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EFFECT OF MICROBIAL ENRICHED COMPOSTS ON GROWTH AND YIELD ATTRIBUTING PARAMETERS OF WHEAT–FODDER MAIZE SEQUENCE IN INCEPTISOL

Nikita B. Gorde[1]*, Ritu S. Thakare[1], V.S. Patil[1], S. R. Shelke[1], B. M. Kamble[1] and M.R. Patil[2]
[1]Department of Soil Science, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India
[2]Department of Agricultural Statistics, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India
*Corresponding author E-mail: nikitagorde88@gmail.com
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ABSTRACT

Soil is a living system where microorganisms regulate nutrient cycling and soil fertility. Enhancing microbial activity through enriched composts improves nutrient availability and crop productivity. A field experiment was conducted during *Rabi 2023–Summer 2024* at the Research Farm of the Department of Soil Science, Post Graduate Institute, MPKV, Rahuri, Maharashtra, to evaluate the effect of microbial enriched composts on growth and yield attributing parameters of a wheat–fodder maize cropping sequence grown on Inceptisol. The experiment was laid out in a Randomized Block Design with ten treatments and three replications, comprising recommended doses of fertilizers (RDF) alone and in combination with farmyard manure, organic composts, and their microbial enriched forms. Enriched composts included urban compost, press mud compost, poultry manure, and vermicompost applied @ 3 t ha^{-1} to wheat, while fodder maize was grown on the residual effects. The results indicated that integrated application of inorganic fertilizers with microbial enriched composts significantly enhanced growth, yield attributes, and quality of wheat. Application of RDF + 3 t ha^{-1} enriched poultry manure recorded significantly higher plant height at all growth stages, chlorophyll content, number of tillers per plant (8.43), spike length (9.89 cm), and test weight (44.47 g), along with the highest protein content (14.49 %) and protein yield (662.96 kg ha^{-1}). Treatments receiving enriched vermicompost and enriched press mud compost were statistically comparable. The residual effects of enriched composts significantly influenced fodder maize growth. GRDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1} + 5 t ha^{-1} FYM recorded the maximum plant height, chlorophyll content, number of leaves, leaf length, leaf width, and stem girth, followed by residual effects of enriched vermicompost and enriched poultry manure. The study concludes that integration of microbial enriched composts with inorganic fertilizers is a viable and sustainable nutrient management strategy for improving productivity, quality, and soil health of the wheat–fodder maize cropping sequence in Inceptisol soils.
***Keywords* :** Inceptisol, microbial enriched compost, wheat, fodder maize, growth parameters, and yield attributes

Introduction

The wheat–fodder maize cropping sequence is widely practiced in semi-arid and sub-tropical regions due to its high productivity and ability to meet food and fodder demands. However, continuous cultivation under intensive systems often leads to nutrient depletion and declining soil fertility because repeated extraction of N, P, and K without adequate replenishment depletes soil nutrient reserves over time. Integrated use of organic amendments with fertilizers has been suggested as a means to sustain soil fertility and crop yields in such sequences. Agricultural waste is increasingly being recognized as a valuable and economical source of organic matter and essential nutrients that can enhance soil fertility and support crop growth (Tariq *et al*., 2022). However, the direct use of raw organic waste is not advisable, as it is unsuitable for agricultural land and crops (Wang *et al*., 2023). Composting has emerged as a highly effective, simple, and low-cost method for processing such waste materials (Mącik *et al*., 2020 and Lima *et al*., 2022). It can be done locally on farms, offering a practical solution for waste management. Composting not only helps in recycling nutrients but also improves the soil's physical and biological properties, increases soil organic matter, and boosts crop productivity (Viaene *et al*., 2016 and Nkonya *et al*., 2023). Since the nutrients in compost are released gradually based on microbial activity, it provides a sustained supply of nutrients to plants over time (DeLuca *et al.,* 2015). Organic manures typically contain low levels of essential nutrients, which are often inadequate to fulfill the nutritional needs of crops, particularly in the absence of inorganic fertilizers (Manna *et al*., 2001). To address this limitation, enriching organic manures and composts with approved additives such as rock phosphate, beneficial microbial cultures, and neem cake has proven to be an effective strategy for enhancing nutrient availability in organic farming systems. Properly prepared compost can transform low-input agriculture into a more productive and sustainable system, and inoculating it with microbial cultures further improves its quality and efficacy. While several studies have documented the benefits of enriched composts on individual crops, limited information is available on their cumulative and residual effects on crop sequences, particularly wheat followed by fodder maize in Inceptisol soils. Understanding the response of wheat and fodder maize to microbial enriched composts under a cropping sequence is crucial for developing sustainable nutrient management strategies that enhance productivity without degrading soil health. Therefore, the present investigation was undertaken to evaluate the effect of microbial enriched composts on growth and yield attributing parameters of wheat–fodder maize sequence in Inceptisol.

