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Impact of Different Rates of N_2 Fertilizer Amendment and Foliar Spraying with Compost Tea on the Biological Activity and the Productivity of Rice Plants

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CURRENTLY, compost tea combined with N chemical fertilizer raises the soil's soluble salts and microbial biomass, which in turn increases rice plant yield. The effects of various chemical N dosages (55, 110, and 165 kg N ha^{-1}) in conjunction with foliar spray and compost tea (140 L ha^{-1}) on soil microbial activity, nutrient content, and rice plant yield were assessed in a field experiment carried out in two consecutive seasons in 2023 and 2024 at the Rice Research and Training Center experimental farm in Sakha, Kafrelsheikh, Egypt (Giza 183). Three replicates of a randomized Complete Block Design were employed. According to the findings, the total number of aerobic, N_2-fixing, nitrogen-fixing cyanobacteria, and nitrifier bacteria was increased significantly ($P \leq 0.05$) when chemical N fertilizer was mixed with compost tea. Higher fertilizer nitrogen rates, however, resulted in a substantial drop in the number of sulphate-reducing bacteria, suggesting that transplanting may have an effect on the soil quality in rice plants at 60 DAS. Additionally, the treatment of 165 kg N ha^{-1} + compost tea resulted in a considerable increase in the highest values of dry matter, grain weight, filled grain per panicle, filled grain percentage, and yield. The microbial communities in compost tea may be the cause of this rise since they promote plant development and nutrient uptake, which increases output. Additionally, compared to the control treatment, the maximum values of N and protein percentage were obtained with an applied of 165 kg N ha^{-1} with spray compost tea. P and K percentages in rice cultivar grain during the 2023 and 2024 seasons showed the similar pattern. As a result, the microbial biomass was significantly impacted and rice plant production was increased by the combined treatment of chemical N fertilizer (165 kg N ha^{-1}) + compost tea.

Keywords: Rice, Organic fertilizers, Nitrogen fertilizers, Microbial biomass, Yield.

1. Introduction

Rice (*Oryza sativa* L.), a principal staple crop, serves as a crucial cereal that sustains over three billion people globally, providing 50 to 80% of their daily caloric consumption **(FAOSTAT, 2019**). In Egypt, approximately 642,501 hectares are farmed each year, resulting in an overall yield of 5.6 million tons **(FAOSTAT, 2023).** Scientists have managed to boost crop production by creating better rice varieties through breeding (molecular), however work is ongoing to further improve the yield characteristics of rice genotypes to address the rising food demand **(Seck et al. 2023; Rezvi et al. 2023).**

Nonetheless, contemporary farming techniques like sustainable fertilizer management could enhance the capability of current varieties to achieve greater yields **(Khan et al. 2024).** The Egyptian farmers utilized substantial quantities of mineral fertilizers to meet the needs of the rice crop. This is quite expensive which leads to environmental contamination. Crop scientists globally are confronting this

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concerning issue and are working to address it by investigating alternative sources that are both economical and environmentally friendly **(Elekhtyar et al. 2017, Ghazy et al. 2024).**

Nitrogen (N) is essential for the growth of crops, enhancing both the yield and quality of rice. Large quantities of synthetic nitrogen are utilized worldwide to enhance productivity. The application of N in scientific contexts fosters root development as well as the absorption of water and N, yet using too much N fertilizer can impede the production of high-yielding and efficient rice **(El-Akhdar et al. 2018, Zhang et al. 2024).** Nitrogen, generally used as urea, is the key element that influences rice yield significantly. Consequently, to enhance nitrogen use efficiency in crops and minimize off-field losses, it is crucial to comprehend the molecular mechanisms responsible for nitrogen homeostasis in heavily nitrogen-fertilized agricultural systems. Even with the best agronomic practices, only 30 to 40% of the urea-based nitrogen applied is absorbed by crops; however, high yields of irrigated rice are usually associated with increased doses of nitrogen fertilizer **(Akter et al. 2022).** Because of various losses (volatilization, leaching… etc), it is challenging to use nitrogenous fertilizer effectively **(Burkitt, 2014).**

Releasing metabolites i.e. growth regulators and hormones, improving the accessibility and absorption of nutrients and inhibiting pathogens in the soil **(Ouf et al. 2023; Ali, and Glick 2024).** Compost tea is rich in humic acids, hormones, amino acids, minerals, and microorganisms. These compounds can boost a range of crops' growth and output while fortifying their disease resistance (**Omara et al. 2022, Rashed and Hammad 2023, Shaker et al. 2024**). Compost tea produces gibberellic acids **(Pant et al. 2012)** and cytokinins **(Zhang et al. 2014),** which can be applied as a root drench or foliar spray to encourage root elongation and plant growth. It also buffers soil pH because of its organic acids and humic compounds **(Van Heerden and Hardie 2020**). The usage of organic fertilizer enhances leaf water conditions, nutrient absorption, nutrient balance, chlorophyll production, osmolytes, hormone levels, secondary metabolite synthesis and antioxidant activities, leading to better resilience against abiotic stress **(Liu et al. 2024).**

