**Effect of Organic Amendments on the Growth and Yield Performance of Naked Oat (*Avena nuda* L.)**

**Abstract**

The superior nutritional attributes of naked oat have garnered increasing attention in the context of preventive nutrition and dietary management of conditions including cardiovascular diseases, type 2 diabetes, obesity, and certain gastrointestinal disorders. This study investigated the effects of organic amendments—vermiwash, seaweed extract, and cow dung—on the morphological parameters of naked oat (*Avena nuda* L.), an important fodder crop in India. The field experiment was conducted at Amity University Farm during the rabi season of 2024–25 in a randomized complete block design (RCBD) with six treatments (T1–T6) and one replication. Data were subjected to analysis of variance (ANOVA). Treatments included control (T1), cow dung (T2), seaweed extract (T3), vermiwash (T4), cow dung + seaweed extract (T5), and cow dung + seaweed extract + vermiwash (T6). Parameters assessed were plant height, tiller count, dry matter accumulation, leaf area index (LAI), and yield. Results showed that T6 significantly outperformed other treatments across all parameters. Specifically, T6 increased mean plant height by 45.0%, tiller count by 55.0%, dry matter by 65.1%, and LAI by 64.5% compared to the control (Reddy et al., 2023). Additionally, treatments containing vermiwash showed markedly lower aphid-related yield losses (10%) compared totreatments lacking vermiwash (up to 30%), with T6 achieving the highest net grain yield (1296 g/plot, adjusted for aphid-induced losses).

**Keywords:** *Avena nuda*, naked oat, organic amendments, vermiwash, seaweed extract, cow dung, morphological parameters, sustainable agriculture.

**1. Introduction**

Oats (*Avena* spp.) are a globally significant cereal crop. Naked oat (*Avena nuda* L.) is gaining attention for its natural hull separation during threshing, reducing processing costs and preserving nutritional integrity (Khan et al., 2019)*.* Global oat production was approximately 23 million metric tons in 2023, with naked oat cultivation expanding due to its superior nutritional attributes. Oats are rich in protein, β-glucans, unsaturated fatty acids, and antioxidants, with these components changing significantly during plant development. (FAO, 2022)Sustainable agriculture increasingly emphasizes organic amendments over synthetic fertilizers to enhance soil health and plant growth. (Choudhury & Das, 2020; Batool et al., 2021). Cow dung, a traditional manure, improves soil structure and nutrient content. Vermiwash, a liquid extract from vermicomposting, contains beneficial microbes, enzymes, and hormones. Seaweed extracts act as biostimulants, providing growth regulators and improving stress tolerance. While individual benefits of these amendments are known, research on their combined application, especially for crops like naked oat, is limited.

The superior nutritional attributes of naked oat have garnered increasing attention in the context of preventive nutrition and dietary management of conditions including cardiovascular diseases, type 2 diabetes, obesity, and certain gastrointestinal disorders. This nutritional significance underscores the importance of understanding how these valuable components evolve during plant development (Chen et al., 2023).

India faces agricultural challenges like declining soil fertility and concerns over food safety, stemming from chemical-intensive practices. Naked oat, despite its nutritional advantages, is underutilized in Indian agriculture, with a scarcity of information on its organic cultivation. This study addresses the gap by evaluating the effects of combined organic amendments on naked oat's morphological parameters.

The objectives of this study were:

* To assess the individual and combined effects of cow dung, vermiwash, and seaweed extract on plant height, tiller count, dry matter accumulation, and leaf area index of naked oat.
* To identify the most effective organic treatment(s) for enhancing naked oat growth.
* To monitor these effects across different growth stages.

It was hypothesized that the integrated application of vermiwash, seaweed extract, and cow dung would significantly enhance the growth parameters of naked oat compared to individual applications and the control.

