, where there was a significant difference between the control and the composted treatments. This shows that composting increased the Ca content of cow dung ranging from 140.0 to 280.0 % and the highest was observed on the uncovered method. This agrees with the work of Lekasi *et al*., (2005), that mineral nutrients are concentrated during composting as the carbon compounds are oxidized by micro organisms.

At the termination of eight weeks of field storage in year 2003, the covered method gave the highest value, which was not significantly different from the other two composted treatments but significantly higher than the control method. In 2004, there was no significant difference among the treatments. The mean values of the two years showed that, the heaped covered treatment gave a significantly higher value than the control and the heaped uncovered treatments. Storing the cow dung in the field after composting showed that, the heaped covered treatment gave a significantly high Ca content of the cow dung compared to the other treatments.

Magnesium

The results of total Mg of cow dung is presented in Table 2. There were no significant differences among the treatments in the two years (2003 and 2004) after composting. However, when the means of the two years were pooled together, the heaped uncovered method gave a significantly higher value than the control method which was up to 121.6 %, but it was statistically at par with the pit and covered methods. This result also agrees with what was observed for Ca above, which corroborates the work of Lekasi *et al*., (2005).

After cow dung field storage in year 2003, the heaped covered method gave a higher value of Mg in cow dung, which was significantly higher than the heaped covered and the control methods. In year 2004 there was no significant difference among the treatments, but the heaped covered method tended to give higher value. The mean of the two years (2003 and 2004) pooled together, showed that the heaped covered method, gave a significantly higher value of Mg in cow dung than the heaped uncovered and control methods which ranged between 18.9 to 118.9 %. These results are also similar to what was observed for the Ca at after field storage, where field storage did not affected the Mg content of heaped covered method. When the mean values of the after composting and after field storage of Ca and Mg were compared, the heaped uncovered and pit treatments decreased, while that of heaped covered increased.

Table 1: Effects of cow dung incubation and handling practices on calcium content (c mol/kg)

Treatments Management practices	After composting			After field storage		
	2003	2004	Mean	2003	2004	Mean
Control	0.22b	0.27b	0.25b	0.22b	0.27	0.25c
Heaped uncovered	0.97a	0.92a	0.95a	0.52ab	0.49	0.50bc
Heaped covered	0.73a	0.47ab	0.60ab	1.13a	0.58	0.85a
Pit covered	0.60ab	0.94a	0.77a	0.83.ab	0.45	0.64ab
SE ±	0.175	0.183	0.135	0.184	0.133	0.111

Means with the same letter(s) within the same column are not significantly($P < 0.05$) different using DMRT

Table 2: Effects of cow dung incubation and handling practices on magnesium content (c mol/kg)

Treatments Management practices	After composting			After field storage		
	2003	2004	Mean	2003	2004	Mean
Control	0.38	0.35	0.37b	0.38b	0.35	0.37b
Heaped uncovered	1.01	0.63	0.82a	0.46b	0.42	0.44b
Heaped covered	0.57	0.43	0.50ab	1.13a	0.49	0.81a
Pit covered	0.71	0.55	0.63ab	0.81ab	0.34	0.58ab
SE ±	0190	0.142	0.018	0.168	0.066	0.102

Means with the same letter(s) within the same column are not significantly($P < 0.05$) different using DMRT

Table 3: Effects of cow dung incubation and handling practices on total microbial population (cfu/g)

Treatments Management practices	After composting			After field storage		
	2003	2004	Mean	2003	2004	Mean
Control	4.75	0.30	2.53	4.75	0.30	2.53b
Heaped uncovered	2.73	26.03	14.38	13.26	34.56	23.90ab
Heaped covered	2.64	2.29	2.48	18.14	46.74	32.44a
Pit covered	19.16	7.16	13.16	13.14	37.53	25.33ab
SE ±	6.155	10.624	6.126	8.024	15.688	8.351

Means with the same letter(s) within the same column are not significantly($P < 0.05$) different using DMRT

Total microbial population

The total microbial population values, of bacteria and fungi in cow dung after composting, using different methods and the control, were not significantly different in two years and the pooled data for the two years (Table 3). However, the cow dung subjected to different handling methods values was higher than that of the control. This was probably due to the fact that the control treatment was oven dried, which must have contributed to the suppression of the microbial growth in the cow dung. After field storage in year 2003 and 2004, there was still no significant difference among the treatments on the microbial population. However, when the values of the two years were pooled together, the covered method gave a significantly higher value than the control. The difference to the two other treatments (heaped uncovered and pit covered) in terms of microbial population was between 28.1 to 35.7 % even though they were statistically at par.

This high microbial population explains why Ca and Mg values were also high in heaped uncovered method at after composting, and high after field storage in heaped covered method. Sullivan (1999) explained that bacteria and fungi among other roles in the soil, help in the break down and release of nutrients including Ca and Mg from organic matter and soil minerals. According to Bruns (2011), soil microbiological networks are critical in delivering water and nutrients to plants in soils and water availability. Soil microbiologist (Fauci and Dick, 1994 Ndiaye *et al*., 2002), have used microbiological analysis of soils, as indices of soil fertility and land use.

CONCLUSION

This study has demonstrated that, composting of the cow dung, using the heaped uncovered method gives significantly ($P < 0.05$) higher values of Ca and Mg, while after field storage the heaped covered method also gives significantly ($P < 0.05$) higher values of the Ca and Mg. In each case where the nutrient content (Ca and Mg) were high, the microbial population of bacteria and fungi were also high. It is therefore concluded that, the high content of Ca and Mg of the cow dung was directly related to the high population of bacteria and fungi. It is therefore recommended that based on this work, cow dung should be used immediately after composting, using the heaped uncovered method, but if it is to be used after field storage the heaped covered method is better.

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