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Effect of Different Organo – Chemical Amendment on Performance Chickpea (*Cicer Arietenum*), Soil Characteristics and Enzyme Activities

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ABSTRACT

In To evaluate the effect of organo – chemical amendments on the growth and yield of Chickpea and physico – chemical characteristics and enzyme activities of soil, a pot experiment was carried out at Department of Soil Science, Gomal University, Dera Ismail Khan (Pakistan). The detail of treatments are Control, inorganic fertilizer (NPK), Biochar, Compost, Farmyard manure (FYM) and poultry manure. The experiment was laid in randomized complete design. The result showed that various growth, yield and root parameters were significantly affected by the addition of organo - chemical amendments. Significantly, higher value for plant height and root length was recorded 33.95 and 23.99 cm for the treatment of compost and poultry manure respectively. The plant and root fresh and dry weight were non – significantly changed by the application of organo – chemical amendments. The yield parameters showed that number of pod per plant were non – significantly changed, however the nodule count, 100 grain weight and grain yield was significantly increased by the application of amendments. The highest nodule count was recorded in the compost treated pots, while both the 100 grain weight and grain yield was found maximum in the pots receiving commercial NPK fertilizer. Soil pH, Bulk density, Organic matter content were significantly improved by the application of treatments. Alkaline and Acid phosphatase assay showed increase in the activity of both enzymes by application of FYM and other organic and chemical amendments. Also, soil macro – nutrients NPK were significantly enhanced by addition of FYM and NPK. It may be concluded from this research that the organic amendments have significantly influenced the growth, yield parameter of Chickpea, soil properties and enzymes activities.

INTRODUCTION

The fertilizer demand has increased over the years due to increasing population and demand for feeding the world. The significance of fertilizers in food productivity and raising soil fertility is certainly high. The International Fertilizer Association in United Nations agenda 2030 have declared that some of the Sustainable Development Goals i.e. 1: No Poverty; 2: No Hunger; 9: Sustainable Industrialization; 13: Climate Change and 15: Life on Land may be achieved by the sustainable use of fertilizers (IFA, 2020). But increase in use of fertilizers have lead to many

environmental problems including green house gas emission, eutrophication and soil degradation (Rutting et al. 2018). Also, the increase in prices of various fertilizers have made the agriculture commodities less economically feasible. In the recent years attempt has been made to try various alternatives which are comparatively more convenient.

The organic amendments have been known for increasing the organic matter content of the soil, stimulates the beneficial soil microbes, which in turn, mobilize the soil nutrients and degrade the toxic substances. Organic amendments area known as slow release fertilizer as they are found in the residual pool and enhance the exchange capacity of the nutrients in soil (Ronga et al. 2016).

Chickpea (*Cicer aretienum*) plays an important crop grown in Pakistan. It is cultivated 73% of the total area occupied by pulses and its contribution to the total pulses production is 76% (PBS, 2020).

Injudicious and continuous use of chemical fertilizers have been reported to have adverse effect on soil properties, affecting the sustainability of crop production. Also, environmental pollution is caused due to more common use (Virmani, 1994). Therefore, a study was carried out to investigate the effect of different organic manures on growth and yield of chickpea and enzymatic activities.

MATERIAL AND METHODS

To evaluate the effect of organo – mineral fertilizer and amendments on the growth, yield of chickpea and soil physico – chemical characteristics and enzymes activities a pot experiment was conducted in year 2021-22. The experiment was carried out in randomized complete design with four replications. The treatments included control, NPK@20:60:20 kg ha^{-1}, biochar @ 5 t ha^{-1}, compost @ 5 t ha^{-1}, farmyard manure and poultry manure @ 10 t ha^{-1} were applied. The pots were filled with 20 kg air dried 2 mm sieved soil collected from the Indus river. Chickpea Var. Nifa 2005 was sown five seeds per plant and later on thin to one plant per pot. Chemical fertilizer sources used were Urea, Diammonium phosphate (DAP) and Sulphate of Potash (SOP). Soil physico – chemical characteristics of soil before the experiment was analysed (Table 1).

Biochar was prepared using the slow-pyrolysis biochar made from *acacia nilotica* wood which is locally available. It was produced by anaerobic combustion of wood in the kilns at temperature 350°C and 500°C. Compost was purchased as a commercial product from the market, while Farmyard manure and poultry manure were obtained from the farm house and poultry farm respectively.

