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Research Article

Effect of Organic and Inorganic Fertilizer on Microbial Weight in Soil in *Amaranthus* spp. Cultivation

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Abstract

Fertilizer plays a vital role in crop cultivation as a source of nutrients and affect the soil health. Microbes present in soil is a biological parameter of soil and important indicator of soil health. The plant's nutrition depends not only on chemical availability but also on nutrient movement and plant characteristics. Nutrient addition causes a significant improvement, in comparison with the control plants. Soils are populated by plant roots, small animals, and many kinds of microbes: protozoa, algae, fungi, and bacteria. Each group is important to the soil's life, but most of the biomass and biological activity is provided by plant roots fungi and bacteria. A field experiment was done at Rajshahi University in 2024 to investigate the effect of organic and inorganic fertilizer as source of nutrient and its effect on soil microbes. *Amaranthus* spp. was cultivated for the study. There were six treatments in this work. T_0= control, T_1= recommended dose of inorganic fertilizer (urea-850 g/deci, TSP-700g, MOP-200 g/deci and gypsum-300 g/deci) T_2= 10% extra from recommended dose of inorganic fertilizer, T_3=cowdung (10 ton/ha), T_4 = vermicompost (2.5 ton/ha) and T_5= trichocompost (2.5 ton/ha). The yield and growth values of *Amaranthus* spp. were higher in inorganic fertilizer treatment (T_1) but soil microbial weight was lower in inorganic fertilizer and high in organic fertilizer. The recommended dose of inorganic fertilizer (T_1) showed the highest values in crop yield but second highest was in trichocompost treatment (T_5) in addition trichocompost treatment showed best result in case of microbial weight and bacteria culture. Trichocompost may be eco-friendly source of nutrient in amaranth cultivation.

Keywords

Inorganic Fertilizer, Microbial Weight, Organic, Soil Health

1. Introduction

Soil microbes are good indicator of soil health which has vital role in sustainable agriculture. Soil health has been defined as" the capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health" [1]. Soil health can be also defined as 'the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans and various soil physical, chemical and biological properties can be used as soil health indicators including soil organic carbon content, microbial biomass soil aggregation state [2]. As the soil provides nutrients, soil is the basis of agriculture and keeps life on Earth going. Whole ecosystems may be impacted by human activities that harm soil health. However, soil is preserved and restored by sustainable gardening and the farming techniques including ju-

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dicial use of fertilizer, use of organic fertilizer, integrated pest management and biological crop protection. These methods create a robust soil ecosystem that can continue to perform its essential roles.

The greatest challenge of the coming years will be to meet the demands of the world's growing population for safe food, healthy soil and an environment free from pollution. The negligent use of inorganic fertilizers and pesticides in conventional crop production is one of the primary causes of declining crop productivity, deteriorating soil health, and serious risks to human and environmental health that have a substantial impact on the sustainability of the agricultural production [3].

Vermicomposting, a highly effective technique for turning solid organic waste into a valuable, practical, and environmentally friendly resource, is an accelerated process that involves the waste's bio-oxidation and stabilization as a result of interactions between certain earthworm species and microorganisms. This is a nutrient-rich organic fertilizer and soil conditioner produced by the decomposition of organic material through the activity of earthworms [4].

The traditional process of composting cow dung takes a long time roughly five to six months and produces mediocre results. Composting based on *Trichoderma* might be a good way to get because *Trichoderma* speed up the composting process, approximately 35 to 40 days, but also improves the quality of compost, lowers the number of heavy metals in compost and serves as an activator to combat soil-borne plant diseases [5]. Trichocompost is a type of compost that is produced using a specific type of fungus called *Trichoderma*. This fungus is known for its ability to break down organic matter and improve soil health. Trichocompost is rich in nutrients and beneficial microorganisms, making it an excellent soil amendment for improving soil fertility and promoting plant growth. It is an eco-friendly and sustainable option for improving soil health and promoting sustainable agriculture practices.

