Role of Irrigation with fish pond water and Zeolite addition on Growth and Production of two hybrids of Cabbage plant *Brassica oleracea* var. Capitata

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DOI: https://doi.org/10.36077/kjas/2025/v17i2.13617

Received date: 9/10/2023

Accepted date: 6/11/2023

Abstract

The study was conducted during the winter agricultural season of 2021-2022 in a field located in the Najaf province to study the effect to three factors on growth and production of to two hybrids of cabbage plant. The experiment included three factors. The first factor was two hybrids of the cabbage plant including the red Cabbage hybrid (Glope Star F1) and the white Cabbage hybrid (Cabbage Liza F1). The second factor was irrigation with three concentrations of with fish pond water including 0, 50, and 100%. The third factor was the addition of three zeolite levels: which were 0, 10,and 20 g plant^{-1}. The results showed that the white cabbage hybrid was significantly superior in terms of average of head weight, recording 1204.40 g and the total yield of 40.15 ton ha^{-1} compared to the red cabbage hybrid. The results also showed that irrigation with fish pond water at a concentration of 100% was superior in increasing both plant height and the leaf area reaching 22.31cm and 162.43 cm^2 leaf^{-1} compared to untreated plants. The results showed that adding zeolite at the level of 20 g plant^{-1} was significantly superior in giving the highest average of dry weight of the shoot reaching to 717.10 g plant^{-1}. The results documented the triple interactions between the white cabbage hybrid, irrigation with 100% fish pond water, and the addition of zeolite at a level of 20g. increases both plant height to 25.03 cm and the leaf area to 168.63 cm^2 Leaf^{-1}. The interactions recorded 958.90 g of dry weight of the shoot, 19.70 cm diameter of the head, 1685 g the average weight of the head, and 56.18 ton ha^{-1} total yield.

Keyword: Cabbage , irrigation ,zeolite, growth parameter.

Introduction

Cabbage (*Barassica oleracea*) represents one of the oldest and most important plants because of its nutritional and medicinal value, as its cultivation areas have increased widely as a result of the increase in the number of workers in the field and because the cabbage contains distinct nutritional elements. This has led to its widespread throughout the world and plays a great and important role in human nutrition (15). Each 100g of fresh leaves of the cabbage plant contains 88.8-93.0% water, 6.1-11.2% dry matter, 3-5.4% carbohydrates, 1-2% proteins, 0.2% fat, 49 mg phosphorus, 238 mg potassium, 12 mg iron, 9 mg magnesium, 30-50 mg vitamin C, 0.05 mg thiamine, 130 IU vitamin A, and 24 calories (9) .Cabbage also has the ability to be stored in refrigerated warehouses while preserving its nutritional properties, which makes it possible to use it throughout the year. This provides a service to communities because cabbage cannot be grown throughout the seasons of the year, and it has contributed to improving human nutritional conditions, especially in winter (11) , Agricultural production is threatened by population growth, shrinking arable land, and water scarcity under the influence of climate change. To ensure food security for the population, there is a need for sustainable agricultural innovations to meet future food needs. Agricultural systems need to develop in a way that leads to improve efficient use of water to ensure food security and improve plant productivity while ensuring the sustainability of agricultural production. In addition, aquatic organisms waste non-consumed water, which affects climate change as a result of its use in aquaculture and agriculture, which affects food security due to water scarcity. Therefore, it is necessary to search for new technologies or ways to efficiently use water in agriculture, on the one hand, and integrate aquaculture into irrigation, on the other hand, The open-system food production technology that integrates aquaculture with irrigation in agriculture relies on exploiting irrigation water storage basins for livestock rearing. Aquatic waste will create a synergy for recycling liquid fish waste, which is rich in nitrogen and phosphorus, which plants need, it can rationalize water in arid and semi-arid lands to sustain resources, use the water consumed in aquaculture for irrigation to save water, eliminate contaminated water, and exploit it as fertilizer for growing crops, as it is the biggest challenge facing farmers' water shortages and diversifying their animal productivity and vegetarianism (19) .

