EFFECT OF SPRAYING SOME MIRONUTRINTS IN SOME TRAITS AND GREEN YIELD OF HYDROPONIC BARLEY

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ABSTRACT

Two experiments were conducted in hydroponic device for the year of (2015 – 2016) in the farm of one of farmers at the Arab Gbour region - Dora - Baghdad, to study the effect of spraying micronutrients on green yield of hydroponic barley. The C.R.D design was used with four replicates for the experiments, which included zinc spraying by three concentrates (125, 100, 75 $mg.L^{-1}$), iron (100, 75, 50 $mg.L^{-1}$) and calcium (600, 400, 200 $mg.L^{-1}$), as well as the control treatment (without spraying) in first experiment. The second experiment which included the blend of fertilizer by using highest concentration of Micronutrients obtained from the results of the first experiment were combinations of fertilizer is (Zn +Fe, Zn +Fe, Zn + Ca, Fe + Ca and Zn + Fe + Ca), as well as the control treatment (without spraying). The results of the first experiment showed that treatments of (Zn3 , Fe3 and Ca3) gave the highest plant height of (26.80 cm , 27.60 cm and 24.90 cm) , highest Green yield reached (28.67 kg m^{-2} , 28.79 kg m^{-2} and 21.26 kg m^{-2}), and highest dry yield reached (6.30 kg m^{-2} ,6.29kg m^{-2} and 5.12 kgm^{-2}) respectively. The results of second experiment showed that the combination of (Zn + Fe + Ca) gave the highest plant height reached 29.05 cm, green yield of (29.25 kg m^{-2}) and dry yield of (5.32 kg m^{-2}). We conclude from this study that it is necessary to add the Micronutrients with high concentrations and to formation of a combination of these elements to give better results than spraying them individually to nourish the plant during its growth in the hydroponic chamber, therefore recommend adding elements of (Zn + Fe + Ca) with concentrations of (125 +100 + 600 mg L^{-1}) to obtain a higher green yield of hydroponic barley.

Key words: Hydroponic device, Barley, Micronutrients, Green yield.

تأثير رش بعض العناصر الصغرى في بعض الصفات وحاصل العلف للشعير المستنبت

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الملخص

نفذت تجربتان في جهاز الاستنبات للعام 2015 -2016 في منطقة عرب جبور – الدورة – بغداد في مزرعة احد الفلاحين بهدف دراسة تأثير رش العناصر الصغرى في حاصل العلف للشعير المستنبت استعمل تصميم CRD بأربعة مكررات للتجربتين شملت معاملات رش الزنك بثلاثة تراكيز (125,100,75 ملغم لتر$^{-1}$) والحديد (100,75,50 ملغم لتر$^{-1}$) والكالسيوم (600,400,200 ملغم لتر$^{-1}$) فضلا عن معاملة المقارنة (بدون رش) اما التجربة الثانية فكانت توليفات سماديه باستعمال أعلى تركيز من العناصر السادية التي أعطت اعلى قيم للمتوسطات للصفات المدروسة التي حصلنا عليها من نتائج التجربة الاولى وشملت Zn+ Fe و Zn + Ca و Fe + Ca و Zn+ Fe+ Ca فضلا عن معاملة المقارنة (بدون رش). اظهرت نتائج التجربة الاولى ان المعاملات Zn3 وFe3 وCa3 قد أعطت اعلى ارتفاع للنبات 26.80 سم و27.60 سم و24.90 سم واعلى حاصل اخضر بلغ 28.67 كغم م$^{-2}$ و 28.79 كغم م$^{-2}$ و 21.26 كغم م$^{-2}$ واعلى حاصل جاف بلغ 6.30 كغم م$^{-2}$ و 6.29 كغم م$^{-2}$ و5.12 كغم م$^{-2}$ بالتتابع . اما في التجربة الثانية فقد تفوقت التوليفة Zn+Fe+Ca بأعطائها أعلى ارتفاع للنبات بلغ 29.05 سم والحاصل الأخضر29.25 كغم .م$^{-2}$ والحاصل الجاف 5.32 كغم م$^{-2}$ نستنتج من هذه الدراسة ضرورة أضافة العناصر السمادية الصغرى بتراكيز عالية وعمل توليفة من تلك العناصر لتعطي نتائج أفضل من رشها كلآ على حده لتغذية النبات أثناء نموه في جهاز الاستنبات ، وعليه نوصي بإضافة العناصر Zn+Fe+Ca بالتراكيز 600 +100 +125 ملغم لتر$^{-1}$ للحصول على اعلى حاصل أخضر من الشعير المستنبت.