The growth parameters including plant height, plant fresh and dry weight, root fresh and dry weight and root length were measured. The yield parameters including number of pods per plant, nodule count, 100 gram weight and grain yield were determined at the harvest of the crop.

Soil physico – chemical characteristics and macro nutrients including Soil pH, Bulk Density, Organic matter content, Soil total nitrogen, extractable phosphorus and extractable potassium were determined after the harvest of crop from each treatment pot. Enzyme assay was carried out for Alkaline phosphatases and acid phosphatases.

Statistical analysis was carried out using the package Statistix 8.1, analysis of variance was determined, least significance difference was calculated for each treatment to compare the means using the procedure given by Steel et al. 1997.

RESULT

Table 1

Physico – chemical characteristics of the soil

Particular	Values
Soil Texture	Sandy loam
pH	7.67
ECe	451 (µS cm^{-1})
Organic Matter	0.43 (%)
Bulk Density	1.41 (g cm^{-3})
Total Soil Nitrogen	0.025 (%)
Olsen Phosphorus	5.93 (mg kg^{-1})
Extractable Potassium	152.9 (mg kg^{-1})

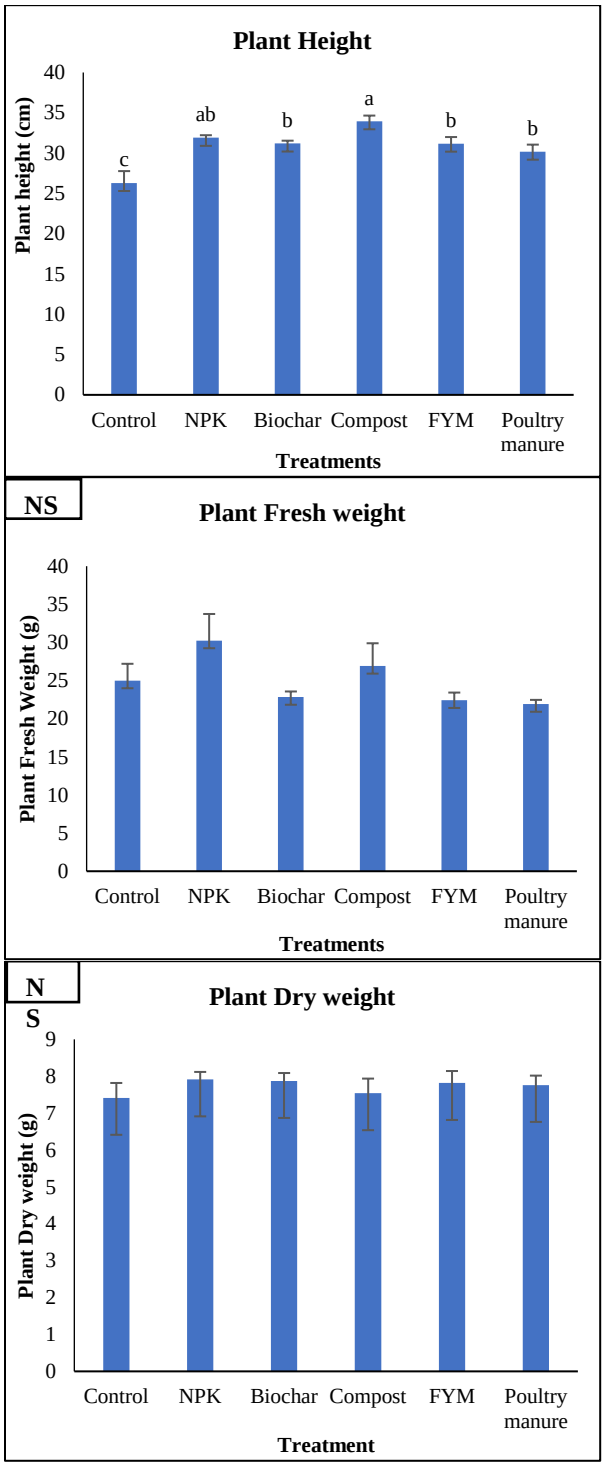
Growth Parameters of Chickpea

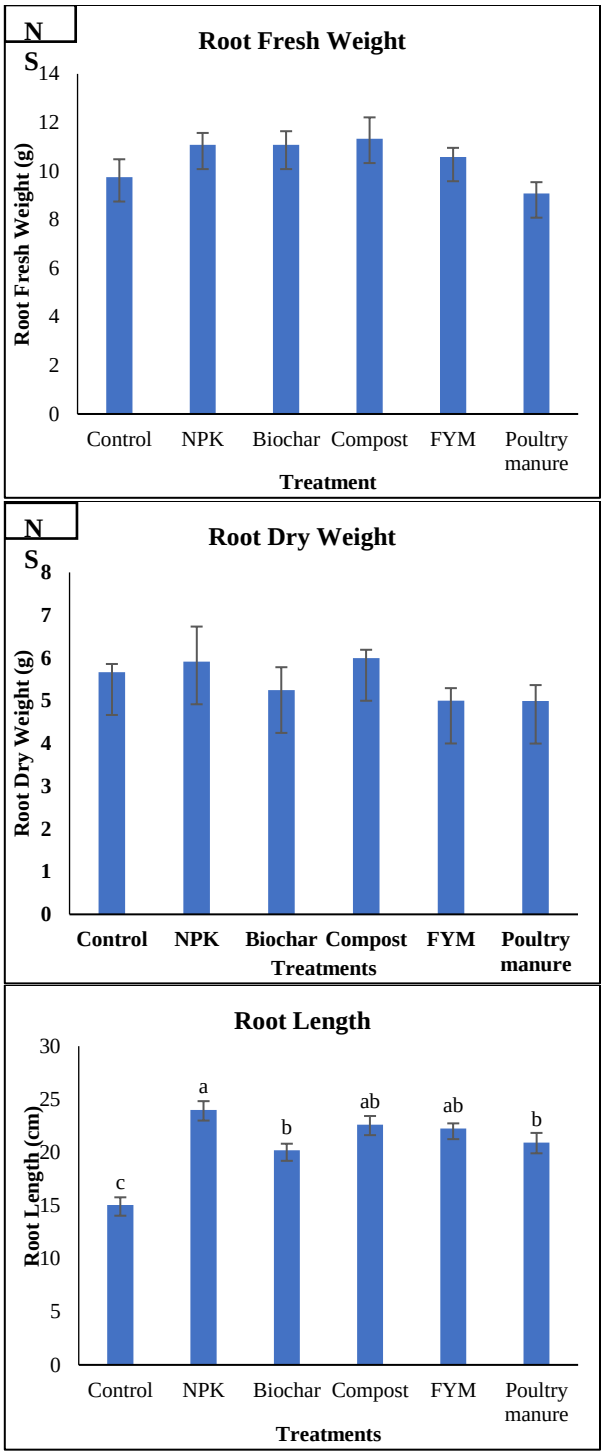
The plant growth parameters showed significant effect of organo – mineral amendments on different parameters including plant height and root length (Fig. 1). The tallest plants of 33.95 cm were recorded in the treatment receiving the compost, which was statistically at par with treatment receiving NPK fertilizer. The shortest plant were recorded in non - treated control. The root length also showed similar trend with the longest root of 24 cm in the NPK treated pots. It was statistically similar to the pots receiving compost and FYM. The least value for root length was found in the control. However, the plant fresh and dry weight and root fresh and dry weight were non –

significantly changed at 5% level of significance by the application of treatments.

