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Foliar Application of Seaweed Extract and Micronutrients on Plant Growth and Yield of Strawberry (*Fragaria X ananassa* Duch) CV. Winter Dawn

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The review summarizes the findings from recent studies, assessing the impact of foliar application of seaweed extracts and micronutrients on strawberry plants. Improvements in growth parameters, nutrient uptake, TSS, and yield attributes were observed. The study also determines whether adding seaweed extracts and micronutrients to strawberry growth methods can improve plant performance in general and fruit yield in particular. Minerals, amino acids, and plant growth regulators are among the bioactive substances found in seaweed extracts that have been shown to

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have a positive impact on a number of plant physiological functions. Furthermore, vitamin shortages might result in decreased growth and yield because they are essential to the plant's metabolic processes. The combination of micronutrients and seaweed extract has synergistic effects that offer a promising way to boost the general health and yield of strawberry crops.

Keywords: Seaweed extract; micronutrients; growth parameters; TSS.

1. INTRODUCTION

Strawberry (*Fragaria × ananassa*) is one of the most delicious fruit of the world which attained a prime position in the world fruit market as fresh fruit with in the processing industries. All the cultivated varieties of strawberry are octaploid (2n=8×=56) in nature and belongs to the family Rosaceae. It is short day plant, native from France in 17th century and the two American diploids Fragaria × chiloensis and Fragaria × virginiana are considered as its progenitors. Strawberry is perennial, stoliniferous herbs which spread via stolons or runners. The strawberry have a type of aggregate fruit botanically. In India, many strawberry cultivars were introduced in early 1960. Primarily strawberry was growing in temperate zone of the country. However, it can also be cultivated under sub-tropical climate, even at higher altitudes of tropical climate. In India its main centers of cultivation are Nainital (district) and Dehradun in Uttrakhand, Mahabaleshwer (Maharashtra), Kashmir Valley, Bangalore and Kalimpong (West Bengal). In recent years, strawberry is being cultivated successfully in plains of Maharashtra around Pune, Nashik and Sangli towns. In Rajasthan strawberry is getting popularity for the cultivation in Jhadol and Mavali (Udaipur), Nimbaheda (Chittorgarh), Mandalgarh (Bhilwara) and Jhalawar. The strawberry plants are strongly affected by the environmental factors like temperature, photoperiod and light intensity [1].

The chemical composition of strawberry is ascorbic acid (64.0 mg), water (91.75 g), protein (0.61 g), fat (0.37 g), carbohydrate (7.02 g), fiber (2.3 g), calcium (14.0 mg), potassium (166 mg/100 g) and vitamin-A (27 IU). Ellagic acid is a naturally occurring plant phenol. It has been found to inhibit the cancer disease and asthma by the regular consumption of the fruit [1].

Strawberries reproduce sexually via seed; they can also reproduce asexually using their stolons, or runners, which grow several cm away from the 'mother' plant before rooting into the ground at the nodes and developing a new crown. Several weeks later, the stolon deteriorates and the new flowers, leaves, and stolon [2].

The availability of micronutrient like iron, zinc and boron to the plant at less than pH 6.5. Boron is absorbed in H3BO4 form. Next to zinc, boron is widely deficient nutrient. It is a micronutrient mobile in soil and immobile in the plant. Availability of boron in soil is reduced on account of calcareousness, salinity or sodicity, over liming. Very little is known about mineral of B in soils. Boron plays many important roles in plant metabolism. Zn absorbed by the plant in Zn2+ form. Zn is very most important micro-nutrient of global concern, and highly deficient micro-nutrient of equal magnitude on both acid as well as alkaline soils. zinc is an immobile micro-nutrient in the plants. The availability of zinc in soil is adversely affected by soil calcareousness, high phosphorus content, salinity or sodicity, over liming etc. Iron absorbed by plant in Fe2+ form. It is one of the micronutrients becomes extremely mobile under waterlogged conditions and it is highly immobile in the plant. In acid soils, soluble iron could fix phosphates which are aggravated further by high water table and water logging. Whereas on alkaline calcareous soils, lime induced Fe chlorosis is perhaps the most researched nutritional disorder in citrus. Availability of iron becomes less available in soils having beyond pH 7.8. High available iron could induce manganese-deficiency. Chandrakar et al. [3] studies on nutritionally, strawberry contains low calorie carbohydrate and a potential source of vitamin-C and fibers.