To achieve food security goals and confronting the threat of climate change, there is a need to transform and adapt agricultural systems that require less water resources, especially in arid and semi-arid areas, as a result, sustainable agriculture is at the heart of the 2030 global agenda to encourage the optimal use of natural resources including land and water in sustainable agriculture, because it depends on healthy ecosystems and the preservation and sustainable management of freshwater aquatic ecosystems (13). In the context of increasing pressure on natural resources and land exacerbated, the technology of combine irrigation using fish pond water provides new opportunities to

build more sustainable food systems through new practices that allow the production of vegetables and fruits in addition to fish (12).In the recent years, interest has begun to study the level of nitrates in soil, water, and plants, and their accumulation in vegetable plants which affects human health as a result of the nitrates being transformed into nitrites, which affects human. Also, their presence in these crops at a level higher than what is permitted by international organizations causes serious diseases, also zeolite helps reducing the accumulation of nitrate and nitrite in plant tissues, and it binds to nitrogen and other elements selectively because it carries negatively charged molecules (8).

Zeolites are natural minerals (hydrated silicates) and are mainly composed of aluminum silicates with sodium and calcium. Their hardness ranges between 3.5 - 5.5, and their specific gravity ranges between 2.0 - 2.4. Natural zeolite minerals, volcanic tuff rocks, are found in different colors such as green, light green, yellowish green, and yellowish white. They are also found within the voids of basalt rocks and are characterized by their transparency or white color. Seven groups were found, such as Analcime, Chabazite , gismondine,Heulandite, Harmontome and Stilbite (7) . Zeolite has an absorptive property by absorbing water presented in the soil to give it to the plant when it needs it. It maintains a constant level of humidity and reduces the risk of it rising. Thus, it prevents root rot and reduces dehydration, which helps the plant adapt to the dry and humid environment. Most studies have confirmed that zeolite has the ability to retain moisture at a rate of up to 50% and nutrients in the root area for a long period of time, in addition, it gradually releases it according to the plant's needs. This reduces the consumption of irrigation water and the amount of fertilizers (21).

1- Explaining the role of irrigation with fish pond water in the growth of two cabbage hybrids and its effect on vegetative and yield indicators.

2- evaluating the effect of adding zeolite and its effects on some vegetative indicators and yield.

Materials and Methods

The research was carried out in the Horticulture and Forestry Division / Najaf Agriculture Directorate during the winter agricultural season of 2021-2022. The seeds were planted in September in cork dishes, then the seedlings were transferred to the permanent field after they reached the stage of 3-4 true leaves. In order to study some physical and chemical characteristics, soil samples were taken before planting at a depth of 0-30 cm, from different locations in the field. Then, soil samples were mixed homogeneously and exposed to the sunlight for 24 hours. After that, Soil was sieved with 2 mm holes sieve. Then, one sample was randomly taken for tests in the Laboratories of the Najaf Agriculture Directorate. Table 1 shows the results of laboratory analyses of field so the field soil allocated for the study was prepared using manual agricultural tools after removing the growing plants and bushes.

Then the process of plowing, smoothing, and leveling was done homogeneously. The land was then divided into three blocks or replication, each block included 18 experimental units. Thus, the total number of experimental units to 54 units, and each included 10 plants. The distance between one plant and another was 0.3 m. The area of the experimental unit was 1.5 m^2, with dimensions of 3 x 0.5 m (length x width), and the distance between one platform and another was 1 m, leaving a distance of 1 m between the units to prevent confusion between treatments.

Drip irrigation system was installed and distributed among all experimental units according to the design for irrigation treatments in fish ponds. An incision was also made with a depth of 0.75 m and a width of 0.5 m to prevent irrigation confusion between the experimental treatments.

The experiment was carried out as a 2×3×3 factorial experiment using a Randomized Complete Block Design according to the Split-Split Plot system with three replicates, The hybrids represented the main plots, irrigation with fish pond water was in the secondary plots (Sub-Plot), and the addition of zeolite was in Sub-Sub-plot. So, and the averages were compared according to the Least Significant Differences Test (LSD) at the probability level of 0.05 using the Gen-static statistical analysis program.

The first factor including: two cabbage hybrids were the red cabbage is Globe star F1 and its symbol is V1, and the white cabbage is Liza F1 and its symbol is V2.

The second factor was irrigation with fish pond water that was prepared for destruction. irrigation was implemented by a drip system, as fish pond water was stored in a water tank made of polyethylene with a capacity of 10,000 liters, The fish pond water concentrations include:

1- Irrigation with 0% fish pond water(ordinary irrigation water), symbol F0.

2- Irrigation with fish pond water at a concentration of 50% and symbol F1.

3- Irrigation with fish pond water at a concentration of 100% and symbol F2.

Dilutions were made using ordinary irrigation water

The third factor includes three additions of zeolite at the level of comparison treatment without addition and its symbol is Z0, addition is 10 g $Plant^{-1}$, which symbol was Z1 and 20 g $Plant^{-1}$, which symbol was Z2.

