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Research Article

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ABSTRACT

Greenhouse and Field experiments were conducted at the Institute for Agricultural Research and Samaru College of Agriculture, Ahmadu Bello University, Zaria. The objectives of the experiments were to evaluate the combine effects of cow dung subjected to different management practices and Urea fertilizer on some Maize growth parameters and to observe the residual effects of the cow dung in the second year. The experiment was a factorial experiment, 3 management practices, 4 duration of storage, and 2 nitrogen levels, laid out in a Randomized complete block design and replicated three times. The Greenhouse study revealed that, combining cow dung subjected to different management practices (pit covered May and surface heaped uncovered June) and Urea at 45 kg N ha^{-1} gave significantly (P < 0.05) higher dry matter yield and surface heaped covered April treatment gave taller plants, which were statistically at par with NPK treatment (120 kg N ha^{-1}). The results of the field studies for the two years were consistent on the dry matter yield and plant height. The field studies showed that, the direct effect, N amended surface heaped covered April gave the highest Maize Stover yield for the two seasons, while on the residual effect, N amended, the surface heaped uncovered March treatments gave the highest stove yields. On plant height, the direct effect N amended surface heaped uncovered May treatments gave significantly taller plants than all other treatments in the two seasons. While on the residual effect, the surface heaped covered April treatment was the one that gave taller plants in the two seasons.

Keywords: Organic Carbon, Total Nitrogen, Cow dung, management practices, urea fertilizer, growth parameters and maize.

Abbreviations: PC = Pit Covered, SHU = Surface Heaped Uncovered, SHC = Surfaced Heaped Covered, RCBD = Randomized Complete Block Design, WAP = Weeks after planting

INTRODUCTION

The Nigerian savanna covers about three quarters of the country's total land area (Kowal and Knabe, 1972). The soils are derived from Aeolian deposits (Jones and Wild, 1975) and kaolinite dominates the clay fraction (Ojanuga, 1979).The soils are low in organic matter (OM), basic cat ions, available phosphorus and nitrogen (N). This low level of OM has made the savanna soils susceptible to major chemical, physical and biological limitations which reduce crop yields (Jones and Wild, 1975). With intensification of cropping, organic matter and N are readily depleted, while phosphorus (P) and other nutrient reserves are slowly but steadily being depleted. The increasing pressure on land, with the traditional practices employed to restore the fertility of these soils, have been rendered unsuitable, as quick fertility restorative practices are needed to meet the increasing demand for food crop production (Kang *et al.,* 1986). About 70 % of the Nigerian population depends on farming for their livelihood and 90 % of these groups are constrained by resources (Heathcote, 1970; Jones and Stockinger, 1976).

In recent years the focus of soil fertility research has been shifted towards the combined application of organic matter and fertilizers as a way to arrest the ongoing soil fertility decline in Sub-Saharan Africa (Vanlauwe, *et al*., 2001c). The organic sources can reduce the dependency on costly fertilizers by providing nutrients that are either prevented from being lost (recycling) or are truly added to the system (biological N-fixation). When applied repeatedly, the organic matter leads to build-up of soil organic matter, thus providing a capital of nutrients that are slowly released (Giller *et al*., 1997), and at the same time increasing the soil's buffering capacity for water, cat ions and acidity (de Ridder and van Keulen, 1990).

Maize (Zea mays L.) is the most important cereal crop in Sub-Saharan Africa (SSA). Along with Rice and Wheat, Maize is one of the three most important cereal crops in the world. According to FAO data, the land areas planted to maize in West and Central Africa alone increased from 3.2 million in 1961 to 8.9 million in 2005. This phenomenal expansion of the land area devoted to maize cultivation resulted to increased production from 2.4 million metric tones in 1961 to 10.6 million metric tones in 2005. While the average yield of maize in developed countries can reach up to 8.6 ton/ha, production per hectare in many SSA countries is still very low (1.3 ton/ha) (IITA, 2007).