To preserve soil health and lessen dependency on chemical inputs, farmers can also choose about utilizing organic fertilizers and sustainable farming practices. For instance, organically managed fields exhibited more complex microbial networks with a larger number of keystone taxa compared to conventionally managed fields [6]. Soil microbes under organic farming where only organic fertilizers (manure, slurry, etc.) are applied would thrive with more complex nutrients sources such as organic amendments compared to microbial communities from conventionally managed fields where mineral fertilizers (e.g., ammonium and nitrate) are the main N inputs. Organic farming relies on soil ecological processes and does not allow any synthetic fertilizer or pesticide use [a, b]. The non-judicial and imbalanced use of chemical fertilizer generates risks on soil, environment, and human health, leading growers' great attention to turn organic manure application for sustainable production techniques [7]. Soil quality is just the ability to operate like an ecosystem. Agricultural production relies on critical processes such as maintaining productivity and biological activity. With conceiving the above scheme in mind, the present research work has been undertaken. Productivity, food security and sustainable agriculture depends on soil health. Effect of source of nutrient on microbial weight in soil and growth and yield of amaranth have to be revealed.

Note:

a) FAO: Food and Agriculture Organization.

b) IFOAM: International Federation of Organic Agriculture Movements.

2. Materials and Methods

2.1. Experimental Site

The research work was conducted in the experimental field of Institute of Environmental Science, University of Rajshahi in 2023-2024 kharif-1 season. Seeds were cultivated in the above field for the experiment in different treatments. The area is situated at 24 °22'North latitude and 88 °36' East longitude which is 18.0 m above sea level (Figure 2).

2.2. Experimental Treatment

The experiment was laid down in a randomized complete block design (RCBD) with three replications having six treatments. The size of each plot was 5m ×5 m. Experimental treatments were T_0 = control, T_1 = Recommendation dose of fertilizer, T_2 = 10% extra of recommendation dose of fertilizer, T_3 = cow dung, T_4 = vermicompost and T_5 = Trichocompost. Seed were sown on 4th April 2024 and harvested after 30 days on 5th May 2024 (Figure 1).