كلمات مفتاحية: جهاز الاستنبات . الشعير . العناصر الصغرى. الحاصل الأخضر

1. INTRODUCTION

The provision of green forage throughout the year and in all seasons may be one of the most important aims that concern the producers and researchers working in the field of animal production in particular and the agricultural sector in general. The barley crop (*Hordeum spp*) is of the oldest grain crops, that its economic importance at present is concentrated in its use as forage given to animals in the form of grain , Straw or green forage and can be early in growth at the end of winter or early spring or may leave sheep in fields of barley to forage on it [18]. , because this plant of winter annual crops, it is not available as green forage throughout the year Therefore, the orientation for technique of the hydroponic, which is one of the modern methods in the production of forage, which is the process of soaking and germination seeds in closed rooms have an atmosphere similar to the natural environment of barley cultivation through controlling by the room temperature, humidity and lighting throughout the year and these rooms do not need large areas of land for the establishment of the project where every 36 m^2 is enough to produce 1 ton of green barley daily [22]. This means possibility to invest the cultivated land with barley for the purpose of forage by planting other plants useful for human nutrition. Studies have indicated that the rate of digestion of hydroponic barley to the animal which may reach 95% and the rate of conversion of up to 80% without causing swelling or indigestion in the animal [21]. That the agriculture in the chambers of hydroponic in the water media is lacking to nutrients media is the soil that is equipped with nutrients for the plant, so it is necessary to add nutrients to meet its need of the plant nutrients by a solution called Nutrient Solution [13, 20, 23]. It is known that zinc affects the activation of a number of enzymes up to 300 enzymes, such as: dehydrogenase, Enolase and Peptidases, important for the synthesis of amino acid (tryptophan), which is the main material in the formation of indol acetic acid (IAA) that necessary for elongation of cells. It is an important factor in the phosphorylation process and the formation of DNA necessary for the formation of protein and affects the metabolism of carbohydrates. In addition, is necessary for the growth of roots and the building of the membrane of the cell, and its reduction leads to increase the permeability [12]. Iron is also an important factor in the formation of chlorophyll and has a role in the formation of RNA Many oxidation and reduction enzymes are active and in the formation of important Cytokines in carbon synthesis and respiration [10]. Calcium also plays an important role in the regulation and absorption of nutrients from the growth media in which the seedling grows and in the building of cells of the cell walls and enters the structure of the middle lamella, which is chemically composed of calcium bactate, which is important for the formation of cellular membranes and has a role in the activation of some enzymes such as: Adenozine triphosphatase and Arigine [9]. Bounzoun [11] found that hydroponic barley spraying with a nutrient solution containing the Micronutrients of (Fe, B, Zn, Mg) and the Macronutrients (NPK) produced a green yield reached of (2.949 - 6.609 kg). Al-sahoeke, et.al [3] indicated when cultivating barley and wheat in the glass house were cultivated under the influence of copper sulphate at concentrations of (2500 and 5000 mg .L^{-1}). In addition to the control treatment (water only), there was a significant increase of green and dry barley yield of (28.86 and 6.87 kg) respectively at the high concentration of the nutritive element compared to the control treatment which a green and dry yield reached of (21.89, 5.12 kg) respectively. Stephen, et.al [24] mentioned, that the treatment of barley and oats with high concentrations of (Cu, Cd, and Zn) when cultured in hydroponic chamber in India, barley was more tolerable to high concentrations of Zn compared to oats. Kamal and Ghaly [18] found, increased the height of hydroponic barley in a 25 cm nutrient solution after 21 days of plant life. Abdel -Hady [7] reported that the cultivated barley spraying in the glass house in Egypt using concentrations of (0, 3000, 6000, 9000, 1200 mg. L^{-1}) NaCl and (0, 15, 30 mg Kg Soil / Zn was the highest

