

Efficacy of Azolla Biofertilizer: Effects on Growth, Biochemical Attributes, and Antioxidant Enzymes in Tomato

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ABSTRACT

Azolla, a free-floating hydrophyte fern, is cultivated in temperate and tropical regions. Its dorsal leaves contain cavities housing cyanobacteria that fix atmospheric nitrogen (N). *Azolla* was amended with the soil before tomato seeds were sown in the treated pots to address the demand for sustainable nutrient management through eco-friendly biofertilizers. This study examined the agronomic efficacy of *Azolla* in influencing growth, biochemical attributes, and antioxidant enzyme responses in tomato (*Solanum lycopersicum* L.) under controlled soil-pot culture conditions. Plants received *Azolla* amendments (0, 50, 100, 150, 200, and 250 g *Azolla* per kg soil), and growth and physiological parameters were measured at developmental stages. *Azolla* significantly enhanced plant performance versus the control in a dose-dependent manner. Optimal responses occurred at intermediate concentrations: 150 g *Azolla* per kg soil maximized dry matter accumulation and ascorbic acid in shoot tissues at tops 30 and leaves of 90 days. Chlorophyll content and peroxidase activity peaked at 100 g *Azolla* per kg soil in leaf tissues across growth stages, while yield of fruits was highest at 50 g *Azolla* per kg soil in 100-day-old plants. All treatments significantly ($P \leq 0.01$) upregulated catalase activity, strengthening the antioxidant defense system. Overall, *Azolla* therefore offers a sustainable biofertilizer strategy for tomato agriculture.

Keywords: *Azolla*; biofertilizer; Tomato (*Solanum lycopersicum* L.); soil-pot culture; sustainable agriculture.

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INTRODUCTION

The continuous increase in the human population, coupled with the depletion of natural resources, is a primary cause of environmental degradation (Maurya *et al.*, 2020). The tomato (*Solanum lycopersicum* L.) ranks among the most commonly utilized vegetables globally (Maham *et al.* 2020) and a widely cultivated culinary vegetable, constitutes a significant element of Indian cuisine (Liu *et al.*, 2022; Maurya *et al.*, 2025). Tomatoes offer both a delicious taste and a wealth of nutritional benefits. (Ali *et al.*, 2020; Haraira *et al.*, 2022; Ibrahim *et al.*, 2023). Improving tomato production has become crucial to maintaining everyday life (Manivannan, 2024).

Environmental pollution, such as the contamination of groundwater, has resulted from the application of chemical fertilizers, which can also accumulate within crops and subsequently enter the human system (Jana *et al.*, 2024). In contrast, biofertilizers used to enhance soil quality and fertility, these are eco-friendly. Composed of natural waste materials, biofertilizers do not contain chemical compounds. They benefit the land by enriching the soil with microorganisms that provide natural and organic nutrients, thereby helping the soil resist diseases.

Consequently, biofertilizers enhance the nutritional quality of the soil and replenish its depleted nutrients (Sura, 2024).

Azolla serves as an effective biofertilizer and green manure in both gardens and rice fields, attributed to its substantial cellulosic content. (Chandra *et al.*, 2022; Jama *et al.*, 2023) *Azolla* species, particularly *Azolla filiculoides* and *Azolla pinnata*, represent promising alternatives to conventional chemical fertilizers in sustainable agriculture. Microorganism-based biofertilizers can serve as substitutes for chemical fertilizers to enhance crop yield, and biofertilizers present a more economical and eco-friendly option, with their primary benefit being their contribution to nitrogen fixation processes. These aquatic ferns exist in symbiotic association with nitrogen-fixing cyanobacteria, making valuable sources of natural plant nutrients (Kumar *et al.*, 2020).

Numerous studies have demonstrated the beneficial properties of biofertilizers across various crops, including beans (Varalakshmi *et al.*, 2022; Ho *et al.*, 2024), cereals (Pathak *et al.*, 2022; Ghimirey *et al.*, 2024; Sura, 2024), and vegetables (M Al-Joboory, 2025; Mahmoudi *et al.*, 2025). Most of these studies confirmed a positive result on

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plant growth. Incorporating fresh or dried *Azolla* with the soil significantly boosts the organic matter levels. Soil microorganisms contribute to the release of macro- and micronutrients by breaking down organic matter. As a result, this method increases the presence of nitrogen, phosphorus, and potassium within the soil. (Kumar *et al.*, 2020) (Ghatage A, et al. 2024) (Pathade A et al. 2024).

