**Evaluating the Effectiveness of Mulches and Soil Amendments on Brinjal (*Solanum melongena* L.) Yield**

**Abstract**

The present investigation aimed to evaluate the effect of soil amendments along with distinct moisture conservation practices on the yield parameter of brinjal with an unpredictable pattern of rainfall. The experiment was conducted at Advanced Centre for Rainfed Agriculture (ACRA), Dhiansar Samba district of J&K in two consecutive years (2022-2023 and 2023-2024). Split plot design was used for this field research included twelve treatments and three replicates of each mulch. RDF (Recommended Dosage of Fertilizer with No Mulch) was compared against a number of moisture conservation techniques, including as mulch (both plastic and organic), soil additives such as biochar (2 and 4 tons per hectare), and rice husk (2 tons per hectare). Results revealed that treatment T3 (RDF in combination with 4 tons of biochar per) along with plastic mulch (PM) elucidated maximum fruit yield of brinjal. Moreover, T1 (RDF) with no mulch (NM) showed minimum fruit yield for both the consecutive years under drip irrigation in rainfed conditions, respectively. The study highlights the importance of integrating moisture conservation methods in drip irrigation systems to boost crop yield in rainfed agricultural system.

**Keywords:** soil amendments; moisture conservation, drip irrigation, biochar, rice husk.

**Introduction**

India encompasses a substantial expanse of rainfed agriculture owing to its monsoon-dependent environment and inadequate irrigation infrastructure. Of the entire cultivated area of 141 million hectares, 92.6 million hectares are suitable for cultivation under rainfed circumstances. It constitutes 56% of India's total agricultural land. Rainfed cultivation would continue to occupy approximately half of the nation's agricultural territory even once the capacity for irrigation was completely fulfilled. Even under the highest development scenarios for irrigated agriculture, rainfed regions must meet about 40% of the long-term increased foodgrain requirement (Suresh *et al*., 2014).

Pyrolyzing biomass, a technique that creates high-carbon compounds by heating biomass gradually without oxygen, yields biochar, a black carbon. Similar to charcoal, it is a fine-grained, porous material that is produced by burning biomass either naturally or in an oxygen-limited environment (Azhar *et* al., 2019; Rafique *et al*., 2019). It can be made from a variety of biomass sources, including wood and bark, farm residue including corncobs, olive husks, and tea waste materials, vegetative matter, animal manures, and other waste materials (Ebrahimi *et al*., 2021). By increasing soil fertility and organic matter, it has a beneficial impact on the soil, which in turn influences crop growth and development. Adding biochar enhances crop growth and development, which eventually results in higher yield, according to numerous studies (Zhang *et al*., 2022; Kayesh et al., 2023).

A subtropical and tropical plant that grows year-round, brinjal (*Solanum melongena* L.), a member of the family Solanaceae, is valued for its berry-like fruit. It is the fourth most important vegetable grown in India, after tomatoes, potatoes, and onions. China, Pakistan, the Philippines, Bangladesh, and India, all cultivate it extensively. The life cycle of eggplant spans 60 to 85 days because it is a warm-season crop. Several Indian states are mainly brinjal growing which mainly includes Bihar, West Bengal, Andhra Pradesh, Karnataka, Tamil Nadu, Orissa, and Karnataka, respectively. Brinjal is grown on an estimated 8.14% of India's vegetable acreage, making up 9% of the nation's total vegetable production (Shen *et* al., 2020). This bushy plant is rich in flavonoids, alkaloids, and other beneficial compounds like as arginine and aspartic acids (Thingujam *et al*., 2016; Sultana et al., 2022).

The Jammu region's rainfed areas are characterized by scorching summers and dry winters, as well as low intrinsic fertility and water-holding ability. In this regard, mulching is an essential technique that can ensure soil moisture retention and increase crop growth and yield. Studies supports that soil coverage with organic or plastic mulch materials improves soil microbial activities and promote nutrient availability for optimum crop production (Gomasta et al., 2023; Abdrabbo et al., 2017). Therefore, the study's goal was to use a drip irrigation method to assess and optimize the beneficial effects of different soil amendments and mulch on the yield parameter of the brinjal crop. According to our research, adding mulch and biochar to the soil would improve the crop yield in drip irrigation under rainfed environments.

