Effect of ammonium to nitrate ratio (NH4+: NO3-) and foliar seaweed extract on growth and leaf quality in Swiss chard (Beta vulgaris var. cicla(

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Abstract:
The experiment was conducted at the Agricultural Research Station(Latitude 32,and Longitude 44.33) /University of Kufa in Najaf Governorate/Iraq to study the effect of the ratio of NH4+: NO3- and spraying seaweed extract on the quality indicators of Swiss chard. A complete randomized block design was used and the data were analyzed according to Duncan's multiple range test at a probability level of 0.05. The results showed that the interaction between the ratio of NH4+: NO3- (200:200) and the seaweed extract at a concentration of 6 g L-1 had a significant effect on increasing the plant height to 77.94 cm, the leaf area to 375.6 cm2 plant-1, the nitrogen ratio to 4.557%, phosphorus to 0.812%, potassium to 3.517%, and calcium to 56.86 mg 100 g-1, while the vegetative yield increased to 3.71 tons ha-1 in the interaction treatment (0:400) and the seaweed extract at a concentration of 6 g.L-1 compared to the comparison treatment, which recorded a decrease in the study indicators.

Keywords: chemical fertilization, vegetable, organic cultivation, leaf yield

Introduction

Swiss chard (Beta vulgaris var. cicla), in the family (Chenopodiaceae), is considered a leafy vegetable crop, widely cultivated in Europe and Asia, and widely used in the Levant and the Middle East. The leaves of the chard plant contain many important minerals such as copper, calcium, iron, sodium, phosphorus, and potassium. It is also considered a leafy vegetable plant with a high content of vitamins B and C, folic acid, and antioxidants such as flavonoids, carotenoids, and syringic acid. In addition, it contains a percentage of fiber that reaches about 1.2 mg.100 g-1 fresh weight (3.(

Foliar nutrition is one of the main ways to feed plants, it compensates for the lack of nutrients in sufficient concentrations and improves the nutritional status of the plant and also works to improve and increase the productivity and quality of marketable crops (11). In the conditions of Iraqi soils, the use of foliar nutrition in addition to the use of soil fertilization has become a necessity due to the washing, sedimentation and fixation processes that occur for these nutrients, especially microelements. Therefore, foliar nutrition may be used as a type of supplementary fertilization that contributes to providing plants with the necessary elements (1). Nitrogen is an essential nutrient for plant growth, constituting 2-5% of the dry matter weight of the plant. Nitrogen plays a vital role in many physiological and vital processes within the plant. Nitrogen is essential in the composition of amino acids, and is included in the composition of the nitrogenous bases Purine and Pyrimidine, which are included in the composition of nucleic acids DNA and RNA. In addition to the role of nitrogen in energy-carrying and energy-giving compounds such as Adonisin Tri- Phospate (ATP) and Nicotinamide Adenine Nucleotide Phosphate

ISSN 2072-3857

(NADP).Which makes nitrogen one of the elements that determine the growth and development of plants (8.(

Organic fertilizers of various types constitute an important and essential source of the major and minor elements that plants need, in addition to their important role in improving the physical, chemical and biological properties of the soil (6). Recently, the importance of using liquid organic fertilizers has emerged

agriculture in the world as one of the most important clean alternatives to nutrients, which has become known as (clean agriculture) due to the compounds that they provide that plants need during their various growth stages, as they contain some organic acids such as humic and fulvic acids and amino acids, and their effective role that is positively reflected in plant's the growth and production (10). Sources have indicated that organic fertilizers may have an effect in

reducing some compounds that may harm human health, especially those that have toxic effects when accumulated, such as nitrate and oxalate compounds (4). Therefore, this research aimed to demonstrate the role of nitrogen fertilization in the form of ammonium and nitrate with spraying of seaweed extract and its effect on vegetative growth indicators, yield , and leaf content of some nutritional elements in the leaves of Swiss chard .