In Nigeria Maize is a staple food of great socio-economic importance. The demand for maize sometimes outstrips supply as a result of the various domestic uses (Akande, 1994). Additionally, other factors like price fluctuation, diseases and pests, poor storage facilities have been associated with low maize production in the country (Ojo, 2003). Maize has been reported to have a high inorganic nutrients requirement in order to obtain good quality and high yields. Mishra *et al*. (1993) and El-kholy and Gomaa (2000) succeeded in reducing the recommended rate of chemical fertilizer without loss in the yield of maize using about 50% of chemical fertilizer in combination with 50% bio-fertilizers. In view of this, national and international bodies have developed interest in promoting Maize production for households' food, security and poverty alleviation. This study therefore seeks to evaluate the combine effects of cow dung subjected to different management practices and urea fertilizer on some growth parameters of maize in the Green house and field studies and its residual effect in the second year.

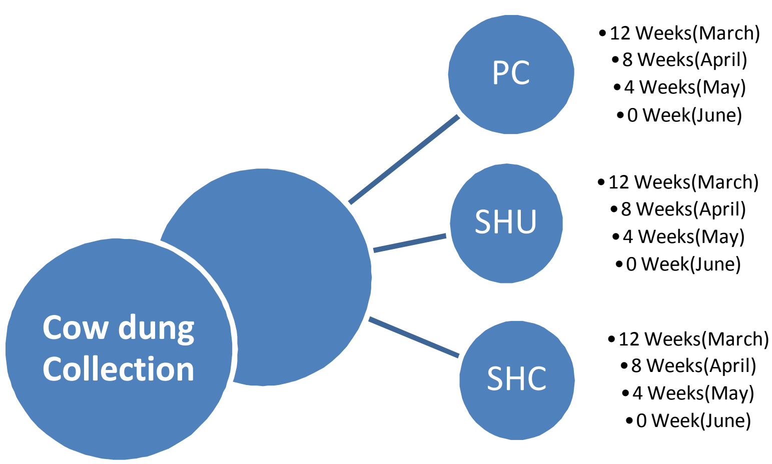
MATERIALS AND METHODS.

Experimental site.

The study consisted of collection and incubation of cow dung and subsequent evaluation using both greenhouse and field experiments. The greenhouse experiment was conducted at the screen house of Institute for Agricultural Research (IAR) Ahmadu Bello University, Samaru, Zaria (Lat. 11° 11" N and Long. 7° 33" E) located in the Northern Guinea Savanna zone of Nigeria. The field studies were also carried out in Samaru at two different locations within the same zone at the IAR Research Farms and the Samaru College of Agriculture (SCA) Farm, Samaru.

Cow dung collection and subjected to management practices.

The cow dung that was used for these experiments (both greenhouse and field experiments) were collected from the National Animal Production Research Institute (NAPRI), Shika-Zaria in years 2003 and 2004. The cow dung collected was subjected to different management practices as described below (Figure 1).



Stage 1 Stage 2 Stage 3

Stage 1= Cow dung Collection
Stage 2=Management Practices (composting or incubation) for four weeks
Stage 3= Field Storage (Exposure) before use in the field

Figure 1: Diagrammatic Presentation of Experimental Set up.

Fresh cow dung was collected early in the morning from pens and piled into a heap. The cow dung was then mixed thoroughly with a shovel with the aim of harmonizing it. After mixing it thoroughly, it was then subjected to the various management schedules as follows: (i) cow dung placed in a pit of 2 x 2 m and 75 cm deep and covered with a polythene sheet, (ii) cow dung heaped on the ground surface and covered with a polythene sheet, and (iii) cow dung heaped on the ground surface and left uncovered. The collection of the cow dung and its distribution to the 3 different management practices was repeated for the next 2-3 days as described above until enough cow dung was gathered. 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.

This experiment started in February, 2003 with the collection of cow dung and allowing it to decompose (composting) for 4 weeks which means the field storage (exposure) of the cow dung was in March to May (12 weeks of field storage before application to the soil as amendment) (Figure 2). 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).

Weeks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Duration of Storage
Month	Treatments	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 2. Diagrammatic presentation of the collection and storage of cow dung.

Cow Dung and Soil Sampling.

Three types of cow dung sampling were carried out in each of the two years. First, fresh cow dung samples (untreated) were taken after mixing thoroughly 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, 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. This set of cow dung after collection was air dried and stored for analysis. The third sampling of the cow dung was done at the time of application and incorporation into the soil {at this stage, the cow dung treatments must have been 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 and for use in the greenhouse and field.

