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## Impact of Integrating between Mineral Nitrogen, Vermicompost and Biochar on Nitrogen-Use Efficiency and Productivity of Panicum Plants Grown on Sandy Soil

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BIOCHAR and Vermicompost are non-traditional organic modifications of agricultural production used to improve crop productivity and soil fertility. Field experiments were carried out to examine the application of a combination of biochar and earthworm compost and N fertilizers to soil fertility, yield, nutrient content, and nitrogen use efficiency. The experiment was laid out in a randomized complete block design (RCBD) with three replicates for each treatment. Application of non-traditional organic fertilizers i.e., biochar (B), and vermicompost (V) at three rates (0,1000 and 2000 kg/ha) combined with three rates of mineral N fertilizer (0, 150, 200 kg N/ha) as ammonium sulfate (20.5% N). These results indicate that the application of earthworm compost and biochar greatly enhances recovery efficiency (R e), agricultural efficiency (A e) and nutrient content. In addition, with the addition of biochar or earthworm compost, the amount of organic matter (OM) and NPK in the soil increased, while the pH of the soil decreased further. The results showed that B2N2 treatment was the most successful in improving nutrient content and N efficiency as well and enhancing panicum plant yield. The application of earthworm compost and biochar reforming improved the productivity, nutrient content, agronomic efficiency recovery efficiency, and nitrogen use efficiency of panicum feed.

**Keywords:** Vermicompost; Biochar; Panicum Forge; Nitrogen Use Efficiency; Plant Productivity.

### Introduction

Sandy soils have low organic content, soil moisture content and nutrient retention due to high permeability, which limit crop yield and endanger global food security in arid and semi-arid countries (Brady and Weil, 1999; Musei *et al.,* 2024).As a result, adding an organic modification is a better way to increase the productivity of these soils.

In modern agriculture, organic fertilizers are considered important, especially in recent landfills, where the level of organic matter is low, since nutritional balance is believed to provide plants with the essential nutrients they need at every stage of development.In addition, it has a positive impact on improving the chemical and physical properties of the soil by reducing environmental pollution due to excessive use of mineral fertilizers, which generally have a maximum utilization rate of about 60%. Increasing the amount of organic matter in the soil increases the ability to retain nutrients and reduces susceptibility to leaching, especially in sandy soils. In addition, it improves the soil's ability to retain water and increases the availability of nutrients.

Biochar is an organic material created by heating biomass to high temperatures (pyrolysis) in an environment with limited oxygen, often above 250°C. Biochar is a crucial component of environmental management since it enhances soil characteristics, manages waste, mitigates climate change, reduces nutrient pollution, and contributes to energy manufacture (Lehmann and Joseph, 2015; **Gyanwali,*et al.*,2024**). Biochar enhances the physical properties of soil, including its ability to retain water and its capability for soil aggregation. Therefore, it enhances the soil cation exchange capacity, and organic carbon, as a result, nutrients are more resistant to leaching and available to plants. (Obia et al., 2016; Amin, 2016; Gao et al., 2016; Muhammad et al., 2016; Shivangi, *et al.*,2024**)**).

Vermicompost, sometimes referred to as worm fertilizer, is a biological process that converts organic waste into nutrient-rich manure through the use of earthworms. It has a variety of beneficial components, including vitamins, hormones, humic compounds, and antioxidants (Aracon *et al.,* 2004). Vermicompost has a fine texture, rich in nutrients, and has a high water-holding capacity ( Atiyeh *et al.*, 2000 and Sinha, *et al.*, 2010). Vermicompost increases the growth of plants and improves the composition of the soil. Plants may

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easily absorb nutrients from vermicompost, which contains soluble potassium, phosphorus, calcium, magnesium, and other vital minerals, (Atiyeh *et al.*, 2000). The presence of plant growth hormones and humic acid concentration in vermicompost is the primary factor that contributes to plant growth. Using vermicompost increases plant growth and productivity, improving agricultural sustainability and economic value. (Arancon *et al.* 2006; Ananthavallia *et al*., 2019).

Panicum is a member of the Poaceae family, which is considered an annual feed. It is a potential fodder plant that is resistant to various stresses, successfully grown in tropical and subtropical climates around the world, and in the phytogeographic regions of Egypt the broad panicum can grow up to 3 meters in height and has a large supply of excellent leaves Muir *et al.* (2001). In addition, it can be produced for up to 10 years and is more productive than alfalfa. Hare *et al.*, 2014).

From the literature, it has been demonstrated that adding biochar or earthworm compost to soil improves soil physicochemical properties such as cation exchange capacity, pH, nutrition and water retention, and promotes soil microbial populations. (King, *et al.,* 2017 and Haipeng *et al.*, 2017). Zhang *et al.*, (2023) showed that the use of earthworm compost and biochar individually or in combination not only increases the productivity of pepper plants and improves fruit quality, but also favors nitrogen use efficiency. (Ebrahimi *et al.*, 2021) revealed that under normal drought, earthworm compost and biochar improved eggplant yield, vegetative growth, and water use efficiency. Also, the advantages of combining different types of compost and biochar have been observed in terms of soil organic content, nitrogen levels, and water storage capacity (D'HOSE, *et al.*,2020). Biochar is produced by pyrolysis of *Pinus monticola* wood and is produced from *pelargonium peltatum* and *Petunia hybrid* (Alvarez, *et al.*, 2017).The aim of this study was to determine whether the integration of mineral nitrogen, earthworm compost and biochar could improve panicum plant growth and productivity, nutrient content, nitrogen use efficiency, and productivity under North Sinai conditions.

