GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(**Published By**: Global Institute for Research & Education)
www.gifre.org

COW DUNG MANAGEMENT ON THE CALCIUM AND MAGNESIUM CONTENT AND TOTAL MICROBIAL POPULATION IN THE NORTHERN GUINEA SAVANNA OF NIGERIA

J. Tanimu[1], E.O. Uyovbisere[2], S.W.J. Lyocks[3], and Y. Tanimu[4]

[1] Department of Soil Science and Land Resources Management, Federal University Wukari, Taraba State
[2] Soil Science Department, Institute for Agricultural Research/Faculty of Agriculture, Ahmadu Bello University, Zaria
[3]Samaru College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria
[4] Department of Biological Sciences, Ahmadu Bello University, Zaria

Abstract

The effect of time and duration of storage of cow dung on the calcium and magnesium content and total microbial population was investigated for two years in Samaru, Northern Guinea Savanna, Nigeria. The treatments were composed of 0, 4, 8 and 12 weeks of cow dung storage in the field after one month of composting and a control treatment. The results showed that, the use of cow dung immediately after composting in May (4 weeks) significantly ($P < 0.05$) released more of Ca and Mg, however after field storage the June (0 week) treatment appeared to be better. The total microbial population, immediately after composting showed bacterial and fungal populations to be more in the June (0 week) treatment, but if stored in the field before use the April (8 weeks) treatment gave a significantly ($P < 0.05$) higher population of the microbes.

Keywords: *calcium, cow dung management, magnesium, microbial population, Nigeria*.

Introduction

According to Camberato *et al.*, (1996) and Fulhage (2000) the nutrient content of manure varies widely with animal species, age, ration and feed consumption, as well as with different methods of storage, handling methods, housing type, temperature and moisture content, treatment and land application. Fulhage (2000) has shown that manure contains the three major plant nutrients, nitrogen, phosphorus and potassium (NPK), as well as many essential nutrients such as Ca, Mg, S, Zn, B, Cu, Mn etc. That, in addition to supplying plant nutrients, manure generally improves soil tilth, aeration, and water holding capacity of the soil and promotes growth of beneficial soil organisms. Manure applied in the proper amounts at the appropriate time can supply some, if not all, of the nutrient requirements of many crops.

Although much work had been done in northern Nigeria during colonial period on the value of manure to various crops (Dennison, 1961) feces of the various groups of livestock have not been characterized according to their contents of plant nutrients (Kallah and Adamu, 1989). They further explained that, chemical composition can be used to compare different sources and/or forms of animal feces. They argued that, it is a fair index for estimating the kind and potential amount of fertilizer elements being recycled on application.

Calcium and Mg are among the essential nutrient elements that play vital roles in the nutrition of the crop. Calcium is an essential part of the plant cell wall structure, provides for normal transport and retention of other elements as well as strength in the plant. It is also thought to counteract the effect of alkali salts and organic acids within a plant. Magnesium is part of the chlorophyll in all green plants and essential for photosynthesis. It also helps activate many plant enzymes needed for growth. There are not always enough of these nutrients in the soil for the plants to grow healthy. This is why farmers use fertilizers (organic and mineral) to add the nutrients to the soil. Although conserving nutrients is a very important aspect of manure management, it is mistaken to regard manure as just a vehicle for 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. 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) have been demonstrated experimentally (Sauerlandt and Tietjen, 1970).

The microbial biomass constitutes the active fraction of soil organic matter (Paul and Voroney, 1984), whose fast turnover makes it important as a potential source of nutrients (Sparling, 1985). It is, thus, involved in the decomposition of organic materials and the cycling of nutrients in the soils (Moore *et al*., 2000). Frequently, it is used as an early indicator of changes in soil chemical and physical properties resulting from soil management and environmental stresses in agricultural ecosystems (Brookes, 1985; Jordan *et al*., 1995; Trasar-Cepedar *et al*., 1998).

Soil Microbiologists (Fauci and Dick, 1994; Ndiaye *et al.*, 2002) have used microbiological analyses of soils as indices of soil fertility and land use. Other researchers have used microbial population and ratios to assess the modification of the soil ecological environment brought about by land use changes (Mendes *et al.*, 1999 and Ndiaye *et al.*, 2002). The data on soil microorganisms in several tropical soils are very limited and grossly underestimated (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 study, crop residues and animal waste were incorporated into the soil for different land use which affected the rate of organic matter decomposition as indicated by the population of microorganisms. The objectives of this study are to assess the effect of time and duration of storage of Cow dung on the Ca, Mg and the total microbial population in the Northern Guinea Savanna of Nigeria.

