Iraqi Journal of Market Research and Consumer Protection
(2025) 17(1): 39-54
DOI:
Mahmood & Hussein

المجلة العراقية لبحوث السوق
وحماية المستهلك

INCREASING BEET PRODUCTION BY RECYCLING SOME ENVIRONMENTAL PRODUCTS

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Received 23/ 6/ 2023, Accepted 27/ 8/ 2023, Published 31/ 3/ 2025

ABSTRACT

The experiment was conducted in the fields belonging to the Department of Horticulture, College of Agricultural Engineering Sciences, University of Baghdad, at the Al-Jadriya Campus/ Station A, during the season of 2022-2023. The aim of the study was to investigate the improvement of beetroot plant growth through water fish irrigation and spraying water lens extract. The experiment consisted of two factors: the first factor was water fish irrigation with the following treatments: (A) Control treatment (river water with recommended fertilization), (B) Water fish irrigation at a concentration of 25%, (C) Water fish irrigation at a concentration of 50%, (D) Water fish irrigation at a concentration of 75%, and (E) Water fish irrigation at a concentration of 100%. The second factor was the spraying of lens extract with the following treatments: (T1) Control treatment, (T2) Spraying with a concentration of 0.25%, (T3) Spraying with a concentration of 0.50%, (T4) Spraying with a concentration of 0.75%, and (T5) Spraying with a concentration of 1%. The experiment was designed according to a randomized complete block design (RCBD) with three replications, resulting in a total of 75 treatments. The results showed that treatment E exhibited superior growth characteristics compared to the control treatment, with an increase in root weight of 71.0 g per root. The results also indicated that spraying lens extract at a concentration of 1% resulted in higher values for growth characteristics compared to the control treatment. Treatment T5 showed significant superiority in root weight compared to all other treatments, with a value of 64.4 g per root compared to the control treatment. The combined treatment ET4, involving Water fish and spraying water lens plant extract, showed significant improvement in most measured growth characteristics compared to the control treatment. Treatment ET5 exhibited the highest root weight, reaching 85.8 g per root compared to the control treatment.

Key words: Beetroot, Fertigation, recycling of discarded fish water, spraying of aquatic plant extract.

[*]**The article is taken from a master's thesis by the first researcher.**

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(2025) 17(1): 39-54

زيادة إنتاجية الشوندر من خلال إعادة تدوير بعض المنتجات البيئية

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الخلاصة

نفذت التجربة في الحقول التابعة لقسم البستنة هندسة الحدائق/ كلية علوم الهندسة الزراعية/ جامعة بغداد/ مجمع الجادرية/ للموسم الخريفي 2022 - 2023 بهدف دراسة تحسين النمو الخضري نبات الشوندر بالرسمدة بماء أحواض الأسماك ورش مستخلص نبات عدس الماء، تتضمن التجربة عاملين: الأول الرسمدة بماء أحواض الأسماك وكالاتي: (A) معاملة المقارنة الرسمدة بماء النهر مع التوصية السمادية (B) الرسمدة بماء الأسماك بتركيز 25%،(C) الرسمدة بماء الأسماك بتركيز 50%، (D) الرسمدة بماء الأسماك بتركيز 75%، (E) الرسمدة بماء الأسماك بتركيز 100 %، والعامل الثاني: رش مستخلص نبات عدس الماء وكالاتي: (T1) معاملة المقارنة، (T2) رش المستخلص بتركيز 0.25%، (T3) رش المستخلص بتركيز 0.50 %، (T4) رش المستخلص بتركيز 0.75%،(T5) رش المستخلص بتركيز 1% ، صممت التجربة وفق تصميم القطاعات التامة التعشية (RCBD) ضمن التجارب المعشعشة (نستد) وبثلاث مكررات وبواقع 25 معاملة لكل مكرر ليكون عدد المعاملات الكلية في التجربة 75 معاملة، اظهرت النتائج تفوق المعاملة E في صفات النمو الخضري المقاسة قياسا بمعاملة المقارنة، وزيادة في وزن جذر النبات بلغ 71.0 غم جذر$^{-1}$ قياسا مع معاملة المقارنة، وبينت النتائج ان رش مستخلص عدس الماء بتركيز 1% اعطى اعلى القيم في صفات النمو الخضري قياسا مع معاملة المقار نة، وتفوقت معاملة T5 معنويا في صفة وزن الجذر على جميع المعاملات بلغت 64.4غم جذر$^{-1}$ مقارنة بمعاملة القياس، اعطت معاملة التداخل ET4 للرسمدة بماء الأسماك والرش بمستخلص نبات عدس الماء تفوقاً معنوياً في معظم صفات النمو المقاسة مقارنة مع معاملة القياس، وأعطت المعاملة ET5 اعلى وزن للجذر بلغت 85.8 غم جذر$^{-1}$ مقارنة بمعاملة القياس.

