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Impact of Organic Manures and Azotobacter on the Growth and Yield of Onion (*Allium cepa L.*)

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ABSTRACT

This paper aims to study the Impact of Organic Manures (Farmyard Manure, Poultry Manure, Vermicompost) and Azotobacter on the Growth and Yield of Onion (*Allium cepa L.)*. The experiment included six treatments, each with three replications. Organic manures were applied at different rates: 20 tons per hectare of farmyard manure, 3 tons per hectare of poultry manure, and 5 tons per hectare of vermicompost, alongside Azotobacter at 2 kg per hectare in various combinations. The results indicated that both organic manures and their combinations with Azotobacter had a significant effect on all growth and yield parameters. The highest plant height (67 cm) and bulb yield (17.72 t/ha) were observed with the combination of 20 t/ha poultry manure and 2 kg of Azotobacter. In contrast, the lowest bulb yield (7.03 t/ha) was recorded in the control treatment, which lacked both manure and biofertilizer. Therefore, the application of 20 t/ha of poultry manure combined with 2 kg of Azotobacter at the time of field preparation is recommended to optimize onion growth and maximize bulb yield.

Keywords: Organic Manure, Bio-Fertilizer, Azotobacter, Onion, Growth, Yield.

INTRODUCTION

Onion (Allium cepa L.) is a globally significant vegetable crop known for its culinary versatility and nutritional value. Widely utilized in various dishes and food preparations, onions hold a substantial domestic and commercial market value. Onion bulbs are rich sources of carbohydrates, proteins, vitamins A, B, and C, calcium, phosphorus, and notably flavonoids—compounds that contribute to reducing the risks of chronic diseases such as cancer, cardiovascular disorders, and diabetes (Ramesh et al., 2017). The nutritional composition of onion includes approximately 89% moisture, 4% sugar, 2% fiber, 1% protein, and 1% fat (Adeyeye et al., 2017). Globally, the

cultivation area under onion is steadily expanding due to its economic returns and agronomic adaptability (FAO, 2011).

Soil fertility management is crucial for achieving optimum onion growth and productivity. Onion cultivation benefits significantly from fertile, well-drained soils enriched with organic matter. Traditionally, chemical fertilizers have played a dominant role in supplying nutrients; however, their excessive and unbalanced use has led to adverse environmental impacts, including soil degradation, reduced microbial activity, and micronutrient imbalances (Singh et al., 2017; Yohannes et al., 2017). Consequently, there is a growing emphasis on alternative nutrient sources such as organic manures and biofertilizers, which offer a sustainable and environmentally friendly approach to soil fertility enhancement.

Organic manures, including farmyard manure (FYM), poultry manure, and vermicompost, improve soil physical and chemical properties, enhance microbial activity, and promote root development (Snyman et al., 1998; Shaheen et al., 2007). Biofertilizers such as Azotobacter contribute to atmospheric nitrogen fixation and further support plant nutrient uptake. The integrated application of organic amendments and biofertilizers has been shown to improve soil health, boost crop yield, and reduce dependency on costly synthetic fertilizers, which are often inaccessible to resource-poor farmers (Salami & Omotoso, 2018).

Organic cultivation not only reduces chemical residues in produce but also improves crop quality and supports sustainable agriculture (Yai & Yadav, 2004). The nutrient availability from organic materials is influenced by factors such as decomposition rate, organic source, climate, and soil type. Therefore, adopting integrated nutrient management strategies involving organic manures and biofertilizers can enhance productivity while preserving environmental integrity. In this context, the present study was undertaken to assess the effect of different levels and combinations of organic manures and Azotobacter on the growth and yield performance of onion.

MATERIALS AND METHODS

This study aimed to evaluate the impact of organic manures and the biofertilizer Azotobacter on the growth and yield of onion, and to identify optimal combinations for enhanced productivity under organic management conditions. The experiment was conducted during the Rabi season at the organic farm of Amity University, Noida, Uttar Pradesh.

Prior to the initiation of the experiment, a comprehensive mechanical and chemical analysis of the soil was performed to determine its initial fertility status.

The experimental design followed a Randomized Block Design (RBD) with six treatments replicated three times. Treatments included different organic manure types and their combinations as follows:

Number of Treatments	Treatments
T_1	FYM
T_2	Vermicompost
T_3	Poultry Manure
T_4	Vermicompost +Azotobacter
T_5	Poultry Manures + Azotobacter
T_6	Control

Treatment Details:

20 tons per hectare of farmyard manure (FYM)

3 tons per hectare of poultry manure

5 tons per hectare of vermicompost

Azotobacter applied at 2 kg per hectare

Combinations of the above treatments

A control plot with no nutrient application

All organic amendments and Azotobacter were incorporated into the soil uniformly before transplanting. Standard agronomic practices were followed throughout the growing season to ensure proper crop management.