dry yield at concentration of 3000 mg.L^{-1}. Dung, et.al [14] found, an increase in protein content of 17.3% when nutrient added compared with no nutrient while dry weight decreased by 13.3% although nutrients were added on the seventh day of hydroponic barley and thus reduced digestion capacity. Al-Zubaidi [2] found when spraying hydroponic barley and oats by nutrient elements, namely zinc with concentrations of (50, 75, 100 mg.L^{-1}), magnesium (500, 1000, 1500 mg L^{-1}) and NPK, as well as the control treatment sprayed with water only, The higher concentration of each element of the spraying was excelled, by giving it the highest plant height and the green and dry yield of both crops. And for the importance of what was mentioned should be there was an experiment to see the effect of different concentrations of some of the micronutrients and better synthesis to increase the production of green and dry barley yield.

2. MATERIALS AND METHODS

Two experiments were carried out in the hydroponic device for 2015 _2016. The hydroponic site was in a farm at the Arab Jabour-Doura district of Baghdad to study the effect of leaf nutrient on the micronutrients in the green yield of hydroponic barley.

Hydroponic device: It consists of a large structure made of stainless steel and envelope from inside with a thick nylon to resist moisture. It is surrounded by double glass windows and is drained from the air for the purpose of controlling the environmental conditions inside. It was 2m length and 1.5m wide and 2m high, and contains shelves from the inside with length of 1.30 m and width of 0.40 m. This chamber contains a lighting system of fluorescent and a water system in addition to an air vicious and all systems are operated automatically. The room temperature was 22°C and the sprinkler system worked every 4 hours in the winter and 2 hours in the summer to spray the seeds.

The first experiment: It was carried out at 14/12/2015 with CRD design four replicates to compare the effect of three micronutrients with three concentrations of each component as well as the control treatment as follows:

1. Zinc (Zn) with concentrations of (125,100,75 mg.L^{-1}): Use chelate zinc, the active ingredient of 13%, it symbolized by (Zn1, Zn2 and Zn3), respectively.
2. Iron (Fe) Concentrations were (100, 75, 50 mg.L^{-1}) in the form of 20% iron (II) Sulfate, it symbolized by (Fe1, Fe2 and Fe3).
3. Calcium (Ca) 10%: Spraying liquid with concentrations of (600,400,200 mg.L^{-1}). It symbolized by (Ca1, Ca2, and Ca3) respectively.
4. In addition to the control treatment, in which plants was sprayed with distilled water only and symbolized with zero treatment. Seeds of barley were planted with a quantity of seed of 3 kg m^{-2} with optimum lighting 18 hours a day^{-1} [2]. The fertilizer used in distilled water was dissolved according to the concentrations mentioned for the treatments. The plants were sprayed on the fourth and seventh day of the plant life by a small sprinkler with the use of a surface tension fracture substance (cleaning substance) with spraying.

Water irrigation is turning off for 12 hours after spraying to allow the plant nutrient absorption. After the completion of the plant life 10 days, the plants took with their roots and the stems and leaves of each experimental unit dimensions of 10 × 10 cm to study the following qualities:

1. **Plant height (cm):** 10 plants were taken randomly from the sample and the average height of the plant was measured from the contact area of the peduncle with seed by a measuring ruler.
2. **Fresh weight (kg.m^{-2}):** The weight of the sample was calculated in grams by the sensitive balance after the addition of ten plants and the readings were converted to kg.m^{-2}
3. **Dry weight (kg.m^{-2}):** After taking the green extract of the samples in paper bags perforated and then dry in an electric oven at a temperature of 65 until the stability of the weight and the

dry index measured on the basis of moisture ratio 14% [6].

$$\mathbf{CGR} = \frac{\mathbf{1}}{\mathbf{A}} \times \frac{\mathbf{W_2 - W_1}}{\mathbf{T_2 - T_1}}$$