الكلمات المفتاحية: الشوندر، الرسمدة، تدوير مياه الأسماك المهملة، رش مستخلص النباتات المائية.

INTRODUCTION

Beetroot, *Beta vulgaris*, belongs to the family Chenopodiaceae and is an important winter crop cultivated for its carbohydrate-rich roots, mineral elements, and vitamins. Its edible leaves are also nutritionally valuable, making all parts of the plant highly nutritious and valuable **(Al-Khafaji *et al*. 2022)**. Cultivated beets, including sugar beets, are economically important crops **(Yolcu *et. al.*, 2021)**. Recently, the strategic importance of beetroot as a source of extracted nitrates from various types of *Beta vulgaris* has been established for preserving and processing various meat products **(Munekata *et al.*, 2021)**. Furthermore, beetroot extract can be added to dairy products to enhance their functional properties, such as antioxidant activity during fermentation. The addition of liquid and dried beetroot extracts significantly improves the physicochemical properties of dairy products **(Flores-Mancha *et al.*, 2021)**. Several studies have been conducted to demonstrate the therapeutic efficacy of beetroot through highly active substances that enhance blood properties in humans **(Triana *et al.*, 2020)**. There are numerous untapped new water sources, one of which is the wastewater from fish farms **(Abdelaouf, 2017)**. The technology of integrating aquaculture with irrigation in agriculture relies on utilizing irrigation water storage ponds for aquaculture. This creates synergy in recycling fish wastewater rich in nitrogen and phosphorus compounds needed by plants. The wise use of water in arid and semi-arid regions is crucial for resource sustainability, and integrating aquaculture into irrigation seems to be an effective technique to conserve water, eliminate liquid waste from aquaculture, utilize it, and provide additional fertilizers for agricultural crops. However, agricultural production is threatened by population growth, shrinking arable land, and water scarcity in the face of climate change. Although aquaculture uses non-consumptive water, global climate change affects the availability of water for both aquaculture and agriculture, thereby impacting food production **(Mustapha and El Bakali, 2020)**. Aquaculture effluent contains a high concentration of nitrogen compounds (ammonia, nitrite, nitrate), phosphorus, and organic matter derived from feed residues and fish excreta **(Nasir *et al.*, 2015). Al-Zaidi (2021)** found increased vegetative growth indices and yield indicators in lettuce plants when irrigated with neglected water fish. There are not many studies on the effect of aquatic plant extracts on freshwater, except for a recent study on the potential biostimulant effect of Lemna minor on maize **(Del Buono, 2021).** Lemna minor, also known as water lens or duckweed, is a floating plant from the family Lemnaceae, widely distributed in lakes, wetlands, and ponds. It exhibits rapid growth and adapts well to adverse environmental conditions. Lemna minor is excellent in removing toxins from polluted water **(Panfili *et al.*, 2019)**. The family Lemnaceae is rich in metabolites known for their antioxidant and antibacterial properties **(Gülçin *et al.*, 2010)**. Moreover, Lemna minor has been recently found to contain high levels of phenolic acids, flavonoids, and phenolics **(Del Buono *et al.*, 2021)**. It serves as a habitat for small invertebrates, a food source for waterfowl, and a promising natural antioxidant **(Gülçin *et al.*, 2010)**. Water lens has been used in food packaging sector **(Luzi *et al.*, 2022)**, improving crop productivity and quality, enhancing plant resistance to drought and salinity **(Del Buono *et. al.*, 2021)**. The aim of this research is to enhance the growth and yield response of beetroot plants through irrigation with water and spraying of water lens plant extract as a biostimulant. Water lens, also known as Lemna minor, is a rapidly growing aquatic plant that serves as a food source for waterfowl and a habitat for small invertebrates. It is also considered a promising natural source of dietary antioxidants **(Gülçin *et al*., 2010). Regni *et al*. (2021)** found that treating olive seedlings in a hydroponic system resulted in increased leaf content of nitrogen, potassium, calcium, magnesium, iron, and zinc, while manganese, sodium, and copper content were unaffected. It also led to increased fresh and dry weight of leaves, stems, branches, and the number of leaves. Water lens is considered a high-quality forage **(Ullah *et al*., 2022)** and a biostimulant for legume crops. Mixing water lens with soil and using black tea infusion as a soil amendment led to improved growth indices and yield indicators in mung bean plants **(Al-Qaisi *et al*., 2019)**.

