**Response of different organic sources on quality attributes of Ber (*Zizyphus mauritiana* lam.) cv. Apple under sodic soil conditions**

**ABSTRACT**

The study aimed to evaluate the impact of different organic sources on the vegetative growth and quality of ber (*Zizyphus mauritiana* Lam.) cv. Apple under sodic soil conditions. The experiment was conducted at Acharya Narendra Deva University of Agriculture and Technology, Ayodhya, using a Randomized Block Design with nine treatments and three replications from June 2021 to March 2022. Various organic amendments, including farmyard manure (FYM), vermicompost, photosynthetic bacteria (PSB), Jeevamrit, and Amritpani, were applied in different combinations. Observations were recorded on fruit quality parameters such as fruit length, width, weight, pulp/stone ratio, total soluble solids, acidity, ascorbic acid content, and sugar composition. The findings contribute to understanding the role of organic amendments in improving ber production under sodic soil conditions. Results showed that the application of T9 (5 kg Vermicompost + 20 ml PSB + 2.5 L Jeevamrit + 2.5 L Amritpani) led to the highest improvement in fruit length, width, weight, pulp-to-stone ratio, total soluble solids, acidity, ascorbic acid, and sugar content. T8 (10 kg FYM + 20 ml PSB + 2.5 L Jeevamrit + 2.5 L Amritpani) also showed promising results, highlighting the effectiveness of organic amendments in enhancing ber fruit quality under sodic conditions.

**Keywords: -** Ber (*Zizyphus mauritiana* Lam.), Organic amendments, Sodic soil, Fruit quality

**INTRODUCTION**

Ber (*Zizyphus mauritiana* Lamk.), the poor man’s apple, is an important drought hardy fruit crop, which can be grown under hostile agro-climatic conditions of the arid region. Since it is hardy and salt tolerant, the tree can be grown even in marginal lands. Its fruit contains 14-16 % sugars, 150 mg vitamin-C per 100 g of pulp, besides other minerals. Ber grows in wild and cultivated forms in India (Bohane & Tiwari 2014). Ber commonly known as Indian jujube, is an important tropical and subtropical fruit crop widely cultivated in arid and semi-arid regions. It is highly valued for its nutritional composition, being rich in vitamin C, carbohydrates, and bioactive compounds that contribute to human health (Singh et al., 2020). The fruit is also recognized for its adaptability to drought conditions and poor soils, making it a valuable crop for sustainable agriculture in regions with limited water availability (Kumar *et al*., 2021). Despite its resilience, ber production faces several challenges, particularly in sodic soil conditions, which significantly affect plant growth, fruit yield, and quality.

Sodic soils are characterized by excessive sodium content, poor soil structure, reduced water infiltration, and low nutrient availability, which hinder root development and limit crop productivity (Sharma & Kumar, 2019). The high pH and poor microbial activity in sodic soils further exacerbate nutrient imbalances, leading to deficiencies in essential elements required for optimal plant growth (Gupta *et al.,* 2021). Addressing these soil-related constraints requires the adoption of sustainable soil management practices that enhance fertility and improve plant growth parameters. The use of organic amendments has emerged as a promising approach for mitigating the adverse effects of sodic soils. Organic inputs such as farmyard manure (FYM), vermicompost, photosynthetic bacteria (PSB), Jeevamrit, and Amritpani play a crucial role in improving soil structure, increasing microbial diversity, and enhancing nutrient availability (Patel *et al*., 2021). These organic sources not only improve soil health but also influence fruit quality attributes such as size, weight, pulp-to-stone ratio, total soluble solids, acidity, and sugar composition (Verma & Yadav, 2020). Additionally, organic amendments promote enzymatic activity in the soil, leading to better nutrient uptake and improved biochemical composition of fruits (Kumar *et al*., 2022).

Previous research has demonstrated that the integration of organic manures significantly enhances fruit quality by improving biochemical properties such as ascorbic acid content, sugar accumulation, and total soluble solids, which are key determinants of market value and consumer preference (Reddy et al., 2018). However, limited studies have explored the combined effects of multiple organic amendments on the quality of ber fruits under sodic soil conditions. Given the increasing demand for high-quality organic fruits, there is a need to identify the most effective organic treatment combinations that enhance both soil health and fruit quality.