Materials and Methods

Experimental Site

A field experiment was conducted during *Rabi* 2023 to *summer* 2024 at the Research Farm of the Department of Soil Science, Post Graduate Institute, MPKV, Rahuri, on Inceptisol soil. The experimental soil was clayey in texture (44% clay, 32% silt, 24% sand) with a bulk density of 1.32 Mg m^{-3}. It was slightly alkaline (pH 8.10), non-saline (EC 0.47 dS m^{-1}), calcareous ($CaCO_3$ 6.72%), and low in organic carbon (0.44%), indicating poor native fertility and the need for organic amendments. Geographically, the experimental site is situated at latitude of 19.034° N and a longitude of 74.064° E, with an elevation of 513 meters above sea level. This region is located on the eastern side of the Western Ghats in Maharashtra. The experimental field featured consistently level topography. The experiment followed a wheat–fodder maize cropping sequence, with Phule Samadhan as the wheat variety and African Tall as the fodder maize variety. Wheat and fodder maize were sown at a spacing of 20 cm and 30 cm, respectively. The gross plot size was 4.0 m × 3.0 m, while the net plot size was 3.60 m × 2.60 m for wheat and 3.40 m × 2.40 m for fodder maize.

Experimental Design and Treatments

The study was laid out in a Randomized Block Design (RBD) comprising 10 treatments with three replications. The experiment comprised ten treatments involving T_1 received the recommended dose of fertilizers (RDF) alone for both wheat (120:60:40 kg N: P_2O_5:K_2O ha^{-1}) and fodder maize (100:50:50 kg N: P_2O_5:K_2O ha^{-1}). T_2 consisted of general recommended dose of fertilizers (GRDF) along with 10 t ha^{-1} FYM for wheat and 5 t ha^{-1} FYM for fodder maize. Treatments T_3 to T_6 involved the application of RDF + 3 t ha^{-1} of urban compost, press mud compost, poultry manure, and vermicompost, respectively, to wheat, while fodder maize was grown on their residual effect. Similarly, treatments T_7 to T_{10} received RDF + 3 t ha^{-1} of enriched urban compost, enriched press mud compost, enriched poultry manure, and enriched vermicompost, respectively, in wheat, with fodder maize raised under the residual influence of the corresponding enriched organic amendments.

Data Collection

Plant height was recorded from five randomly selected plants per plot. In wheat, measurements were taken at 30, 60, 90 DAS and at maturity, while in fodder maize, height was recorded at harvest. Height was measured from ground level to the tip of the spike (excluding awns) in wheat. Number of tillers per plant, spike length, and test weight (1000-grain weight) in wheat were recorded at harvest from five randomly selected plants per plot using standard procedures. Total chlorophyll content was measured using a SPAD meter at 30, 60, and 90 DAS in wheat and at 30 DAS in maize from the topmost fully expanded leaves (Ling *et al*., 2011).In fodder maize, number of leaves per plant, leaf length, leaf width, and stem girth were recorded at harvest from five randomly selected plants per plot. Protein content was calculated by multiplying nitrogen content by 6.25.

