Effect of Mulching Soil and foliar Addition of Nano-Zinc on the chemical characteristic of hybrid of Red Cabbage Brassica oleracea var. capitata L.

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Abstract:
The experiment was conducted at the Agricultural Research Center of the Department of Horticulture and Landscape Engineering/College of Agriculture/Tikrit University for the agricultural season 2023-2024. With the aim of the effect of mulching red, silver, black, without mulching and addition foliar with Nano-zinc oxide at concentrations (0, 50, 100) mg L-1 For study the chemical on the chemical characteristics of the HANNAR hybrid of red cabbage. The experiment was designed with a split-plot system, according to a randomized complete block design (RCBD), with three replications, and the means were compared according to the Duncan polynomial test at the 5% probability level. The results showed that silver mulch was significantly superior in the percentage of nitrogen (N), the percentage of proteins, the concentration of anthocyanin pigment and nitrates in the heads, and the percentage of ascorbic acid. However no significant differences were recorded in the percentage of Elements phosphorus (p) and (k)) with black mulch. Compared to black mulch was superior in the percentage of zinc in the leaves (Zn), Spraying at a concentration of 50 mg L-1 gave a significant increase in the percentage of phosphorus and potassium, the concentration of anthocyanin pigment, nitrates, and the percentage of ascorbic acid. While the interaction (BZ50) recorded the highest value of the element (P) with an increase of 152.94%, while the binary interaction (BZ100) gave the highest value in the percentage of the element zinc in the leaves (Zn) which reached13.44 mg kg-1 compared to (RZ0. (

Keywords: Silver mulch, Nano-zinc oxide, chemical characteristic, Red cabbage.

Introduction:

Red Cabbage, which belongs to the cruciferous s family Brassicacea (Cruciferae), and whose e scientific name is Brassica oleracea var. capitata forma rubra L. is considered one of the desirable winter vegetables in Iraq. It grows in relatively cold and humid weather. Its original habitat is east of the Mediterranean Sea. The red cabbage is grown in order to obtain the heads that are Composed as a result of the leaves wrapping around the enlarged terminal bud and are the part of the plant that is consumed. Each 100 gm contains Of fresh leaves, it contains 6.2-11.2% dry matter, 1-2 proteins, 3-5.4% carbohydrates, 30-50 mg vitamin C, 130 IU vitamin A, 49 mg phosphorus, 238 mg potassium, 1.2 mg iron, 9 mg magnesium, and 24 calories. From a nutritional and therapeutic, Studies have confirmed that Red cabbage cleanses the liver and digestive tract and reduces obesity due to its ability to dissolve fats in the body and cholesterol and balance pressure and sugar[5], treating stomach and duodenal ulcers and strengthening the Immune system [11,12]. Soil mulching is known as one of the important agricultural operations in the commercial production of vegetables in most parts of the world, and mulches made of polyethylene (plastic mulches) in particular, which are available in different types and

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colors and are characterized by their lightly weight, flexibility, free of odors and toxic substances, And it can be transported easily of being easily transported . It is easily from one area to another, and the process of Brush it on the ground is carried out easily and conveniently, and it has different effects on soil conditions, as it is used to increase yields, improve crop quality reduce water consumption, protect roots in freezing weather, enhance the content of organic matter, improve the physical properties of the soil, and avoid jungle and harmful weeds that grow in Soil [16], The use of modern nanotechnology, which has the ability to produce Extremely small particles of various elements and provides more benefits than ordinary molecules. Its use has spread in many fields, including agriculture, by producing Nano-fertilizers and fertilizers, which are either added to the soil to improve the properties of the soil. And increase its fertility or spray it on the plant [18]. Zinc is one of the micronutrients that the plant needs in small quantities, and there are those that are considered the fourth most important nutrient that affects yield after nitrogen, phosphorus, and potassium [11].It is one of the nutrient elements that has a role in activating a number of enzymes that are involved in the building process of photosynthesis, and also has an important role in increasing the production of chlorophyll and starch and increasing the plant's resistance to various pathogens [15.[

studies investigated that were conducted on the effect of mulching the soil with plastic mulch on the chemical characteristics were in a study conducted by [17] to test three treatments of mulching the soil with plastic mulch of the squash plant Cucurbita pepo, where the results showed superiority of the treatment with black geotextile mulch in both characteristics and the percentage of nitrogen in the leaves. It reached 2.669%, phosphorus reached 0.414%, potassium reached 3.172%, and the leaves' content of Zinc reached 63.46 mg kg-1, and the highest chlorophyll content in the leaves reached 67.00 mg 100 g-1.