Figure 1

Growth parameter as influenced by the organo – chemical amenments





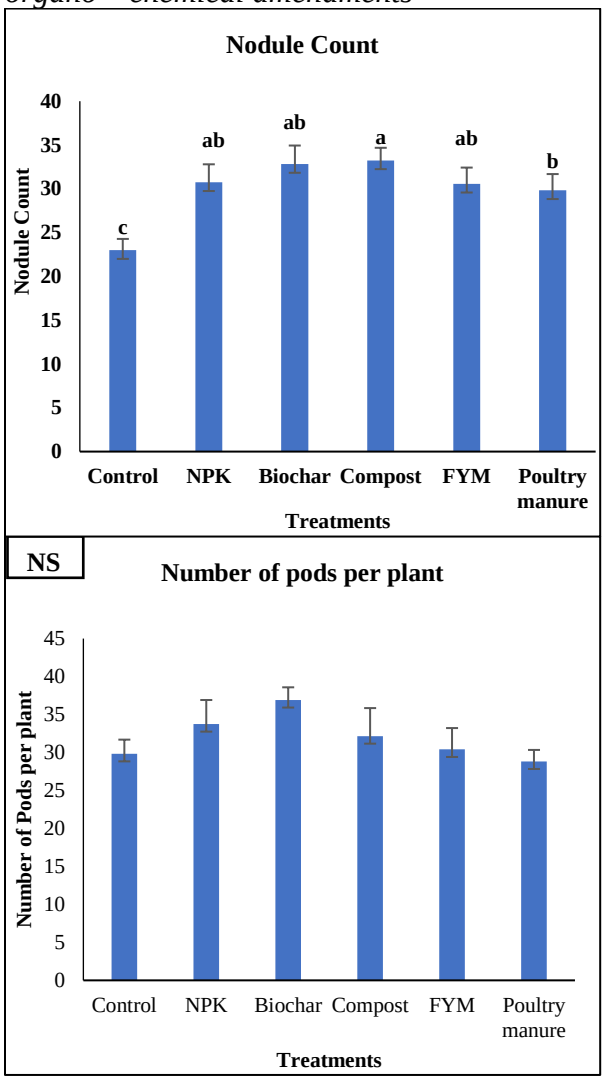
Yield Parameters of Chickpea

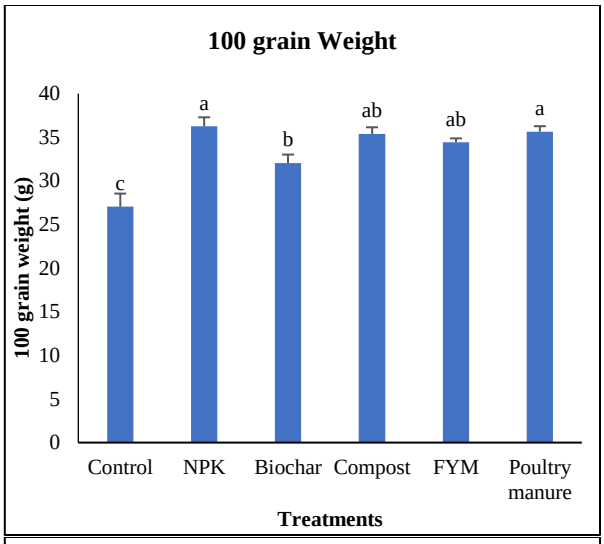
The yield parameters of chickpea were significantly affected by the nodule count, 100 grain weight and grain yield. Bacteria in the root nodule of legume promotes plant growth and yield. The results have shown significantly higher

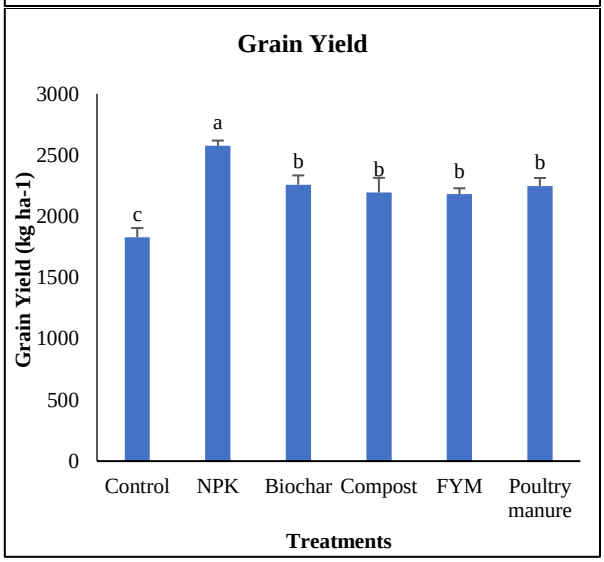
number of nodules in the compost treated pots, which was statistically at par with NPK, Biochar and FYM treated pots. The least was found in the control. The 100 grain weight was recorded higher in NPK (36.25 g) and poultry manure (35.64 g) amended pots. It was statistically similar with Compost and FYM treated pots. The least was recorded in the control. The grain yield was found significantly higher 2577 kg ha^{-1} in pots receiving NPK. It was followed by the rest of the treatments except control, which yielded the lowest grain yield. The number of pods per plant were non – significantly changed by the application of treatments.