Results and Discussion

Growth and yield attributing parameters of wheat

Germination (%)

The influence of microbial enriched composts on germination percentage of wheat was evaluated at harvest and recorded in table 1.The highest germination (94.93%) was recorded in T_9 -RDF + 3 t ha^{-1} Enriched Poultry Manure, which was statistically at par with T_{10} -RDF + 3 t ha^{-1} Enriched Vermicompost (94.63%), T_5 -RDF + 3 t ha^{-1} Poultry Manure (93.97%), T_8 -RDF + 3 t ha^{-1} Enriched Press Mud Compost (93.57%), and T_2 -GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM) (93.17%). Lowest germination percentage (90.10), was recorded in T_1 -RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}). The highest germination percentage in enriched poultry manure treatments was attributed to improved nutrient availability, enhanced microbial activity, and production of growth-promoting substances, which created favorable soil conditions for early seedling establishment.

Number of tillers

The effect of microbial enriched composts on the number of tillers per plant was assessed at harvest and recorded in table 1. Maximum tillering (8.43) was recorded in T_9 -RDF + 3 t ha^{-1} Enriched Poultry Manure, which was statistically at par with T_{10} -RDF + 3 t ha^{-1} Enriched Vermicompost (8.27), T_5 -RDF + 3 t ha^{-1} Poultry Manure (7.73), T_8 -RDF + 3 t ha^{-1} Enriched Press Mud Compost (7.40), and T_2 -GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM) (7.20). Lowest number of tillers (5.90) was recorded in T_1 -RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}). Higher tillering under enriched poultry manure was due to improved nitrogen availability, enhanced microbial activity, and better root proliferation, which promoted axillary bud development, while RDF alone resulted in lower tiller formation due to absence of organic carbon and microbial stimulation.

Length of spike (cm)

The influence of microbial enriched composts on spike length was measured at harvest and recorded in table 1.The longest spike (9.89 cm) was recorded in T_9 -RDF + 3 t ha^{-1} Enriched Poultry Manure, statistically at par with T_{10} -RDF + 3 t ha^{-1} Enriched Vermicompost (9.81 cm), T_5 RDF + 3 t ha^{-1} Poultry Manure (9.57 cm), T_8 RDF + 3 t ha^{-1} Enriched Press Mud Compost (9.37 cm), and T_2 -GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM) (9.27 cm). Lowest spike length (8.17 cm), was recorded in T_1 -RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}). The increase in spike length with microbial enriched composts was attributed to sustained nutrient release, improved nutrient uptake, and growth-promoting microbial activity

Test weight (g)

The effect of microbial enriched composts on test weight of wheat grains was evaluated at harvest and recorded in table 1**.** The highest test weight (44.47 g) was observed in T_9 -RDF + 3 t ha^{-1} Enriched Poultry Manure, statistically at par with T_{10} -RDF + 3 t ha^{-1} Enriched Vermicompost (44.20 g), T_5 -RDF + 3 t ha^{-1} Poultry Manure (43.30 g), T_8 -RDF + 3 t ha^{-1} Enriched Press Mud Compost (42.97 g), and T_2 -GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM) (42.17 g) and Lowest test weight (40.27 g) was recorded in T_1 -RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}).

The superior growth and yield attributes of wheat under 3 t ha^{-1} enriched poultry manure (T_9) were due to the synergistic effect of nutrient enrichment and microbial inoculation, which enhanced nutrient availability and uptake. Similar improvements in crop growth, chlorophyll content, and yield with poultry manure–microbe integration have been reported by Zafar *et al.* (2011), Manna *et al.* (2012), Selvamani *et al.* (2019), Lokhande (2020), Praneeth *et al.* (2021), Atif *et al.* (2023), Arshad *et al.* (2024), and Khan *et al.* (2025).