The crop growth rate (CGR) was calculated on the basis of Hunt equation (25) as follows:
Where A: The area occupied by the plants sample (m^2)
W1: The dry weight of the sample at the beginning of the period which equals zero
W2: Dry weight of the sample at the end of the period
T1: The time at the beginning of agriculture which equals zero
T2: The time of the plants it took to grow is 10 days

The second experiment: In this experiment barley seeds were cultivated at 2016-3-26 to know the best combination of elements using the best concentrations obtained from the first experiment in the breeding device and the combinations were as follows:
Ca3+Fe3
Ca3+Zn3
Fe3+Zn3
Ca3+Fe3+Zn3
In addition to the control treatment (without spraying)
It was sprayed by a small sprinkler on the fourth and seventh day of the plant's life and the irrigation was stopped for 12 hours to allow the plant to absorb the micronutrients. The samples were collected after the tenth day to study the required traits, which are similar to the first experiment. The design was CRD and with four replicates for growth traits and yield. Three replicates were used to analyze plant component ratios for the second experiment only by digesting the plant samples (leaves, stems and seeds) in the wet method using sulfuric acid 4 ml and 1 ml perchloric acid to estimate:

1. **The ratio of Zinc, Iron and Calcium:** The samples were analyzed by an Atomic Absorption Spectophotomtry device of 5000 US industry along a 213.9nm wavelength in the service laboratory - Life Sciences Department - college of Science - University of Baghdad.
2. **Protein ratio:** Protein ratio was extracted by equation:
   Nitrogen ratio × 5.5 (EL-Deeba, 2009)
   The above percentages were estimated at the Graduate Studies Laboratory, college of Agriculture, University of Baghdad.

The data were analyzed using the computer in the GENSTAT Version 7 program and the mean of the mean was calculated using of Least Significant difference (L.S.D) under 5% probability level

3. RESULTS AND DISCUSSION

1. Plant height

The results of Table (1) show the effect of the concentrations of the micronutrients on the mean height of the plant, which increased by increasing the concentration of each fertilizer component. The Zn3, Fe3 and Ca3 spraying treatments gave the highest average of 26.80 cm, 27.60 cm and 24.90 cm respectively, with increasing ratio of 34.26% and 38.27 And 24.74% compared to the control treatment, which has a plant height of 19.96 cm. The increase in the rate of plant height can be attributed to the role of micronutrients added by Spray solutions in many physiological processes, such as increasing the chlorophyll content in the leaves necessary to raise the efficiency of photosynthesis. Zinc is an enzyme activator and the formation of nucleic acids. It is involved in the formation of amino acid tryptophan, Acetic acid (Indol Acetic Acid IAA), an hormone (Auxins) is important for the elongation and growth of cells [12]. Iron and calcium have two roles: elongation of cells, synthesis of proteins and carbohydrates and formation of chlorophyll [4].

Table 1: Effect of spraying of micronutrients in average plant height (cm) for hydroponic barley

Treatments	Average plant height (cm)
0	19.96
Zn1	24.22
Zn2	24.68
Zn3	26.80
Fe1	24.30
Fe2	26.48
Fe3	27.60
Ca1	22.65
Ca2	24.90
Ca3	26.35
0.05L.S.D	1.98

2. Green yield:

Table (2) shows a significant increase in the green yield increase in the high concentrations of fertilizers, the high concentration of Zn3, Fe3 and Ca3 gave the highest averages of 28.67 $kg.m^{-2}$, 28.79 $kg.m^{-2}$, and 21.26 $kg.m^{-2}$, respectively. This result is consistent with Fazaeli, et.al [16]. they indicated that during the growth cycle of plants in the micronutrients media, the green yield Increasing with increase the root system and plant height and may be attributed to this increase in the green yield to the roles of elements used in many of the phylogenetic processes, including increasing the proportion of chlorophyll necessary to raise the efficiency of carbon representation and the formation of amino acid Tryptophan that necessary for elongation of cells and Increase plant height as shown in Table (1), which is positively reflected in the increase in green yield.