Therefore, the research aims to improve the growth and yield of beetroot plants by irrigating them with water fish and applying water lens plant extract as a biostimulant.

MATERIALS AND METHODS

The research was conducted in the fields belonging to the Department of Horticulture and Garden Engineering, College of Agricultural Engineering Sciences, University of Baghdad, Jadriya Campus, Station A, during the autumn season of 2022-2023. The beetroot variety used was Dark Red. The field soil was prepared for beetroot cultivation by plowing it with a moldboard plow, followed by harrowing with disc harrows and leveling with a leveling blade to achieve a smooth and homogeneous surface. The remnants of plant roots and bushes were then removed, and the seeds were sown on October 1, 2022.

The beetroot seeds were sown in plots, and the designated area was divided into three equal sections. Each section was further divided into twenty-five experimental units (25x3

repetitions), resulting in a total of 75 experimental units. The area of each experimental unit was 3 m² (1.5x2 m²). The seeds were sown in four rows with a spacing of 20 cm between rows and 15 cm between seeds within a row, with three repetitions. The number of plants per row was 12, resulting in a total of 48 plants per experimental unit.
A meter was used to measure the quantity of water fish applied as a factor in the study for irrigating the plots. The water fish was obtained from a specially designated pond, where carp fish were raised.

Table (1): Some chemical and physical characteristics of the experimental field soil.

Measured Characteristic		Value	Unit Measurement
EC 1:1		2.1	dS/m
pH 1:1		7.31	-
Available Nitrogen		26	mg/kg soil
Available Phosphorus		3.12	mg/kg soil
Available Potassium		222.56	mg/kg soil
Calcium Carbonate		226.41	g/kg
Organic Matter		7.6	g/kg
Dissolved Calcium (Ca+2)		16.59	meq/L
Magnesium (Mg+2)		9.38	meq/L
Sodium (Na+)		4.19	meq/L
Bicarbonate (HCO3)		1.6	meq/L
Dissolved Chloride		25.31	meq/L
Dissolved Potassium		1.7	meq/L
Soil Texture	Sand	476	g/kg soil
	Clay	264	
	Silt	260	
Soil Type Sand clay loam			

Table (2). The content of water lens plant extract of nutritional elements and chemical substances.

Amino Acid	Value (%)	Attribute (%)
Leucine	1.06	11.22 moisture
Arginine	0.71	23.75 protein
Valine	0.7	1.82 Fat
Lysine	0.68	1.64 Ash
Phynelalanine	0.61	14.16 crude fiber
Aspartic acid	2.43	58.65 Nitrogen
Glumatic acid	3.34	-
Serine	0.71	-

Table (3): Chemical analysis of the experimental fish water.

Property	Value	Measurement Unit
pH level	7.10	-
Electrical Conductivity	1.91	dS/m
Cations:		mmol/L
Calcium (Ca+2)	5.17	mmol/L
Magnesium (Mg+2)	3.23	mmol/L
Sodium (Na+1)	2.75	mmol/L
Anions:		mmol/L
Sulfate (SO-2)	7.14	mmol/L
Chloride (Cl-1)	5.04	mmol/L
Carbonate (CO3-2)	0.0	mmol/L
Sodium Adsorption Ratio (SAR)	0.95	$(mmol/L)^{0.5}$
Water Classification *	Classified according to the American Salinity Laboratory's classification system	-
Ammonium Ion (NH_4)	17	$mg.L^{-1}$
Nitrate Ion	8	$mg.L^{-1}$
Boron Ion	0.5	-

Table (4): Chemical Composition of Fish Feed Ingredients.

