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INVESTIGATION OF ROLES OF SEEDBED METHODS AND MANURE TYPES ON SOIL PROPERTIES IN ACID SOILS, SOUTHEASTER NIGERIA.

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ABSTRACT

A field experiment was conducted to evaluate effect of seedbed methods and manure sources on selected soil chemical properties on acid sand soils. A 3x5 factorial experiment was carried out in a randomized complete block design (RCBD) with three replications. Three seedbed methods; sunken bed, mound and ridge occupied the main plot, while five manure sources; control o t/ha, cowdung, goat dung, poultry droppings at 5 t/ha and NPK 15:15:15 at 200kg/ha were in the sub plots. Composite soil samples were collected before and after treatment application from the experimental plots at 0-15cm depth. The results showed that application of different manure sources and seedbed methods significantly improved soil fertility status. The results showed that sunken bed plots had the highest pH of 5.44±0.33, followed by mound, pH of 5.23± 0.21, while Ridge soil had the least value of 5.09 ± 0.22. Among manure sources the highest pH was obtained in cow dung of 5.34 ±0.30, followed by NPK with pH of 5.32 ±0.15, while control had the least value of 5.02 ±0.06. The highest organic matter was obtained in NPK 15:15:15 (3.82 ±1.28%), followed by poultry dropping (2.57 ±0.77%), while cow dung had the least value (2.14 ±0.21%). Also, Ridged plots had the highest base saturation of 84.16 ±2.07%), followed by sunken bed (81.47 ±5.18%), while mound had the least value (80.02 ±2.01%). In relation to manure sources, the highest base saturation was obtained in goat dung (83.33 ±3.89%), followed by poultry dropping (82.79 ±3.79%), while control soil had the least value (80.27 ±3.57%). The results showed that Ridged soil performed better, followed by mound; while goat dung was better than others in relation to their effects on soil chemical properties.

Keywords: Seedbed methods, manure sources, chemical properties, acid sand soils, land-use practices.

INTRODUCTION

Poor soil management practices that lead to soil instability and low inherent fertility to most soils is responsible for poor crop yield. The soils are low in cation exchange capacity and are generally poor buffered and rapidly lose their fertility due to intensive continuous cultivation (Onofiok, 2002; Udoh *et al*., 2021) and high weathered condition that brought about rapid decomposition of organic materials also, due to the quality of organic materials, that are transient in nature. Acid sands are derived from coastal plain sand parent material, which is characterized by low fertility status, and therefore cannot on their own support intensive crop production.

Excessive use of inorganic fertilizers negatively affects soil environment, human health and reduces profit margins and farmers gain, though it is used to boast crop production to meet the increasing demands of consumers. The use of organic fertilizer otherwise called manures, increasecrop production as well as improve the soil quality. Manure contains almost all the nutrients needed by crop compared to inorganic fertilizers which can only supply certain nutrient, that lead to severe nutrient imbalance in the soil. According to Kabiret *al*, (2013), nutrient imbalance is one of the major factors responsible for deterioration of soil quality and low crop yield. Hence there is need to apply organic amendments that can complement inorganic fertilizer, to improve fertility status and in turns improves crop production.

The physical, chemical and biological soil manipulation during cultivation operations, changes the fertility status of the soil significantly and the changes manifested in good or poor performance of crops (Ohiri and Ezumah, 1991). Also, tillage operations loosen the soil and break aggregate apart, resulting in changes in soil properties such as bulk density, pore size distribution and composition of soil atmosphere; these affects plant growth. Appropriate tillage practices are those that avoid the degradations of soil properties, but maintain crop yields as well as ecosystem stability (Lal, 1981; and Greenland, 1981).

Tillage aims to increase crop production while conserving resources (soil and water) and protecting the environment, erosion control, weed control, seedbed preparation and water infiltration enhancement. Appropriate tillage practices and nutrient imbalance is one of the major factors responsible for deterioration of soil quality and low crop yield. Hence, there is need to research on seedbed methods and organic amendments that can be used in complementing organic fertilizer to improve the low fertility status and soil quality. Therefore, it is important to carry out research findings on effect of seedbed methods and manure sources on chemical properties of soil on acid sand soils inAkwaIbom State University Teaching and Research Farm, Nigeria.