Green manure is a valuable method for boosting soil fertility and encouraging sustainable farming by converting natural crop residues into beneficial organic materials. This approach enhances both the structure and nutrient levels of the soil, while also contributing to environmental well-being, thus playing a vital role in environmentally conscious agricultural systems. (Singh *et al.*, 2023; Joshna *et al.*, 2024; Wang *et al.*, 2025)

Annually, approximately 200 million tons of nitrogen are essential for agricultural activities, facilitating the production of food for humans and animals and supporting industrial applications. Consequently, nitrogen is the most critical component of agricultural systems. (Grzebisz & Niewiadomska, 2023)

Replacement of Chemical Fertilizers

Azolla extract demonstrates considerable fertilizing capabilities and is frequently utilized in Tomato and other vegetable cultivation (Hanafy & El-Emary, 2018; Zeleke *et al.*, 2024). Through ongoing harvesting, *Azolla* cultures can produce substantial protein yields without the requirement for nitrogen fertilizers. The blue-green algae found in *Azolla* effectively convert solar energy and enrich the soil with organic matter. The biofertilizer extract obtained from cultivated *Azolla* biomass can be used in agricultural lands by replacing chemical fertilizers to enhance crop yield. The enhancement of tomato plant yields, particularly in Asia, can be significantly achieved by promoting nitrogen fixation through the inoculation of *Azolla* filiculoides, a highly efficient species. Additionally, refining soil management and cropping practices plays striking role in this process (Kumar *et al.*, 2020).

MATERIAL AND METHOD

Tomato (*Solanum lycopersicum* L.) plants were grown in soil-pot culture. The soil was treated with *Azolla* as biofertilizer at the rates of 0, 50, 100, 150, 200 and 250 g per kg soil. Samples of the tomato plants were taken at different stages of growth: tops at 30 days, tops and leaves at 90 days and fruits at 100 days. These samples were used to calculate the dry matter yield, content of chlorophyll, and the activities of catalase and peroxidase enzymes. These analyses were conducted following the procedures outlined by Mishra (2000).

Plants of tomato (*Solanum lycopersicum* L.) were grown in 10-in pots filled with 5 kg of prepared soil under soil-pot culture. The soil was carefully homogenized and sieved to remove stones, plant debris and other unwanted materials before it was put into the experimental pots. Biofertilizer was prepared from dried *Azolla* biomass and was applied to the soil at six levels i.e., 0, 50, 100, 150, 200 and 250 g *Azolla* per kg soil which was labeled as T0

(control), T1, T2, T3, T4 and T5 respectively. Accurately weighed dried *Azolla* was amended properly in the soil for uniform distribution of the biofertilizer. *Azolla* was not applied to control group. Pots were treated and seeds of the same variety of tomato were sown in the pots and all experimental setups were maintained under uniform pot-culture condition to ensure that the results could be compared consistently and reliably. Other cultural practices including irrigation were uniformly used throughout the experiment.

Plant samples were taken at various growth stages for biochemical and growth-related analyses. Shoot tops were collected 30 days after planting (DAP), while both shoot tops and leaves were gathered at 90 DAP. Fruits were picked at 100 DAP. After collection of the plant materials, they were employed to measure the yield of dry matter, chlorophyll, ascorbic acid levels, and the activities of the antioxidant enzymes catalase (CAT) and peroxidase (POD). After collection, the samples intended for biochemical analysis were processed correctly, and the dry matter content was measured using the designated plant material. The results from the various *Azolla* treatments were analyzed to determine how different application rates of dried *Azolla* affect the growth, biochemical properties, and antioxidant enzyme activities in tomato plants (Zeleke *et al.*, 2024).

Dry matter yield was quantified by drying finely chopped and thoroughly mixed plant samples in a forced-draught oven at 65°C for 24 h or until a constant weight was achieved. The method outlined by Petering *et al.* (1940) was employed to determine chlorophyll content. Chlorophyll was isolated using acetone in this method, and the absorbance of the extract obtained was measured with a digital spectrophotometer. To determine the chlorophyll content, the absorbance values recorded were compared against a standard calibration curve, which was established following the method outlined by Comar and Zscheile (1942). The titrimetric method outlined by Harris and Roy (1933) was employed to assess the ascorbic acid content. Catalase (CAT) activity was quantified using the permanganate titration technique as detailed by Euler and Josephson (1927). The evaluation of peroxidase (POD) activity followed the procedure described by Gahagen *et al.* (1968). Plant samples were collected at designated growth phases for biochemical analysis, and the results were outlined based on the distinct analytical techniques employed.

