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Comparative Study of Mulching Practices and Biofertilizers on Yield Attributes of Finger Millet (Variety- *VL Mandua 379*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at Himalayan University farm, Jullang, Itanagar, Arunachal Pradesh, during the *kharif* season of 2023 with 8 treatments replicated thrice in randomized block design, to determine the effect of different types of mulching and biofertilizer on yield of finger millet (*Eleusine coracana*.). The available nutrient status showed high nitrogen (N), low phosphorus (P), and medium potassium (K) levels. The experiment included the following treatments T_1-Control, T_2-Karanj leaf mould at + *Azotobacter*, T_3-Karanj leaf mould + *PSB*, T_4- Neem leaf mould +

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Azotobacter, T_5-Paddy straw + jute bag + *Rhizobium*, T_6-Paddy straw + *PSB*, T_7-Black polythene + *Azotobacter* and T_8-Saw dust + *Rhizobium.* The highest finger length (cm) recorded was 5.92 cm at harvest, highest test weight (g) recorded was 3.06 g at harvest, highest grain yield (t ha^{-1}) recorded was 4.05 t ha^{-1} at harvest, highest straw yield (t ha^{-1}) recorded was 7.92 t ha^{-1} at harvest and harvest index (%) of 34.66 % at harvest were observed with treatment T_5 - Paddy straw + jute bag + *Rhizobium.*

Keywords: Finger millet; mulching; biofertilizer; grain yield; straw yield.

1. INTRODUCTION

Finger millet (Eleusine coracana) is one of the most cultivated millets and India plays a significant role on the World's finger millet production map as it produces around 41% of world's production followed by Africa. In world, finger millet ranks fourth in importance among millets after sorghum, pearl millet and foxtail millet [1].

Finger millet is the traditional staple food in Southern Karnataka. It is even grown in hilly regions of Uttar Pradesh and Himachal Pradesh, up to an altitude of 2100 - 2300 m above mean sea level. The crop has high adaptability to harsh climatic conditions, being tolerant of drought and heat stress. The grains of finger millet are nutritionally rich and superior to many kinds of cereal and hence designated as "Nutri cereal". It contains protein (9.2 percent), carbohydrates (76.32 per cent), and fat (1.29 per cent). It is very rich in minerals (2.70 per cent) such as calcium (452 mg/1000g) and iron (3.90 mg/100g) [2]

Mulching is the process or practice of covering the soil/ground to make more favorable conditions for plant growth, development and efficient crop production. While natural mulches such as leaf, straw, dead leaves and compost have been used for centuries, during the last 60 years the advent of synthetic materials has altered the methods and benefits of mulching [3,4].

In India, biofertilizer refers to the use of microorganisms to meet nutritional needs, whereas in other countries, the term microbial bioinoculant is used [5]. Biofertilizers are bio-based organic fertilizers that either could be from plant or animal sources or from living or dormant microbial cells that have the potential to improve the bioavailability and bioaccessibility of nutrient uptake in plants [6,7].

The purpose of this research is to evaluate the impact of various mulching techniques and biofertilizer applications on the yield performance of finger millet (Variety- *VL Mandua 379*). By assessing how different mulching materials influence soil moisture, temperature and weed control and how biofertilizers enhance soil fertility and nutrient availability, the study aims to identify optimal combinations that maximize yield. This research seeks to promote sustainable agricultural practices by reducing chemical fertilizer reliance, improving soil health and providing practical recommendations for farmers to enhance finger millet productivity and food security.

2. MATERIALS AND METHODS

The experiment was conducted in the *Kharif* season of 2023 at Himalayan University in Itanagar. The Crop Research Farm is located in Jullang on the university campus at 27.14°N latitude and 93.62°E longitude, with an altitude of 320 meters above sea level. The site is part of the Eastern Himalayan region, and the agro-climatic zone falls under the sub-tropical zone of Arunachal Pradesh. The physio- chemical properties of soil in the experimental field, Himalayan University is presented in Table 1.