Materials and Methods

Cow Dung Collection, Duration of Storage/Ageing in the Field before Application and Incorporation

The cow dung that was used for these experiments were collected from the National Animal Production Research Institute (NAPRI), Shika-Zaria in years 2003 and 2004. Fresh cow dung was collected early in the morning from pens and heaped up. The cow dung was then mixed thoroughly with a shovel with the aim of harmonizing it. The cow dung was then allowed to decompose for four weeks (one month, the ageing period) without any disturbance before it was removed and stored in the field.

Cow dung was collected in February, 2003 and allowed to decompose (composting) for 4 weeks (Figure 1). This means the field storage (exposure) of the cow dung started in March for 12 weeks of field storage before application to the soil as amendment.

Weeks	Treatments	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Duration of Storage
Month		January				February				March				April				May				
Activity	Treatment 1					Composting				Field Storage												12wks
	Treatment 2									Composting				Field Storage								8wks
	Treatment 3													Composting				Field Storage				4wks
	Treatment 4																	Composting				0 wk

Figure 1. Diagrammatic Presentation of the collection and storage of Cow dung.

The same cow dung treatment as described for February above was repeated in March against April to May (8 weeks of field storage before application to the soil as amendment), April against May (4 weeks of field storage before application to the soil as amendment) and May against June (0 week) where cow dung was collected at the termination of composting (incubation) and applied to the field immediately without field storage (the moisture content was taken into consideration). The same procedure was repeated in the second year (2004).

Cow Dung Sampling

Three cow dung samples were collected at certain stages in each of the two years. First, fresh cow dung samples (untreated) were taken after harmonizing the cow dung before subjecting them to any management practice. These samples were oven dried immediately after collection at 65^{o} C for 3 days and stored for analysis. Secondly, another set of samples were taken after subjecting the cow dung to the three different management practices (already discussed above) but before taking them to the field for storage. The third set of samples of the cow dung was collected at the time of application and incorporation into the soil (at this stage, the cow dung treatments was exposed at the field in storage after the 1 month of composting/ageing period for different time durations of 12 weeks, 8 weeks, 4 weeks and 0 week). These were all carefully processed and kept for analysis.

Cow dung chemical and microbial Analysis

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

Data analysis

All data collected was subjected to analysis of variance (ANOVA) and the means separated using the Duncan Multiple Range test (DMRT).

Results and Discussion

Calcium

The results of cow dung Ca is shown in Table 1. At the termination of one month incubation in 2003, the May and April treatments which were statistically the same gave the highest values of Ca. The May treatment was however significantly higher ($P < 0.05$) than the June, March and control treatments. In year 2004, there was no significant effect on the Ca content of the cow dung among the treatments. When the two years values were pooled together, the results showed that, the May treatment gave the highest Ca value, which was statistically at par with the April treatment, but significantly higher than the March, June and control treatments. This period probably coincided with the on set of the rains (appendix 1) which probably favours more microbial activity for nutrient release, but before population explosion of the microbes which will in turn use the nutrients. That again explains why the June treatment has low Ca but more population of the microbes. When the values of the two years were pooled together the May treatment was higher than the control by up to 82.5 %.

Table 1: Effects of cow dung incubation and duration of storage on calcium content (c mol kg $^{-1}$).

Duration of storage	After incubation			After field storage		
	2003	2004	Mean	2003	2004	Mean
Control	2.24b	1.03	0.63bc	0.24b	0.79a	0.52
0 Week (June)	0.50b	0.93	0.71bc	1.04a	0.41b	0.72
4 Weeks (May)	1.29a	1.01	1.15a	0.80ab	0.48ab	0.64
8 Weeks (April)	0.94a	0.88	0.91ab	0.56ab	0.50ab	0.53
12 Weeks (March)	0.28b	0.66	0.47c	0.82ab	0.47ab	0.65
SE ±	0.129	0.125	0.098	0.210	0.093	0.120

Means followed by the same letter(s) within the column are not significantly different at 5 % level of significance using DMRT.

At the time of application and incorporation into the soil in 2003, after cow dung has been subjected to different durations of field storage, the highest value among the treatments was observed in June, which was statistically at par with the March, April and May treatments, but significantly higher than the control treatment. In year 2004, the control treatment that gave the least value in 2003 was the highest in 2004. The other 3 treatments, March, April and May were statistically at par with the 2 treatments. Pooling the means of the 2 years together, the result gave no significant effect among the treatments. The possible ways of loosing Ca in the manure is through erosion or leaching. This probably showed that the duration of storage in the field did not affect the Ca content of the manure. If you look at the months of storage (March, April and May) these are months that the rains were not fully established to have cause erosion or leaching of Ca. But, the June treatment gave a higher value which was 38.5 % higher than the control. This showed that the application of cow dung in June will release more Ca to the soil than at the other periods.