RESULT AND DISCUSSION

Dry Matter Yield (Table 1, Fig. A): Dry matter yield increased with higher biofertilizer levels, reaching up to 150 g *Azolla* per kg of soil in the tops at both 30 and 90 days, as well as in the leaves at 90 days. For fruits of 100-day-old tomato plants, the increase was observed up to 50 g *Azolla* per kg of soil. However, exceeding 150 g *Azolla* per kg of soil in the tops at 30 and 90 days, and in the leaves at 90 days, as well as beyond 50 g *Azolla* per kg of soil in the fruits of 100-day-old tomato plants, resulted in a

reduction in dry matter yield. In comparison to the control, all biofertilizer levels up to 150 g *Azolla* per kg of soil in the tops of plants at both 30 and 90 days, as well as in the leaves at 90 days, and up to 50 g *Azolla* per kg of soil in the fruits of 100-day-old plants, demonstrated a highly significant increase ($P=0.01$) in dry matter yield. The exception was the 200 g *Azolla* per kg soil level in the tops at both 30 and 90 days, where the increase in dry matter yield did not achieve significance over the control. Nevertheless, the 150 and 200 g *Azolla* per kg soil levels in the fruits of 100-day-old plants, and the 250 g *Azolla* per kg soil level in the tops at both 30 and 90 days, leaves at 90 days, and fruits of 100-day-old plants, showed an increase in dry matter yield comparing to the control. However, at the 200 g *Azolla* per kg soil level in the leaves at 90 days, the dry matter yield was identical to that of the control.

At all levels up to 150 g *Azolla* per kg soil, a highly significant increase in dry matter yield ($P=0.01$) was observed in the tops of both 30 and 90 days and in the leaves of 90 days. In the fruits of 100-day-old tomato plants, this increase was significant up to 50 g *Azolla* per kg soil, except for the 100 over 50 g and 150 over 100 g *Azolla* per kg soil levels in the tops of 30-day-old plants, where the increase was significant at $P=0.05$. Conversely, a highly significant decrease in dry matter yield ($P=0.01$) was noted at 100 over 50 and 150 over 100 g *Azolla* per kg soil levels in the fruits of 100 days; at 200 over 150 g *Azolla* per kg soil in the tops of both 30 and 90 days, leaves of 90 days, and fruits of 100 days; and at 250 over 200 g *Azolla* per kg soil in the tops of both 30 and 90 days and leaves of 90 days. This decrease was significant ($P=0.05$) at the 250 over 200 g *Azolla* per kg soil level in the fruits of 100-day-old tomato plants. In tomato plants, the highest dry matter yield was recorded at a concentration of 150 g *Azolla* per kg of soil in the tops at both 30 and 90 days, as well as in the leaves at 90 days. For fruits of 100-day-old plants, the highest yield was achieved with 50 g *Azolla* per kg of soil as a biofertilizer.

Kumar *et al.* (2020) observed substantial improvements in plant morphology when treated with *Azolla* extracts. The root and shoot lengths of tomato plants grown in 100% *Azolla* extract progressively increased on days 30, 60, and 90. The number of leaves in tomato plants treated with 100% *Azolla filiculoides* extract reached 49, 48, and 90 on days 30, 60, and 90, respectively, showing better results than both the control treatments and lower concentrations. Hanafy and El-Emary (2018) observed that the 20% *Azolla pinnata* treatment produced the highest vegetative growth parameters, yielding plant length and number of fruits.

Azolla treatment, when utilized as a biofertilizer, resulted in the highest vegetative growth parameters, thereby enhancing plant yield. (Maze *et al.*, 2023; Ahmad & Tariq, 2021; Hanafy & El-Emary, 2018;)

Chlorophyll (Table 1, Fig. B): In tomato plants, the chlorophyll content rose as the biofertilizer level

increased, reaching its peak at 100 g *Azolla* per kg of soil in the leaves of plants aged 30 and 90 days. When the biofertilizer level exceeded 100 g *Azolla* per kg of soil, the chlorophyll content in the leaves of both age groups began to decline. Compared to the control, all levels up to 150 g *Azolla* per kg of soil in the leaves of both 30 and 90-day-old plants exhibited a highly significant increase in chlorophyll content ($P=0.01$). However, beyond the 150 g *Azolla* per kg soil level, a reduction in chlorophyll content was assessed in the leaves of both age groups, except for the 150 g *Azolla* per kg soil level in the leaves of 30-day-old plants, where the value matched that of the control.

