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COMPARATIVE EFFICIENCY OF DIFFERENT ORGANIC FERTILIZERS ON SORGHUM GROWTH, NUTRIENT UPTAKE AND SOIL CHEMICAL PROPERTIES

MAZHAR NOOR SALIM *
Department of Agronomy, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.
*Corresponding Author Email: mazharnoorsalim@gmail.com

ZAMMURAD IQBAL AHMAD
Department of Agronomy, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.

GHULAM ABBAS SHAH
Department of Agronomy, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.

KHALID SAIFULLAH
Institute of Soil and Environmental Science, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.

ADEEL ANWAR
Department of Agronomy, PMAS-Arid Agriculture University, Rawalpindi, Pakistan.
Email: dradeelanwar@uaar.edu.pk

Abstract

Decreasing soil fertility and organic matter are among the main factors affecting agricultural productivity particularly in semi-arid and arid areas. Different types of organic materials or waste can be turned into compost, and this composted organic material has substantial potential to enhance the soil fertility and organic matter. Hence, it is crucial to explore the role of locally sourced organic materials which are environmentally safe, inexpensive and perhaps an effective way of maintaining the soil fertility and improving of crops productivity. Currently a pot experiment was conducted to assess the influence of various organic fertilizers on sorghum growth, nutrients uptake and soil chemical properties. Seven different organic fertilizers such as vermicompost, haryali khaad, bio gold, nutri compost, farmyard manure (FYM), parthenium compost and plant fert compost including control during 2015. Sorghum was planted as a test crop in pots. Results indicated that use of organic fertilizers considerably enhanced the growth and dry matter of sorghum plants. However, parthenium compost showed better outcomes as compared to other organic fertilizers. Parthenium compost increased the chlorophyll content of sorghum and resulted in higher plant height, dry matter, leaf area index followed by vermicompost and plant fert compost. Likewise, sorghum plants showed higher uptake of nutrients such as nitrogen, phosphorus and potassium in their shoot and root after application of parthenium compost followed by vermicompost. Parthenium compost also increased the soil mineral N, P and K content while other organic fertilizer showed non-significant difference when compared with control. Soil showed slight reduction in pH and electrical conductivity (EC) after application of parthenium compost than other organic fertilizers. However other organic fertilizers increased ammonia emission during decomposition in pots as compared to control treatment followed by Parthenium compost. Hence the use of parthenium compost for improving crop efficiency and recycle the nutrients and accomplishing sustainable agriculture is highly encouraging.

Keywords: Biofertilizers, Nutrients, Organic Matter, Sorghum, Vermicompost.

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INTRODUCTION

Dependence on inorganic fertilizers is to exchange high input for higher productivity; though the yield problem was resolved, it also caused a series of detrimental environmental effects such as serious soil degradation (reduced soil organic matter, acidification and nutrient imbalance) and groundwater contamination (Alzamel et al. 2022). Likewise, extensive use of chemical fertilizers will also have negative impacts on the metabolism of organic compounds in plants (Ozlu and Kumar, 2018). Although organic fertilizers have some deficiencies, such as lower nutrient contents, slower decomposition and diverse nutrient composition relying on its organic material. However, organic fertilizers have numerous benefits due to balance supply of essential minerals and improved soil nutrient accessibility that would be an inevitable practice towards the sustainable agriculture (Ye et al. 2019). Organic fertilizers release nutrients slowly, in a sense, they provide nutrients in small amounts over a long period of time, and at the same time they improve the structure of the soil. In addition, organic fertilizers enhance the soil chemical, biological and physical properties, improve soil structure and increase water retention or holding capacity of soil which in turn enhance crop yield and production and maintain the quality of crop produce (Beeby et al. 2020). The various forms of organic manures such farmyard manure, poultry manure, urban or municipal waste, and waste materials from industries such as food, rice, cotton, sugarcane etc. are being applied in agricultural fields for sustaining the crops yield.

Organic fertilizers contained or made from various types of plant materials either fresh or dried plant material, composts, animal dung, vermicompost and agricultural by-products (Suhaida et al. 2022). Organic fertilizers can vary in their nutrient contents because they vary greatly in source material, and the organic fertilizer is the best that is easily biodegradable in the soil after application (Niyibizi et al. 2022). A substantial increase in crop production has been observed with the use of organic fertilizers and their quality has also improved (Alzamel et al. 2022). Nutrients from organic sources help to increase and preserve the soil microflora, which is very important for soil health and result in an improvement in soil physiochemical and biological qualities (Maguire et al. 2020). Some organic fertilizers have higher quantity of organic carbon that increase soil fertility, and comprised of all of the necessary nutrients in the precise quantities that increased nutrients availability, soil physical condition and enzymes activities (Pierre-Louis et al. 2021; Choudhary et al. 2022; Makkar et al. 2022).

Composting is the best way to deal with large amounts of organic waste material. Composting provides an alternative for waste disposal that is safe as well as being more economical and environmentally friendly (Nguyen et al. 2022). This process converts organic waste into a stable humus-like material through biological process and resultant material can be stored and/or used without in the field without any adverse effect on environment (Awasthi et al. 2022). Composting is an exothermic process in which various types of microorganisms use oxygen from the air and convert organic waste into products that can be reused as soil conditioners and organic fertilizers (Al-Nawaiseh et al. 2021; Sołowiej et al. 2021). Various types of organic waste materials such as poultry, dry leaves,

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rotten fruits, crop residues, weeds biomass and vegetable waste can be used as compost material for the production of high-quality compost (Gusain et al. 2018; Tanveer et al. 2022). Application of farmyard manure enhanced microbial activity in soil and considerably enhanced the nutrients availability to crop (Choudhary et al. 2022). Vermicompost is also type of organic fertilizer which has potential to increase nutrients availability and is being used for sustainable crop production (Najar et al. 2015). Addition of vermicompost improves soil fertility, bulk density, porosity of and various properties of soil and thus makes it more productive for plant growth (Lim et al. 2015). It was hypothesized that organic fertilizers would improve the growth and yield contributing attributes of sorghum, enhance the structure and fertility of soil and nutrient uptake. The primary objective of experiment was to observe the influence of different composts on crop growth, nutrient up takes and soil chemical characteristics.

MATERILAS AND METHODS

To explore the role of different composts on crop growth, nutrient up takes and soil chemical properties, a pot research trail was conducted at Department of Agronomy, Arid Agriculture University Rawalpindi, Pakistan during spring season 2015. Experimental treatment was composed of Bio Gold compost, Haryali Khaad compost, parthenium compost, Plant Fert compost, Nutri compost, farmyard manure, vermicompost and control treatment (no use compost). This study was planned in Completely Randomized Design repeated thrice. Vermicompost was taken from NARC, Islamabad while bio gold compost, haryali khaad, plant fert compost, nutria compost was purchased from market. Well rotten farmyard manure was taken from cattle farm while parthenium compost was prepared by researcher itself.

