SOIL CHEMICAL PROPERTIES AND DRY MATTER YIELD OF CORN AS INFLUENCED BY ORGANIC MATTER AMENDMENT

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Abstract

The study was conducted to evaluate the influence of corn cob, corn stover, sunflower, chicken manure and mucuna on a strongly acidic soil (pH= 4.03; Al =1.45 me/100g) by evaluating its effects on soil chemical properties, root elongation and dry matter yield. Rates of organic materials were 0, 4, 8 and 16 tons/ha. In Completely Randomized Design (CRD) with 3 replications, a total of 18 treatments including calcium carbonate and calcium sulfate were laid out. Corn cob, corn stover and chicken dung application at 4, 8 and 16 tons/ha increased the soil pH, but not all treatments revealed significant difference over the control. Maximum rate of corn cob (16 tons/ha) and all rates of chicken manure were established to be comparable with lime application ($CaCO_{3)}$. Along with the five organic materials, chicken manure was determined to be effective and promising organic resource due to its favorable effect to several of the chemical properties which showed significant increase in root length and dry matter yield. Throughout its application, pH was increased, marked organic matter build up, exchangeable aluminum (Al) greatly reduced and phosphorus availability was significantly increased.

Keywords: *Organic Matter Amendment, dry matter yield, mucuna, chicken manure, corn cob, corn stover, sunflower*

Introduction

Low crop production is evident in strongly acid soils, this is generally due to poor soil fertility and accompanied by some constraints such as: aluminum toxicity, phosphorus deficiency and other related constraints. Aluminum toxicity do direct harm to the roots and decrease root growth and translocation of nutrients. Sanchez (1976) and Baize (1993) supported this premise asserting that the most common root of acid soil infertility is aluminum toxicity which carries out direct damage to the roots and decrease root growth and translocation of calcium and phosphorus.

This problem is a fundamental constraint to any farming system and this must be resolved. Today's challenges in agriculture require steadily more attentions to management influences that have practical and are directed towards environment. That is,

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increasing the production without harming the environment or the so called "Sustainable Agriculture".

The use of organic materials that are readily available in the field is the practical method that could make the goals of this program a realistic one. This practice is based on the notion that when organic materials go through decomposition it will generate organic acids that are capable chelating or of binding aluminum such that it renders aluminum insoluble and not toxic to plant. Hence the conduct of this study was conceived to attain the objectives below.

Objectives

This study aimed to evaluate and compare the influence of organic materials on the chemical properties of soil and their potential to alleviate aluminum toxicity in acid soil, to determine the effect of organic materials on root length of corn and to evaluate and compare the ability of organic materials on the dry matter yield of corn.

Research Method and Design

The experiment investigated the effect of different organic materials in strongly acid soils with high in exchangeable aluminum. The soil sample was from Barobo, Valencia, Bukidnon. It was collected at random in the whole sampling area at a depth of 0-15 cm. The sample was mixed thoroughly during air-drying to have a composite soil sample, air-dried, pulverized, sieved and were analyzed in the laboratory using the methods in Table 1.

Table 1. Chemical method used in the soil analysis

Chemical Property	Method	Reference
Soil pH	1:1 Soil:H_2O	Mclean, 1982
Exch. Al	1 N KCl Extraction	Yuan, 1959
Organic Matter	Walkley & Black	Allison, 1965
Ext. P	Bray P_2	Bray & Kurtz. 1945