Table 1. Some physical and chemical characteristics of the field soil before planting.

Dismissed	Unit	Quantity
Clay	%	2.8
Silt	%	9.2
Sand	%	88

Soil texture	sandy	
Quantity	Unit	Properties
EC	Decismens. M^{-1}	3.8
pH	7.7	
Nitrogen availability	%	39.4
phosphorus availability	%	8.1
Potassium availability	$Mg.kg^{-1}$	233
Organic matter	%	0.1

Table 2. Content of some nutritional elements in fish pond water

Unit	Quantity	Element
%	21	N
	13	P
	11.7	K
	90	Ca
$Mg.L^{-1}$	43.2	Mg
	0.03	Mn
	0.017	Cu
	0.95	Fe
	0.22	Zn
	30	NH_4
	96	NO_3
	357.78	Ascorbic acid
ds/m^{-1}	2870	EC
----	6.8	pH

Results and Discussion

Plant height (cm)

The results of Table (3) showed the significant superiority of the white cabbage hybrid regarding the plant height. It gave the highest average plant height of 20,400 cm compared to the red cabbage hybrid which gave the lowest average plant height of 20.00 cm.Regarding irrigation with fishpond water, the significant superiority of irrigation with fishpond water at 100%. it gave the highest average plant height of 23.31 cm compared to the comparison control which gave the lowest average plant height of 17.44 cm. The addition of zeolite at a level at 20 g plant^{-1} significantly increased the height of the plant reaching 21.44 cm compared to the untreated plants which gave the lowest average height of 18.61 cm. Regarding the triple interaction between the experimental factors, the interaction of the V2W2Z2 treatment gave the highest rate of plant height of 25.03 cm compared to the triple interaction of the V1W0Z0 treatment, which gave the lowest rate of 15.67 cm. In addition, the treatment of V2W2Z2 was not significantly different from V1W0Z0 treatment which scored 24.83 cm.

Table 3. Effect of hybrids, irrigation with fish pond water, the addition of zeolite, and interactions between them on plant height (cm)

Hybrid	Levels of zeolite g plant^{-1}	Irrigation with fish pond water			V*Z) Hybrid x addition of zeolite (V*Z)	Hybrid means
		W0 / 0%	W1/ 50%	W2 / 100%		
The red cabbage (V1)	Z0	15.67	18.47	21.67	18.60	20.00
	Z1	17.67	19.67	23.67	20.33	
	Z2	19.00	19.33	24.83	21.06	
The white cabbage (V2)	Z0	16.17	18.33	21.33	18.61	20.40
	Z1	17.83	21.10	23.33	20.76	
	Z2	18.33	22.13	25.03	21.83	
	$LSD_{(V \times W \times Z)}$ =0.82				$LSD_{(VxZ)}$= N.S	LSD $_{(V)}$ = 0.20
(v*w) Hybrids × irrigation with pond water			Irrigation with pond water × addition of (Z*W) zeolite			
Percentage of fish pond water	The red cabbage	The white cabbage	Z0	Z1	Z2	The mean irrigation with fish pond water

W0	17.44	17.44	15.92	17.75	18.67	17.44
W1	19.16	20.52	18.40	20.38	20.73	19.84
W2	23.39	23.23	21.50	23.50	24.93	23.31
$LSD_{(V\times W)}$ =0.41			$LSD_{(W\times Z)}$=N.S			$LSD_{(W)}$=0.35
The mean of zeolite addition $LSD_{(Z)}$=0.35			18.61	20.54	21.44	

Leaf area (cm^2 $leaf^{-1}$): The results of Table (4) showed that the two hybrids differed significantly in leaf area. The White cabbage hybrid was significantly superior in average leaf area (160.27 cm^2 $leaf^{-1}$) compared to the red cabbage hybrid which gave the lowest rate of 156.46 cm^2 $leaf^{-1}$. the significant superiority of the irrigation treatment with fish pond water at 100% concentration was recorded, which gave the highest average leaf area of 162.43 cm^2 $leaf^{-1}$ compared to the comparison treatment which gave the lowest rate of 154.13 cm^2 $leaf^{-1}$.The zeolite treatment at a level of 20 g $plant^{-1}$ was significantly superior in giving the highest average leaf area of 159.72 $cm^2.leaf^{-1}$ compared to the comparison treatment which gave the lowest rate of 157.14 cm^2 $leaf^{-1}$.As for the triple interaction, the interaction of the V2W2Z2 treatment was significantly superior. It gave the highest average leaf area of 168.63 cm^2 $leaf^{-1}$ compared to the treatment of V1W0Z0 which gave the lowest rate of 151.14 cm^2 $leaf^{-1}$.