Materials and methods

The field experiment was carried out on 25 January,2023 at the Agricultural Research Station affiliated to the College of Agriculture/ University of Kufa / Najaf Governorate. The effect of the ratio of ammonium to nitrate in fertilizer and spraying with organic fertilization with algae extract on some qualitative indicators of chard was studied. The seeds were planted in lines of 25 cm between lines and a planting distance of 15 cm, leaving a distance of 50 cm between one experimental unit and another for the purpose of service and isolation of experimental units and leaving 1 meter between one sector and another. The drip irrigation system was used, and irrigation was repeated whenever the plant needed it. All service operations were carried out according to the recommendations for planting the crop. The experiment included studying the effect of two factors; the first is the effect of nitrogen fertilization 400 mg L-1 in the form of ammonium (NH4+) which used urea CO(NH2)2 as its source or nitrate (NO3-) which used Potassium Nitrate as its source, and a combination of both at half the level 200:200 mg L-1 in addition to the control treatment without fertilization

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NH_4^{+1}: NO_3^{-1} Ratio		**Nitrogen level ($Mg.L^{-1}$)**
NO_3^{-1}	**NH_4^{+1}**	
0	**0**	**Control 0: 0**
0	**1**	**0 : 400**
1	**0**	**0 : 400**
0.50	**0.50**	**200 :200**

ISSN 2072-3857

The second factor was spraying seaweed extract (Seaweed Extract - Algae Power) containing Organic Matter at a rate of 50%, Seaweed Extract at a rate of 12%, Alginic acid at a rate of 20%, and K2O at a rate of 12% at three concentrations (0, 3, and 6 ml. L-1). The plants were sprayed twice during the growing season, the first spray was after the formation of 4 true leaves, while the second was two weeks after the first spray. The control treatment was also sprayed with distilled water. The spray was applied with a 10-liter backpack sprayer until the degree of complete wetness, with a time difference of 48 hours between one solution and another. The treatments were distributed in a 4×3 factorial experiment in a Random Complete Block Design with three replicates, three sectors, each sector containing 12 experimental units, with a total of 36 experimental units. The means were compared according to Duncan's Multiples Range Test at a probability level of 0.05, to show the significant differences between the means using the Genestst program.

The experiment was completed and the data were taken that filled the studied indicators: plant height (cm), leaf area of the plant (cm2 plant-1) for three fully expanded leaves from each experimental unit. The scanner and ImageJ program were used (15). The percentage of dry matter in the vegetative group (%) and the weight of the vegetative yield (ton. ha-1) were also estimated. The measurements also included qualitative indicators based on the contents of the leaves of nutrients in the fourth or fifth leaf down from the plant apical. The leaf samples were digested (5) and then the solution was filtered and stored in tightly sealed glass containers
and the elements were estimated. The percentage of nitrogen in the leaves (%) was estimated using the Micro kjeldhal device (14). The percentage of phosphorus in the leaves (%) was estimated using the Spectrophotometer device and at a wavelength of 420 nm and was estimated using the ammonium vanadate-molybdate method. The percentage Percentage of potassium and calcium in leaves (%) using Flame Photometer (14), and leaf calcium content (mg. 100 g-1.(

RESULTS AND DISCUSSION

The results showed the effect of the ammonium to nitrate ratio in increasing the vegetative growth indicators under study, where a significant increase was recorded in plant height, plant content of dry matter (%) and total leaf area (Table1). The balanced nitrogen ratio ammonium: nitrate (200:200) showed a significant effect in increasing plant height to 62 cm compared to 53 cm in the control. Also, spraying with 6 ml.L-1 SWE led to an average plant height of 64 cm compared to the control, which recorded only 49 cm, while the highest plant height was recorded in the interaction treatment 200:200 nitrate: ammonium with spraying with 6 ml. L-1 SWE, which recorded 77 cm compared to only 44 cm in the untreated control. The leaf area (cm2. plant-1) also at a balanced fertilization level (200:200) recorded the highest rate of 353.0 cm2. Plant-1 compared to the control which recorded only 237.3 cm2.plant-1. Also, spraying with 6 ml. L-1 SWE led to a significant increase in leaf area to 309.8 cm2.plant-1 compared to 280.4 cm2.plant-1 in the control treatment. In general, the highest values of leaf area were recorded in the interaction treatment 200:200 nitrate: ammonium in interaction with spraying with 6 ml. L-1 SWE, which led to 375.6 cm2.plant-1 compared to the control treatment 212.2