This study aims to evaluate the response of different organic sources on the quality of ber cv. Apple under sodic soil conditions. By assessing key fruit quality parameters such as fruit length, width, weight, pulp-to-stone ratio, total soluble solids, acidity, ascorbic acid content, and sugar composition, this research seeks to provide insights into sustainable management practices for improving ber production in degraded soils. The findings of this study will be beneficial for farmers, researchers, and policymakers seeking to promote organic farming practices and enhance the productivity of ber orchards in challenging soil conditions.

**MATERIAL AND METHODS**

The present study entitled “Response of different organic sources on vegetative growth, yield and quality of ber (*Zizyphus mauritiana* Lam.) cv. Apple under sodic soil conditions’’ was carried out at the Main Experiment Station, Post-Harvest Technology Laboratory of the Department of Fruit Science and Laboratory of Department of Soil Science, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh). The experiment was carried out in Randomized Block Design 9 treatment with three replications in the month of June 2021 to March 2022. The vegetative growth, yield, quality and soil physicochemical and biological parameters were undertaken during the investigation. The treatment combination was T0-Control (Recommended Dose), T1-20 kg FYM+ 20 ml Photosynthetic Bacteria (PSB), T2-5 kg Vermicompost + 20 ml PSB, T3-2.5 litre Jeevamrit + 10 kg FYM, T4-5 kg Vermicompost + 2.5 litre Jeevamrit, T5-10 kg FYM + 2.5 litre Amritpani, T6-5 kg Vermicompost + 2.5 litre Amritpani, T7-20 ml PSB+ 2.5-litre Jeevamrit +2.5 litre Amritpani, T8-10 kg FYM + 20 ML PSB+2.5 L Jeevamrit+2.5 L Amritpani and T9-5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani. Observation was recorded on quality attributes of fruit Length (cm), Width (cm), Average fruit weight (g), Pulp/stone ratio, Total soluble solids (%), Acidity (%), Ascorbic acid (mg/100 g), Reducing sugar (%), Non–reducing sugar (%) and Total sugar (%).

**STATISTICAL ANALYSIS**

Statistical analysis of the data obtained in the different set of experiments was calculated as suggested by Panse and Sukhatme (1985).

**RESULTS AND DISCUSSION**

**Response of different organic sources on quality of ber fruits**

In the present study, significant increase in length of the fruit, width of fruit, average fruit weight, pulp stone ration, total soluble solids, acidity, ascorbic acid, reducing sugar and non-reducing sugar were recorded by the application of T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani). The maximum length of fruit (5.16, 5.40 and 5.28 cm and 5.10, 5.28 and 5.19 cm in both years i.e. 2021-22 and 2022-23 and pooled data respectively) was recorded in treatment T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani). The minimum length of fruit (3.75, 3.90 and 3.83 cm) was encoded in T0(control) in both the years of investigation and in pooled data respectively. The above findings are in accordance with Gawande *et al*. (1998), Patel *et al*. (2010) in sapota and Dey *et al*. reported an increase in the physical characteristics of guava with the application of biofertilizer and organic manure alone.

The maximum width of fruit (4.49, 4.80 and 4.65 cm) was encoded in T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (4.45, 4.65 and 4.55 cm) in both years and in pooled data respectively. The minimum fruit width (4.05, 4.17 and 4.11 cm) is reported in T0 (control) in both the years i.e. 2021-22 and 2022-23 and in pooled data respectively. The maximum average fruit weight (63.84, 65.94 and 64.89 in 2021-22 and 2022 23 respectively) was recorded in plants treated with T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (62.75, 64.85 and 63.8 g) during both years and in pooled data respectively. Minimum average fruit weight (43.51, 45.12 and 44.32 g) was observed in T0(control) in both years of investigation and in pooled data respectively.