**Materials and Methods**

**Experimental Site**

The Advanced Centre for Rainfed Agriculture (ACRA), a Dryland Research Station of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, located in Dhiansar in the Samba District, was the site of the experiment in 2022 and 2023. The testing site is 332 meters above mean sea level and is situated at latitude 32 ̊ 39 ́ N and longitude 74 ̊ 58 ́ E. The plot's consistent topography made it ideal for growing brinjal.

For brinjal, transplanting was carried out on each raised bed with a 90 cm x 90 cm gap. A split plot design was used for the experiment, with three main plots and four subplots each receiving varying amounts of mulch and fertilizer.

**Treatment Details**

The following twelve treatments were used: T1: Biochar (B0) + No Mulch (NM); T2: Biochar (B0) + Plastic Mulch (PM); T3: Biochar (B0) + Organic Mulch (OM); T4: Biochar (B1) + No Mulch (NM); T5: Biochar (B1) + Plastic Mulch (PM); T6: Biochar (B1) + Organic Mulch (OM); T7: Biochar (B2) + No Mulch (NM); T8: Biochar (B2) + Plastic Mulch (PM); T9: Biochar (B2) + Organic Mulch (OM); T10: Rice Husk (RH) + No Mulch (NM); T11: Rice Husk (RH) + Plastic Mulch (PM); T12: Rice Husk(RH)+ Organic Mulch (OM). The critical difference (CD) was calculated at the 5% probability level in situations when treatment differences were found to be substantial.

**Table 1: Treatment details.**

|  |  |
| --- | --- |
| **MAIN PLOT** | **SUB PLOT** |
| No mulch | No amendment (RDF) |
| Plastic mulch | Biochar @2 t/ha |
| Organic mulch | Biochar @4t/ha |
|  | Rice husk @2t/ha |

**Results and Discussion**

**Effect of various mulches on yield parameters of brinjal**

The yield was recorded maximum in plants grown under the plastic mulch for both the years, (26.7 t ha⁻¹ in 2022 and 30.6 t ha⁻¹ in 2023) followed by organic mulch (24.7 t ha⁻¹ in 2022 and 30.3 t ha⁻¹ in 2023), while no mulch recorded the minimum yield (21.6 t ha⁻¹ in 2022 and 22.4 t ha⁻¹ in 2023), respectively. The critical difference (CD) values at 5% significance level indicated that these differences were statistically significant for both parameters across the two years (CD for yield: 3.02 t ha⁻¹ in 2022 and 1.01 t ha⁻¹ in 2023) (Table 2). This may be explained by the fact that mulching improves soil moisture content significantly, controls temperature swings, raises the availability of nutrients in the soil, optimizes the soil microclimate, and suppresses weeds, all of which contribute to an increase in growth and yield (Subedi and Adhikari, 2024).

As advocated by various studies, mulching has a profound impact on yield as it reduces competition for nutrients, space, and light, leading to higher marketable yields (Gomasta et al., 2023; Abdrabbo et al., 2017). Some free-flying insects need light from the sun to maintain their horizontal orientation while they are in the air; however, when light from the ground enters their body, they are unable to carry on with their regular flight pattern. The typical orientation of flight is disrupted by the light reflection from below when the ground is covered with black silver-coated plastics contributing to higher marketable yield (Shimoda & Honda, 2013).