## Materials and Methods

In the newly reclaimed desert at Baloza Research Station, Desert Research Centre, North Sinai Governorate, Egypt, a field study was conducted at the latitudes of 31° 3° 0' North and the longitude of 32° 36° 0' East. It was conducted in the 2021 season. The experiment was laid out in a randomized complete block design (RCBD) that includes thirteen treatments with three replicates for each treatment. Application of non-traditional organic fertilizers i.e., biochar (B), and vermicompost (V) which were added during soil preparation at three rates (0,1000 and 2000 kg/ha) combined with three rates of mineral N fertilizer (0, 150, 200 kgN/ha) as ammonium sulfate (20.5% N). Fig 1 illustrates the schematic diagram showing the studied treatments.

Seedlings of *Panicum Maximum* were inserted in an open field in June 2021 and irrigated with water from the El-Salam canal (EC ≈ 1.67dSm$^{-1}$) by using a drip irrigation system with drippers 4L/h. Panicum rquirments of phosphorus and potassium fertilizers were added for all treatments as recommended by the Egyptian Ministry of Agriculture as follow; 48kg $P_2O_5$/fad as ordinary superphosphate (15.5% $P_2O_5$) and 60kg $K_2O$/fad as potassium sulfate (50% $K_2O$). All plants were grown using conventional agricultural practices. The initial physical and chemical and physical properties of the experimental soil (table, 1) were carried out using the standard methods outlined by Sparks *et al.*, (2020).

**Table 1. Some initial physical and chemical properties of the experimental soil.**

| Depth | 0-30 cm |
|---|---|
| Particle size distribution % | |
| Sand | 89.12 |
| Silt | 6.34 |
| Clay | 4.54 |
| Texture class | sandy |
| pH soil (1:1) | 8.47 |
| EC (dS/m) in soil paste extract | 1.19 |
| Soluble ions in saturated soil extract (cmolc/L) | |
| $Na^{*}$ | 3.91 |
| $K^{+}$ | 2.03 |
| $Ca^{++}$ | 3.92 |
| $Mg^{++}$ | 2.04 |
| Cl - | 3.45 |
| $HCO_3^{--}$ | 3.43 |
| $SO_4^{--}$ | 5.02 |
| Available nutrients (mg/kg) | |
| N | 10 |
| P | 3.65 |
| K | 24 |

The chemical analysis of the applied organic soil amendment (biochar and vermicompost) is illustrated in Table (2). The above ground green fodder (10 cm above the soil's surface) was harvested in two cuttings, where the 1$^{st}$ cut was on September 15$^{th}$, while the 2$^{nd}$ one was on November 15$^{th}$, respectively. One median plot of 1 m$^2$ in the centre of each experimental plot was chosen to be harvested for fresh and dried fodder and its weights (Mg/ha) and plant height in cm were recorded.

**Table 2. Nutrient contents of biochar and vermicompost.**

| Soil amendments | Vermicompost | Biochar |
|---|---|---|
| pH extract (1:10) | 8.57 | 7.95 |
| EC extract (1:10) | 3.42 | 0.81 |
| T.C | 12.77 | 50.40 |
| O.M | 21.96 | 86.67 |
| Macronutrients (%) | | |
| N | 1.95 | 0.55 |
| P | 0.42 | 0.56 |
| K | 1.04 | 0.21 |
| micronutrients **(mg/l)** | | |
| Cu | 44 | 8 |
| Fe | 1720 | 708 |
| Mn | 59 | 39 |
| Zn | 121 | 42 |

**Plant analyses**

Straw samples of *Panicum Maximum* were collected from each plot and dried in an oven at 60 ºC and digested as described by Cottenie *et al.*, (1982), and analyses for different nutrients were as follows:
nitrogen was measured Using Jackson's (1973) micro-Kjeldahl method. Crude protein was calculated by multiplying the total nitrogen concentration by 6.25. In accordance with Watanabe and Olson (1965), phosphorus was colored using the ammonium molybdate and ascorbic acid procedure and then measured using a spectrophotometer. Potassium was measured using a flame photometer In accordance with Page et al., (1984).
using DTPA + ammonium carbonate solution Using the Soltanpour (1985) method. Organic matter content was calculated by the Walkley and Black technique Using phenanthroline as an indication (Black *et al.*, 1965)

**Statistical analyses**

The current work data was statistically investigated with the Statistics version 9 computer programmer (Analytical software, 2008). The results attained were analysed by F-test .The significant differences between the means of the treatments were considered at 5% level according to Duncan's multiple test range.

**Soil analysis**

The available nitrogen (N-$NO_3$) in soil samples was extracted using a 2M potassium chloride solution according to Dhank and Johnson (1990), available potassium and phosphorus were extracted.

**Efficiency parameters of N fertilizer**

The following formulas were used to evaluate the parameters of nutrient efficiency Zhang *et al.*, (2022).

**1-Recovery efficiency (RE)**

$$\text{Re (\%)} = \frac{\text{Total N uptake (kg N/ha) of the treatment - Total N uptake (kg N/ha) of the control x100}}{\text{Applied N (kg N/ha) of the treatment}}$$

**2- Agronomy efficiency (AE)**

$$\text{Ae (kg yield / kg N applied)} = \frac{\text{Dry weight (kg) of the treatment - dry weight of the control (kg)}}{\text{Applied N (kg N/ha) of the treatment}}$$

**3- Nitrogen use efficiency (NUE)**

$$\text{NUE (kg yield/kg N applied)} = \frac{\text{Dry weight (kg) of the treatment}}{\text{Applied N (kg N/ha) of the treatment}}$$