Figure 1. *Experimental plots in the Rajshahi University campus.*

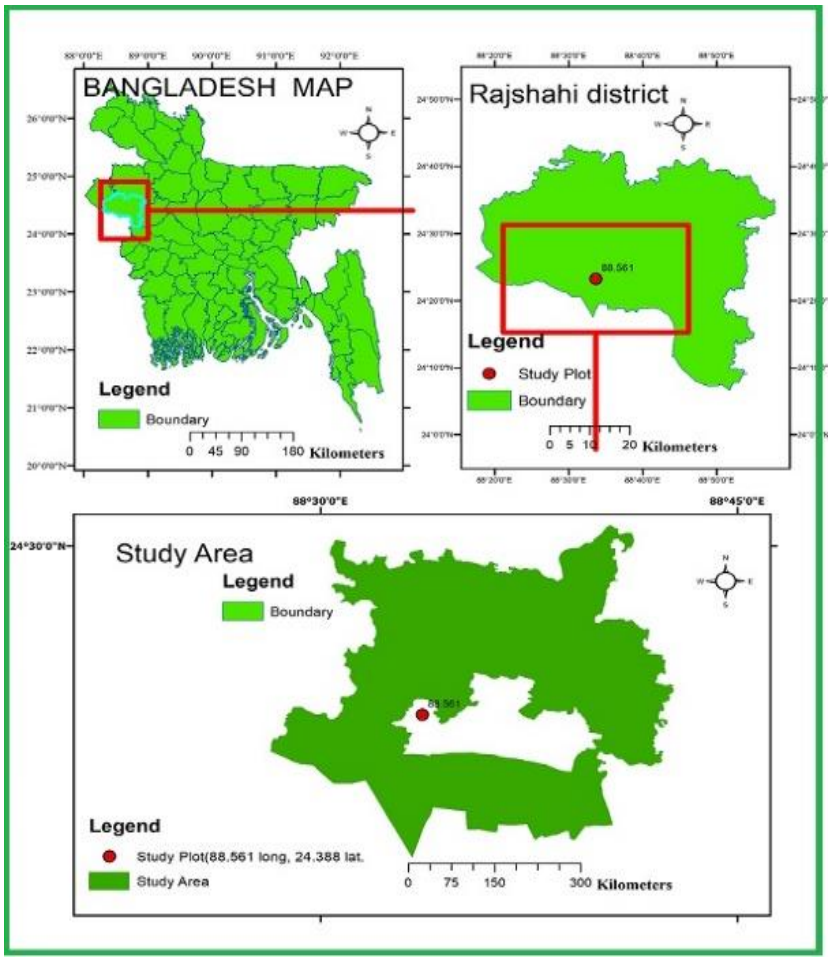

Figure 2. *Location of study area.*

2.3. Vegetable Cultivation Method

Land was prepared by spade for several times to obtain the desirable tilth. Laddering was done to level the soil. The large clods were broken into small pieces by wooden hammer. Weeds and others stubbles were removed from the field. Seeds were sown after the land preparation. Organic fertilizers were incorporated in soil 15 days before land preparation. Inorganic fertilizers were mixed during final land preparation. Further all agricultural practices like irrigation and weeding were done as regularly.

2.4. Soil samples Collection

Soil samples were collected before one month of sowing. Samples were collected randomly from the field in depth of 6 inches with help of spade. The soil sample was packaged in polythene bags then send laboratory for tests. After harvesting soil samples from each plot were collected as described before and plant samples from each plot was send to Ecology and Biodiversity Laboratory and Microbiology Laboratory of Department of Microbiology, University of Rajshahi.

2.5. Data Collection

Plant height, shoot length, root length, and stem length were measured in cm and the yield was measured in kg per decimel (Figure 3).

Figure 3. *Data collection from the experimental plots.*

2.6. Measurement of Microbial Weight

Soil containing microbial weights were measured using Escudero and Madirolas protocol (2022) with a slight modification [8]. For this research, first, 1 g soil was added with 1 ml autoclave distilled water in a test tube and mixed well using vortex machine. After that, the mixtures were filter using What Man filter paper [9]. Instantly liquid was collected and total volume was made up to 1 ml using distilled water. Later, weights of liquid containing microbes were measured using double beam UV-Vis Spectrophotometer (Infitek, USA).

2.7. Preparation of LB Liquid Medium

The best method was followed for preparation of the LB liquid medium [10]. In brief, a beaker containing required amount of distilled water was taken. Then the required constitution (yeast, peptone) were added one by one after dissolving the other. Then, the medium was taken into a measuring cylinder and required volume was made by adding double distilled water. Then the medium was taken again in the beaker and placed on magnetic stirrer for homogenous mixing of the constitution. The pH of the medium was also adjusted. The pH of the constitution was generally adjusted to 7.3-7.5 using 0.1 N NaOH and 0.1 N HCl where necessary with the help of pH meter. The prepared medium was distributed in conical flasks and covered with aluminum foils and autoclave at 121°C under 15 Ib/sq inch above atmospheric pressure for 20 minutes. After autoclaving, the medium was taken in the sterilized laminar air flow cabinet and dispend into autoclaved petridishes or glass bottles.

2.8. Isolation and Culture of Bacteria

Bacterial culture and growth were performed by a previous method [11]. First of all, crop roots were surface disinfested using a dilute sodium hypochlorite solution (10%) and rinsed thoroughly. Once bacterial streaming is confirmed, surface-disinfested tissue is placed in a LB liquid medium and is allowed to grow bacteria into LB liquid medium overnight in an incubator at 37 ℃. LB broth medium containing Test tube was used as negative control (Figure 4). After incubation culture media was changed in to turbid. But the control test tube media was crystal clear.

Figure 4. *Culture of bacteria in the microbiology lab.*

3. Results and Discussion

The experimental data revealed that organic and inorganic fertilizer significantly affect the growth and yield of *Amaranthus* spp. and weight of microbes present in the soil also influenced by the experimental treatments. Plant height, shoot length, stem length root length as well as yield are significantly differed from each other. The highest plant height (32.70 cm), shoot length (39.66 cm), and stem length (28.04 cm) were found in T_1 treatment and yield (51.93 kg/ deci) was highest in the same treatment. In case of root length the highest value was in T_5 (9.68 cm) followed by T_4 (8.91 cm). The lowest values were found in T_0 the control treatment in all the respective characters (Table 1).

