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Assessment of the Effect of Different Bio-Stimulants on the Growth, Quality, and Yield of Strawberries in a Sub-Tropical Climatic Region: A Case Study

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This case study investigates the impact of different bio-stimulants, including Novel prime organic liquid nutrient, Vermi wash, and Cow urine, on vegetative growth, flowering, and fruit yield of sweet sensation variety of strawberry plants. An intensive research work was carried out at an experimental land located in north Konkan zone of Maharashtra, India. The experiment employs a Completely Randomized Design (CRD) with three replications to evaluate growth at various stages and yield parameters. The results demonstrate that the strategic application of 2% concentration of

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Novel prime organic liquid nutrient and 2% Vermiwash significantly improves the plant growth and yield of strawberry. This treatment remarkable yielded 5418 kg/ha, while the appreciable yield achieved to 4733 kg/ha for the Vermiwash treatment. The results also highlight the potential of sustainable strawberry cultivation and suggesting its viability for countries that traditionally depend on rain-fed crops. This may significantly improve the pattern of agricultural practices in those regions. Strawberry cultivation is an economically significant horticultural practice worldwide. Enhancing the growth, quality, and yield of strawberry plants is crucial for improving production and profitability.

Keywords: Strawberry; bio-stimulants; plant growth regulatory; quality; yield; organic nutrients.

1. INTRODUCTION

The strawberry, a member of the Rosaceae family, is adored for its delicious taste, delicate flavours, and rich levels of antioxidants, vitamins C, iron, and essential minerals [1]. In India, strawberry cultivation is primarily concentrated in the temperate regions, typically experience relatively mild temperatures without extreme heat in the summer or severe cold in the winter. Additionally, sub-tropical areas (experience mild winter, hot and humid with high temperatures in summer) also have the potential to cultivate this crop under irrigated conditions.

The study began in November 2022, during the early phase of the winter season, at the ASPEE Agricultural Research and Development Foundation (ARDF) in the North Konkan region of Maharashtra, India. The climate in this area is characterized as subtropical, hot, and humid, with a maximum temperature reaching 40.6°C, a minimum of 8.3°C, and an annual rainfall of 2293 mm (Government of Maharashtra) [2].

Strawberries grow well under temperate climates, typically in the range of 15-27°C. However, certain cultivars can also flourish in sub-tropical conditions. Crucially, flower-bud formation relies on a sunlight period of 12 hours or less and moderate temperatures, with each cultivar having unique day length and temperature preferences. Sandy loam to loamy soil with a pH of 5.7-6.5 is ideal for its cultivation. Prominent strawberry varieties cultivated in India include Chandler, Tioga, Torrey, Selva, Belrubi, Fern, and Pajaro, Premier, Red cost, Local Jeolikot, Dilpasand, Bangalore, Florida 90, Katrain Sweet, Pusa Early Dwarf, and Blakemore (NHBI)[3].

The present study considers the Sweet Sensation variety of strawberries with the aim of analysing how various bio-stimulants affect the growth and yield parameters of strawberry plants. Bio-stimulants, such as organic liquid nutrients, vermiwash, and cow urine, have gained attention as potential enhancers of plant growth and fruit production.

This transformation has unlocked fresh prospects for agricultural practices in nations such as India, Pakistan, and Bangladesh, where rain-fed crops have traditionally been the linchpin of livelihoods.

In order to highlight the significance of the present study, it is valuable to briefly discuss noteworthy and relevant research endeavours undertaken by various practitioners in a similar manner.

Verkleij conducted a comprehensive review of seaweed extracts, specifically Seamino. The findings revealed that these extracts can fortify plant resistance against pests and diseases, foster plant growth, and enhance crop yield and quality [4]. In the similar study Crouch and Staden emphasized the importance of seaweed extracts in agriculture, citing their high concentrations of organic matter, microelements, vitamins, fatty acids, and growth regulators such as auxins, cytokinins, and gibberellins [5].

Paroussi et al. assessed the impact of GA3 (gibberellic acid) and different photoperiod regimes on the growth and flowering of strawberry plants [6]. Pérez et al. investigated the growth and developmental patterns of several strawberry cultivars, which included Elsanta, Bolero, and Everest [7].

Taha discovered that applying seaweed extracts, specifically Soluamine, to strawberry plants significantly increased fruit size, the number of fruits per plant, and overall plant yield, while Marmarine seaweed extracts notably increased fruit fresh weight [8].