**Effect of fertilizer levels on yield parameters of brinjal**

In case of soil amendments, T3 (RDF + 4 tons biochar per hectare) revealed the highest yield for both the years (27.2 t ha⁻¹ in 2022 and 29.8 t ha⁻¹ in 2023), followed by T2 (25.5 t ha⁻¹ and 29.2 t ha⁻¹), T4 (23.4 t ha⁻¹ and 25.6 t ha⁻¹). Whereas, the lowest yield was recorded by T1 (21.1 t ha⁻¹ and 26.6 t ha⁻¹), respectively. The differences were statistically significant as indicated by the CD values at 5% (yield CD: 0.90 t ha⁻¹ in 2022 and 1.19 t ha⁻¹ in 2023) (Table 2). This may be due to the fact that since biochar has good effects on various soil parameters, including reduced bulk density, improved nutrient availability, and improved uptake, it may stimulate plant growth in soils modified with it (Windeatt *et al*., 2014). Biochar's active functional groups have the potential to improve the chemical characteristics of soil, including its ability to exchange cations, retain and release water and nutrients, and improve plant access to nutrients, all of which can lead to increased production (Ebrahimi *et al*., 2021). Concurrently, water insufficiency measures fail to meet the standard water requirements of eggplant plants, leading to a drop in their actual water consumption and, subsequently, a decline in output (Wang et al 2022). By combining biochar with other amendments, it can result in improving the surface reactivity, increases the nutrient load, stimulate microbial colonization and degrade harmful substances of biochar and it may also affect compost quality as well (Souri *et al*., 2019). Nevertheless, our results revealed that soil amendment with biochar and mulching could be a potential strategy for reducing the adverse effect of environment on eggplants growth and yield.

**Interaction effect**

The interaction between mulching methods and soil amendments was statistically significant for yield parameters for both the consecutive years, further emphasizing the importance of combining these practices to optimize fruit yield. The results suggest that the effectiveness of treatments depends on the specific combination of mulching and amendment strategies employed. Overall, the study highlights the potential of integrating mulching methods (especially plastic mulch) with soil amendments (such as biochar) to enhance brinjal yields, offering valuable insights for sustainable agricultural practices in regions with limited water resources.

**Table 2: Effect of mulching and soil amendments on yield (t ha-1) in brinjal.**

**Treatments yield (t ha-1)**

2022 2023

**Mulching (M)**

NM *(No Mulch)* 21.6 22.4

PM *(Plastic Mulch)* 26.7 30.6

OM *(Organic Mulch)* 24.7 30.3

CD (5 %)1.100.54

**Soil Amendments (SA)**

T1: *Recommended Dose of fertilizers* 21.1 26.6

T2: RDF + *2 tons biochar per hectare* 25.5 29.2

T3: RDF + *4 tons biochar per hectare* 27.2 29.8

T4: RDF + *2 tons Rice husk* *per hectare* 23.4 25.6

CD (5 %) 0.90 1.19

**Interaction (M × SA)** NS 2.17

**Interaction (SA × M)** NS 2.0

**Conclusion**

The present investigation indicates that application of INM is vital in improving the yield of brinjal during rainfed condition with erratic rainfall. Among the treatments, the application of T3 (4 t/ha biochar) and plastic mulch ensured consistently higher fruit yield in both the seasons (2022–2023 and 2023–2024) due to synergistic effects of enhanced soil structure, improved water holding capacity of soil, and availability of nutrient in holistic manner. On the other hand, control (T1) treatment (only RDF without any mulch) had the lowest grain yield which was evidence of conventional fertilization would be inadequate to reduce the effect of moisture stress under less irrigated condition.

These results underscore the urgent need to optimize the strategies associated with moisture storage and preservation that includes the practices like biochar application and mulching in the rainfed agriculture by applying them into the drip irrigation systems. This kind of practices not only enhance crop yield but also play a role in the long-term soil health and sustainability. The investigation underscores the importance of implementing integrated soil and water management solutions in the context of recent growing climatic unpredictability, in particular for erratic rainfall, in context of increasing yield stability and for climate-smart vegetable production systems.

Subsequent studies could investigate the long-term implications of these amendments on soil microbial dynamics, nutrient cycling, and economic viability to facilitate the larger implementation at the farm scale.

**Disclaimer**

Author(s) declares that no generative AI tool (chatGPT etc) as well as text-to -image generator have been used during writing or editing of this manuscript.

**Compliance with ethical standards**

**Ethical issues:** None

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