To improve soil nutrients and boost crop productivity, chemical and organic fertilizers can be used in combination. **El-maghraby et al. (2024)** showed that foliar application with compost tea significantly enhances soil properties, bacterial and fungal community as well as maize and wheat crop yield. Organic amendments improve soil quality traits; whereas the mixture of chemical fertilizers with cattle and poultry waste boosts soil fungal community structure. The application of both organic and inorganic fertilizers influences microbial biomass and nutrient concentrations, which in turn have an indirect effect on yield. According to **Liu et al. (2023),** using appropriate cropping methods and partially substituting organic fertilizers for mineral fertilizers can increase soil nutrient availability, microbial activity, and rice yield. **Krismawati et al. (2024**) examined how mixing organic and inorganic fertilizers affected rice output and discovered that the recommended rates of inorganic fertilizer treatment with 1,000 kg of organic fertilizer per hectare increased soil C-organic levels and rice grain yield by 23.25%. In addition, **Amer et al. (2020)** showed that foliar application of compost tea was more effective treatment in improving yield of rice and wheat in salt affected soils. **Xu et al. (2025)** demonstrated that the long-term use of both chemical and organic fertilizers enhances OC storage and increases rice plant productivity, thereby aiding agricultural sustainability. Our research aimed to explore the synergistic impact of compost tea as a foliar spray alongside various amounts of mineral N_2 fertilizer to improve the microbial biomass production, nutrient content, and yield of rice plants (Giza183) in the 2023 and 2024 growing seasons.

2. Materials and Methods

In order to investigate the effects of applying compost tea spray at different nitrogen levels on the behavior of the Giza183 rice cultivar, two field experiments were conducted in the 2023 and 2024 growing seasons. During the two seasons, wheat was the prior crop. Table 1 lists a few characteristics of the soil location at RRT Center, Sakha, Kafr El-Sheikh, Egypt.

Table 1: Before planting in the summers of 2023 and 2024, a few soil characteristics of the experimental soil.

Soil properties	2023	2024
Texture	Clayey	Clayey
O.M (%)	1.22	1.35
pH	8.2	8.3
EC (dS m^{-1})	3.2	3.39
N (total, ppm)	435.00	515.00
P (Avaliable, ppm)	5.8	6.3
K (Avaliable, ppm)	215	240.8
NH_4 (Available, ppm)	16.0	17.3
NO_3 (ppm)	13.5	14.6

The experimental design was randomized Complete Block Design with three replications. The treatments were as follows: T1: 55 kg N ha^{-1} + with compost tea; T2: 55 kg N ha^{-1} + without compost tea; T3: 110 kg N ha^{-1} + with compost tea; T4: 110 kg N ha^{-1} + without compost tea; T5: 165 kg N ha^{-1} + with compost tea and T6: 165 kg N ha^{-1} + without compost tea. The recommended dose of N applied for rice cultivation was 165 Kg ha^{-1}

The permanent field was properly prepared, having been plowed twice and then well-leveled with water. After 30 days of seeding, the seedlings were carefully removed from the nursery and dispersed over the plots. At a pace of two to three seedlings per hill, the seedlings were manually moved into 15 m^2 plots with a transplant spacing of 20 x 20 cm. Before harvesting, plots were kept inundated for two to three weeks.

The test soil was treated with fertilizers containing zinc, phosphorus, and nitrogen. The dry soil was treated with a basal application of calcium super phosphate (15 % P_2O_5) at a rate of 36 kg ha^{-1} prior to plowing. A final ⅓ dose of N was added before panicle initiation (roughly 30 days after transplanting), after a ⅔ dose of N was applied and incorporated into the dry soil prior to flooding. Nitrogen (urea 46% N) was added at rates of 55, 110, and 165 kg N ha^{-1}, depending on the treatment. Apply compost tea spray (DAT) three times a week (30 and 45 days after transplanting). The application of agronomic treatments have been done in accordance with the recommended methods of rice cultivation. Compost tea was diluted with 460 L water ha^{-1} and administered topically at a rate of 140 L ha^{-1}. Throughout the two seasons, the compost tea traits were as follows: pH (7.1 and 7.3); EC (2.44 and 2.73 dS m^{-1}); total nitrogen (5125 and 5288 ppm); available phosphorus (3355 and 3715 ppm); available potassium (4336 and 4534 ppm); total bacterial count (7.4 and 7.7 log cfu mL^{-1}); total actinomycetes count (4.60 and 4.80 log cfu mL^{-1}); and total fungal count (4.10 and 4.12 log cfu mL^{-1}); respectively.

Measurements

Microbial enumeration

Sterile physiological saline (8.5 gL^{-1}) was used to create a series of decimal dilutions. 1.0 ml of the higher dilutions and the traditional plate counts method were used to assess the total aerobic and total nitrogen-fixing bacterial counts **(Allen, 1950).** Additionally, the most probable number (MPN) technique, developed by **(Cochrane 1950),** was used to identify the cyanobacteria, nitrifiers, and sulphate-reducers. All microbiological enumerations were finished 60 days after transplantation.

