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Increasing Biomass And Availability Of Micronutrient In Maize Using Goat And Cow Manures

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ABSTRACT
Organic manure not only enriched with nutrients but it also provides organic matter, which is more useful for enhancement of crop productivity as well nutritional status of nutrient deprived soils. A greenhouse experiment was conducted at the Department of Soil Science, Lasbela University of Agriculture, Water and Marine Sciences, Uthal Lasbela during 2019-20, to assess the effect of various rates of goat and cow manure alone on the availability of micronutrients. Experimental layout included 20 plots with one cultivar i.e., "*CV. Akbar*" of maize variety was organized into Complete Randomized Design (CRD) having five treatments and replicated three times. Results indicated that significantly maximum values of EC (1.65 dsm^{-1}), pH (8.19), organic matter (1.65 %), total nitrogen (0.15 g kg^{-1}), available phosphorus (20.30 mg kg^{-1}), available potassium (119.30 mg kg^{-1}), available copper (11.00 mg kg^{-1}), available manganese (37.00 mg kg^{-1}), available iron (52.00 mg kg^{-1}), available zinc (37.00 mg kg^{-1}), fresh plant weight (95 g), dry plant weight (74 g), fresh root weight (12.33 g), dry root weight (2.66 g), plant height (114 cm), number of green leaves (10.33), number of dry leaves (6.66), stem girth (15.7 cm) and leaf area index (14.66 cm) was recorded in maize crop at the rate of cow manure 5%. While, lower values of EC (1.29 dsm^{-1}), pH (7.40), organic matter (0.93 %), total nitrogen (0.03 g kg^{-1}), available phosphorus (7.41 mg kg^{-1}), available potassium (73.82 mg kg^{-1}), available copper (5.50 mg kg^{-1}), available manganese (24.00 mg kg^{-1}), available iron (35.00 mg kg^{-1}), available zinc (8.00 mg kg^{-1}), fresh plant weight (33 g), dry plant weight (15.66 g), fresh root weight (3 g), dry root weight (1 g), plant height (45.6 cm), number of green leaves (3.33), number of dry leaves (2.66), stem girth (7.69 cm) and leaf area index (5.53 cm). It was conclusively registered that addition of organic manure provided all essential organic and micro- nutrients to plant. Organic manure enriched will all essential minerals is leastexpensive and alternative management strategy as compared to inorganic nutrient supplementationto soil for maintenance of sustainable agriculture and soil conservation.

Key Words: Organic manure, micronutrient availability, crop traits, biomass yield and maize.

Introduction
Maize (*Zea mays* L), often called maize, is a cereal grain that originated in Mesoamerica. While several hypotheses exist about maize's progenitor (Poehlman& Sleper, 2017). Agriculture is the foundation of Pakistan's economy. Approximately 68 percent of the population is directly or indirectly involved in farming through the production, processing, and distribution of main agricultural commodities. Agriculture is responsible for around 21 % of our GDP, employs approximately 68 percent of the rural population, and employs approximately 45 percent of the overall national labour force. Agriculture is critical to Pakistan's economy, providing for 18.9 percentage of GDP and employed 42.3 percent of the labour force. (Government of Pakistan, 2014). The agricultural sector is confronted with numerous global challenges due to shifts in environmental conditions, necessitating efforts to boost crop yields in regions experiencing water scarcity. Additionally, global warming presents a significant challenge, contributing to decreased rainfall in many areas and, consequently, a decline in wheat production (Koveta, 2010 et al).
Despite its significance, maize yield in Pakistan remains substantially lower than in many developing countries. Several factors contribute to this, with nutrient deficiency being a major issue. In addition to the widespread deficiency of nitrogen (N) and phosphorus (P), zinc (Zn) is also lacking (Gibbson, 2006). NPK (nitrogen, phosphorus, potassium) plays a crucial role in plant

growth and vitality. Nitrogen is a key component of nucleic acids, proteins, amino acids, phytohormones, and various enzymes. It also supports canopy expansion, absorption of solar radiation, and overall plant development (Milford et al., 2015). Although our environment is rich in atmospheric nitrogen (N_2), this form is inert and not directly available to plants for their growth, development, and reproduction (Fan et al., 2016; Zouheir et al., 2016). Phosphorus is vital for plant life as it contributes to key structural compounds and acts as a catalyst in various biochemical processes. It enhances root growth, strengthens stems, boosts flower formation and seed production, leads to earlier and more uniform maturity, improves crop quality, and increases resistance to plant diseases. The application of nitrogen, phosphorus, and potassium fertilizers in optimal amounts can significantly boost maize yields (Bhardwaj et al., 2010; Cheema et al., 2003). Nitrogen, in particular, is critical for influencing plant growth and yield.

Studies indicate that leaf area tends to expand as nitrogen levels increase, especially when soils are amended with organic fertilizers. This expansion is likely due to a higher nitrogen supply, which aids in leaf area development during the vegetative stage and helps maintain the leaf area throughout the growth period (Obi and Ebo, 1995). Research by Okalebo et al. (2002) observed that plants receiving 20 t ha-1 of cattle manure grew marginally taller ($p < 0.05$) compared to those treated with different manure levels or left untreated. The steady increase in maize plant height with higher cattle manure application rates suggests that greater manure quantities enhance nutrient availability, supporting plant growth through improved photosynthesis. The report further highlighted that plants treated with 20 t ha-1 of organic fertilizer developed more leaves, showing a slight ($p < 0.05$) increase compared to the control group and those with lower manure levels. Applying cattle manure at different levels likely improved soil fertility and structure, enriched organic matter, and boosted microbial activity (Adekiya and Agbede, 2009). The nutrients released from the manure can promote vigorous root development (Sanni, 2016), which, in turn, may have supported enhanced leaf growth (Adekiya and Agbede, 2009).

Soil fertility is a key component that influences plant productivity. It is determined by the availability or lack of nutrients, such as macronutrients and micronutrients. Micronutrient availability is highly reliant on soil conditions. Organic matter, soil pH, lime content, sand, silt, and clay concentrations, as demonstrated by many research trials, are variables that influence micronutrient availability. . Wheat yield efficiency and the influence of agricultural finance on wheat yield Several socioeconomic factors influence wheat variety adoption, including farm size, formal education, family size, experience, market distance, optimum fertiliser use, improved irrigation systems, hired labour, soil fertility, and climatic conditions. (G. S. MaddalaJ. Elliott, 2014 *et al.*) The primary causes of soil fertility depletion in Pakistan include intensive cropping systems, unbalanced fertiliser usage, the application of macronutrients alone, and a lack of information about micronutrients and organic manures.

The role of nutrients (both micro and macro) in agricultural plant development is well acknowledged. However, in underdeveloped Plant nutrients is not used to its full capacity in impoverished countries, and as a result, soil product can be easily is reduced. is usually underestimated, and the use of simply main plant nutrients (N, P, and K) is inadequate, and the the use of macro and micronutrient fertilisers in the growing zone may not be sufficient to fulfil crop demands.(Firdous et al., 2017) Optimum fertilizer management is required to maintain sustainable yields, enhance fertilizer nutrient usage efficiency, and conserve fertiliser supplies (Chuan et al., 2016). The macro- and micronutrients have a key role in crop nutrition and are thus vital for increasing yields, improving plant growth, and development (Imran & Gurmani, 2011).

Manure may be thought of as the initial fertilizer and is an essential ingredient for those interested in organic gardening. Cows, horses, cattle, pigs, goats, and poultry are the most important sources of manure (Adekiya et al. (2016). Through utilizing manure, you'll be applying essential micro and macronutrients to your soil that will steadily release over time, as well as improving soil aeration and water preservation, both of which will help you develop healthy soil structure and texture (Adhikary et al. (2010). Strong soil also provides a nurturing environment for beneficial soil species and earthworms. Using manure also ensures you're recycled, which reduces the reliance on artificial fertilizers. Nutrients in the soil and manure source, age, how they were stored (piled, scattered, turnedover or not), and the animal bedding content that might be mixed in all affect how manures vary from one another Akram et al., 1982). As a result, detailed advice about how long manure should be aged before usage, how much to use, and the expected nutrient content is difficult to come by. Both of these mechanisms have an effect on the nutritional quality of manures in general. The estimated amountsof total nitrogen (N), phosphate (P), and potassium (K) that should be present in particular manures according to the general breakdown of nutritional material (Fan et al. 2016). Manure is highly useful in compostingbecause of its high nitrogen content, which stimulates soil bacteria and aids in the gradual decomposition of organic matter. This micronutrient often has the highest risk of polluting land and water. Nitrates and ammonium will accumulate in the groundwater and contaminate the water supply. Understanding how nitrogen enters the soil is critical to ensure that it is utilized wisely. There is, however, a paucity of studies that attempt to quantify the growth and physical properties responses as affected by manures amendments. Such studies would provide pertinent information for use in evaluating the economic benefits of organic fertilizer or organic manure on the observed responses for up scaling organic manure use in the world agriculture Hammad et al. (2019).

In this study, the role of manures in enhancing soil fertility is highlighted through their contribution of organic matter and essential nutrients. Organic manure supplies all the necessary nutrients for plant growth, though in smaller quantities. It plays a key role in maintaining the carbon-to-nitrogen ratio in the soil, which, in turn, boosts soil fertility and productivity. Considering the importance of these benefits, this research was designed to evaluate how different application rates of goat and cow manure affect the availability of macronutrients. The primary objectives include assessing the impact of goat and cow manure as soil amendments on soil physical properties, and their effects on shoot and root biomass. Additionally, the study aims to investigate how micronutrient availability, with and without manure amendments, influences nutrient content in maize crops.

MATERIALS AND METHODS

Greenhouse experiment

A greenhouse study was performed at Uthal Experimental farm Lasbela University of Agriculture Water and Marine Sciences. Fertile (plough Layer) soil was used to assess five treatment therapies in a complete randomized design (CRD). The detail of experiment are given as under. T1= Control (No amendment) T2= GM (Goat manure 3% 210 g) T3= GM (Goat manure 5% 350 g) T4= CM (Cow manure 3% 210 g) T5= CM (Cow manure 5%). Planting of maize in the greenhouse area, five maize seeds (CV. Akbar) were planted. The seedlings were thinned during germination. The plants were watered when required and harvested when they reached the tasseling level.

Soil sampling and analysis

Before and after maize planting and processing, soil samples from greenhouse fields were obtained and tested for the following physio-chemical properties: Soil's composition the soil texture was calculated using Bouyoucos Hydrometer (Lu, 2000). Electrical conductivity was measured at 25 degrees Celsius with a portable conductivity metre (Hana Model-8733, Germany) and a standard reference solution with 1412 dSm^{-1} conductivity (KCl=0.0100M) (Lu, 2000). A portable pH metre (Orion (ISE) Model-SA-720 USA) was used to assess soil water pH extract using pH 4.0 and pH 9.0 buffers. (Rowel, 1994). The soil organic proportion was measured using the Walkley-Black method (Jackson, 1958a). Using Kjeldahl's technique and Kjeldahl's device, total soil nitrogen (percentage) was calculated (Jackson, 1958b). The AB-DTPA method used to evaluate functional spectrophotometer phosphorus (Model Specord-200 PC, Analytik Jen, Germany) (Soltanpour and Schwab, 1977). A flame photometer (Jenway UK PFP-7 model) was used to measure potassium content (Lu, 2000). Total nitrogen was measured using digestion method kjeldahl (Lu, 2000). A spectrophotometer and chloric nitric acid solution were used to measure the plant phosphorus amount (Jackson, 1958). The acid wet digestion system ($HCLO_3/HNO_3$) was used with a flame photometer to test potassium (Lu, 2000).

Calculation and statistics.

Using the I B M Statistical Package for Social Scientists, a one-way study of variance (ANOVA) was conducted for the care and control means (SPSS 20.0). Duncan's Multiple Range Test was used to distinguish the means. The importance level was set to ($P < 0.05$).