Property	Value (%)
N (Nitrogen)	3.1
P (Phosphorus)	0.97
K (Potassium)	1.83
C (Carbon)	68.6
C:N ratio	22.12
Zn (Zinc)	0.53
Fe++ (Iron)	0.72

The experiment included two factors:

Factor 1: Water fish Irrigation Concentration

- A-Control treatment: Irrigation with river water with recommended fertilization **(Al-Naimi, 1999)**.
- B-Irrigation with water fish at 25% concentration.
- C-Irrigation with water fish at 50% concentration.
- D-Irrigation with water fish at 75% concentration.
- E-Irrigation with water fish at 100% concentration.

Factor 2: Water Lens Plant Extract
- T1-Control treatment: Spraying with distilled water only.
- T2-Spraying with water lens plant extract at 0.25% concentration.
- T3-Spraying with water lens plant extract at 0.50% concentration.
- T4-Spraying with water lens plant extract at 0.75% concentration.

T5-Spraying with water lens plant extract at 1% concentration.

The water lens plant extract was prepared by collecting a quantity of water lens plant bushes from the Tigris River (Wasit Governorate) and sterilizing them using a 0.5% sodium hypochlorite solution for two minutes. Then, the bushes were washed twice with distilled water. A 10g portion of the dried bushes was taken and dried at a temperature of 40-45°C until a constant weight was achieved. Then, 1g of the dried bushes was mixed with 100ml of distilled water using either a mortar and pestle or an electric blender. The suspension was then placed in a shaker (100 cycles) for 24 hours. Afterward, the extract was filtered using a cloth and filter paper in a Büchner funnel to obtain the extract **(Panfili *et al*., 2019)**.

Measurement indicators:
1. Leaf Count (Number of leaves per plant).
2. Leaf Area (cm² per plant). It is calculated using the Digimizer software.
3. Chlorophyll Content in leaves (mg/100g fresh weight). **(Goodwin, 1976)**.
4. Percentage of Nutrient Content (N.P. K) in leaves. **(Cresser & Parson, 1979)**.
5. Plant Yield (g per root).

RESULTS AND DISCUSSION

The results in (Table, 5) the leaf count rate of beet plants indicate a significant effect of water fish treatments on the leaf count rate of beet plants. Treatment (E) showed a higher leaf count rate, with value of 41.80 number of leaves per plant^{-1}, compared to the control treatment (A) with rate value of 33.27 number of leaves per plant^{-1}, while the lowest rate was observed in treatment (B) with a value of 28.8 number of leaves per plant^{-1}. The treatments using water lens plant extract also had a significant effect, with treatment (T5) yielding the highest leaf count rate with the value of 41.13 number of leaves per plant^{-1}, and treatment (T1) showing the lowest rate with the value of 31.00 number of leaves per plant^{-1}. There was also a significant interaction between water fish treatments and water lens plant extract treatments. The results revealed that the highest interaction rate was observed in treatment (ET4) with the value of 49.33 number of leaves per plant^{-1}, while the lowest rate was observed in treatment (CT3), with the value of 24.67 number of leaves per plant^{-1}.

Table (5): Effect of water fish treatments, water lens plant extract treatments, and their interaction on the leaf count rate of beet plants (number of leaves per plant^{-1}).

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	27.67	27.67	29.33	35.67	46.00	33.27
B	29.00	27.00	31.67	25.00	31.33	28.80
C	29.67	39.33	24.67	37.33	40.67	34.33
D	34.67	27.33	40.67	31.67	44.33	35.73
E	34.00	37.67	44.67	49.33	34.33	41.80
L.S.D (0.05) for Interactionn	5.469					(L.S.D) at 0.05 for water fish fertigation concentrations
Irrigation rate with water lens plant extract	31.00	31.80	34.20	35.80	41.13	3.254
L.S.D (0.05) Concentrations of irrigation with waterLensplant extract	2.446					
A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.						