Before the commencement of the greenhouse experiment, surface soil sample (0 to 30 cm depth) was collected from the field where the field experiment was going to be conducted at SCA farm. The soil was air-dried and sieved to pass through the 2 mm sieve.

Cow Dung and Soil Analysis

Cow dung samples were digested using wet oxidation method. K and Ca, Mg were determined by flame photometry and atomic absorption respectively, P was determined by the vanadomolybdate yellow colour method (Juo.1979); while N was determined by micro kjedahl (Bremner, 1982); and OC by walkey-Black method (Nelson and Sommers, 1982).

The surface soil samples for both greenhouse and field studies were analyzed by the following methods: for particle size distribution the standard hydrometer method (Klute, 1986) was used. The soil pH was determined in water and 0.01 M CaCl2 with a pH glass electrode using a soil: solution ratio of 1:2.5. Organic Carbon was determined by wet oxidation method of Walkley–Black (Nelson and Sommers,1982).

Exchangeable bases were determined by extraction with neutral 1 N NH_4O AC saturation method. Potassium in the extract was determined by the flame photometer , while Ca and Mg were determined by atomic absorption spectrophotometer (Juo, 1979). Available P was extracted by the Bray 1 method. The P concentration in the extract was determined calorimetrically. Total N was determined by the Kjeldahl procedure (Bremner and Mulvaney, 1982 and Bremner, 1982).

Greenhouse Experiment.

The treatments consisted of three cow dung management methods, surface heaped uncovered (SHU), surface heaped and covered (SHC) and cow dung placed in a pit and covered with polythene sheet (PPC), four storage periods, after 1 month ageing: 12 weeks, 8 weeks, 4 weeks and 0 week, two levels of N: 0 kg N ha-1 and 45 kg N ha-1 and 120 kg N ha-1 NPK (27:13:13). The experiment was a factorial experiment, 3 x 4 x 2, laid out in a Randomized complete block design (RBCD) and replicated three times.

Each pot was filled with 3 kg of the soil sample. The cow dung samples which were carefully ground and sieve to pass through a 2 mm sieve and were added at the rate of 5.0 t ha -1 (7.50 g) to each pot and thoroughly mixed with the soil, watered at field capacity for two weeks before maize (var. Oba super II) was sown. A recommended rate of NPK at 120 kg N ha-1 was also added. Samples of soil and the cow dung before mixing were taken and kept for chemical analysis. Three seeds were sown per pot and later thinned to two plants per pot at two weeks after planting (WAP).

Observations were made on weekly basis, from the 2 weeks after planting(WAP). Plant height was measured from the soil surface to the leaves whorl using a meter rule. The plants were harvested after 6 weeks of growth in the greenhouse. Each pot was harvested by cutting the plants at the soil level. The plant shoots harvested were washed thoroughly with water and dried for 48 hours in an oven set at 65o C and weighed for dry matter yield (DMY).

Field Experiments.

The field experiments were conducted at two locations. The first trial was carried out at the IAR Farm, Samaru in the year 2003, and 2004 seasons. The second trial was established at the SCA Farm, Samaru in 2004 and 2005 seasons. In all the experiments, the same treatment combinations, experimental design, observations and procedures were maintained as in the greenhouse experiment, except that the NPK combination was not included.

The treatments and experimental design in the field were the same as described in the greenhouse experiment. However there was a control treatment where no cow dung or nitrogen fertilizer was applied. These gave a total of 25 treatment combinations (NPK treatment was not included). The experiment was a factorial experiment with 3 factors, laid out in a randomized complete block design replicated three times.

The land was plowed and harrowed and the field was mapped out into plots in the first year of the experiment. The plot sizes were 4 x 5 m (20m2) and each plot was separated from the other by one meter. The plots were then ridged manually at 75 cm between ridges and immediately after cow dung application to avoid the transfer of the manure from one plot to another and to also incorporate the manure into the soil.

In the second year of the experiment, when the residual effect was to be observed, the same plots were maintained and the ridging was also done manually to avoid the transfer of soil from one plot to another.