RESULTS AND DISCUSSION

Assessment of chemical properties of sub-soil under treatment of organic manure

The aim of the study in 2019-20 was to see how different rates of goat and cow manure alone affected micronutrient availability, maize shoot and root biomass, and a few soil products. A greenhouse experiment at Uthal Experimental Farm, Lasbela University of Agriculture, Water and Marine Sciences, provided fertile soil (plough layer). T1= Control (No amendment), T2= GM (Goat manure 3 percent 210 g), T3= GM (Goat manure 5 percent 350 g), T4= CM (Cow manure 3 percent 210 g), and T5= CM (Cow manure 5% 350 g). The soil samples were carefully collected from sub- soil portion adjacent to plants and preserved into plastic polythene bags for assessment of chemical properties of soil. It was noticed that nutrients availability in subsoil portion where maize sown is comparatively higher as compared to rhizosphere environment of maize where maximum nutrients are received by the plant.

Before analysis of soil

Soil textural class was silty clay loam, pH was 7.90, EC was (0.98 dsm^{-1}), organic matter was (0.6 %), total nitrogen (0.43 g kg^{-1}), available phosphorus was (5.05 mg kg^{-1}), available potassium was (65.7 mg kg^{-1}), available copper was (3.0 mg kg^{-1}), available manganese was (19 mg kg^{-1}), available iron was (30 mg kg^{-1}) available zinc was (5 mg kg^{-1}).

Electrical conductivity

The cow manure given to maize crop at the rate of (cow manure 5%) produced electrical conductivity of maximum (1.65 dsm^{-1}); closely followed by the 3% cow manure with average electrical conductivity upto (1.41 dsm^{-1}), respectively. The maize crop receiving goat manure (5%) and goat manure (3%) resulted in reduction of electrical conductivity upto (1.39 dsm^{-1}) and (1.36 dsm^{-1}), respectively. The crop showed minimum electrical conductivity (1.29 dsm^{-1}) under control (no amendment) as shownin below graph representation.

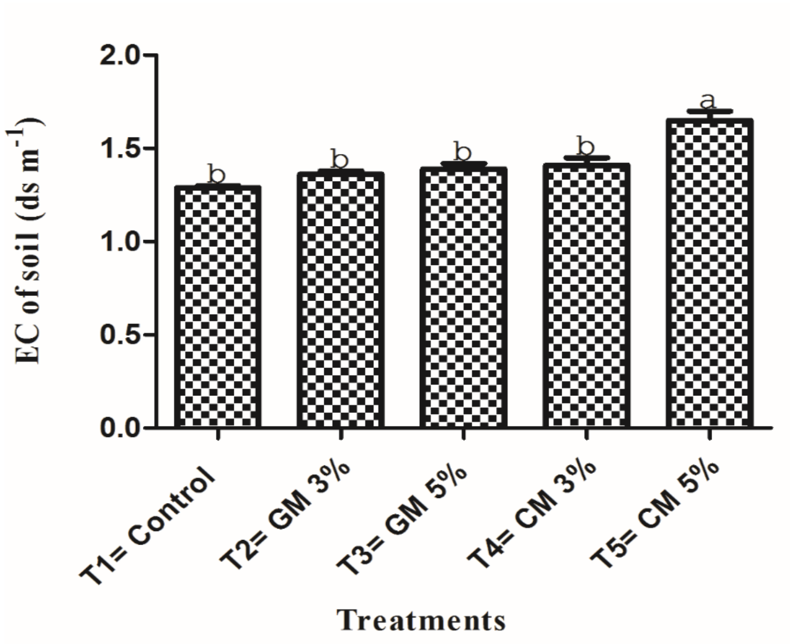

Figure 4.1: Graphical representation for electrical conductivity of subsoil sample influenced by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

pH

The cow manure given to maize crop at the rate of (cow manure 5%) produced pHof maximum (8.19); closely followed by the 5% goat manure with average pH upto (8.23), respectively. The maize crop receiving (Goat manure 3%) and (cow manure 3%) resulted in reduced pH up to (8.13) and (7.99), respectively. The subsoil sample showed minimum pH (7.40) under control (no amendment).

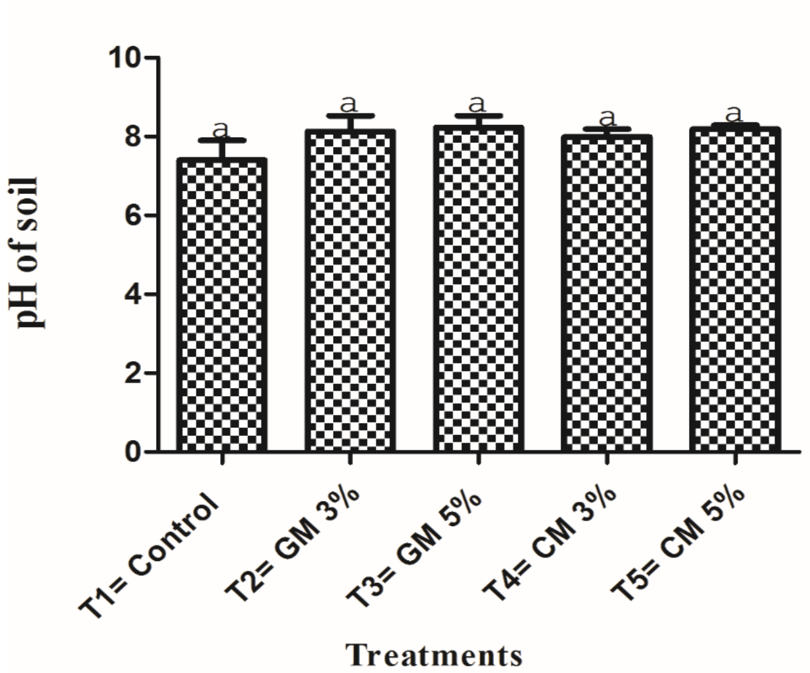

Figure 4.2: Graphical depiction for relative pH of subsoil sample influenced by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Organic matter %

The cow manure given to maize crop at the rate of 5% produced organic matter of maximum (1.65 %); closely followed by the 3% cow manure with average organic matter upto (1.60 %), respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced organic matter upto (1.53 %) and (1.35 %), respectively. The crop showed minimum organic matter (0.93 %) under control (no amendment) as demonstrated in figure 4.3.

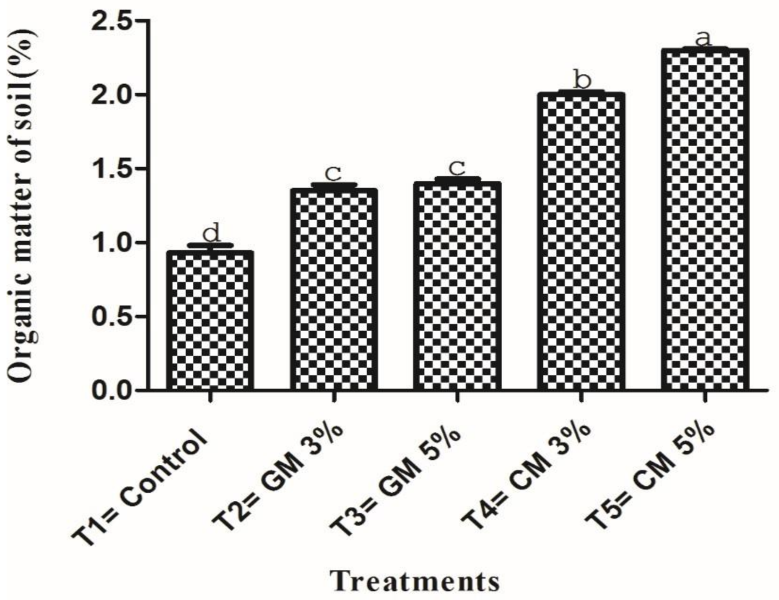

Figure 4.3: Graphical demonstration for organic matter contents in subsoil sample influenced by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Total nitrogen (g kg^{-1})

The cow manure given to maize crop at the rate of 5% produced total nitrogen of maximum (0.15 g kg^{-1}); closely followed by the 3% cow manure with average total nitrogen upto (0.13 g kg^{-1}), respectively. The maize crop receiving 5% goat manure and 3% goat manure resultedin reduced total nitrogen upto (0.10 g kg^{-1}**)** and (0.07 g kg^{-1}**)**, respectively. The crop showed minimum total nitrogen (0.03 g kg^{-1}) under control (no amendment) as revealed in figure 4.4

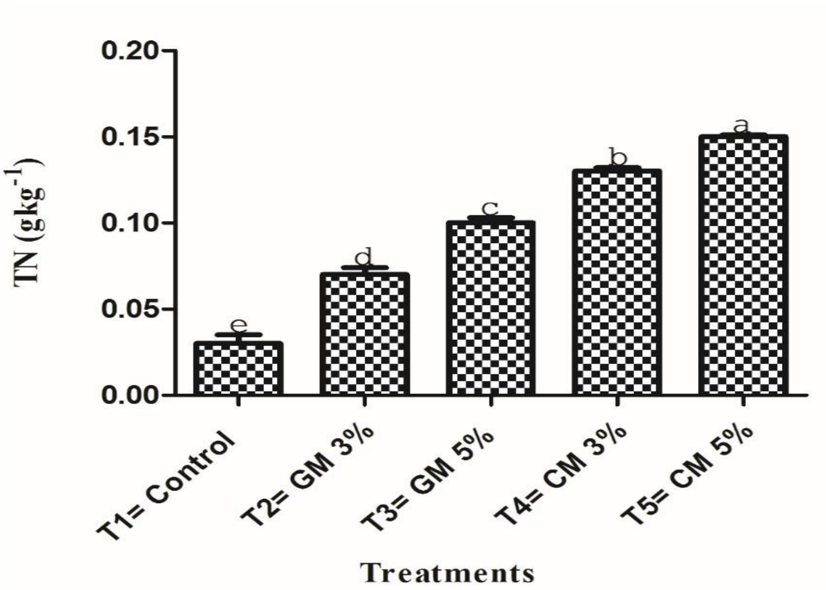

Figure 4.4: Graphical illustration for total nitrogen content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available phosphorus (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available phosphorus of maximum (20.30 mg kg^{-1}); closely followed by the (3% cow manure) with average available phosphorus (16.40 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced available phosphorus at range of (14.56 mg kg^{-1}) and (12.76 mg kg^{-1}), respectively. The crop showed minimum available phosphorus (7.41 mg kg^{-1}) under control (no amendment) as depicted in figure 4.1.5.

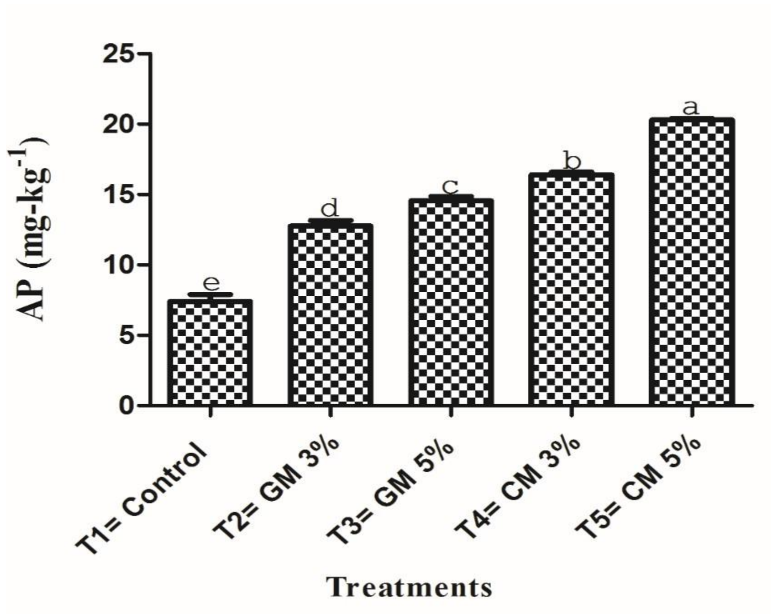

Figure 4.5: Graphical illustration for Available Phosphorus (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available potassium (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available potassium of maximum (119.30 mg kg^{-1}), closely followed by the 3% cow manure with average available potassium upto (115.29 mg kg^{-1}), respectively. The maize crop receiving (5% goat manure) and (3% goat manure) resulted in reduced available potassium upto (108.56 mg kg^{-1}) and (105.00 mg kg^{-1}), respectively. The crop showed minimum available potassium (73.82 mg kg^{-1}) under control (no amendment).