Total aerobic bacteria

The soil extract agar medium **(Mahmoud 1955)** was used to determine the total aerobic bacteria count. It had the following ingredients in g L^{-1}: 500 ml of soil extract; 500 ml of tap water; 0.5 of K_2HPO_4; 0.5 of yeast extract; 1.0 of glucose; and 15.0 of agar agar. After adjusting the medium to pH 7, it is autoclaved for 15 minutes at 121°C, and then incubation for 5 days at 28 °C.

Total N_2 fixing bacteria

A free-living putative N_2-fixing bacterial medium was used to count the total number of N_2-fixing bacteria **(Rennie 1981).** Solution I (0.8 g of K_2HPO_4 and 0.2 g of KH_2PO_4; 28.0 mg of Na_2Fe EDTA; 25.0 mg of $Na_2MoO_4.2H_2O$; 0.1 g of NaCl; 0.1 g of yeast extract; 5.0 g of mannitol; 5.0 g of sucrose; 0.5 mL of Na-lactate (60% v=v); 900 mL of H_2O; and 15.0 g of agar). Solution II: 100 mL of H_2O; 0.2 g of $MgSO_4.7H_2O$; 0.06 g of $CaCl_2$. Solution III: 10:0 mg mL^{-1} of p-aminobenzoic acid (PABA) and 5.0 mg mL^{-1} of biotin. After adjusting the pH of solutions I and II to 7, autoclaving them for 15 minutes at 121°C, letting them cool to 48°C, and thoroughly mixing them and add 1 mL L^{-1} of solution III by filter-sterilized 0:45 mm.

N_2 - fixing cyanobacteria

By the MPN, N_2 - fixing cyanobacteria was determined **(El–Nawawy et al. 1958),** using the Modified Watanabe medium, which adjusted to pH 7, autoclaved for 15 minute at 121°C .

Sulphate reducing bacteria

According to **Abd El-Malik and Risk (1958),** Starkey's medium was used to count the MPN of sulphate-reducing bacteria. After adjusting the medium's pH to 7, it is autoclaved for 15 minutes at 121°C. Ferrous sulphide developed a bluish-black coloration that indicated positive tubes when the infected tubes were cultivated for two weeks at 30°C.

Nitrifiers bacteria

Stephenson's medium, which contained g L^{-1} of ammonium sulphate 2, K_2HPO_4 0.75, $FeSO_4.7H_2O$ 0.01; KH_2PO_4 0.25, $MnSO_4.4H_2O$ 0.01; $MgSO_4.7H_2O$ 0.03; $CaCl_2$ 0.002; and 1000 ml of distilled water, was used to identify the nitrifiers bacteria for autotrophic nitrifiers **Stephenson (1950).** After adjusting the medium's pH to 7, it was autoclaved for 15 minutes at 121°C. Each tube was autoclaved and then filled with a sterile $CaCO_3$ knife tip. The generated nitrate was detected using diphenylamine in concentrated sulfuric acid after three weeks of incubation at 30°C.

Yield and its attributes:

Dry matter accumulation: 60 days after transplanting, the dry weight of the plants was measured in g m^{-2}. Number of panicles m^{-2}: was calculated after counting the panicles in the hill at harvest. Weight of panicles (g): The actual average weight in grams was calculated after ten major panicles were randomly selected from each plot. Number of filled grains panicle^{-1}: From the chosen panicles in each plot, the number of filled grains panicle^{-1} was determined. 1000 grain weight (g): Following harvest, thousands of rough grains were weighed to the closest 0.001 g from each plot. Grain yield (t ha^{-1}): When the grains had a moisture content of roughly 18–20%, rice plants were harvested. Ten square meters were physically harvested from the center of each plot, collected in bundles, and allowed to dry in the field for 3 days. Weighing the air-dried bundles allowed us to record the combined weight of the grain and straw. Grain weight per 10 m^2 was measured after the air-dried bundles were mechanically threshed. A portable moisture meter was used to estimate the moisture content. Grain weight was changed to reflect the 14% moisture content. Grain yield weight was converted to tons per acre.

Chemical compositions:

Sparks et al. (2020), described methods for determining nitrogen, phosphorus, and potassium in the dry matter of grains, respectively

Statistical analysis:

The gathered data was subjected to analyses of variance in compliance with **Gomez and Gomez (1984).** Treatment means were compared using Duncan's Multiple Range Test **(Duncan, 1955).** All statistical analyses were conducted using the "COSTAT" computer software suite.

3. Results

Microbial enumeration

The total number of aerobic and N_2-fixing bacteria, as well as their distribution and abundance, were analyzed and expressed in terms of log10 converted CFU g^{-1} soil. In contrast, cyanobacteria, nitrifiers, and sulphate-reducing bacteria were counted as colony forming units (CFU g^{-1} soil). The microbial enumeration revealed that variations may be noted in the rates at which nitrogen fertilizer and compost tea foliar spray were applied.