Table 2: Effect of spraying of micronutrients in average green yield ($kg.m^{-2}$) for hydroponic barley

Treatments	Average green yield ($kg.m^{-2}$)
0	16.32
Zn1	21.67
Zn2	26.30
Zn3	28.67
Fe1	23.93
Fe2	23.90
Fe3	28.79
Ca1	18.72
Ca2	20.52
Ca3	21.26
0.05 L.S.D	1.98

3. Dry yield

Table (3) shows the significant increase in the average dry yield by the effect of the spraying treatments relative to the control treatment. The higher the concentration of the nutrient lead to the higher the dry yield. The concentrations of (Zn3, Fe3 and Ca3) were gave the highest averages of (6.30 $kg.m^{-2}$ and 6.29 $kg.m^{-2}$ and 5.12 $kg.m^{-2}$), respectively. The increase in dry weight may be due to the positive effect of leaf nutrients and increase their concentration by increasing plant height

as shown in Table (1) and its important role in the physiological and biological processes within the plant and activating many enzymes that increase the efficiency of carbon representation about an increase in dry weight.

Table 3: Effect of spraying of micronutrients in average dry yield ($kg.m^{-2}$) for hydroponic barley

Treatments	Average dry yield ($kg.m^{-2}$)
0	3.34
Zn1	4.79
Zn2	5.56
Zn3	6.30
Fe1	5.11
Fe2	5.43
Fe3	6.29
Ca1	4.36
Ca2	4.75
Ca3	5.12
0.05 L.S.D	0.52

4. Crop growth rate (C.G.R)

The results of Table (4) show significant differences between the averages parameters of barley growth rate and the effect of micronutrients. The highest growth rate of the crop when spraying the plant with treatment Zn3 was 0.62 $g.m^{-2}.day^{-1}$, which did not differ significantly from the treatment of spraying Fe3. While the concentration Ca3 gave highest growth rate of the crop compared to other concentrations of calcium and a control treatment which reached of 5.12 $g.m^{-2}.day^{-1}$, while the control treatment gave the lowest growth rate of 3.34 $g.m^{-2}.day^{-1}$. This may be due to the fact that the plants at high concentrations performed better in terms of their resistance to light and increase the efficiency of carbon representation and the division and elongation of cells at higher rates, which was reflected in increased plant height as Table (1) and that the relative growth rate depends on the accumulation of the substance Dry in the plant within 10 days for the original weight of these plants measured for the previous [5]. This is confirmed by our results from an increase of the average weight of dry matter when the high concentration of each element fertilizer as shown in Table (3).

Table 4: Effect of spraying of micronutrients in growth rate of the crop ($g.m^{-2}.day^{-1}$) for hydroponic barley

Treatments	Growth rate of the crop ($g.m^{-2}.day^{-1}$)
0	0.33
Zn1	0.47
Zn2	0.55
Zn3	0.62
Fe1	0.50
Fe2	0.54
Fe3	0.62
Ca1	0.43
Ca2	0.47
Ca3	0.50
0.05 L.S.D	0.52

The second experiment

1. Plant height

Table (5) shows that there are significant differences between the fertilizer combinations in plant height. The combination of (Zn + Fe + Ca) gave the highest average reached of 29.05 cm while the control treatment gave the lowest plant height was 23.32 cm, And the superiority of the combinations of elements combined may be attributed to the important effects of these elements. iron has a role in the composition of many compounds Citokrom and Ferredoxin important in the process of carbon representation and calcium important for the division and expansion of the cell as well as the role of zinc in the elongation of the plant through the stimulation of the hormone auxin and this leads to increased rates Growth thus increased plant height [17, 19].

Table 5: Effect of nutrients combinations in average plant height (cm) for hydroponic barley

Treatments	Average plant height (cm)
0	23.32
Zn+Fe	27.52
Zn+Ca	27.30
Fe+Ca	27.00
Zn+Fe+Ca	29.05
0.05L.S.D	1.08

2. Green yield:

The results of Table (6) show a significant increase in the average green yield by the effect of fertilizer treatments compared to the control treatment. (Ca + Fe + Zn) gave the highest average of 29.25 $kg.m^{-2}$ while the control treatment gave 17.55 $kg.m^{-2}$. No significant difference was observed between (Fe + Zn, Fe + Ca and Zn + Ca), but significantly excelled from the control treatment, the increase in the green yield may return to the positive role of these elements when spray together in raising the efficiency of the carbon representations and thus increase the green yield.