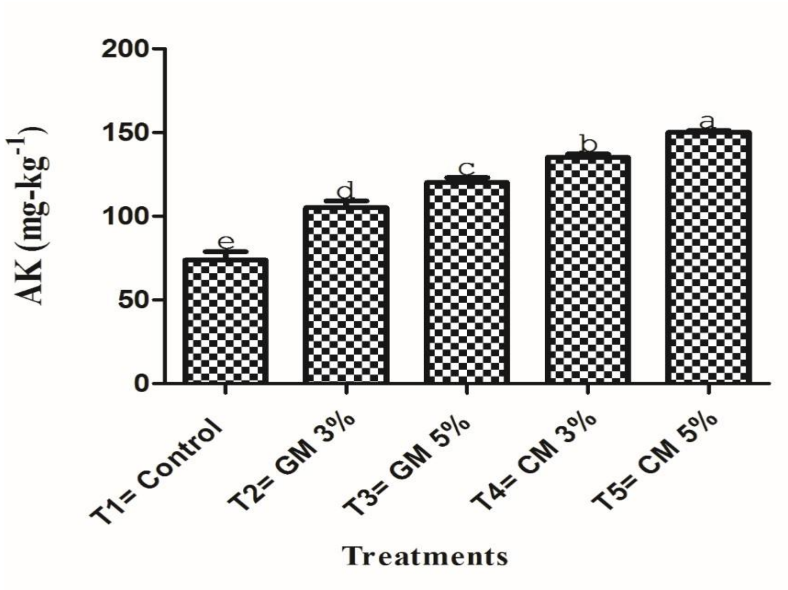

Figure 4.6: Graphical illustration for Available Potassium (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available Copper (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available copper of maximum (10.50 mg kg^{-1}); closely followed by the (cow manure 3%) with average available copper upto (8.50 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available copper upto (7.50 mg kg^{-1}) and (6.50 mg kg^{-1}), respectively. The crop showed minimum available copper (5.50 mg kg^{-1}) under control (no amendment).

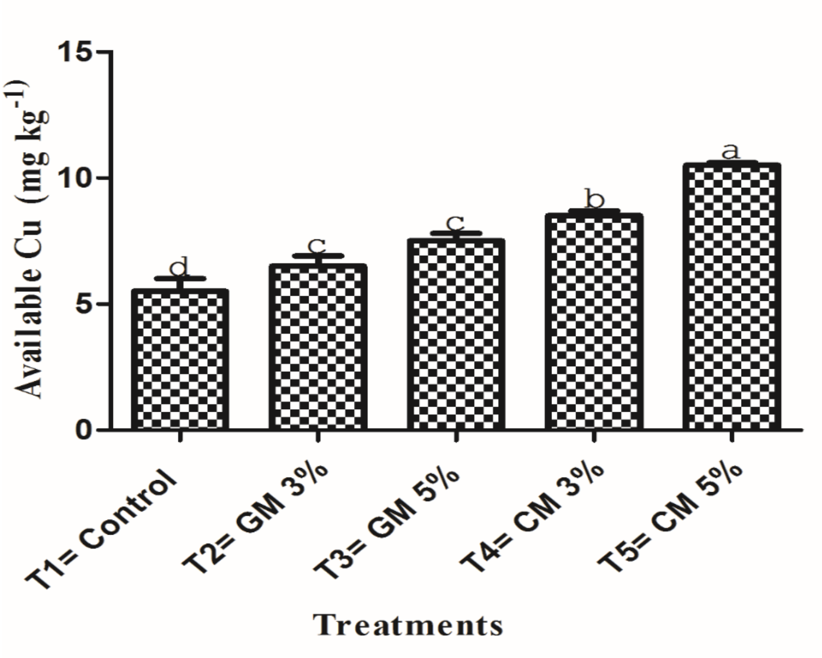

Figure 4.7: G raphical illustration for Available Copper (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available manganese (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available manganese of maximum (31.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available manganese upto (29.00), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available manganese upto (27.00 mg kg^{-1}) and (26.00 mg kg^{-1}),respectively. The crop showed minimum available manganese (24.00 mg kg^{-1}) under control (no amendment).

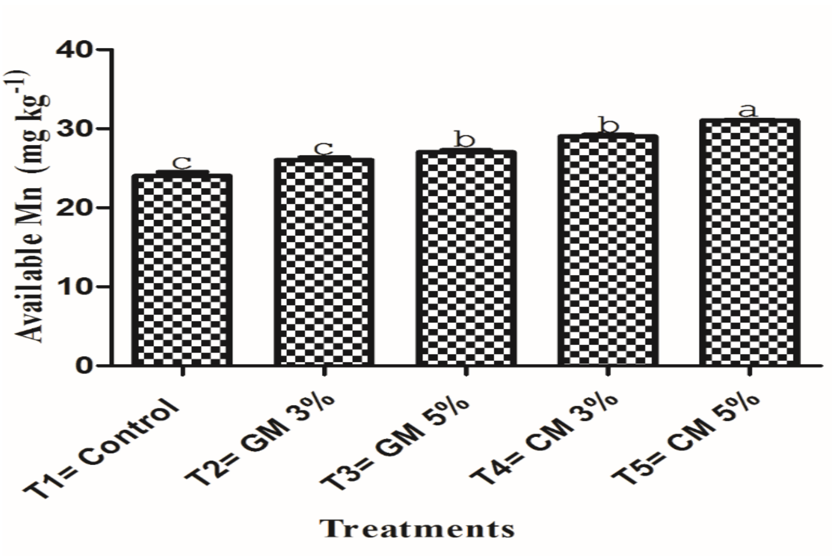

Figure 4.8: Graphical illustration for Available Manganese (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available iron (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available iron of maximum (47.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available iron upto (45.00 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available iron upto (43.00 mg kg^{-1}) and (40.00 mg kg^{-1}), respectively. The crop showed minimum available iron (35.00 mg kg^{-1}) under control (no amendment).

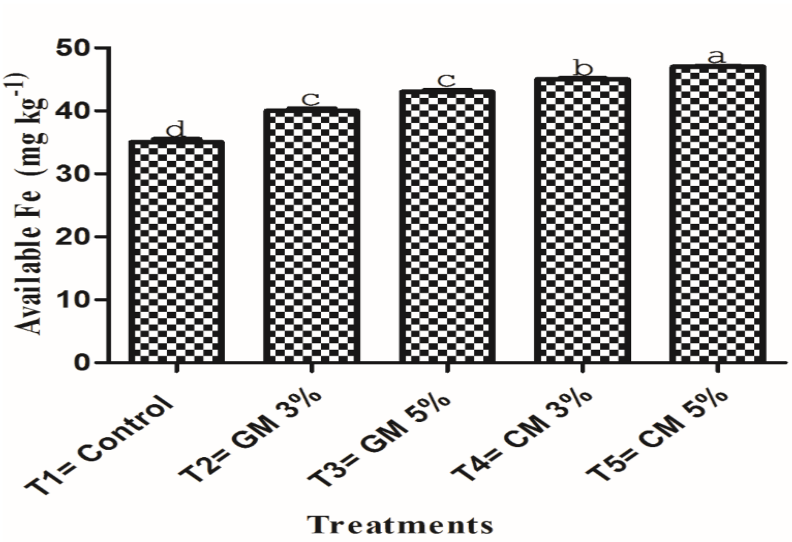

Figure 4.9: Graphical illustration for Available Iron (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available zinc (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available zinc of maximum (13.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available zinc upto (11.00 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available zinc upto (10.00 mg kg^{-1}) and (9.00 mg kg^{-1}), respectively. The crop showed minimum available zinc (8.00 mg kg^{-1}) under control (no amendment).

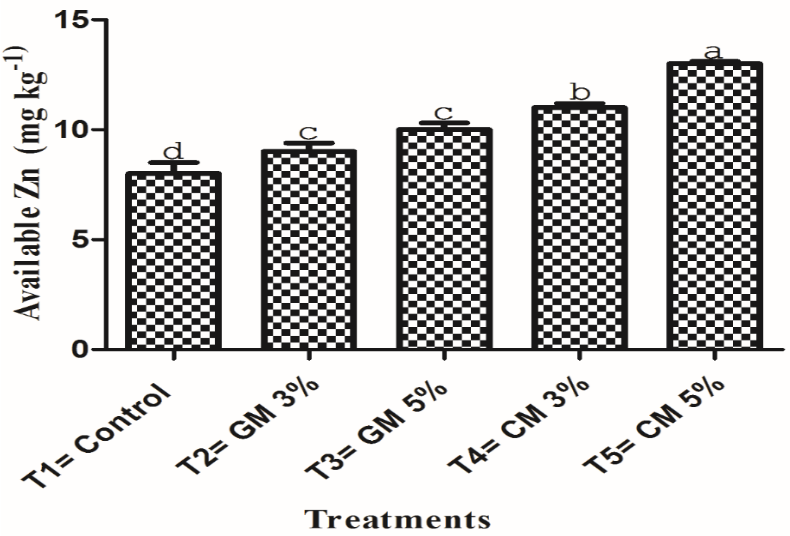

Figure 4.10: Graphical illustration for Available Zinc (mg kg^{-1}) content in subsoil sample impacted by organic manure application. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Assessment of soil chemical properties from rhizosphere environment of maize after treatment of organic manures

Electrical conductivity

The cow manure given to maize crop at the rate of cow manure 5% produced electrical conductivity of maximum (1.53 dsm^{-1}); closely followed by the 3% cow manure with average electrical conductivity upto (1.28 dsm^{-1}), respectively. The maize crop receiving goat manure (5%) and goat manure (3%) resulted in reduced electrical conductivity upto (1.20 dsm^{-1}) and (1.15 dsm^{-1}), respectively. Minimum electrical conductivity was recorded (1.00 dsm^{-1}) under control (no amendment).

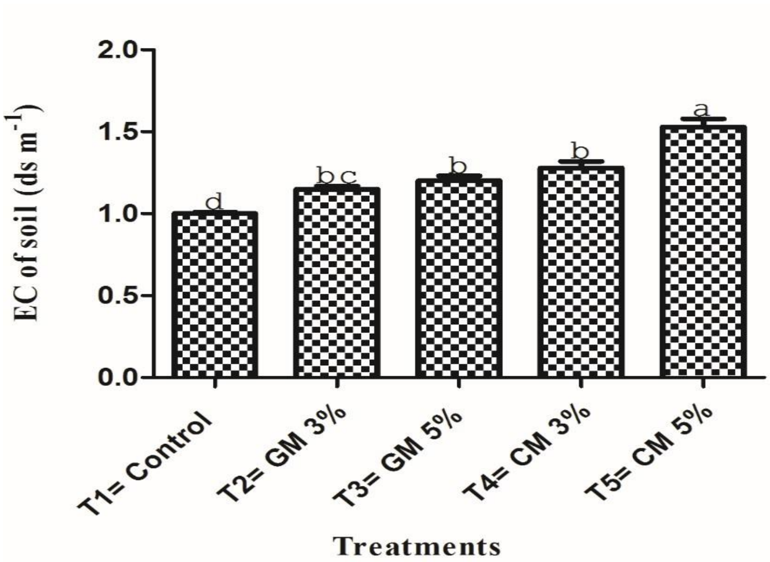

Figure 4.11: Graphical depiction for estimation of soil electrical conductivity from rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

pH

The cow manure given to maize crop at the rate of (cow manure at 5%) produced pH of maximum (8.23); closely followed by the (5% goat manure) with average pH upto (8.06), respectively. The maize crop receiving (Goat manure 3%) and (Cow manure 3%) resulted in reduced pH upto (8.00) and (7.20), respectively. Minimum pH (7.50) was recorded under control (no amendment).