MATERIALS AND METHODS

Description of the study area

The study was conducted at the teaching and research farm, AkwaIbom State University,ObioAkpaCampus. The area lies between latitudes $7^0 30^1$E and $8^0 0^1$E and longitudes $4^0 30^1$ and $5^0 30^1$E (SLUS AK, 1996). The soils are derived from coastal plain sand parent material. These highly weathered parent materials also dominated by low activity clays such as kaolinite and the amorphous oxide of Al and Fe.

The State is within the wet, humid rain forest zone of WestAfrica. It is characterized by two distinct seasons, the wet season and the dry season. The wet season lasts from March to October and the dry season from November to February with annual mean rainfall of 3000 mm-4000 mm, with relative humidity of 75-95%, also with mean maximum temperature of 30^0C and mean minimum temperature of 23^0C Enwezor *et al* (1990). According to Peter *et al.*, (1989) the soils in AkwaIbom State are rich in free iron but have low weathering potential and mineral reserve and therefore of low physical and chemical fertility status, because of prolonged deep weathering and cycles of erosion. The soils are unstable due to the nature of the parent material and climatic conditions. The soils have loamysand and sandy loam texture in the surface, and sandy clay loam, sandy clay and clay in the subsurface. The soils are rich in free iron, and iron oxides predominate in the clay fraction and are strong acidic (Ogban and Essien, 2016).

The vegetation is generally the rainforest which in AkwaIbom State has been reduced in most places completely to farmlands of short duration fallow < 4 years, and to secondary forest of oil palm (Ogbanet *al.*, 2004). A variety of tree and food crops grown in the State, include: oil palm, cocoa, rubber, maize, cassava, plantain/banana, yam and vegetables.

Experimental Design and Filed Layout

The experiment was a 3x5 factorial laid out in RandomisedComplete Block Design (RCBD). It comprise two (2) treatments which include three (3) levels of seedbed methods namely; Tilled, Mound and Ridge and five (5) levels of manure sources which are control (ot/ha), cow dung (CD), Goat dung (GD), Poultry manure (PM) and NPK 15:15:15. The experimental site was cleared manually and seedbeds measuring 1mx0.6m were made.

Soil Sampling

The soil samples were collected before planting at random from 0-15cm depth from the experimental site bulked, air-dried, crushed and sieved through a 2mm mesh for routine analysis. Another set of soil samples were collected at the same depth at harvest, 12 weeks after manure application. The samples were air-dried, crushed and sieved through a 2mm mesh for determination of chemical properties.

Laboratory Analysis

Particle size distribution was determined using the Bouyoucos Hydrometer method as described by Klute (1982), after dispersing the soil particles with sodium hexamataphosphate solution. The textural class of the soil was determined using the USDA textural triangle. Soil pH was determined in 1:2.5 soil/water ratio using a glass electrode pH meter

(JENWAY 3520 MODEL) as described by Udoet *al*., (2009). Electrical conductivity was determined in a 1:2.5 soil/water mixtures using conductivity bridge (Rhaodes, 1982). Total Nitrogen was determined by the macro- Kjeldahldigestion and distillation method as described by Udoet *al*., (2009).

Organic carbon content of the soil was determined using Walkely and Black wet oxidation method. The organic matter contents was obtained by multiplying the organic carbon by Van Brenmelon factor of 1.729 based on the assumption that organic matter contains approximately fifty eight percent (58%) carbon (Udoet *al*., 2009). Available P was extracted by PorayP.1 method of PorayandKurlz and was determined by the blue colour method of Murphy and Riley (1962). Exchangeable bases (Ca, Mg, K and Na) with IMNH4 OAC (pH-7). Ca and Mg was determined by EDTA titration while K and Na was determined by flame photometer as described byUdoet *al*. (2009).

Exchangeable acidity was extracted with IMKCL as described by Udoet *al*., (2009). Effective cation exchange capacity was determined by IITA summation method by summing up the exchangeable cations (TEB) and exchangeable acidity.