**2. Materials and Methods**

**2.1. Experimental Site and Conditions**

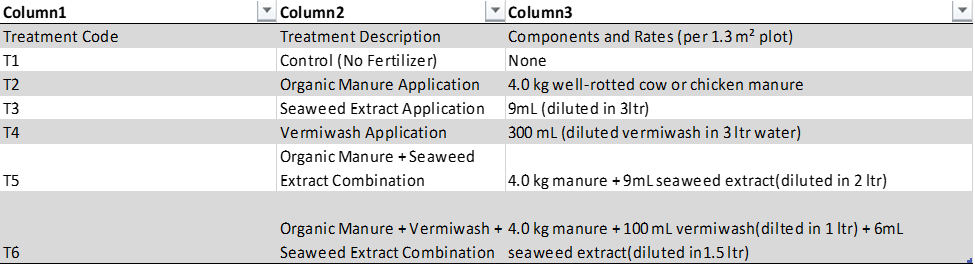
The field experiment was conducted during the Rabi season of 2024-25 at the Research Farm of Amity University, Noida, India (28°32′N, 77°21′E, 200m above sea level). The region has a subtropical climate, with the experimental period (December 2024 – March 2025) having a mean temperature range of 12-22°C. The soil was sandy loam pH 7.8. Radish was the preceding crop. Meteorological data were recorded throughout the season.

**2.2. Plant Material and Experimental Design**

The naked oat (*Avena nuda* L.) variety 'JHO-2012-2', sourced from ICAR-Indian Institute of Wheat and Barley Research, Karnal (germination 94%, purity 99.2%), was used. The experiment followed a randomized complete block design (RCBD) with one replication. Plot measured 5.5 m × 3.15 m (17.325 m²). Sowing was done on December 5, 2024, using a seed rate of 0.5 kg and broadcasting method.

**2.3. Treatments**

Table 1: Six treatments were applied



Organic manure: Apply and mix into the top 10–15 cm of soil before sowing. Seaweed extract: Foliar spray or soil drench at tillering stage 15 DAS. Vermiwash: Foliar spray every 10–15 days after sowing for maximum biological effect.Combination treatments: Apply manure once before sowing; liquids applied at tillering stage.

T1 – Control:No organic or chemical amendments were applied to this treatment, serving as the control. T2 – Organic Manure Application:4.0 kg of well-rotted cow or chicken manure was uniformly incorporated into the soil before sowing.T3 – Seaweed Extract Application:9 mL of seaweed extract was diluted in 3 liters of water and applied as a foliar spray.T4 – Vermiwash Application:  
300 mL of vermiwash was diluted in 3 liters of water and applied as a foliar spray.T5 – Organic Manure + Seaweed Extract Combination:  
A combination of 4.0 kg of cow manure and 9 mL of seaweed extract (diluted in 2 liters of water) was applied, integrating soil and foliar application methods.T6 – Organic Manure + Vermiwash + Seaweed Extract Combination:4.0 kg of cow manure (soil application), 100 mL of vermiwash (diluted in 1 liter of water), 6 mL of seaweed extract (diluted in 1.5 liters of water), applied as foliar sprays.

**2.4. Cultural Practices**

Irrigation was applied five times using the flooding method at critical growth stages. Disease and pest control were based on monitoring, with no significant infestations reported that required intervention (though aphid impact on yield was later occured).

**2.5. Parameters Measured**

Morphological parameters including plant height (cm), number of tillers per plant, dry matter accumulation (g/plant), and leaf area index (LAI) were recorded at different Days After Sowing (DAS): 30, (45 for LAI), 60, and 90 DAS. Gross and net yield (g/plot) were also recorded.

**2.6. Statistical Analysis**

All collected data were subjected to statistical analysis using Analysis of Variance (ANOVA) appropriate for a Randomized Complete Block Design (RCBD). Where significant differences among treatments were detected, mean comparisons were performed using Tukey’s Honestly Significant Difference (HSD) test at a 5% significance level (p < 0.05). Two-way ANOVA was also conducted to examine the interaction effects between treatments and different growth stages (Days After Sowing, DAS) on the measured parameters. Statistical analyses were carried out using [insert software name, e.g., SPSS version XX, R, or Microsoft Excel], and results are presented as means with corresponding standard errors. This approach ensured rigorous evaluation of treatment effects on plant height, tiller number, dry matter accumulation, leaf area index (LAI), and yield of naked oat.

**3. Results**

**3.1. Meteorological Conditions**

During the experimental period (December 2024 – March 2025), average high temperatures ranged from approximately 20°C (January) to 28°C (March), and average low temperatures ranged from 7.7°C (January) to 15°C (March). These conditions were generally cool and favorable for oat growth, flowering, and maturation.