Magnesium

The duration of storage of cow dung affected the Mg content of cow dung (Table 2). In year 2003, the results showed that, the May treatment gave the highest value, which was statistically at par with April treatment but significantly higher than all other treatments. In year 2004, there were no significant differences among the treatments. Although the June treatment tended to give a higher value.

Table 2: Effects of cow dung incubation and duration of storage on Magnesium content (c mol kg $^{-1}$).

Duration of storage	After incubation			After field storage		
	2003	2004	Mean	2003	2004	Mean
Control	0.37bc	0.39	0.38b	0.87	0.40b	0.63
0 Week (June)	0.35bc	0.69	0.52b	1.02	0.39b	0.71
4 Weeks (May)	1.41a	0.54	0.98a	0.55	0.34b	0.45
8 Weeks (April)	0.93ab	0.41	0.67ab	0.38	0.37b	0.37
12 Weeks (March)	0.29c	0.47	0.38b	0.56	0.62a	0.59
SE ±	0.171	0.148	0.112	0.234	0.063	0.121

Means followed by the same letter(s) within the column are not significantly different at 5 % level of significance using DMRT

When the means of the two years were pooled together, the May treatment gave the highest value, which was 157.9 % higher than the control treatment.

For after storage and before field incorporation, the results showed that there was no significant difference among the treatments in 2003; although the June treatment tended to give higher value than all other treatments. In year 2004, time of application affected the Mg content of cow dung. The March treatment gave a significantly higher value than all other treatments, the other treatments were not statistically different from each other. Mean of the two years showed no significant effects on all the treatments. However, the June treatment tended to give a higher value which was up to 12.7 % higher than the control treatment. This showed that the application of cow dung in June after field storage for 0 week will release more Mg to the soil than at the other months.

Total Microbial Population

In Table 3 is the result of the effects of incubation and duration of field storage on the microbial population of fungi and bacteria in cow dung. The results showed that after subjecting cow dung to composting (incubation) at different times (months) and durations, microbial population at in April (8 weeks duration) was significantly higher than the March (12 weeks duration) which was statistically not different from the control, May (4 weeks) and June (0 week) treatments. At year 2004 and the means of the two years there were no significant differences among the treatments, although the June treatment tended to give a higher microbial population value which was up to 537.0 % over the control treatment.

Table 3: Effects of cow dung incubation and duration of storage on total Microbial population (cfu/g).

Duration of storage	After incubation			After field storage		
	2003	**2004**	**Mean**	**2003**	**2004**	**Mean**
Control	4.7a	0.8	2.7	4.7	0.8c	2.7c
0 Week (June)	4.6ab	30.2	17.4	14.3	30.5ab	22.4abc
4 Weeks (May)	4.0ab	8.5	6.2	15.0	45.8ab	30.4ab
8 Weeks (April)	7.4a	2.8	5.1	23.0	64.0a	43.5a
12 Weeks (March)	1.2b	6.4	3.8	2.0	24.7ab	13.4bc
SE ±	1.02	12.68	6.42	7.66	16.60	8.60

Means followed by the same letter(s) within the column are not significantly different at 5 % level of significance using DMRT

At after different durations of field storage, just before incorporation into the soil in 2003, the results did not show any significant effect among the treatments, however the April treatment tended to give a higher value. The 2004 result showed that, the April (8 weeks) treatment also gave a significantly higher microbial population than the control, but was statistically at par with the March (12 weeks), May (4 weeks) and June (0 week) treatments. A similar pattern was maintained, when the two years values were pooled together. The microbial population was high in April probably due to the high temperatures that are normally experienced in this month, which will naturally encourages microbial growth. The results also showed that, composting cow dung generally encourages increase in the microbial population in the cow dung, since all composted treatments had higher population than the control when the two years were pooled together. Population increase of 390.0 % to 1493.4 % over the control was obtained. This agrees with Mendes (1999) and Isirimah *et al*., (2006) who reported that incorporating large amounts of livestock wastes into surface soil alter the microbial population of soil quantitatively and qualitatively and the population of bacteria and fungi at the site where oil palm effluent was deposited were high indicating that the soil is biologically active. Isirimah *et al*., (2006) also reported that, 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. In other words, the higher the population of microorganisms the better the soil, because there will be more decomposition and more nutrient release into the soil.

Conclusion

At the termination of incubation of the cow dung, the May (4 weeks) treatments gave significantly ($P < 0.05$) higher content of Ca and Mg than other treatments in the two years, but after field storage and at the time of incorporation into the soil the June (0 week) treatments gave higher values of both Ca and Mg. Total microbial population of cow dung at after incubation, showed that the June (0 week) treatments gave the highest values, while after field storage the April (8 weeks) treatments gave significantly higher values.

It is recommended that, using cow dung after incubation in May (4 weeks) will significantly released more Ca and Mg to the soil than the other treatments than further exposing (storing) it before use, while the use of cow dung after storage in April (8 weeks) will significantly give higher microbial population than the other treatments.