Base saturation (%) was calculated as follows:

$$\%Bsat = \frac{Ca+Mg+K+Na}{ECEC} \times 100$$

Where,

Bsat = Base Saturation

ECEC = Effective cation Exchange Capacity

2.5 Statistical Analysis

The data generated wereanalysed using descriptive statistics, while two-way analysis of variance was used to compare treatment means. Significant difference was tested at $P<0.05$ using Statistical Analysis Software (SAS)

RESULTS AND DISCUSSION

Chemical Composition of Organic Fertilizers used for the study

The chemical composition of organic fertilizers are presented in table 1. Poultry manure (PM) had Ca content of 1600 mg/kg, cow dung (CD) had Ca content of 2400 mg/kg, while 400 mg/kg was obtained for goat manure (GM). Also, Mg of 320 mg/kg, 480 mg/kg and 810 mg/kg were obtained in PM, CD and GD, respectively. While Na level of the manure was between 220.30 mg/kg in PM and 255.19 mg/kgin GD. The result also showed that PM had Nitrogencontent of 1.98%, CD and GD had Nitrogen content of 2.80 and 1.96%, while the Nitrogen content in NPK 15:15:15 fertilizer was 15%. The phosphorus contents of the organic fertilizers were 360 mg/kg, 1180 mg/kg and 240mg/kg for PM, CD and GD, respectively. While K level was 420.11 mg.kg, 3931.0 mg.kg and 4011.20 mg/kg for PM, CD and GD, respectively.Though GD had relatively higher elemental content than others, the nutrient contents of these fertilizers suggest that they would be useful materials to boost crop yields. These are in close range to values obtained by Zaller and Kopke (2004), who reported an average of 3.9% N, 3.7% p_2O_5 and 2.5% k_2O for poultry manure.

Physico-Chemical Properties of the Soil BeforeApplication of Manure Sources

Physico-chemical properties of the soil before application of manure sources is presented in table 2. Electrical conductivity of the soilfairly low (0.02 ds/m) much lower than the 2 ds/m reported by FAO (1990) for classifying soil as saline. Organic matter was 3.88%, slightly higher that 2% reported by Onofiok (2002) for classifying it as low. This suggests that the soil lacked ability to supply adequately essential nutrients such as organic matter and the exchangeable cations to crops.

Total Nitrogen was very low (0.10%). The value was lower than 2% reported by FAO (2011) cited in Udoh *et al*. (2021) as a critical value. This implies that the experimental soil was deficient in Nitrogen before application of manure. The low Nitrogen might be attributed to low organic matter content of the soil. Available phosphorus was moderately low, 17.99 mg/kg slightly higher than the 15 mg/kg reported by Enwezoret *al*. (1990) as critical value for crop production. Exchangeable cations of the soil were generally low. Generally, the fertility status of the soil was very low before the application of the manures. This suggests the need for manure application to improve its fertility status for improved crop production.

Table 1: Chemical composition of the manure sources

Parameters	Unit	PM	CD	GM
TN	%	1.98	2.80	1.90

Ca	mg/kg	1600.0	2400.0	4000.0
Mg	mg/kg	320.0	480.0	810.0
P	mg/kg	360.0	118.0	290.0
Na	mg/kg	220.3	240.1	255.2
K	mg/kg	420.1	393.1	401.1

PM – Poultry manure, CD- cow dung, GM- Goat manure, TN- Total Nitrogen, Ca- calcium, Mg- magnesium, P- phosphorus, Na- sodium, K- Potassium

Table 2: Chemical Properties of The Soils Before Manure Application

Soil Property	Unit	Distribution (Value)
Sand	%	94.60
Silt	%	0.60
Clay	%	4.80
pH		4.70
Electrical conductivity	ds/m	0.02
Organic matter	%	3.88
Total Nitrogen	%	0.10
Available phosphorus	mg/kg	17.99
Exchangeable Acidity	cmol/kg	2.40
Calcium	cmol/kg	2.94
Magnesium	cmol/kg	1.26
Potassium	cmol/kg	0.07
Sodium	cmol/kg	0.07
Effective cation exchange capaacity	cmol/kg	6.74
Base Saturation	%	64.39