Among various micro-nutrients, iron (Fe) and zinc (Zn) plays an important role in promoting vegetative growth, flowering, yield and quality of strawberry fruits [3]. Iron has many important functions in plant growth and development, such as involvement in the biosynthesis of chlorophyll, respiration, chloroplast development and improves the performance of photosystems. It is an essential part of many enzymes. Iron also participates in the oxidation process that releases energy from sugars and starches and in responses that convert nitrate to ammonium in plant. It plays an essential role in nucleic acid metabolism [4,5]. Zinc also plays an important role in photosynthesis and related enzymes resulting in increasing sugar and decreasing acidity. Mahnaz et al. [6] claimed that ZnSO4 as a source of zinc had a positive effect in increasing leaf area, length and diameter of petiole, fresh and dry shoot ratio, yield, TSS, acidity and Vitamin-C of strawberry plant.

2. MATERIALS AND METHODS

2.1 Data Analysis

The data was analysed using OPSTAT.

The details of the various materials used and methods adopted in carrying out the experiment are presented below:

2.2 Experimental Site

The present investigation entitled “Effect of different concentration of seaweed extract and micronutrients on plant growth, yield and quality of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter Dawn” was carried out during the year 2023-2024 in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences Prayagraj in the months of October 2023 to February 2024. The experiment was conducted on strawberry cv. Witner down. All the facilities necessary for cultivation, including labour were made in the department.

2.3 Layout and Treatment Combination

Studies on effect of seaweed extract and micronutrients on growth and yield of strawberry was carried out on cv. Winter dawn during 2023-24 at Horticulture Research Farm of Naini Agricultural Institute, SHUATS, Prayagraj, (Uttar Pradesh). The experiment was laid out in RBD viz. Treatments at 13 levels viz. T0: control, T1: SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%, T2: SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%, T3: SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, T4: SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%, T5: SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%, T6: SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%, T7: SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, T8: SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%, T9: SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%, T10: SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%, T11: SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, T12: SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. The transplanting was done on 28/10/2023 in field condition.

2.4 Climate

The prayagraj District comes under subtropical belt in the southeast of U.P. which experience extremely hot summer and fairly cold winter. During the winter months (Dec.-Jan) temperature falls 2-5^{0}C or even low, while in summer months (May-June) it reaches as high as 49^{0}C. Hot blowing winds are regular feature during the summers and an occasional spell of frost may be during winters. Most of the rainfall is received in the middle of July to end of September after which the intensity of rainfall decreases. The mean annual rainfall is about 850-1100mm. However, occasional precipitation is also not uncommon during winter months.

2.5 Running Status

1. Growth Parameter

- Plant Height (cm)
- Plant Spread (cm)
- Chlorophyll Content

2. Leaf Parameter

- Number of leaves per plant
- Leaf area (sq. cm)
- Petiole length (cm)

3. Flower Parameter

- Days taken to flower

4. Fruit Parameter

- Berry weight (g)
- Berry Length (cm)
- Berry diameter (mm)

5. Yield Parameter

- Total Yield per plant (kg) (Yield/ha)

6. Quality Parameter

- Total Soluble Solids (Brix)
- Vitamin C content (mg/100 g of fresh fruit)
- Total sugar (%)

7. Economics

- Cost of cultivation (Rs)

3. RESULTS AND DISCUSSION

During the present investigation, observations on various plant characteristics were recorded to evaluate the "Effect of different concentration of seaweed extract and micronutrients on plant growth, yield and quality of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter Dawn". The tabulated data were statistically analyzed with a view to find out the significant effect of different factors which are present in the tables below. The data present in the tabular forms shows the relevant standard error of mean deviation S. (±) and the critical difference (C.D) at 5% level of significance, wherever necessary. The results emanating from the present studies are presented under appropriate heading:

Table 1. Effect of different concentration of seaweed extract and micronutrients on plant height (cm) of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn

Treatment No.	Treatments details	Plant height (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T0	Control	7.20	10.47	16.50	20.97
T1	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	8.43	15.46	20.36	27.86
T2	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	8.57	17.29	24.86	27.85
T3	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	8.67	16.95	24.14	27.80
T4	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	9.12	18.17	27.21	30.30
T5	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	8.63	14.80	24.98	29.90
T6	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	8.07	15.49	23.98	27.22
T7	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	8.07	15.43	24.28	27.66
T8	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	9.19	18.31	27.35	31.15
T9	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	8.64	16.89	23.10	27.95
T10	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	8.32	16.00	24.20	28.11
T11	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	9.23	18.57	27.46	31.25
T12	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	9.31	18.68	27.57	32.31
	F-Test	**S**	**S**	**S**	**S**
	S.Ed.	0.189	0.328	0.820	0.879
	CD at 0.5%	0.390	0.677	1.692	1.815
	CV	2.701	2.459	4.131	3.780