The high-yielding onion variety 'Pusa Red' was selected for this experiment. This variety is known for its mild pungency and excellent storage capacity. Onion seeds were initially sown in a nursery, and 72-days-old seedlings were transplanted to the main experimental field in the evening hours. The spacing adopted was 20 cm between rows and 10 cm between plants. Gap filling was carried out 7 days after transplanting and continued until 15 days after transplanting to ensure uniform crop stand.

Organic inputs comprising farmyard manure (FYM) at 20 t ha^{-1}, poultry manure at 3 t ha^{-1}, and vermicompost at 5 t ha^{-1} were applied individually and in various combinations. Azotobacter biofertilizer was included as a nitrogen-fixing microbial inoculant. No chemical fertilizers were used. All organic manures were thoroughly incorporated into the soil before transplanting. Nitrogen from organic sources was applied in three equal splits: half at the time of field preparation and the remaining half at 30 and 45 days after transplanting (DAT). Phosphorus and potassium were applied as basal doses based on nutrient equivalency from the organic inputs.

Standard agronomic practices including irrigation, weeding, and plant protection were uniformly applied across all plots. Onion bulbs were harvested manually at physiological maturity. Growth observations were recorded on five randomly selected and tagged plants from each plot at intervals of 30 days (i.e., 30, 60 and 90 DAT). Parameters such as plant height, bulb weight, bulb diameter (polar and equatorial), and yield per plot were measured.

STATISTICAL ANALYSIS

All collected data were subjected to statistical analysis using the procedures recommended by Gomez and Gomez (1984). For treatment effects found to be statistically significant at the 5% probability level ($p \leq 0.05$), the critical difference (CD) was computed to separate means. Since the study utilized organic manures (FYM, poultry manure, and vermicompost) in combination with Azotobacter instead of chemical fertilizers, the results were interpreted within the framework of organic nutrient management. Recent studies (Kumar et al., 2018; Sharma et al., 2020; Singh et al., 2022; Meena et al., 2023) support the effectiveness of such bio-organic inputs in enhancing crop performance under sustainable production systems.

RESULTS AND DISCUSSION

Plant Height (cm)

The plant height varied significantly among treatments from 36 DAT onwards. The maximum plant height at 90 DAT (67 cm) was recorded in T5 (a combination of poultry manure and Azotobacter), while the lowest height (49.6 cm) was observed in the control (T1). Treatment T6 consistently outperformed other treatments throughout the growth stages, likely due to the synergistic effects of organic manures and microbial inoculants enhancing nutrient availability and uptake (Bandyopadhyay et al., 2022; Mahapatra et al., 2017).

Fresh Weight and Bulb Diameter

Significant differences were observed in bulb fresh weight and diameter among treatments. The highest bulb fresh weight (93.74 g) and maximum polar diameter (7.3 cm) were recorded in T5, followed by T4. The control plot recorded the lowest bulb weight (26.06 g) and diameter (5.0 cm). The increase in bulb size and weight with organic amendments can be attributed to improved soil structure, microbial activity, and nutrient cycling (Kumar et al., 2021; Yadav et al., 2023).

Equatorial Diameter

The equatorial bulb diameter was also significantly affected. T5 recorded the maximum equatorial diameter (7.3 cm), indicating a more uniform bulb shape and size under organic management. These findings are consistent with those of Singh et al. (2020), who reported that organic nutrient management led to better vegetative growth and yield components in onion.

Bulb Yield (t ha^{-1})

Bulb yield ranged from 7.4t ha^{-1} in the control to 17.72 t ha^{-1} in T5. The substantial yield increase under T5 treatment was due to enhanced fresh weight, bulb diameter, and overall plant vigor. Organic manures, when used in combination with Azotobacter, improve the physical, chemical, and biological properties of the soil, resulting in higher productivity (Patil et al., 2019; Alam et al., 2024). These results corroborate earlier studies (Bhati et al., 2018; Gererufael et al., 2020; Sharma et al., 2021) and further reinforce that integrated organic nutrient management significantly enhances onion growth and yield compared to untreated controls

CONCLUSION

This study highlights the significance and potential benefits of integrating organic nutrient sources, particularly farmyard manure, in promoting the growth and development of onion crops. Among the treatments evaluated, the combined application of 3 t ha^{-1} poultry manure and 2 kg ha^{-1} Azotobacter resulted in the highest bulb yield (17.72 t ha^{-1}), significantly outperforming the control plots, which recorded the lowest yield. Thus, the T5 treatment emerged as the most effective strategy for enhancing both the growth and productivity of onions under the given experimental conditions.

Author Contributions

Maibam Sanjana: Conceptualization, field experimentation, data collection, statistical analysis, and manuscript writing.

Adhikarimayum Julia Devi: Research and Field Assistance.

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