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Study of foliar boron and zinc applications and ground addition of seaweed extract (Acadian) on vegetative and flowering growth traits of Strawberry

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ABSTRACT

The study was conducted in the greenhouse of Department of Horticulture and Landscape Gardening deportment, College of Agriculture and Forestry, University of Mosul Iraq. During the growing season 2018-2019. To study the effect of foliar spraying with boron at two concentrations (30 and 60 mg / l boric acid) and foliar spraying with two concentrations of zinc (50 and 100 mg /l zinc sulfate) and the ground addition of (Acadian) Seaweed extract at two concentrations (4 and 8 g/l) in addition to the control treatment (untreated plants) in the vegetative growth, flowering and yield traits of strawberry plants. A Randomized Complete Block Design (R.C.B.D) was used to implement the experiment, with three replications.

Kay words : *Fragariaananassa, Foliar nutrition, Tryptophan, Seeweeds extract*

Introduction

Fragaria ananassa Duch is one of the most important fruits with small fruits and widespread in different regions of the world due to a large number of its cultivars and their ability to adapt and grow in different environmental conditions, which goes back to the Rosaceae family (Zhao, 2007). It is native to Europe and North America, as well as cultivated in Italy, Bologna, the Netherlands, France and Bulgaria. It is the fourth most consumed fruit, after apples, oranges, and bananas (Virginie, 2010; Hussein *et al*., 2021). The area of cultivated land in the world in strawberry is estimated at about 257 thousand hectares, and the statistics of the World Food and Agriculture Organization indicates that the global production of strawberry fruits for the year 2010 amounted to about 9.223.815 million tons ((FAO. 2017). Strawberry is of great importance in the human diet, due to its commercial importance as well as its indispensable nutritional value ((Prasanna *et al.,* 2007).

Foliar nutrition plays an important role in the quality and production of strawberry ((Hasan et al., 2019; Hussein *et al*., 2020). Zinc is the essential element for plant growth and development and is necessary for the production of the amino acid Tryptophan. Some research has shown that there is an association between flower production and treatment with zinc ((Rutkowski *et al*., 2006; Manea *et al*., 2019).

Boron is one of the basic elements in plant nutrition as it is essential in the growth and maturity of the plant, despite the plant's need for it is very limited proportions (Tyagi, *et al*., 2018), as boron works to keep calcium insoluble proportions and regulate the balance between the elements of calcium and potassium in the plant and regulate nitrogen ab-

sorption and it also has a relationship with the transfer of sugars in the plant (Al-Hadethi *et al.,* 2019; Padhi and Swain, 2006). It has been shown that the application of some use of seaweed extracts of great importance in the field of agriculture because it has no harmful effect on health and the environment and is less expensive compared to industrial growth organizations (Al-Bakar, *et al*., 2020; Toman *et al.,* 2020). Seaweed extracts and bio-extracts affect plant metabolism when used in small quantities by stimulating and synthesizing the natural hormone, as well as increasing the stimulation of nutrient absorption and root growth and increasing plant resistance to unfavorable conditions (Al-Juthery *et al*., 2018). The multiple functions of extracts when added to the soilor sprayed on plants, stimulates root growth and increases the thickness of the stem (Mehdizadeh and Mushtaq, 2020; O'Dell, C. 2003) as well as increases vegetative growth by increasing the efficiency of the photosynthesis process in addition to protecting the plant from harsh conditions such as drought, coldness and senescence by supporting plant cells ((Al-Bakkar *et al.,* 2021; Alrawi *et al*., 1980). The aim of the study is to study the effect of seaweed extract, boron and zinc on the growth, flowering and yield of seedlings of strawberry cultivars Liberation D, Orlans.

Materials and Methods

The study was conducted in the greenhouse of the Department of Horticulture and Landscape Gardening deportment, College of Agriculture and Forestry, University of Mosul, Iraq. Where the house was equipped with the conduct of tillage the soil and making terraces 14 meters long, 40 cm wide and cm high, and the terraces were covered with black plastic to prevent the growth of the weeds. Where strawberry seedlings were brought and root pruning and yellow and large leaves were removed from the seedlings to create a balance between vegetative and root growth. The seedlings were treated with a fungicide by completely submerging the seedlings with the fungicide (Chjazol) (10 g/l) to prevent the formation of fungi. Then the seedlings were cultivated on 11/20/2018, where the distance between one plant and another was 40 cm in one line. Weeding and watering were carried out whenever needed, as the plants were watered by drip irrigation. Where the seedlings were treated by watering them with Acadian seaweed extract at two concentrations (4, 8 g/l), spraying with boron at two concentrations (30 and 60 mg /l of boric acid) and foliar spraying with two concentrations of zinc (50 and 100 mg /l zinc sulfate) in addition to Control treatment (untreated plants). Randomized Complete Block Design (R.C.B.D) was used to implement the experiment, with three replicates (Karhu *et al.,* 2007).