In plants aged 30 and 90 days, chlorophyll content exhibited a highly significant rise ($P=0.01$) with each incremental level, reaching up to 100 g of *Azolla* per kg of soil. However, a highly significant reduction ($P=0.01$) in chlorophyll content was observed when the amount increased to 150 g compared to 100 g, and further decreased at 200 g compared to 150 g of *Azolla* per kg of soil in the leaves of both age groups. Moreover, when comparing 250 g to 200 g of *Azolla* per kg of soil, a notable reduction ($P=0.05$) was detected in the leaves of plants aged 90 days, whereas a very significant reduction was evident in those aged 30 days. Tomato plants, both at 30 and 90 days old, showed the greatest chlorophyll levels in their leaves when the soil contained 100 g of *Azolla* per kg.

Chlorophyll accumulation is a critical indicator of photosynthetic efficiency. In the 100% *Azolla filiculoides* treatment, chlorophyll 'a' content was 18.8 mg and 25.6 mg on days 30 and 60, respectively, chlorophyll 'b' was 12.14 mg and 14.66 mg, and total chlorophyll was 13.44 mg and 15.56 mg on the same intervals. The improvement in chlorophyll content and leaf numbers was observed to be highest in 100% concentrations compared to other treatments, as chlorophyll absorbs the light energy required to convert carbon dioxide and water into glucose (Kumar *et al.*, 2020). Jama *et al.* (2023) observed in his study that the application of *Azolla* as a biofertilizer give rise to an increase in chlorophyll content with vegetable crops, and Duy Hoang *et al.* (2023) evaluated the effects of different doses of *Azolla* fertilizer on the growth and yield of Malabar spinach (*Basella alba*).

Ascorbic Acid (Table 1, Fig. C): In tomato plants, the concentration of ascorbic acid increased with higher levels of biofertilizer, peaking at 150 g of *Azolla* per kg of soil in the tops of plants aged 30 and 90 days. When the biofertilizer level exceeded 150 g *Azolla* per kg of soil, the ascorbic acid content in the tops of both age groups of plants began to decline. Compared to the control, all levels up to 200 g *Azolla* per kg of soil in the tops of both 30-day-old and 90-day-old plants exhibited a highly significant increase ($P=0.01$) in ascorbic acid content. When 250 g of *Azolla* was added per kg of soil, the ascorbic acid levels in the tops of plants aged 90 days decreased, whereas those in the tops of 30-day-old plants stayed consistent with the control group.

In tomato plants aged 30 and 90 days, the application of biofertilizer at levels up to 150 g *Azolla* per kg soil resulted in a marked increase in ascorbic acid content, with a statistically significant difference ($P=0.01$) from earlier measurements. On the other hand, when the biofertilizer concentration was increased to 200 g and subsequently to 250 g *Azolla* per kg soil, a significant reduction ($P=0.01$) in ascorbic acid content was observed in both age groups. The maximum ascorbic acid content was found at the 150 g *Azolla* per kg soil concentration in the tops of both 30 and 90 days old tomato plants.

Tomatoes are abundant in antioxidants such as vitamin C (ascorbic acid) and carotenoids, which contribute positively to human health. Regular consumption of tomatoes and their products has been linked to a decreased risk of chronic diseases, including cardiovascular conditions, according to research findings. (Tarkeshwar *et al.*, 2024; Yanai, 2017; Burton-Freeman *et al.*, 2015; and Palfi & Tomic-Obrdaj, 2014). Tomato fruits cultivated in greenhouses generally exhibit reduced vitamin C levels, primarily due to the use of artificial lighting. This is because natural light serves as the primary regulator of vitamin C levels in plants. (Ntagkas, 2020; Ntagkas *et al.*, 2016; Verkerke *et al.*, 2015). As a new approach, the environmental impacts of each unit of natural vitamin C can also be estimated. Subsequently, the results obtained from this estimate will be used as a reference to compare the environmental impacts of the production of natural vitamin C with the industrial production of vitamin C in future research.