Table 1: Nutrients analysis of organic fertilizers

Compost or organic fertilizer	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Bio gold compost	0.66	0.31	2.24
Haryali khaad compost	0.66	0.32	3.75
Parthenium compost	0.83	0.39	4.83
Plant fert compost	0.77	0.37	4.28
Nutri compost	0.69	0.32	3.36
Farmyard manure	0.76	0.34	2.14
Vermicompost	0.77	0.35	2.86

After taking the respective amount of compost 22.32 g (5 tons ha^{-1}), it was mixed with soil then pots (22.5 cm diameter × 40 cm height) were filled. Each pot was filled with 10 kg of soil and organic fertilizer then 5 sorghum seeds were sown in each pot. The crop was sown in the wire house. Irrigation was provided according to need of crop. All other cultural practices were same for all treatments.

Observations

For plant height, randomly sorghum plants were tagged from each treatment and their height was noted using meter rod and then it was averaged. For leaf area index, leaves were separated from plant and leaf area was noted using digital leaf area meter JVC

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TK-5310). After measuring the leaf area, leaf area index was recorded through the given formula.

$$\text{Leaf area index (LAI)} = \frac{\text{Leaf area}}{\text{Ground area}}$$

For shoot dry weight, one plant from each treatment was uprooted carefully and roots were separated from the plant. Shoot and root was chopped separately and sun-dried before putting in oven. After sun-drying, the chopped shoot and root was placed in oven (WFO-600ND, Tokyo Rikakiai Co. Ltd., Japan) at 70°**C** for 48 h and then dry weight was recorded separately in grams using digital balance (Model Number: HC2204).

Soil pH and EC was determined before and after experiment using pH and EC meter. Soil from each pot was taken and its water suspension was ready by using 1:2.5 soil and water. The contents were allowed to equilibrate for thirty min and recorded the pH (Page and Laidlaw, 1982).

Nitrogen concentration of soil was recorded by colorimetric analysis of soil samples where 0.2 g of the same material was taken in different digestion tubes containing. The digestion mixture of 4.4 ml comprising selenium powder, lithium sulfate and hydrogen oxide was added and digested for 2 h at 360°C until the solution becomes colorless, then water (50 mL) was water and shacked well. When it cooled down, its final volume was increased up to 100 mL and after the settlement the clear solution was analyzed for N concentration calorimetrically (Nelson and Sommers, 1996).

To determine available P, 5 g soil was placed in an Erlenmeyer flask containing hundred milliliter of 0.5 M $NaHCO_3$ solution. The flakes were shaken for thirty min and filtered. In volumetric flask (50 mL) 1 mL of SN H_2SO_4, 10 mL of the filtrate was added and then 40 mL hot water was also added. After this, eight mL of reagent B was added to develop the color. Then the sample was run in spectrophotometer (Nelson and Sommers, 1982) and after 10 minutes, readings were noted.

For volatile potassium, 5 g of soil was placed in a 50 mL centrifuge tube, added 33 mL of ammonium acetate solution was added and then it was kept for 5 minutes. The solution was centrifuged until the supernatant liquid was obtained and then it was poured into a 100 mL volumetric flask. The solution was then diluted to hundred milliliters with ammonium acetate and the K concentration was noted from flame photometer (Havre, 1961).

For organic matter of soil, 1 g of air-dried soil was put in a beaker (500 mL capacity) with 10 mL of 1N potassium dichromate and concentrated H_2SO_4 (20 mL) and mixture was allowed to stand for 10 minutes. Then 10 mL of H_3PO_4, 200 mL of distilled water and 10-15 drops of $(C_6H_5)_2NH$ indicator were added and solution was reacted with 0.5 M $(NH_4)_2Fe(SO_4)_2\cdot 6H_2O$ until the color changed from violet-blue to green. The amount of $(NH_4)_2Fe(SO_4)_2\cdot 6H_2O$ consumed in the process was calculated to estimate the organic matter (Walkley and Black, 1934).

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Nitrogen concentration of sorghum plant was measured through micro-Kjeldahl apparatus (Bremner, 1965). The diluted solvent (5 mL) was put in a Kjeldhal tube and that was placed on the Kjeldahl ammonia distillation unit. In each tube, 5 mL of 40% sodium hydroxide (NaOH) was added. Solution of boric acid (5 mL) was put in conical flask containing some drops of indicator mixture. When distillate reached 40 mL, it was stopped and kept for few to cool it. After few minutes, distillate was stirred against 0.01 N H_2SO_4 until the solution-colored change to pink. A blank solution was run to correlate the reading. N percentage was estimated by equation given below.

$$\text{N \% age} = \frac{(V2 - V1) \times N \times 0.014}{W} \times 100$$

Here, V2 shows the volume of H_2SO_4 needed to titrate the solution while V1 indicates the quantity of H_2SO_4 needed to titrate the blank solution. N represents the H_2SO_4 normality while W shows the weight of the sample.

Phosphorus concentration of sorghum plant was recorded using a spectrophotometer (Jackson, 1962). The extracted solution of 2 mL was mixed in 2 mL of Barton's reagent and the total volume was maintained at 50 mL. This sample was placed separate for half an hour before the injection to spectrophotometer. The blank solution was also run and then P calculated from spectrophotometer and reagents used in blank run were calibrated to calculate final P value using a standard curve.

For potassium concentration, air dried and grinded material of 5 g sorghum plant was put in digestion tube and concentrated H_2SO_4 5 mL was added in the tubes (Wolf, 1982). After incubating the tubes for overnight at room temperature, 35% H_2O_2 (0.5 mL) put to the sides of digestion tubes and heated at 350°C for thirty min. Then digestion tubes were removed and cooled down. Then 0.5 mL of H_2O_2 was added slowly to tubes till the digested material become colorless. Then extract was filtered and used for determining K using spectrophotometer (Jackson, 1962).

The SPAD meter was used for measurement of leaf chlorophyll concentrations. SPAD is widely used for rapid and accurate the measurement of leaf chlorophyll concentration.

Statistical analysis

Data were examined statistically by using statistics software and the difference among treatment means were compared at 5% probability by using LSD test (Gomes and Gomes, 1984).

RESULTS

Ammonia emission (µg m^{-3})

All the organic fertilizers contributed to ammonia emission however farmyard manure emitted high quantity of ammonia (121.00 µg m^{-3}) in to atmosphere followed by bio gold compost (117.73 µg m^{-3}) and plant fert compost (101.38 µg m^{-3}) while remaining organic fertilizers were statistically at par with control (Fig. 1). Parthenium compost and nutria

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compost released minimum amount of ammonia emission (46 µg m^{-3}) in to atmosphere however higher than control treatment (46 µg m^{-3}).