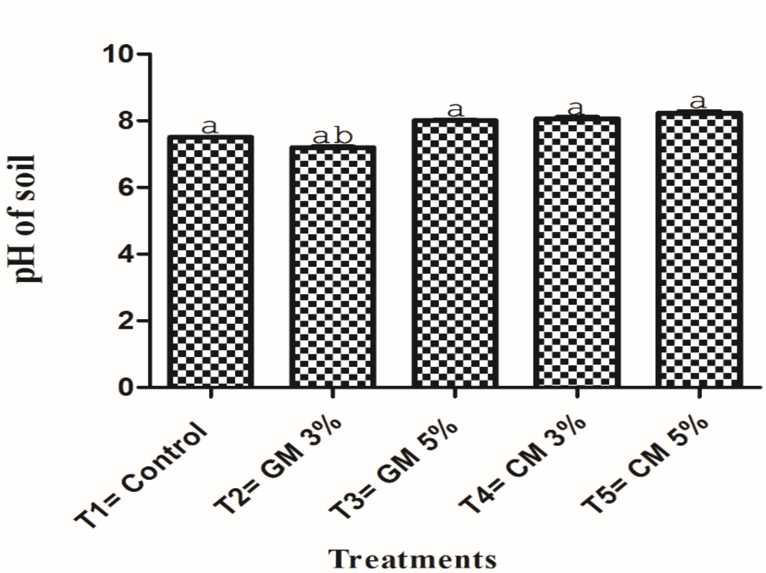

Figure 4.12: Graphical depiction for estimation of soil pH from rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Organic matter %

The cow manure given to maize crop at the rate of (cow manure 5%) produced organic matter of maximum (1.81 %); closely followed by the (cow manure 3%) with average organicmatter upto (1.77 %), respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced organic matter upto (1.33 %) and (1.21 %), respectively. Minimum was notedorganic matter (0.86 %) under control (no amendment).

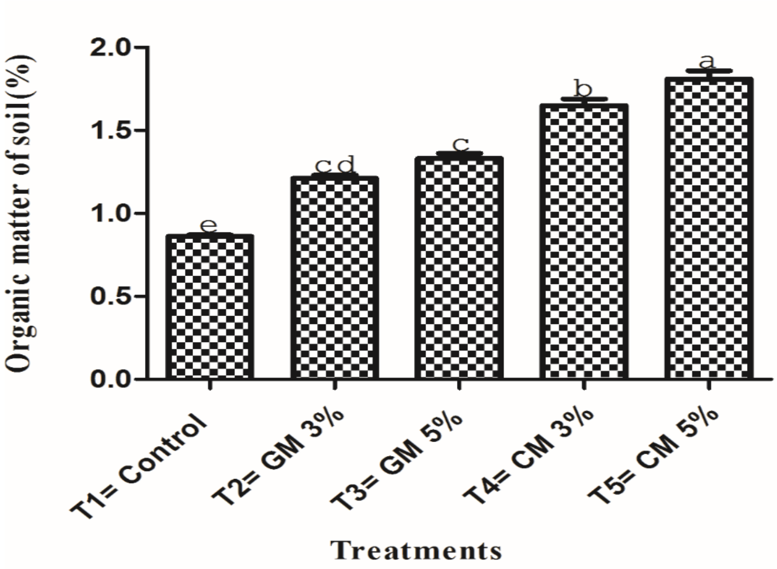

Figure 4.13: Graphical depiction for estimation of organic matter content from rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Total nitrogen (g kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced total nitrogen of maximum (0.14 g kg^{-1}); closely followed by the 3% cow manure with average total nitrogenupto (0.12 g kg^{-1}), respectively. The maize crop received (goat manure 5%) and (goat manure 3%) resulted in reduced total nitrogen upto (0.10 g kg^{-1}) and (0.06 g kg^{-1}), respectively. Minimum total nitrogen was recorded (0.03 g kg^{-1}) under control (no amendment).

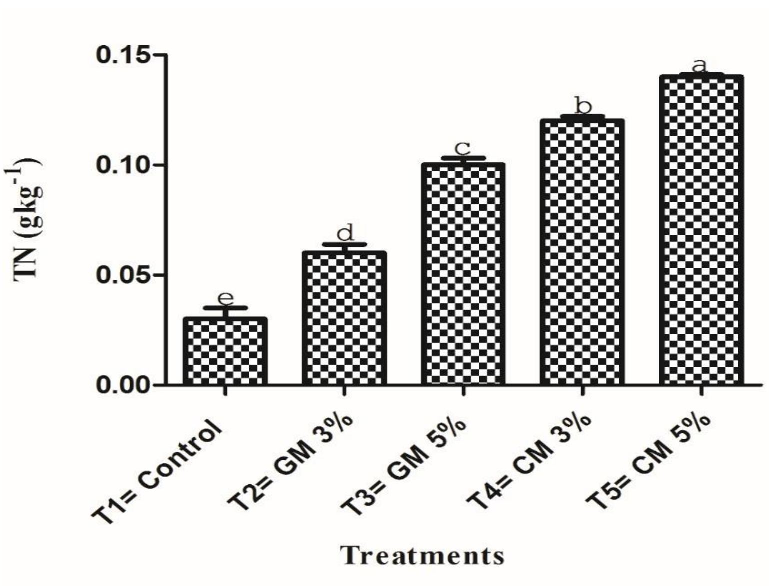

Figure 4.14: Graphical depiction for estimation of total Nitrogen (g kg^{-1}) content in rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available phosphorus (mg kg^{-1})

The cow manure given to maize crop at the rate of cow manure 5% produced available phosphorus of maximum (18.18 mg kg^{-1}); closely followed by the (cow manure at 3%) with average available phosphorus up to (13.15 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure at 3%) resulted in reduced available phosphorus upto (14.15 mg kg^{-1}) and (10.12 mg kg^{-1}), respectively. Minimum available phosphorus was noted (7.21 mg kg^{-1}) under control (no amendment).

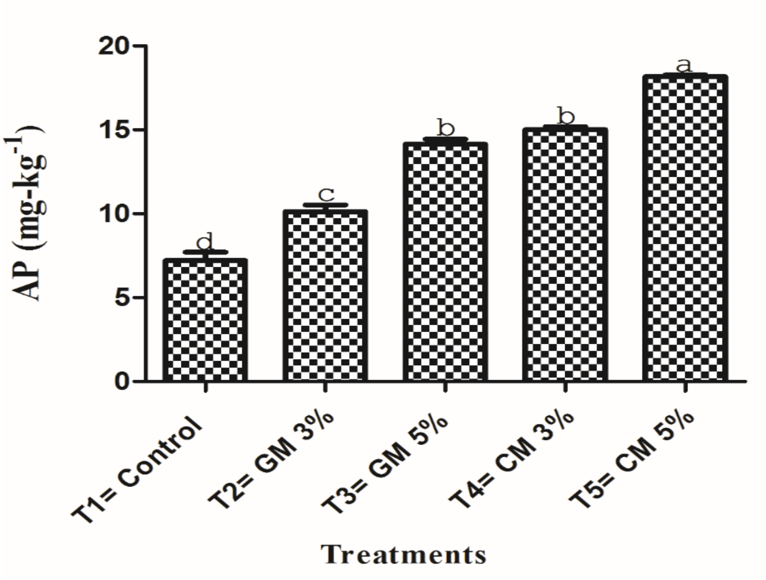

Figure 4.15: Graphical depiction for determination of available phosphorus (mg kg^{-1}) content in rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available potassium (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available potassium of maximum (117.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available potassium upto (113.3 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available potassium upto (107.37 mg kg^{-1}) and (100.20 mg kg^{-1}), respectively. Minimum available potassium was recorded (60.19 mg kg^{-1}) under control (no amendment).

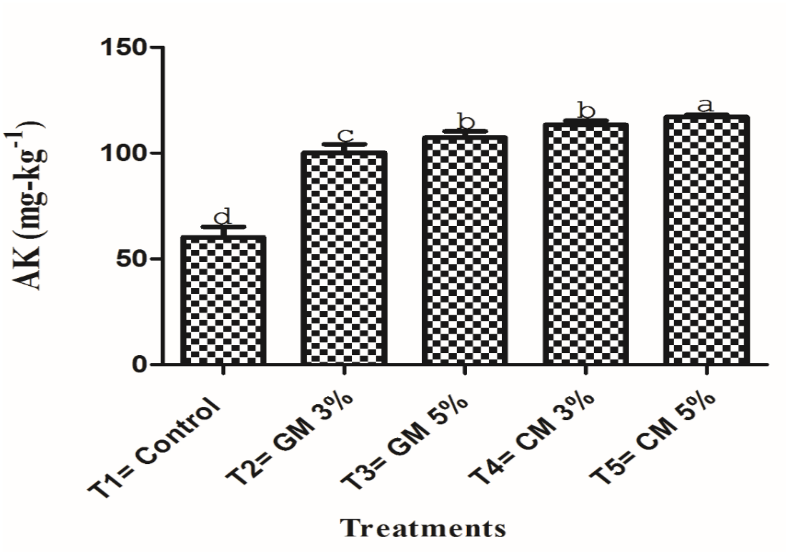

Figure 4.16: Graphical depiction for determination of available potassium (mg kg^{-1}) content in rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available copper (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available copper of maximum (11.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available copper upto (9.50 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available copper upto (8.50 mg kg^{-1}) and (7.50 mg kg^{-1}), respectively. Minimum available copper was noted (6.50 mg kg^{-1}) under control (no amendment).

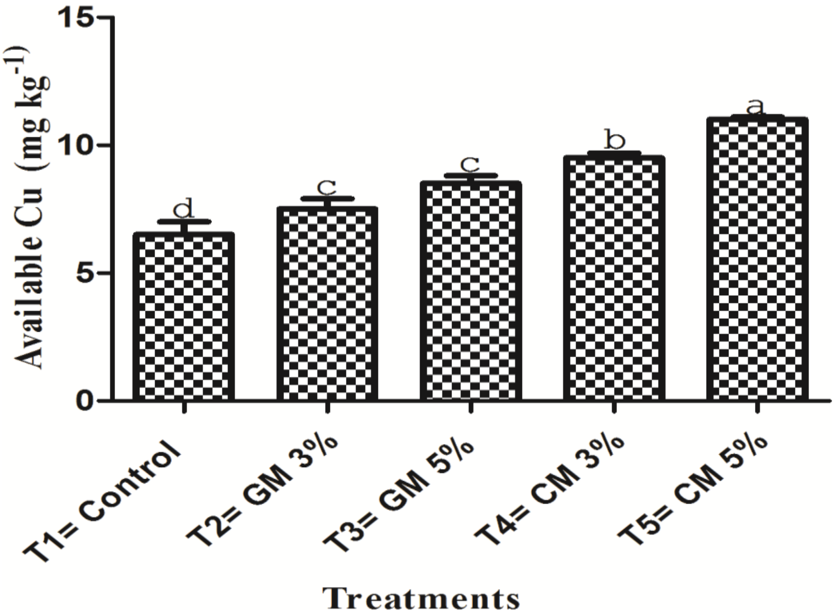

Figure 4.17: Graphical depiction for determination of Available Copper (mg kg^{-1}) content in rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available manganese (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available maganese of maximum (37.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available maganese upto (33.00 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available maganese upto (30.00 mg kg^{-1}) and (28.00 mg kg^{-1}),respectively. Minimum available manganese was recorded (26.00 mg kg^{-1}) under control (no amendment).