[4]reported the results related to the use of different concentrations of nano-zinc oxide (100,50,0) mg L-1 on cauliflower plants and their effect on the chemical characteristics, where the treatment with concentrations (50 and 100) mg L-1, which did not differ significantly, was higher. The percentage of nitrogen concentration in the leaves before the formation of heads is 5.05% and 4.62% over Respectively, the treatment with a concentration of 50 mg L-1 gave the highest values in the percentage of potassium and phosphorus in the leaves before the formation of heads, reached 4.76% and 0.510%, respectively. The highest percentage of zinc in the leaves before the formation of heads was 116.64 mg kg-1.

Due to the absence of any published studies on the use of silver mulch (reflective) in Tikrit Governorate, the role and needs of the plant for the element zinc, and determine the best concentration of Nano-zinc oxide for the red cabbage plant, We decided to conduct this study with the more than one study objective is specified of improving the growth, yield and chemical components of the red cabbage plant.

Material and Methods:

The experiment was conducted at the Agricultural Research Station of the Department of Horticulture and Landscape Engineering - College of Agriculture-Tikrit University for the agricultural season 2023-2024, To study the effect of application some treatments on the chemical characteristics of the hybrid cabbage red (HANNAR). The

experiment included studying the effect of two factors: Using mulching in three types of plastic mulch : The first is silver (This type of mulch is silver on top and black on the bottom. One end faces the soil and prevents weed growth, while the silvery top reflects light, repelling and scattering insects) the second is black, and the third is red, without covering. The second factor is three concentrations of Nano-zinc oxide (0, 50, 100) mg.L-1. The foliar addition of the aforementioned element was carried out in two stages, the first 30 days after planting the seedlings in the field, and the second stage 15 days after the first addition .

Thus, this experiment included 12 treatments carried out in the field using a factorial experiment The seeds were planted in cork dishes with a capacity of 209 liters in the Wooden canopy of the Department of Horticulture on August 1, 2023, using peat moss as a planting medium by placing a seed Only one in each eye, and after it reaches the appropriate age for planting, 3-4 true leaves. After a period of 50-60 days has passed from planting, begin transferring the seedlings and planting them in the permanent place, inside holes in the cover with an area of 10 cm for each hole. The plants were planted after dividing the field into three replicates, and the replicates were divided into experimental units. Each replicate contained 12 experimental units, and each experimental unit was 2 meters long and 1.5 meters wide .

The area of the experimental unit was 3 square metres. In each line, 4 plants were planted, such that the distance between one plant and another was 50 cm, so that one experimental unit contains 8 plants, alternately on both sides of the terrace. The results were analyzed according to Duncan's multinomial test according to the SAS program (1996), and the means were compared at a significance level of 0.05 [7.[

Studied traits:

The percentage of nitrogen (%)The element was estimated after digestion by Micro Kjeldahl apparatus according to the method of [13], phosphorus (%) Using a spectrophotometer at a wavelength of 882 nm, the element was measured according to the method of [24]., potassium (%) Use of the FlamePhotometer according to the method given in [26],zinc (mg kg-1) Using an atomic absorption spectrometer at a wavelength of 284.56 nm and after using the standard zinc curve, the concentration of the element was calculated [2], the percentage of proteins (%)was calculated on a dry weight basis using the equation below: Percentage of protein (%) = Percentage of nitrogen (%) × 6.25 [3].the concentration of anthocyanin pigment in the heads (mg 100 g -1 fresh weight) It was estimated according to the method given in [21], and the percentage of nitrates in Heads (mg kg-1) It was estimated using a spectrophotometer at a wavelength of 410 nm, as stated in [26], a.nd ascorbic acid

percentage (mg g-1) The ascorbic acid content was determined using the titration method by reducing the dye Dichlorophenol [15.[

Results and Discussion:

Percentage of Nitrogen(%)