Effect of Seedbed Methods on Soil Chemical Properties

The effects of seedbed practices on soil chemical properties is shown in Table 3. Seedbed methods significantly increased soil pH. Sunken bed had the highest mean pH value of 5.44± 0.33, mound plots had 5.23±021, while ridge plot had the least pH value of 5.09±.22. Organic matter result shows that seedbed methods had significant effect (P<0.05) on organic matter. The ridge had the highest organic matter content of 2.90± 0.45%, mound had 2.71± 1.37%, while Sunken Bed had the least value of 2.31± 0.47%. This significant increase in soil organic matter under different seedbed methods, confirms that seedbed practices aids in organic matter break down through aeration and activity of micro-organisms. A similar result was obtained by Adekiyaet *al.* (2009), when they studied tillage effects on soil properties in soil of south western Nigeria. Seedbed methods. Significantly affected total Nitrogen with highest value of 0.08± 0.03% being recorded in mound, 0.08± 0.02% recorded in Ridge, while the least value was recorded in 0.06± 0.02%.The variation in total Nitrogen, reflects variation in organic matter indicating possible organic matterdecomposition and release of total Nitrogen to the soil. There is close link between organic matter and total Nitrogen in the soil in line with Onofiok (2002).

Table 3: Effect of Seedbed Method on Soil Chemical Properties

Parameters	Sunken bed	Mound	Ridge
pH	5.44$\pm 0.33a$	5.23$\pm 0.2b$	5.09$\pm 0.2b$
OM	2.31$\pm 0.47c$	2.71$\pm 1.37b$	2.90$\pm 0.45a$
TN	0.06$\pm 0.02b$	0.08$\pm 0.03a$	0.08$\pm 0.02a$
AV.P	18.48$\pm 13.21c$	47.81$\pm 9.97a$	43.40$\pm 9.0b$

Ca	9.37±1.24b	11.14±1.16b	11.35±1.08a
Mg	3.01±0.19c	3.42±0.44b	3.65±0.39a
Na	0.06±0.01ab	0.06±0.02ab	0.06±0.01a
K	0.12±0.02	0.12±0.2	0.11±0.02
ECEC	14.88±2.0b	18.0±2.60a	17.68±1.59a
Bs	81.47±.5.1	80.02±5.2	84.16±2.0

Means with the same letter along the same column are not significantly different (p<0.05)
OM – Organic matter, TN – Total Nitrogen, Av.p – Available Phosphorus, Ca – calcium, Mg – Magnesium, Na – Sodium, K – Potassium, ECEC – Effective cation exchange capacity, Bs – Base Saturation.

Available phosphorus shows that mound had the highest value of 47.81mg/kg ± 9.97, followed by Ridge 43.40,mg/kg ± 9.0, while Sunken bed plots had the least mean value of 18.48mg/kg ± 13.21. Differences among treatment were significant (P<0.05). However, the treatment values were above the 15mg/kg available phosphorus reported by Enwezoret *al*., (1990) as value for critical limit for crop production. This may be due to application of phosphorus, which according to Umohet *al*., (2021)study, revealed that the concentration of P fixed increased with increasing rate of P added in the soils. Seedbed methods has significant effect in soil exchangeable calcium. The highest mean value of 11.35 cmol/kg±1.08 was obtained in Ridge plots, followed by mound with mean value of 11.14 cmol/kg± 1.16 and the least mean value of 9.37 cmol/kg± 1.24 recorded in Sunken bed. Exchangeable magnesium was affected by seedbed methods. Ridge plots had the mean value of 3.6 cmol/kg± 0.39, followed by mound of 3.42 cmol/kg± 0.44, while Sunken bed plots had the least mean value of 3.01 cmol/kg± 1.19).

Exchangeable potassium was not significantly affected by seedbed. Sunken bed and mound had the highest mean values 0.12 cmol/kg± 0.02, respectively, while Ridge plots had the least mean value of 0.11cmol/kg± 0.02). However, these differences were not statistically significant. Effective cation exchange capacity (ECEC) was affected by seedbed methods. The highest meanvalue of 18.0 cmol/kg± 2.60 was recorded in mound, closely followed by Ridge with mean value of 17.65 cmol/kg± 1.59,whileSunken bed had the least mean value of 14.88 cmol/kg± 2.0). Seedbedmethod significantly affected Base saturation. Ridge plot had the highest mean value 84.16% ± 2.07, followed by Sunken bed with mean valueof 81.47% ±5.18, while the least value was observed with mound plots. Seedbed methods significantly influenced soil chemical properties. This may be attributed to improvement in soil aeration due to loosening of soil particles that enhances micro-organism activities for easy, decomposition, that leads to addition of organic matter which increases soil chemical properties.

