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Jeevamrit: Cultivating Sustainable Agriculture for a Resilient and Eco-friendly Future

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A B S T R A C T

This article presents an in-depth examination of Jeevamrit, a bio- fertilizer integral to sustainable agricultural practices. Focused on its composition, impact on soil properties, effects on crop yield and quality, and challenges and future directions, this review sheds light on the potential of Jeevamrit to revolutionize modern farming. Advocated by agricultural luminary Subhash Palekar, Jeevamrit embodies a holistic approach to farming, emphasizing soil fertility preservation and ecosystem health. Scientific studies underscore its efficacy in enhancing soil structure, nutrient availability, and crop resilience, contributing to increased agricultural productivity. Despite challenges such as awareness gaps and variability in input quality, addressing these hurdles through farmer education, research, and policy support is imperative. Future research should prioritize long-term field trials to assess Jeevamrit's sustainability and explore synergies with other natural inputs. By incentivizing the adoption of sustainable farming practices, policymakers can pave the way for a resilient and environmentally responsible agricultural future. Jeevamrit symbolizes the transformative potential of sustainable agriculture, ensuring food security, environmental integrity, and the well-being of farming communities.

Introduction

In the contemporary agricultural landscape, where the reliance on chemical fertilizers and pesticides poses significant environmental and health risks, sustainable alternatives like Jeevamrit are gaining traction. In India, this transition has been particularly propelled by agricultural experts such as Subhash Palekar. Palekar's advocacy for natural farming practices has garnered considerable attention, promoting the utilization of locally sourced organic inputs to preserve soil fertility and enhance crop productivity. This approach underscores a holistic understanding of agriculture, acknowledging the interconnectedness of soil health, plant vitality, and environmental sustainability.

At the crux of this sustainable agricultural paradigm lies the practice of Jeevamrit, a bio-fertilizer meticulously crafted from readily available farm resources. Jeevamrit acts as a potent soil tonic, enriching it with a diverse consortium of beneficial microorganisms, including nitrogen-fixing bacteria, phosphorus-solubilizing fungi, and plant growth-promoting rhizobacteria (Kumar *et al.*, 2017).

Composition and Preparation of Jeevamrit

Jeevamrit is a traditional bio-fertilizer integral to natural farming practices, composed of a mix of locally sourced organic ingredients. The primary components include:

Cow dung

Provides a diverse array of beneficial microorganisms that aid in decomposing organic matter and enhancing soil fertility.

Cow urine

Contains nitrogen, phosphorus, potassium, and various growth-promoting hormones and enzymes.

Jaggery

Serves as an energy source for the microbial population, boosting their growth and activity.

Pulse flour

Provides proteins that act as a nitrogen source, further enhancing microbial growth.

Soil

Introduces native soil microorganisms to the mixture, ensuring compatibility with the field soil microbiome.

The preparation involves mixing these components in specific proportions and allowing the mixture to ferment over a period of time. Typically, the process involves combining 10 kg of fresh cow dung and 10 liters of cow urine with 2 kg of Jaggery, 2 kg of pulse flour, and a handful of soil from the field. These ingredients are added to 200 liters of water in a large container and stirred well to ensure uniformity. The mixture is allowed to ferment for 48 hours, during which it is stirred twice daily to ensure proper aeration and microbial activity. After fermentation, Jeevamrit is ready for application and can be diluted with water for use as a soil drench, foliar spray, or seed treatment solution (Singh *et al.,* 2015).

Mechanisms and Benefits

Microbial Population Enhancement

Jeevamrit introduces a diverse array of microorganisms into the soil, including nitrogen-fixing bacteria, phosphate-solubilizing bacteria, and actinomycetes. Studies have shown that the application of Jeevamrit significantly increases the microbial population in the soil, which plays a crucial role in nutrient cycling and organic matter decomposition (Desai *et al.,* 2013; Hardik N. Lakhani *et al.,* 2020).

Soil Enzyme Activity

The application of Jeevamrit has been linked to enhanced soil enzyme activities, such as dehydrogenase, phosphatase, and urease. These enzymes are vital for organic matter decomposition and nutrient mineralization, thus improving soil fertility and plant nutrient uptake (Sharma *et al.,* 2015; Hardik N. Lakhani *et al.,* 2020).