The treatments include T_1- Control, T_2- Karanj leaf mould + *Azotobacter*, T_3-Karanj leaf mould + *PSB*, T_4- Neem leaf mould + *Azotobacter*, T_5-Paddy straw at + jute bag + *Rhizobium*, T_6-Paddy straw at 5kg/ha + *Phosphorus solubilizing bacteria*, T_7-Black polythene + *Azotobacter* and T_8-Saw dust + *Rhizobium.* Biofertilizers were added with the method of seed inoculation. The experiment was laid out in a Randomized Block Design (RBD) in the year of 2023. The various methods for calculation of yield parameters are given below:

2.1 Finger Length (cm)

Five random ears were harvested and finger length was noted. The length of the ear was noted from the base spikelet till the longest finger excluding the odd finger and mean values were calculated.

Table 1. Physio-chemical properties of soil in the experimental field, Himalayan University

Particulars	Value	Methods Employed
Sand (%)	54.2%	International pipette method (Piper, 1966)
Silt (%)	29.5%	
Clay (%)	16.3 %	
Soil Texture	Sandy Loam	
Soil pH	4.25	Potentiometric method (Piper, 1966)
Organic carbon	1.59 %	Walkely and Black wet oxidation method (Jackson, 1973)
Electrical conductivity	0.452 dS/m	Conductivity bridge (Jackson, 1973)
Available Nitrogen	613.5 Kg/ha	Alkaline permanganate method (Subbaiah and Asija, 1956)
Available Phosphorus	4.86 Kg/ha	Bray's method. (Jackson, 1973)
Available Potassium	218.4 Kg/ha	Flame photometer method (Jackson, 1973)

2.2 Test Weight (g)

The 1000 seeds from five fresh cobs were obtained immediately after harvest, weighed and the average weight was expressed in g.

2.3 Grain Yield (t ha^{-1})

The net plot was marked, harvested separately and dried. After threshing, grains were separated, cleane and weighed. Later the grain yield per net plot was expressed on a per t ha^{-1} basis.

2.4 Straw Yield (t ha^{-1})

The straw from net plot area was cut close to the ground level and was left for sun drying in the field. Later it was weighed and computed as straw yield in t ha^{-1}.

2.5 Harvest Index (%)

It was calculated for each of the plot and was represented in percentage. The following formula was used (Donald, 1962).

Harvest index (HI) = (Economic yield (kg ha^{-1})/ Biological yield (kg ha^{-1})) X 100

2.6 Statistical Analysis

The experiment was laid out in Randomized Block Design. The data recorded during investigation were subjected to statistical analysis as per method of analysis of variance (ANOVA). The significance and non-significance of the treatment effect were judged with the help of 'F' variance ratio test. Calculated 'F' value (variance ratio) was compared with the Table 2 value of 'F' at 5% level of significance. If calculated value exceeded the Table 2 value, the effect was significant.

3. RESULTS

3.1 Finger Length (cm) and Test Weight (g)

The finger length (cm) and test weight (g)) recorded at harvest, is presented in Table 2. The data shows that there was a significant effect of different treatments on the test weight (g) and finger length (cm).

Among treatments, significantly higher finger length (5.92cm) were observed with T_5 treatment (Paddy straw+ Jute bag+ *Rhizobium*) which remained on par with application of T_8 Treatment (saw dust + *Rhizobium*) (5.49 cm), Paddy straw + *Phosphorus Solubilizing Bacteria*(T_6) (5.28 cm) and Black polythene + *Azotobacter* (T_7) (5.15 cm). Whereas, the significantly lower finger length (3.05 cm) were recorded with the absolute control (T_1).

Similarly, significantly higher test weight (3.06g) were observed with T_5 treatment (Paddy straw+ Jute bag+ *Rhizobium*) which remained on par with application of T_8 Treatment (saw dust + *Rhizobium*) (3.05g)), Paddy straw + *Phosphorus Solubilizing Bacteria*(T_6) (3.03g) and Black polythene + *Azotobacter* (T_7) (3.01g). Whereas, the significantly lower test weight (2.92g) were recorded with the absolute control (T_1).