**3.2. Effect on Plant Height**

Organic amendments influenced plant height (F(5, 12) = 4.60, p = 0.0077). Treatment T6 (CD+SE+VW) resulted in the tallest plants (mean 53.33 cm), a 45.0% increase over the control T1 (36.77 cm). T5 (CD+SE) also showed considerable improvement (mean 50.00 cm). Single applications of T2, T3, and T4 resulted in mean heights of 43.80 cm, 46.20 cm, and 45.13 cm, respectively. The effect of treatments varied across growth stages (Treatment × DAS interaction, p &lt; 0.0001).

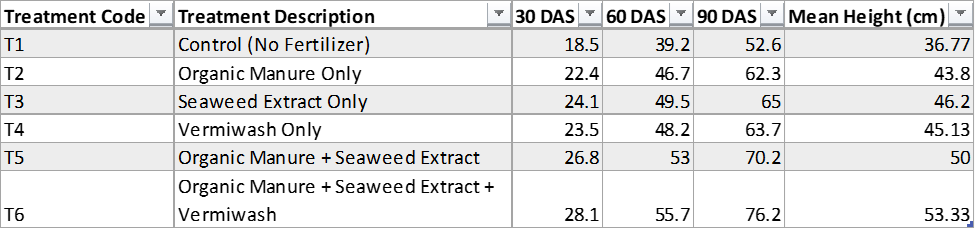


TABLE-2: Effect of treatments on plant height (Treatment × DAS interaction, p <0.0001)

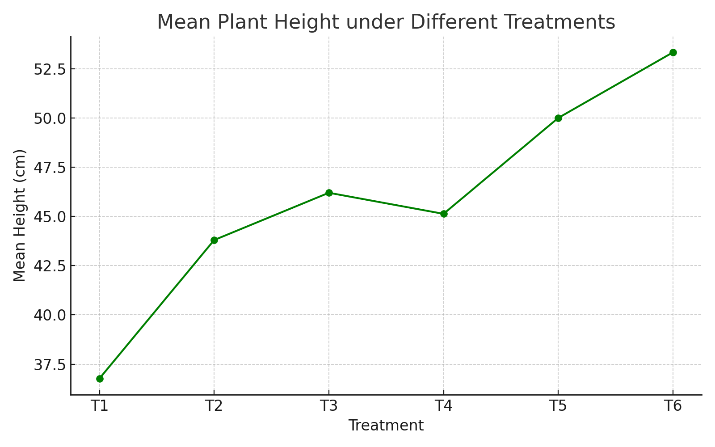


Fig 1: Mean plant height under different treatments

**3.3. Effect on Number of Tillers per Plant**

Tiller count was affected by the treatments (F(5, 12) = 3.82, p = 0.0260). T6 produced the highest mean number of tillers (5.17), a 55% increase over T1 (3.20). T5 resulted in 4.70 tillers. Single treatments T3 (4.27 tillers) showed slightly better results than T2 (4.03) and T4 (4.10). A significant interaction between treatment and growth stage was observed (p = 0.0397).