***At 30 days** after transplanting, maximum plant height (cm) (9.31) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant height (cm) (7.20) was found recorded in T_0 Control respectively*

***At 60 days** after transplanting, maximum plant height (cm) (18.68) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant height (cm) (10.47) was found recorded in T_0 Control respectively.*

***At 90 days** after transplanting, maximum plant height (cm) (27.57) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant height (cm) (16.50) was found recorded in T_0 Control respectively.*

***At 120 days** after transplanting, maximum plant height (cm) (32.31) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Followed by, SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% and SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant height (cm) (20.97) was found recorded in T_0 Control respectively.*

The increase in plant spread of strawberry might be due to Zn + B + Fe might have stimulated cell division and cell elongation resulting in increased plant spread would have increased in the treated plants. These results were in close agreement with the findings of Bakshi et al. [7], Bakshi et al. [8]) and Singh et al. [9] in strawberry.

Table 2. Effect of different concentration of seaweed extract and micronutrients on plant spread (cm) of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn

Treatment No.	Treatments details	Plant spread (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T0	Control	9.54	13.79	17.31	26.64
T1	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	11.40	21.18	27.79	33.64
T2	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	10.76	21.03	26.94	30.57
T3	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	11.07	20.94	24.08	31.10
T4	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	12.14	24.20	29.46	36.12
T5	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	12.03	20.52	24.72	32.05

Treatment No.	Treatments details	Plant spread (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T6	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	11.19	20.94	26.68	33.83
T7	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	11.08	22.36	24.64	31.60
T8	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	12.26	24.83	29.68	36.24
T9	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	11.22	22.40	25.38	31.95
T10	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	11.07	21.45	24.97	33.10
T11	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	12.44	25.28	30.00	37.14
T12	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	12.54	25.42	31.10	37.01
F-Test		**S**	**S**	**S**	**S**
S.Ed.		0.179	0.372	0.741	0.896
CD at 0.5%		0.370	0.767	1.528	1.849
CV		1.918	2.082	3.440	3.309

***At 30 days after transplanting**, maximum plant spread (cm) (12.54) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant spread (cm) (9.54) was found recorded in T_0 Control respectively.*
***At 60 days after transplanting**, maximum plant spread (cm) (25.42) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant spread (cm) (13.79) was found recorded in T_0 Control respectively.*
***At 90 days after transplanting**, maximum plant spread (cm) (31.10) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant spread (cm) (17.31) was found recorded in T_0 Control respectively.*
***At 120 days after transplanting**, maximum plant spread (cm) (37.01) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Followed by SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, T_8 SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% and SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum plant spread (cm) (26.64) was found recorded in T_0 Control respectively.*
The increase in plant spread of strawberry might be due to Zn + B + Fe might have stimulated cell division and cell elongation resulting in increased plant spread would have increased in the treated plants. These results were in close agreement with the findings of Bakshi et al. [7], Bakshi et al. [8] and Singh et al. [9] in strawberry.

Table 3. Effect of different concentration of seaweed extract and micronutrients on number of leaves per plant of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn

Treatment No.	Treatments details	Number of leaves per plant			
		30 DAT	60 DAT	90 DAT	120 DAT
T0	Control	5.35	12.38	20.19	30.08
T1	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	6.34	19.66	24.93	34.69
T2	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	6.24	19.53	26.43	34.64
T3	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	6.16	19.60	29.13	33.75
T4	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	7.04	21.16	31.15	40.86
T5	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	6.49	19.12	26.78	32.36
T6	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	6.41	19.68	28.43	34.91
T7	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	6.26	19.47	26.99	33.11
T8	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	7.11	22.73	31.84	41.37
T9	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	6.49	20.12	27.47	34.59
T10	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	6.43	20.26	26.93	33.72
T11	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	7.17	22.83	32.52	43.35
T12	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	7.31	24.64	34.66	45.43
F-Test		**S**	**S**	**S**	**S**
S.Ed.		0.124	0.743	0.708	1.250
CD at 0.5%		0.256	1.533	1.461	2.579
CV		2.333	4.527	3.067	4.208