3.2 Grain Yield and Straw Yield

The grain yield (t ha^{-1}) and straw yield (t ha^{-1}) recorded at harvest, is presented in Table 3. The data shows that there was a significant effect of different treatments on the grain yield (t ha^{-1}) and straw yield (t ha^{-1}) of finger millet.

Table 2. Effect of different types of mulching and biofetilizer on finger length (cm) and test weight (g) of finger millet

Treatment combinations	Finger length(cm)	Test weight(g)
T_1- Control	3.05	2.92
T_2- Karanj leaf mould + *Azotobacter* at 5kg/ha	5.01	2.98
T_3- Karanj leaf mould + *PSB* at 5kg/ha	4.75	2.94
T_4- Neem leaf mould + *Azotobacter* at 5kg/ha	4.44	2.93
T_5- Paddy straw + jute bag + *Rhizobium* at 5kg/ha	5.92	3.06
T_6- Paddy straw + *PSB* at 5kg/ha	5.28	3.03
T_7- Black polythene + *Azotobacter* at 5kg/ha	5.15	3.01
T_8- Saw dust at + *Rhizobium* at 5kg/ha	5.49	3.04
F Test	S	S
SEd (±)	0.08	0.04
CD (P=0.05)	0.68	0.06

Table 3. Effect of different types of mulching and biofetilizer on grain yield (t ha^{-1}) straw (t ha^{-1}) of finger millet

Treatment combination	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1- Control	1.72	3.69
T_2- Karanj leaf mould + *Azotobacter* at 5kg/ha	3.54	7.10
T_3- Karanj leaf mould + *PSB* at 5kg/ha	3.47	6.75
T_4- Neem leaf mould + *Azotobacter* at 5kg/ha	3.36	6.44
T_5- Paddy straw + jute bag + *Rhizobium* at 5kg/ha	4.05	7.92
T_6- Paddy straw + *PSB* at 5kg/ha	3.84	7.28
T_7- Black polythene + *Azotobacter* at 5kg/ha	3.79	7.15
T_8- Saw dust at + *Rhizobium* at 5kg/ha	3.97	7.49
F Test	S	S
SEd (±)	0.06	0.08
CD (P=0.05)	0.59	1.02

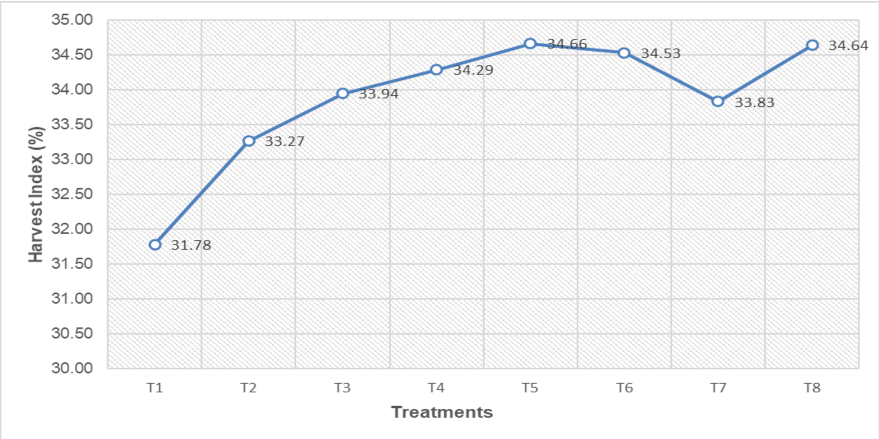

Fig. 1. Effect of different types of mulching and biofertilizer on Harvest Index (%) of finger millet

The maximum grain yield at harvest (4.05 t ha^{-1}) was recorded with T_5 (Paddy straw+ Jute bag+ *Rhizobium*) followed by T_8 (saw dust + *Rhizobium*) (3.97 t ha^{-1}), T_6 (3.84 t ha^{-1}) and T_7 Black polythene + *Azotobacter* (3.79 t ha-1). The lowest grain yield (1.72 t ha^{-1}) was recorded with absolute control (T_1).