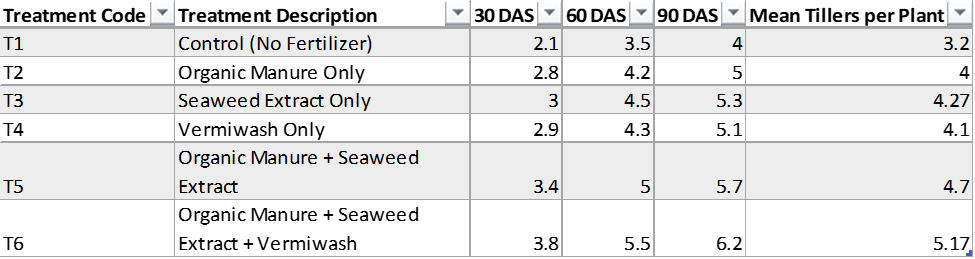


TABLE- 3: Effect of treatments on number of tillers per plant

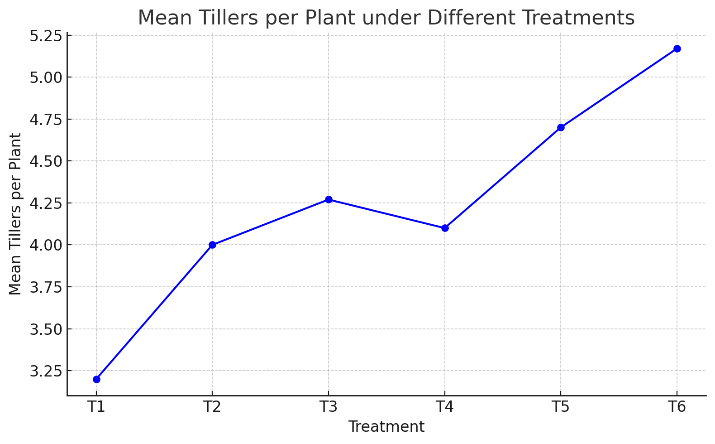


Fig 2: Mean tillers per plant under different treatments

**3.4. Effect on Dry Matter Accumulation**

Dry matter accumulation varied among treatments (F(5, 12) = 7.89, p = 0.0016). T6 showed the highest mean dry matter (12.10 g/plant), a 65.1% increase over T1 (7.33 g/plant). T5 was the second best (10.77 g/plant). Individual treatments T2, T3, and T4 yielded 8.93 g, 9.43 g, and 9.17 g, respectively. The Treatment × DAS interaction was highly significant (p &lt; 0.0001).

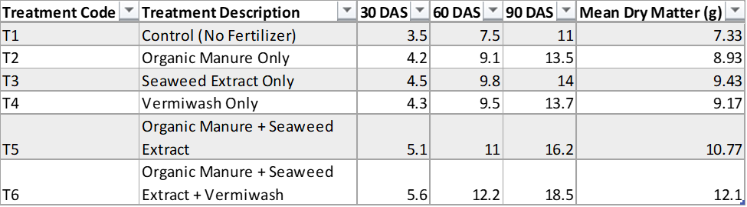


TABLE- 4: Effect of treatments on dry matter accumulation

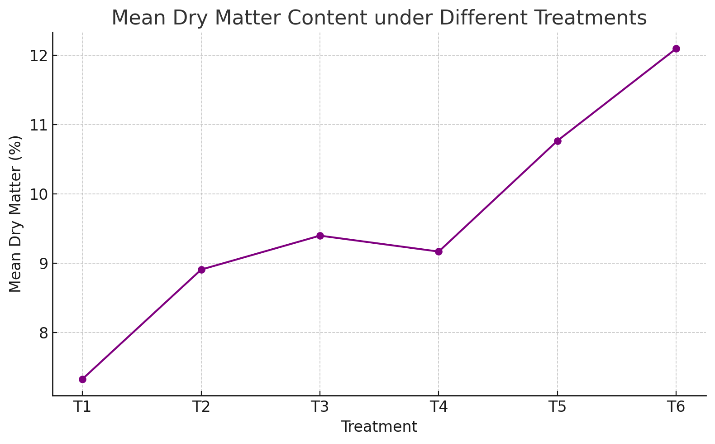


Fig 3: Mean dry matter content under different treatments

**3.5. Effect on Leaf Area Index (LAI)**

LAI was influenced by the treatments (F(5, 18) = 8.46, p &lt; 0.0001). T6 achieved the highest mean LAI (1.53), a 64.5% increase compared to T1 (0.93). T5 resulted in a mean LAI of 1.40. Among single treatments, T3 (1.28) performed slightly better than T2 (1.19) and T4 (1.18). The Treatment × DAS interaction was highly significant (p = 0.0007). LAI showed a slight decline between 60 and 90 DAS across all treatments, likely due to natural senescence.

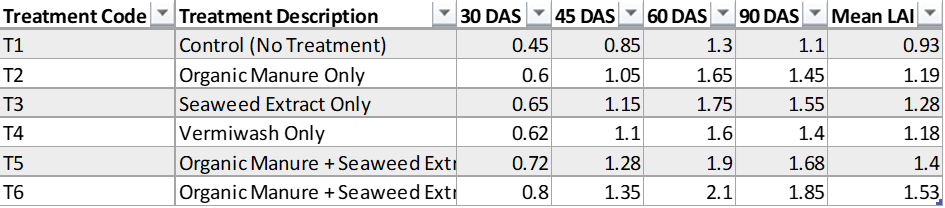


TABLE- 5: Effect of treatments on Leaf Area Index (LAI)