Figure 2

Yield parameters of gram as influenced by organo – chemical amendments





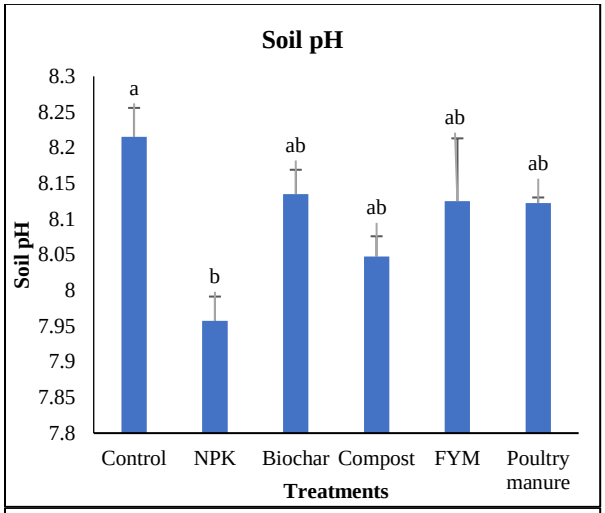


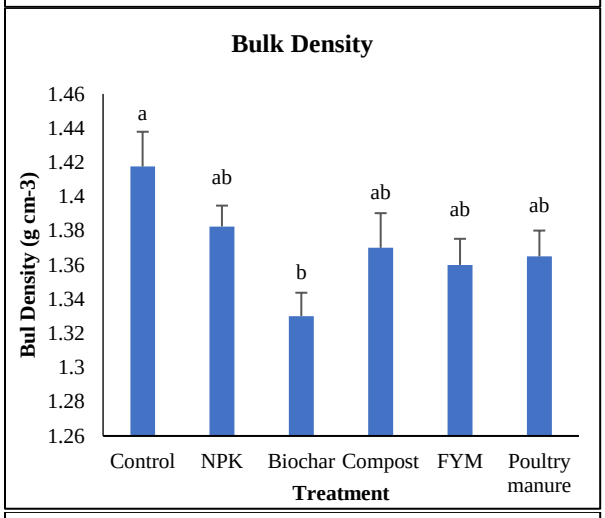
Soil Physico – chemical Properties and Enzyme Activities

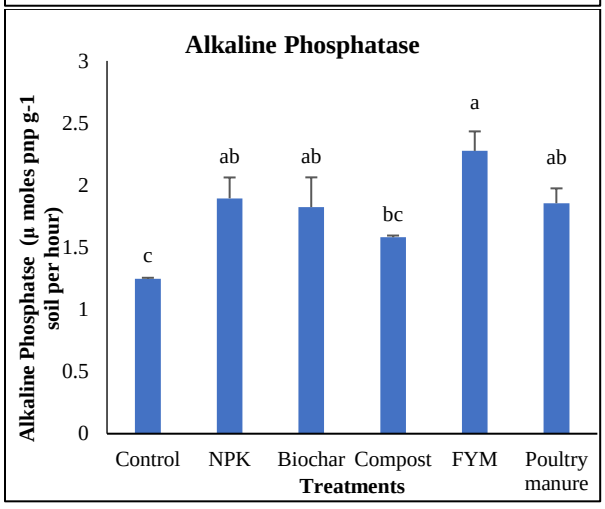
The physico – chemical characteristics including the soil pH and Bulk density were significantly improved by the application of various treatments (Fig 3). Both the parameter were significantly reduced by the application of NPK fertilizer and biochar amendments respectively. The highest soil pH and bulk density were recorded in the control. The alkaline and acid phosphatase enzyme were also found significant enhanced by the application of organo – mineral treatments (Fig 3). Activity of both alkaline and acid phosphatase were 2.27 and 0.711 µ moles pnp g^{-1} soil $hour^{-1}$ recorded in the FYM treatment respectively. Least activity of alkaline and acid phosphatase was recorded in the untreated control.

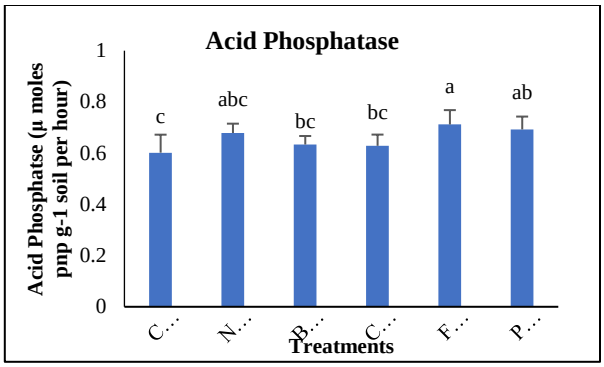
Figure 3

Soil physico – chemical characteristics and Phosphatase enzymes influenced by Organo - chemical amendments