Study traits

1. The weight of one fruit

The readings were taken from the five plants selected for each experimental unit, and were averaged according to the following equation:

$$\text{Average fruit weight (g)} = \frac{\text{Total fruit weight of the selected plants per experimental unit}}{\text{The total number of fruits of the selected plants}}$$

2. The fruits number

Readings took place from the start of the fruit harvest to the last harvest of the five plants.

3. The yield of one plant

The readings were taken from the five plants for each experimental unit, and were averaged according to the following equation:

$$\text{Average yield per plant (g)} = \frac{\text{The sum of the total yield of the selected plants for each experimental unit}}{\text{The number of plants selected}}$$

4. The average length of one fruit

The length of the fruit was taken for each pound and the average length of one fruit per tree was extracted.

5. The average diameter of one fruit

The diameter of the fruits selected for each experiment unit is taken after harvest, using the vernia.

6. Average number of leaves

The average number of leaves in plants was calculated for each experimental unit after the last harvest

7. Number of stolen /seedlings

The number of purples per plant was counted in the pilot unit.

8. Number of crowns/plant

The number of crowns was counted for each experimental unit.

9- The chlorophyll content of leaves

The chlorophyll content of the leaves of the five selected plants was read using a field device (CCI OPTI-SCIENCES) Chlorophyll Content lndex. An average of three readings per plant, and three readings were taken, the first at the beginning of the activity, the second after spraying with the elements, and the third after the last harvest at the end of the harvest season, and the average of these readings was taken (Saieed, 1990).

10. Number of flowers/plant

The readings were taken at the start of flowering until the end of flowering for the five plants for each experimental unit, after which the total number of flowering for one plant was calculated according to the following equation:

Average number of total flowers per plant= $\frac{\text{The number of the total flowers of a plant}}{5}$

11. Percentage of Total Soluble Solids (T.S.S)

Total soluble solids were measured using a (Hand Refractometer) device. Ten ripe and homogeneous fruits from each experimental unit were cut into slices and placed in an electric mixer for a period of (2-3) minutes, after which the juice was filtered with a cotton cloth, and the reading was taken to represent (TSS) in the juice.

The leaf area of one seedling (cm^2)

The area of one leaf

Two middle leaves were taken from each plant of the selected plants within the experimental unit after the last genie (4/25/2019), then drawn on white (A4) duplicating sheets of weight and area by means of an electric duplicating device, based on the method of [22], and this weight was compared with the weight of the area of the plant leaf according to the following equation:

Results

1. Quantitative yield traits

Table 1 showed that the control treatment significantly excelled on boric acid and zinc sulfate in the weight of the fruit, reaching 10.4900 g, while there were no significant differences between the Acadian seaweed extract. The control treatment also showed the excelled of the used concentrations of seaweed extract, boric acid and zinc sulfate in the number of fruits, which reached 59,000 fruits. It also showed that the control treatment excelled on the levels of seaweed extract, boric acid and zinc sulfate in the yield of one plant, which amounted to 548.61 g. In the same table, it was shown that the control treatment was excelled and gave the average length of one fruit, which amounted to 2.9833 cm, on the concentrations used in each of 8 g/l. From seaweed extract, boric acid and zinc sulfate, there was no significant difference with 4 g/l of seaweed extract, and there were no significant differences in the average diameter of one fruit.

Vegetative traits

The results in Table 2 showed that the control treatment excelled the number of crowns, which reached

Table 1. The effect of foliar spraying with boron, zinc and the ground addition of the seaweed extract (Acadian) on the quantity yield (fruit weight (g), number of fruits, plant yield (g), average length of fruit (cm) and the average fruit diameter (mm)) for acacia plant.

