Evaluating the Efficacy of Different Bioinoculants and Bioenhancers on the Vegetative growth and Yield of Strawberry (Fragaria x ananassa) cv. Winter dawn

Abstract

The strawberry (Fragaria x ananassa) cv. Winter dawn is a significant fruit within the Fragaria genus and is classified under the Rosaceae family. There is a growing trend in adopting strawberry cultivation even in subtropical conditions. However, there is still a need to promote the standardization of agricultural techniques for strawberry cultivation in subtropical regions to increase production while maintaining quality. This study was conducted to evaluate the efficacy of different bioinoculants and bioenhancers on the vegetative growth and yield of Strawberry (Fragaria x ananassa) cv. Winter dawn transplanted during the winter season of 2022-23 at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj. The experiment comprised of nine treatments viz. T0- CONTROL (RDF), T1- Azotobacter @400g/100m², T2- PSB @400g/100m², T3- Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l, T4- Amritpani (3 times diluted with non-chlorinated water) @250ml/l, T5- Azotobacter @400g/100m² + Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l, T6- PSB @400g/100m² + Amritpani (3 times diluted with non-chlorinated water) @250ml/l, T7- Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l+ Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m², T8- Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + PSB @400g/100m². The experiment was laid out in Randomized Block Design. The results revealed that the treatment T7 (Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m²) was found to be best in terms of Vegetative growth viz., Plant height (25.67cm), Plant spread (27.00cm (E-W), 27.00cm (N-S)), Petiole length (12.00cm), No. of leaves per plant (22.00), Chlorophyll content (60.69), Days to first flowering (40.67), No. of fruits (16.00), No. of flowers (19.00), Fruit set (84.18%), and Fruit yield (2.13Kg) of strawberries.

Keywords: Subtropical cultivation, Biofertilizers, Winter dawn, Vegetative growth

Introduction

Strawberries are versatile plants that can adapt to various climates, including tropical, sub-tropical, and temperate regions at high altitudes of up to 3000 meters above sea level, as long as there is reliable access to irrigation. Their widespread distribution as a fruit crop can be attributed to their genetic diversity, highly heterozygous nature, and ability to thrive in diverse environmental conditions.

Over the past 50 years, the efforts of strawberry breeders have significantly increased global interest in strawberry cultivation, leading to a substantial rise in production. As a result, strawberries have become immensely popular and are considered one of the most delightful, refreshing, and tender fruits worldwide. Their vibrant colors, pleasant flavor, and enticing aroma make them highly sought after by people around the globe (Sharma and Yamdagni, 2000). Furthermore, ripe strawberries are a rich source of vitamins and minerals, including vitamin A (60 IU/100g of edible portion) and vitamin C (30-120mg/100g of edible portion) (Singh et al., 2007).

Bioinoculants are formulations that contain beneficial microorganisms like Azotobacter and Phosphorus Solubilizing Bacteria (PSB). Azotobacter is a nitrogen-fixing bacterium that converts atmospheric nitrogen into a usable form for plants, thus promoting plant growth and development. PSB, on the other hand, solubilizes insoluble phosphorus in the soil, making it accessible for absorption by strawberry plants. These bioinoculants have the potential to improve nutrient availability, enhance soil health, and contribute to sustainable agriculture.

In addition to bioinoculants, bioenhancers such as Jeevamrit and Amritpani are organic substances that stimulate soil microbial activity and nutrient cycling. Jeevamrit is a fermented mixture of beneficial microorganisms, organic matter, and water. It enriches the soil with beneficial microbes, enhances nutrient availability, and aids in the decomposition of organic matter. Amritpani, another bioenhancer, is a concoction prepared by fermenting various plant materials. It promotes the growth of beneficial microorganisms, enriches the soil with organic matter, and improves nutrient availability.

Therefore, this study aimed to assess the effect of various bioinoculants (Azotobacter and PSB) and bioenhancers (Jeevamrit and Amritpani) on the growth and yield parameters of Winter Dawn strawberries (Fragaria × ananassa). By understanding the effects of these bioinoculants and bioenhancers, we can contribute to the development of sustainable agricultural practices that reduce reliance on synthetic inputs and enhance strawberry production in an eco-friendly manner.