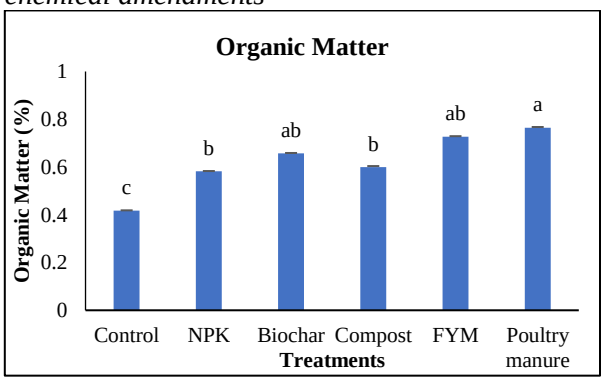


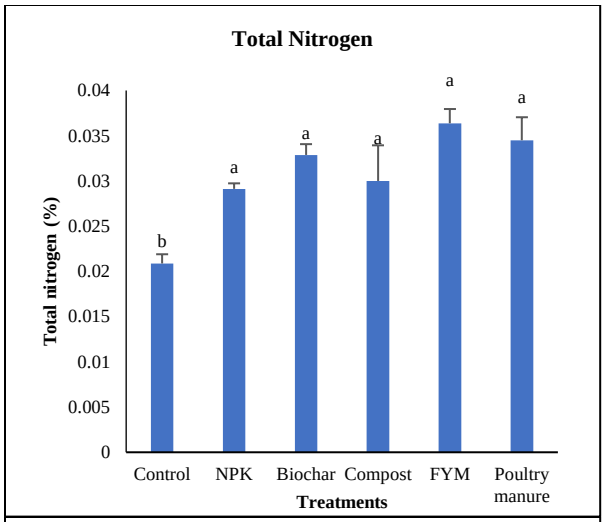
Soil Organic matter Content and Macronutrients

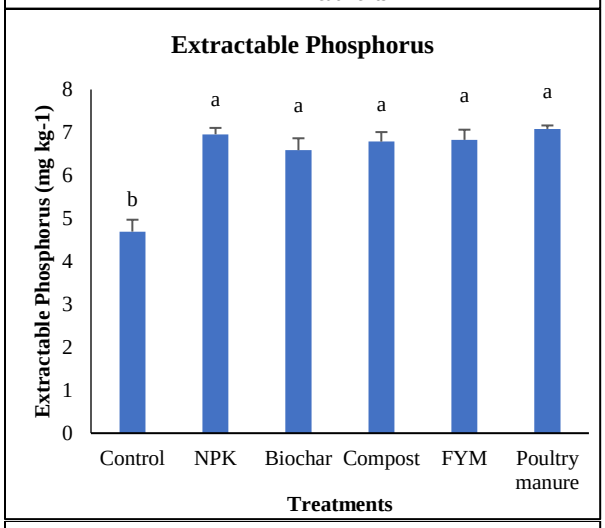
The Soil organic matter content was significantly enhanced by the application of organic amendments (Fig 4) . The highest organic matter of 0.76% was recorded in the pots receiving poultry manure, which was statistically at par with FYM and biochar treated pots. The least was recorded in the untreated control. Total Nitrogen content was recorded 0.036% in FYM which was statistically similar with rest of the treatments except control which yielded the least value of 0.02%. Extractable phosphorus recorded after the application of organo – chemical treatments showed significantly higher value of 7.08 $mgkg^{-1}$ in poultry manure treated pots, which was statistically similar with rest of the treatments except for control. Extractable potassium determined after the treatment of chemical and organic amendments showed significant increment. The highest potassium was recorded in NPK treated pots with value of 155.5 mg kg^{-1}, which was statistically with compost treated pots. The least was recorded in the control with value 137 mg kg^{-1}.