The results of (Table, 6) the leaf area of beet plants**,** indicate that the water fish concentration treatment had a significant effect on the leaf area of the plant. Treatment (E) showed the highest mean with the value of 49.28 dm²/plant^{-1}, compared to the control treatment (A), while treatment (B) had the lowest mean with the value of 32.68 dm²/plant^{-1} . As for the treatments with water lens plant extract, they also had a significant effect. Treatment (T5) resulted in the highest leaf area mean 52.34 dm²/plant^{-1}, compared to the control treatment (T1) with the value of 35.26 dm²/plant^{-1}, while the lowest mean for spraying with water lens plant extract was observed in treatment (T2) with the value of 35.20 dm²/plant^{-1}. The interactions between water fish concentration and spraying with water lens plant extract also had a significant effect on the leaf area of the sugar beet plant. Treatment (AT5) showed a significant superiority over the other treatments by yielding the highest mean, 64.43 dm²/plant^{-1} compared to the lowest mean in the control treatment (AT1), with value of 19.51 dm²/plant^{-1}.

Table (6): The effect of water fish irrigation and spraying with water lens plant extract, and their interaction, on the leaf area of beet plants (dm²/plant^{-1}).

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	19.51	35.09	35.22	45.69	64.43	39.99
B	28.73	26.53	37.72	32.53	37.88	32.68
C	34.91	43.54	32.89	53.76	48.44	42.71
D	47.19	36.90	54.20	44.64	57.02	47.99
E	45.95	33.96	52.23	60.31	53.95	49.28
L.S.D (0.05) Intraction	8.797					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	35.26	35.20	42.45	47.39	52.34	2.763
L.S.D (0.05) Concentrations of irrigation with waterLens plant extract	3.934					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

The results of (Table, 7) of the total chlorophyll content indicate a significant effect of water fish fertilization treatments on the chlorophyll content of beet leaves. Treatment (E) showed the highest chlorophyll content with the value of 149.0 mg/100g fresh weight, compared to the control treatment (A), which yielded the lowest, 96.4 mg/100g fresh weight. (Table, 7) shows that spraying of water lens plant extract had a significant effect, with treatment (T5) outperforming all other treatments by providing the highest value, 142.2 mg/100g fresh weight compared to the control treatment (T1), which had the lowest value of 102.8 mg/100g fresh weight. There was also a significant interaction between water fish fertilization and spraying of water lens plant extract on the chlorophyll content of the leaves. The highest chlorophyll content was observed in treatment (ET4) with a value of 207.0 mg/100g fresh weight, while the lowest chlorophyll content was found in the control treatment (AT1) with a value of 62.8 mg/100g fresh weight.

Table (7): The effect of water fish irrigation, spraying with water lens plant extract, and their interaction on the total chlorophyll content (mg/100g fresh weight) of beet plant leaves.

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	62.8	95.2	74.8	91.6	157.5	96.4
B	112.1	114.4	94.2	103.7	93.1	103.5
C	72.4	100.8	115.6	111.7	194.2	119.0
D	84.1	127.8	189.4	86.9	131.5	123.9
E	182.3	117.4	103.5	207.0	134.7	149.0
L.S.D (0.05) of Interactions	38.02					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	102.8	111.1	115.5	120.3	142.2	27.45
L.S.D (0.05) Concentrations of	17.00					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

The results from (Table, 8) the nitrogen percentage in beetroot plant leaves indicate a significant effect of the water fish fertigation treatments on the nitrogen percentage in the leaves. Treatment (E) with a value of 3.429 %, exhibited the highest nitrogen percentage compared to the control treatment (A) with a value of 2.830 %, while treatment (B) had the lowest percentage with a value of 2.783 %. Regarding the impact of the spraying with water lens plant extract, it was also found to be significant. Treatment (T4) showed a significantly higher nitrogen percentage with a value of 3.032 %, compared to control treatment (T1) with a value of 2.833 %, that had the lowest nitrogen percentage. The interaction between water fish fertigation treatments and spraying with water lens plant extract also had a significant effect on the nitrogen percentage in the plant leaves. Treatment (ET4) outperformed all other treatments by providing the highest nitrogen percentage 3.610 %, compared to the control treatment (AT1) with a value of 2.570 %, while treatment (CT1) had the lowest nitrogen percentage in the leaves valued 2.465 %.

Table (8): Effect of water fish fertigation, spraying with water lens plant extract, and their interaction on the nitrogen percentage in beet plant leaves.