Total count of aerobic bacteria and N_2- fixing bacteria

Overall, it was discovered that the total count of aerobic and N_2-fixing bacteria was significant ($p \leq 0.05$) in relation to the various rates of nitrogen fertilizer and foliar spray with compost tea following treatment at 60 DAS from transplanting. The treated rice plants with 110 Kg N ha^{-1} treatment with foliar application by compost tea exhibited increases of 6.63 and 6.03 log CFU ml^{-1} in the total count of aerobic bacteria (Figure 1A) and 4.89 and 5.25 log CFU ml^{-1} in N_2-fixing bacteria (Figure 1B) when compared to the other treatments that were studied during the 2023 and 2024 seasons. As previously mentioned, for the total count of aerobic bacteria, all investigated treatments might be grouped in descending order as T3 > T2 > T5 > T6 > T1 > T4 and for N_2-fixing bacteria, T3 > T1 > T2 > T5 > T6 > T4 (Figure 1).

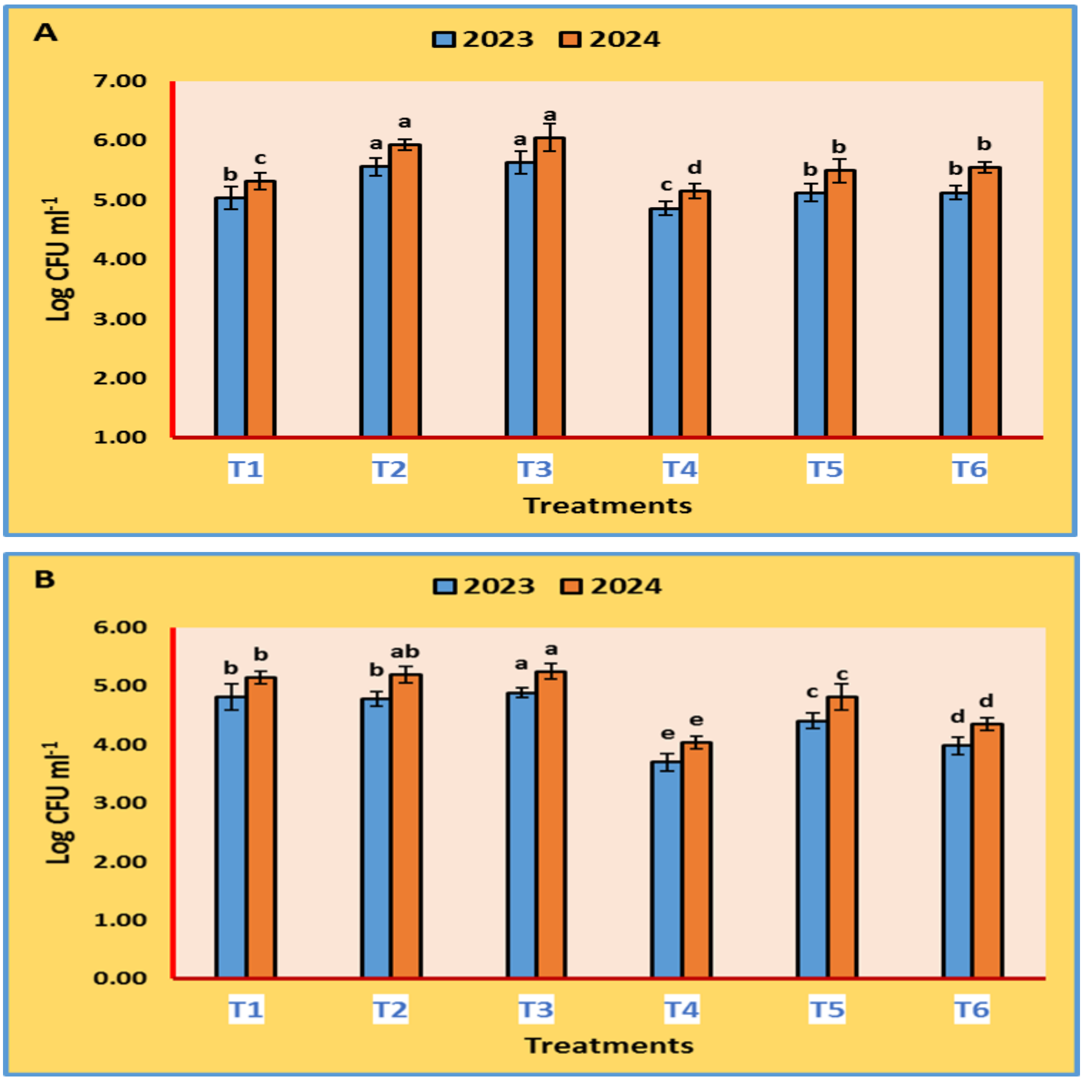

Figure 1: Behavior of different rates of nitrogen fertilizer and foliar spray with compost tea on total count of aerobic bacteria (A) and N_2- fixing bacteria (B), at 60 days from transplanting during 2023 and 2024 seasons. T1: 55 Kg N ha^{-1} + with compost tea; T2: 55 Kg N ha^{-1} + without compost tea; T3: 110 Kg N ha^{-1} + with compost tea; T4: 110 Kg N ha^{-1} + without compost tea; T5: 165 Kg N ha^{-1} + with compost tea and T6: 165 Kg N ha^{-1} + without compost tea