Growth parameters and chlorophyll content of sorghum

Application of different organic fertilizer to sorghum plants enhanced the chlorophyll content however parthenium compost increased maximum chlorophyll content of sorghum (37.I SPAD) followed by plant fert compost (35.5 SPAD) and farmyard manure (34.4 SPAD) (Fig. 2). Plants growing without application organic fertilizer showed minimum chlorophyll content (27.6 SPAD). Likewise, sorghum plant height and leaf area index (LAI) increased significant after application of different organic fertilizers (Fig. 3 and 4). Among the different sources of organic fertilizers, parthenium compost resulted in maximum plant height and LAI followed by plant fert and vermicompost. Sorghum plants grown in control pots showed minimum height and LAI. Similarly, application of parthenium compost to sorghum resulted in greater shoot dry weight followed by vermicompost, plant fert and farmyard manure while minimum shoot dry weight was recorded for plants grown without organic fertilizers (Fig. 5). While nutria compost, haryali khaad and bio gold compost produced the shoot dry matter statistically equal to each other but higher than control treatment. Similar trend was observed for root dry weight where sorghum plants produced maximum root dry weight after application of parthenium compost followed by vermicompost (Fig. 5). Root dry weight of sorghum plant was similar where plant fert compost and FYM were applied. Similarly, haryali khaad and bio gold compost had non-significant difference with other for root dry matter. Minimum root dry weight was recorded for plants grown without application of organic fertilizers.

NPK uptake in sorghum plants

Application of various organic fertilizers significantly affected the NPK concentration in sorghum shoot. Higher N contents in sorghum shoot and root was recorded where parthenium compost was applied followed by vermicompost and plant fert compost (Fig. 6). While minimum N contents in sorghum shoot and root was observed from control pots. Similar trend was depicted for P uptake in shoot and root of sorghum plants (Fig. 7). Use of parthenium compost resulted in maximum shoot and root P uptake followed by vermicompost, plant fert compost, FYM and nutri compost. Minimum P uptake in sorghum root and shoot was recorded for the plants grown without organic fertilizers. Alike organic fertilizers substantially increased the uptake of K in sorghum shoot and root as compared to control treatment where organic fertilizers were not applied (Fig. 8). Significantly high shoot and root K uptake was depicted where parthenium compost was used followed by vermicompost and plant fert compost. While minimum uptake of K in shoot and root was recorded in control pots.

Soil minerals (NPK) and organic matter

Different organic fertilizers significantly affected the soil minerals such has N, P and K. After harvest of sorghum plants, soil of pots was analyzed for N, P and K. Application of parthenium compost showed maximum soil mineral N followed by vermicompost, plant fert compost, FYM and nutri compost (Fig. 9). While minimum soil mineral N was recorded

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where organic fertilizers were not applied. Similar trend was depicted for soil P and K (Fig. 9). Likewise, higher concentration of P and K was noted in soil where parthenium compost was mixed with soil followed by plant fert compost, vermicompost, farmyard manure and nutri compost (Fig. 10 and 11). The least soil P and K was noted for the soil where no soil amendment was carried out. Likewise, organic fertilizers increased the soil organic matter content (Fig. 12) and maximum soil organic matter (OM) was recorded where parthenium compost was used for sorghum plants followed by vermicompost, FYM, plant fert compost and nutri compost. While minimum soil OM content was recorded from control treatment.

Soil pH and electrical conductivity

After the harvest of sorghum crop, the soil was analyzed for pH and electrical conductivity (EC) and outcomes indicated that soil pH decreased to some extent after application of organic fertilizers when compared with initial soil analysis before sowing of sorghum plants (Fig. 13). Statistical analysis of the data showed insignificant influence of organic fertilizer on soil pH. However, among the different organic fertilizers applied to sorghum plants, parthenium compost reduced maximum soil pH. Whereas, application of organic fertilizers significantly improved the soil electrical conductivity. Among the different organic fertilizers applied to sorghum plants, parthenium compost produced significantly higher soil electrical conductivity against the minimum was observed from control plots (Fig. 14).

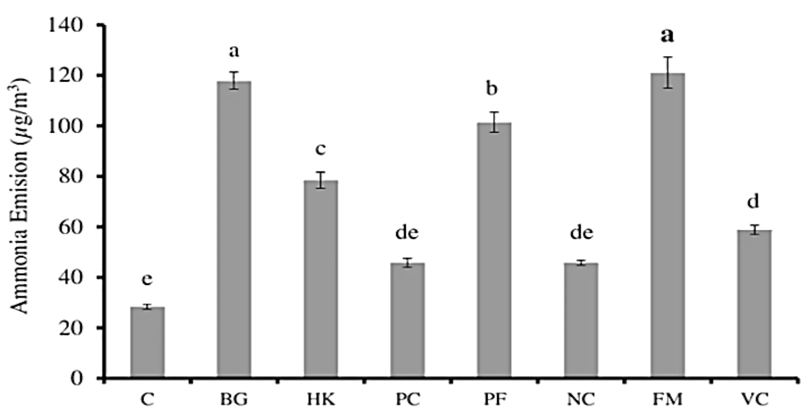

Figure 1: Effect of different organic fertilizers on ammonia emission (μg/m^3).

VC = Vermi compost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

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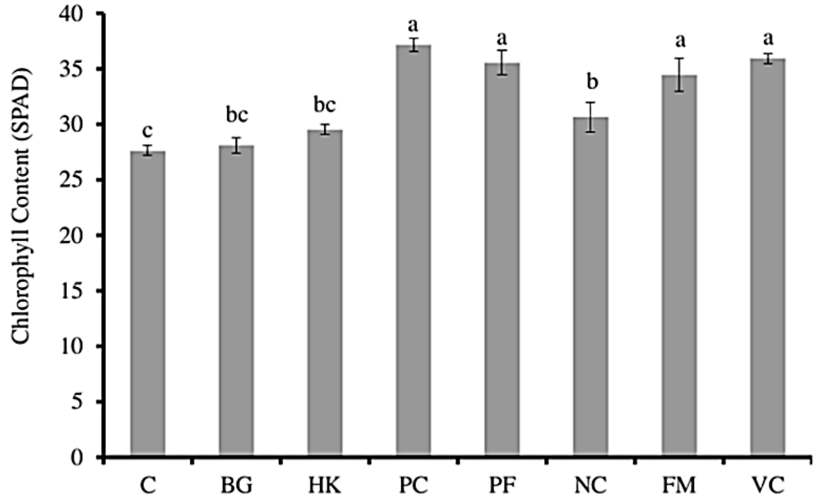

Figure 2: Effect of different organic fertilizers on sorghum chlorophyll contents.

