EFFECT OF MOISTURE CONTENT AND SPRAYING WITH ZINC IN THE YIELD OF SEEDS AND OIL OF THE BORAGE PLANT (*Anchusa azurea*)

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ABSTRACT

The experiment was conducted in the greenhouses of the winter season 2016 - 2017 in Diyala Province using a factorial experiment according to Randomized Complete Blocks Design (RCBD), to study the effect of three levels of moisture content (50, 70 and 90%) of the field capacity and two treatments of spraying with zinc (0, 200 mg.L^{-1}) in the leaves number, dry plant weight, 100 seed weight, plant seed yield and oil percentage in seeds. The results showed that the water content at (90%) of the field capacity led to a significant increase in the leaves number, dry plant weight and plant seed yield, which reached (15.5 leaves, 38.06 g.plants^{-1}, 2.01 g.plants^{-1}), respectively. While led the irrigation at moisture content (70%) of field capacity to significantly increased the weight of 100 seeds and oil percentage of seeds was 2.00 g and 29.80% respectively, In addition, the spraying of zinc produced a significant increase in all the studied indices (14.67 leaves.plants^{-1}, 37.75 g.plants^{-1}, 1.96 g, 2.05 g seeds.plants^{-1}, 29.43% oil).There was also a significant bi-interaction between the factors above, The treatment of the mixture (90% of the field capacity with spraying with zinc) gave a significant increase in seed yield and oil percentage in seeds (2.21g seeds.plants^{-1}, 30.01%) respectively.

Keywords: Moisture content, Borage (*Anchusa azurea*), Zinc, Oil.

تأثير المحتوى الرطوبي والرش بالخارصين في حاصل البذور والزيت لنبات لسان الثور (*Anchusa azurea*)

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المستخلص

نفذت التجربة بأصص في البيوت المحمية للموسم الشتوي 2016- 2017 في محافظة ديالى باستعمال تجربة عاملية وفقاً تصميم القطاعات العشوائية الكاملة (RCBD) لدراسة تأثير ثلاث مستويات من المحتوى الرطوبي (50، 70، 90) % من السعة الحقلية ومعاملتين من الرش بالخارصين (0 ، 200) ملغم – لتر$^{-1}$ في عدد الاوراق والوزن الجاف للنبات ووزن 100بذرة وحاصل البذور بالنبات ونسبة الزيت للبذور .اظهرت النتائج :ان المحتوى المائي عند (90%) من السعة الحقلية ادى الى زيادة معنوية في عدد الاوراق والوزن الجاف للنبات وحاصل البذور بالنبات وبلغت (15.5 ورقة ، 38.06 غم.نبات$^{-1}$، 2.01 غم.نبات$^{-1}$) على التوالي ، في حين ادى الري عند المحتوى (70%) من السعة الحقلية زيادة معنوية في وزن 100 بذرة ونسبة الزيت في البذور بلغت (14.67 2.00غم ، 29.80%) على التوالي ، كما ادى الرش بالخارصين الى تفوق معنوي في جميع المؤشرات المدروسة بلغت (ورقة.نبات$^{-1}$ ، 37.75 غم.نبات$^{-1}$ ، 1.96 غم , 2.05 غم بذور.نبات$^{-1}$, 29.43 % زيت) . كما حصل تداخل ثنائي معنوي بين العوامل اعلاه ، واعطت معاملة التداخل (90% من السعة الحقلية مع الرش بالخارصين) زيادة معنوية في حاصل البذور ونسبة الزيت وبلغت (2.21غم بذور.نبات$^{-1}$ ، 30.01%) على التوالي .

الكلمات المفتاحية : المحتوى الرطوبي ، لسان الثور ، الخارصين ، الزيت.

1. INTRODUCTION

Anchora azurea is one plants of *Boraginaceae* family. Canada is in the forefront of countries that producing it, followed by England and America, and this plant is cultivated at the upper latitudes which increases the proportion of linoleic acid - alpha in oil seed to 47%. The importance of