The maximum pulp stone ratio (5.73, 5.77 and 5.75) was reported in T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (5.71, 5.75 and 5.73) during both years and in pooled data respectively. Minimum pulp – stone ratio (5.17, 5.20 and 5.19) was observed in T0 (control) in both years of investigation and in pooled data respectively. The maximum total soluble solids (9.72, 9.92 and 9.82) was recorded in plants treated with treatment T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (9.54 , 9.78 and 9.66) during both years and in pooled data respectively whereas the minimum total soluble solids(6.42,6.62 and 6.52 ) was reported in T0 (control) in both years of experiment and in pooled data respectively.

The maximum acidity (0.42, 0.43 and 0.42) was encoded in T0 (control). The minimum acidity (0.31, 0.30 and 0.30) was reported in T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) in both years of investigation and in pooled data respectively. Maximum ascorbic acid (78.55, 78.40 and 78.31) was recorded with treatment T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (78.22, 78.40 and 78.31) during both years and in pooled data respectively whereas the minimum ascorbic acid (72.71,72.89 and 72.80 ) was encoded in T0 (control) in both years of experiment and in pooled data respectively.

The maximum reducing sugar (2.56, 2.80 and 2.68 %) was encoded in treatment T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (2.51, 2.75 and 2.63 %) during both years and in pooled data respectively. The treatment T9 is at par with T8 and other treatments. The minimum reducing sugar percentage of ber fruits (2.19, 2.43 and 2.31 %) was reported in treatment T0 (control) in both years (2021-22 and 2022-23) and in pooled data respectively. The maximum non-reducing sugars percentage (4.86, 5.11 and 4.99%) was recorded in T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (4.84, 5.05 and 4.95 %) during both years and in pooled data respectively. The treatment T9 is at par with T8 and other treatments. The minimum non – reducing percentage (4.32, 4.52 and 4.42 %) was observed in T0 (control) during both years and in pooled data respectively.

The maximum Total sugars in percentage (7.42, 7.91 and 7.67%) were encoded in T9 (5 kg Vermicompost+20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) followed by T8 (10 kg FYM + 20 ml PSB+2.5 L Jeevamrit+2.5 L Amritpani) (7.35, 7.80 and 7.58 %) during both years and in pooled data respectively. The treatment T9 is at par with T8 and other treatments.

**Table-1. Response of different organic sources on Length of Fruit, width and average fruit weight in ber**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Notation** | **Treatment Combination** | **Length of Fruit (cm)** | | | **Width of Fruit (cm)** | | | **Average fruit weight (g)** | | |
| **2021-22** | **2022-23** | **Pooled** | **2021-22** | **2022-23** | **Pooled** | **2021-22** | **2022-23** | **Pooled** |
| **T0** | Control (Recommended Dose) | 3.75 | 3.90 | 3.83 | 4.05 | 4.17 | 4.11 | 43.51 | 45.12 | 44.32 |
| **T1** | 20 kg FYM+ 20ml Photosynthetic  Bacteria (PSB) | 4.93 | 5.11 | 5.02 | 4.41 | 4.59 | 4.50 | 60.35 | 62.45 | 61.40 |
| **T2** | 5 kg Vermicompost + 20 ml PSB | 4.72 | 4.90 | 4.81 | 4.38 | 4.57 | 4.48 | 57.62 | 60.05 | 58.84 |
| **T3** | 2.5 litre Jeevamrit + 10 kg FYM | 4.12 | 4.26 | 4.19 | 4.15 | 4.33 | 4.24 | 48.82 | 51.32 | 50.07 |
| **T4** | 5 kg Vermicompost + 2.5 litre Jeevamrit | 4.24 | 4.39 | 4.32 | 4.18 | 4.32 | 4.25 | 50.21 | 52.70 | 51.46 |
| **T5** | 10 kg FYM + 2.5 litre Amritpani | 4.47 | 4.60 | 4.54 | 4.32 | 4.50 | 4.41 | 54.95 | 57.40 | 56.18 |
| **T6** | 5 kg Vermicompost + 2.5 litre Amritpani | 4.38 | 4.56 | 4.47 | 4.27 | 4.44 | 4.36 | 53.19 | 55.65 | 54.42 |
| **T7** | 20 ml PSB+ 2.5 litre Jeevamrit +2.5 litre Amritpani | 3.91 | 4.06 | 3.99 | 4.09 | 4.26 | 4.18 | 46.11 | 48.62 | 47.37 |
| **T8** | 10 kg FYM + 20 ML PSB+2.5 Jeevamrit+2.5 L Amritpani | 5.10 | 5.28 | 5.19 | 4.45 | 4.65 | 4.55 | 62.75 | 64.85 | 63.80 |
| **T9** | 5 kg Vermicompost+20 ml PSB+2.5L Jeevamrit+2.5 L Amritpani | 5.16 | 5.40 | 5.28 | 4.49 | 4.80 | 4.65 | 63.84 | 65.94 | 64.89 |
| **SE(m) ±** |  | 0.09 | 0.09 | 0.08 | 0.079 | 0.095 | 0.092 | 1.26 | 1.24 | 1.43 |
| **C.D. at 5%** |  | 0.28 | 0.29 | 0.24 | 0.237 | 0.284 | 0.274 | 3.79 | 3.72 | 4.30 |