Table 4. Effect of the hybrids, irrigation with fish pond water, the addition of zeolite, and their interactions on leaf area ($cm^2.leaf^{-1}$)

Hybrid	Levels of zeolite g $plant^{-1}$	Irrigation with fish pond water			V*Z) Hybrid x addition of zeolite (V*Z)	Hybrid means
		W0 / 0%	W1/ 50%	W2 / 100%		
The red cabbage (V1)	Z0	151.14	156.53	158.32	155.33	156.46
	Z1	154.27	155.84	160.19	156.77	
	Z2	155.01	157.88	158.98	157.29	
The white cabbage (V2)	Z0	154.60	158.91	163.34	158.95	160.27
	Z1	153.85	160.14	165.11	159.70	
	Z2	155.87	161.97	168.63	162.16	
	$LSD_{(V\ x\ W\ x\ Z)}$ =2.45				$LSD_{(V\ x\ Z)}$=N.S	$LSD_{(V)}$ =2.29
(v*w) Hybrids × irrigation with pond water			Irrigation with pond water × addition of (Z*W) zeolite			

Percentage of fish pond water	The red cabbage	The white cabbage	Z0	Z1	Z2	The mean irrigation with fish pond water
W0	153.48	154.78	152.87	154.06	155.44	154.13
W1	156.75	160.34	157.72	157.99	159.92	158.54
W2	159.16	165.70	160.83	162.65	163.80	162.43
$LSD_{(V\times W)}$ =1.80			$LSD_{(W\times Z)}$=N.S			$LSD_{(W)}$=1.01
The mean of zeolite addition $LSD_{(Z)}$=0.97			157.14	158.23	159.72	

Head diameter (cm): The results in Table (5) showed significant differences between the two hybrids in head diameter. The white cabbage hybrid was significantly superior, giving the highest head diameter average of 17.93 cm compared to the red cabbage hybrid which gave the lowest average of 15.65 cm. the results of irrigation with fish pond water at a concentration of 100% showed significant superiority. It gave the highest head diameter of 17.83 cm compared to the comparison treatment which gave the lowest average of 15.67 cm. Adding zeolite at a level of 20 g plant-1 significantly increased head diameter. It gave 17.21 cm compared to the comparison treatment which gave the lowest rate of 16.37 cm. the triple interaction recorded significant superiority regarding the leaf area. The interaction of the V2W2Z2 treatment gave the highest head diameter of 19.70 cm compared to the triple interaction of the V1W0Z1 treatment which gave 14.50 cm.

Table 5. Effect of hybrids, irrigation with fish pond water, the addition of zeolite, and their interactions on head diameter (cm)

Hybrid	Levels of zeolite g plant^{-1}	Irrigation with fish pond water			V*Z) Hybrid x addition of zeolite (V*Z)	Hybrid means
		W0 / 0%	W1/ 50%	W2 / 100%		
The red cabbage (V1)	Z0	14.52	15.50	16.20	15.41	15.65
	Z1	14.50	15.57	16.57	15.54	
	Z2	15.30	15.93	16.77	16.00	
The white cabbage (V2)	Z0	15.67	17.57	18.77	17.33	17.93
	Z1	17.00	18.20	18.97	18.06	
	Z2	17.03	18.50	19.70	18.41	

	$LSD_{(V \times W \times Z)}$ =0.48			$LSD_{(VxZ)}$=0.27		$LSD_{(V)}$ =0.27
Hybrids × irrigation with pond water (v*w)			Irrigation with pond water × addition of (Z*W) zeolite			
Percentage of fish pond water	The red cabbage	The white cabbage	Z0	Z1	Z2	The mean irrigation with fish pond water
W0	14.77	16.57	15.10	15.75	16.17	15.67
W1	15.67	18.09	16.53	16.88	17.22	16.88
W2	16.51	19.14	17.48	17.77	18.23	17.83
$LSD_{(V \times W)}$ =0.30			$LSD_{(W \times Z)}$=N.S			$LSD_{(W)}$=0.24
The mean of zeolite addition $LSD_{(Z)}$=0.20			16.37	16.80	17.21	