Table 1 : Effect of microbial enriched composts on growth and yield attributing parameters of wheat

Sr. No.	Treatments	Germination (%)	Number of tillers	Length of spike (cm)	Test weight (g)
T_1	RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1})	90.10	5.90	8.17	40.27
T_2	GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM	93.17	7.20	9.27	42.17
T_3	RDF + 3 t ha^{-1} Urban Compost	90.97	6.20	8.63	40.50
T_4	RDF + 3 t ha^{-1} Press Mud Compost	91.60	6.29	8.86	40.97
T_5	RDF + 3 t ha^{-1} Poultry Manure	93.97	7.73	9.57	43.30
T_6	RDF + 3 t ha^{-1} Vermicompost	92.07	6.80	9.14	42.00
T_7	RDF + 3 t ha^{-1} Enriched Urban Compost	92.07	6.47	8.96	41.83
T_8	RDF + 3 t ha^{-1} Enriched Press Mud Compost	93.57	7.40	9.37	42.97

T_9	RDF + 3 t ha^{-1} Enriched Poultry Manure	94.93	8.43	9.89	44.47
T_{10}	RDF + 3 t ha^{-1} Enriched Vermicompost	94.63	8.27	9.81	44.20
S.E(m) ±		0.59	0.44	0.25	0.81
C.D. at 5 %		1.76	1.32	0.76	2.40

Chlorophyll content (SPAD) of wheat

The total chlorophyll content of wheat was measured using a SPAD meter at 30, 60, and 90 days after sowing (DAS) to assess the effect of microbial enriched composts (fig. 1), as chlorophyll content is a reliable indicator of photosynthetic efficiency and plant health.

The chlorophyll content was significantly influenced by the application of microbial enriched composts and organic amendments at all growth stages. At 30 DAS, the highest SPAD values were recorded in T_9 (RDF + 3 t ha^{-1} Enriched Poultry Manure) and T_{10} (RDF + 3 t ha^{-1} Enriched Vermicompost) (43.01 and 43.00, respectively), which were statistically at par. These treatments were followed by T_5 (RDF + Poultry Manure), T8 (RDF + Enriched Press Mud Compost), and T_2 (GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM). The lowest SPAD value was observed in T_1 (RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1})). At 60 DAS, chlorophyll content reached its peak, with T_9 and T_{10} again recording the highest SPAD values (52.01 and 52.00), followed by T_5, T_8, and T_2. The minimum SPAD value was noted in T_1. At 90 DAS, T_9 recorded the highest chlorophyll content (46.48), which was statistically at par with T_{10}, T_5, and T_8, while T_1 recorded the lowest values. The higher chlorophyll content observed under T_9 can be attributed to improved nitrogen availability, enhanced microbial activity, better soil health, and sustained nutrient release from enriched composts, which collectively supported efficient chlorophyll synthesis. These results are consistent with Zafar *et al.* (2011) and Arshad *et al.* (2024), who reported improved wheat growth, physiology, and nutrient uptake with the combined use of poultry manure, inorganic fertilizers, and beneficial microbes. Similarly, Güneş *et al.* (2014) observed increased chlorophyll content and photosynthetic activity in wheat under integrated application of organic and inorganic nutrient sources due to improved nutrient availability and soil biological activity.

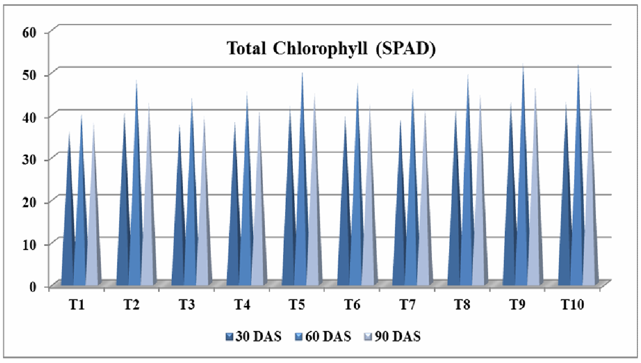

Fig. 1: Effect of microbial enriched composts on total chlorophyll content (SPAD) of wheat