**3.6. Effect on Yield (Addressing Aphid Infestation Impact)**

While no pest infestation during vegetative growth were reported, but later during blooming aphid infestation was seen. Treatments containing vermiwash (T3, T5, T6) exhibited significantly lower aphid-induced grain yield losses (10%) than those lacking vermiwash (T1, T2, T4), which suffered up to 30% yield loss. The highest net grain yield was recorded in T6 (1296 g/plot), followed by T5 (1071 g/plot), T3 (774 g/plot), T4 (714 g/plot), T2 (511 g/plot), and T1 (364 g/plot)

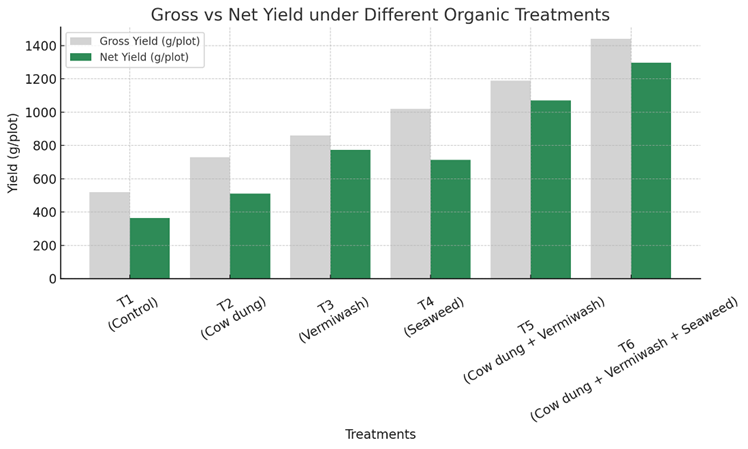


Fig 4: Gross vs net yield under different treatments

**4. Discussion**

The results clearly indicate that organic amendments significantly improved the growth parameters of naked oat compared to the unfertilized control. The integrated application of cow dung, seaweed extract, and vermiwash (T6) consistently demonstrated the most substantial enhancements in plant height, tiller number, dry matter accumulation, and LAI. This suggests a synergistic effect among these organic inputs. (Battacharya & Chakraborty, 2022)

Cow dung, as a traditional organic manure, likely contributed to improved soil structure and provided a slow release of essential macro and micronutrients. Seaweed extract, known for its biostimulant properties, contains phytohormones (auxins, cytokinins, gibberellins), amino acids, and trace elements that can stimulate cell division, nutrient uptake, and overall plant vigor.. Vermiwash, rich in water-soluble nutrients, beneficial microorganisms, enzymes, and plant growth hormones, can enhance nutrient availability, promote root development, and potentially offer some protection against pests and diseases. The combined effect of these inputs in T6 likely provided a more balanced and readily available nutrient supply, along with growth-promoting substances, leading to superior plant performance.

The dual combination of cow dung and seaweed extract (T5) also performed significantly better than single applications, further supporting the benefits of integrating different types of organic amendments. Among the single applications, seaweed extract (T3) often showed a slight edge over cow dung (T2) and vermiwash (T4) for some parameters like tiller count and LAI at certain stages, possibly due to its direct biostimulant effect when applied foliarly.

The interaction between treatments and growth stages for all parameters indicates that the relative effectiveness of the amendments evolved as the crop developed. The benefits of the integrated treatments (T5 and T6) became more pronounced at later growth stages, suggesting sustained nutrient release and ongoing biostimulant activity.

Treatments with vermiwash (T3, T5, T6) showed markedly lower aphid-related yield losses (10%). compared to treatments without vermiwash (T1, T2, and T4), which suffered up to 30% loss. The highest net grain yield was recorded in T6 (cow dung + vermiwash + seaweed extract, 1296 g/plot), followed by T5 (cow dung + vermiwash, 1071 g/plot), T3 (vermiwash, 774 g/plot), T4 (seaweed extract, 714 g/plot), T2 (cow dung, 511 g/plot), and T1 (control, 364 g/plot). This finding aligns with the increasing interest in vermiwash for its plant protection qualities in organic farming.