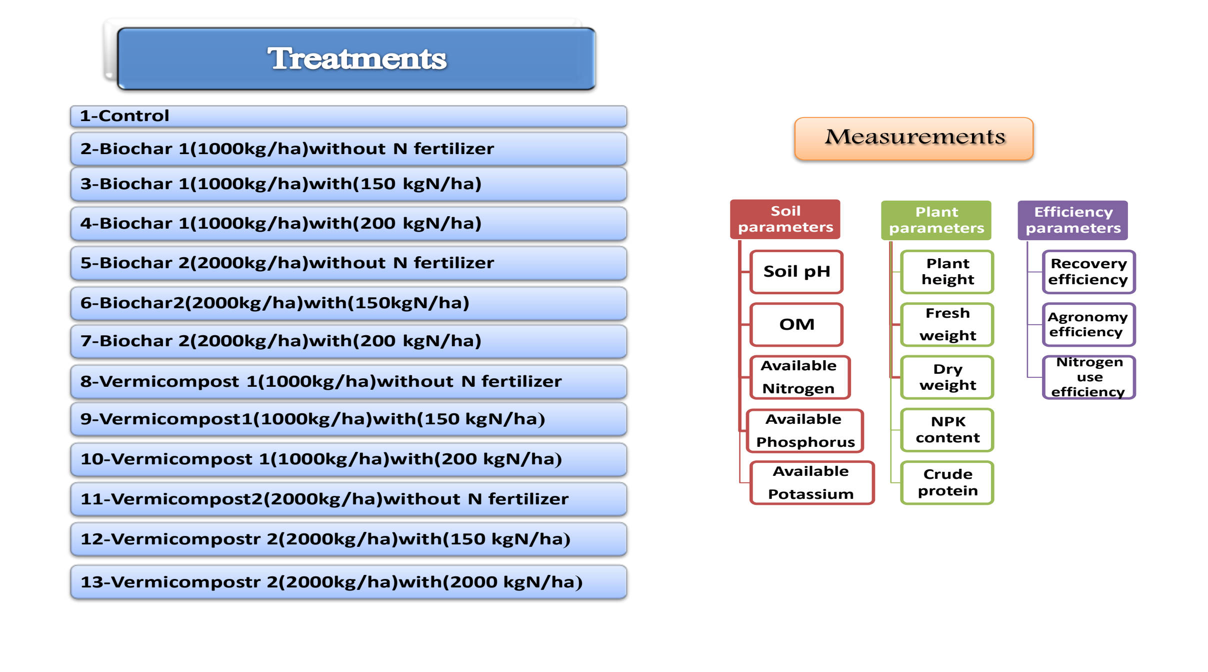


**Fig. 1. The flowchart of the studied treatments and measurements.**

## 3. Results

### Parameters of Growth and Yield of Panicum Maximum

Fresh and dry weights (Mg/ha) and plant height (cm) of Panicum forage significantly increased due to the applications of Soil non-traditional amendments; biochar and vermicompost combined with N fertilizers to the sandy soil (Table 3). These increases became more noticeable with increasing biochar and earthworm compost application levels compared to the control (unamended soil). The B2N2 treatment gave the greatest significant value of fresh and dry weights of herb (Mg/ha) and plant height (cm) (13.07, 13.70, 3.56, 3.85,133.67 and145.70, respectively), treated with two cuts, compared with control and all studies treatments in two cuts.

### Macronutrient content and crud protein

The data in Table (4) show the change in NPK content of Panicum feed during the two cuts by applying soil modifications combined with biochar(B) and vermicompost(V) and nitrogen fertilizers. The response of total N in plant straw to soil amendments with N fertilizer was observed that the treatment of B2 N2 recorded the highest significant increases (1.29&1.38%during two cuts) in total N content in contrast to the control and other studied treatments. Regarding improving crude protein, the B2 N2 was superior to the other materials (14.31% and 14.88% throughout the two cuts). Conversely, control (unamended) produced the lowest result

**Table 3. Effect of the biochar, vermicompost, and nitrogen fertilizer on plant height (cm), fresh and dry weight (Mg/ha) of Panicum Maximum plant in two cuts.**

| Treatments | **Plant height** (cm) | | **Fresh weight** (Mg /ha) | | **Dry weight** (Mg /ha) | |
|---|---|---|---|---|---|---|
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| **control** | 62.77g | 68.43g | 3.86h | 4.06h | 1.67h | 1.80g |
| **B1N0** | 82.47f | 89.90f | 6.10f | 6.40f | 2.60e | 2.37f |
| **B1N1** | 113.10cd | 123.27cd | 11.53b | 12.20b | 3.01cd | 3.26cd |
| **B1N2** | 116.40cd | 126.87cd | 11.63b | 12.13b | 3.10cd | 3.35cd |
| **B2N0** | 97.77e | 106.60e | 11.26b | 11.83b | 2.20f | 2.81e |
| **B2N1** | 121.27bc | 132.20bc | 9.16cd | 9.60cd | 3.23bc | 3.49bc |
| **B2N2** | 133.67a | 145.70a | 13.06a | 13.70a | 3.56a | 3.85a |
| **V1N0** | 71.30g | 77.70g | 4.83g | 5.53g | 1.90g | 2.05g |
| **V1N1** | 111.57d | 121.60d | 9.60c | 10.06c | 2.97d | 3.21d |
| **V1N2** | 111.57d | 121.60d | 7.20e | 7.56e | 2.97d | 3.21d |
| **V2N0** | 93.13e | 101.50e | 5.30g | 5.06g | 2.48e | 2.68e |
| **V2N1** | 121.03bc | 131.93bc | 8.83d | 9.26d | 3.22bc | 3.48bc |
| **V2N2** | 126.10ab | 137.47ab | 12.90a | 13.56a | 3.36ab | 3.63ab |
| **F-test** | ** | ** | ** | ** | ** | ** |

Control (unamended soil), B1 (1000 kg/ha), B2 (2000 kg/ha), V1 (1000kg/ha) and V2 (2000 kg/ha).Three rates of mineral N fertilizer (0, 150, 200kgN/ha).Means in the same column followed by different letters are significant according to the Tukey's test ($P \leq 0.05$).