VC = Vermi compost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

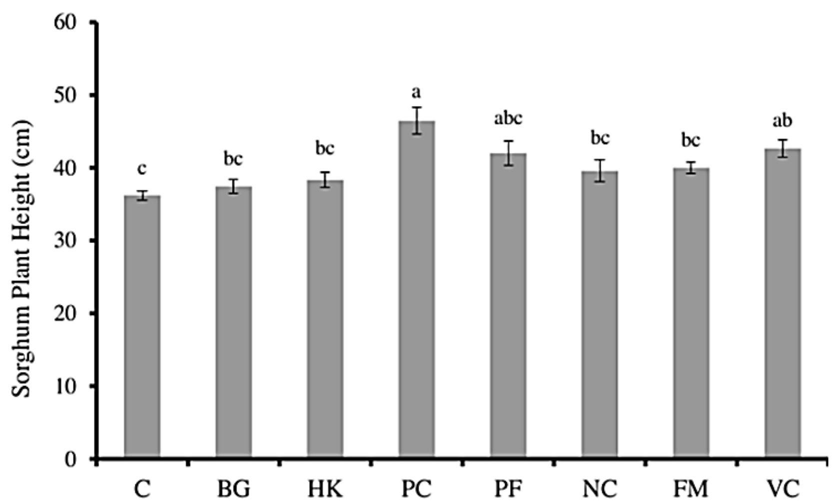

Figure 3: Effect of different organic fertilizers on sorghum plant height.

VC = Vermi compost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

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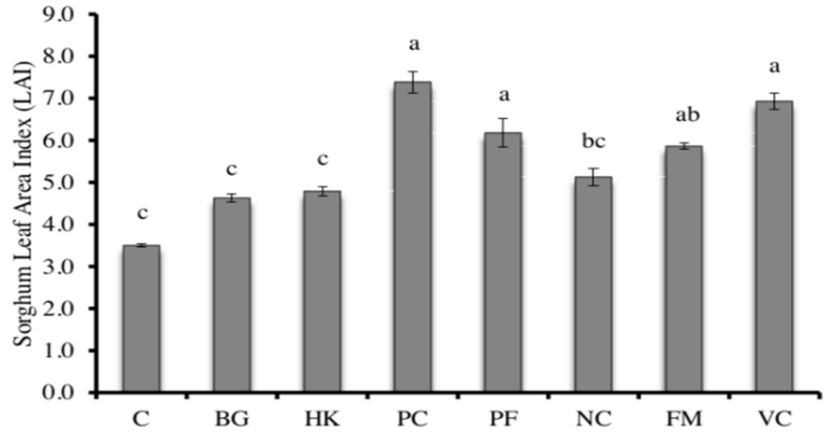

Figure 4: Effect of different organic fertilizers on leaf area index of sorghum

VC = Vermi compost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

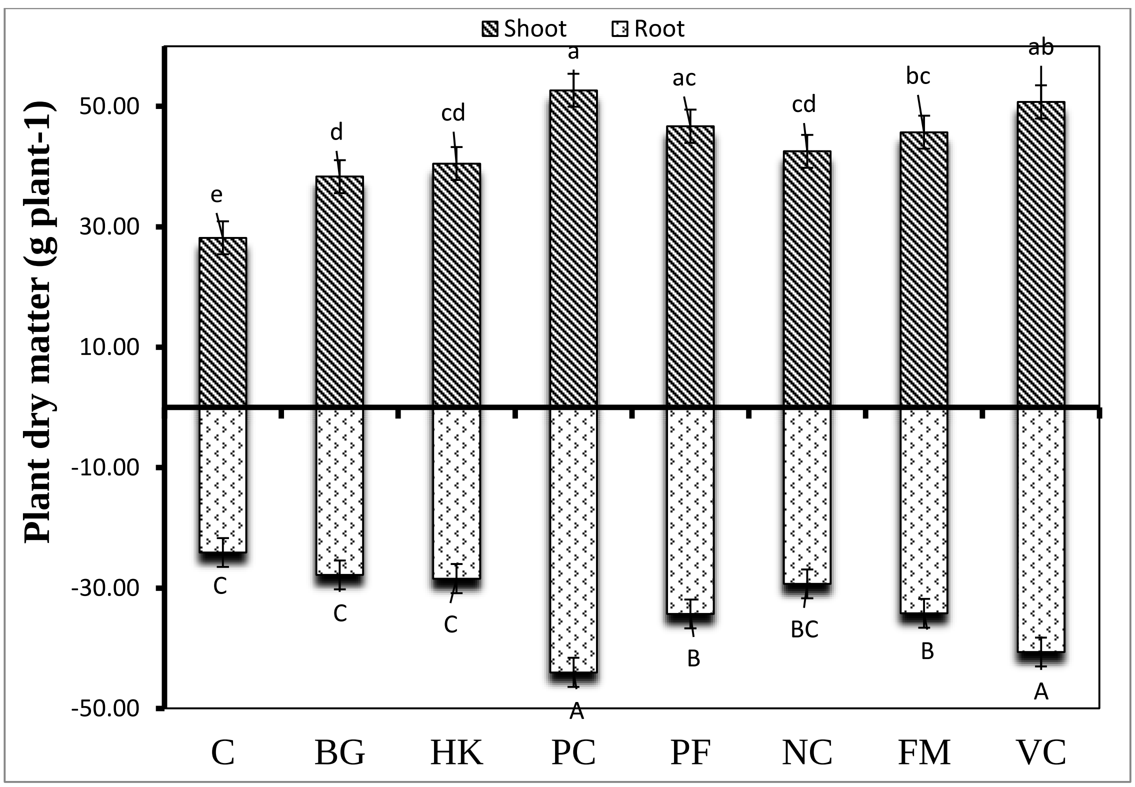

Figure 5: Effect of different organic fertilizers on plant dry matter (shoot and root) yield (g plant^{-1}).

VC = Vermi compost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

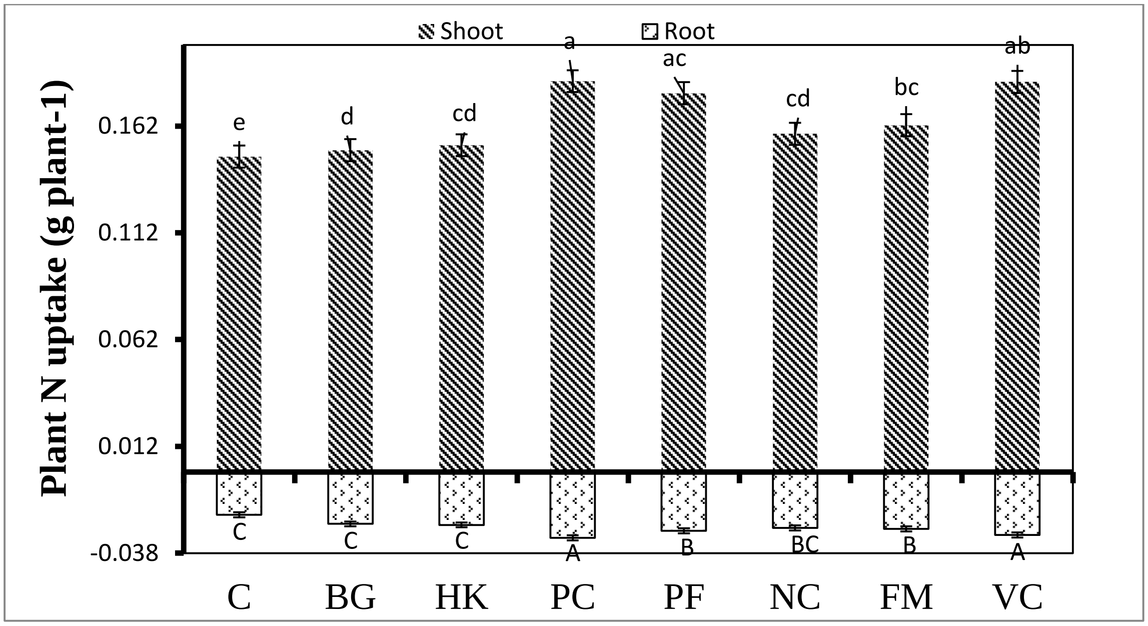

Figure 6: Effect of different organic fertilizers on plant nitrogen uptake (g plant^{-1}).