Crop Yield and Quality

Research indicates that crops treated with Jeevamrit exhibit improved growth parameters, such as plant height, number of tillers, and grain yield. For instance, Patel *et al.,* (2021a) reported that the application of Jeevamrit in a rice-wheat cropping system resulted in a 15% increase in yield compared to conventional practices (Hardik N. Lakhani *et al.,* 2020).

Soil Health and Structure

Jeevamrit enhances soil aggregation and porosity, which are critical for root development and water infiltration. The organic acids produced during the fermentation process also help in chelating soil nutrients, making them more available to plants (Kumar *et al.,* 2002; Hardik N. Lakhani *et al.,* 2020).

Impact on Soil Chemical and Microbial Properties

Chemical Properties

Nutrient Availability

Jeevamrit enhances the availability of essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K). The organic matter in cow dung and urine decomposes, releasing these nutrients in a form readily available to plants. Studies have shown increased levels of macro and micronutrients in soils treated with Jeevamrit compared to those managed with conventional fertilizers.

For example, soils treated with Jeevamrit showed an increase in nitrogen content by 25-30%, phosphorus by 20-25%, and potassium by 15-20% (Patel *et al.,* 2021b; Hardik N. Lakhani *et al.,* 2020).

Soil pH

The application of Jeevamrit can help maintain a balanced soil pH, making it conducive for microbial activity and nutrient uptake by plants.

Organic Matter Content

Regular application of Jeevamrit increases the organic matter content of the soil, enhancing soil structure, water-holding capacity, and cation exchange capacity (CEC), leading to better retention of nutrients and improved soil fertility over time (Hardik N. Lakhani *et al.,* 2020).

Microbial Properties

Microbial Biomass and Diversity

Jeevamrit is rich in beneficial microorganisms, including bacteria, fungi, and actinomycetes, which proliferate upon application to the soil. This increase in microbial biomass enhances soil respiration and enzymatic activities critical for nutrient cycling and soil health. Studies indicate a 35-40% increase in soil microbial biomass and a 25-30% increase in microbial diversity in fields treated with Jeevamrit (Desai *et al.,* 2013; Hardik N. Lakhani *et al.,* 2020).

Soil Enzymatic Activities

The enzymatic activities in soil, such as dehydrogenase, urease, and phosphatase activities, are significantly enhanced by Jeevamrit application. These enzymes are involved in the transformation of organic matter into plant-available nutrients, thereby improving soil fertility and plant health. For instance, dehydrogenase activity increased by 30-35%, urease activity by 25-30%, and phosphatase activity by 20-25% in soils treated with Jeevamrit (Sharma *et al.,* 2015; Hardik N. Lakhani *et al.,* 2020).

Disease Suppression

The microbial diversity and activity promoted by Jeevamrit can help suppress soil-borne pathogens through competitive exclusion and the production of antimicrobial compounds, leading to healthier plants with reduced incidence of diseases (Patel *et al.,* 2021a; Hardik N. Lakhani *et al.,* 2020).

Effects on Crop Yield and Quality

The use of Jeevamrit, a natural agricultural input, has shown significant potential in enhancing crop yield and quality, particularly in wheat and tomato cultivation. Studies have demonstrated:

Wheat

Treated crops experience notable increases in grain yield, with research showing yield improvements of up to 20-25% compared to conventional farming practices. This increase is largely due to enhanced nutrient availability and improved soil health stimulated by microbial activity. Average wheat yield increased from 3.5 tons per hectare to 4.2 tons per hectare with Jeevamrit application (Singh *et al.,* 2019; Hardik N. Lakhani *et al.,* 2020).

Tomato

The combination of Jeevamrit and Panchagavya, another organic input, has led to a 30-35% increase in plant growth parameters, including plant height, leaf area, and overall biomass. Furthermore, fruit yield in tomatoes has shown improvements of around 25-30%, accompanied by enhanced quality parameters such as higher nutrient content, including vitamins and minerals, and improved shelf life by approximately 20-25%. Tomato fruit yield increased from 20 tons per hectare to 26 tons per hectare with the use of Jeevamrit (Kumar *et al.,* 2002; Hardik N. Lakhani *et al.,* 2020). The underlying mechanisms for these benefits include improved nutrient availability through the promotion of beneficial soil microorganisms, enhanced soil structure and water retention, and beneficial plant-microbe interactions that facilitate better nutrient absorption and pathogen protection (Desai *et al.,* 2013; Hardik N. Lakhani *et al.,* 2020).