Effect of Manure Sources on Soil Chemical Properties after Application (3 Months)

Effect of manure sources on soil chemical properties is presented in Table 4. Soil pH was statistically affected (P<0.05) by manure sources, when compared with control, different manure treatments significantly increased soil pH. Application of cow dung (CD) had highest mean increase of 5.35% followed by NPK 15:15:15 fertilizer of 5.33%, goat dung (GD) 5.31 and poultry dropping of 5.27% over control of 5.02% Application of different manure treatment significantly affected by organic matter content (P<0.05). When compared with control, application of cow dung reduced organic matter content by 2.14%, represented 7.76%, over Control. Other manure treatment improved organic matter content up to 3.82, 2.57 and 2.35%, represented 64.66; 10.78 and 1.29% for N:P:K 15:15:15, poultry dropping and goat dung, respectively.

Table 4: Effect of Manure on Chemical Properties of the Soil

Location	Control	CD	GD	PD
pH	5.02±0.06b	5.31±0.30a	5.31±0.33a	5.27±0.26a

OM	2.32±0.51c	2.14±0.21c	2.35±0.46bc	2.57±0.77b
TN	0.06±0.01b	0.06±0.01b	0.07±0.02b	0.07±0.01b
AVP	28.05±16.41d	30.44±15.82cd	37.12±21.05b	33.47±18.77c
Ca	10.08±1.82	10.7±1.82	10.95±0.12	10.39±1.83
Mg	3.21±0.36b	3.51±0.62a	3.39±0.35ab	3.23±0.47b
Na	0.06±0.01	0.06±0.01	0.06±0.01	0.06±0
K	0.08±0.02c	0.12±0.02ab	0.13±0.01a	0.11±0.01ab
ECEC	16.03±3.25c	17.93±3.38a	17.67±2.40a	15.44±2.56d
BS	80.27±3.57b	80.85±7.19b	83.33±3.89a	82.79±3.79a

Means with the same letters along the same column are not significantly different (p>0.05).
OM – Organic matter, TN – Total Nitrogen, Av.p – Available Phosphorus, Ca – calcium, Mg – Magnesium, Na – Sodium, K – Potassium, ECEC – Effective cation exchange capacity, Bs – Base Saturation.

This improvement in organic matter could be attributed to the level of organic carbon content of the applied manures. Application of different types of manure significantly increased soil total Nitrogen, when compared with control. NPK fertilizer increases total Nitrogen to 0.11% represent 83.33% over control. Poultry droppings and goat manure had similar effect on total Nitrogen of 0.07, represented 16.67%, while cow dung manure shows no significant effect.

Available phosphorus was affected by different types of manure (P<0.05). NPK fertilizer had the highest effect on soil available phosphorus of 53.73 mg/kg, represented 91.55% over control. Goat dung, poultry droppings and cow dung increased soil available P up to 37.12, 33.47 and 30.44 mg/kg, represented 32, 19.32 and 8.52%, respectively over control. Udohet *al.* (2021), observed that different animal manures significantly improved soil available P.

The mean values of exchangeable Ca varied with types of manure applied. NKP fertilizer and Goat Dung increased exchangeable Caby 10.95 cmol/kg similarly. Cow dung and poultry manures increased soil exchangeable Ca by 10.73 and 10.39 cmol/kg represented 6.45 and 3.08%, respectively over control.

The implication of the improvement in exchangeable Ca observed in NPK and cow dung manures is that, if properly managed these two manure sources have similar capacity to build calcium content of the soil.

Exchangeable Mg was affected significantly by different manure sources. The increase in exchangeable Mg was in order, cow dung (3.51cmol/kg) > NPK (3.46 cmol/kg) > GD (3.39 cmol/kg) > PD (3.23 cmol/kg), and represented 9.35, 7.79, 5.61 and 0.62%, respectively over control. Exchangeable K result shows that goat dung had highest mean value of 0.13 cmol/kg, followed by cow dung with mean value of 0.12 cmol/kg, while poultry droppings and NPK had the same mean value of 0.11 cmol/kg, represented 8.33%, respectively.