Fertigation with water fish	**Spraying with water lens plant extract**					**Water fish fertigation rate**
	T1	T2	T3	T4	T5	
Control A	2.570	2.915	2.800	2.950	2.912	2.830
B	2.810	2.635	2.490	3.040	2.940	2.783
C	2.465	2.815	2.800	3.060	2.905	2.809
D	2.885	2.675	3.200	2.500	3.025	2.857
E	3.435	3.525	3.275	3.610	3.305	3.429
L.S.D (0.05) For Intraction	0.3256					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	2.833	2.912	2.913	3.032	3.018	0.1422
L.S.D (0.05) Concentrations of irrigation with water lens plant extract	0.1456					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

The rates in (Table, 9) indicate that the use of water fish fertigation led to a significant increase in phosphorus percentage. Treatment (E) showed the highest percentage of 0.3480 %, compared to the control treatment (A), which had the lowest percentage of 0.2920 %. As for the effect of spraying with water lens plant extract, it was found to be significant. Treatment (T3) yielded the highest phosphorus percentage of 0.3346 %, while the control treatment (T1) had the lowest percentage of 0.2936 %. The interaction between water fish fertigation and spraying with water lens plant extract also showed significant effects. Treatments (CT3) with a value of 0.4040 % outperformed control treatment (AT1) with a value of 0.2660 % in terms of phosphorus percentage, while the lowest phosphorus percentage of 0.2460 % was observed in treatment (AT4) in beet leaves.

Table (9): Effect of water fish fertigation, spraying with water lens plant extract, and their interaction on the phosphorus percentage in beetroot leaves.

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	0.2660	0.2810	0.3210	0.2460	0.3460	0.2920
B	0.2890	0.2540	0.3290	0.3190	0.3140	0.3010
C	0.2740	0.3090	0.4040	0.2690	0.2540	0.3020
D	0.2740	0.3290	0.2540	0.3090	0.3490	0.3030
E	0.3650	0.3500	0.3650	0.3500	0.3100	0.3480
L.S.D (0.05) interaction	0.04707					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	0.2936	0.3046	0.3346	0.2986	0.3146	0.04872
L.S.D (0.05) Concentrations of irrigation with water lens plant extract	0.02105					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

From the results of (Table, 10) of the potassium percentage in beet leaves it is evident that the treatments involving the use of water fish had a significant effect. Treatment (E) showed the highest percentage of 4.381 % compared to the control treatment (A) with a value of 3.858%, while treatment (B) exhibited the lowest percentage of 3.689 %. The table demonstrates the significant effect of applying a solution of water lens plant extract, as treatment (T5) significantly outperformed all other treatments by yielding the highest potassium percentage 4.006 %. Conversely, the control treatment (T1) had the lowest percentage of 3.721%. Furthermore, the interaction between the use of water fish and the foliar application of water lens plant extract had a significant effect. Treatment (ET1) yielded the highest percentage of 4.525 %, compared to the control treatment (AT1) with a value of 3.195%, while the lowest value of 2.890 % was observed in treatment (BT1).

Table (10): Effect of water fish irrigation, water lens plant extract spray, and their interaction on the potassium percentage in beet plant leaves.

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	3.195	3.875	4.0165	4.020	4.035	3.858
B	2.890	4.120	3.646	3.870	3.620	3.689
C	3.980	3.350	3.520	3.790	3.980	3.724
D	4.015	3.650	4.130	3.555	3.915	3.853
E	4.525	4.495	4.295	4.440	4.180	4.381
L.S.D (0.05) of interaction	0.3183					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	3.721	3.892	3.951	3.935	4.006	0.1525
L.S.D (0.05) Concentrations of irrigation with water lens plant extract	0.1423					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

The results of (Table, 11) of plant yield indicate a significant effect of water fish irrigation treatments on the weight of beet roots (plant yield). Treatment (E) exhibited the highest root weight with a value of 71.0 g per root^{-1}, compared to the control treatment (A), which yielded the lowest value of 38.0 g per root^{-1}. The table demonstrates that the application of water lens plant extract spray had a significant effect on plant yield, as treatment (T5) outperformed all other treatments by yielding the highest value of 64.4 g per root^{-1}, compared to the control treatment (T1) which yielded the lowest value of 46.1 g per root $^{-1}$. Furthermore, the interaction between water fish irrigation and water lens plant extract spray had a significant effect on plant yield, with the highest plant yield with a value of 85.8 g per root^{-1} observed in treatment (ET5) compared to the measurement treatment (AT1) which yielded the lowest value of 28.21 g per root $^{-1}$.