N_2 fixing cyanobacteria, sulphate reducing bacteria and nitrifiers bacteria

In general, it was discovered that the presence of N_2-fixing cyanobacteria, sulphate-reducing bacteria, and nitrifiers bacteria in relation to varying nitrogen fertilizer rates and foliar sprays with compost tea following treatment was significant ($p \leq 0.05$). In comparison to the other treatments studied during the 2023 and 2024 seasons, the treated rice plants with 165 Kg N ha^{-1} treatment and foliar application by compost tea showed an increase values of 19.09 $\times 10^3$ g^{-1} soil and 19.20 $\times 10^3$ g^{-1} soil for nitrogen fixing cyanobacteria and 0.82 $\times 10^3$ g^{-1} soil and 0.90 $\times 10^3$ g^{-1} soil for nitrifiers bacteria (Figure 2A, C). Conversely, it was discovered that the number of sulphate-reducing bacteria decreased noticeably and significantly as fertilizer nitrogen rates increased (Figure 2B), yielding results of 0.08 $\times 10^3$ g^{-1} soil and 0.20 $\times 10^3$ g^{-1} soil with foliar compost tea application and 0.16 $\times 10^3$ g^{-1} soil and 0.25 $\times 10^3$ g^{-1} soil without foliar compost tea application at 165 Kg N ha^{-1} treatment during 2023 and 2024 seasons, respectively.