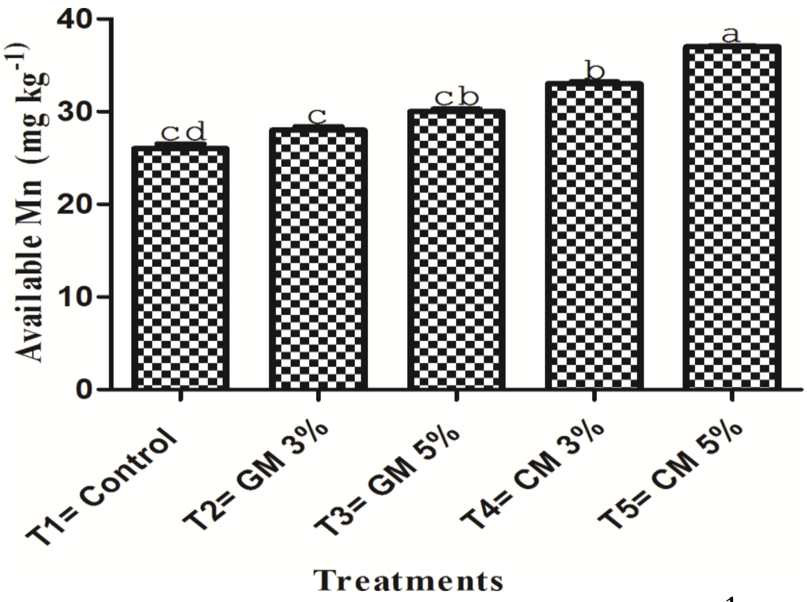

Figure 4.18: Graphical depiction for determination of Available Maganese (mg kg^{-1}) content in rhizosphere environment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available iron (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available iron of maximum (52.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available iron upto (48.00 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available iron upto (46.00 mg kg^{-1}) and (43.00 mg kg^{-1}),respectively. Minimum available iron was recorded (40.00 mg kg^{-1}) under control (no amendment).

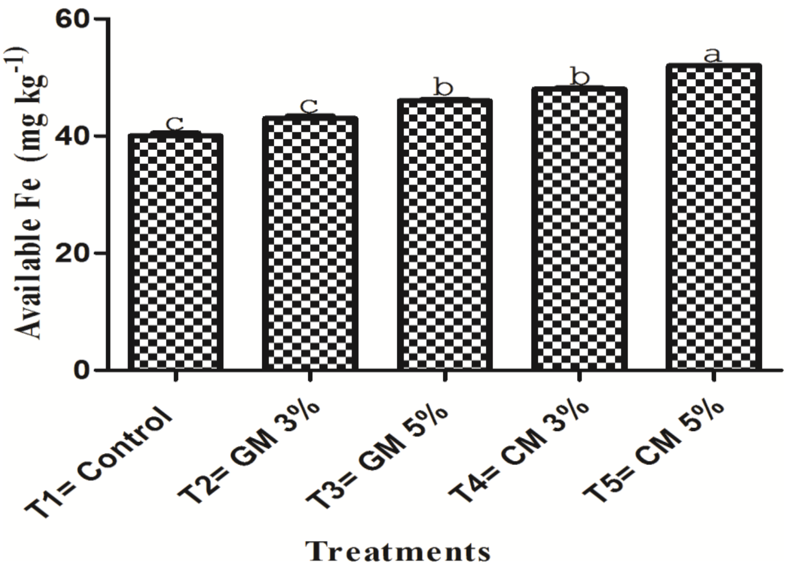

Figure 4.19: Graphical depiction for determination of Available Iron (mg kg^{-1}) content in rhizosphereenvironment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Available zinc (mg kg^{-1})

The cow manure given to maize crop at the rate of (cow manure 5%) produced available zinc of maximum (14.00 mg kg^{-1}); closely followed by the (cow manure 3%) with average available zinc upto (12.00 mg kg^{-1}), respectively. The maize crop receiving 5% goat manure and (goat manure 3%) resulted in reduced available zinc upto (11.00 mg kg^{-1}) and (10.00 mg kg^{-1}),respectively. Minimum available zinc was noted (9.00 mg kg^{-1}) under control (no amendment).

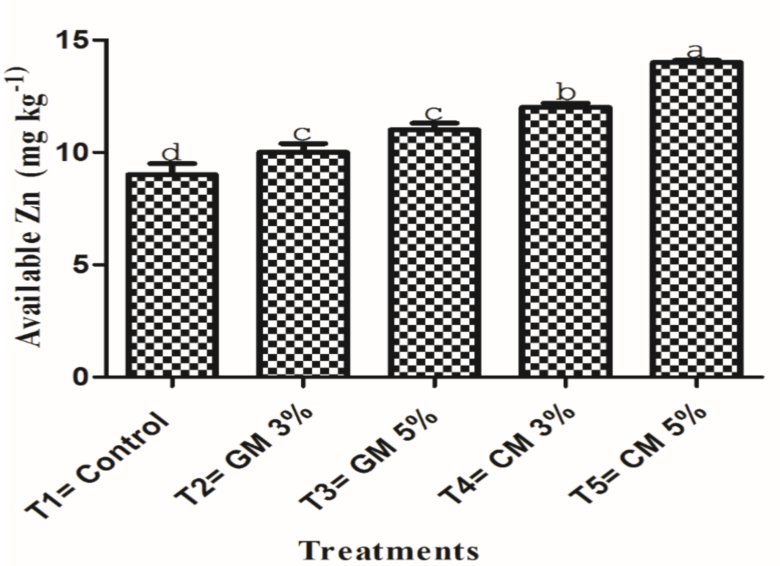

Figure 4.20: Graphical depiction for determination of Available Zinc (mg kg^{-1}) content in rhizosphereenvironment of maize influenced by treatment of organic manure. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Fresh plant weight (g)

The cow manure given to maize crop at the rate of cow manure 5% produced fresh plant weight of maximum (95 g); closely followed by the 3% cow manure with average fresh plant weight upto (81 g), respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced fresh plant weight upto (76 g) and (64 g), respectively. The crop showed minimum fresh plant weight (33 g) under control (no amendment).

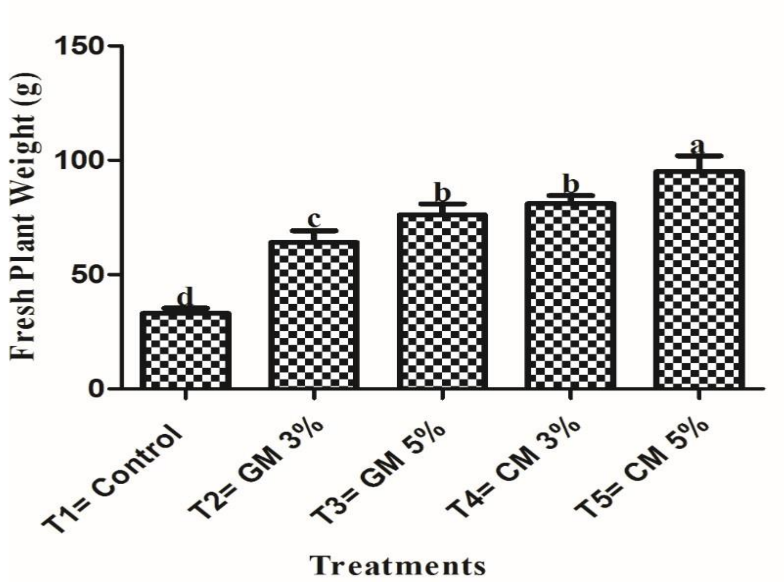

Figure 4.21: Fresh plant weight (g) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Dry plant weight (g)

The cow manure given to maize crop at the rate of cow manure 5% produced dry plant weight of maximum (74.00 g); closely followed by the 3% cow manure with average dry plant weight upto 65.00 g, respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced dry plant weight upto (51.00g) and (41.00g), respectively. The crop showed minimum dry plant weight (15.66 g) under control (no amendment).

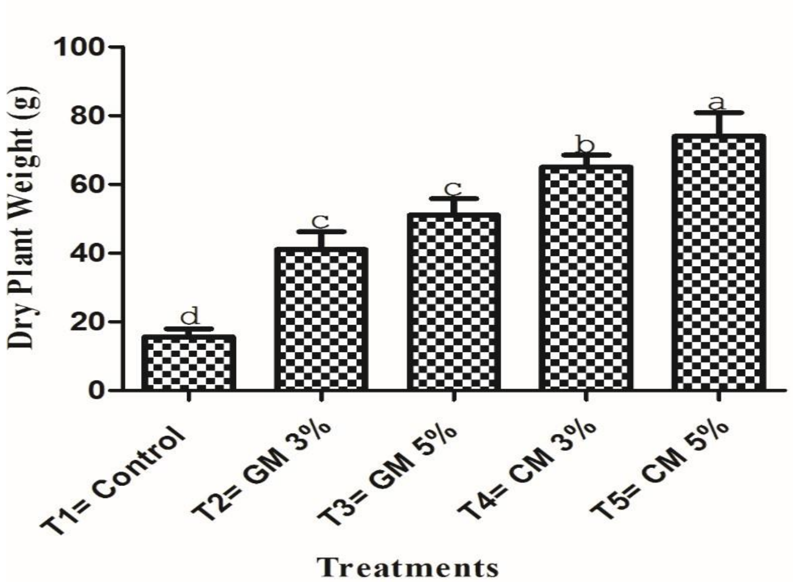

Figure 4.22: Dry plant weight (g) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Fresh root weight (g)

The cow manure given to maize crop at the rate of (cow manure 5%) produced fresh root weight of maximum (12.33 g); closely followed by the 3% cow manure with average fresh root weight upto 10.66 g, respectively. The maize crop receiving (5% of goat manure) and (3% of goatmanure) resulted in reduced fresh root weight upto (9.00 g) and (8.00 g), respectively. The crop showed minimum fresh root weight (3.00 g) under control (no amendment).

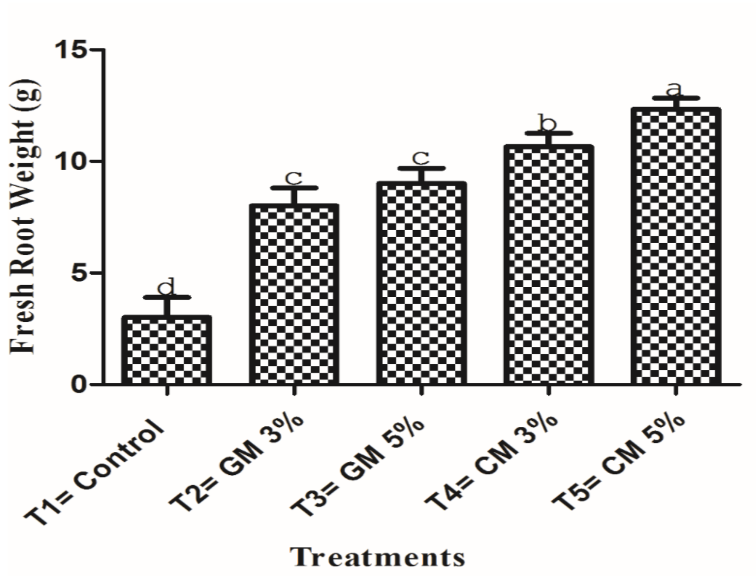

Figure 4.23: Fresh root weight (g) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Dry root weight (g)

The cow manure given to maize crop at the rate of (cow manure at 5%) produced dry root weight of maximum (2.66 g); closely followed by the 3% cow manure with average dry root weight upto1.66 g, respectively. The maize crop receiving (5% goat manure) and (3% goat manure) resulted in reduced dry root weight upto (3.00 g) and (2.00 g), respectively. The crop showed minimum dry root weight (1.00 g) under control (no amendment).

