Middle East Journal of Agriculture Research **Volume : 09 | Issue : 01| Jan.-Mar. | 2020**
EISSN: 2706-7955 ISSN: 2077-4605 **Pages:130-133**
DOI: 10.36632/mejar/2020.9.1.13

Role of Boron and Calcium on growth, flowering and yield of strawberry (*Fragaria* x *ananassa* Duch) var. Liberation D'Orleans

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Received: 10 Nov. 2019 / Accepted 05 Jan. 2020 / Publication date: 10 Feb. 2020

ABSTRACT

This study was conducted in the field of Horticulture Dept. at Agricultural & Forestry College, Mosul University during the season of 2017/2018. The aim was to study the effect of Calcium concentration (0.25 and 0.5% as calcium chloride) and Boron concentration (30 and 60 $mg.L^{-1}$ as Boric acid) and control (Untreated plants), on the growth, flowering and yield of strawberry plant var. Liberation D'Orleans. The design of the experiment was a Randomized Complete Block Design (RCBD) with three replications. Results indicated that the plants which sprayed with 0.25% Ca gave the highest and significantly different results of average of No. leaves/plants (43.67), leaf area (4268.1 cm^2), No. of runner/ plant (21.58) in comparison with control, except the highest average of vegetative dry weight (187.71) gm. While 0.5% Ca spraying application gave the best average, which differs significantly in No. of flowers/plant (20.00), Total yield/plant (112.34gm) and Total yield/Exp. unit (449.37gm). compared to control.

The best effect of Boron was shown in the dry weight of root that gave 174.71 g and it differs significantly in comparison with Ca conc. and control treatment (non-spraying).

***Keywords*:** strawberry, Boron and Calcium, foliar, growth, yield

Introduction

Strawberry (*Fragaria* × *ananassa* Duch), a perennial cool-season crop, is popular as fresh fruit in high demand for the taste, profitability, high yield, and good quality. The production of strawberries, one of the most delicious, nutritive, and refreshing fruits, has gained a strong interest over the past decade (Singh *et al.,* 2007).

Currently, the production of strawberry in more than 63 countries, the global production of strawberry in 2012 about 4516810 tons and planted area of 241,109 hectares and the United States ranks first in the list of producing countries with a total of 1366850 tons, more than a quarter of the world production (FAO, 2014).

The genus, Fragaria, of the family Rosaceae (sub-family Rosoideae) includes 20 wild species, three naturally occurring hybrid species and the modern cultivated strawberry (*F.* × *ananassa* Duch.), originated in North America, South America, Asia and Europe (Hummer *et al.*,2011).

In addition to its medicinal benefits, the fruits of strawberry are used in the elimination of some bacteria and help reduce sugar, in cases of atherosclerosis, neurological disorders, kidney disease, yellow glands, liver disease and treatment of anemia (Samra *et al.,* 2005; Taha, 2004).

The availability of macro and micro-nutrients is very important for the growth of plants as the lack of any of them lead to a significant imbalance in growth and yield. There are some of these elements in the soil in good quantities, but availability of these nutrients to the plant hardly corresponds to the needs of the natural growth of the plant (Al-sa'eedi, 2000).

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In some lands, many factors determine their movement and readiness to benefit from the growing plant and plants in these lands do not respond in many cases to fertilizers added to the soil to continue the decrease of the availability of these nutrients to the plant (Abdul and Mohammed, 1986).