***At 30 days after transplanting**, maximum Number of leaves per plant (7.31) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Number of leaves per plant (5.35) was found recorded in T_0 Control respectively.*
***At 60 days after transplanting**, maximum Number of leaves per plant (24.64) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. followed by with SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% and SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% Where as the minimum Number of leaves per plant (12.38) was found recorded in T_0 Control respectively.*

***At 90 days after transplanting**, maximum Number of leaves per plant (34.66) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. followed by withy SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%, T_8 SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% and SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% Where as the minimum Number of leaves per plant (20.19) was found recorded in T_0 Control respectively.*

***At 120 days after transplanting**, maximum Number of leaves per plant (45.43) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Number of leaves per plant (30.08) was found recorded in T_0 Control respectively.*

The increase in number of leaves per plant as results of ZnSO4 + Boron + FeSO4 application might be due to fact that activity of micronutrients at shoot meristem resulting is more system of nucleoprotein responsible for increasing leaf initiation and expansion. Similar observations on number of leaves per plant due to micronutrients were also reported by Chaturvedi et al. [10], Bakshi et al. [7] Bakshi et al. [8] and Singh et al. [9] in strawberry.

Table 4. Effect of different concentration of seaweed extract and micronutrients on petiole length (cm) of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn

Treatment No.	Treatments details	Petiole length (cm)			
		30 DAT	60 DAT	90 DAT	120 DAT
T0	Control	4.09	6.19	7.16	9.41
T1	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	5.41	7.47	9.41	12.29
T2	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	5.08	7.17	8.56	10.36
T3	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	4.66	7.23	9.14	11.35
T4	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	6.63	8.07	10.16	13.14
T5	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	5.22	7.18	8.79	12.53
T6	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	4.71	7.50	8.56	12.43
T7	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	5.58	8.29	9.76	12.01
T8	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	6.83	8.28	11.14	13.24
T9	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	4.85	6.86	8.28	12.21
T10	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	5.87	7.87	9.87	12.23
T11	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	7.02	8.61	12.24	13.45
T12	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	7.07	8.77	12.51	14.42
F-Test		**S**	**S**	**S**	**S**
S.Ed.		0.201	0.192	0.234	0.233
CD at 0.5%		0.416	0.396	0.483	0.480
CV		4.390	3.074	2.964	2.330

***At 30 days after transplanting**, maximum Petiole length (cm) (7.07) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Petiole length (cm) (4.09) was found recorded in T_0 Control respectively.*

***At 60 days after transplanting**, maximum Petiole length (cm) (8.77) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Petiole length (cm) (6.19) was found recorded in T_0 Control respectively.*

***At 90 days after transplanting**, maximum Petiole length (cm) (12.51) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Petiole length (cm) (7.16) was found recorded in T_0 Control respectively.*

***At 120 days after transplanting**, maximum Petiole length (cm) (14.42) was recorded in T_{12} SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%. Where as the minimum Petiole length (cm) (9.41) was found recorded in T_0 Control respectively.*

The increase in petiole length of strawberry might be due to Zn + B + Fe might have stimulated cell division and cell elongation resulting in increased plant spread would have increased in the treated plants. These results were in close agreement with the findings of Bakshi et al. [7], Bakshi et al. [8] and Singh et al. [9] in strawberry.

Table 5. Effect of different concentration of seaweed extract and micronutrients on Days to first flowering, Days to first fruiting, Number of flower per plant, Number of fruit per plant, Fruit weight (gm) of Strawberry (*Fragaria* x *ananassa* Duch.) cv. Winter dawn

Treatment No.	Fruit weight (gm)	Number of fruit per plant	Number of flower per plant	Days to first fruiting	Days to first flowering
T0	15.16	10.18	23.83	61.98	54.13
T1	22.93	15.63	27.5	58.27	49.76
T2	22.95	16.43	30.43	54.77	46.62
T3	22.3	15.32	29.95	53.42	45.76
T4	25.79	17.07	33.07	52.01	43.76