Similarly, the maximum straw yield at harvest (7.92 t ha^{-1}) was recorded with T_5 (Paddy straw+ Jute bag+ *Rhizobium*) followed by T_8 (saw dust + *Rhizobium*) (7.49 t ha^{-1}), T_6 (7.28 t ha^{-1}) and T_7 Black polythene + *Azotobacter* (7.15 t ha^{-1}). The lowest straw yield (3.69 t ha^{-1}) was recorded with absolute control (T_1).

3.3 Harvest Index (%)

The harvest index (%) recorded at harvest is graphically represented in Fig. 1.

4. DISCUSSION

Longer finger length was observed in T_5- Paddy straw + jute bag + *Rhizobium* at 5kg/ha. The decomposition of organic mulches enhances soil fertility and microbial activity, further supporting robust plant growth and development. Additionally. *Rhizobium*'s promotion of soil health and microbial activity improves nutrient cycling and availability, further supporting the plant's growth. The synergistic interactions with other beneficial microorganisms also enhance the solubilization of nutrients, making them more accessible to the plants. These factors collectively contribute to the overall growth vigor of the crop, resulting in longer fingers.

The mulches also suppress weed growth, reducing competition for water and nutrients, and enhance soil structure and microbial activity, further supporting robust plant development. These combined factors lead to healthier plants with better grain filling and development, resulting in higher test weight index. In addition, Yanni et al. [8] reported that inoculation of rhizobium showed significant increase in test weight.

Highest grain yield and straw yield was recorded in T_5- Paddy straw + jute bag + *Rhizobium* at 5kg/ha. Since more than one mulching material was applied in T_5 i.e paddy straw and jute bag mulch, Saroa and Lal [9] and Khurshid et al. [10] concluded that organic matter was significantly higher when more mulch was applied, contributing to the increase in yield of finger millet in T_5. Application of straw mulch increased yield by 100 and 200 per cent, respectively over control [11]. Marketable yield from mulched plot was significantly higher than those produced on bare soil. This difference can be attributed to moisture conservation, higher soil temperature, weed control and increased mineral nutrient uptake in the mulched plot through improved root temperatures, as reported by Orozco et al. [12]. These findings are in agreement with Gangwar et al. [13] who reported that paddy straw mulch on mulberry showed maximum leaf yield (46%) compared to sorghum (32.4%) and blackgram mulching (23.08%) over control. In addition, the increased nitrogen availability by the addition of Rhizobium along with improved uptake of other essential nutrients like phosphorus and potassium, supports stronger root development and overall plant health, contributing to higher yield. Rebika and Nongmaithem [14] reported that rhizobium inoculation increased the yield in their studies on different species. Also, Anjum et al. [15] found that inoculation significantly increased yield and yield components in mung bean and reported that seed inoculation was more effective and gave better results than soil inoculation.

The harvest index is a crucial parameter that indicates how effectively a plant partitions dry matter to its economically valuable parts. A higher harvest index value suggests that a plant is more efficient at producing a valuable yield. Additionally, the interaction effect of different types of mulching and biofertilizer on the harvest index was found to be non-significant.

5. CONCLUSION

In conclusion, this study demonstrates that integrating mulching and biofertilizers into finger millet cultivation practices can lead to significant improvements in yield attributes. Treatments with paddy straw and jute bag mulch combined with *Rhizobium* (T_5) showed the most notable improvements in finger length (cm), test weight(g), grain yield (t ha^{-1}), straw yield (t ha^{-1}) and harvest index (%). These findings provide a promising pathway for enhancing food security and promoting sustainable farming practices in finger millet-growing regions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

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 writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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