References

Ayanaba, A. and Sanders, F. E. (1981). Microbiological factors in Characterization of Soils in relation to their classification and management for crop production.(D.J. Greenland Ed.) Clarendon press, Oxford, pp 164-186.

Brookes, P.C.(1995). The use of microbial parameters in monitoring soil pollution by heavy metals. *Biol. Fert. Soils*, 19:269-279.

Camberato, J., B. Lippert, J. Chastain and O. Plank, (1996). Land application of Manure. http:/hubcap.clemson.edu/~blpprt/manure.html. (Accessed, Nov. 2010).

Dennison, E.B., (1961). The value of farm yard manure in maintaining fertility in Northern Nigeria. *Emp. J. Expl. Agric.*, 29(6) 330-336.

Fauci, M.F. and R.P. Dick, (1994). Microbial Biomass as an indicator of Soil Quality: Effects of Long Term management and recent Soil amendments. *Soil Sci. Soc. American J.*, 35: 567-570.

Fulhage, C.D.,(2000). Reduce environmental problems with proper land application of animal manure. University of Missouri Extension. USA.

Isirimah, N.O., C. Igwe and D.N. Ogbonna, (2006). Soil microbial population as Ecological indicator of changes resulting from different land use and management in Rivers state of Nigeria. *Nigerian Journal of Soil Science,* 16:164-169.

Jordan, D; Kremer, R.J., Bergfield, W.A., Kim, K.Y. and Cacrnio, V.N., (1995). Evaluation of microbial methods as potential indicators of soil quality in industrial agricultural fields. *Biol. Fert. Soils*, 19:297-302.

Juo, A.R.S.,(1979). Selected methods for soil and plant analysis. IITA Manual Series. No. 1, Ibadan, Nigeria.

Kallah, M.S. and A.M. Adamu, (1989). The importance of animal feaces as fertilizer. Gefu, J.O; Adu I.F; Lufadeju, E.A; Kallah, M.S and Awogbade,M.O. (Eds) Pastoralism in Nigeria: Past, Present and Future. Proc. Of the National Conf. on Pastoralism in Nigeria held at NAPRI, Shika-Zaria, Nigeria, 26-29 June, 1988.

Mendes, I.C., A.K. Bandick, R.P., Dick and P.J. Bottomlcy, (1999). Microbial biomass in soil aggregates affected by winter cover crops. *Soil Sci. Soc. Am. J.,* 63:873-881.

Moore, J.M., Klose., and Tabaatbai, M.A.,(2000). Soil microbial biomass, Carbon and Nitrogen as affected by cropping systems. *Biol. Fert. Soils*, 31:200-213.

Ndiaye, E.L., J.M. Sandeno, D. McGrath and R.P. Dick,(2002). Integrative indicators for detecting change in soil quality. *American Journal of Alternative Agr.*, Vol. 15 No. 1.

Paul E.A. and Voroney, R.P., (1984). Field interpretation of microbial biomass activity measurements. *In Current Perspectives in Microbial Ecology* M.J. Klug and C.A. Reddy eds). Pp 509-514. American Society for Microbiology, Wahington.

Sauerlandt, W. and C. Tietjen, (1970). Humuswirschaft des Ackerbaues. DLG-verlag. Frankfurt. 239 pp.

Sparling, G.P., (1985). The soil biomass. *In soil Organic Matter and Biological Activity* (D. Vaugan and R.E. Malcolm, Eds), pp. 223-262. Nijhoff, Dordrecht, The Netherlands.

Trasar-Cepeda, C., Leiros, C., Gil-Sotres, F., and Seoane, S., (1998). Towards biochemical quality index for soils: an expression relating several biological and biochemical properties. *Biol. Fert. Soils*, 26:100- 106.

***APPENDIX 1*: SAMARU METEOROLOGICAL OBSERVATIONS DURING PERIOD OF STUDY.**

Month	**Rainfall (mm)**	**Temperature (^oC)**		**Relative Humidity (%)**	**Sunshine Hours**
		Min.	**Max.**		
		2003			
February	0.0	19.4	36.4	72.5	8.1
March	0.0	21.8	36.8	71.3	5.9
April	31.0	24.7	37.8	71.0	7.2
May	78.4	24.0	37.5	72.1	7.4
June	69.2	23.4	32.3	82.3	6.8
		2004			
February	0.0	16.7	31.5	13.6	NA
March	13.6	19.6	34.6	16.9	NA
April	7.8	25.8	38.0	54.1	NA
May	162.8	22.2	34.5	66.0	NA
June	190.5	20.4	31.1	77.9	NA

NA = Not available

Source: Meteorological Office, Institute for Agricultural Research, Ahmadu Bello University, Samaru,