this plant for the medicinal uses for oil of its seeds and the high unsaturated fatty acids produced by Prostaglandin in the body as a compound anticoagulant and blood pressure and cholesterol and reduce the side effects of diabetes in the destruction of walls of blood vessels and arteriosclerosis [8]. As well as the presence of other chemical compounds in its vegetable parts such as Rosmarinic acid and Mucilage and Tannins and Alkaloids and Saponins [21]. The exposure of plants to water stress affects a number of biochemical, physiological and developmental changes of the plant [28], and a decrease in photosynthesis activity as a result of closing holes and reducing chlorophyll efficiency [25]. As well as its negative effects on the readiness of nutrients and their absorption from the soil and its transfer to the plant [16]. To understand the capabilities of the borage plant to grow and produce in an area, it is necessary to find ways or means to tolerate and grow the plant in the harsh environment, including water stress. The exposure of crops to water stress conditions led to reduce the seed yield and oil content in their seeds [22, 27]. Medical plants need to increase the productivity to fertile soils and rich in nutrients ready for absorption, and important nutrients that have a major role in plant nutrition and development, are Micro elements[11]. Especially that the base soils of hot climate in central and southern Iraq have the effect of sedimentation, elements stabilization and the formation of complexes not ready for absorption by plant roots [12]. The importance of zinc to participate in a number of vital processes, including the manufacture and synthesis of amino acid Tryptophan, which is derived from the hormone Indole acetic acid IAA necessary to prolong the cells and increase their growth [10]. In addition to its effective contribution to the formation of chlorophyll and the building of molecules of amino acids and carbohydrates [19] and stimulate a number of active enzymes for the process of photosynthesis or regulation of growth [4]. [24] also explained that the zinc element played a vital role in the production of oil in the seeds, this agreed with [1, 30] that spraying the two flaxseeds and pistachios in the field of zinc led to an increase in seed and oil yield in which. Studies were conducted on the borage plant in Iraq. This experiment was conducted to find ways to cope with water stress using the leaf nutrition with zinc and its effect on the production of seeds and oil.

2. MATERIALS AND METHODS

The experiment was conducted in a greenhouse during the winter season 2016-2017 in the Silty loam soil as shown in Table (1) in Diyala province, which is between 44-46 latitude and 34-36 longitude and is classified within the limited rainfall areas to study the effect of moisture content and spray with zinc in the yield of seeds and oil for borage plant. The plastic plant pot with top diameter of 30 cm was initialized, The dry weight soil in it is 7,500 g. The NPK fertilizer was added with rate 0.28 g. plant pot^{-1} Mixing with soil before planting, The cultivating was done on 5/11/2016 at the rate of three seeds in one pit and then removed to be one plant in pit after a week of germination to keep four plants for each pot, a factorial experiment was used according to Randomized Complete Blocks Design (RCBD) with four replicates, The first factor was the exposure of plants to three levels of field capacity (50, 70, 90%) after having been determined in advance by weight method and according to [18], The second factor: spraying with zinc at concentration of (200 $mg.L^{-1}$) as leaf nutrition in $ZnSO_4.H_2O$ (Zn% 23), with spraying twice after the focus was divided into two parts first on 22/12/2016 and the second after the first week of the week, while the second treatment (control) was sprayed with distilled water only. The plants were sprayed with a 5 L using hand spray, a diffuser substance with the solution (dishwashing liquid (R-COOK)) was added with rate of 1 $ml.L^{-1}$ to increase the surface tension of the water and facilitate the absorption of plant tissues. In the process bulge the guard cells and open the stomata. The mature seeds were collected at the beginning of May 2017.

Studied traits:

leaves Number.plant-1 (at the beginning of the stem elongation), dry weight of the plant (g), weight of 100 seeds (g), seed

yield per plant (g) and percentage of oil in seeds (%): The seed oil ratio was estimated using the Microsteam distillation system [15]. Data and results were statistically analyzed by variance analysis and values were measured using L.S.D at a probability level of 0.05 [29].

Table 1: Chemical and Physical Properties of Experiment Soil Before cultivating

Clay%	Silt %	Sand%	Texture	ready N $mg.kg^{-1}$	ready P $mg.kg^{-1}$	ready K $mg.kg^{-1}$	Organic substance g.kg-1	pH	EC $ds.m^{-1}$
247	670	83	Silty loam	45	11.16	195	13.1	7.49	4.24