ISSN 2072-3857

cm2.plant-1. Findings in table (3) indicated that the ammonium to nitrate ratio had a significant effect in increasing the percentage of dry matter of the vegetative group. The percentage of dry matter increased with the effect of balanced fertilization 200:200 to 21.90%, compared to the control which recorded 14.94%. Also, spraying SWE at 6 ml.L-1 led to the highest value of 19.70%, compared to the control

treatment which decreased the percentage of dry matter to 16.23%. The interaction treatment 200:200 nitrate: ammonium interacted with spraying at 6 ml.L-1 SWE, which led to 24.64%, compared to the control treatment which decreased to 13.99% (Table1). As the vegetative yield weight , it also differed according to the effect of the treatments, as the nitrogen fertilizer ratio (0:400) showed a significant effect in increasing the yield to 2.99 ton. ha-1, which did not differ from the balanced treatment (200:200), which recorded 2.91 ton. ha-1, compared to the control (0:0) of the lowest yield of 2.58 ton. ha-1. It was also found that spraying SWE at 6 ml. L-1 led to the highest yield of 3.47 ton. ha-1, compared to the control, in which the yield was decreased to 1.96 ton. ha-1.

As for the qualitative indicators of leaf nutrient content, the results of Table (2) showed that the ratio of ammonium to nitrate had a significant effect in increasing the leaf content (%) of nitrogen, phosphorus, potassium, and calcium. The results showed that balanced nitrogen fertilization (200:200) led to a significant increase in leaf nitrogen content to 3.902%, phosphorus to 0.787%, potassium to 3.363%, and calcium to 55.22 mg 100 g-1, compared with the control treatment (0:0) which gave 2.509%, 0.491%, 2.606%, and 35.38 mg 100 g-1. The results also recorded a significant effect of spraying with SWE on the same qualitative indicators of leaf nutrient content. Where spraying with SWE at a concentration of 6 ml. L-1 recorded leaf content of nitrogen, phosphorus, potassium and calcium, which recorded values of 3.670%, 0.634%, 3.016%, and 47.85 mg 100 g-1, compared to the control treatment, which recorded rates that decreased to 1.679%, 0.606%, 2.858%, and 44.30 mg 100 g-1 (Table 2.(

Table 1. Effect of ammonium to nitrate ratio and spraying with seaweed extract SWS and their interactions on Swiss chard vegetative growth and yield indicators

NH_4^{+1}: NO_3^{-1} mg. L^{-1}	SWE ml. L^{-1}	Plant height cm	Leaf area cm^2 $plant^{-1}$	Shoot dry matter %	Yield weight Ton. ha^{-1}
Control (0:0)	**0**	42.39 e	212.2 f	13.99 f	1.58 e
	3	61.35 bcd	244.4 e	14.14 ef	2.69 c
	6	57.76 cd	255.3 e	16.70 d	3.47 ab
NH_4^{+1}: NO_3^{-1} (400:0)	**0**	54.82 cd	281.0 c	17.29 c	2.08 d
	3	51.39 d	278.6 c	16.40 d	3.18 b
	6	59.27 bcd	285.2 c	16.87 d	3.71 a
NH_4^{+1}: NO_3^{-1}	**0**	56.29 cd	292.1 c	15.85 e	1.78 de

ISSN 2072-3857

(0:400)	**3**	55.07 cd	289.0 c	15.71 e	3.06 b
	6	64.19 abc	323.2 d	21.97 b	3.21 b
NH_4^{+1}: NO_3^{-1} (200:200)	**0**	44.57 ed	336.5 b	17.80 c	2.40 cd
	3	65.81 ab	346.9 b	24.64 a	2.85 bc
	6	77.94 a	375.6 a	23.26 ab	3.50 ab
Mean of NH_4^{+1}: NO_3^{-1}	**(0:0)**	53.83 c	237.3 d	14.94 d	2.58 b
	(400:0)	55.16 b	281.6 c	16.85 c	2.99 a
	(0:400)	58.52 ab	301.4 b	17.84 b	2.68 b
	(200:200)	62.77 a	353.0 a	21.90 a	2.91 a
Mean of SWE	**0**	49.52 c	280.4 c	16.23 c	1.96 c
	3	58.40 b	289.7 b	17.72 b	2.94 b
	6	64.79 a	309.8 a	19.70 a	3.47 a

*Values are means of 3 replications, means followed by the same letter(s) are not significantly different according to Duncan's multiple range test (P≤0.05.(