Cow dung subjected to different management practices which had been conveyed and stored in the field at 12,8,4 and 0 week(s) were applied manually at 5.0 t ha -1 on dry matter weight basis in the first year of the experiment. The plots were then immediately ridged manually with the hand hoe to incorporate the cow dung. In the second year of the experiment, the residual effect of the first year applications was observed. That is, there was no application of cow dung in the second year.

In both years (direct and residual trials) of the experimentation, maize (Var. Oba super II) was sown at two seeds per hole, at a spacing of 25 cm within the row. The seedlings were later thinned to one plant per hill at two weeks after planting. The same procedure was repeated in the second year, when the residual effect was to be observed.

A blanket application of P was applied as single super phosphate (SSP) at the rate of 60 kg P2O5 ha-1 and at 45 kg N ha-1 as urea was applied in two split equal doses to the appropriate plots. The first application was done immediately after the first weeding. The second dose was applied at the time of second weeding. All methods carried out in the first year were repeated in the second year of evaluating the residual effect.

During the first and the second years of the trials, when the maize was fully matured at the time of full cob formation, the plant height of five randomly sampled plants in each plot were measured and the mean calculated.

The net plots (four inner rows) were harvested when the crop was fully matured and dry. After harvesting, the maize stover was cut and left in the field to dry and the dry stover weight was taken for each treatment.

Statistical Analysis

The data collected from the greenhouse and the field studies were subjected to Analysis of Variance (ANOVA) using the SAS package (SAS Inst., 1999). The means where significant were separated using the Duncan's Multiple Range Test (DMRT) at 5% level of probability, except otherwise stated.

RESULTS AND DISCUSSION.

The results of soil samples of study areas are presented in Table 1, while the NPK content of cow dung used for the two seasons based on different management practices and durations of storage are presented in Table 2.

Table 1. Some physical and chemical properties of the soil of the first and second experimental sites at commencement of study.

Parameters	IAR Farm	SCA Farm
Sand (g kg^{-1})	640	360
Silt (g kg^{-1})	210	540
Clay (g kg^{-1})	150	100
Texture	Sandy loam	Silt loam
pH 1:2.5 (H_2O)	5.90	5.90
pH 1:2.5 ($CaCl_2$)	5.10	5.20
Organic Carbon (g kg^{-1})	7.40	4.40
Total N (g kg^{-1})	0.53	0.70
C/N ratio	14.00	6.29
Bray 1 P (mg kg^{-1})	7.00	2.00
Exchangeable Calcium (cmol kg^{-1})	2.00	1.60
Exchangeable Magnesium (cmol kg^{-1})	0.80	1.00
Exchangeable Potassium (cmol kg^{-1})	1.84	0.49
Exchangeable Sodium (cmol kg^{-1})	1.87	1.13

IAR = Institute for Agricultural Research
SCA = Samaru College of Agriculture

Maize Dry Matter Yield and Plant Height in the Greenhouse.

The results of maize dry matter yields are presented on Table 3. The results showed that, the NPK treatment gave the highest dry matter yield (22.77 g) per pot, while the control treatment, where manure and nitrogen fertilizers were not added, gave the least values (4.61 g) per pot. The results also showed that the N amended treatments gave values that were generally higher than treatments of direct evaluation, that is, where only the manure was added, without the addition of urea fertilizers.

Among the N amended treatments, the pit covered May (20.04 g) and surface heaped uncovered June (19.29 g) treatments gave the highest values and they were significantly not different from the NPK treatment that gave the highest value. The two treatments in Table 4.2 had 1.75 % total N each, which were next to the highest value. Many workers have already reported an increase in dry matter yield of Stover and plant height as N levels increased. Tanimu *et al*. (2007) reported higher doses of N fertilizers increased grain yield and yield related components of Maize.

The response of Maize plant height to manure and N fertilizer application are shown in Table 3. The results revealed that, at 2 and 3 WAP, the differences among the treatments were not very consistent. But from 4 WAP, the N amended treatments tended to give higher plant height values. At the 4 WAP the surface heaped uncovered June treatment gave the tallest plants (18.17 cm) which was followed by the NPK treatment (18.08 cm). It can be said that this was when the nutrients released by mineralization of the manure started influencing the growth of the plants.