A laboratory set–up was made using a disposable plastic cup placed with 250 g soil (ODW). Chopped fresh organic materials were added and combined namely: corn cob, corn stover, chicken dung, sunflower and mucuna. Water was supplemented to field facility covered with cellophane and incubated for two months to permit the materials for decomposition. Eighteen treatments were laid out including the control, lime and calcium sulfate in three replications. After incubation the glass were planted with corn and were harvested after 14 days. Soil chemical analysis was done using the method reflected in Table 1. Root length was measured using Line Intersect Method and was oven dried to obtain the dry matter yield. Analysis of Variance (ANOVA) was done

using Completely Randomized Design (CRD) and comparison among means was analyzed using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Initial Chemical Characteristics of the Soil. Initial analysis revealed that the soil used has a pH of 4.43 and is classified as very strongly acidic. Exchangeable aluminum is considered toxic to corn which Samonte and Ocampo (1977) reported that 0.2 cmol/kg is the critical value wherein above this value, yield of corn decreases. Organic matter content is 4.67 % with an extractable phosphorus content (Bray P2) is 4.46 ppm and is considered inadequate for crop production. Exchangeable potassium content of the soil is 0.165 cmol/kg which is below the adequacy level of 0.20 cmol/kg.

Influence of Organic Matter on Some Chemical Properties of the Soil

Soil pH. The results of the study revealed that the used of lime significantly increased the soil pH (4.95) over the control which is 4.03 (Fig. 1). Applying corn cobs at all rates, increased the pH but no marked differences were observed over the control. Corn stover also increased soil pH, at 4 tons/ha the pH increased to 4.22. Doubling the rate, increased the pH to 4.76 which is significant over the control. However, at highest rate (16tons/ha) reduced the soil pH to 4.12. Increasing rates of chicken manure correspondingly increased the pH and the increases were comparable with the liming effect. Sunflower at 4 and 6 tons/ha also increased the pH but no significant difference over the control. Soil pH slightly decreased with application of mucuna at 4 and 16 tons/ha with a value of 3.93 and 3.90 respectively. The observed increased in pH when applied with organic materials can be attributed to ligand exchange reaction must have occurred between OH^- of hydrous oxides of aluminum and carboxyl acids functional groups in organic materials, releasing OH ions causing an increase in pH (Hue and Amien, 1989).

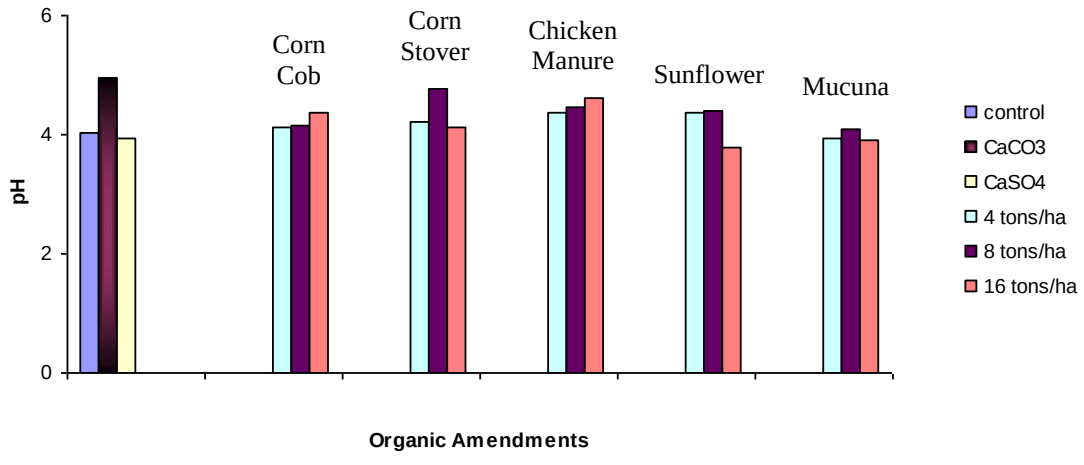

Figure 1. Effect of organic materials on soil pH

Exchangeable Aluminum. Observation showed that almost all of the organic materials at all rates reduced the aluminum content, but only the application of chicken manure at all rates were found to have a tremendous reduction in the aluminum content. At 4 tons/ha, exchangeable aluminum reduced to 0.8 me/100g which is from 1.46 me/100g. Doubling the rate to 8 tons/ha also reduced the aluminum two times that of the application of 4 tons/ha. Reduction in aluminum was further observed with 16 tons/ha of chicken manure, wherein aluminum was only 0.17 me/100g which was comparable the to the effect of lime on the reduction of aluminum content of the soil (Fig. 2). The favorable effect of selected organic materials to the detoxifiction of aluminum was attributed to the capacity of organic materials to chelate or bind metallic cations such aluminum forming alumino-organic complexes that renders it insoluble and non-toxic (Bessho and Bell, 1992; Misayaka et al, 1991; Wong and Swift, 1995).