Strawberries harvested from plants that received 25% of their nitrogen from Farm Yard Manure, combined with 75% from urea and supplemented with *Azotobacter*, demonstrated superior quality. This was evident through measurements of total soluble solids, total sugars, ascorbic acid, and anthocyanin content. (Pathak *et al.* 2017; Iqbal *et al.* 2009). However, Maham *et al.* (2020) highlighted that, While irrigation and fertilization are important for tomato growth and their environmental effects, they do not significantly influence the vitamin C content.

Unit Catalase (Table 1, Fig. D): In tomato plants, catalase activity increased with the application of biofertilizer, peaking at a concentration of 150 g *Azolla* per kg of soil in the tops of plants at both 30 and 90 days, as well as in the leaves of 90-day-old plants. When the biofertilizer level surpassed 150 g *Azolla* per kg of soil, a reduction in catalase activity was noted in the tops of plants at both 30 and 90 days and in the leaves of 90-day-old plants. Compared to the control, all biofertilizer levels significantly ($P=0.01$) enhanced catalase activity in the tops of plants at both 30 and 90 days and in the leaves of 90-day-old plants.

Increased catalase activity was notably significant ($P=0.01$) across all levels compared to their preceding stages in the plant parts examined, specifically in the tops at 30 and 90 days and in the leaves of 90-day-old plants, up to a biofertilizer concentration of 150 g *Azolla* per kg

soil. A significant decrease in catalase activity ($P=0.01$) was observed at 200 g compared to 150 g *Azolla* per kg soil, and at 250 g compared to 200 g *Azolla* per kg soil in the tops of both 30 and 90 days and in the leaves of 90-day-old tomato plants. The highest catalase activity was recorded at the 150 g *Azolla* per kg soil level of biofertilizer in the tops of both 30 and 90 days and in the leaves of 90-day-old tomato plants.

The activity of catalase in tomato plants is enhanced by the increased application of *Azolla* as a biofertilizer. (González-Gordo *et al.*, 2024; Maswada *et al.*, 2020; Leung, 2018; ; Kolmykova *et al.*, 2015)

Peroxidase (Table 1, Fig. E): Raising biofertilizer levels to 100 g *Azolla* per kg of soil in the tops of plants aged 30 and 90 days, as well as in the leaves of 90-day-old plants, enhanced the peroxidase activity in tomato plants. However, exceeding 100 g *Azolla* per kg of soil in these plant parts led to a reduction in peroxidase activity. Compared to the control, the increase in peroxidase activity was notably significant ($P=0.01$) at all biofertilizer levels up to 150 g *Azolla* per kg of soil in the tops of 30 and 90-day-old plants and the leaves of 90-day-old plants. Beyond the 150 g *Azolla* per kg soil level, all levels resulted in a decrease in peroxidase activity in the tops of both 30 and 90-day-old plants and the leaves of 90-day-old plants compared to the control.

Peroxidase activity showed a highly significant increase ($P=0.01$) across all levels compared to their preceding levels in specific plant parts, namely the tops of both 30 and 90-day-old plants and the leaves of 90-day-old plants, up to a biofertilizer concentration of 100 g *Azolla* per kg soil. Conversely, a highly significant decrease ($P=0.01$) in peroxidase activity was noted at 150 g compared to 100 g *Azolla* per kg soil, at 200 g compared to 150 g *Azolla* per kg soil, and at 250 g compared to 200 g *Azolla* per kg soil in the tops of both 30 and 90-day-old plants and the leaves of 90-day-old tomato plants. The peak peroxidase activity was observed at the 100 g *Azolla* per kg soil level of biofertilizer in the tops of both 30 and 90-day-old plants and the leaves of 90-day-old tomato plants.

Non-toxicity and Organic Farming Potential

The extract is a desirable biological fertilizer supplement for chemical fertilizers in organic farming. The extract is non-toxic, harmless, non-flammable, and effective for all plants in attaining better germination, growth, and yield (Kumar *et al.*, 2020).

Biochemical Benefits of *Azolla*-Treated Tomatoes

In addition to its agronomic parameters, *Azolla pinnata* plays an important role in maximizing the antioxidant potential of tomatoes due to its ability to provide tomato with valuable contents of vitamins, beta carotene, growth promoters, and minerals. *Azolla* is recognized for its higher nutritional value and can replace traditional protein products, making *Azolla*-treated tomatoes nutritionally superior for human consumption (Hanafy & El-Emary, 2018).