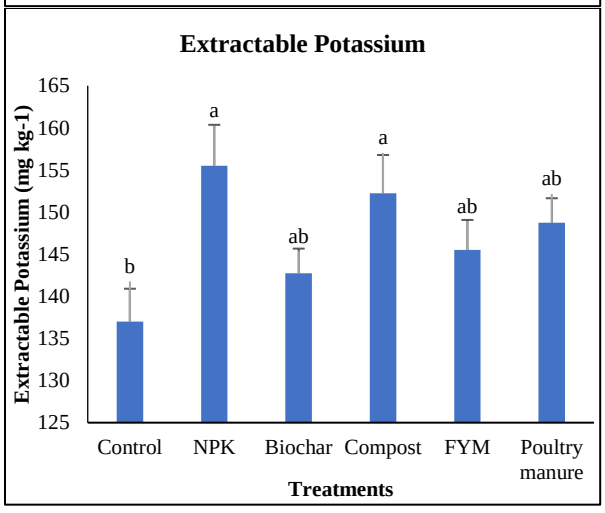
Figure 4

Soil organic matter and macro – nutrients content as affected by the addition of soil Organo - chemical amendments









DISCUSSION

Organic manure and chemical fertilizer are consider important for enhancing the crop growth and yield by improving the soil physico – chemical characteristics, cycling of nutrients and also influence soil health by increasing microbial activity. In the current research an attempt was made to study the effect of chemical fertilizer (Urea, DAP and SOP) and organic amendments (biochar, compost, FYM and poultry manure) on the growth and yield of Chickpea. Also, the physico – chemical characteristics and macro – nutrients were studied. Plant height is an important growth parameter which influences other growth and yield parameters. Our results are in agreement with finding of Sohu et al. (2015) who reported that plant height of chickpea enhanced by the application of NPK fertilizer @ 18:36:10 kg ha^{-1}). Also, Khan et al. (2021) reported that sole use of organic, inorganic amendments result in increment of shoot and root lengths of chickpea. The root length enhanced due to use of organic manure and inorganic fertilizers provided better soil properties like aeration and low bulk density of soil, which helped in better root proliferation (Ismail et al. 2017).

Nodule count was significantly increased by the application of organic amendments specially Compost, FYM and Biochar. Similar result have been observed by Khan et al. (2020) who found greater number of nodule count by the application of Biochar and inorganic fertilizer. Soysal (2021) recorded higher 100 grain weight by the application of poultry manure at 1000 kg ha^{-1}.

Shukla et al. (2013) found that application of compost at 75 kg ha^{-1} along with the chemical fertilizer significantly enhanced the grain yield of chickpea. The increase in morphological characteristic and grain yield could be due to the increment of the yield components (plant height, number of pods per plant, seed weight per plant and 100 seed weight) consequently (Ebaid and El-Refaee, 2007).

Soil characteristics were significantly affected by the application of different organo – mineral treatments. Soil pH was decreased in treatment receiving inorganic fertilizer due to their acidic reaction as compared to the organic amendments. These results were in agreement with findings of Naz et al. (2018). Bulk density has been significantly affected by the organic amendments, the highest reduction was recorded in the biochar treatments. Biochar has been reported to decrease the bulk density of coarse texture soils due to its smaller size (Chang et al. 2021).

Soil enzymes have significant role in the biological cycling of different nutrients carbon, phosphorus and nitrogen in soil (Zhao et al., 2019; Acosta-Martinez et al., 2014) and enzymes are considered as potential indicators of soil nutrient cycling (Liu et al. 2017). The greater activity of enzymes in the soil rhizosphere improved by the addition of organic manures and may be attributed as the exogenous enzymes from the organic amendments (Lu et al. 2015). Also, the contribution of soil microorganisms by production of enzymes may be positively correlated with the increase in the C and N ratio and the availability of substrate (Geisseler et at. 2010). Adeyemo et al. (2019) reported higher soil organic matter content by the application of poultry manure at 10 Mg ha^{-1}.

Organic fertilizer have been reported to have positive effect on the soil nutrient content. Addition of fertilizers of organic origin in soil exerted a positive impact on the fertility of soil and growth of the plant and it varies due to the quality of raw materials used for the production of these fertilizers (Abbas et al. 2019).

Conclusion

The Organo – chemical minerals applied showed significant effect on the different parameters of chickpea crop, it may be concluded from the finding of the current research that the organic amendments including the poultry manure, Compost, FYM, Biochar and inorganic NPK fertilizer have significantly increased the growth parameters including the plant height and root length, which has also enhanced the yield parameters viz. nodule count, 100 grain weight and grain yield. The soil properties including the soil pH, bulk density and organic matter was significantly improved. The enzyme activities have significantly increased by the application of organic amendments. Finally, the macronutrient content were significantly increased by the organic manures and NPK fertilizer after the harvest of the Chickpea crop.

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