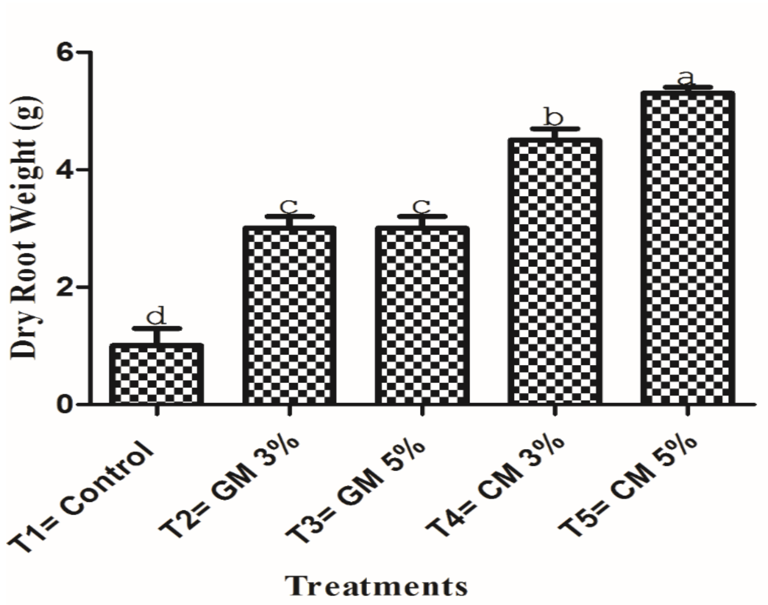

Figure 4.24: Dry root weight (g) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of (p≤0.05), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Plant height (cm)

The cow manure given to maize crop at the rate of cow manure 5% produced plant height of maximum (114.00 cm); closely followed by the 3% cow manure with average plant height upto (104.00 cm,) respectively. The maize crop receiving 5% goat manure and 3% goat manure resulted in reduced plant height upto (94.00cm) and (84.33 cm), respectively. The crop showed minimum plant height (45.60 cm) under control (no amendment).

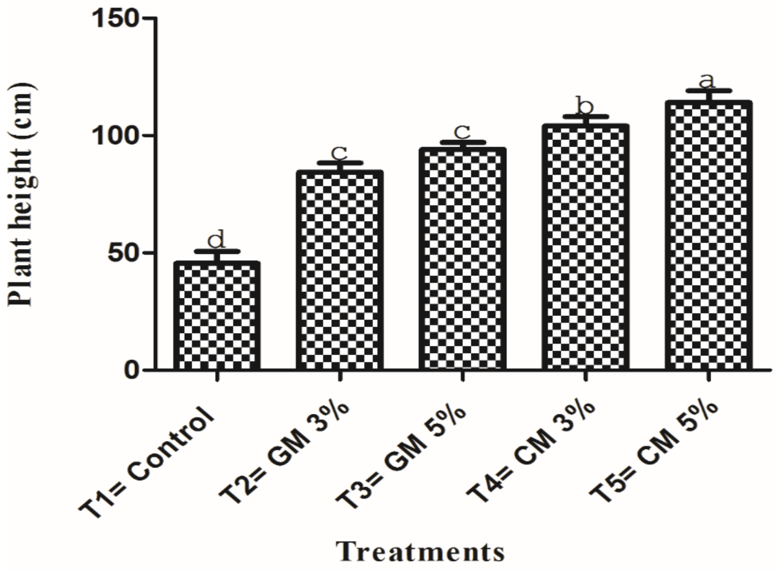

Figure 4.25: Plant height (cm) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Number of green leaves

The cow manure given to maize crop at the rate of (cow manure at 5%) produced number of green leaves of maximum (10.33); closely followed by the (cow manure at 3%) with average number of green leaves upto (9.33), respectively. The maize crop receiving (5% of goat manure) and (3% of goat manure) resulted in reduced of number of green leaves upto (7.00) and (6.66), respectively. The crop showed minimum number of green leaves (3.33) under control (no amendment).

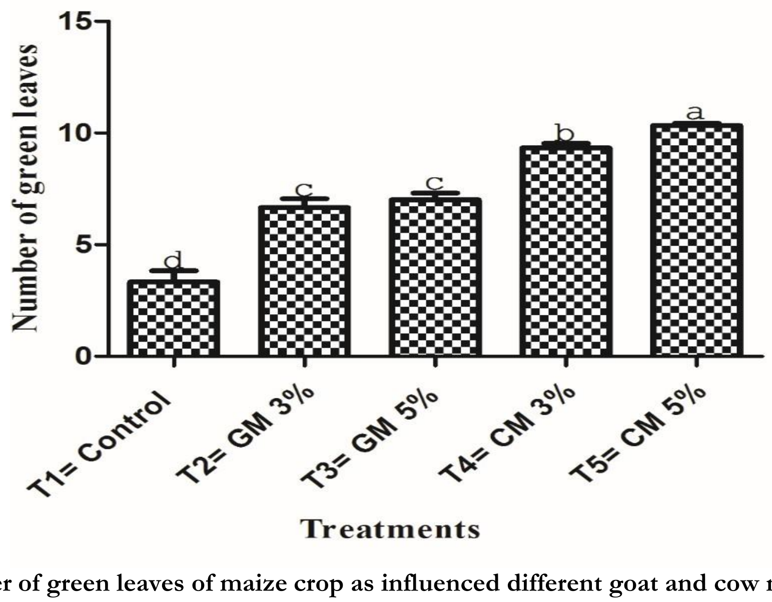

Figure 4.26: Number of green leaves of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Number of dry leaves

The cow manure given to maize crop at the rate of (cow manure at 5%) produced number of dry leaves of maximum (6.66); closely followed by the (cow manure at 3%) with average number of dry leaves upto (5.33, respectively. The maize crop receiving 5% goat manureand (goat manure at 3%) resulted in reduced number of dry leaves upto (4.33) and (3.33), respectively. The crop showed minimum number of dry leaves (2.66) under control (no amendment).

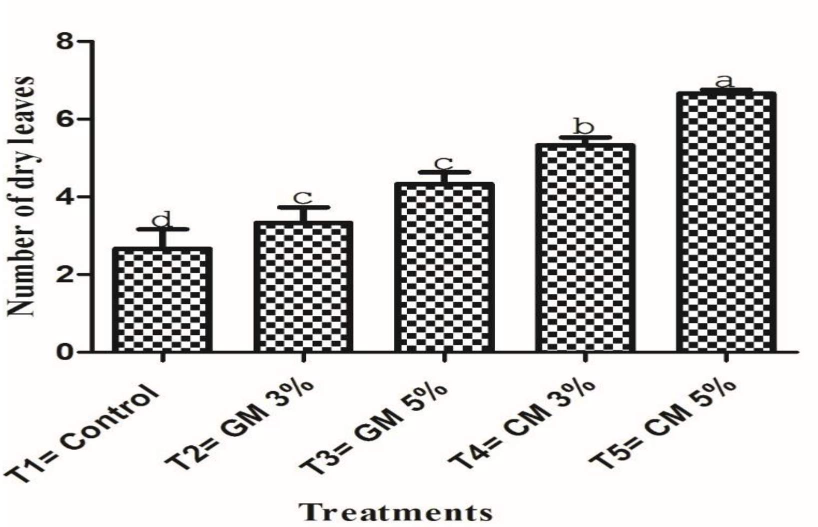

Figure 4.27: Number of dry leaves of maize crop as influenced different goat and cow manures..Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Stem girth (cm)

The cow manure given to maize crop at the rate of (cow manure at 5%) produced stem girth of maximum (15.70 cm); closely followed by the (cow manure at 3%) with average stem girth upto (14.80 cm), respectively. The maize crop receiving 5% goat manure and 3% goatmanure resulted in reduced stem girth upto (13.76cm) and (12.23 cm), respectively. The crop showed minimum stem girth (7.69 cm) under control (no amendment).

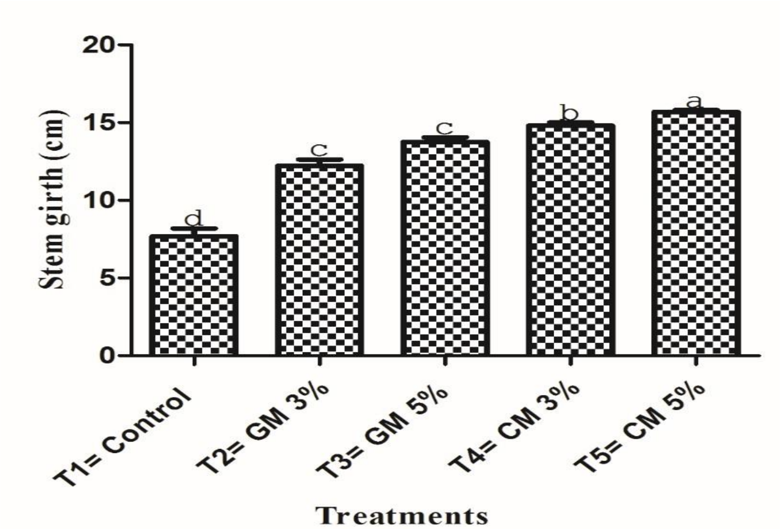

Figure 4.28: Stem girth (cm) of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Leaf area index (cm)

The cow manure given to maize crop at the rate of (cow manure at 5%) produced leaf area index of maximum (14.66 cm); closely followed by the (cow manure at 3%) with average leaf area index upto (13.00 cm), respectively. The maize crop receiving (goat manure 5%) and (goat 3%) manure resulted in reduced leaf area index upto (11.33 cm) and (9.63 cm), respectively. The crop showed minimum leaf area index (5.53) under control (no amendment).

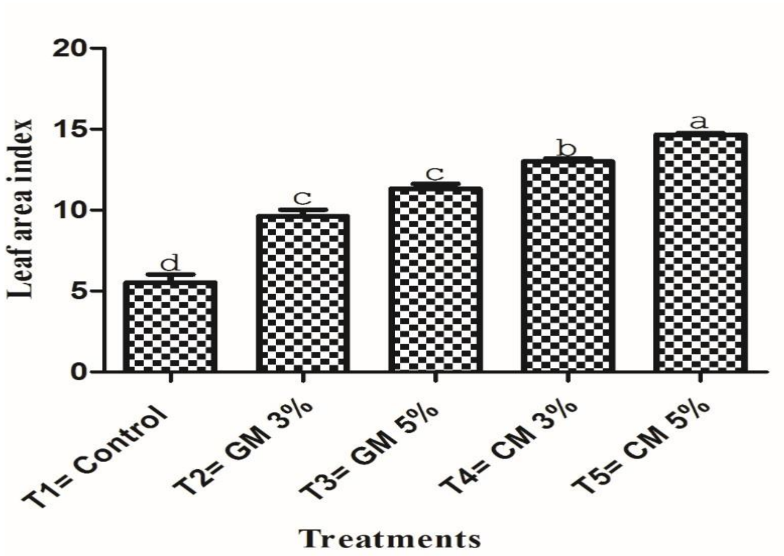

Figure 4.29: Leaf area index of maize crop as influenced different goat and cow manures. Above mean values in graph indicating similar letters does not significantly differ at probability value of ($p \leq 0.05$), Recommended treatments: T1= Control (No amendment); T2= GM (Goat manure 3%); T3= GM (Goat manure 5%); T4= CM (Cow manure 3%); T5= CM (Cow manure 5%).

Discussion

The application of N, P, and K fertilizers is important to increase crop yields since the proper use of nutrients by plants is dependent on the application method of these nutrients. In Pakistan's irrigated production systems, higher fertilizer and water usage, as well as lower residual soil nitrate levels, are critical to achieving high yields (Akram et al., 1982).