Materials and Methods

Materials

Strawberry (Fragaria × ananassa) cv. Winter dawn was used for the present study. The experimental plants were treated with two bioinoculants and two bioenhancers, consisting nine treatment combinations viz. CONTROL (RDF), Azotobacter @400g/100m², PSB @400g/100m², Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l, Amritpani (3 times diluted with non-chlorinated water) @250ml/l, Azotobacter @400g/100m² + Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l, PSB @400g/100m² + Amritpani (3 times diluted with non-chlorinated water) @250ml/l, Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l+ Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m², Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + PSB @400g/100m². All the plants were maintained under uniform cultural schedule during the entire course of investigation.

Study Area

The study was conducted at the Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, located in Prayagraj, Uttar Pradesh, India. Prayagraj has a sub-tropical climate, situated at an elevation of 78 meters above sea level, with latitude and longitude coordinates of 25.87°N and 81.15°E, respectively. The region experiences cold winters with occasional frosts, while summers can be very hot, with temperatures reaching up to 115°F in May and June. The average annual rainfall in Prayagraj is approximately 1013.4 cm. The research field had a length of 14m and a width of 4m, providing a total area of 44m². Winter Dawn strawberry plants were spaced at 30cm × 30cm, resulting in 243 plants distributed across the experimental field.

Sampling Design

A randomized block design was employed, with the control group (T0) receiving the recommended dose of fertilizer (RDF). The remaining eight treatment groups (T1-T8) received different combinations of bioinoculants and bioenhancers, including Azotobacter, PSB, Jeevamrit, and Amritpani. Various growth parameters such as Plant height, Plant spread, No. of leaves per plant, No. of fruits, No. of flowers, Fruit set and Fruit yield.

Result-

The effects of different bioinoculants and bioenhancers on the vegetative growth and yield of Winter Dawn strawberries were assessed through various parameters. The treatments included a control (T0), as well as combinations of Azotobacter (T1), PSB (T2), Jeevamrit (T3), Amritpani (T4), Azotobacter + Jeevamrit (T5), PSB + Amritpani (T6), and Jeevamrit + Amritpani + Azotobacter (T7). Measurements were taken at 30, 60, and 90 days after treatment (DAT).

The results showed that the T7 treatment consistently outperformed all other treatments and the control in terms of vegetative growth and yield attributes. At 30 DAT, T7 recorded the maximum plant height of 9.33 cm, while the control exhibited significantly lower plant height at 5.40 cm. Similar trends were observed at 60 and 90 DAT, indicating the sustained effect of the treatment. Moreover, T7 exhibited the maximum plant spread, with values of 13.33 cm (E-W) and 14.00 cm (N-S) at 30 DAT, 21.33 cm (E-W) and 22.50 cm (N-S) at 60 DAT, and 27.00 cm (E-W) and 27.00 cm (N-S) at 90 DAT. The control consistently had the smallest plant spread throughout the study period.

The number of leaves per plant was significantly higher in the T7 treatment compared to other treatments and the control. At 30 DAT, T7 had an average of 7.00 leaves per plant, while the control had only 4.33 leaves. Similar trends were observed at 60 and 90 DAT, with T7 consistently exhibiting the highest leaf count.

In terms of reproductive attributes, T7 again showed superior performance. It recorded the highest number of flowers per plant, with an average of 19.00 flowers, compared to the control's average of 12.33 flowers. T7 also had the highest fruit set percentage at 84.18%, indicating a higher rate of successful fruit development. The number of fruits per plant was also significantly higher in T7, with an average of 16.00 fruits, while the control had only 7.67 fruits.

The ultimate measure of success, fruit yield, also favored the T7 treatment. It achieved a maximum yield of 2.13 kg, while the control had the lowest yield at 0.90 kg. These results highlight the overall effectiveness of the Jeevamrit, Amritpani, and Azotobacter combination in promoting vegetative growth, flower and fruit development, and ultimately, higher fruit yield.