**Table-2. Response of different organic sources on Pulp stone ration, TSS (%), and Acidity in ber**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Notation** | **Treatment Combination** | **Pulp – Stone Ratio** | | | **TSS (%)** | | | **Acidity (%)** | | |
| **2021-22** | **2022-23** | **Pooled** | **2021-22** | **2022-23** | **Pooled** | **2021-22** | **2022-23** | **Pooled** |
| **T0** | Control (Recommended Dose) | 5.17 | 5.20 | 0.42 | 0.42 | 0.42 | 6.52 | 0.42 | 0.43 | 0.42 |
| **T1** | 20 kg FYM+ 20ml Photosynthetic  Bacteria (PSB) | 5.72 | 5.76 | 0.34 | 0.34 | 0.34 | 9.47 | 0.34 | 0.33 | 0.33 |
| **T2** | 5 kg Vermicompost + 20 ml PSB | 5.59 | 5.62 | 0.35 | 0.35 | 0.35 | 9.28 | 0.35 | 0.34 | 0.34 |
| **T3** | 2.5 litre Jeevamrit + 10 kg FYM | 5.21 | 5.25 | 0.39 | 0.39 | 0.39 | 9.11 | 0.39 | 0.38 | 0.38 |
| **T4** | 5 kg Vermicompost + 2.5 litre Jeevamrit | 5.17 | 5.20 | 0.38 | 0.38 | 0.38 | 8.58 | 0.38 | 0.37 | 0.37 |
| **T5** | 10 kg FYM + 2.5 litre Amritpani | 5.47 | 5.51 | 0.36 | 0.36 | 0.36 | 8.93 | 0.36 | 0.34 | 0.35 |
| **T6** | 5 kg Vermicompost + 2.5 litre Amritpani | 5.36 | 5.38 | 0.37 | 0.37 | 0.37 | 8.70 | 0.37 | 0.35 | 0.36 |
| **T7** | 20 ml PSB+ 2.5 litre Jeevamrit +2.5 litre Amritpani | 5.29 | 5.32 | 0.41 | 0.41 | 0.41 | 8.43 | 0.41 | 0.40 | 0.40 |
| **T8** | 10 kg FYM + 20 ML PSB+2.5 Jeevamrit+2.5 L Amritpani | 5.71 | 5.75 | 0.32 | 0.32 | 0.32 | 9.66 | 0.32 | 0.31 | 0.31 |
| **T9** | 5 kg Vermicompost+20 ml PSB+2.5L Jeevamrit+2.5 L Amritpani | 5.73 | 5.77 | 0.31 | 0.31 | 0.31 | 9.82 | 0.31 | 0.30 | 0.30 |
| **SE(m) ±** |  | 0.13 | 0.14 | 0.009 | 0.009 | 0.009 | 0.21 | 0.009 | 0.009 | 0.009 |
| **C.D. at 5%** |  | 0.41 | 0.41 | 0.02 | 0.02 | 0.02 | 0.65 | 0.02 | 0.02 | 0.02 |