Table (4) also includes the response of total P in Panicum fodder. Increases in N fertilizer were found to raise the total P content, while simulations involving the addition of B and V were found to promote P content. Additionally, the application of soil amendments concurrently with N led to an increase in the plant's total P. In contrast to the other studied treatments and the control, the B2 N2 treatment showed the greatest significant increases in total P content (0.17&0.19% in two cuts). Table 4 also includes a response for the total K in plant straw. It was discovered that increasing soil application significantly increased total K content, and simulations showed that adding N fertilizer improved total K. Also, soil amendments with biochar and vermicompost with N had a significant impact on total K. In contrast to the other treatments and the control under investigation, the B2 N2 treatment produced the most significant increases (2.78&2.78%
in two cuts) in total in total K content. So, when comparing the effect of the first and second cuttings on nutrient content, the second cutting outperformed the first.

**Nitrogen use efficiency**

Using data from Table 5, the nitrogen utilization efficiency was calculated as the yield per unit of N fertilizers. N use efficiency response to soil modification; with biochar (B) and earthworms compost (V) N fertilizers, it was found that the processing of B2N1 recorded the highest increases (48.68%, 21.64 and 36.16kg kg-1, respectively) for the recovery efficiency (RE), an agronomic efficiency (AE) and nitrogen use efficiency (NUE) compared with control and other studied treatments.

The study used regression modeling to investigate the correlation between soil modification (biochar and vermicompost) combined with N and N use efficiency (Figure 2). The B2 N2 treatment showed that the most positive relationships between biochar and earthworm compost applications were found in recovery efficiency (RE), agricultural efficiency (AE), and nitrogen use efficiency (NUE), with $R^2$ values of 0.9463, 0.9553, and 0.9057, respectively. This indicates that application of soil amendments with N had a potential effect to increase Efficiency parameters of N fertilizer.

**Table 4. Effect of the biochar, vermicompost, and nitrogen fertilizer on NPK content (%) of Panicum Maximum plant in two cuts.**

| Treatments | N (%) | | P (%) | | K (%) | | Crude protein (%) | |
|---|---|---|---|---|---|---|---|---|
| | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut | 1st cut | 2nd cut |
| **control** | 1.51k | 1.55k | 0.08i | 0.09g | 0.85h | 0.90h | 9.47k | 9.69k |
| **B1N0** | 1.96i | 2.03i | 0.12g | 0.13e | 1.46ef | 1.55ef | 12.27i | 12.69i |
| **B1N1** | 2.05fg | 2.13fg | 0.13ef | 0.14d | 1.77d | 1.88d | 12.86fg | 13.32fg |
| **B1N2** | 2.14cd | 2.23cd | 0.14c | 0.16c | 2.02c | 2.14c | 13.43cd | 13.94cd |
| **B2N0** | 1.98hi | 2.05hi | 0.12g | 0.13e | 1.50e | 1.59e | 12.42hi | 12.86hi |
| **B2N1** | 2.20bc | 2.29bc | 0.16b | 0.18b | 2.59b | 2.75b | 13.78bc | 14.31bc |
| **B2N2** | 2.28a | 2.38a | 0.17a | 0.19a | 2.78a | 2.94a | 14.31a | 14.87a |
| **V1N0** | 1.86j | 1.93j | 0.10h | 0.11f | 1.30g | 1.38g | 11.68j | 12.06j |
| **V1N1** | 2.02gh | 2.09gh | 0.13fg | 0.14de | 1.71d | 1.82d | 12.64gh | 13.09gh |
| **V1N2** | 2.11de | 2.19de | 0.14cd | 0.15c | 1.96c | 2.08c | 13.23de | 13.72de |
| **V2N0** | 1.89j | 1.95j | 0.11h | 0.12f | 1.34fg | 1.42fg | 11.84j | 12.23j |
| **V2N1** | 2.08ef | 2.15ef | 0.14de | 0.15c | 1.90c | 2.02c | 13.03ef | 13.50ef |
| **V2N2** | 2.24ab | 2.33ab | 0.16ab | 0.18b | 2.68ab | 2.85ab | 14.04ab | 14.59ab |
| **F-test** | ** | ** | ** | ** | ** | ** | ** | ** |

Control (unamended soil), B1 (1000 kg/ha), B2 (2000 kg/ha), V1 (1000kg/ha) and V2 (2000 kg/ha).Three rates of mineral N fertilizer (0, 150, 200kgN/ha).Means in the same column followed by different letters are significant according to the Tukey's test ($P \leq 0.05$).

**5. Soil fertility status**

According to the data on soil pH in soil water extract, 1:1 (Figure. 3). Soil pH was found to decrease due to the effects of soil improvements such as Biochar(B) and vermicompost(V) with N fertilizer. The pH value of treatment B2N2 was 7.8, while the control had a value of 8.45. The pH of all treatments was lower than the control, which reflected the direct effect of the biodegradation of organic matter on the decrease in the initial soil pH.

Data presented in figure (4) shows the variation of OM% as soil amendments were applied; biochar (B) and vermicompost (V) with N fertilizer. Increasing the application of B and V increased OM%, were the treatment of B2 N2 recorded the highest significant increases availability of OM% compared with control and other studied treatments.

**Table 5. Effect of the biochar(B),vermicompost(V) and nitrogen fertilizer on recovery efficiency (RE), an agronomic efficiency (AE) and nitrogen use efficiency (NUE) of Panicum Maximum plant.**

| Treatments | RE (%) | AE (kg kg$^{-1}$) | NUE (kg kg$^{-1}$) |
|---|---|---|---|
| **Control** | --- | --- | --- |
| **B1N1** | 33.90 | 18.62 | 30.51 |
| **B1N2** | 28.56 | 14.88 | 31.37 |
| **B2N1** | 48.68 | 21.64 | 36.16 |
| **B2N2** | 43.66 | 19.67 | 33.63 |
| **V1N1** | 28.80 | 18.07 | 26.38 |
| **V1N2** | 23.66 | 13.55 | 30.95 |
| **V2N1** | 36.16 | 21.53 | 34.42 |
| **V2N2** | 35.48 | 17.57 | 33.55 |

B1 (1000 kg/ha), B2 (2000 kg/ha), V1 (1000kg/ha) and V2 (2000 kg/ha), N1(150kgN/ha) and N2 (200kgN/ha).