Head weight (g): The results of Table (6) showed significant differences between the two hybrids in the average head weight, as the white cabbage hybrid excelled by giving the highest average head weight of 1204.40 g head^{-1} compared to the red cabbage hybrid which scored the lowest average of 0630.1 g head^{-1}.Irrigation with fish pond water at a concentration of 100% was significantly superior in giving it the highest rate of head weight of 1,170.1 g head^{-1} compared to the control treatment which gave the lowest rate of 654.00 g head^{-1}**.** The addition of zeolite at a level of 20 g plant^{-1} was significantly superior in terms of average head weight. It gave 1015.60 g compared to the control treatment which gave the lowest rate of 821.90 g. The triple intervention of V2W2Z2 had a significant superiority in giving the highest rate of average head weight of 1685.30 g head^{-1}compared to the triple intervention of the V1W0Z0 which gave the lowest rate of 439.30 g head^{-1}.

Table 6. Effect of hybrids, irrigation with fish pond water, the addition of zeolite, and their interactions on average head weight (g)

Hybrid	Levels of zeolite g plant^{-1}	Irrigation with fish pond water			V*Z) Hybrid x addition of zeolite (V*Z)	Hybrid means
		W0 / 0%	W1/ 50%	W2 / 100%		
The red cabbage (V1)	Z0	439.30	566.70	721.30	575.80	630.10
	Z1	466.30	634.00	733.30	624.60	
	Z2	522.00	674.30	873.70	690.00	
The white cabbage	Z0	642.30	1117.70	1444.30	1068.10	1204.40
	Z1	842.70	1246.70	1522.70	1204.00	

(V2)	Z2	1011.30	1326.70	1685.30	1341.10	
	$LSD_{(V \times W \times Z)}$ =30.49				$LSD_{(VxZ)}$=30.17	$LSD_{(V)}$=38.68
Hybrids × irrigation with pond water (v*w)			Irrigation with pond water × addition of (Z*W) zeolite			
Percentage of fish pond water	The red cabbage	The white cabbage	Z0	Z1	Z2	The mean irrigation with fish pond water
W0	475.90	832.10	540.80	654.50	766.70	654.00
W1	625.00	1230.30	842.20	940.30	1000.50	927.70
W2	789.40	1550.80	1082.80	1148.00	1279.50	1170.10
$LSD_{(V \times W)}$=32.77			$LSD_{(W \times Z)}$=15.09			$LSD_{(W)}$=7.49
The mean of zeolite addition $LSD_{(Z)}$=9.71			821.90	914.30	1015.60	

Total yield (ton ha^{-1})

The results of Table (7) indicated that the two hybrids differed significantly in the total yield. The white cabbage hybrid excelled significantly by giving the highest rate of 40.15 ton.ha^{-1} compared to the red cabbage hybrid which gave the lowest rate of 21.00 ton ha^{-1}.The irrigation treatment with fish pond water at a concentration of 100 % was significantly superior in giving it the highest total yield of 39.00 ton ha^{-1}, compared to the comparison treatment which gave the lowest rate of 21.80%. The zeolite addition treatment at a level of 20 g plant^{-1} was significantly superior by giving it the highest rate of total yield of 33.85 ton ha-1 compared to the control treatment which gave the lowest rate of 27.40 ton ha^{-1}. The triple interaction of V2W2Z2 was significantly superior in giving the highest total yield rate of 56.18 ton ha^{-1} compared to V1W0Z0 treatment, which gave the lowest rate of 14.64 ton ha^{-1}.

Table 7. Effect of hybrids, irrigation with fish pond water, the addition of zeolite, and interactions between them on total yield (tonha^{-1})

Hybrid	Levels of zeolite g plant^{-1}	Irrigation with fish pond water			V*Z) Hybrid x addition of zeolite (V*Z)	Hybrid means
		W0 / 0%	W1/ 50%	W2 / 100%		
The red cabbage	Z0	14.64	18.89	24.04	19.19	21.00
	Z1	15.54	21.13	25.78	20.82	

(V1)	Z2	17.40	22.48	29.12	23.00	
The white cabbage (V2)	Z0	21.41	37.26	48.14	35.60	40.15
	Z1	28.09	41.56	50.76	40.13	
	Z2	33.71	44.22	56.18	44.70	
	$LSD_{(V \times W \times Z)}$ =1.02				$LSD_{(VxZ)}$=1.01	LSD $_{(V)}$ =1.29
(v*w) Hybrids × irrigation with pond water			Irrigation with pond water × addition of zeolite (Z*W)			
Percentage of fish pond water	The red cabbage	The white cabbage	Z0	Z1	Z2	the mean irrigation with fish pond water
W0	15.86	27.74	18.03	21.82	25.56	21.80
W1	20.83	41.01	28.07	31.34	33.35	30.92
W2	26.32	51.69	36.09	38.27	42.65	39.00
$LSD_{(V \times W)}$ =1.09			$LSD_{(W \times Z)}$=0.50			$LSD_{(W)}$=0.25
the mean of zeolite addition $LSD_{(Z)}$=0.32			27.40	30.48	33.85	