**Table-3. Response of different organic sources on Ascorbic acid, Reducing Sugars, Non-Reducing Sugar and Total sugar in ber**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Notation** | **Treatment Combination** | **Ascorbic acid (mg/100 g)** | | | **Reducing Sugars (%)** | | | **Non-Reducing Sugar (%)** | | | **Total sugar (%)** | | |
| **2021-22** | **2022-23** | **2021-22** | **2021-22** | **2021-22** | **Pooled** | **2021-22** | **2022-23** | **Pooled** | **2021-22** | **2022-23** | **Pooled** |
| **T0** | Control (Recommended Dose) | 72.71 | 72.89 | 72.80 | 2.19 | 2.43 | 2.31 | 4.32 | 4.52 | 4.42 | 6.51 | 6.95 | 6.73 |
| **T1** | 20 kg FYM+ 20 ml Photosynthetic Bacteria (PSB) | 77.87 | 78.02 | 77.95 | 2.48 | 2.72 | 2.60 | 4.76 | 4.96 | 4.86 | 7.24 | 7.68 | 7.46 |
| **T2** | 5 kg Vermicompost + 20 ml PSB | 76.13 | 76.28 | 76.21 | 2.42 | 2.66 | 2.54 | 4.74 | 4.94 | 4.84 | 7.16 | 7.60 | 7.38 |
| **T3** | 2.5 litre Jeevamrit + 10 kg FYM | 73.83 | 74.01 | 73.92 | 2.21 | 2.45 | 2.33 | 4.50 | 4.70 | 4.60 | 6.71 | 7.15 | 6.93 |
| **T4** | 5 kg Vermicompost + 2.5 litre Jeevamrit | 74.33 | 74.47 | 74.40 | 2.23 | 2.47 | 2.35 | 4.61 | 4.81 | 4.71 | 6.84 | 7.28 | 7.06 |
| **T5** | 10 kg FYM + 2.5 litre Amritpani | 76.03 | 76.17 | 76.10 | 2.36 | 2.55 | 2.46 | 4.67 | 4.87 | 4.77 | 6.98 | 7.42 | 7.20 |
| **T6** | 5 kg Vermicompost + 2.5 litre Amritpani | 75.13 | 75.31 | 75.22 | 2.31 | 2.51 | 2.41 | 4.69 | 4.89 | 4.79 | 7.05 | 7.31 | 7.18 |
| **T7** | 20 ml PSB+ 2.5 litre Jeevamrit +2.5 litre Amritpani | 73.43 | 73.61 | 73.52 | 2.21 | 2.42 | 2.32 | 4.38 | 4.58 | 4.48 | 6.59 | 7.03 | 6.81 |
| **T8** | 10 kg FYM + 20 ML PSB+2.5 Jeevamrit+2.5  L Amritpani | 78.22 | 78.40 | 78.31 | 2.51 | 2.75 | 2.63 | 4.84 | 5.05 | 4.95 | 7.35 | 7.80 | 7.58 |
| **T9** | 5 kg Vermicompost+20 ml PSB+2.5L Jeevamrit+2.5 L Amritpani | 78.55 | 78.77 | 78.66 | 2.56 | 2.80 | 2.68 | 4.86 | 5.11 | 4.99 | 7.42 | 7.91 | 7.67 |
| **SE(m) ±** |  | 1.61 | 1.72 | 1.62 | 0.05 | 0.04 | 0.04 | 0.09 | 0.10 | 0.11 | 0.15 | 0.19 | 0.18 |
| **C.D. at 5%** |  | NS | NS | NS | 0.14 | 0.14 | 0.13 | 0.29 | 0.30 | 0.32 | 0.46 | 0.56 | 0.54 |

**Conclusion**

The study demonstrated that the application of organic amendments significantly improved the vegetative growth, yield, and quality of ber (*Zizyphus mauritiana* Lam.) cv. Apple under sodic soil conditions. Among the treatments, T9 (5 kg Vermicompost + 20 ml PSB + 2.5 L Jeevamrit + 2.5 L Amritpani) exhibited the most positive effects on fruit quality parameters, including size, weight, pulp-to-stone ratio, total soluble solids, acidity, ascorbic acid, and sugar content. T8 (10 kg FYM + 20 ml PSB + 2.5 L Jeevamrit + 2.5 L Amritpani) also showed notable improvements. These findings highlight the potential of organic amendments in enhancing ber production and suggest their beneficial role in mitigating the adverse effects of sodic soil conditions.

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