Nitrogen plays a vital and essential role in many physiological processes that occur inside the plant. It participates in the construction of DNA and RNA nucleic acids and the manufacture of amino acids and proteins that are important in the process of building protoplasm and activating plant growth (19). In addition, nitrogen plays an important role in stimulating many enzymes and enzyme cofactors that enter into several vital processes that lead to increased division of meristematic cells and thus affect the growth and increase in the size of leaf cells (18). Increasing plant height or leaf area means increasing one of the phenotypic characteristics directly related to the plant's ability to absorb and metabolize carbon as a result of increasing the total metabolic materials manufactured in the plant, and the final result is reflected in the increase in the vegetative yield (9). However, it is noted from the results that there is a difference in the studied vegetative growth indicators due to the effect of the ammonium to nitrate ratio (NH4+1: NO3-1), especially when the absorbed nitrogen is in the form of ammonium or balanced with nitrate (200:200). This may be due to the fact that ammonium NH4+ is under the pressure of metabolism immediately after its absorption by the plant, it is converted into amino acids to participate in other vital processes such as the construction of nucleic acids, proteins, chlorophyll and enzymes (16). While nitrate NO3-1 after its absorption suffers from the process of reduction to ammonia NH3 before its metabolism and combination with other organic compounds to form vital compounds (12.(

On the other hand, the clear improvement in the indicators under study due to the effect of spraying with SWE is generally attributed to the role of such fertilizers (organic) that are characterized by containing water-soluble nutrients. These compounds contribute directly or indirectly to encouraging and increasing the plant growth rate through

enzymatic or hormonal action (13). Accordingly, organic foliar fertilization has affected the plant growth rate, which has a positive effect on increasing the number and size of leaf cells, resulting in an increase in the growth and size of the vegetative group represented by plant height and leaf area (17). This type of fertilization has affected the absorption of water and nutrients and the efficiency of leaves in the photosynthesis process, which results in the accumulation of manufactured nutrients and the availability of vital materials necessary for the growth of the vegetative group. This, in turn, led to a high increase in biomass production, which was reflected in an increase in dry matter and leaf nutrient content (2,7.(

Table2. Effect of ammonium to nitrate ratio and spraying with seaweed extract SWE and their interactions on Swiss chard leaf content of some macro nutrients (N,P,K,Ca(

NH_4^{+1}: NO_3^{-1} mg. L^{-1}	SWE ml. L^{-1}	Nitrogen %	Phosphor %	Potassium %	Calisum mg.$100g^{-1}$
Control (0:0)	**0**	1.713 e	0.476 i	2.510 h	33.01 j
	3	2.373 cde	0.490 k	2.667 g	36.91 i
	6	3.443 bc	0.507 j	2.640 g	36.20 i
NH_4^{+1}: NO_3^{-1} (400:0)	**0**	2.563 cd	0.553 g	2.733 f	42.51 h
	3	2.487 cde	0.531 h	2.743 f	44.50 g
	6	3.020 bc	0.540 h	2.777 f	46.12 f
NH_4^{+1}: NO_3^{-1} (0:400)	**0**	2.110 d	0.627 f	2.933 e	48.17 e
	3	2.527 cd	0.647 e	3.067 de	50.71 d
	6	3.483 bc	0.677 d	3.130 d	52.23 c
NH_4^{+1}: NO_3^{-1} (200:200)	**0**	4.170 ab	0.769 c	3.257 c	53.48 b
	3	2.980 cd	0.781 b	3.317 b	55.30 ab
	6	4.557 a	0.812 a	3.517 a	56.86 a
Mean of NH_4^{+1}: NO_3^{-1}	**(0:0)**	2.509 b	0.491 d	2.606 d	35.38 d
	(400:0)	2.690 b	0.541 c	2.751 c	44.38 c
	(0:400)	2.706 b	0.650 b	3.043 b	50.37 b
	(200:200)	3.902 a	0.787 a	3.363 a	55.22 a
Mean of SWE	**0**	1.679 c	0.606 c	2.858 c	44.30 c
	3	2.591 b	0.612 b	2.948 b	46.86 b
	6	3.670 a	0.634 a	3.016 a	47.85 a

*Values are means of 3 replications, means followed by the same letter(s) are not significantly different according to Duncan's multiple range test (P≤0.05.(

ISSN 2072-3857

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