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

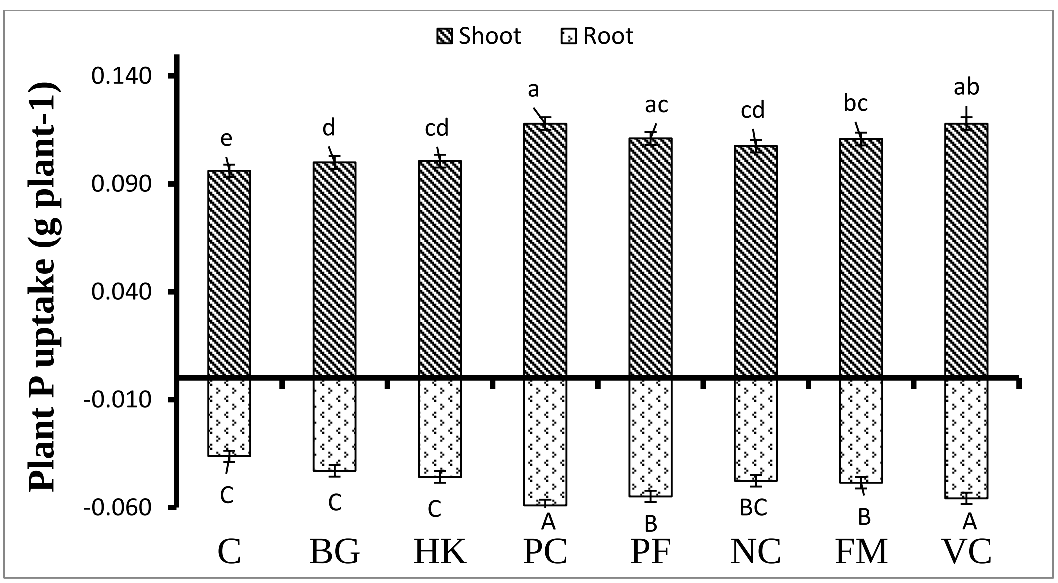

Figure 7: Effect of different organic fertilizers on plant phosphorus uptake (g plant^{-1}).

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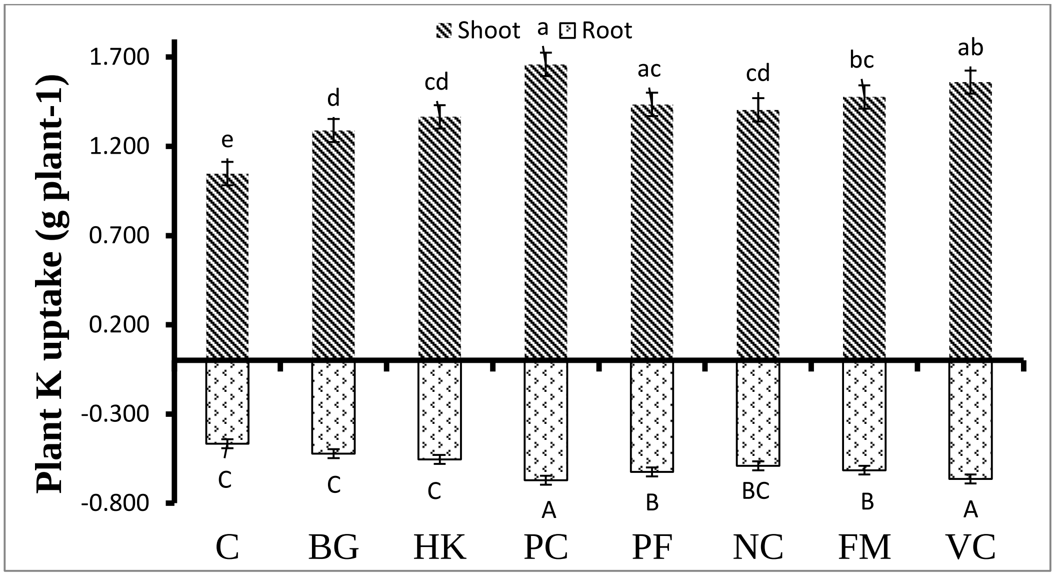

Figure 8: Effect of different organic fertilizers on plant potassium uptake (g plant^{-1}).

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

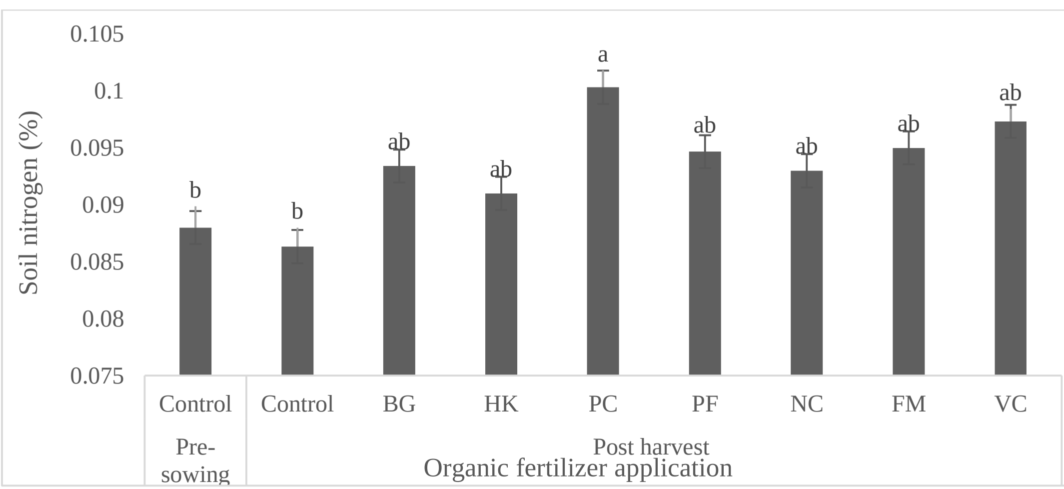

Figure 9: Effect of different organic fertilizers on soil mineral N.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