Plant height of wheat

The effect of microbial enriched composts and different nutrient management practices on the plant height of wheat at 30, 60, 90 DAS, and at harvest showing the comparative growth response of wheat under various treatments was presented in table 2**.**

Plant height increased progressively from 30 DAS to harvest across all treatments. At 30 DAS, the maximum plant height was recorded in T_9 (RDF + 3 t ha^{-1} enriched poultry manure, 39.00 cm), which was statistically at par with T_{10} (RDF + 3 t ha-1 Enriched Vermicompost 38.33 cm), T_5 (RDF + 3 t ha^{-1} Poultry Manure 37.30 cm) and T_2 (GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM 35.67 cm). At 60 DAS, T_9 (RDF + 3 t ha^{-1} enriched poultry manure, 39.00 cm 67.00 cm) remained superior and was statistically at par with T_{10} (RDF + 3 t ha-1 Enriched Vermicompost 66.50 cm), T_5 (RDF + 3 t ha^{-1} Poultry Manure 64.50 cm), T_8 (RDF + 3 t ha^{-1} Enriched Press Mud Compost 63.00 cm) and T_2 (62.20 cm). At 90 DAS, the tallest plants were observed in T_9 (RDF + 3 t ha^{-1} enriched poultry manure, 39.00 cm 85.00 cm), which was statistically at par with T_{10} (RDF + 3 t ha-1 Enriched Vermicompost 84.33 cm), T_5 (RDF + 3 t ha^{-1} Poultry Manure 82.00 cm), T_8 (RDF + 3 t ha^{-1} Enriched Press Mud Compost 81.80 cm) and T_2 (GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM 81.53 cm). At harvest, the highest plant height was recorded in T_9 (RDF + 3 t ha^{-1} enriched poultry manure, 39.00 cm 90.33 cm) and was statistically at par with T_{10} (RDF + 3 t ha-1 Enriched Vermicompost 89.47 cm), T_5 (RDF + 3 t ha^{-1} Poultry Manure 87.20 cm) and T_8 (RDF + 3 t ha^{-1} Enriched Press Mud Compost 87.00 cm). The lowest plant height at all growth stages was observed under T_1 (RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1})).

The superior growth response under enriched poultry manure may be attributed to its higher nutrient content, faster mineralization, and enhanced microbial activity, resulting in improved nutrient availability, chlorophyll synthesis, and photosynthetic efficiency. Similar improvements in plant height under integrated nutrient management have been reported by Zafar *et al.* (2011) and Boateng *et al.* (2006). The combined application of organic manures with RDF ensures immediate as well as sustained nutrient supply, leading to improved vegetative growth and overall crop vigor, as also reported by Praneeth *et al.* (2021).

Table 2: Effect of microbial enriched composts on plant height of wheat

Sr. No.	Treatments	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1})	32.33	56.0	74.00	79.20
T_2	GRDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1} + 10 t ha^{-1} FYM	35.67	62.2	81.53	85.20
T_3	RDF + 3 t ha^{-1} Urban Compost	33.60	58.5	76.67	81.80
T_4	RDF + 3 t ha^{-1} Press Mud Compost	34.00	58.0	77.00	82.00
T_5	RDF + 3 t ha^{-1} Poultry Manure	37.30	64.5	82.00	87.20
T_6	RDF + 3 t ha^{-1} Vermicompost	35.00	61.0	78.00	83.37
T_7	RDF + 3 t ha^{-1} Enriched Urban Compost	34.87	59.0	77.50	82.70
T_8	RDF + 3 t ha^{-1} Enriched Press Mud Compost	36.87	63.0	81.80	87.00
T_9	RDF + 3 t ha^{-1} Enriched Poultry Manure	39.00	67.0	85.00	90.33
T_{10}	RDF + 3 t ha^{-1} Enriched Vermicompost	38.33	66.5	84.33	89.47
S.E(m) ±		1.15	1.7	1.26	1.71
C.D. at 5 %		3.41	5.09	3.74	5.07

Protein content and Protein yield of wheat

Data mentioned in fig 2 and 3 indicates that protein content and protein yield of wheat varied significantly among the treatments.