Adesemoem and Kloepper highlighted the significance of plant growth-promoting

rhizobacteria (PGPR) as biofertilizers or microbial inoculants, highlighting their crucial role in an integrated nutrient management system [9]. Esitken et al. performed an analysis on the effects of plant growth-promoting bacteria (PGPB) on the yield, growth, and nutrient content of organically grown strawberries [10].

Karlidag et al. carried out research to explore the capacity of plant growth-promoting rhizobacteria in alleviating the detrimental effects of salt stress on strawberry plants [11].

Sharma et al. conducted field studies to examine the growth and flowering attributes of different strawberry cultivars in Himachal Pradesh, India [12].

In the Kurdistan Region of Iraq, Taha and Haji conducted a study to explore the effects of bio stimulants and seaweed extracts on the vegetative growth and fruit characteristics of two short-day strawberry cultivars. The experimental field was organized in a split-plot design with four replicates [13-15].

In their latest study, Rana et al. evaluated the improvement in the growth, yield, and nutritional qualities of strawberry plants (Fragaria × ananassa Duch.) through the application of a bio-stimulant in the form of seaweed extract in the region of Himachal Pradesh, India[14].

The subsequent sections describe materials and methods, experimental details, a discussion of results, and conclude with final remarks.

2. MATERIALS AND METHODOLGY

The study began in November 2022, during the early phase of the winter season. The climate in this area is characterized as subtropical, hot, and humid, with a wide temperature range 8.3°C to 40.6°C, an annual rainfall of 2293 mm (Government of Maharashtra) [2]. The experiment was conducted using a Completely Randomized Design (CRD) with three replications. The treatments consisted of three different bio-stimulants, each applied at two different concentrations, resulting in a total of 6 experimental treatment actions namely T1 to T6. The experimental setup and treatment details are summarized in Table 1 and Table 2, respectively.

2.1 Parameters Measured

During the trails, the following parameters were recorded in due time of experiment to assess the impact of different bio-stimulants:

Table 1. Experimental design

Particular	Details
Transplanting Date:	November 12, 2022
Variety of Strawberry	Sweet sensation
Planting Spacing:	45cm × 45cm
Plants per Treatment:	15
Net Plot size:	2.25m × 1.35m
Gross Plot size:	2.70m × 1.80m
Total Plants per Replication:	90

Table 2. Treatment details

Treatment	Action
T1:	T1: Novel prime organic liquid nutrient (1%)
T2:	T2: Novel prime organic liquid nutrient (2%)
T3:	T3: Vermiwash (1%)
T4:	T4: Vermiwash (2%)
T5:	T5: Cow urine (1%)
T6:	T6: Cow urine (2%)

Plant Height (cm), Plant Spread (cm), Number of Leaves per Plant, Number of Runners per Plant, Number of Flowers per Plant, Number of Berries per Plant, Fruit Length (cm), Fruit Weight (g) and Fruit Yield (kg/ha). The experimental results, including the mean values and standard errors, are summarized in Table 3.

3. RESULTS AND DISCUSSION

The analysis of variance (ANOVA) revealed significant differences among the treatments for all parameters. The results also examine the impact of different bio-stimulants on various aspects of strawberry cultivation. The key findings are highlighted below:

3.1 Plant Height

The shortest plant, measuring 18.36 cm were observed with Treatment T5, while longest was recorded 34.47 cm with treatment T2 (2% Novel prime organic liquid nutrient). However, an appreciable plant height 31.24 cm was noticed with treatment T4 (2% Vermiwash). Taha and Haji and more recently Tajdinian et al observed the similar effect with macroalgal treatment [13,16].