At 5 WAP and 6 WAP, the NPK treatments gave the tallest plants (23.70 cm and 33.50 cm respectively) when compared to other treatments, while the untreated control, where no manure and N fertilizer were applied, gave the least values (11.83 cm and 12.83 cm respectively). Among the N amended treatments, the surface heaped uncovered June treatment consistently maintained the taller plants. These results agreed with what was observed with the dry matter yield in the greenhouse experiment, where the surface heaped uncovered June treatment gave higher dry matter yield of maize. This may still be attributed to the higher N content of this treatment at the time of field application (Table 4.2) which enhanced high growth rate of the maize as reported by some workers (Tanimu *et. al*., 2007). Good manure should synchronize mineral nitrogen release and plant demand such that the peak mineral nitrogen release coincides with peak plant biomass development and hence peak nitrogen requirements (Myers *et al.,* 1994). Lekasi *et al*. (2005) also reported that it is advantageous if the organic materials added to the soil mineralize to release nutrients slowly and the rate of nutrient mineralization increases as the plant growth progresses. As the plant matures, it is expected that a good soil would have released adequate nutrients for optimum plant growth.

Table 2. Total NPK content of cow dung used for greenhouse and field studies.

Management practices (one month incubation)	Time of manure exposure in the field before use (weeks)	2003 SEASON						2004 SEASON					
		N (%)		P (%)		K (%)		N (%)		P (%)		K (%)	
		a	b	a	b	a	b	a	b	A	b	a	b
SHUM	**12**	1.05	1.40	0.75	0.25	5.48	1.65	0.88	1.00	0.67	0.64	3.60	2.78
SHUA	**8**	1.40	1.40	0.39	0.39	1.43	1.65	1.23	1.08	0.60	0.67	3.30	3.08
SHUY	**4**	1.40	1.58	0.60	0.50	1.35	1.35	1.23	1.20	0.60	0.91	2.55	6.08
SHUJ	**0**	1.75	1.75	0.53	0.75	1.25	2.25	1.20	1.23	0.67	0.71	3.68	2.63
SHCM	**12**	1.23	1.40	0.75	0.67	1.35	1.75	1.05	1.08	0.39	0.51	1.73	2.10
SHCA	**8**	1.40	1.05	0.83	0.39	1.50	1.28	1.23	1.10	0.46	0.60	0.98	4.65
SHCY	**4**	1.23	1.23	0.67	0.32	1.65	1.43	1.23	1.58	0.53	0.71	1.88	3.53
SHCJ	**0**	2.10	1.93	0.91	0.75	1.50	3.08	1.23	1.25	0.53	0.60	0.98	2.55
PCM	**12**	1.75	1.45	0.79	0.39	3.15	1.98	1.05	1.05	0.80	0.60	4.88	1.58
PCA	**8**	1.75	1.05	0.60	0.32	5.25	1.20	1.58	1.58	0.53	0.53	4.28	1.80
PCY	**4**	1.58	1.75	0.67	0.49	3.68	1.58	1.98	1.05	0.53	0.71	3.15	2.63
PCJ	**0**	1.75	1.58	0.83	0.53	4.28	1.58	1.70	1.70	0.58	0.53	3.60	1.73
CONTROL	**-**	1.58		0.75		1.65		1.55		0.73		1.50	

SHUM = Surface heaped uncovered March,
SHUA = Surface heaped uncovered April,
SHUY = Surface heaped uncovered May
SHUJ = Surface heaped uncovered June

SHCM = Surface heaped covered March,
SHCA = Surface heaped covered April,
SHCY = Surface heaped covered May
SHCJ = Surface heaped covered June

PCM = Pit covered March,
PCA = Pit covered April,
PCY = Pit covered May
PCJ = Pit covered June

a = At termination of 1 month incubation
b = At time of application for field trial

Table 3.Effects of cow dung management practices, time of application and nitrogen levels on the dry matter yield and plant height of maize in the greenhouse