The maximum protein content (14.49 %) and protein yield (662.96 kg ha^{-1}) were recorded in T_9 RDF + 3 t ha^{-1} Enriched Poultry Manure, which was statistically at par with T_{10} -RDF + 3 t ha^{-1} Enriched Vermicompost (14.47 %, 644.75 kg ha^{-1}), T_5 -RDF + 3 t ha^{-1} Poultry Manure (14.41 %, 616.86 kg ha^{-1}), and T_8 -RDF + 3 t ha^{-1} Enriched Press Mud Compost (14.36 %, 615.57 kg ha^{-1}), T_6 -RDF + 3 t ha^{-1} Vermicompost (13.89 %,555.4 kg ha^{-1}),T_7 -RDF + 3 t ha^{-1} Enriched Urban Compost (13.49 %, 532.6 kg ha^{-1}). The lowest protein content (12.05%,) and protein yield (349.39kg ha^{-1}) were observed in T_1 -RDF (120:60:40 kg N, P_2O_5 and K_2O ha^{-1}).

The highest protein content observed in T_9 can be attributed to the synergistic effects of nitrogen rich enriched poultry manure, microbial inoculants that enhanced nutrient availability, and the balanced nutrient supply from RDF, collectively improving nitrogen uptake and protein synthesis in wheat grains. Similar findings were reported by Zafar *et al.* (2011), who demonstrated that integrating poultry manure, inorganic phosphorus fertilizers, and phosphate-solubilizing bacteria (PSB) significantly increased maize protein content (by 61–104%) and phosphorus uptake (from 13 to 37 g kg^{-1}) compared to the control. Aldal'in (2017) also reported that the use of poultry litter as an organic manure enhanced maize grain protein content, emphasizing its positive role in improving crop protein levels. Likewise, Khan *et al.* (2022) observed that applying 150 kg N ha^{-1} from poultry manure with 20 t ha^{-1} biochar significantly improved wheat grain protein content (10.66%) compared to the control (10.05%).