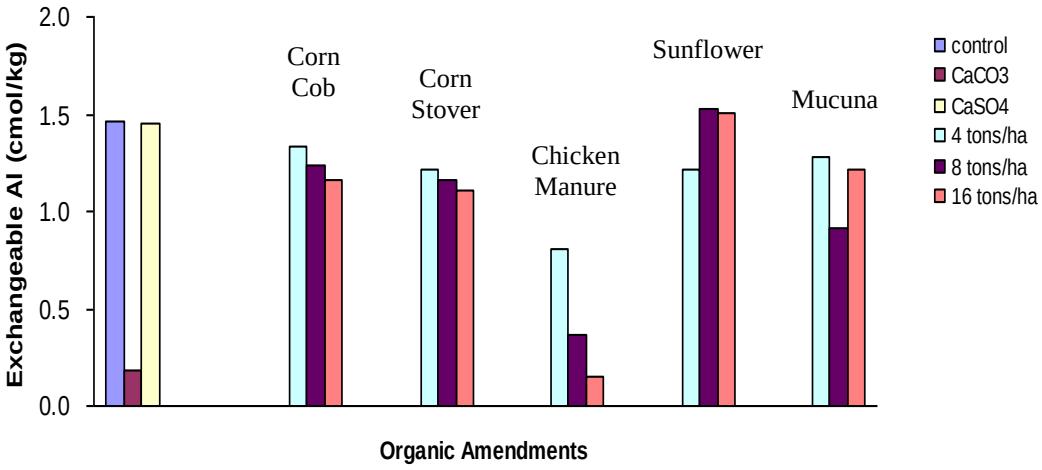

Figure 2. Effect of organic amendments on exchangeable aluminum

Organic Matter Content. The effect of organic amendments on organic matter content is shown in Figure 2a. The used of corn cob and corn stover at escalating rates, augmented the organic matter content of the soil in the same way, but its increased were not significant more than the control. Highest rate of chicken manure (16 tons/ha) increased the OM content to 4.89% but the difference was not significant over the used of 8 tonslha (4.85%). Using mucuna at highest pace noticeably increased the organic matter content and considerably higher than the application of 8 tons/ha.

The observed difference in the improvement of OM content with the use of chicken manure, sunflower and mucuna is attributed to the nitrogen content of the said materials. The average N content of farm manure is 3.15% (Hue, 1992). Mucuna

contains 3% N and sunflower contains 3.8% N, (Hairah, 1992). Alexander (1977) highly emphasized that N is a key nutrient for organic decomposition. If the N content of the substrate is elevated and readily employed, the microflora gratifies its needs from its source and supplementary quantities are unnecessary. He further stated that if the substrate is poor in N, decomposition is slow.