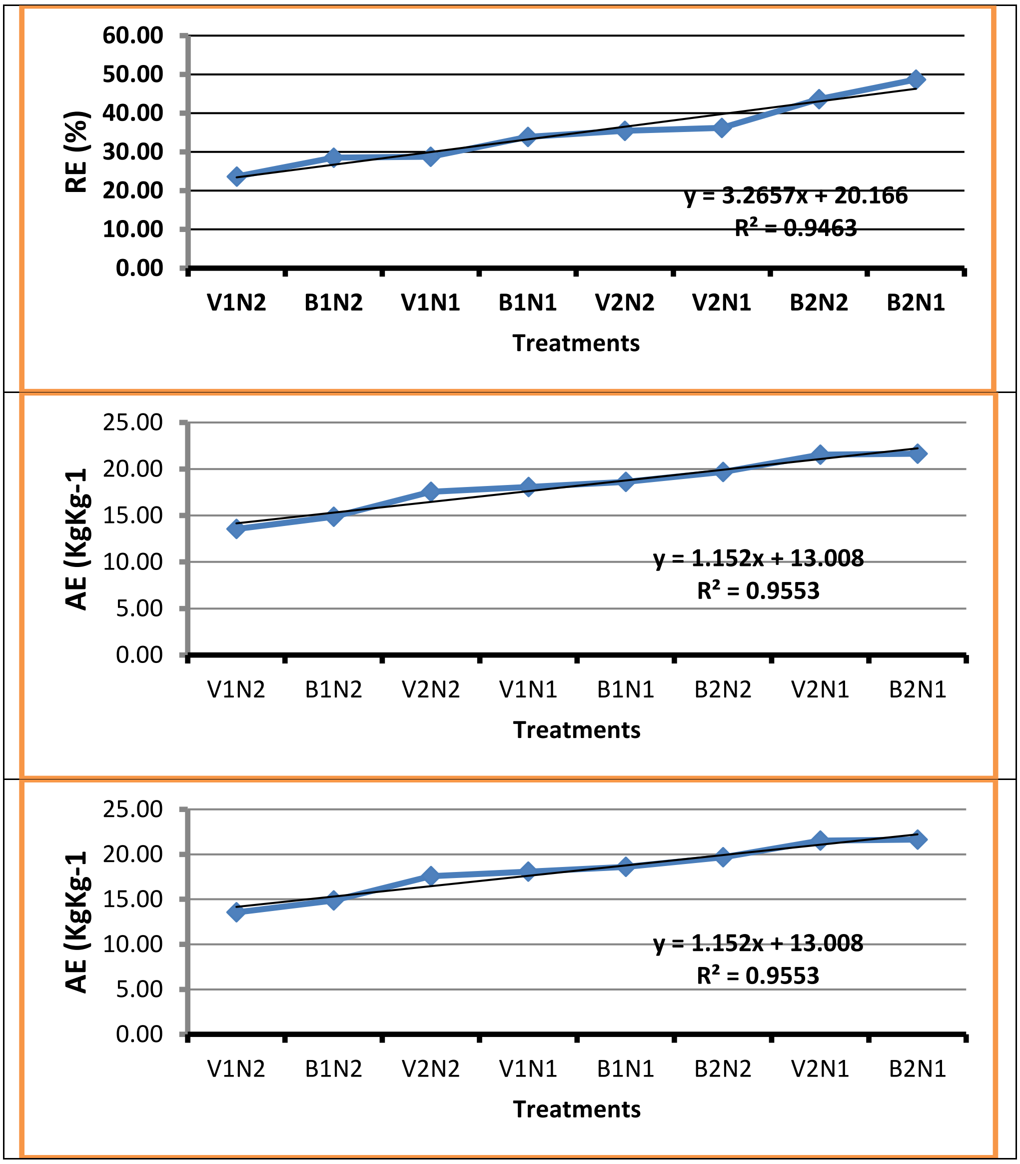


**Fig. 2. Relationship between Biochar(B) , Vermicompost(V), nitrogen fertilizer and Efficiency parameters of N fertilize.**