The results shown in the tables above indicate that hybrids have a significant effect on vegetative growth and yield indicators. This is attributed to the variation in the genetic composition of these hybrids, as the genes of each hybrid were expressed in a different way from the other hybrid. In addition, the interaction of genetic factors with the surrounding environment affected the performance of the hybrids. Quantitative properties are controlled by a large number of genes, and the effect of these properties is considered a secondary type, which makes them greatly influenced by the environment. This creates a secondary effect on the performance of hybrids resulting from the interaction between environment and genes, which increases the presence of dormant genes. The effect of these genes can appear in a specific environment called the gene-environment (18). Also, the growth requirements of hybrids and their adaptation to environmental conditions increase the efficiency of the photosynthesis process, the accumulation of synthesis nutrients, and increase in the strength of vegetative and root growth (3). This is consistent with what was found by Al-Khikani (2) , and Al-Shammari *at al* (5) and also with Saeed and Harith (22), as they confirmed that the genetic composition has a significant effect on the indicators of vegetative growth and the outcome of cabbage.

Irrigation with fish pond water was significantly superior regarding the vegetative growth and yield indicators. The reason may be due to the role of macro- and micronutrients contained in fish pond water (Table 2) as it is a source of the most important elements such as nitrogen, phosphorus, and potassium, and increasing them may encourage the plant to increase vegetative

growth. Or, nitrogen is involved in the synthesis of many important organic compounds. Its importance lies in improving the characteristics of vegetative growth and yield that occur within plant tissues, as it contributes to many vital activities and stimulates enzymatic systems and enzymatic chaperones, as well as the Purine and Pyrimidine bases, in addition to increase the formation of nucleic acids (DNA and RNA) (17 and 14). It stimulates the plant to produce plant hormones, such as auxins, gibberellins, cytokinins, and synthetic proteins, which encourages the process of cell division and elongation (4). This was reflected positively in increasing the plant height (Table 3), and the leaf area. (Table 4) (23 and 16).Phosphorus also plays an important role in enzymatic reactions and cell division to carry out the process of carbon synthesis. In addition, it has a vital role in the formation of ATP, which transfers energy and thus increases the efficiency of photosynthesis and then increases the size and number of cells, which is reflected in an increase in vegetative growth indicators and yield and. Potassium contributes to the transport of metabolic products, which leads to an increase in vegetative growth and yield (23). The reason may be due to its major effect in the levels of nitrogen in the plant, or the increased absorption of Fe, Zn, and S, which led to an increase in the chlorophyll content in the plant, which was reflected in positively in increasing the size of the vegetative total and leaf area (10). These results agreed with what was found by Al-Zaidi (6) who found that irrigation with fish pond water increases soil fertility and increases the readiness of in lettuce plants. This improves the characteristics of vegetative growth and yield because it is rich in organic matter and nutrients. Organic materials contribute to improving the physical, chemical, and biological characteristics of the soil, which increases its porosity and aeration and raises the temperature of the root growth media. thus, it increases the absorption of water and nutrients and reflects positively on indicators of vegetative growth and yield.

The results presented in the tables showed that zeolite had a significant effect on the characteristics of vegetative growth and yield of the cabbage plant. This is may be due to the role of zeolite in maintaining the quality of the soil, as it prevents soil clumping by increasing aeration in the root growth medium and increasing its porosity (20), which leads to create a good growth environment for roots.

This had a positive impact on the characteristics of vegetative growth and yields. Zeolite contributes to the stability of organic matter and prevents its loss through the washing process or other loss processes by capturing the necessary elements and releasing them when the plant needs them in batches, which enhances the growth of the plant. This agrees with the finding of Al-ibrameemi (1).

Conclusion

The results showed that irrigation with Irrigation with fish pond water (100%) was significantly increasing plant height and leaf area, while the triple interaction between Liza F1 variety, irrigation with fish pond water, and adding zeolite at a rate of 20 g plant^{-1} showed a significant effect on increasing plant weight, which was positively reflected in increasing the total yield rate.

Conflict of interest

The authors declare no conflict of interest.

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