Treatments	DMY (g)		Plant height at 2 WAP (cm)		Plant height at 3 WAP (cm)		Plant height at 4 WAP (cm)		Plant height at 5 WAP (cm)		Plant height at 6 WAP (cm)	
	oN	+N	oN	+N	On	+N	oN	+N	oN	+N	oN	+N
SHU												
SHUM	7.51hij	11.50fgh	10.00ab	9.00bc	8.80bcd	10.08a-d	14.73a-d	16.08a-d	16.33d-g	18.92b-e	18.72fg	23.08def
SHUA	8.93g-j	15.82c-e	9.00abc	9.67ab	10.47a-d	10.47a-d	15.62a-d	14.87a-d	17.50cde	20.08a-d	19.53efg	25.85bcd
SHUY	9.44ghi	12.79efg	10.00ab	9.33abc	11.10abc	10.78abc	15.23a-d	17.20abc	17.08c-f	22.38ab	19.42efg	29.17ab
SHUJ	7.60hij	19.28abc	10.00ab	9.67ab	10.92abc	10.75abc	13.87b-e	18.17a	16.55def	23.08a	19.20fg	30.42ab
SHC												
SHCM	6.03ij	12.49efg	9.00abc	10.00ab	9.58a-d	12.10a	12.38de	15.75a-d	13.38fgh	21.67ab	17.03gh	29.37ab
SHCA	8.46g-j	17.73bcd	10.00ab	10.00ab	10.92abc	11.95ab	15.07a-d	17.92a	16.80def	22.40ab	19.58efg	29.67ab
SHCY	8.47g-j	16.13b-e	9.33abc	10.00ab	10.85abc	11.58ab	14.15a-d	17.33ab	15.62e-h	22.67ab	16.67gh	28.17bc
SHCJ	7.01ij	12.27efg	9.00abc	8.67bc	9.83a-d	8.78bcd	13.78b-e	13.50b-e	15.02e-h	22.58ab	16.92gh	25.83bcd
PC												
PCM	7.02ij	13.69def	10.33a	10.00ab	9.60a-d	10.90abc	13.78b-e	16.00a-d	15.53e-h	20.75abc	17.58gh	28.01bcd
PCA	5.46ij	13.95def	9.33abc	9.33abc	9.02a-d	9.68a-d	10.03e	16.03a-d	12.48gh	20.92abc	15.92gh	26.28bcd
PCY	5.98ij	20.04ab	9.00abc	10.00ab	9.50a-d	10.83abc	13.32b-e	17.88a	15.17e-h	22.25ab	17.13gh	27.75bcd
PCJ	7.21hij	15.68c-f	9.67ab	9.00abc	11.00abc	7.92cd	14.75a-d	13.16cde	15.92efg	17.12c-f	17.33gh	24.17cde
Control	4.61j		8.00c		7.33d		12.67de		11.83h		12.83h	
NPK	22.77a		10.00ab		11.35ab		18.08a		23.70a		33.50a	
SE±	1.323		0.436		0.933		1.173		1.212		1.521	

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

SHUM = Surface heaped uncovered March,
SHUA = Surface heaped uncovered April,
SHUY = Surface heaped uncovered May
SHUJ = Surface heaped uncovered June

SHCM = Surface heaped covered March,
SHCA = Surface heaped covered April,
SHCY = Surface heaped covered May
SHCJ = Surface heaped covered June

PCM = Pit covered March,
PCA = Pit covered April,
PCY = Pit covered May
PCJ = Pit covered June

oN = Direct evaluation, +N = 45 kg N ha $^{-1}$

Table 4.Effects of manure management practices, time of application and nitrogen levels on maize Stover yield (kg ha^{-1}) in IAR and SCA farms.