Table (11): The Effect of water fish Irrigation, water lens plant extract spray, and their interaction on plant yield (g per root^{-1}).

Fertigation with water fish	Spraying with water lens plant extract					Water fish fertigation rate
	T1	T2	T3	T4	T5	
Control A	28.2	45.8	28.2	44.5	43.2	38.0
B	28.8	60.0	38.8	67.5	45.0	49.8
C	60.0	52.5	57.0	58.8	81.0	64.0
D	50.0	55.0	60.6	67.4	58.0	58.2
E	63.2	45.8	84.5	78.2	85.8	71.0
L.S.D (0.05) Intraction	21.76					L.S.D (0.05) for water fish fertigation concentrations
Irrigation rate with water lens plant extract	46.1	51.8	55.9	63.3	64.4	18.65
L.S.D (0.05) Concentrations of irrigation with water lens plant extract	9.73					

A: Control treatment (Measurement)., B: Water fish concentration of 25%, C: Water fish concentration of 50%, D: Water fish concentration of 75%, E: Water fish concentration of 100%. T1: Comparative treatment (Spraying with distilled water only)., T2: Concentration of water lens plant extract at 0.25%., T3: Concentration of water lens plant extract at 0.50%., T4: Concentration of water lens plant extract at 0.75%., T5: Spraying with water Lens plant extract at 1% concentration.

Plants supplied with abundant nitrogen tend to increase the number and size of leaf cells, resulting in an increase in leaf surface area. This finding is consistent with the study conducted by **Akinwole *et al*. (2015)**, which revealed that water fish irrigation enhances soil fertility and nutrient availability, leading to improved vegetative growth of plants. Water fish is rich in organic matter and nutrients **(Ghanbari *et al*., 2007)**, which improve the physical, chemical, and biological properties of the soil by increasing its surface area and aeration. Consequently, this raises the temperature within the root zone, resulting in increased nutrient uptake and positive effects on plant growth **(Al-Halfi and Al-Azzawi. 2022)**. Additionally, the increase in organic matter in the soil releases nutrients that play a crucial role in plant growth and development **(Salman and Hussein. 2023)**.

CONCLUSIONS

From the results of (Table, 3), it is evident that the water fish treatment outperformed the control treatment in terms of studied vegetative growth characteristics (chlorophyll content), especially at a concentration of 100% E. This can be attributed to the presence of macro and micronutrients in fishpond water, such as nitrogen, phosphorus, and potassium, which promote vegetative growth. Furthermore, the application of lens plant extract at different concentrations improved chlorophyll content in the leaves due to the presence of amino acids, which are essential for chlorophyll synthesis **(Haronn, 2002)**. The presence of chloromate acid in this extract also contributes to chlorophyll synthesis. Moreover, the high-water content in fishponds, which is rich in nutrients and organic matter, increases nutrient availability and absorption by plants, as well as improves soil structure, moisture retention, and aeration. This provides a suitable environment for root growth and enhances nutrient uptake by the roots **(Shayaa & Hussein, 2019; Al-Hlfie, 2020).**

The abundance of readily available nitrogen throughout different growth stages contributes to balanced nutrient uptake by the plants, as water contains nitrogen elements. This led to an increase in phosphorus content, as water containing phosphorus leads to the release of organic acids that dissolve primary minerals and phosphate compounds, resulting in increased phosphorus availability and accumulation in the plant. Organic acids, such as humic and fulvic acids, facilitate the release of potassium and other elements from soil minerals in the root zone, aiding their absorption by plants **(Ramadan, 2015)**. The increase in the NPK content in beet leaves when treated with lens plant extract indicates the success of foliar (spraying) fertilization, which positively influenced the concentration of these elements within the leaves **(Al-Khafaji *et al*., 2022).** Therefore, there was a clear response in the beet yield, specifically root weight, to increasing levels of fishpond water irrigation, which led to increased vegetative growth and positively affected yield characteristics (**Akinwole *et al*., 2015, Abid and Hussein, 2021**). Fishpond water irrigation increased nutrient availability, reduced losses, enhanced plant utilization, and ensured the supply of necessary elements, resulting in vigorous vegetative growth and a good root yield.

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