CONCLUSION

Studies have shown that *Azolla*-based biofertilizers can be a feasible, sustainable and economically efficient alternative to chemical fertilizers for vegetable production. Aquatic ferns improve the plant growth parameters by increasing germination, vegetative growth, chlorophyll synthesis and accumulation of nutrients. At the same time they beneficially modify the soil properties by modifying its pH and increasing the availability of macroelements, especially nitrogen. *Azolla* extracts are non-toxic and effective in organic farming systems and can also contribute to soil organic matter and therefore are vital tools for sustainable agriculture and reducing pollution from synthetic fertilizers.

Conflict of Interest: The authors affirm that no financial, personal, or professional conflicts of interest have potentially influenced the research, its outcomes, or the interpretation of the findings.

Author Contributions: Garima Singh and Pooja Yadav were responsible for the planning and experimental design of the study examining the efficacy of *Azolla* biofertilizer in tomato cultivation. Garima Singh and Bhavna Yadav participated in the field collection of *Azolla* and its subsequent transfer for cultivation and experimental application. Jitendra Mohan provided comprehensive supervision and oversight of the experimental activities.

Narendra Kumar Shukla contributed to the review and critical revision of the manuscript. Narendra Babu Shakya was involved in the conceptualization, scientific direction, and project leadership, as well as the interpretation of data concerning tomato growth, biochemical attributes, and antioxidant enzyme responses. He also contributed to manuscript preparation and its critical revision. All authors reviewed and approved the final version of the manuscript.

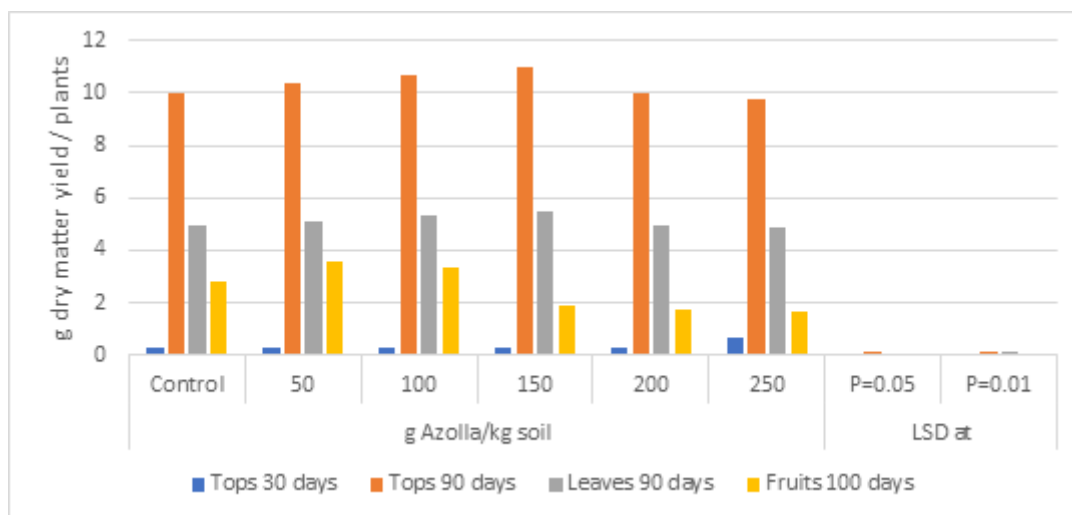
Ethical Compliance: This study entailed the cultivation of tomato plants and the application of *Azolla* as a biofertilizer within controlled pot-culture conditions. As the study did not involve human participants or animals, ethical approval for human or animal subjects was not necessary. The experiment adhered to institutional guidelines for responsible plant research and laboratory practices.

Data Access Statement: The data produced and examined in this study concerning the efficacy of *Azolla* biofertilizer in tomato cultivation are accessible from the corresponding author upon reasonable request. These data encompass measurements pertaining to plant growth, biochemical attributes, antioxidant enzyme activities, and soil nutrient status.