Effective cation exchange capacity (ECEC) was significantly affected by different manure sources when compared with control. Cow dung, goat dung and NPK fertilizer increase ECEC by 17.93 cmol/kg, 17.67 cmol/kg and 17.21 cmol/kg, represented 11.85%, 10.23% and 7.36%, respectively over control. This implies that apart from poultry droppings, these organic manures are more efficient in building exchangeable bases than NPK fertilizer.

Cow dung and NPK fertilizer reduces base saturation by 80.85% and 81.18%, represented 0.52 and 0.11%, respectively. However, goat dung and poultry manures improved soil base saturation by 83.33 and 82.79%, represented 3.15 and 1.87%, respectively over control.

Interactive Effect of Seedbed Methods and Manure Types on Soil Chemical Properties

Interaction effect of manures and different seedbed methods on soil pH is presented in figure 1. Generally, all manure sources had highest pH in the Sunken bed soils except goat dung, which had its highest pH in mound soils and the effect was statistically significant (P<0.05). It can be inferred from this trend that seedbed method and types of manure have significant influences on the efficiency of organic manure on soil pH. Interaction effect of these manures on organic matter level of the soil under different seedbed methods was highly significant (P<0.01), as shown in figure 2. NPK had the highest organic matter on mound plots. But for cow dung, goat dung and poultry dung manures, the highest organic matter contents was obtained in ridge soils, while sunken bed soil had the least values and the differences was statisticallysignificant (P<0.05).

Interaction effect of seedbed methods and manure sources on total Nitrogen content of the soil was highly significant (P<0.01), shown in figure 3. NPK and cow dung had the highest total Nitrogen in mound, while cow dung has the highest total Nitrogen in ridge soil, poultry droppings had highest total Nitrogen in sunken bed soil. Interaction effect seedbed methods on Available P was statistically significant (P<0.05) shown in figure 4. NPK and seedbed methods effect on available P. Ridge soils recorded highest P content in mound, while poultry droppings and goat dung had the highest effect on Sunken bed and mound, respectively. Interaction effect seedbed methods and manure sources on calcium content of the soil was significant (P<0.05). The pattern was similar across all the manure sources except NPK (figure 5). Interaction effect was significant (P<0.05), with NPK having the highest Mg in mound, while others had the highest Mg in ridged soil (figure 6).

Interaction effect of seedbed methods and manuresources on exchangeable Na showed significant difference (P<0.05). Figure 7 shows that goat dung, poultry droppings and NPK had the highest Na values in ridged soil, while cow dung and control soils had the highest Na value in mound. Interaction effects of seedbed methods and manure sources on exchangeable K, shows that cow dung and poultry droppings had the highest K value in Sunken bed soils, cow dung and the control soil had the highest K in mound, while NPK has the highest K value in ridged soils (figure 8) and the differences were significant (P<0.05).

Interaction effect of seedbed methods and manure sources on effective cation exchangeable capacity (ECEC) (figure 9), shows that cow dung, goat dung and the control soils had similar pattern with the highest ECEC obtained in mound followed by ridge. Poultry droppings had the highest ECEC on ridge soil followed by Sunken bed soil. NPK had the highest ECEC in mound followed by Sunken bed soils. Cow dung and control soils had the highest K value in mound, while NPK had the highest K on ridged soil and the difference were significant (P<0.05). Interaction effect of seedbed methods and manure sources on Bs shows that control, cow dung and goat dung, were higher in ridge and sunken bed soils than mound. Poultry droppings pattern was in the increasing order, ridge > Mound > Sunken bed, whereas in NPK, mound > Ridge > Sunken and differences were significant (figure 10).

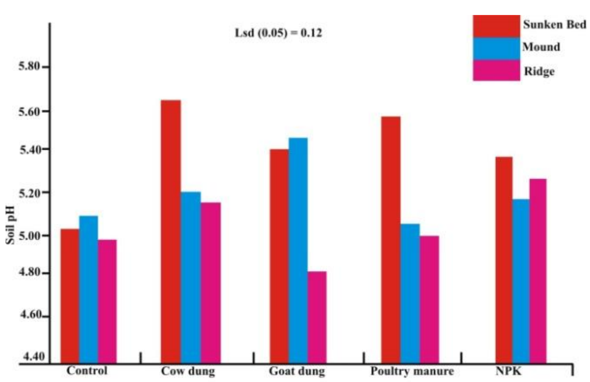

Figure 1: Interactive effect of seedbed methods and manures on soil pH.