Table 3. Performance metrics of different treatments on strawberry plants

Treatment	Plant height (cm)	Plant Spread (cm)	No. of leaves per plant	No. of runners per plant	No. of flowers per plant	No. of berries per plant	Fruit length (cm)	Fruit weight (g)	Fruit Yield (kg/ha)
T 1	27.28	29.98	40.53	7.07	18.87	16.87	3.52	20.4	4321
T 2	34.47	34.11	52.13	8.47	24.53	22.53	4.28	24.91	5418
T 3	23.89	28.18	36.47	6.2	17.2	15.20	3.27	18.4	3978
T 4	31.24	31.99	44.93	7.67	22.47	20.47	3.91	22.28	4733
T 5	18.36	18.96	25.2	4.07	13.33	11.33	2.57	13.11	2743
T 6	21.95	24.63	30.9	5.53	15.47	13.47	2.9	16.01	3429

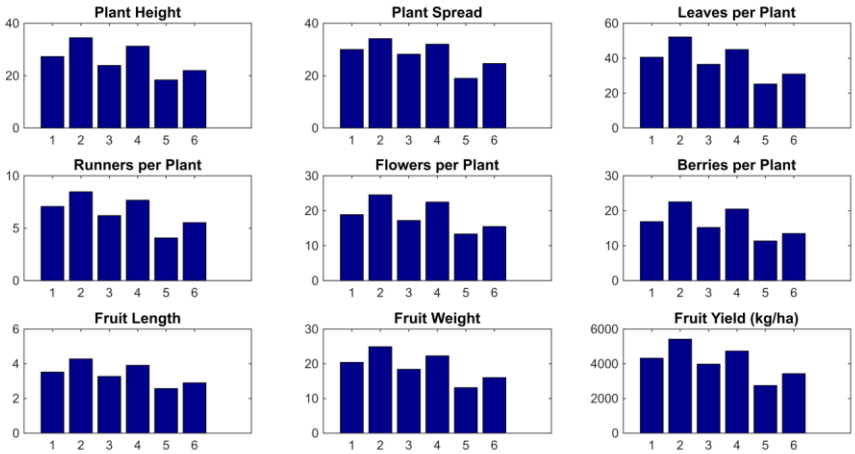

Fig. 1. Effect of different treatments on various parametrs

3.2 Yield and Fruit Characteristics

The highest values for all parameters were achieved with treatment T2. Subsequently, an appreciable effect was observed with treatment T4 (2% Vermiwash), indicating their positive effects on strawberry growth and yield. Notably, T2 exhibited the highest fruit yield of 5418 kg/ha, followed by T4 with 4733 kg/ha. The graphical illustrations are shown in Fig. 1.

The findings of this study revealed that the application of 2% Novel prime organic liquid nutrient and 2% Vermiwash can significantly improve the growth and yield of strawberry plants. These bio-stimulants may enhance nutrient uptake, promote root development, and contribute to increased flowering and fruit yield. Recent reported contributions by Sharma, Taha and Haji, Tajdinian et al and Rana et al supported the significance of the present case study [12,13,14,16].

The improved vegetative growth, characterized by plant height, plant spread, and the number of leaves, is likely attributed to enhanced nutrient availability in the soil owing to the bio-stimulant application. Furthermore, the increased number of runners per plant suggests better vegetative propagation, potentially resulting in a denser strawberry canopy.

The substantial increase in the number of flowers and berries per plant with treatments T2 and T4 could be due to enhanced nutrient availability, which is crucial during the flowering and fruit development stages of strawberry plants. Moreover, the increased fruit length, fruit weight, and fruit yield in these treatments underscore the importance of optimal nutrition for high-quality strawberry production. According to the NHBI, Govt. of India report, the current average yield of strawberry, ranges from 45 to 100 q./ha. However, by adopting well-managed orchard practices, this yield could be further enhanced to 175 to 300 q./ha. [3]. A fertilizer dose of 25-50 tonnes farmyard manure, 75-100 kg. N, 40-120 kg. P_2O_5, 40-80 kg. K_2O/ha may be applied according to soil type and variety planted [3]

4. CONCLUSION

The detailed investigation revealed that the application of 2% Novel Prime organic liquid

nutrient and 2% Vermiwash led to significant improvements in the growth, flowering, and fruit yield of strawberry plants, achieving a remarkable yield of 5418kg/ha (54.18 q/ha). This yield is particularly notable in the sub-tropical region, as the national average typically ranges from 45-100 q/ha. However, by adopting well-managed orchard practices, this yield could be further enhanced up to 175 to 300 q./ha. (NHBI) [3].

These bio-stimulants show great potential for integration into strawberry cultivation practices, offering the prospect of enhanced crop productivity and quality.

Further research is essential to explore the long-term effects and determine the optimal application rates of bio-stimulants such as organic liquid nutrients, vermiwash, and cow urine. These substances have garnered attention for their potential to enhance plant growth and fruit production, particularly in the context of commercial strawberry farming.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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