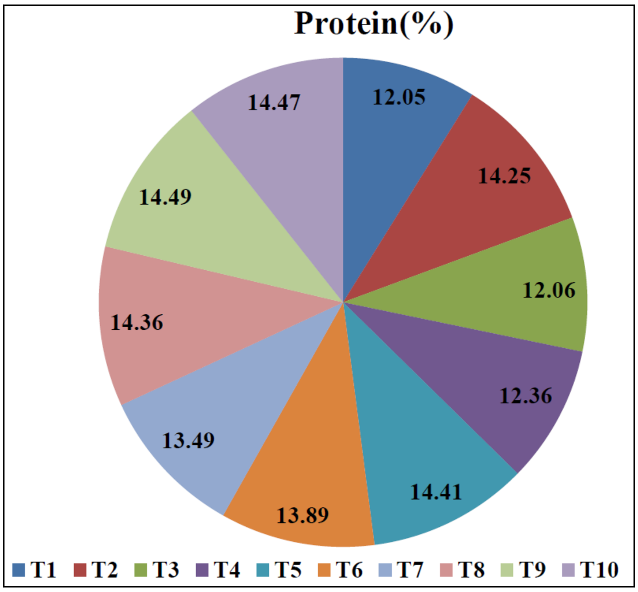

Fig. 2: Effect of microbial enriched compost on protein content of wheat

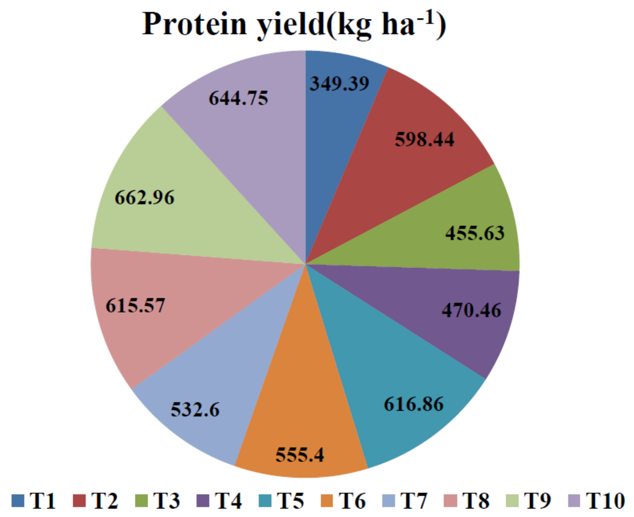

Fig. 3 : Effect of microbial enriched compost on protein yield of wheat

Growth and yield attributing parameters of fodder maize

Germination (%)

Data presented in table 3 revealed that the highest germination percentage (93.00%) was recorded in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), which was statistically at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (92.00%), T_9 - RDF + Residual effect of Enriched Poultry Manure (92.00%), T_8 - RDF + Residual effect of Enriched Press Mud Compost (91.00%), T_6 - RDF + Residual effect of Vermicompost (91.00%) and T_7 - RDF + Residual effect of Enriched Urban Compost (90%). The lowest germination (88.00%) was observed in T_1 - RDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1}). Higher germination was due to improved soil moisture, better seed soil contact, and enhanced microbial activity provided by FYM, which created favorable conditions for seed emergence.

Height at harvest

The findings summarized in table 3 indicated that the tallest plants were recorded in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (195.78 cm), and were statistically at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (193.79 cm), T_9 - RDF + Residual effect of Enriched Poultry Manure (192.23 cm), T_8 - RDF + Residual effect of Enriched Press Mud Compost (191.04 cm), while, the shortest plants were in T_1 - RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1}) (167.00 cm). Greater plant height resulted from the balanced and continuous supply of nutrients from GRDF and FYM, promoting efficient root development, cell elongation, and overall vegetative growth.

Chlorophyll (SPAD)

As per the observations recorded in table 3 Chlorophyll content was highest in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (47.69 SPAD), at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (46.61 SPAD), T_9 - RDF + Residual effect of Enriched Poultry Manure (45.56 SPAD), T_8 - RDF + Residual effect of Enriched Press Mud Compost (43.79 SPAD), T_6 - RDF + Residual effect of Vermicompost (42.91 SPAD, while the lowest was in T_1 - RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1}) (39.05 SPAD). Increased chlorophyll content was attributed to higher nitrogen availability and improved nutrient uptake, leading to enhanced chlorophyll synthesis and photosynthetic efficiency.

Number of leaves

The results outlined in table 3 demonstrated that the number of leaves per plant was highest in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (14.60), at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (14.13), T_9 - RDF + Residual effect of Enriched Poultry Manure (14.00), T_8 - RDF + Residual effect of Enriched Press Mud Compost (13.53) with the lowest in T_1 - RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1}) (12.40). The increased number of leaves was due to sustained nutrient release and improved soil health, which supported vigorous vegetative growth and leaf initiation.

Leaves length

According to the data presented in table 3 the Leaf length was maximum in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (110.17 cm), at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (108.40 cm), T_9 - RDF + Residual effect of Enriched Poultry Manure (107.47 cm), while T_1 - RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1}) (99.91 cm) had the shortest leaves. Longer leaves were observed because of improved nutrient availability and better soil physical conditions, which enhanced cell expansion and leaf growth.

Leaves width

Data in table 3 highlighted that the Leaf width was highest in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (6.53 cm), at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (6.31 cm), T_9 - RDF + Residual effect of Enriched Poultry Manure (6.14 cm), T_8 - RDF + Residual effect of Enriched Press Mud Compost (5.97 cm) and T_6 - RDF + Residual effect of Vermicompost (5.93 cm) with the lowest in T_1 - RDF (100:50:50 kg N, P_2O_5 and

K_2O ha^{-1}) (5.37 cm). Higher leaf width was associated with adequate nitrogen and micronutrient supply, resulting in broader leaves and increased photosynthetic surface area.