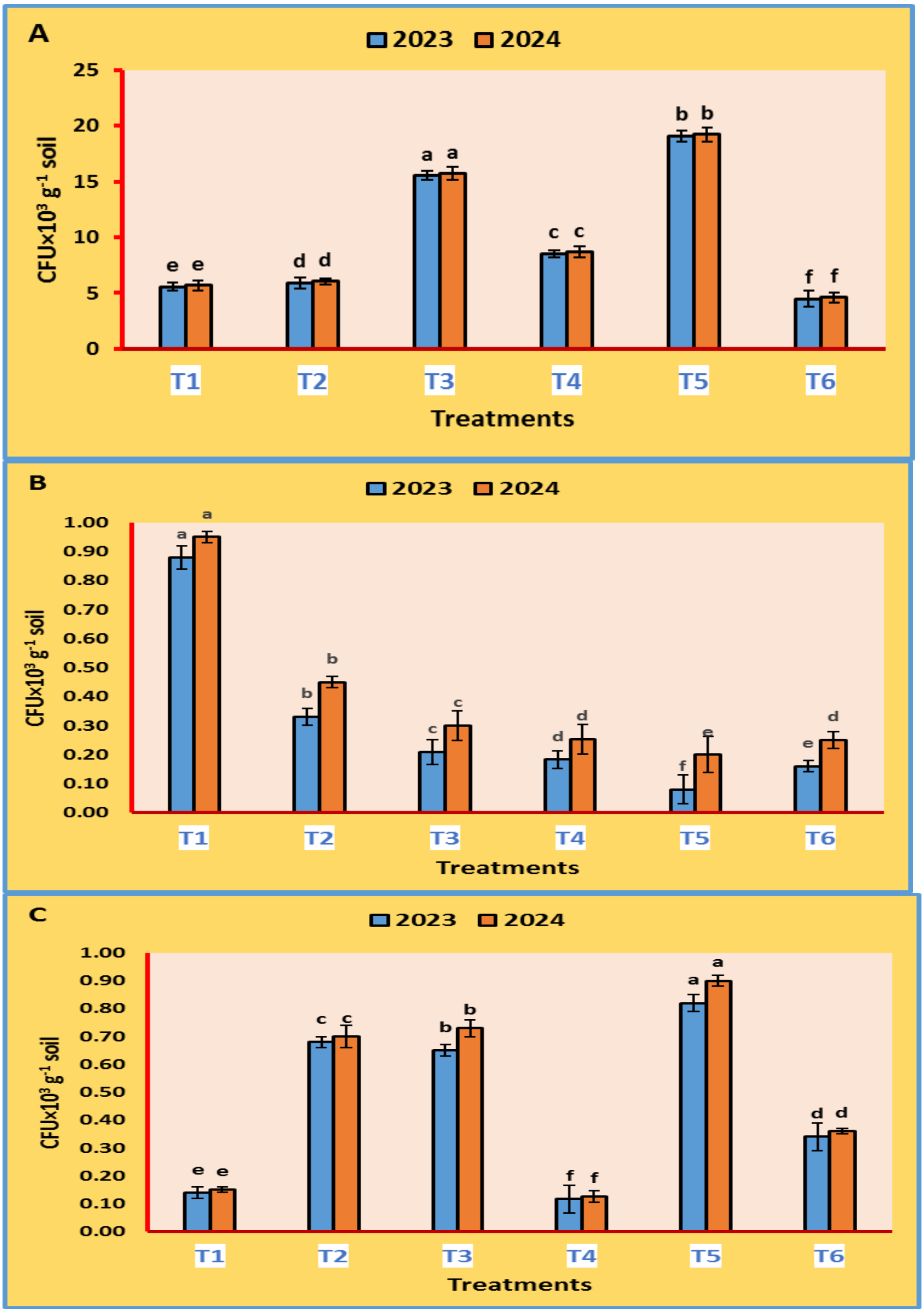

Figure 2: Behavior of different rates of nitrogen fertilizer and foliar spray with compost tea on N_2-fixing cyanobacteria (A), sulphate reducing bacteria (B) and nitrifies bacteria (C) at 60 days from transplanting during 2023 and 2024 seasons. T1 – T6: See below Figure 1.

Dry matter of plant

Figure 3 shows the dry matter accumulation (DAT) of rice cultivar Giza 183 in the 2023 and 2024 seasons as influenced by nitrogen rates and compost tea. Data showed that dry matter accumulation at 60 significantly increased by increasing nitrogen level application with compost tea foliar spray as bio-organic fertilizer. Dry matter was gradually increased by increasing nitrogen rate and spray with compost tea.

Plants treated 165 kg N ha^{-1} +with compost tea (T5) accumulated greater dry matter than the other in both seasons, but plants received 110 kg N ha $^{-1}$+ with compost tea (T3) gave the same dry matter accumulation by application 165 kg N ha^{-1} without compost tea with no significantly difference (Figure 3).

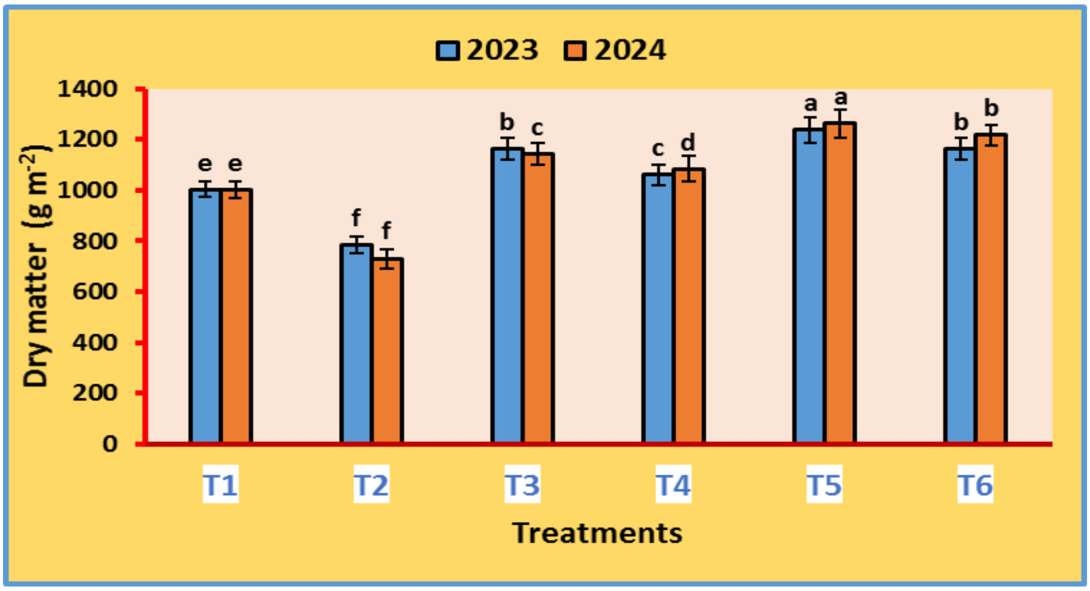

Figure 3: Dry mater accumulation (g m^{-2}) of rice cv. Giza 183 as affected by different nitrogen levels and compost tea in 2023 and 2024 seasons at 60 days from transplanting. T1 – T6: See below Figure 1.

Yield and its attributes

Number of panicle, panicle weight and number of filled grain/panicle

Table 2 showed that number of panicle (m^{-2}), panicle weight (g) and number of filled grain/panicle percentage of Giza 183 rice as affected by different rates of N fertilizers and foliar spray with compost tea in 2023 and 2024 seasons. Grain weight, number of filled grain per panicle and filled grain percentage increased significantly by increase of nitrogen level with spray compost tea compare without compost tea. Application of 110 kg N ha^{-1} with spray compost tea gave the same results of application of 165 kg N per hectare without spray compost tea (Table 2).