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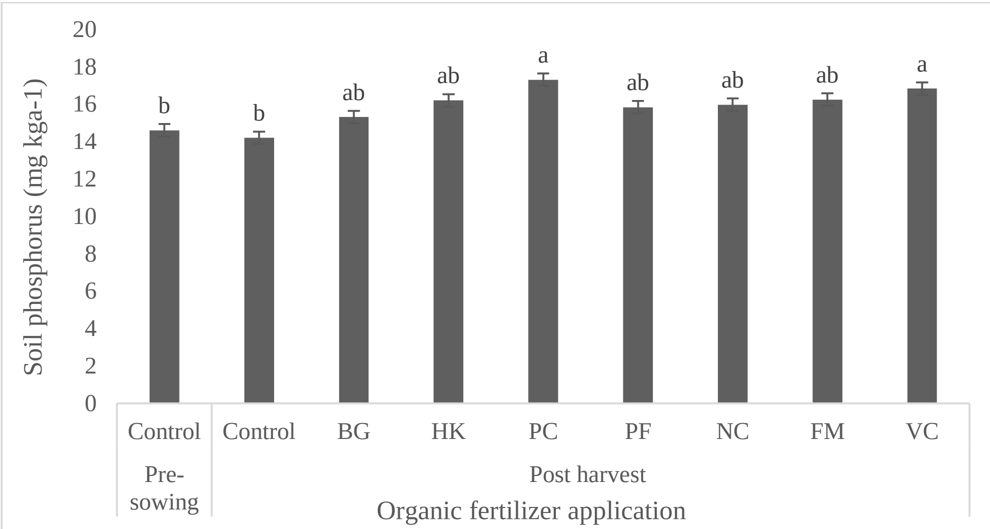

Figure 10: Effect of different organic fertilizers on soil mineral P.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

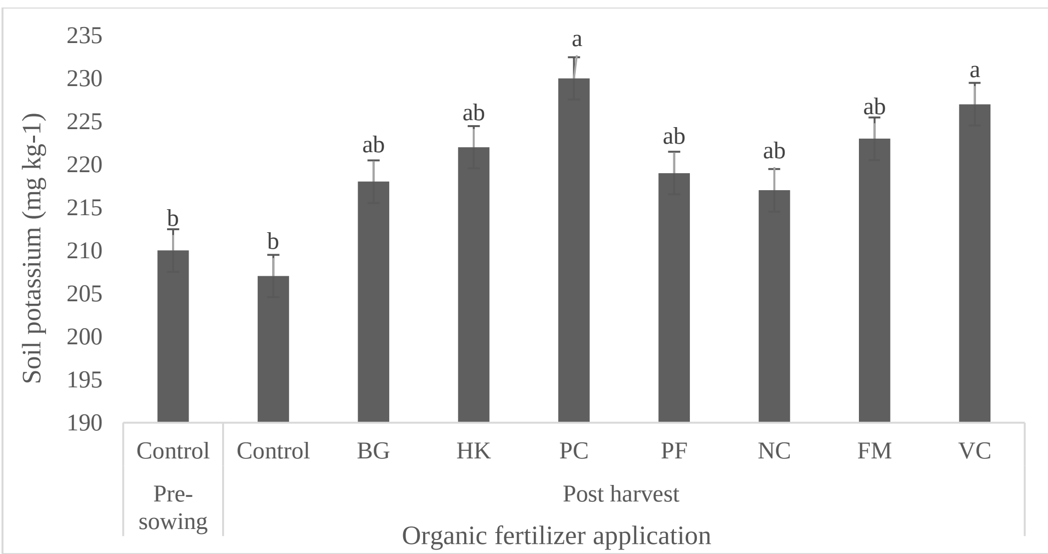

Figure 11: Effect of different organic fertilizers on soil mineral K.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

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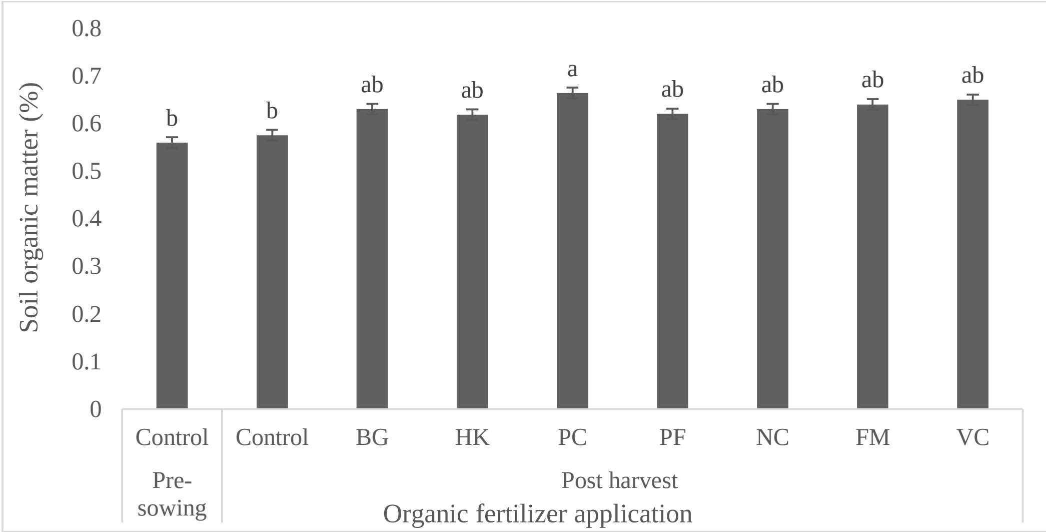

Figure 12: Effect of different organic fertilizers on soil organic matter.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

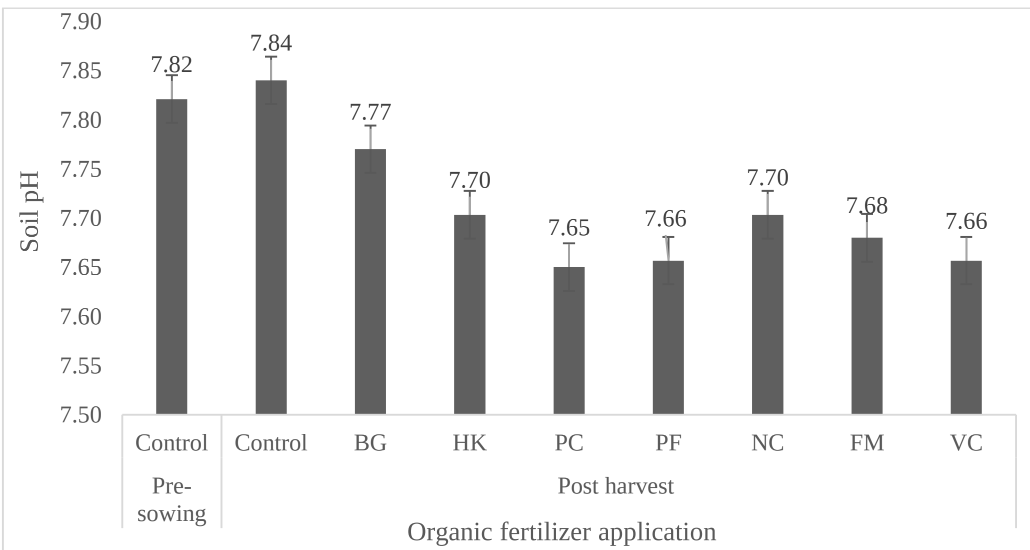

Figure 13: Effect of different organic fertilizers on soil pH.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