Dawood *et al.* (2010) noticed that the foliar application of Boron at conc. (0, 10, 20 and 30 mg.L-1) using Boric acid (17% Boron) on two strawberry cultivars (Fragaria × ananassa Duch.) Cv. (Hapil and Kaiser's samling), the best result of the leaf area (93.58 cm^2), flower set percentage (56.73%) and fruit weight (10.10 gm) are increased in plants sprayed with 20 $mg.L^{-1}$ of Boron. Another experiment conducted by Aziz *et al.* (2017) to study the Effect of spraying different conc. of chelated Ca (0, 50, 100 mg.L-1), Boron (0, 10, 20 mg.L-1) on vegetative growth and yield of Fragaria × ananassa Duch. Cv. Festival. The spraying of Chelated Ca at 100 mg.L-1 gave a significant increase in Leaf area, No. of Leaves, Chlorophyll content in leaves and the dry weight of vegetative growth (33.49, 47.06, 39.97, 19.94) respectively. As soon as a significant increase in fruit volume and fruit weight (18.79 cm3 and 12.11 gm) respectively, in comparison with control treatment (non- spraying). While the spraying of 20 $mg.L^{-1}$ B achieved a significant increase in the same vegetative growth above, so that in the average of fruit Number(6.51), fruit volume(cm^3), total yield/plant (72.78gm) and total yield/area (1.45 ton/hectare). Kim *et al*. (2019) found that spraying plants with pro-Ca at conc. (0, 50, 100, 150 and 200 $mg.L^{-1}$) after 30 days of transplantation. The spraying with 200 $mg.l^{-1}$ achieved higher No. of the runner was 8.2 didn't differ significantly in comparison with control. Mehraj *et al.* (2015) studied the effect of foliar application of (Calcium Oxide CaO) at conc. (0, 50, 100 ppm) on strawberry plants, the best result, No. of fruit (20.00/Plant) and single fruit weight (14.2 g) were achieved in plants sprayed with 100ppm of CaO.

The present study aimed to investigate the foliar applications of calcium (Ca) and boron (B) on strawberry plants to enhance the vegetative growth, flowering and yield. As well as, improving the qualitative properties of fruits.

Materials and Methods

The study was carried out in the field of the Dept. of Horticulture and Landscape Design, College of Agriculture and Forestry, the University of Mosul. Iraq, the soil of the field was prepared through the process of removing the bushes and then tilling and softening, then leveling by agricultural tractor, later divided into terraces with 80 cm width and 30 cm high. The seedlings were planted on 28/11/2017, the distance between one plant and another 30 cm in one line, and in order to balance the vegetative and rooting, roots trimmed (section of the roots removed) and the yellowing adult leaves were removed too. Rather than treated with an innate pesticide (Parafan) (10g/l) for the prevention of fungi by completely submerging the seedlings until the total wetness. The service operations were carried out from the graying and irrigation, as soon as irrigation system was drip followed (whenever needed), fertilization was carried out uniformly for all plant treatments. The fertilizer recommendations were applied as followed in the strawberry fields.

Table 1: Physical and chemical characters of field soil.

Characteristics and measurement units	Spring season 2018
pH of Soil	7.7
Electrical conductivity EC ($dc.M^{-1}$)	1.0
Organic Matter %	0.69
Nitrogen with childahl ($mg.kg^{-1}$)	42.0
Soluiable Phisphorus with sodium bicarbonate ($mg.kg^{-1}$)	9.6
Potassium with Ammonium acetate ($mg.kg^{-1}$)	101.0
Sand ($g.kg^{-1}$)	612
Silts ($g.kg^{-1}$)	280
Clay ($g.kg^{-1}$)	108
Soil Mixture	Sandy - Loam

The analysis was conducted in Agricultural Research Station, Abo Ghreeb, Baghdad.

The studying treatments are: spraying (Boron) as Boric acid in concentration (30 and 60 $mg.L^{-1}$), in addition, calcium (0.25 and 0.5%) as calcium chloride rather than control (untreated plants). A

simple experiment conducted by using Randomized complete block design (R.C.B.D) with three replicate with four plants per replicate.

The parameters in this study included: Number of leaves/plants, Leaf area(cm^2), Chlorophyll content Model 502 (SPAD) Chlorophyll meter (Konica Minolta sensing, ine), Number of runner/plant, Vegetative dry weight (gm), roots dry weight (gm), No. of flowers/ plants, fruit weight (gm), Total yield/ plant (gm), Total yield/ Exp. unit (gm). The data analyzed by using (SAS, 2001) and data tested statistically by using Duncan multiple tests at 0.05 (Anonymous, 2001).