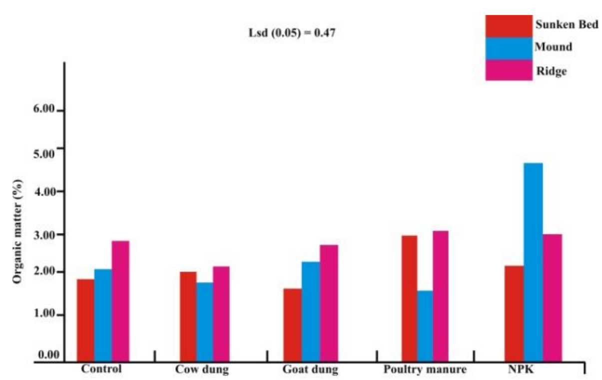

Figure 2: Interactive effect of seedbed methods and manures on soil organic matter

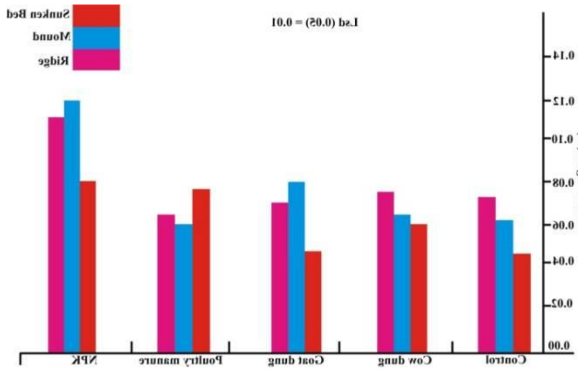

Figure 3: Interactive effect of seedbed methods and manures on Total Nitrogen.

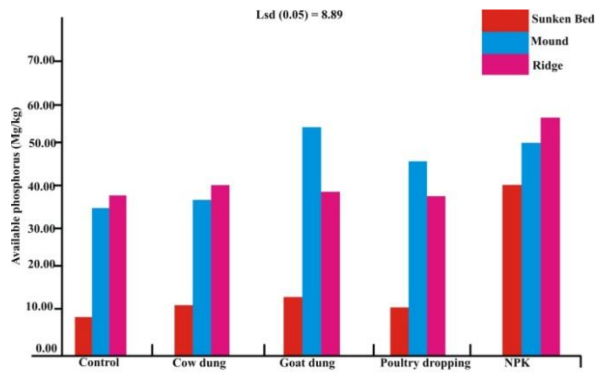

Figure 4: Interactive effect of seedbed methods and manures on soil Available phosphorus

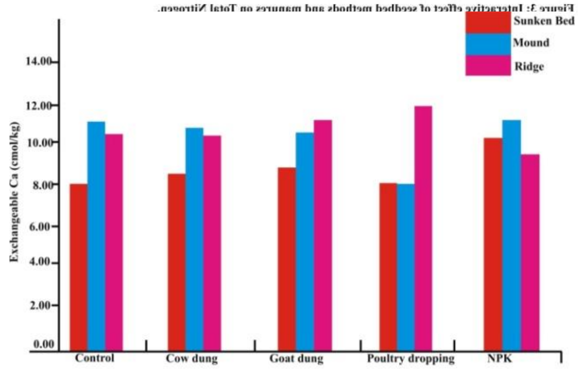

Figure 5: Interactive effect of seedbed methods and manures on Exchangeable Calcium

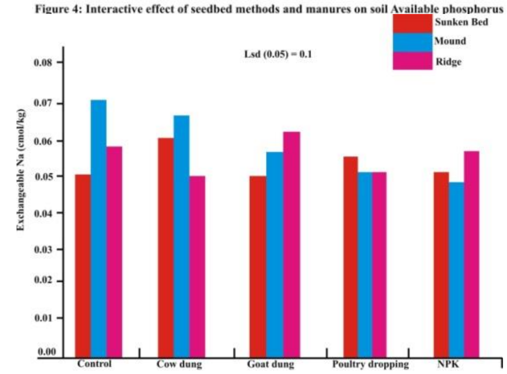

Figure 7: Interactive effect of seedbed methods and manures sources on exchangeable Na