Treatments	Concentration		Fruit weight (g)	Number of fruits	Plant yield (g)	Average length of fruit (cm)	Average fruit diameter (mm)
Acadian seaweed	0	M1	6.5367 C	13.333 E	87.09 E	2.4233 BC	2.0367 A
extract	4 g/L	M2	8.6633 B	20.500 D	177.26 D	2.4100 BC	2.6400 A
	8 g/L	M3	9.3133 AB	59.000 A	548.61 A	2.5233 B	2.5367 A
Boric acid	30 mg/L	M4	6.1200 C	19.333 D	118.66 E	2.0633 C	2.5200 A
	60 mg/L	M5	5.5533 C	3.667 F	20.00 F	2.400 BC	2.4700 A
Zinc sulfate	50 mg/L	M6	10.4900 A	24.667 C	258.44 D	2.6367 AB	2.4333 A
	100 mg/L	M7	9.8200 AB	42.000 B	413.12 C	2.9833 A	2.0367 A

Values that share the same letter within the same factor or its interaction, there are no significant differences between them, according to the Duncan polynomial test at a probability level of 5%

Table 2. The effect of foliar spraying with boron, zinc and the ground addition of the seaweed extract (Acadian) on the number of crowns, number of stolen, number of leaves and leaf content of chlorophyll for strawberry plant

Treatments	Concentration		Number of crowns	Number of stolen	Number of leaves	Leaf content of chlorophyll
Acadianseaweed extract	0	M1	6.500 C	4.5000 C	19.000 C	48.450 D
	4 g/l	M2	8.500 BC	7.7500 B	23.000 B	62.533 A
	8 g/l	M3	3.333 D	5.3333 C	20.500 C	53.950 C
Boric acid	30 mg/l	M4	2.500 D	2.6667 D	21.000 BC	55.050 BC
	60 mg/l	M5	1.333 D	3.0000 D	13.250 D	48.800 D
Zinc sulfate	50 mg/l	M6	9.333 B	10.5000A	31.500 A	59.250 AB
	100 mg/l	M7	14.500 A	11.0000A	30.000 A	57.067 BC

Values that share the same letter within the same factor or its overlaps, there are no significant differences between them, according to the Duncan polynomial test at a probability level of 5%.

Table 4. The effect of foliar spraying with boron, zinc and the ground addition of the seaweed extract (Acadian) on The number of flowers, percentage of total Soluble Solids(T.S.S), leaf area, and leaf area of seedlings for the strawberry plant

Treatments	Concentration		The number of flowers	TSS	Leaf area	Leaf area of seedlings
Acadian seaweed extract	0	M1	14.333 ED	8.2000 BC	62.86 C	1213.5 DE
	4 g/l	M2	28.333 C	8.3667 BC	119.66 B	2411.4 C
	8 g/l	M3	59.333 A	9.1667 AB	78.37 C	1579.8 D
Boric acid	30 mg/l	M4	20.000 D	8.5000 BC	73.33 C	1540.6 D
	60 mg/l	M5	10.000 E	7.5333 C	67.18 C	894.8 E
Zinc sulfate	50 mg/l	M6	29.000 C	9.9500 A	134.06AB	4212.9 B
	100 mg/l	M7	43.000 B	8.9000 AB	160.43 A	4812.9 A

Values that share the same letter within the same factor or its overlaps, there are no significant differences between them, according to the Duncan polynomial test at a probability level of 5%.(

14,500, on seaweed extract, boric acid and zinc sulfate. The control treatment and the treatment at a concentration of 4 g/l of seaweed extract Acadia excelled on the other treatments, reaching (11,000 and 10.500), respectively. As for the number of leaves, the control treatment and 4 g/l of seaweed extract were excelled and gave more than (31,500 and 30,000) leaves, respectively, on other treatments of boric acid and zinc sulfate. The same table showed that the control treatment, which amounted to 62,543, was significantly excelled to 8 g/l of seaweed extract, boric acid and zinc sulfate.

Qualitative and quantitative yield traits

Table 3 showed that the control treatment excelled on Acadian seaweed extract, boric acid and zinc sulfate in the number of flowers, with the highest average of 59,333 flowers. The control treatment was excelled on boric acid and zinc sulfate in the percentage of Total Soluble Solids, which reached the highest percentage of 9.9500%. There was no significant difference between the control treatment and the seaweed extract. The control treatment was excelled on 8 g/l of seaweed extract, boric acid and zinc sulfate in an area of one leaf which reached 160.43 cm 2 and there was no significant difference with 4 g/l of seaweed extract. In the same table it was shown that the control treatment was excelled on other treatments of Acadian seaweed extract, boric acid and zinc sulfate in the leaf area of the seedlings, which reached 4812.9 cm^2.

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