Treatments	IAR farm				SCA farm			
	Direct effect(2003)		Residual effect(2004)		Direct effect(2004)		Residual effect(2005)	
	oN	+N	oN	+N	oN	+N	oN	+N
SHU								
SHUM	1354.2gh	2895.8a-e	1058.3ed	2487.5a	583.3i	2666.7b-e	500.0i	1875.0a
SHUA	1558.3fgh	3575.0ab	1154.2cde	2320.8abc	866.7hi	3858.3ab	641.7ghi	1425.0a-d
SHUY	2600.0b-g	3233.3abc	1904.2a-d	1745.8a-e	1825.0d-i	3258.3abc	833.3f-i	1166.7c-f
SHUJ	2091.7c-g	2858.2a-f	1187.5cde	2179.2a-d	558.3i	2258.3c-g	666.7ghi	1125.0c-g
SHC								
SHCM	1512.5gh	2666.7b-g	1175.0cde	2054.2a-d	566.7i	2541.7b-f	1083.3d-h	1525.0a-d
SHCA	2004.2c-g	4008.3a	1483.3a-e	2433.3ab	1466.7e-i	4433.3a	875.0e-i	1750.0ab
SHCY	1887.5d-h	3083.3a-d	1408.3a-e	1900.0a-d	1066.7ghi	2958.3bcd	675.0ghi	1416.7a-d
SHCJ	2112.5c-g	2895.8a-e	1520.8a-e	2533.3a	1266.7f-i	2125.0c-h	833.3f-i	1458.3a-d
PC								
PCM	1704.2e-f	3458.3ab	1137.5cde	2062.5a-d	1033.3ghi	37.8-3ab	608.3hi	1583.3abc
PCA	2079.2c-g	3245.8abc	1237.5b-e	2445.8ab	1700.0d-i	3241.7abc	625.0hi	1333.3b-e
PCY	2070.8c-g	2970.8a-e	1500.0a-e	2558.3a	1058.3ghi	2816.7bcd	1416.7a-d	1833.3a
PCJ	2087.5c-g	2862.5a-f	1341.7a-e	2487.5a	800.0hi	2158.3c-h	750.0f-i	1458.3a-d
Control	650.0h		645.8e		875.0hi		625.0hi	
SE±	392.23		361.15		404.41		148.05	

Means with the same letter(s) within the same group are not significantly different at 5% level of significance

SHUM = Surface heaped uncovered March,
SHUA = Surface heaped uncovered April,
SHUY = Surface heaped uncovered May
SHUJ = Surface heaped uncovered June

SHCM = Surface heaped covered March,
SHCA = Surface heaped covered April,
SHCY = Surface heaped covered May
SHCJ = Surface heaped covered June

PCM = Pit covered March,
PCA = Pit covered April,
PCY = Pit covered May
PCJ = Pit covered June

oN = Direct evaluation, +N = 45 kg N ha $^{-1}$

Table 5.Effects of manure management practices, time of application and N levels on plant height of maize (cm) in the field in years 2003 and 2004 and their residual effects

Treatments	2003 Season				2004 Season			
	Direct effect		Residual effect		Direct effect		Residual effect	
	oN	+N	oN	+N	oN	+N	oN	+N
SHU								
SHUM	223.33def	229.33cde	183.67gh	183.67gh	99.33i	197.33d-f	118.33gh	175.67ab
SHUA	185.00ij	191.00hij	193.00d-g	198.67de	179.00fg	242.67ab	122.00gh	187.67a
SHUY	231.00b-e	248.33a	178.33hi	216.00b	193.67c-g	267.00a	152.00cd	13033efg
SHUJ	198.33ghi	216.00ef	165.33j	202.33cd	87.00i	193.67c-g	108.00hi	178.33a
SHC								
SHCM	237.33a-d	206.67fgh	191.33efg	194.00def	169.33fg	195.33c-g	139.00def	144.67de
SHCA	180.00j	235.00a-d	171.67ij	229.67a	185.00d-g	217.00bc	143.33de	184.67a
SHCY	215.00efg	217.67ef	155.67k	184.33fgh	131.33h	261.67a	144.00de	177.33ab
SHCJ	198.33ghi	188.67ij	184.00gh	231.67a	164.33g	208.33cde	115.67ghi	161.67bc
PC								
PCM	214.67efg	242.67abc	177.00hi	197.33de	164.33g	211.00de	100.00i	189.00a
PCA	237.67a-d	222.00def	121.33l	185.00fgh	192.00c-g	218.33bc	126.67fg	180.00a
PCY	192.00hij	247.67ab	169.00ij	183.00gh	177.33efg	209.33cd	152.33cd	187.33a
PCJ	215.00efg	229.00cde	177.00hi	209.33bc	93.67i	192.67c-g	154.67cd	192.67a
Control	151.67k		83.33m		94.67i		123.33fgh	
SE±	5.319		3.088		9.417		5.306	

Means with the same letter(s) within the same column are not significantly different at 5% level of significance