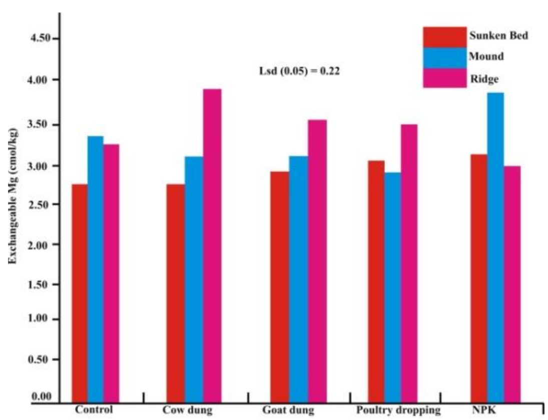

Figure 6: Interactive effect of seedbed methods and manures sources on exchangeable Mg

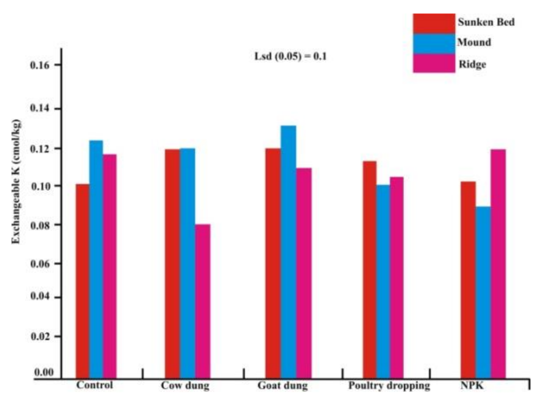

Figure 8: Interactive effect of seedbed methods and manures sources on exchangeable K

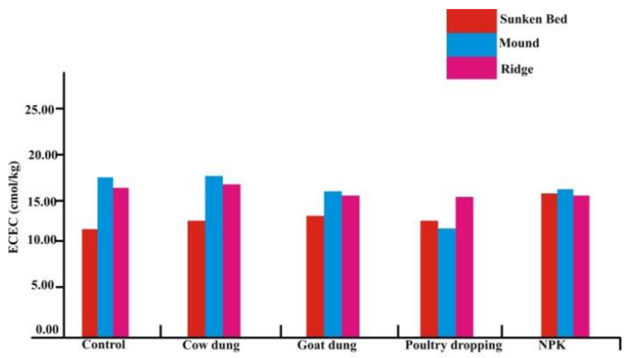

Figure 9: Interactive effect of seedbed methods and manures on sources on ECEC

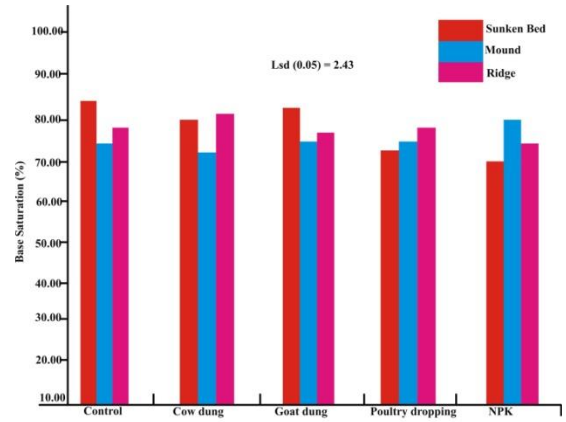

Figure 10: Interactive effect of seedbed methods and manures on Base Saturation

CONCLUSION

The findings revealed that ridges was comparatively better than mound, while mound wasrelatively better than Sunken bed method in relation to soil fertility status. Soil treated with goat dung was more fertile than those fertilized with cow dung, poultry droppings and NPK 15:15:15. It could therefore, be inferred that ridge is the best seedbed method, while goat dung is the best manure source. This is an indication that goat dung has great positive influence of soil chemical properties than NPK 15:15:15. In recommendation, the use of ridge is highly recommended over that of mound and sunken bed, while utilization of goat manure is most recommended over cow dung, poultry dropping and NPK 15:15:15 for improve soil chemical properties.

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