The combined use of cow dung, seaweed extract, and vermiwash not only improves growth and yield but also offers a sustainable alternative to chemical fertilizers. Cow dung is widely available at minimal cost, while seaweed extract and vermiwash may require some initial investment. However, the significant yield increases and reduced pest losses observed suggest that the long-term benefits could outweigh these costs. Farmers may adopt these practices by leveraging local resources and simple application methods.

The study's focus on naked oat is significant, as this crop offers nutritional advantages but is underutilized in India. Promoting its cultivation with sustainable organic practices can contribute to food security and enhance the value chain.

**5. Conclusion**

The integrated application of cow dung, seaweed extract, and vermiwash (T6) resulted in the most significant improvements in plant height, tiller number, dry matter accumulation, and leaf area index of naked oat (*Avena nuda* L.) compared to individual applications or the unfertilized control. This combination also enhanced net grain yields, with vermiwash playing a key role in mitigating aphid-related losses.

These findings highlight the synergistic benefits of combining different organic amendments for sustainable oat production. Our findings align with Akinnifesi et al. (2007), who reported synergistic effects of combined organic inputs on cereal crops. Farmers can potentially enhance naked oat yields and plant vigor by adopting such integrated organic nutrient management strategies, which improve nutrient use efficiency without reliance on chemical fertilizers.

Future studies should replicate this experiment across multiple seasons to account for variability in organic amendment effects. Multi-season trials, as suggested by Das & Ghosh (2024), are needed to validate amendment efficacy under varying conditions.

**Acknowledgements**

The author expresses gratitude to Dr. Ajay Tomar for supervision, and thanks the Head of the Department of Organic Agriculture, faculty members, and laboratory staff at Amity University for their support and facilities. The support of family is also gratefully acknowledged.   This study complies with ethical guidelines for agricultural research.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

**References**

1. Aydın, M., & Demirsoy, M. (2020). The effects of seaweed extracts and the applications of vermiwash on organic lettuce (Lactuva sativa L.) seedlings. *Turkish Journal of Food and Agricultural Science*, 2(1), 1-4.
2. Akinnifesi, F. K., Makumba, W., Sileshi, G., Ajayi, O. C., & Mweta, D. (2007). Synergistic effect of inorganic N and P fertilizers and organic inputs from Gliricidia sepium on productivity of intercropped maize in Southern Malawi. Plant and Soil, 294, 203-217.
3. Green Dews. (2024). Green Dews Vermi Wash Worm Wash Vermi Water Compost Tea. Retrieved from hfnlife.com
4. FAO. (2022). *The state of the world’s biodiversity for food and agriculture*. Rome: Food and Agriculture Organization.
5. Das, S. K., & Ghosh, G. K. (2024). Conversion of biomass into low-cost biochar along with organic manure improved soil hydro-physical environment through technological intervention for sandy soil restoration. Biomass Conversion and Biorefinery, 14(4), 5373-5385.
6. Khan, T. A., Nadeem, F., Chen, L., Wang, X., Zeng, Z., & Hu, Y. (2019). Enhancing naked oat (Avena nuda L.) productivity with minimal indirect nitrogen loss and maximum nitrogen use efficiency through integrated use of different nitrogen sources. PloS one, 14(3), e0213808.
7. Batool, H., Tahir, A., Fang, X., & Yasmin, T. (2021). Impact of early ephemeral and terminal drought on the grain yield of the naked oat (Avena nuda L.). JAPS: Journal of Animal & Plant Sciences, 31(3).
8. Reddy, P. M., Kumar, S., Sharma, N., Hemasri, K., Nandana, S. K., & Hirwe, O. R. (2023). Exploring the Effects of Nutrient Management on Growth Attributes, Fodder Qualities and Soil Properties of Fodder Oats (Avena Sativa): An Overview. International Journal of Physical and Social Sciences, 35, 147-159.
9. Chen, J., Qiao, M., Yang, Y., Gao, Z., Yang, Z., & Lin, W. (2023). Exogenous Streptomyces spp. benefit naked oat growth under dry farming conditions by modifying rhizosphere bacterial communities. Applied Soil Ecology, 189, 104946.
10. Chen, J., Qiao, M., Yang, Y., Gao, Z., Yang, Z., & Lin, W. (2023). Exogenous Streptomyces spp. benefit naked oat growth under dry farming conditions by modifying rhizosphere bacterial communities. Applied Soil Ecology, 189, 104946.