SHUM = Surface heaped uncovered March, SHUA = Surface heaped uncovered April, SHUY = Surface heaped uncovered May SHUJ = Surface heaped uncovered June

SHCM = Surface heaped covered March, SHCA = Surface heaped covered April, SHCY = Surface heaped covered May SHCJ = Surface heaped covered June

PCM = Pit covered March, PCA = Pit covered April, PCY = Pit covered May PCJ = Pit covered June

oN = Direct evaluation, +N = Amended

Maize Stover yield and plant height in the field

Results of the effects of treatments on maize Stover yield for direct and residual effects for the two seasons are shown in Table 4. The direct effect N amended surface heaped covered April gave higher Stover yield for the two seasons. But on the residual effect with N amendment, pit covered May treatment gave higher Stover yields for the two years. Observing the direct evaluation (non-N amended) treatments, the surface heaped uncovered May treatments gave higher Stover yields for the two years, except the residual effect in 2004, that the pit covered May treatment gave a higher value. Some of the discrepancies observed on the treatments could be explained from some of the reasons already stated that, the rate of mineralization of organic matter depends on many factors, including temperature and rainfall, the quality of the soil organic nitrogen, the quality of the organic inputs to the system (Palm *et al.,* 1993). Again, since mineralization is microbially driven, it is influenced by many factors, including temperature, soil moisture, soil properties and manure characteristics (Cassman and Munns, 1980; Eghball, 2000).The N amended treatments were consistently higher than the non-N amended treatments in all the seasons and at both direct and residual effects. It's been reported that for the poorly buffered soils of the savanna, integrated soil fertility management systems, which combine the use of organic matter and inorganic fertilizer are needed (Sanchez and Salinas, 1981; Kang and Spain, 1986), organic matter from tree foliage cannot be used alone, but with some level of inorganic fertilizer (Uyovbisere and Elemo, 2002). The maize plant heights for the two years and for both the direct and residual effects are presented in Table 5.

The results showed that, plant height was affected by the various treatments, and there was consistency in the two years and the direct and residual effects. Though the treatments that gave higher values of Stover were not the same with what was observed on the plant height. The same reasons already advanced could be Responsible for this pattern of behaviour. That is, the differences on the rates of mineralization which affected the rates of nutrient released and even lost through either volatilization or leaching as stated by (Lekasi *et al.*, 2005). On the direct effect N amended, the surface heaped uncovered March treatments gave significantly taller plants in the two seasons.

The N amended surface heaped covered April treatment at the residual effect gave taller plants at the two seasons, these values correlated to what was obtained in the green house, where this same treatment gave taller plants (at 4 and 6 WAP) which were not significantly different from the NPK treatment that gave the tallest plants. However, most of the direct effect plots gave taller plants than the residual effect in the two seasons at each equivalent level of comparison. Also, the N amended plots gave taller plants than the direct evaluation plots. The effects are attributable to nutrient contributions of the materials and rate of nutrient release (Tian *et. al*; 1992a). The control plots also consistently gave shorter plants than the manure and N amended treatments, except at the residual effect of 2004 season.

CONCLUSION

In the Greenhouse the NPK treatment gave higher dry matter yield and plant height values than the N amended cow dung treatment, which was also higher than the non N amended cow dung treatment, the control gave the least value. Among the N amended cow dung treatments, the pit covered May and surface heaped uncovered June treatments gave the highest dry matter yield and surface heaped covered April treatment gave significantly taller plants, which were statistically at par with the NPK treatment. This revealed that, combining cow dung and Urea at 45 kg N ha^{-1} successfully reduced the N requirement for Maize in terms of dry matter production and plant height respectively.

The results of the field studies among the treatments were consistent for the two years. The field studies showed that the direct effect, N amended surface heaped covered April gave the highest Maize Stover yield for the two years, while on the residual effect, N amended (+N), the surface heaped uncovered March treatments gave the highest Stover yields. On plant height the direct effect N amended surface heaped uncovered May treatments gave significantly taller plants than all other treatments in the two seasons. While on the residual effect, the surface heaped covered April treatment was the one that gave taller plants in the two seasons. The control treatment (where no cow dung or N was applied) consistently gave the lowest values of both maize dry matter yield and plant height.

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