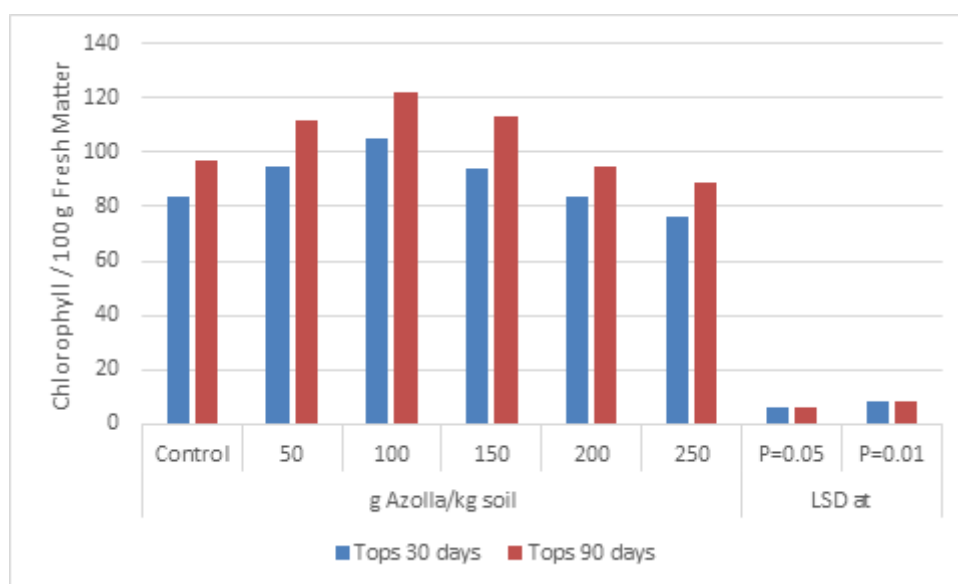
Funding: This study was conducted without the support of any specific grant or financial assistance from funding agencies, commercial entities, or other external sources.

Table 1: Effect of *Azolla* as biofertilizer on Dry Matter Yield, Chlorophyll, Ascorbic acid, Catalase and Peroxidase activities of Tomato (*Solanum lycopersicum* L) plants

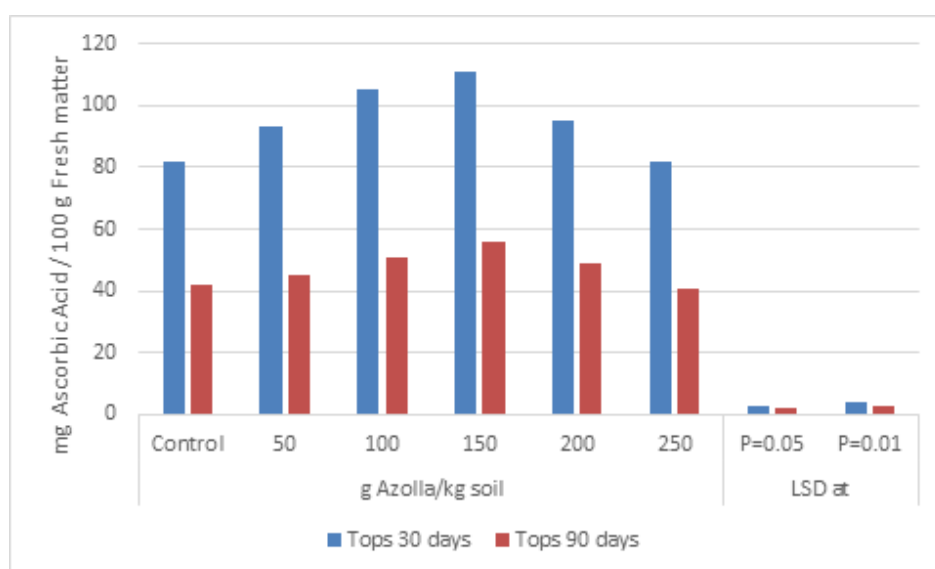
Plant parts	Days	g <i>Azolla</i> per kg soil						LSD	
		C	50	100	150	200	250	P=0.05	P=0.01
g Dry matter yield / plants									
Tops	30	0.300	0.297	0.308	0.319	0.290	0.650	0.009	0.013
Tops	90	9.97	10.40	10.65	11.00	9.98	9.75	0.12	0.17
Leaves	90	4.98	5.10	5.34	5.50	4.98	4.84	0.07	0.11
Fruits	100	2.83	3.59	3.33	1.90	1.72	1.66	0.06	0.09
mg Chlorophyll / 100 g Fresh matter									
Tops	30	84	95	105	94	84	76	6	8
Tops	90	97	112	122	113	95	89	6	8
mg Ascorbic Acid / 100 g Fresh matter									
Tops	30	82	93	105	111	95	82	3	4
Tops	90	42	45	51	56	49	41	2	3
Unit Catalase / 100 g Fresh matter									
Tops	30	6.27	6.87	7.47	8.25	7.65	6.84	0.09	0.13
Tops	90	2.14	2.30	2.50	2.76	2.56	2.29	0.06	0.09
Leaves	90	3.20	3.35	3.63	3.96	3.69	3.29	0.07	0.11
Δ O. D. Peroxidase									
Tops	30	0.020	0.024	0.037	0.023	0.019	0.014	0.002	0.003
Tops	90	0.032	0.039	0.056	0.037	0.030	0.025	0.002	0.003
Leaves	90	0.026	0.033	0.045	0.031	0.025	0.020	0.001	0.002