Table 2: Number of panicle (m^{-2}), panicle weight (g) and number of filled grain/panicle of rice cv. Giza 183 as affected by varying nitrogen levels and compost tea in 2023 and 2024 seasons

Treatments	No panicles (m^{-2})		Panicle weight (g)		No of filled grain/panicle (%)	
	2023	2024	2023	2024	2023	2024
T1	401.60 e	405.00 e	3.60 c	3.90 c	140.40 d	140.20 e
T2	390.60 f	375.30 f	3.10 d	3.09 d	138.30 e	138.20 f
T3	495.00 c	490.60 c	4.07 b	4.20 b	147.80 b	146.80 c
T4	484.00 d	470.30 d	3.60 c	3.70 c	145.10 c	145.20 d
T5	528.60 a	530.30 a	4.40 a	4.50 a	150.70 a	150.50 a
T6	510.30 b	513.30 b	4.10 b	4.30 b	148.60 b	148.60 b
F. test	**	**	**	**	**	**

According to Duncan's Multiple Range Test (DMRT), the means of each component in a column that is marked by the same later are not significantly different at the 0.05 level. T1 – T6: See below Figure 1.

Filled grain, 1000-grain weight and grain yield

Results in Table 3 showed that 1000-grain weight (g) and grain yield ton ha^{-1}. The combinations of fertilizers had a significant effects on 1000 grain weight in both season. The lowest values of 1000 grain weight obtained with the highest treatment of fertilizer (165 kg N ha^{-1} + with compost tea). Grain yield increased significantly with spray compost tea with any level of nitrogen fertilizer compare without compost tea in both season. The highest grain yield obtained with treatment 165 kg N ha^{-1} + with compost tea (T5) compare with 165 kg N ha^{-1} without compost tea and there was no significant differences between treatment 110kg N/ha^{-1} + with compost tea (T3) and 165 kg N ha^{-1} + without compost tea (T6) in grain yield the first season only this increase in grain yield may be due to microbial communities present in compost tea which stimulate nutrient uptake and plant growth and leads to yield enhancement (Table 3).

Table 3: Filled grain (%), 1000-grain weight (g) and grain yield (t ha^{-1}) of rice cv. Giza 183 as affected by different nitrogen levels and compost tea in 2023 and 2024 seasons

Treatments	Filled grain (%)		1000 grain weight (g)		Grain yield (t ha^{-1})	
	2023	2024	2023	2024	2023	2024
T1	90.15 e	90.30 e	25.50 b	25.50 b	7.65 e	7.61 d
T2	88.52 f	89.10 f	26.43 a	26.00 a	6.56 f	6.34 e
T3	92.21 c	92.70 c	24.10 cd	24.60 c	9.88 c	10.74 b
T4	91.06 d	91.30 d	25.46 b	25.10 bc	9.13 d	8.87 c
T5	93.45 a	94.20 a	23.53 d	23.60 d	11.50 a	11.53 a
T6	92.81 b	93.60 b	24.50 c	24.50 c	10.71 b	10.82 b
F. test	**	**	**	**	**	**

According to Duncan's Multiple Range Test (DMRT), the means of each component in a column that is marked by the same later are not significantly different at the 0.05 level. T1 – T6: See below Figure 1.

Chemical compositions

Data presented in Table 4 showed that chemical elements and protein in grain of Giza 183 rice cultivar as affected by foliar spray compost tea as bio-organic fertilizer under different nitrogen fertilizers rates in 2023 and 2024 seasons. Nitrogen and protein % in grain increased significantly by increase of nitrogen level with spray compost tea compare without compost tea. The highest value of N and protein % were obtained with application of 165 kg N per hectare with spray compost tea compere without compost tea. In addition, P and K % in grain of Giza 183 rice cultivar in 2023 and 2024 seasons recorded the highest values at T5 treatment (165 kg N ha^{-1} + with compost tea), while the lowest value obtained with application T2 treatment (55 kg N ha^{-1} + without compost tea) in both season (Table 4).

Table 4: Protein, nitrogen, phosphorus and potassium (%) in grains of rice cv. Giza 183 as affected by different nitrogen levels and compost tea in 2023 and 2024 seasons

Treatments	Protein (%)		N (%)		P (%)		K (%)	
	2023	2024	2023	2024	2023	2024	2023	2024
T1	6.91 e	6.41 d	0.061 c	0.060 d	0.161 e	0.163 e	0.35 c	0.33 c
T2	5.02 f	4.84 e	0.057 d	0.048 e	0.153 f	0.155 f	0.28 d	0.28 d
T3	7.82 c	6.80 c	0.089 b	0.072 b	0.174 c	0.175 c	0.38 b	0.36 b
T4	7.32 d	6.43 d	0.062 c	0.065 c	0.163 d	0.167 d	0.34 c	0.33 c
T5	9.69 a	8.50 a	0.126 a	0.117 a	0.217 a	0.226 a	0.41 a	0.40 a
T6	8.61 b	7.43 b	0.090 b	0.072 b	0.178 b	0.183 b	0.39 b	0.37 ab
F. test	**	**	**	**	**	**	**	**

According to Duncan's Multiple Range Test (DMRT), the means of each component in a column that is marked by the same later are not significantly different at the 0.05 level. T1 – T6: See below Figure 1.