The current study found that when cow manure was applied at a rate of 5%, the maize crop yielded the highest electrical conductivity (1.65 dsm^{-1}), when under supervision it produced the lowest electrical conductivity (1.29 dsm^{-1}). Under control (no amendment). The application of cow manure to maize crops at a rate of 5% yielded pH values of (8.19) and (7.40), respectively, under controlled conditions (no amendment). The cow manure applied to the maize crop at a rate of 5% provided the highest organic matter (1.65 %) and the lowest organic matter (0.93%) under (no amendment). The cow manure applied to the maize crop at a rate of 5% provided a gross total nitrogen of (0.15 g kg^{-1}) percent, but the minimum total nitrogen (0.03 gkg^{-1}) was held under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided the highest available phosphorus (20.30 mg kg^{-1}) and the lowest available phosphorus (7.41 mg kg^{-1}) under control (no amendment). The application of cow manure to maize crops at a rate of 5% resulted in maximum available potassium (119.30 mg kg^{-1}) and minimum available potassium (73.82 mg kg^{-1}) under control (no amendment). The highest electrical conductivity (1.53 dsm^{-1}) was achieved with cow manure applied to the maize crop at a rate of 5% whereas the minimum electrical conductivity (1.00 dsm^{-1}) was achieved under control (no amendment). Cow manure applied to maize crops at a rate of 5% developed pH values of maximum (8.23) and minimum (7.50).Under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided the highest organic matter (1.81 %), whereas the crop had the lowest organic matter (0.86 %) under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided maximum total nitrogen (0.14 g kg^{-1}) and the crop showed minimum total nitrogen (0.03 g kg^{-1}) under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided maximum available phosphorus (18.18 mg kg^{-1}) and minimum available phosphorus (7.21 mg kg^{-1}) under control (no amendment).The application of cow manure to maize crops at a rate of 5% resulted in maximum available potassium (117.00 mg kg^{-1}) and minimum available potassium (60.19 mg kg^{-1}) under control (no amendment). The maize crop received cow manure at a rate of 5% resulting in a maximum fresh plant weight (95 g) and a minimum fresh plant weight (33 g) under control (no amendment).

The cow manure applied to the maize crop at a rate of 5% resulted in agross dry plant weight (74.00 g) and a minimum dry plant weight (15.66 g) under control (no amendment). Cow manure applied to maize crops at a rate of 5% provided fresh root weights of maximum (12.33 g) and minimal (3.00 g) under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided a gross dry root weight of (2.66 g), but a minimum dry root weight of (1.00 g) under control (no amendment). The cow manure applied to the maize crop at a rate of 5% resulted in maximum plant height (114.00 cm) and minimum plant height (45.60 cm) under control (no amendment). The maize crop generated a maximum number of green leaves (10.33) at a pace of 5% cow manure, compared to a minimal number of green leaves (3.33) under control (no amendment). The cow manure applied to the maize crop at a rate of 5% provided the highest amount of dry leaves (6.66) and the lowest number of dry leaves (2.66) under control (no amendment). Cow manure applied to maize crops at a rate of 5% cow manure yielded stem girths of maximum (15.70 cm) and minimum (7.69 cm) under control (no amendment). The maize crop received cow manure at a rate of 5% resulting in a maximum leaf area index (14.66 cm) and a minimum leaf area index (5.53cm) under control (no amendment). Nitrogen (N) is a key plant nutrient that influences plant growth and yield (Akanbi et al., 2000), and leaf area increases as N levels rise. Increased leaf area in organic fertilizer-amended soils was more likely due to increased nitrogen supply, which facilitated leaf area during vegetative production and often helped to sustain usable leaf area during the growth cycle (Obi and Ebo, 1995). Okalebo et al., (2002) found that plants treated with 20 t ha^{-1} cattle manure grew slightly taller ($p<0.05$) than plants treated with other levels of manure or controls. The consistent rise in maize plant height with increasing cattle manure rates shows that the amount of manure applied influences the supply of nutrients for absorption by plants, promoting robust plant growth through effective photosynthesis. In this report, plants amended with 20 tha^{-1} of organic fertilizer had the most plant leaves, which was slightly ($p<0.05$) higher than the control and other plants amended with other rates.

The application of cattle manure to the soil at various levels may have strengthened soil productivity and structure, increased soil organic matter, and increased microbial activity (Adekiya and Agbede, 2009), and the nutrients released from manure thus promote and stimulate rapid root production (Sanni, 2016), which may have enhanced leaf growth (Adekiya and Agbede, 2009). Higher rates of nutrients raised the total crop weight and volume in (Adebayo, et al., 2010; Aminifard et al. (2010); Ayuso, et al., 1996, and Iqtidar., et al., 2006. This may be due to the calming influence of cattle manure 480, which provides the plant with the nutrients it needs to produce a higher yield. Increasing the amount of cattle manure applied improved maize growth, which may be attributed to a balanced supply of nutrients to the plants, resulting in a favorable soil condition. The soil's nutrient supply and water keeping capability improved as a consequence of these favorable factors, resulting in increased growth and production (Ogar and Asiegbu, 2018). Plant height increase was most successful and visible in plants treated with poultry manure, owing to adequate N levels (Sa-nguansak, 2016). The lack of N uptake in the untreated plots may be attributed to the plant having to depend on the native fertility of the soil, which was found to be deficient in total N. This discovery revealed that plant height is influenced by nutritional availability (Sharma, 1991). Plant height is a critical growth characteristic that is related to a plant's yield capacity (Tisdale and Nelson, 1990). Only poultry manure-treated plants had thicker stems than untreated plants on the 50 percent tasseling day. This finding is consistent with a previous study by Ayoola and Adeniran(2005), which found that differences in nutrient source among treatments result in significant differences in stem girth per plant. In southwest Nigeria, Odiete et al. (2016) and Ojeniyi and Adegboyeaga (2003) discovered that goat manure increased the growth and yield of okra,amaranthus, celosia, and maize. Samuel et al. (2003) discovered that goat manure improved soil pH, nitrogen, and plantain yield in southeast Nigeria. In light of these findings and the need to encourage goat manure use for vegetable development, this study looked at the effects of various rates of goat dung (manure) and NPK fertilizer on soil and leaf nutrient concentrations, pepper output, and fruit yield in southwest Nigeria. According to Opara-Nadi et al. (2015), further research is required to compare the results of organic manures and inorganic fertilizers under field conditions and in different agro-ecological zones.

Nandita et al. (2015) showed that each incremental impact of nitrogen and phosphorus fertilizers increased the HQPM-1 hybrid's LAI, dry matter output, plant growth, and yield (grain and stover) as compare to control. Plant height, LAI, dry matter output, grain yield and stover yield were all highest with 235 kg N ha^{-1}. It was recommended that appropriate concentrations of N (240 kg ha^{-1}) and P (100 kg ha^{-1}) should be used to achieve maximum yield in the agro-ecological conditions of the South Telanganaarea. Kevin, (2017) assessed the interaction of organic fertilizer and plant population density affected the growth and yield of two maize cultivars. Three concentration levels of poultry manure (0, 2.5, 5.0 t ha^{-1}), two population densities (95,556 and 53,333 plants/ha), and two maize varieties were assigned in factorial variations (DMRESR-Y andSuwan-1-SR). When 5 t/ha poultry manure was added to Suwan-1-SR at a density of 53,333 plants/ha resultantly considerable variation ($p\leq 0.05$) was recorded in all parameters. However, there was only a small gap in grain yield between 5 and 2.5 t/ha. As a result, applying 2.5 t ha^{-1} poultry manure to the Suwan-1-SR maize variety at a plant density of 53,333 plants t ha^{-1} provided the best yield, feeding the enhancing population of maize consumers while also sharing more straw for animal feed. Kolawole et al. (2018) revealed Animal manures increased plant height, leafarea index, and amount of leaves, total dry matter, ear weight, and grain yield substantially ($P<0.5$).In plots handled with rabbit manure, the maximum ear yield (11.61 t ha) and grainyield (5.77 t ha) were found, relative to the lowest ear and grain yields (7.05 and 3.66 t ha, respectively) in control plots. Plants fed with rabbit manure, on the other hand, were not substantially better than those treated with other manures. Because of its ease of supply, collection, and high nutrient composition, poultry manure is suggested to be used by maize growers for highmaize productivity under intensive and continuous cropping of humid ultisols locations.

Lalrammuanpuia et al. (2016) analyzed the effects of organic fertilizers with varying concentrations, containing essential minerals such as nitrogen, phosphorus, and potassium, on the growth and yield of local maize varieties. The study found a significant ($P\leq0.05$) positive response of maize growth and yield to fertilizer application. Additionally, the duration of the jhum cycle had a substantial ($P\leq0.05$) impact on growth and yield, with the longest cycle resulting in the highest productivity. Given the low soil nutrient levels and the acidic nature of soil in Mizoram, applying a reduced amount of urea over an extended jhum cycle was considered effective. Toyin et al. (2017) investigated how these nutrients affect maize growth and nutrient uptake through three independent pot experiments, each replicated three times using a randomized block design. The experiments involved various treatments: 0, 30, 60, 90, 120, 150, and 180 kg N ha^{-1}; 0, 30, 60, 90, 120, 150, and 180 kg P ha^{-1}; and 0, 30, 60, 90, 120, 150, and 180 kg K ha^{-1}, respectively. Swam 1 maize seeds were sown in containers, and N, P, and K treatments were applied two weeks after planting (WAP). Data on plant height, stem thickness, number of leaves, leaf weight, distance, and leaf area were collected biweekly for 8 weeks, with dry matter yield and nutrient uptake being measured at the conclusion of the experiments. The findings revealed that the application of 120 kg N ha-1 led to significant increases in plant height (66%), leaf number (96%), and dry matter accumulation in maize, whereas 150 kg N ha^{-1} significantly boosted leaf area and P concentration (157%). Using 60 kg P ha-1 notably increased plant height (26%), stem thickness, leaf area, leaf count (54%), shoot dry weight, and N concentration. Conversely, applying 180 kg ha-1 of K enhanced plant height (16%), stem girth (61%), leaf count, leaf area (24%), leaf duration (10%), leaf width (10%), and N and K uptake and concentration. The optimal applications for promoting maize growth and nutrient uptake were identified as 120 to 150 kg N ha^{-1}, 60 kg P ha^{-1}, and 180 kg K ha^{-1}. In a separate study, Adekiya et al. (2016) conducted experiments during the early cropping seasons of 2014 and 2015 to evaluate how varying levels of cow dung (0, 2, 4, 6, 8, and 10 t ha^{-1}) influenced soil physical properties, maize growth, and yield. The study utilized six treatments, each replicated four times in a randomized complete block design. The results showed that cow dung application improved soil porosity, moisture retention, and infiltration rate, while also enhancing maize growth and yield compared to untreated soil. It also reduced bulk density, soil temperature, and the soil dispersion ratio. The researchers concluded that increased soil porosity, combined with reduced bulk density, led to better water infiltration and retention, resulting in lower soil temperatures and higher maize yield. Hariadi et al. (2016) highlighted that lead has long been recognized as having an impact on plants, emphasizing the need to monitor its effects closely.