Stem girth

The findings summarized in table 3 Stem girth was greatest in T_2 - GRDF (100:50:50 kg N, P_2O_5, and K_2O ha^{-1} + 5 t ha^{-1} FYM), (6.27 cm), at par with T_{10} - RDF + Residual effect of Enriched Vermicompost (6.11 cm), T_9 - RDF + Residual effect of Enriched Poultry Manure (5.81 cm), T_8 - RDF + Residual effect of Enriched Press Mud Compost (5.71 cm) and T_6 - RDF + Residual effect of Vermicompost (5.68 cm) with the lowest in T_1 - RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1}) (4.43 cm).

The enhanced growth and yield attributes of fodder maize resulted from improved nutrient availability under integrated application of organic and inorganic sources, which supplied essential nutrients and improved soil fertility through chelation and organic matter addition. Similar benefits of integrated nutrient management on crop productivity and soil health have been reported by Urkurkar *et al.* (2010), Thakur *et al.* (2011), Singh *et al.* (2019), Gohil (2017), Patel *et al.* (2016), Mukherjee (2015), Shirale *et al.* (2014), Mondal *et al.* (1997), Gorde (2023), and Titirmare (2024).

Table 3: Effect of microbial enriched composts on growth and yield attributing parameters of fodder maize

Sr. No	Treatments	Germination (%)	Height at harvest (cm)	Chlorophyll at 30 days (SPAD)	Number of leaves	Leaves length (cm)	Leaves width (cm)	Stem girth (cm)
T_1	RDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1})	88.00	167.00	39.05	12.40	99.91	5.37	4.43
T_2	GRDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1} + 5 t ha^{-1} FYM	93.00	195.78	47.69	14.60	110.17	6.53	6.27
T_3	RDF + Residual effect of Urban Compost	89.00	171.67	39.71	13.00	102.04	5.47	4.41
T_4	RDF + Residual effect of Press Mud Compost	89.00	173.87	40.00	13.20	103.68	5.53	4.65
T_5	RDF + Residual effect of Poultry Manure	90.00	186.27	41.85	13.33	104.40	5.69	5.63
T_6	RDF + Residual effect of Vermicompost	91.00	190.53	42.91	13.53	104.45	5.93	5.68
T_7	RDF + Residual effect of Enriched Urban Compost	90.00	181.86	40.18	13.27	104.00	5.56	5.11
T_8	RDF + Residual effect of Enriched Press Mud Compost	91.00	191.04	43.79	13.53	107.41	5.97	5.71
T_9	RDF + Residual effect of Enriched Poultry Manure	92.00	192.23	45.56	14.00	107.47	6.14	5.81
T_{10}	RDF + Residual effect of Enriched Vermicompost	92.00	193.79	46.61	14.13	108.40	6.31	6.11
S.E(m) ±		0.52	2.62	1.93	0.38	0.72	0.25	0.21
C.D. at 5 %		1.54	7.79	5.74	1.14	2.15	0.73	0.63

Conclusion

Microbial enriched composts combined with recommended fertilizers significantly improved growth, yield, and quality of wheat and fodder maize in Inceptisol soils. RDF + 3 t ha^{-1} enriched poultry manure gave the highest plant height, chlorophyll, tillers, spike length, test weight, protein content, and protein yield in wheat. GRDF (100:50:50 kg N, P_2O_5 and K_2O ha^{-1} + 5 t ha^{-1} FYM enhanced fodder maize growth, including plant height, Germination (%),Chlorophyll content ,leaf number, leaf length and width, and stem girth. Residual effects of enriched composts, especially enriched vermicompost and enriched poultry manure, which were at par Vermicompost showed higher residual effect because it had higher humus content and released nutrients slowly and steadily, maintaining availability for succeeding crops. Overall, the use of microbial enriched composts in integrated nutrient management is a viable strategy to improve yield, quality, and soil health in wheat–fodder maize cropping sequences under Inceptisol soils.

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