Results and Discussion

The results in Table (2) show that all treatments resulted in a significant difference in No. of leaves in comparison with control (29.67), the treatment (0.25% Ca) gave the highest No. of leaves (43.67). While the leaf area increased in plants treated with 0.25% Ca (4268.1 cm^2) and significant difference with 30 $mg.L^{-1}$ Boron and control that gave (3312.7 and 1900.8 cm^2) respectively. The best average of chlorophyll content was in treatment 0.5% Ca that gave 40.19 (spad) and it is significantly different compared to both Boron conc. and the control treatment that gave 35.44 (spad). There is no significant difference between the treatments of Boron and Calcium conc. in No. of runner/plant, but spraying the plants with 0.25% Ca gave a higher average of No. of runner/plants (21.58) that differ significantly with control (15.42). whereas, there is no significant difference between all experimental treatments in vegetative dry weight except the treatment 30 $mg.L^{-1}$ Boron that decreased significantly (140.75 gm) in comparison with other treatments. The highest dry weight of root was shown in plants sprayed with 60 $mg.L^{-1}$ Boron (174.71 gm) and differ significantly with other treatments.

Table 2: Role of Boron and Calcium on plant growth of strawberry (*Fragaria* x *ananassa* Duch.) cv. Liberation D'Orleans

Parameters / Treatments	No. of leaves/ plant	Leaf area (cm^2)	Chlorophyll content (SPAD)	No. of runner/ plant	Vegetative dry weight (g)	Roots dry weight (g)
Control	29.67 b	1900.8 c	35.44 c	15.42 b	182.85 a	113.34 b
30 $mg.L^{-1}$ B	37.92 a	3312.7 b	34.150 c	19.250 ab	140.75 b	79.76 c
60 $mg.L^{-1}$ B	39.75 a	3751.1 ab	32.95 c	20.17 ab	169.10 a	174.71 a
0.25 % Ca	43.67 a	4268.1 a	37.70 ab	21.58 a	187.71 a	94.03 bc
0.5% Ca	41.17 a	4147.2 a	40.19 a	18.71 ab	169.45 a	70.25 c

*Means in each column which have the same letter did not differ significantly at p> 0.05.

The Data in the table (3) showed that the No. of flower/plant was significantly increased in plants sprayed with 0.5% Ca and gave 20.00 flower in comparison with all other treatments. Rather than the higher average of fruit weight was 12.65 gm in plant treated with 0.25 Ca so, it differs significantly with control (8.95 gm). Moreover, the (Total yield/plant and total yield/ Exp. unit gm) was higher (112.34 and 449.37 gm respectively) in plants treated with 0.5% Ca that differ significantly with all other treatments for both parameters.

Table 3: Role of Boron and Calcium on the yield of strawberry (*Fragaria* x *ananassa* Duch.) cv. Liberation D'Orleans

Parameters / Treatments	No. of flowers/ plants	fruit weight (g)	Total yield/ plant (g)	Total yield/ Exp. unit (g)
Control	14.80 b	8.95 b	39.45 c	157.79 c
30 $mg.L^{-1}$ B	10.42 b	10.00 ab	45.83 bc	183.30 bc
60 $mg.L^{-1}$ B	13.17 b	12.64 a	43.46 bc	173.83 bc
0.25% Ca	13.80 b	12.65 a	77.16 b	308.63 b
0.5% Ca	20.00 a	12.17 ab	112.34 a	449.37 a

*Means in each column which have the same letter did not differ significantly at p> 0.05.

All data in Tables 2 and 3 showed, that the plants sprayed with Calcium concentrations gave higher averages in most parameters studies, that's may attribute to the Calcium effect on cells trigger signaling pathways related to growth, development, and responses to both abiotic and biotic stresses

including pathogen attack (Thor, 2019). It also improves the N use efficiency. However, Calcium increases cell wall strength and thickness; therefore, this is a pivotal nutrient for fruit firmness. (Easterwood, 2012) (Kirsten, 2013).

Moreover, sprays of Ca or B plus Ca increased soluble solids concentration and titratable acidity of fruit after 3 days of holding at room temperature. These results indicate that sprays of $CaCl_2$ with the addition of Tween 20 should be recommended to improve the quality and shelf-life of strawberry fruit, particularly in pro-ecological production where the application of fungicides is restricted (Trejo-Téllez and Gómez-Merino, 2014).

The Boron is often recommended as a supplemented nutrients for strawberries, and the good value of (B) effect on the dry weight of roots may be considered to the essential effect of (B) on roots formation (Handley, 2007).

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