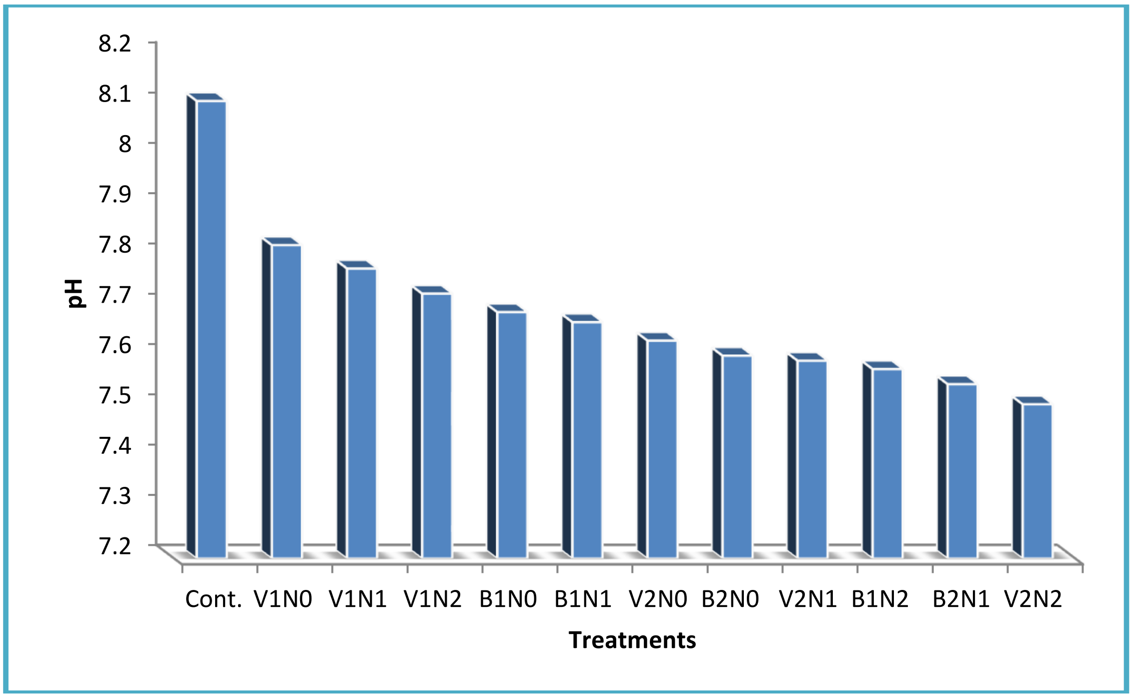


**Fig. 3. Effect of the biochar (B), vermicompost (V) and nitrogen fertilizer on pH soil, Error bars represent standard errors.**

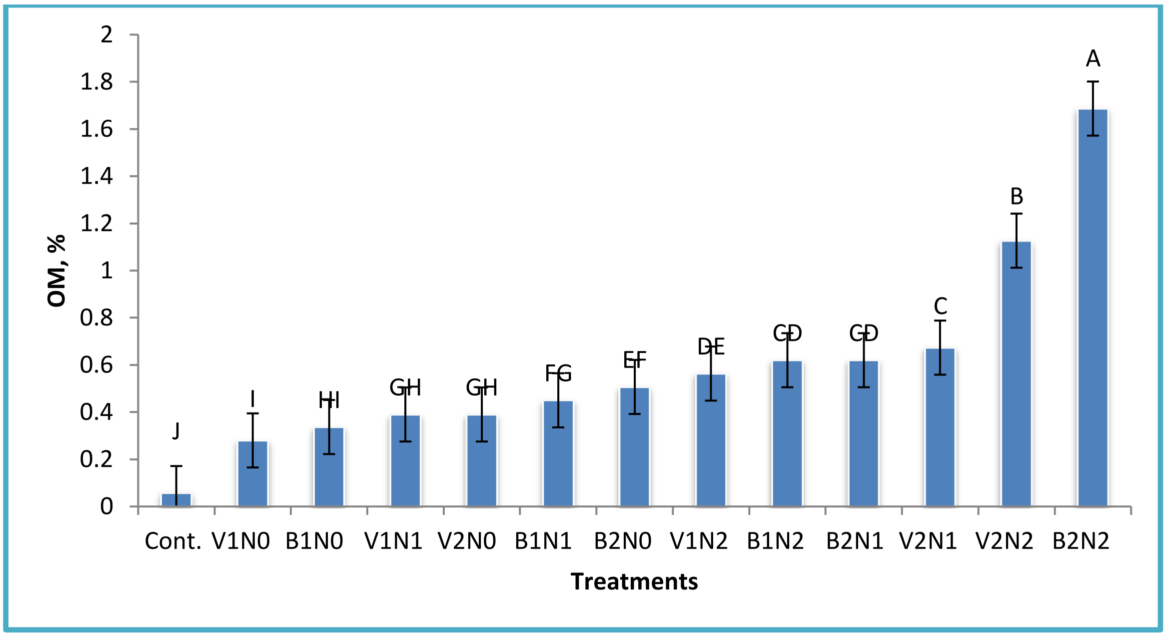


**Fig. 4. Effect of the biochar(B), vermicompost (V) and nitrogen fertilizer on OM% soil, Error bars represent standard errors.**

Figure (5) shows the variation of available N in soil owing to the application of Soil amendments; biochar (B) and vermicompost (V) with N fertilizer. Increasing the application of B and V significantly increased the availability of N-$NO_3$ soil. The application of N fertilizer significant increased availability of N-soil. The treatment of B2 N2 recorded the highest significant increases availability of N-soil compared with control and other studied treatments.