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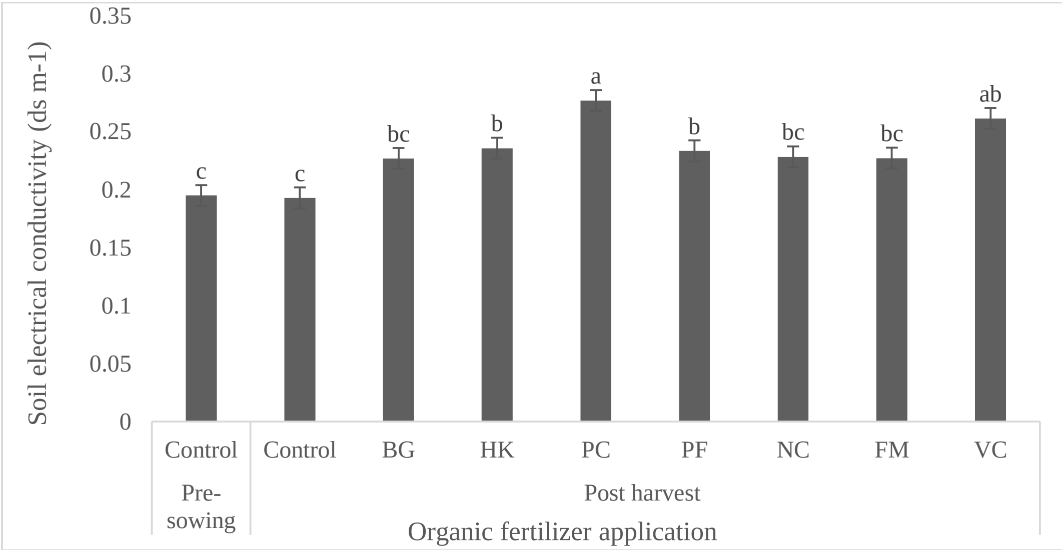

Figure 14: Effect of different organic fertilizers on soil EC.

VC = Vermicompost, FM = Farmyard manure, NC = Nutri compost, PF = Plant fert compost, PC = Parthenium compost, HK= Haryali khaad compost, BG = Bio gold compost, C = Control.

DISCUSSION

Parthenium compost showed excellent outcomes regarding plant growth, dry matter production. The improvement in growth of sorghum, shoot and root dry matter and chlorophyll content was probably due to higher nutrients content in parthenium compost as indicated by analysis report of organic fertilizers (Table 1). Due to higher N, P and K quantity in parthenium compost, it increased the photosynthesis and chlorophyll content which resulted in higher growth and plant height (fresh and dry weight) as compared to plants fertilized with other organic fertilizers. Parthenium compost contains two times more N, P and K than farmyard manure and significantly increased the plant growth (Ameta et al. 2016; Vyankatrao, 2017). Parthenium compost also has several macro and micronutrients such as N (1.58%), P (0.33%), K (1.64), S (0.29%) and Fe (7829 ppm), Mn (304 ppm), Zn (116 ppm) and Cu (66 ppm) (Bhoyar *et al*., 2007; Kishor *et al*., 2010). Similarly, total N, P, and K in soil and their uptake to sorghum plants (roots and shoots) was higher when parthenium compost was applied. Higher concentration of N, P, and K nutrients in the soil and their transfer to the sorghum plants was due to the fact that the amount of these nutrients (N, P, and K) in parthenium compost was quite high (Kishor et al. 2010). Parthenium weed composting, apart from the eco-friendly management of parthenium, showed benefits in term of supplementing the soil nutrients, which increased yield and yield characteristics in chilli crop (Ahmad et al. 2016).

The results indicated that organic fertilizers especially parthenium compost improved the soil chemical characteristics such as EC and organic matter and reduced the pH and ammonia emission. It might be because decent quality compost comprises massive quantities of organic compounds that have constructive influence on the biological processes in the soil and can improve the chemical soil characteristics and nutrient contents (Zhang et al. 2012). Many complex organic compounds transform in soil and many act the on organic content of compost and these enzymes are secreted by microbes. As the properties of soil improved, it encourages the growth and development of soil microbes, which constantly decayed the organic compounds and minerals in the soil and compost into soil humus that improved the soil nutrients balance. Therefore, due to the better nutrients and organic content in the parthenium compost, it improved the soil chemical characteristics and increased the uptake of nutrients to sorghum plants.

CONCLUSION

Application of organic manures was effective in improving the sorghum growth and soil properties. Among various organic amendments, application of parthenium compost significantly increased growth, nutrient uptake, and dry matter of sorghum and improved soil chemical properties. Thus, parthenium compost is one of the cheapest sources of available plant nutrients with high efficiency, may be appropriate as replacements of inorganic fertilizers, and help to solve the shortage and increasing cost of the chemical fertilizers.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1) Ahmad, W., Shah, M., Khan, F., Malik, W., Hussain, S., Munsif, F. and Ahmad, I. 2016. Comparative effectiveness of *Parthenium* weed compost on growth and yield of chili crop. Pakistan Journal of Weed Science Research 21: 505-516.

2) Al-Nawaiseh, A. R., Aljbour, S. H., Al-Hamaiedeh, H., El-Hasan, T. and Hemidat, S. 2021. Composting of organic waste: A sustainable alternative solution for solid waste management in Jordan. Jordan Journal of Civil Engineering 15: 363-377.

3) Alzamel, N. M., Taha, E. M., Bakr, A. A. and Loutfy, N. 2022. Effect of organic and inorganic fertilizers on soil properties, growth yield, and physiochemical properties of Sunflower seeds and oils. Sustainability 14(19):12928. https://doi.org/10.3390/su141912928

4) Ameta, S. K., Benjamin, S., Ameta, R. and Ameta, S. C. 2016. Vishishta Composting: a fastest method and ecofriendly recipe for preparing compost from Parthenium hysterophorus weed. Journal of Earth, Environment and Health Sciences 2: 103-108.

5) Awasthi, M. K., Singh, E., Binod, P., Sindhu, R., Sarsaiya, S., Kumar, A. and Zhang, Z. 2022. Biotechnological strategies for bio-transforming biosolid into resources toward circular bio-economy: A review. Renewable and Sustainable Energy Reviews 156: 111987.