Table 1 - Effect of Bioinoculants & Bioenhancers on Plant Height, Plant Spread, No. of leaves per plant of Strawberry

Sr. No.	Treatment	Treatment Combinations	Plant Height(cm)	Plant Spread(cm)	No. of Leaves/Plant
1	**T0**	CONTROL (RDF)	15.67	22.33	15.33
2	**T1**	Azotobacter @400g/100m²	16.47	22.67	16.00
3	**T2**	PSB @400g/100m²	16.90	23.33	21.00
4	**T3**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	17.73	25.67	19.33
5	**T4**	Amritpani (3 times diluted with non-chlorinated water) @250ml/l	19.10	26.00	16.67
6	**T5**	Azotobacter @400g/100m² + Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	24.50	26.67	20.33
7	**T6**	PSB @400g/100m² + Amritpani (3 times diluted with non-chlorinated water) @250ml/l	21.30	25.33	17.33
8	**T7**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l+ Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m²	25.67	27.00	22.00
9	**T8**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + PSB @400g/100m²	23.23	26.00	20.00

Table 2 - Effect of Bioinoculants & Bioenhancers on No. of Fruits per plant, No. of Flowers per plant and Fruit set percentage of Strawberry

Sr. No.	Treatment	Treatment Combinations	No of Fruits/ Plant	No of Flowers/ Plant	Fruit set (%)
1	**T0**	CONTROL (RDF)	7.67	12.33	62.17
2	**T1**	Azotobacter @400g/100m²	9.67	13.67	70.69
3	**T2**	PSB @400g/100m²	11.00	14.67	75.08
4	**T3**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	11.67	15.67	74.44
5	**T4**	Amritpani (3 times diluted with non-chlorinated water) @250ml/l	13.67	17.67	75.97
6	**T5**	Azotobacter @400g/100m² + Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	14.67	18.00	83.00
7	**T6**	PSB @400g/100m² + Amritpani (3 times diluted with non-chlorinated water) @250ml/l	11.33	15.33	74.16
8	**T7**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l+ Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m²	16.00	19.00	84.18
9	**T8**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + PSB @400g/100m²	12.00	16.00	74.93

Table 3 - Effect of Bioinoculants & Bioenhancers on Yield per plot of Strawberry

Sr. No.	Treatment	Treatment Combinations	Yield/ plot (Kg)
1	**T0**	CONTROL (RDF)	0.90
2	**T1**	Azotobacter @400g/100m²	1.50
3	**T2**	PSB @400g/100m²	1.67
4	**T3**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	1.33
5	**T4**	Amritpani (3 times diluted with non-chlorinated water) @250ml/l	1.67
6	**T5**	Azotobacter @400g/100m² + Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l	1.70
7	**T6**	PSB @400g/100m² + Amritpani (3 times diluted with non-chlorinated water) @250ml/l	1.93
8	**T7**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l+ Amritpani (3 times diluted with non-chlorinated water) @250ml/l + Azotobacter @ 400g/100m²	2.13
9	**T8**	Jeevamrit (3 times diluted with non-chlorinated water) @250ml/l + Amritpani (3 times diluted with non-chlorinated water) @250ml/l + PSB @400g/100m²	2.07