The results of Table 1 show significant differences for both the soil mulch treatments and the method of adding Nano zinc oxide, as the soil mulch treatment with silver mulch outperformed by giving it the highest value, which was 2.97%, with an increase rate of 33.78% compared to the comparison treatment (without coverage), which recorded the lowest value of 2.22%. As for the treatment of the method of adding nano zinc oxide, no significant differences were shown between

the spraying treatment at a concentration of 50 and 100 mg L-1, as they reached 3.09%, with an increase rate of 87.27% compared to the treatment without spraying, which reached 1.65%.% . As for the Bilateral interference between the established treatments, the silver mulch treatment with spraying with Nano zinc oxide at a concentration of 50 and 100 mg L-1 (SZ50) and (SZ100) was superior, as they reached 3.88% and 3.87%, with an increase rate of 191.72% and 190.97%, respectively, compared to the treatment of mulching the soil with the red mulch and without spraying (RZ0), which was about 1.33%.

Table (1) The effect of mulching and the addition of Nano-zinc oxide and Their interactionson the percentage of nitrogen (%) of the red cabbage plant

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	1.33 g	2.88 b	2.90 b	2.23 c
Silver (S)	1.81 e	3.87 a	3.88 a	2.97 a
Black (B)	1.75 f	2.84 c	2.83 c	2.46 b
Without Mulching (W)	1.72 f	2.76 d	2.76 d	2.22 d
Rate Nano-zinc oxide	1.65 b	3.09 a	3.09 a	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05.(

Percentage Phosphorus(%)

The results of Table 2 indicate that there are no significant differences between the silver and black soil mulch treatments in the percentage of phosphorus, as they reached 0.34% and an increase of 13.33% when compared with the control treatment, which gave the lowest value of 0.27%. As for the treatment method of adding nano zinc oxide, we note the superiority of the spraying treatment at a concentration of 50 mg L-1, which reached 0.40% and an increase rate of 90.47% compared to the treatment without spraying (comparison), which gave the lowest value of 0.21%. As for the binary interaction between the implemented treatments, it was found that the interaction between the black mulch treatment and the nano zinc oxide spray at a concentration of 50 mg L-1 (BZ50) was superior in giving the highest value of 0.43% and an increase rate of 152.94% compared to the comparison treatment (WZ0) which was about 0.17% .

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Table (2) The effect of mulching and the addition of Nano-zinc oxide and their interactions on the percentage of phosphorus (%) of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	20 fg	0.40 b	0.38 bc	0.30 b
Silver (S)	0.27 e	0.40 b	0.40 b	0.34 a
Black (B)	0.22 f	0.43 a	0.39 b	0.34 a
Without Mulching (W)	0.17 h	0.36 d	0.36 d	0.27 c
Rate Nano-zinc oxide	0.21 c	0.40 a	0.38 b	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05.(

Percentage Potassium(%)

Through Table No. 3, it appears to us that there are no significant differences between the treatment of mulching the soil with the black mulch and the silver mulch in giving them the highest value of 3.36% and 3.34% respectively, with an increase rate of 33.33% and 32.53% compared to the comparison treatment (without mulch), which amounted to 2.52%. As for the treatment of the Nano zinc oxide addition method, the spraying treatment with a concentration of 50 mg L-1 outperformed by about 3.72% and an increase rate of 52.45% compared to the treatment without spraying (comparator) by about 2.44%. Regarding the binary interaction between treatments, we note that the treatment with the silver cover and spraying at a concentration of 50 mg L-1 (SZ50) outperformed in recording the highest value, which reached 4.03%, with an increase rate of 83.18% compared to the comparison treatment (WZ0), which recorded the lowest value, which reached 2.21% .

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Table (3) The effect of mulching and the addition of Nano-zinc oxide and their interactions on the percentage of potassium (%) of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	2.45 i	3.92 b	2.87 f	2.34 b
Silver (S)	2.62 g	4.03 a	3.43 d	3.34 a
Black (B)	2.50 h	3.91 b	3.86 c	3.36 a
Without Mulching (W)	2.21 j	3.03 e	2.89 f	2.52 c
Rate Nano-zinc oxide	2.44 c	3.72 a	3.26 b	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05 (

Concentration of Zinc (mg kg-1(

By observing Table No. 4, we find significant differences between the single treatments and the binary interaction, as the treatment with the black mulch recorded the highest value of 10.37 mg kg-1, with an increase rate of 15.86% compared to the comparison treatment, which reached 8.95%. As for the treatment of adding nano zinc oxide, we note the superiority of the spraying treatment at a concentration of 100 mg L-1, as it reached 12.27 mg kg-1, with an increase rate of 85.90% compared to the comparison treatment, which reached 6.60 mg kg-1. As for the binary interaction treatments, we note that the treatment with the black mulch and spraying at a concentration of 100 mg L-1 (BZ100) was superior by about 13.44 and an increase rate of 110% compared to the treatment with the red mulch and without spraying (RZ0), which was about 6.40 mgkg-1 .