6) Beeby, J., Moore, S., Taylor, L. and Nderitu, S. 2020. Effects of a one-time organic fertilizer application on long-term crop and residue yields, and soil quality measurements using biointensive agriculture. Frontiers in Sustainable Food System 4: 58-67.

7) Bhoyar, M. G., Chiranjeeva, M. R. and Gavkare, O. J. 2007. Possible uses of parthenium-An agricultural waste. Control Pollution 30: 233-236.

8) Bremner, J. M. 1965. Inorganic Forms of Nitrogen. In: Black, C.A., et al., Eds., Methods of Soil Analysis, Part 2, Agronomy Monograph No. 9, ASA and SSSA, Madison, 1179-1237.

9) Choudhary, R. C., Bairwa, H. L., Kumar, U., Javed, T., Asad, M., Lal, K. and Abdelsalam, N. R. 2022. Influence of organic manures on soil nutrient content, microbial population, yield and quality parameters of pomegranate (*Punica granatum* L.) cv. Bhagwa. Plos One 17(4): e0266675. https://doi.org/10.1371/journal.pone.02666752022.

10) Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural research; John Wiley & Sons: New York, NY, USA.

11) Gusain, R., Pandey, B. and Suthar, S. 2018. Composting as a sustainable option for managing biomass of aquatic weed Pistia: A biological hazard to aquatic system. Journal of Cleaner Production 177: 803-812.

12) Havre, G. N. 1961. The flame photometric determination of sodium, potassium and calcium in plant extracts with special reference to interference effects. Analytica Chimica Acta 25: 557-566.

13) Jackson, M. L. 1962. Soil chemical analysis. Prentice Hall. Englewood Cliffs, New York, U.S.A.

14) Kishor, P., Maurya, B. R. and Ghosh, A. K. 2010. Use of uprooted Parthenium before flowering as compost: a way to reduce its hazards worldwide. International Journal of Soil Science 5: 73-81.

15) Lim, S. L., Wu, T. Y., Lim, P. N. and Shak. K. P. Y. 2015. The use of vermicompost in organic farming: overview, effects on soil and economics. Journal of the Science of Food and Agriculture 95: 1143-1156.

16) Maguire, V. G., Bordenave, C. D., Nieva, A. S., Llames, M. E., Colavolpe, M. B., Garriz, A. and Ruiz. O. A. 2020. Soil bacterial and fungal community structure of a rice monoculture and rice-pasture rotation systems. Applied Soil Ecology 151: 103535.

17) Makkar, C., Singh, J., Parkash, C., Singh, S., Vig, A. P. and Dhaliwal, S. S. 2022. Vermicompost acts as bio-modulator for plants under stress and non-stress conditions. Environment, Development and Sustainability 1-52. https://doi.org/10.3390/agronomy12122957

18) Najar, I. A., Khan, A. B. and Hai, A. 2015. Effect of macrophyte vermicompost on growth and productivity of brinjal (*Solanum melongena*) under field conditions. International Journal of Recycling of Organic Waste in Agriculture 4: 73-83.

19) Nelson, D. W. and Sommers, L. E. 1982. Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties. Agronomy Monograph 9: 539-579

20) Nelson, D. W. and Sommers, L. E. 1996. Total Carbon, Organic Carbon, and Organic Matter. In: Sparks, D.L., et al., Eds., Methods of Soil Analysis. Part 3. Chemical Methods, SSSA Book Series No. 5, SSSA and ASA, Madison, WI, 961-1010.

21) Nguyen, M. K., Lin, C., Hoang, H. G., Sanderson, P., Dang, B. T., Bui, X. T. and Tran, H. T. 2022. Evaluate the role of biochar during the organic waste composting process: A Critical Review. Chemosphere 134488. https://doi:10.1016/j.chemosphere.2022.134488.

22) Niyibizi, L., Vidakovic, A., Haldén, A. N., Tabaro, S. R. and Lundh, T. 2022. Aquaculture and aquafeed in Rwanda: current status and perspectives. Journal of Applied Aquaculture, 1-22. https://doi.org/10.1080/10454438.2021.2024315

23) Ozlu, E., and Kumar, S. 2018. Response of soil organic carbon, pH, electrical conductivity, and water stable aggregates to long-term annual manure and inorganic fertilizer. Soil Science Society of America Journal 82: 1243.

24) Page, R. E. and Laidlaw, H. H. 1982. Closed population honeybee breeding. 2. Comparative methods of stock maintenance and selective breeding Journal of Apicultural Research 21: 39-44.

25) Pierre-Louis, R. C., Kader, M. A., Desai, N. M. and John, E. H. 2021. Potentiality of vermicomposting in the South Pacific island countries: A review. Agriculture 11: 876.

26) Sołowiej, P., Pochwatka, P., Wawrzyniak, A., Łapiński, K., Lewicki, A. and Dach, J. 2021. The effect of heat removal during thermophilic phase on energetic aspects of biowaste composting process. Energies 14: 1183.

27) Suhaida, M. N., Faizah, A. K., Norhanizan, U., Azimah, H. and Shah, S. Z. 2022. Effects of organic fertilizer on growth performance and postharvest quality of pak choy (Brassica rapa subsp. chinensis L.). AgroTech–Food Science, Technology and Environment 1: 43–50.

28) Tanveer, A., Sarwar, M., Asghar, M. S., Saleem, M. F., Maqsood, H., Ali, B. and Rizwan, M. 2022. Reducing nutrient uptake in okra weeds by suppressing their population through alligator weed compost mulch for better pod yield and quality. Arabian Journal of Geosciences 15: 1-10.

29) Vyankatrao, N. P. 2017. Conversion of *Parthenium hysterophorus* L. weed to compost and vermicompost. Bioscience Discovery 8: 619-627.

30) Walkley, A. and Black, I. A. 1934. An examination of the Degtjareff Method for Determining Soil Organic Matter, and a proposed Modification of the Chromic Acid Titration Method. Soil Science, 37: 29-38.

31) Wolf, B. 1982. The comprehensive system of leaf analysis and its use for diagnosing crop nutrient status. Communications in Soil Science and Plant Analysis 3: 1035-1059.

32) Ye, G., Lin, Y., Liu, D., Chen, Z., Luo, J., Bolan, N., Fa, J. and Ding, W. 2019. Long-term application of manure over plant residues mitigates acidification, builds soil organic carbon and shifts prokaryotic diversity in acidic Ultisols. Applied Soil Ecology 133: 24–33.

33) Zhang, Q. C., Shamsi, I. H., Xu, D. T., Wang, G. H., Lin, X. Y., Jilani, G. and Chaudhry, A. N. 2012. Chemical fertilizer and organic manure inputs in soil exhibit a vice versa pattern of microbial community structure. Applied Soil Ecology 57: 1-8.