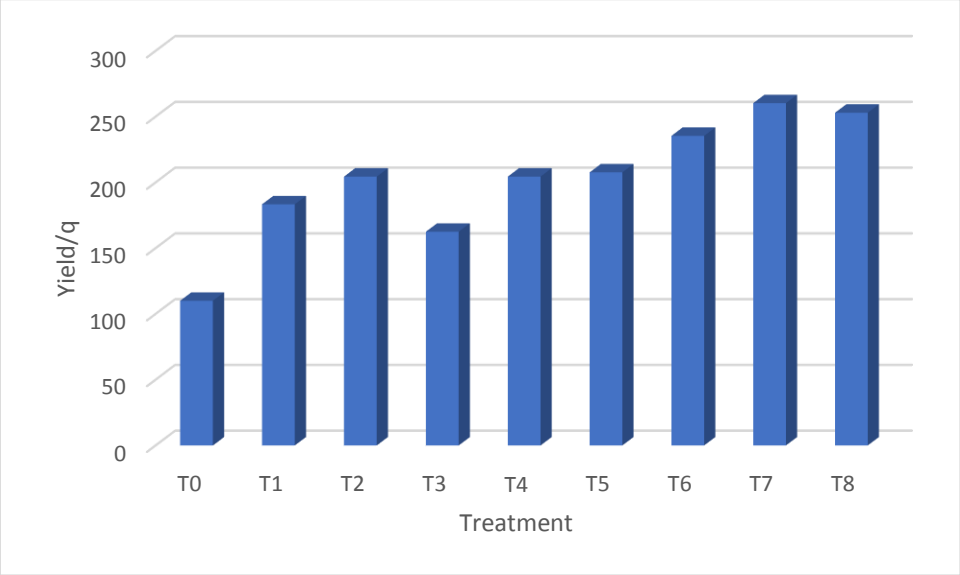

Figure 1: Effect of different bioinoculants and bioenhancers on fruit yield of strawberry (Fragaria × ananassa) cv. Winter dawn

Discussion-

The significant improvement in vegetative growth and yield attributes observed in the T7 treatment (Jeevamrit + Amritpani + Azotobacter) can be attributed to the synergistic effects of the individual components. Jeevamrit, a microbial mixture, is known to enhance nutrient availability and uptake, leading to improved plant growth. Amritpani, a fermented solution rich in nutrients, provides an additional boost to the plants, supporting their growth and development. Azotobacter, a nitrogen-fixing bacterium, increases nitrogen availability, a critical nutrient for plant growth.

The combined application of Jeevamrit, Amritpani, and Azotobacter in the T7 treatment have promoted optimal nutrient uptake and utilization, resulting in enhanced plant height, spread, and leaf production. These factors contribute to increased photosynthetic activity and ultimately result in a higher yield potential. Furthermore, the improved flower and fruit set percentages in the T7 treatment indicate the positive effect of bioinoculants and bioenhancers on reproductive processes, ensuring a higher number of fruits per plant.

The superior performance of the T7 treatment in terms of fruit yield underscores the importance of microbial inoculants and bioenhancers in sustainable strawberry production. By harnessing the power of beneficial microorganisms and nutrient-rich solutions, farmers can reduce their reliance on synthetic fertilizers and chemical inputs. This approach not only promotes environmentally friendly practices but also contributes to improved crop productivity and overall agricultural sustainability. The findings of this study highlight the potential of using bioinoculants and bioenhancers as effective tools for enhancing strawberry production while minimizing the negative impacts associated with conventional farming methods. Further research is warranted to optimize the application methods and assess long-term effects to ensure the scalability and practicality of these treatments in commercial strawberry cultivation.

Conclusion

In conclusion, the results of this study clearly demonstrate the efficacy of the T7 treatment (Jeevamrit + Amritpani + Azotobacter) in promoting the vegetative growth and yield of Winter Dawn strawberries. The combination of these bioinoculants and bioenhancers significantly enhanced various growth parameters, including plant height, spread, leaf count, flower and fruit production, fruit set percentage, and fruit yield.

The application of Jeevamrit, Amritpani, and Azotobacter collectively contributed to improved nutrient availability, uptake, and utilization by the plants. This led to enhanced photosynthetic activity, vigorous growth, and increased reproductive success. The synergistic effects of these components resulted in substantial improvements in plant height, spread, leaf production, flower and fruit formation, and ultimately, higher fruit yield.

Overall, the findings of this study support the adoption of bioinoculants and bioenhancers, particularly the T7 treatment, as an effective strategy for enhancing the vegetative growth and yield of Winter Dawn strawberries. Further research and field trials are recommended to optimize application methods, evaluate long-term effects, and assess the economic feasibility of these treatments in commercial strawberry farming.

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