Table 6: Effect of nutrients combinations in average green yield ($kg.m^{-2}$) for hydroponic barley

Treatments	Average green yield ($kg.m^{-2}$)
0	17.55
Zn+Fe	28.24
Zn+Ca	28.2
Fe+Ca	29.01
Zn+Fe+Ca	29.25
0.05L.S.D	1.00

3. Dry yield

The average dry yield was significantly increased when the nutrients spraying was standardized by control treatment. Table (7) shows that the treatment of (Zn + Fe + Ca) has given the highest mean of 5.32 $kg.m^{-2}$ compared to the control treatment gave 2.82 $kg.m^{-2}$. This increase may be attributed to the role of these nutrients in the activation of biological processes, which is reflected on the paper area and the volume of food processed to build plant tissues. This is confirmed by the increase in plant height as shown in Table (5) and green yield as shown in Table (6).

Table 6: Effect of nutrients combinations in average dry yield ($kg.m^{-2}$) for hydroponic barley

Treatments	Average dry yield ($kg.m^{-2}$)
0	2.82
Zn+Fe	4.79
Zn+Ca	4.00
Fe+Ca	4.97
Zn+Fe+Ca	5.32
0.05L.S.D	0.47

4. Ratio of iron, zinc and calcium

As shown in Table (8), there is a significant increase in the concentration of iron, zinc and calcium in the plant, (Zn + Fe + Ca) gave the highest concentration of iron, zinc and calcium reached of (11.20, 9.8 and 0.30 $mg.kg.m^{-1}$) respectively, and an increase ratio of (74.72%, 80.81% and 200%), respectively compared to the control treatment of (6.41 and 5 .42 and 0.10 $mg.kg.m^{-1}$). This due to the increase in elements when spraying the three elements together may be due to the active role of these elements in activating nutrient absorption.

Table 8: Effect of nutrients combinations in Percentage of iron, zinc and calcium for hydroponic barley

Treatments	Iron concentration ($mg.kg.m^{-1}$)	Zinc concentration ($mg.kg.m^{-1}$)	Calcium concentration ($mg.kg.m^{-1}$)
0	6.41	5.42	0.10
Zn+Fe	10.65	8.41	0.12
Zn+Ca	8.54	9.14	0.15
Fe+Ca	9.71	6.46	0.20
Zn+Fe+Ca	11.20	9.80	0.30
0.05 L.S.D	1.61	1.40	0.01

5. Protein ratio

Table (9) indicates that there is a significant effect of the spraying of the fertilizer combinations in the protein ratio of hydroponic barley. The treatment (Zn + Fe + Ca) has been given the highest protein yield of 24.30% and did not differ significantly from the treatment of (Zn + Fe) as it gave 23.68%, while the control treatment gave the lowest percentage of protein reached 14.40% The increase can be attributed to the direct and indirect iron-zinc relationship by increasing the representation of nitrogen and the formation of important amino acids RNA and DNA in the protein synthesis process [1].

Table 9: Effect of nutrients combinations in average protein ratio (%) for hydroponic barley

Treatments	Average protein ratio (%)
0	14.40
Zn+Fe	23.68
Zn+Ca	22.90
Fe+Ca	21.80
Zn+Fe+Ca	24.30
0.05L.S.D	5.61

It is concluded from the study that it is necessary to add the micro-fertilizer elements with high concentrations and to make a combination of these elements to give better results than spraying them individually to help the plant during the period of growth in the hydroponic and therefore we recommend adding the elements (Zn + Fe + Ca) with concentrations of (600 +1500 + 100 mg.L^{-1}) to obtain the highest green yield of hydroponic barley, and to make different combinations of nutrients and study their effect on a number of forages crops in the plant.

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