3. RESULTS AND DISCUSSION

Leaves number per plant

The results of Table (2) showed a significant effect of the moisture content and spraying with zice and the interaction between them in the leaves number per plant. The treatment 90% of the field capacity excelled by giving the highest average number of leaves per plant (15.5) which did not significantly differ from the treatment 70% With an increase of 48% compared to the treatment 50% of the field capacity which gave the lowest average of 10.5 leaves. The decrease in moisture content negatively affects the partial closure of the gaps and the lack of stabilization of carbon dioxide and with the consumption of part of the energy stored in the plant by water absorption process low production process of photosynthesis, and water stress increases the density of protoplasm in the cell and this changes the path of breathing towards Pentosatus phosphate or lack of spread of roots in the soil [23] and therefore reduce the number of leaves in the plant. This is consistent with [17] that indicated the exposure of the crop to drought during the stages of vegetative growth led to a reduction in the leaves number per plant. The results in the above table also showed a significant effect of spraying with zinc in this trait. The spraying treatment was superior to the zinc and gave the highest average of 14.6 leaves compared to the non-spraying treatment which was 12.3 leaves. This is agreed with [17] that showed the spraying of the Rapeseed crop significantly affected the increase in the leaves number per plant. There was a significant interaction between the above factors in the leaves number per plant. The interaction treatment (90% of the field capacity with spraying with zinc) excelled the highest rate of 17.0 leaves with an increase of 70% compared with the lowest interaction rate (50% With no spraying with zinc) and had 10.0 leaves.

Table 2: Effect of Moisture Content and Spraying with zinc in the Leaves number per plant

Treatments	Soil Moisture Content %			
Spraying with zinc $mg.L^{-1}$	50	70	90	The average effect of zinc
0.00	10.0	13.0	14.0	12.33
200	11.0	16.0	17.0	14.67
The average effect of zinc	10.5	14.5	15.5	
LSD (0.05) Zinc 1.228, Moisture content 1.504, Interaction 2.127				

Dry weight of plant (g)

Table (3) shows that there was a significant effect on the experiment factors studied in the dry weight trait of the plant (g). The treatment 90% of the field excelled capacity by giving the highest average dry plant weight of 38.06 g. Although it did not differ significantly from the treatment effect of 70%An increase of 29% compared to the lowest average of 29.57 g at 50% treatment of

the field capacity. This decrease in weight may be due to the impact of water stress from emergence through vegetative growth, which may cause weakness in many physiological and chemical changes, including the ability to absorb nutrients and perform photosynthesis [5, 33],This negatively affects the processes of formation and growth of the vegetative parts by inhibiting the division and expansion of cells, The [3] confirmed that the moisture content of the soil is determined by the production of the biomass of the plant. The same results confirm obtaining a significant effect of spraying of zinc in the dry weight of the plant, gave the treatment of spraying with zinc the highest average (37.75 g.Plant^{-1}) and an increase of (18)% compared to the treatment of non-spraying gave (31.94) g. This may explain the role of the zinc element in increasing the leaf area [2], which contributes to increasing the ability of the plant to achieve photosynthesis, which is positively reflected in the growth of plant growth and the production of biomass [6, 26]. There was a significant interaction between the levels of moisture content and spraying with zinc in dry weight of the plant, where the interaction was achieved (90% of the field capacity with zinc spray), the highest rate of this trait was 40.91 g, while the lowest rate was (27.20) g for the treatment of interaction (50% Of field capacity with no spraying with zinc).

Table 3: Effect of Moisture Content and Spraying with zinc in the dry weight of the plant

Treatments	**Soil Moisture Content %**			
Spraying with zinc mg.L^{-1}	50	70	90	The average effect of zinc
0.00	27.20	33.40	35.21	31.94
200	31.94	40.40	40.91	37.75
The average effect of zinc	29.57	36.90	38.06	
LSD (0.05) Zinc 1.435, Moisture content 1.757, Interaction 2.485				

Weight 100 seed (g)

The results of Table (4) show that there are significant differences between the arithmetic parameters of the moisture content parameters and their effect in this trait. The highest average weight of 100 seeds (g) at the treatment (70%) of the field capacity was 2.00 g, however, it did not differ significantly from the treatment 90% of the field capacity and the lowest average was found at the treatment (50%) of the field capacity was (1.83) g. The period of fullness of the seeds is a time sensitive to water stress, where water stress negatively affects the processing of materials for seed representation [7] as well as the effect of water stress in reducing the period of seed filling [14] This is reflected negatively on seed size and its weight [20]. There was also a significant effect on the treatment of spraying with zinc in this trait and gave the treatment of spraying with zinc the highest average of 1.96 g compared with the lowest mean 1.89 g when treated with no spraying. The reason for the increase may be due to the role of the zinc element in raising the efficiency of the breathing processes and photosynthesis of the plant as a result of its positive effect in increasing the leaf area, which increases the accumulation of materials manufactured for the process of photosynthesis in the seed during the period of its fullness. In parallel, the lack of competition between seeds on food Produce reduces the chance of miscarriage and low weight [13]. The results of Table (4) showed a significant overlap between the levels of moisture content and spraying with zinc in the weight of 100 seeds, where the treatment of interaction of (70% of the field capacity with spraying with zinc) excelled by giving the highest rate of 2.04 g compared to the lowest rate of 1.80 g for interaction of (50% Of field capacity with no spraying with zinc).