4. Discussion

Investigating how inorganic and organic fertilizer treatments affect the dynamics and structure of the plant rhizosphere microbial population as well as how they improve rice plant growth and production is essential to achieving the sustainable development goals. The experiment's findings demonstrated that rice plant development was much enhanced in soils receiving varying N dosages of inorganic fertilization or compost tea as an organic fertilizer, with the inorganic fertilizer treatments producing the greatest plant growth. Thus, for optimal uptake and utilization, N supply and crop need must be synchronized. In the rhizosphere of rice plants grown under varying rates of N fertilizer, the total count of aerobic bacteria, nitrogen-fixing bacteria, cyanobacteria, nitrifiers, and sulphate-reducing bacteria at the flowering stage varied significantly with respect to the foliar spray with compost tea in both seasons 2023 and 2024 ($p \leq 0.05$).

Soil degradation, nutrient cycling, organic matter breakdown, and bioremediation of soil contamination are all impacted by the diversity of soil microorganisms **(Li et al. 2012).** According to **Edmeades (2003),** changes in the makeup and structure of the microbial population in terrestrial agro-ecosystems are reliable markers of soil biological activity and crop productivity. Nitrogen fertilizer significantly ($P \leq 0.05$) raised the Shannon, Pielou, and Simpson diversity indices in comparison to the control soil, resulting in a more stable soil environment for plants **(Chen et al. 2018). Chen et al. (2019)**

claim that the addition of N and C cycle bacteria alters the rhizosphere soil's utilization of carbon and nitrogen, which could impact the production of rice crops. Comparative metaproteomics was used to understand the connections between nitrogen treatments, soil microbiota, and plant root response. By hydrolyzing urea through the action of urease in the soil, which releases NH_4-N, soil nitrogen mineralization is an essential process that provides a sufficient amount of nitrogen required for plant growth and development **(Chang et al. 2007; Tao et al. 2009).** This process has an impact on the soil microbial community, particularly the state of the soil's physico-chemical conditions **(Burke et al. 2011).** According to our findings, the N fertilizer (165 Kg N ha^{-1}) significantly increased the microbial community ($P \leq 0.05$) in comparison to the other treatments under study, creating a more stable soil environment for plants. Several studies have demonstrated that compared to soils receiving low-N fertilization, soils receiving N input generate more extracellular enzymes involved in the biogeochemical cycles linked to C, N, and P transformations **(Francioli et al. 2016; Murugan et al. 2019).** Accordingly, our study demonstrated that under all inorganic fertilization treatments (55, 110, and 165 Kg N ha^{-1}), the rhizosphere microbial activity (total count of aerobic bacteria, N_2-fixing bacteria, cyanobacteria, and nitrifiers) increased in response to N fertilization; however, the foliar spray with compost tea treatment resulted in a minor improvement **(Chen et al. 2019; Omara et al. 2022; Carrascosa et al. 2023, Elbagory et al. 2024).**

The substantial rise in dry weight caused by compost tea may be the cause of the increase in dry matter accumulation for the vegetative development and yield components **(Vanishri and Anil 2019).** Applying compost tea along with nitrogen fertilizers increases plant biomass and yield and may stimulate plant growth **(Kim et al. 2015).** Additionally, compared to when compost tea was not used, the number of panicles m^{-2} at harvest increased greatly due to the higher nitrogen content. This could be because compost tea significantly increased the number of productive tillers per plant. These findings concur with those of **Vanishra and Anil (2019).** The 1000-grain weight, the number of spikelet panicals^{-1}, and the number of filled spikelets panicals^{-1} all show these outcomes.

The efficiency of foliar spraying with compost tea in raising rice plant productivity and lowering the need for mineral fertilizers has been the subject of numerous studies. **Elekhtyar et al. (2017)** discovered that, although there were no appreciable variations with recommended dosages, combining chemical fertilizers with compost tea greatly enhanced crop yield and productivity in Egyptian hybrid rice, reducing the need for chemical NPK fertilizers by one-third, lowering input costs, and minimizing environmental pollution. Additionally, **Abou Hussien et al. (2021)** shown that compost tea increases the macro-micronutrient content, soil chemical and microbial characteristics, and nodule numbers, straw, and seed yield in faba bean plants. In addition, when sprayed to soil or foliage, compost tea extract dramatically increased tomato plants' vegetative growth metrics, yield, and fruit weight in controlled greenhouse circumstances offering important insights for agricultural practices **(Abubaker et al. 2024)**.

Conclusion

A field experiment at the Rice Research and Training Center in Egypt found that compost tea combined with nitrogen chemical fertilizer significantly increased soil microbial activity, nutrient content, and rice plant yield. The study found that higher fertilizer nitrogen rates led to a drop in sulphate-reducing bacteria, suggesting that transplanting may affect soil quality. The combination of chemical nitrogen fertilizer 165 kg N ha^{-1} with spray compost tea resulted in higher values of dry matter, grain weight, filled grain per panicle, filled grain percentage, and yield. This suggests that compost tea may promote plant development and nutrient uptake, increasing rice plant production.

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