In case of microbial weight it was found that T_5 treatment that is tricho-compost treatment had highest (1.161 µg/kg of soil) weight of microbes and T_2 that was 10% extra from recommendation dose of inorganic fertilizer showed the lowest (0.1293 µg/kg of soil). It might be due to excessive chemical harm the microbes and trichocompost enhance the presence of microbes. T_4 treatment that was vermicompost was the second highest among the treatments (Table 2).

Table 1. Morphological characters and yield of Amaranthus spp.

Treatments	Plant height in cm	Shoot length in cm	Stem length in cm	Root length in cm	Yield in kg/decimel
T_0	18.65 e	25.65 f	15.01 e	6.9 e	19.81 e
T_1	32.70 a	39.66 a	28.04a	8.24 c	51.93 a
T_2	27.01 c	33.80 d	23.33 c	7.23 d	46.69 c
T_3	24.39 d	32.28 e	20.33 d	7.61 d	31.67 d
T_4	28.48 b	35.96 c	24.96 b	8.9 b	48.89 b
T_5	32.04 a	37.46 b	27.39 b	9.68 a	50.16 b
LS	*	*	*	*	*
CV	3.27	2.61	3.85	11.06	2.14

Table 2. Microbial weight of different treatments.

Treatments	Weight of microbes in µg/kg of soil
T_0	0.4594 d
T_1	0.4061 e
T_2	0.1239 f
T_3	0.6747 c
T_4	0.9584 b
T_5	1.1617 a
LS	*
CV	3.27

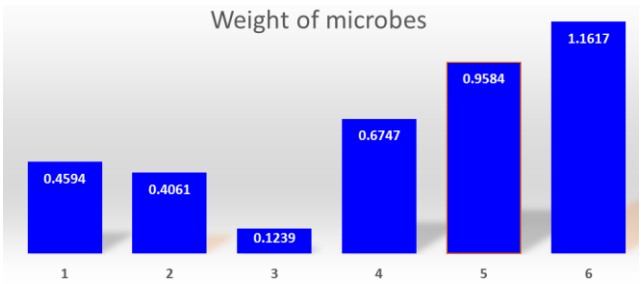

Figure 5. Weight of microbes in microgram per 1 kg soil.

Figure 5 presenting the weight of microbes of six different treatment in the experiment. The highest weight of microbes was present in T_5 treatment and the lowest microbes were found in T_2 treatment that is 10% extra from recommendation dose of inorganic fertilizer (T_2).

Microbial population enhanced by cow dung application and maintain soil health for sustainable agriculture. Cow dung and vermicomposting improve productivity and increase soil organic matter and water holding capacity. It also influences productivity of yield [12]. Microorganisms make organic manures in break down state in soil to have carbon and release nitrogen for the plants. organic manure application can change C:N ratio [13]. Five groups of microorganisms (bacteria, actinomycetes, fungi, algae, and Protozoa) are present in soil. Among them heterotrophs require an organic substrate. Population of zymogenous organisms grow rapidly when an organic substrate is added [14]. soil microbes provide soil richness by slow releasing nutrients, continuous breaking down of complex macro- molecules and natural products into simpler ones to enrich beneficial substance, maintaining physical and chemical properties of the soil [15].

4. Conclusions

Soil microbes enhance the nutrient use efficiency of the plant make the soil favorable for plant growth and development. Organic fertilizers make the soil well for soil microbe's population and play important role for soil health. Crop yield also influenced by soil health. The study revealed that organic source of nutrient lead the enhancement of microbial weight which is good indicator of soil health, emphasizing its significance and relevance.

Abbreviations

LS	Level of Significance
CV	Coefficient of Variation
RCBD	Randomized Complete Block Design

Author Contributions

Sabia Sultana: Formal Analysis, Investigation, Writing – original draft, Writing – review & editing

Md Redwanur Rahman: Data curation, Supervision, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare that no conflicts of interest.

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