The aim of the study was to contribute to the initiative of increasing efficiency by encouraging the use of manure such as goat and cow manure in maize production. On the soil media growth of maize in the glasshouse, different formulations of goat and cow manure were added. Biophysically, the development was tracked by assessing the surface electrical difference and region of the plants, as well as looking for signs of chlorosis. As opposed to maize grown in apure soil medium, the addition of manure to the soil increased leaf area and electrical potential gap. Renewable fertilizers, such as cow and goat manure, were found to be effective in growing plant development. The leaves grew well in a mixture of 2/3 soil and 1/3 goat manure, supplemented by a mixture of 2/3 soil and 1/3 cow manure. There were no indicators of stress symptoms such as chlorosis, implying that all of the manure formulations included in the study are potentially healthy for plants and soil, and pose no risk to human health. Further testing is required to ensure no lead pollution. Krzysztof et al. (2016) revealed that a single-factor experiment was established in a randomized complete block design with 4 replications for each treatment. The findings revealed that the experimental element had a substantial impact on the macronutrient quality of the maize organs studied. As compared to the monitor, mineral fertilization greatly improved N concentration. Although the experimental element had a significant impact on the discrepancies in phosphorus and potassium content between the therapies, nutrient increases were not detected in any of the organs studied as opposed to the regulation. Maize stems, leaves, and husks showed a particularly strong response to the absence of potassium fertilization or the application of different rates of this ingredient. The form of phosphorus used as a fertilizer had little impact on the P content of maize organs or the overall amount of this nutrient accumulated in the plant. As a consequence of P and K fertilization, the percentage shares of grain acquired nutrients in the overall nutrient accumulation in the aboveground biomass displayed important distinction. The majority of nitrogen and phosphorus is deposited in maize grain (60–70%), while potassium was accumulated in the stems (50–61%). Regardless of the procedure studied, regression analysis revealed that total nitrogen accumulation dictated maize yields. Amos et al. (2015) used cow dung to test the production of vegetable maize. The treatments included four cow dung application rates (0, 5, 10, and 15t/ha) and three local vegetable maize varieties, Bataji, Choci, and Dan-Bauchi. Both of the treatments were factorially mixed and arranged in a randomized split-plot layout. With elevated rates of cattle manure, growth and yield parameters, as well as final yields, all increased dramatically (P 0.05). Plant height increased by 24%, leaf area increased by 27%, and fresh husked cob weight increased by 13% after 15 t/ha was applied, among other things. In most of the parameters, Bataji outperformed Dan-Bauchi and Choci regardless of application rates, with the exception of kernel density and 1000 seed weight, where Choci outperformed the other two varieties substantially.

For good production of vegetablemaize in Bauchi and its environs, the Bataji variety with 15 t/ha is recommended. Gul et al., (2015) performed research to detect certain physiochemical properties and metal concentrations in pond sediment samples obtained from a fish pond. The soil texture, pH, total dissolve solids (TDS), conductivity, and metal concentrations were all measured. The pH of pondsoil ranged from 9.1 to 9.3 with an average value of 9.2, gross dissolved solids (TDS) ranged from to 175.3 mg L^{-1} with an average value of 174.6 mg/L. Manure may be thought of as the initial fertilizer and is an essential ingredient for those interested in organic gardening. Cows, horses, cattle, pigs, goats, and poultry are the most important sources of manure. Through utilizing manure, you'll be applying essential micro and macronutrients to your soil that will steadily release over time, as well as improving soil aeration and water preservation, both of which will help you develop healthy soil structure and texture. Strong soil also provides a nurturing environment for beneficial soil species and earthworms. Using manure also ensures you're recycled, which reduces the reliance on artificial fertilizers. Nutrients in the Soil and Manure Forms Source, age, how they were stored (piled, scattered, turnedover or not), and the animal bedding content that might be mixed in all affect how manures vary from one another. As a result, detailed advice about how long manure should be aged before usage, how much to use, and the expected nutrient content is difficult to come by. Both of these mechanisms have an effect on the nutritional quality of manures in general. The estimated amountsof total nitrogen (N), phosphate (P), and potassium (K) that should be present in particular manures according to the general breakdown of nutritional material. Manure is highly useful in composting because of its high nitrogen content, which stimulates soil bacteria and aids in the gradual decomposition of organic matter. This macronutrient often has the highest risk of polluting land and water. Nitrates and ammonium will accumulate in the groundwater and contaminate the water supply. Understanding how nitrogen enters the soil is critical to ensure that it is utilized wisely. The effects of unequal applicant numbers and frequencies, which can affect crop yield, have not been well recorded. Furthermore, the bulk of animal manure analysis focuses on crop yield rather than soil nutrient abundance. Research has shown that applying goat manure can significantly enhance crop growth rates, yields, resilience to stress, and the quality of the produce (Maerere et al., 2001; Awodun et al., 2007; Akanni & Ojeniyi, 2008; Odedina et al., 2011; Nweke et al., 2013). For example, Ojeniyi and Adegboyega (2003) demonstrated that goat manure positively affected the growth and yield of crops such as okra, amaranthus, celosia, and maize. Additionally, it has been identified as a beneficial source of essential nutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and organic matter for crops like pepper, cassava, and okra (Awodun et al., 2007; Odedina et al., 2011; Nweke et al., 2013). According to Smith and Ayenigbara (2015) and Ojeniyi and Adegboyega (2003), goat manure (GM) and cow manure (CM) enriched the soil with key nutrients such as N, P, K, Ca, and Mg. In soils prone to phosphorus fixation, using GM and CM has been found to reduce phosphorus sorption, with their liming effect being a crucial factor in this process (Gichangi and Mnkeni, 2009).

Regarding maize production in developing countries, the yields are often lower than potential levels due to various factors, including nutrient deficiencies. After nitrogen (N) and phosphorus (P), zinc (Zn) deficiency is also common (Gibbson, 2006). NPK is critical for plant growth and vitality, playing an important role in forming essential biomolecules like nucleic acids, proteins, amino acids, phytohormones, and enzymes. Nitrogen supports canopy expansion, the absorption of sunlight, and overall plant development (Milford et al., 2015). Although nitrogen is abundant in the atmosphere, in the form of N2, it is largely inert and not directly usable by plants for their growth and reproduction (Fan et al., 2016; Zouheir et al., 2016).

Phosphorus (P) is also vital for plant health as it is part of key structural compounds and acts as a catalyst in many biochemical reactions. Its presence supports root growth, increases stem strength, enhances flower formation and seed production, accelerates maturity, improves crop quality, and boosts disease resistance. The appropriate use of fertilizers containing nitrogen, phosphorus, and potassium can significantly enhance maize yield (Bhardwaj et al., 2010; Cheema et al., 2003). The provision of these nutrients in various amounts is crucial for increasing plant biomass and nutrient uptake.

Ojeniyi et al. (2013) studied the impact of poultry manure (PM) on soil properties, cocoyam growth, and nutrient absorption (Xanthosoma sagittifolium). This study employed a randomized complete block design (RCBD) with five different tillage methods and PM rates (0, 2.5, 5.0, 7.5, and 10 t ha-1), with three replications. As PM application rates increased from 0 to 10 t ha-1, soil temperature and bulk density decreased, while soil porosity and moisture content improved. Leaf nitrogen and phosphorus content increased up to 10 t ha-1 of PM, while potassium, calcium, magnesium, and cormel yields improved at rates from 1 to 7.5 t ha-1. There was a strong positive correlation between PM and leaf nutrient content, with optimal results seen at 7.5 t ha-1 for cocoyam yield and soil improvement.

In a separate study, Okoroafor et al. (2013) investigated how organic manure influences maize growth and yield. The research used a randomized complete block design (RCBD) with three different treatments, each repeated three times across nine plots of 3m x 3m. The study measured stem number, stem thickness, plant height, cob frequency, and cob weight post-harvest. The analysis revealed significant differences ($p<0.05$) among the treatments, with poultry droppings providing the best results for maize growth and yield. Based on these findings, farmers are advised to use poultry manure for optimal outcomes.

Tanimu et al. (2013) explored the combined effects of cow dung, managed through different methods, and urea fertilizer on maize growth parameters, as well as the residual impact of cow dung in the following year. The study used a factorial design, including three management practices, four storage durations, and two nitrogen levels, arranged in a randomized complete block design with three replications. Results from the two-year study highlighted that the immediate application of nitrogen-enriched surface-heaped cow dung in April yielded the highest stover output across both growing seasons. Additionally, the residual effects of the nitrogen-enriched, surface-heaped, and exposed treatment applied in March resulted in the highest stover yields. Furthermore, the immediate application of nitrogen-enriched surface-heaped cow dung in May led to the tallest plants over the two seasons, while the residual impact of the covered April treatment produced taller plants during both seasons.

Adhikary et al. (2010) used the maize hybrid Pioneer 30-Y-87 as a test subject in their experiments, which included six different fertilizer levels and three plant densities (57,100, 71,400, and 99,900 plants ha-1). Maize, known for its high production capacity, requires more nutrients during its growth compared to other cereal crops. The crop's unique nutrient uptake patterns necessitate targeted fertilizer applications to meet its nutrient demands throughout growth (Szulc et al., 2018; Timsina et al., 2001). Nitrogen is particularly critical in influencing the vegetative and grain yield of maize. Mismanagement of nitrogen can lead to high nitrate (NO3) concentrations in water bodies, causing eutrophication (Warren et al., 2006; Ye et al., 2017). The study found that the plots fertilized with 250 kg N ha-1 and 15 kg Zn ha-1, planted at a density of 99,900 plants ha-1, had the highest plant height and grain yield. In contrast, those treated with 150 kg N ha-1 and 0 kg Zn ha-1, planted at a density of 57,100 plants ha-1, had the lowest values. Both plant height and grain yield increased proportionally with higher fertilizer rates and plant densities. Additionally, zinc supplementation contributed significantly to growth accelerated maize crop tasseling and silking; nevertheless, nitrogen application had no major impact on tasseling and silking. Protein content of maize grain was also influenced by fertilizer levels and plant densities. Higher nitrogen application increased grain protein quality. It is well established that the abundance of vital nutrients in soil eventually places considerable emphasis on yield and its components of particular crops (Franzen and Grant. 2016; Ye et al., 2017). Through utilizing manure, you'll be applying essential micro and macronutrients to your soil that will steadily release over time, as well as improving soil aeration and water preservation, both of which will help you develop healthy soil structure and texture. Strong soil also provides a nurturing environment for beneficial soil species and earthworms. Using manure also ensures you're recycled, which reduces the reliance on artificial fertilizers. Nutrients in the Soil and Manure Forms Source, age, how they were stored (piled, scattered, turned over or not), and the animal bedding content that might be mixed in all affect how manures vary from one another. As a result, detailed advice about how long manure should be aged before usage, how much to use, and the expected nutrient content is difficult to come by. Both of these mechanisms have an effect on the nutritional quality of manures in general. Pakistan's soils are usually alkaline and calcareous in nature with poor organic matter, thereby suffering nitrogen depletion. Results showed that poor fertilizer usage productivity applied fertilizers (Fazli et al., 2008). An alternative path to increasing crop production with minimal use of chemical fertilizers was then mandatory (Eppendorfer, (1971). Ghaffari et al. (2011) investigated the impact of integrated nutrients on maize (*Zea mays* L.) development, yield, and quality in the spring of 2009 at the University of Agriculture, Faisalabad's Agronomic Research Area. The consistency parameter of maize (oil content) was greatly improved by foliar application of multi-nutrients solution, however using a prescribed doseof fertilizer in addition to a single spray of Multi-nutrients was cost-effective. Adhikary et al. (2010) performed an experimental field study in the acidic soil environment (5.1 pH) at the National Maize Research Program during the winter season of three consecutive years (2007 to 2009) to assess the influence of micronutrients (B, Zn, Mo, S, and Mn) on the grain yield of maize (var. Rampur Composite) (NMRP), The parameters of plant growth and yield were investigated. The results showed that all treatments had significant impact on growth performance and yield attributes of maize. Manure may be thought of as the initial fertilizer and is an essential ingredient for those interested in organic gardening. Cows, horses, cattle, pigs, goats, and poultry are the most important sources of manure. Through utilizing manure, you'll be applying essential micro and macronutrients to your soil that will steadily release over time, as well as improving soil aeration and water preservation, both of which will help you develop healthy soil structure and texture. 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This macronutrient often has the highest risk of polluting land and water. Nitrates and ammonium will accumulate in the groundwater and contaminate the water supply. Understanding how nitrogen enters the soil is critical to ensure that it is utilized wisely.

Conclusion

After reviewing the results of the current study, it was conculded that maize growth and yield increased in lockstep with growing cow and goat numbers, and maize crops fertilized with cow manure at a rate of 5% resulted in the highest growth and yield.

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