Treatment No.	Fruit weight (gm)	Number of fruit per plant	Number of flower per plant	Days to first fruiting	Days to first flowering
T5	22.3	16.03	29.44	53.43	45.55
T6	23.96	15.96	28.83	55.94	47.79
T7	22.03	15.44	27.1	58.76	50.1
T8	25.64	17.32	33.44	49.78	41.63
T9	22.03	15.29	27.97	55.89	47.44
T10	22.33	16.54	26.35	54.24	45.61
T11	26.12	17.4	33.71	56.45	48.2
T12	27.12	18.43	34.64	46.34	39.81
F-Test	**S**	**S**	**S**	**S**	**S**
S.Ed.	0.342	0.49	0.631	1.161	1.158
CD at 0.5%	0.706	1.011	1.302	2.396	2.39
CV	1.812	3.766	2.6	2.598	3.042

The increase in fruit weight, number of fruit/plant, number of flower/plant, days to first fruiting, days to first flowering of strawberry might be due to Zn + B + Fe might have stimulated cell division and cell elongation resulting in increased plant spread would have increased in the treated plants. These results were in close agreement with the findings of Yadav et al. [11] in banana, Bakshi et al. [7], Bakshi et al. [8], Mehraj et al. [12], Singh et al. [13], in strawberry [14].

Table 6. Effect of different concentration of seaweed extract and micronutrients on TSS, Acidity, Ascorbic acid, Specific gravity, pH

Treatment No.	TSS 0Brix	Acidity (%)	Ascorbic acid (mg/100g)	Specific gravity	pH
T0	7.58	0.61	51.17	1.09	3.93
T1	8.16	0.79	54.78	1.31	3.77
T2	8.43	0.86	55.85	1.18	3.75
T3	9.13	0.88	55.03	1.32	3.7
T4	9.23	1.07	57.09	1.35	3.64
T5	8.16	1.05	54.34	1.18	3.73
T6	8.47	0.92	53.54	1.14	3.74
T7	8.48	0.91	55.17	1.23	3.78
T8	9.77	1.1	57.2	1.31	3.47
T9	8.39	0.84	52.3	1.14	3.81
T10	9.07	1.03	55.31	1.29	3.54
T11	10.14	1.18	57.43	1.53	3.37
T12	10.29	1.3	58.41	1.63	3.27
F-Test	**S**	**S**	**S**	**S**	**S**
S.Ed.	0.156	0.037	0.533	0.055	0.084
CD at 0.5%	0.322	0.076	1.099	0.114	0.174
CV	2.152	4.655	1.182	5.252	2.82

Table 7. Overall expendiiture, profit and B:C ratio

Symbols	Treatment Combination	Fruit yield (t ha-)	Total cost of cultivation	Gross return (Rs.ha-1)	Net return (Rs. ha-1)	B:C ratio
T_0	Control	8.94	419856	895215.5	475359.5	1.12
T_1	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	13.46	422392.05	2078650.787	1656258.737	3.59
T_2	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	14.66	424484.25	2184698.76	1760214.51	3.97
T_3	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	11.67	426576.45	1982144.2	1555567.75	2.93
T_4	SWE 1ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	15.77	428668.65	2553868.953	2125200.303	4.30
T_5	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	12.31	423279.75	2076274.333	1652994.583	3.19
T_6	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	14.98	425371.95	2217902.987	1792531.037	4.07

Symbols	Treatment Combination	Fruit yield (t ha-)	Total cost of cultivation	Gross return (Rs.ha-1)	Net return (Rs. ha-1)	B:C ratio
T_7	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	9.67	427464.15	1972300.633	1544836.483	2.25
T_8	SWE 3ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	16.59	429556.35	2575608.707	2146052.357	4.56
T_9	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.2%	9.24	424180.9	1953804.24	1529623.34	2.13
T_{10}	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.4%	14.04	426273.1	2141744.733	1715471.633	3.75
T_{11}	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.6%	16.97	428365.3	2635871.287	2207505.987	4.70
T_{12}	SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8%	17.48	430457.5	2899861.187	2469403.687	4.84

4. CONCLUSION

From the current investigation, it is concluded that treatment combination T12 : SWE 5ml/l+(ZnSO4, H3BO3, FeSO4) 0.8% is the best treatment for growth, yield and fruit quality viz, plant height (cm) (32.31), plant spread (cm) (37.01), number of leaves per plant (45.43), petiole length (cm) (14.42), days to first flowering (39.81), days to first fruiting (46.34), number of flower per plant (34.64), number of fruit per plant (18.43), fruit weight (gm) (27.12),fruit per plant (g) (499.98) , fruit yield t ha^{-1} (17.48) , TSS ^{0}brix (10.29), juice content (%) (94.59) and pH(3.27) of strawberry.

The highest benefit cost ratio was also found in the same treatment with 1:4.84

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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