Additional Scientific Data Supporting Jeevamrit's Efficacy

Microbial Diversity and Function

A study by Sharma *et al.,* (2020) indicated that Jeevamrit-treated soils exhibited a significant increase in

beneficial microbial populations, including a 40% increase in actinomycetes and a 35% increase in nitrogen-fixing bacteria. This diversity enhances soil resilience against pathogens and environmental stressors.

Microbial functional diversity also improved, with notable increases in soil respiration rates and enzyme activities, crucial for nutrient cycling and organic matter decomposition (Patel *et al.,* 2021a; Hardik N. Lakhani *et al.,* 2020).

Soil Organic Carbon

Application of Jeevamrit has been shown to increase soil organic carbon (SOC) levels by up to 30%, as reported by Singh *et al.,* (2015). Higher SOC levels contribute to better soil structure, increased water-holding capacity, and enhanced nutrient availability, fostering a more productive agricultural ecosystem.

Improved SOC levels also support the sequestration of atmospheric carbon, mitigating climate change impacts by reducing greenhouse gas emissions from agricultural activities (Hardik N. Lakhani *et al.,* 2020).

Plant Growth-Promoting Rhizobacteria (PGPR)

Jeevamrit promotes the growth of PGPR, which enhances plant growth by producing phytohormones, solubilizing phosphate, and protecting plants from pathogens. Patel *et al.,* (2021b) documented a 50% increase in PGPR populations in Jeevamrit-treated soils.

PGPR also aid in the synthesis of siderophores, which enhance iron availability to plants, crucial for chlorophyll production and overall plant health (Desai *et al.,* 2013; Hardik N. Lakhani *et al.,* 2020).

Water Use Efficiency

Improved soil structure and increased microbial activity resulting from Jeevamrit application enhance water infiltration and retention. Studies have shown a 15-20% increase in water use efficiency in crops treated with Jeevamrit, leading to better drought resilience and reduced irrigation needs. Enhanced water retention in the soil reduces the need for frequent irrigation, thus conserving water resources and lowering farming costs (Sharma *et al.,* 2015; Hardik N. Lakhani *et al.,* 2020).

Enhanced Nutrient Uptake

Jeevamrit enhances the availability and uptake of essential nutrients such as nitrogen, phosphorus, potassium, and micronutrients like zinc and iron. This is facilitated by the increased microbial activity and soil enzyme functions that break down organic matter and release nutrients in plant-available forms.

Crop tissue analysis from Jeevamrit-treated fields has shown higher nutrient concentrations, indicating better nutrient assimilation and utilization by plants (Patel *et al.,* 2021a; Hardik N. Lakhani *et al.,* 2020).

Challenges and Future Directions

Despite its numerous benefits, the widespread adoption of Jeevamrit faces several challenges:

Awareness and Training

Lack of knowledge and training among farmers regarding its preparation and application. Many farmers may be unfamiliar with the process of making Jeevamrit or may not fully understand its benefits.

Input Quality Variability

Inconsistencies in the quality of inputs can affect its effectiveness. Ensuring consistency in the quality of inputs is essential for maximizing the benefits.

Research and Standardization

Further research is needed to standardize practices related to Jeevamrit production and application. This includes identifying the optimal composition of inputs, refining application methods, and assessing its long-term effects on soil health and crop productivity (Kumar *et al.,* 2002; Hardik N. Lakhani *et al.,* 2020).

Recommendations

To overcome these challenges, a multi-faceted approach is recommended:

Farmer Education

Extension services and training programs to raise awareness and provide necessary skills for Jeevamrit production and application.

Continuous Research

Long-term field trials and studies to assess Jeevamrit's sustainability, optimize its composition, and explore its interactions with other natural inputs.

Policy Support

Incentives and subsidies for adopting sustainable farming practices, along with the development of standards for bio- fertilizer production.

Jeevamrit exemplifies a holistic approach to sustainable agriculture, integrating traditional knowledge with modern scientific insights. Its adoption can lead to improved soil health, increased crop productivity, and a sustainable farming ecosystem. By embracing such eco-friendly practices, we can address the pressing challenges of modern agriculture and pave the way for a greener and more sustainable future. Jeevamrit symbolizes the transformative potential of sustainable agriculture, ensuring food security, environmental integrity, and the well-being of farming communities.

Author Contribution

Hardik N. Lakhani: Investigation, formal analysis, writing—original draft.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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