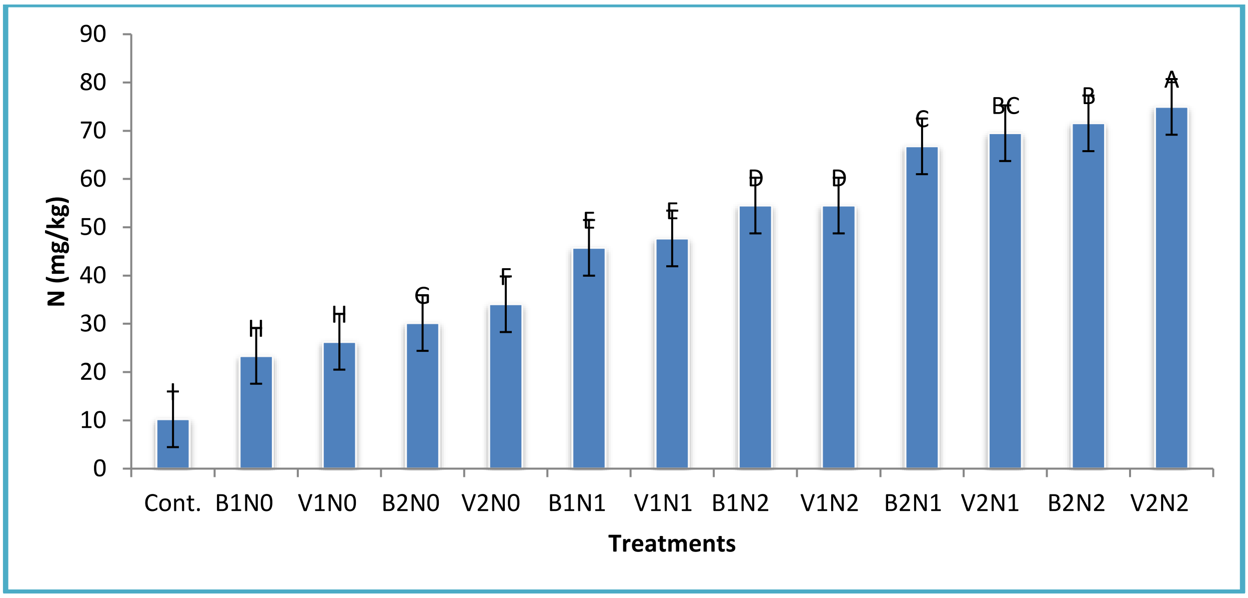


**Fig. 5. Effect of the biochar(B), vermicompost (V) and nitrogen fertilizer on N availability in soil, Error bars represent standard errors.**

Figure (6) shows the response of available P - soil. The effects of rates of Soil amendments; biochar and vermicompost combined with N fertilizer on available P-soil content ,that indicates the increasing the doses of B&V significant increased amounts of available P in soils. The application of N fertilizer significant increased availability of P-soil. The treatment of B2 N2 recorded the highest significant increases for availability of P-soil compared with control and other studied treatments.

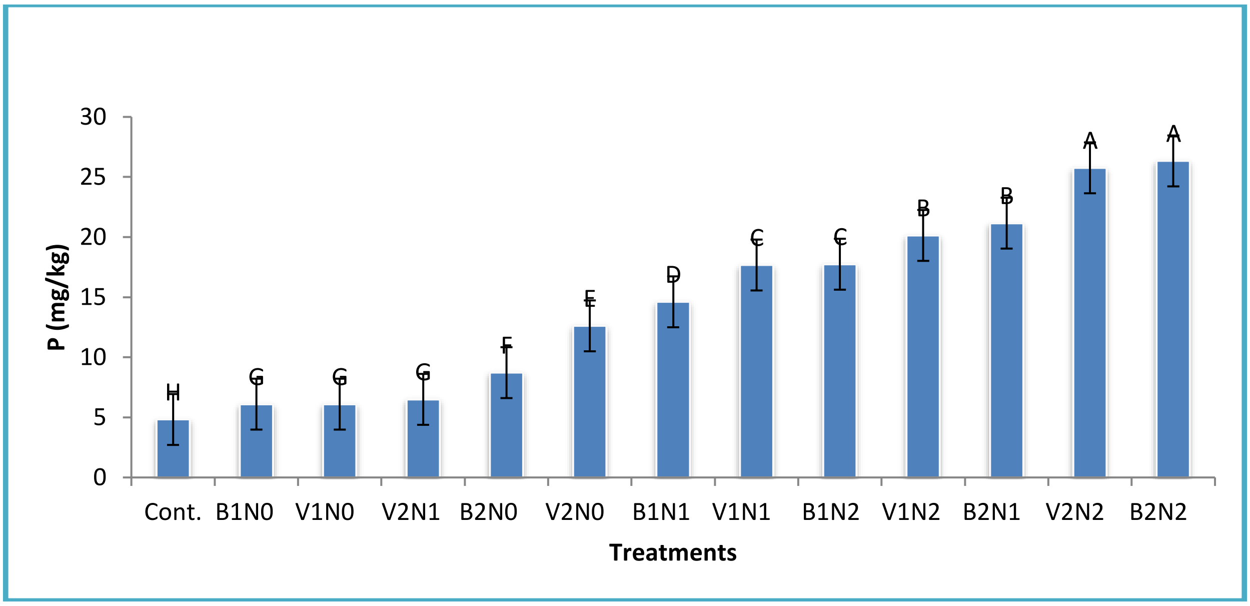


**Fig. 6. Effect of the biochar(B), vermicompost (V) and nitrogen fertilizer on P availability in soil, Error bars represent standard errors.**

Data listed in figure 7 presents the response of available K-soil. The effects of rates of Soil amendments; biochar and vermicompost combined with N fertilizer on available K-soil, that indicates the increasing the doses of soil amendments increased amounts of available K in soils. The application of N fertilizer significant increased availability of K-soil. When soil amendments were added simultaneously with N it was noticed that the treatment of B2 N2 recorded the highest significant increases for availability of K-soil compared with control and other studied treatments.