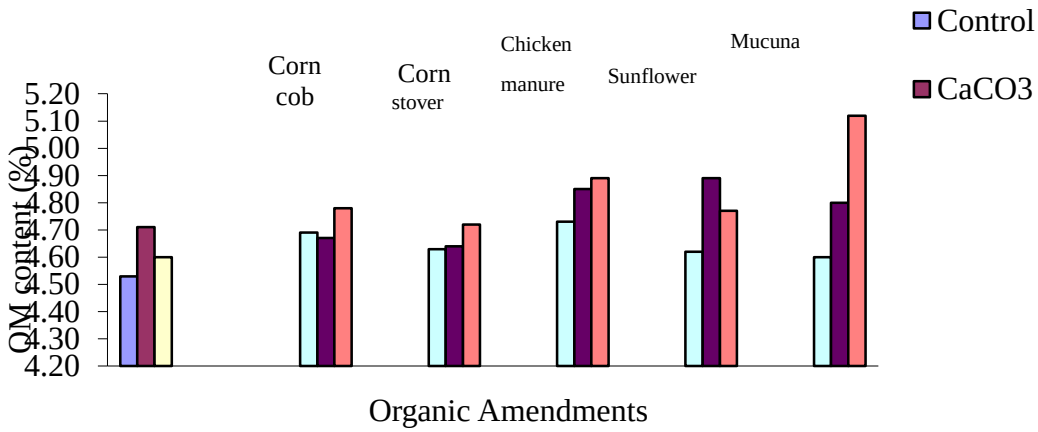

Figure 2a. Effect of organic amendment on organic matter content

Extractable Phosphorus. Figure 4 shows the influence of organic amendments on soil phosphorus. Extractable P in soil increased with lime application but significant difference was not observed over the control. Corn cob, corn stover, sunflower and mucuna at three rates did not significantly affect the extractable P. It was only the chicken manure at all rates greatly increased the P content in the soil. At 4 tons/ha, the extractable P markedly increased to 6.97 ppm. Doubling the rate to 8 tons/ha correspondingly increased to 13.77 ppm. At highest rate of chicken manure, P was almost three-fold.

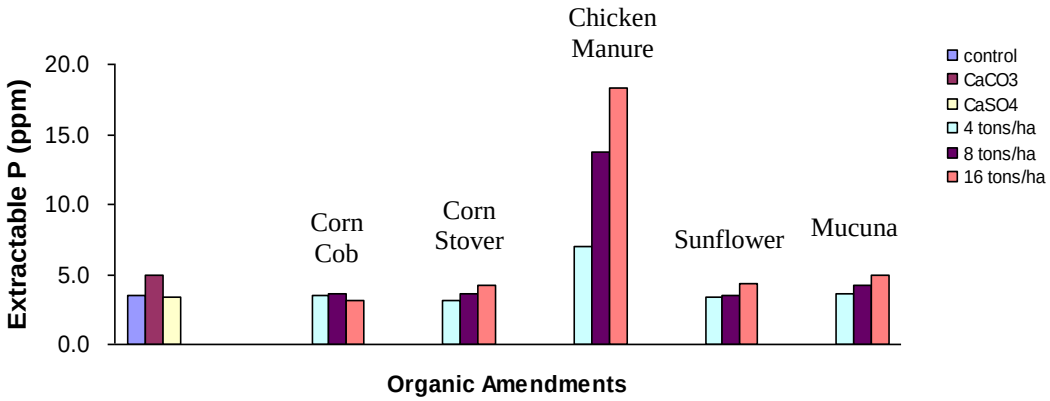

Figure 3. Effect of organic amendments on mean extractable phosphorus

The favorable effect on improving significantly the P availability in acid soils is probably due to the chelation of aluminum by organic matter, then reducing the amount of exchangeable aluminum which is responsible for the release of P fixed , thereby increasing the available P content. The high P content of chicken manure also contributed to the increased availability of P. Hue (1992) found out that chicken manure contains about 1.64% of P. While other materials such as corn stover and corn cob were found out to have little amount of P, 0.08 and 0.04 respectively as reported by Duque et al. (1995).

Root Length and Dry Matter Yield of Corn as Affected By Organic Amendment

Root length at 14-Day Growth Period. Results (Fig.4) showed that lime gave the highest mean root length (618 cm) and significantly higher than the control. The used of corn cob increased the root length of corn but insignificant difference over the control and all rates were observed. Using corn stover at increasing rates correspondingly increased root length, but only at 16 tons/ha showed a significantly longer roots and comparable to lime addition. Study of Harper et al (1995) revealed a favorable root elongation on Zea mays on the use of Eucalyptus camaldulensis,.

All rates of chicken manure significantly gave longer roots over the control. They all showed comparable effect to lime addition. Sunflower and mucuna increased root length but significant difference over the control was not observed.