Table 4: Effect of Moisture Content and Spraying with zinc in the weight 100 seed (g)

Treatments	Soil Moisture Content %			
Spraying with zinc mg.L^{-1}	50	70	90	The average effect of zinc
0.00	1.80	1.97	1.92	1.89
200	1.87	2.04	1.99	1.96
The average effect of zinc	1.83	2.00	1.95	
LSD (0.05) Zinc 0.032, Moisture content 0.040, Interaction 0.056				

Seed yield (g.plant^{-1})

Table (5) show that there is a significant effect of moisture content of the soil in the seed yield of the plant. The treatment 90% of the field capacity excelled by giving the highest average of (2.01 g.plant^{-1}) which did not significantly differ from the treatment 70% And an increase rate of (20.3)% compared to the treatment of 50%, which gave the lowest seed production of the plant (1.67g). The decrease may be due to the negative effect of water stress in nutrient readiness in soil, and consequently in reducing the leaves number in the plant of the same level as shown in Table (2) and the leaf area and its reflection on the photosynthesis of Carbony metabolism products for photovoltaic construction and reduction of their rate of transmission of reproductive parts [32]. this agreed with [9]. The results of the above table show that there was a significant effect of spraying with zinc on the plant seeds yield. The spraying treatment of the two species achieved the highest mean of (2.05 g.plant^{-1}) with an increase of (18.4%) On the treatment of non-sprinkling with the zinc that it gave of (1.73 g.Plant^{-1}). The reason for this is the vital role of spraying with zinc in increasing the leaves number in the plant as shown in Table (2), as well as its contribution in stimulating a number of photosynthetic enzymes, which positively affect the growth characteristics and seed yield. This finding is similar to what it reached [30]. There was a significant interaction between the levels of the above factors in the seed yield of the plant, where the interaction treatment (70% of the field capacity with spraying with zinc) achieved the highest rate of (2.21g.plant-1) and an increase of (46%) compared to the interaction treatment (50% of the field capacity with no spraying of zinc) which gave (1.51g).

Table 5: Effect of Moisture Content and Spraying with zinc in seed yield (g.plant^{-1})

Treatments	Soil Moisture Content %			
Spraying with zinc mg.L^{-1}	50	70	90	The average effect of zinc
0.00	1.51	1.80	1.89	1.73
200	1.83	2.21	2.13	2.05
The average effect of zinc	1.67	2.00	2.01	
LSD (0.05) Zinc 0.076, Moisture content 0.093, Interaction 0.131				

Percentage of Oil (%)

Table (6) show that there was a significant effect for the moisture content and spraying with zinc and interaction between them in the percentage of oil in seeds. The treatment 70% of the field capacity excelled by giving the highest percentage of oil in the seeds (29.80%) compared to the lowest average 28.70%, at the treatment 50% of the field capacity. The decrease in oil may be due to the effect of water stress at treatment 50% of the field capacity to reduce the production of carbohydrate compounds in the plant, which reduces the proportion of fat in seeds [31]. This agreed with [27] that water stress reduces the proportion of oil in the Rapeseed seeds. The results in the above table indicate that the spraying with zinc treatment was superior in the percentage of oil by giving the highest average for this trait (29.43%) compared to the non-spraying treatment which gave the lowest average of the percentage of oil (29.03 %). This agreed with [30] that spraying the zinc on the vegetative part of the

flax plant led to an increase in the percentage of oil in the seeds. Table (6) confirm that there is a significant effect of the interaction between the above factors and achieved the interaction (70% of the field capacity with spraying with zinc) by giving the highest percentage of oil (30.01%) and the lowest percentage of oil (28.50) found for interaction of (50% of field capacity with no spraying with zinc).

Table 5: Effect of Moisture Content and Spraying with zinc in seed yield (g.plant^{-1})

Treatments	**Soil Moisture Content %**			
Spraying with zinc mg.L^{-1}	50	70	90	The average effect of zinc
0.00	28.50	29.60	1.89	29.03
200	28.90	30.51	2.13	29.43
The average effect of zinc	28.70	29.80	2.01	
LSD (0.05) Zinc 0.378, Moisture content 0.463, Interaction 0.655				

We conclude that the borage plant is sensitive to water stress and that reducing the soil moisture content to 50% of the field capacity led to the reduction of both seed yield and the percentage of oil in the seeds of the plant and the spraying with zinc (200 mg.L^{-1}) resulted in a significant increase in all indicators of the studied experiment.

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