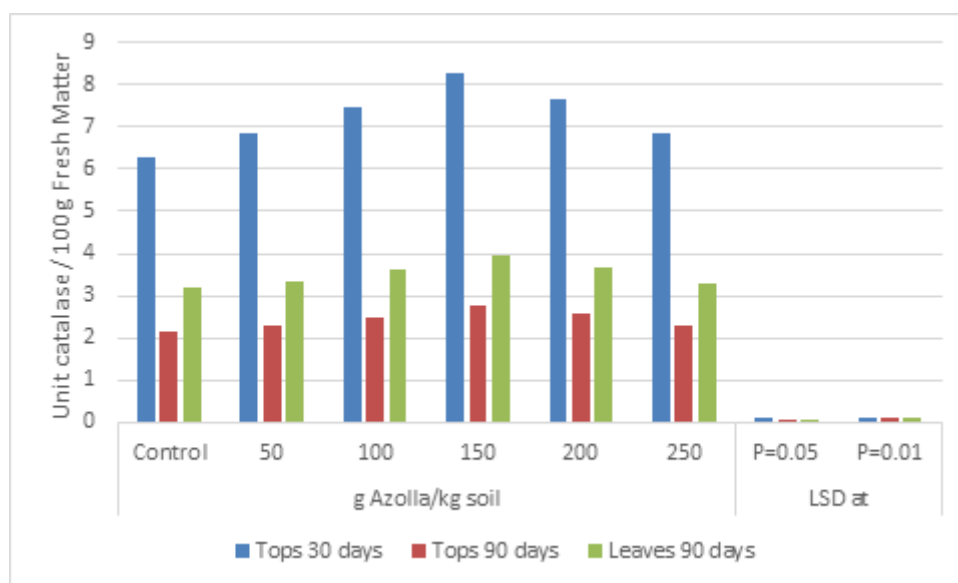
(A)



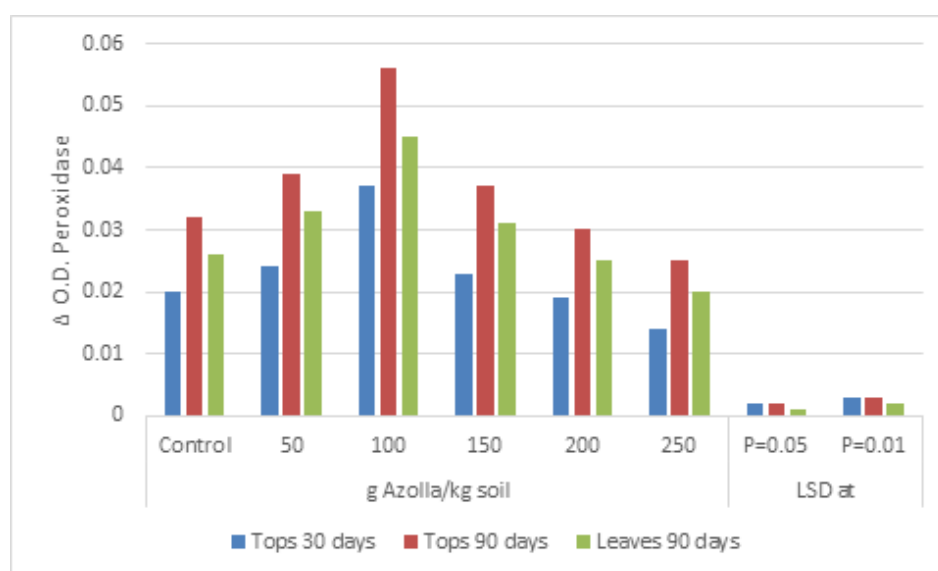
(B)



(C)



(D)



(E)

Figure: Effect of *Azolla* as biofertilizer on Dry Matter Yield (A), Chlorophyll (B), Ascorbic acid (C), Catalase (D) and Peroxidase activities (E) of Tomato (*Solanum lycopersicum* L) plants

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