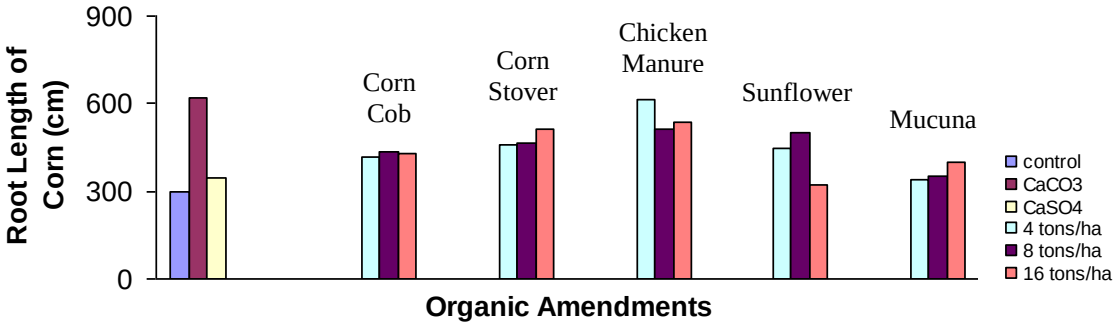

Figure 4. Effect of organic materials on root length of corn (14-day growth period)

Dry Matter Yield of Corn. Figure 5 shows the effect of organic amendments on the dry matter yield of corn. Application of lime gave a higher dry matter yield over the control. The used of corn cob at the pace of 4 tons/ha gave the minimum yield (406 mg) , on the other hand, its decreased was not significant more than the control. Increasing the rates to 8 and 16 tons/ha increased the yield to 572 and 540 mg respectively.

Increasing rates of chicken dung correspondingly increased the dry matter yield of corn. At 16 tons/ha highest yield was obtained (693 mg), comparison among the rates showed insignificant differences. The higher yield was not only thrown in by the aluminum detoxification but also by its high nutrient content of chicken compost. Hue (1992) found out that chicken manure has 3.15% N, 1.64% P, 2.07% K, 7.87% Ca and 0.72 % Mg.

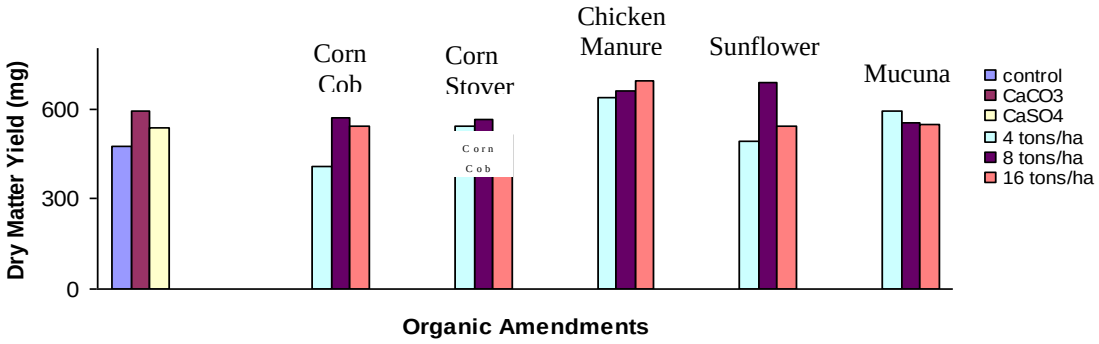

Figure 5. Effect of organic materials on dry matter yield of corn (14-day growth period)

Conclusion

Among the organic sources, chicken manure was found to be promising and effective organic source, that showed significant increased in root length and dry matter yield because of its favorable effects to the soil chemical properties such as pH, phosphorus, OM matter content and its potential to alleviate aluminum toxicity.

Recommendations

Chicken manure is a good source and recommended organic material considering its beneficial contribution to the soil and crop. Corn cob, corn stover, sunflower and mucuna can also be use as soil organic matter enricher. It is further recommended to combine plant residues with manure especially chicken manure.

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