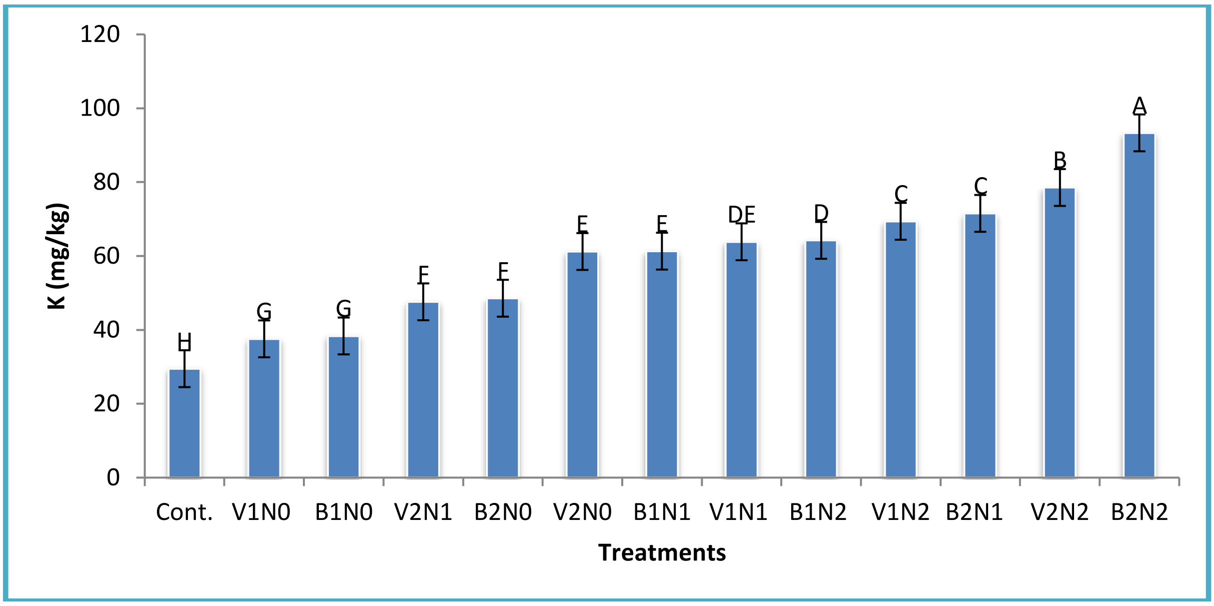


**Fig. 7. Effect of the biochar(B), vermicompost (V) and nitrogen fertilizer on K availability in soil. Error bars represent standard errors.**

**4. Discussion**

Nowadays biochar and vermicompost are frequently utilized as important organic amendment in agricultural production and have been shown to have some benefits for improving soil fertility and crop productivity. (Hossain, *et al.*, 2020; Tikoria, *et al.*, 2022). This might be the result of biochar's ability to directly adsorb nutrients from the soil, minimizing nutrient loss, due to its high specific surface area and mineral content. (Li, *et al.*, 2023; Lv, *et al.*, 2023). Vermicompost improves crop yields by stimulating enzymes involved in chlorophyll synthesis, plant development, and fruit ripening. (Zuo, *et al.*, 2018; Liu, *et al.*, 2022).

In the present study, the applications of biochar and vermicompost increase the vegetative growth and productivity of panicum (table 3). Similar findings were mentioned by (Shi, *et al.*,2020) who propose that adding biochar to the coarse-sandy subsoil enhanced the growth of maize Fresh biomass increased by 13.8% and 25.1% for shoots and roots, respectively, under Bio-MUC as opposed to conventional urea (UF).Also, the application of biochar is advantageous for increasing crop production and root growth. (Manzoor *et al.*, 2022; Wu D. et al., 2022; Wan et al., 2023; Hafez *et al.*, 2024).

Considering table 4, it shows that the NPK content of panicum plant significant increased by addition biochar and vermicompost. As a result, organic amendments include a high concentration of nutrients and small molecules of organic material necessary for plant growth. These compounds are rapidly transformed into active components that plants may absorb and use with the help of microbes, hence improving nutrient accumulation. (Singh et al., 2008; Wang et al., 2020; Hegab, et al.,2023).

From (table 5 and figure2), it was found that the treatment of B2 N1 recorded the highest increases nitrogen use efficiency compared with control and other studied treatments. Similar results were reported by El Sharkawi et al. (2018 who confirmed that when granular biochar-based fertilizers were added to sandy soil, mustard spinach significantly increased N use efficiency when compared to mineral fertilizers.

(Shi, et al.,2020) The application of biochar has been shown to have increased the efficiency of N use for biomass production by 24% more than urea, which can aid plant uptake and N translocation to shoots.

Figures 3, 4, 5, 6 & 7 Showed that the nutrient in organic fertilizers is more available for plant absorption than in mineral fertilizers. This could be because the decomposition of the organic fertilizer releases carbon dioxide into the air, which lowers the pH of the soil and enhances phosphate and other element availability. These findings may be due to lower pH as a result of the effect of acidic product production during organic modified biodegradation. **(Kannika, *et al.*, 2019**).When Biochar is incorporated into sandy soils, nitrogen loss due to leaching decreases and ammonium and nitrate retention increases（Cao, *et al.*, 2017). Furthermore, because of its high efficient phosphorus concentration, biochar can be used in place of conventional phosphorus fertilizers. This is because phosphorus may affect the cycle and efficiency of phosphorus in the soil through adsorption and desorption. (Kong, *et al.* 2023; Pokharel and Chang, 2023; Yan, *et al.*, 2023 similarly, biochar can increase the effective potassium content of soils (Xia, *et al.*, 2 0 2 2; Yang, *e t al.*, 2023). Numerous individuals use biochar as an amendment to improve soil fertility.Applying biochar may enhance soil fertility by increasing the availability of nutrients (N, P, K, Na, K, Ca, and Mg). According to (Gyanwali, *et al.*, 2024; El-Sherpiny, *et al*, .2024; Khalafalla, *et al.*, 2024). Both Vermicompost and biochar are natural resources that increase fertility and reduce the need for inorganic mineral fertilizers. (Alvarez,*et al.*,2017).

## 5. Conclusion

This study demonstrated the benefits of applying soil amendments, such as biochar (B) and vermicompost (V), combined with N fertilizer, for increasing panicum productivity, and minimizing pollution hazard through improving then use efficiency. recovery efficiency (RE), agronomic efficiency (AE), and nitrogen use efficiency (NUE) increased by using biochar (B) and vermicompost (V) compared to an amended soil .The results showed The treatment of B2 N2 was the most effective in increasing the productivity of panicum fodder and improving nutrient content, soil organic matter content and NPK availability. While B2 N1 treatments increased N-use efficiencies. As a result, the use of biochar and vermicompost (2000 kgha$^{-1}$) is recommended as a soil amendment to improve soil fertility and increase panicum fodder productivity in sandy soil.

**6. Conflicts of interest.** There are no conflicts to declare.

**7. Formatting of funding sources** There is no funding agency.

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