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Table (4) The effect of mulching and the addition of Nano-zinc oxide and their interactions in estimating the concentration of zinc (mg kg-1 Dry weight)of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	6.40 j	9.60 g	11.43 c	9.08 c
Silver (S)	6.51 j	10.07 f	13.16 b	10.14 b
Black (B)	7.05 i	10.37 e	13.44 a	10.37 a
Without Mulching (W)	6.44 j	9.35 h	11.04 d	8.95 c
Rate Nano-zinc oxide	6.60 c	9.85 b	12.27 a	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05<(

Percentages

The results in Table 5 indicate significant differences between the implemented treatments, as the silver mulch treatment outperformed by recording the highest value for the protein percentage in the plant, which reached 19.09%, with an increase rate of 37.83% compared to the control treatment of 13.85%. As for the treatment of adding Nano zinc oxide, we note that the spraying treatment at a concentration of 50 mg L-1 was superior by about 19.26% and an increase rate of

Proteins(%)

68.65% compared to the comparison treatment, which was about 11.42%. As for the binary interaction treatments, it showed us that the treatment with the silver mulch and spraying at a concentration of 50 mg L-1 (SZ50) recorded the highest value of 24.21% and an increase rate of 197.66% when compared to the treatment with the red cover and without spraying (RZ0), which recorded the lowest value of 8.31%.

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Table (5) The effect of mulching and the addition of Nano-zinc oxide and their interactions in percentages relative to proteins (%) of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	8.31 o	17.98 d	18.10 ef	13.98 c
Silver (S)	15.64 l	24.21 a	22.53 b	19.09 a
Black (B)	10.96 m	17.77 de	17.69 h	15.36 b
Without Mulching (W)	10.77 m	17.22 g	17.24 i	13.85 c
Rate Nano-zinc oxide	11.42 c	19.29 a	18.89 b	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05 .(

Concentration of Anthocyanin pigment in the heads

)mg 100 g -1 fresh weight(

The data in Table (6) indicate the effect of mulching treatments and the addition of Nano-zinc oxide on the concentration of dye in the cabbage heads. We notice a significant superiority of the mulching treatment with silver mulch , as it gave the highest concentration of 514.78 mg 100 g -1 fresh weight, with an increase rate of 10.51% when compared to the treatment without mulch (comparison) had a dye concentration reached 465.97 mg 100 g-1. As for the treatment of adding Nano-zinc oxide, the results showed that spraying at a concentration of 50 mg L-1 was superior to about 522.28 mg 100 g-1, with an increase rate of 27.73% compared to the treatment without addition (comparison), which gave the lowest value of 408.89 mg 100 g-1. Regarding the bilateral interference of the implemented treatments, we note that the treatment of covering with silver mulch and spraying with a concentration of 50 mg L-1 (SZ50) outperformed by about 528.27 mg 100 g-1, with an increase rate of 45.51% compared to the comparison treatment (WZ0), which amounted to 363.03mg100g

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Table(6) The effect of mulching and the addition of Nano-zinc oxide and their interactions in estimating the concentration of anthocyanin pigment in the heads (mg 100 g -1 fresh weight)of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	372.12 l	521.33 cd	511.40 h	480.62 c
Silver (S)	488.10 j	528.27 a	521.89 c	514.78 a
Black (B)	412.33 k	524.33 b	515.26 e	494.01 b
Without Mulching (W)	363.03 m	515.20 f	500.15 i	465.97 d
Rate Nano-zinc oxide	408.89 c	522.28 a	512.17 b	-

*Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05 .(

Percentage of Nitrate in the heads (mg kg-1(

The results in Table 7 showed significant differences between the treatments in the percentage of nitrates in the heads of cabbage, as the comparison treatment (without the cover) outperformed by recording the lowest value of the nitrate percentage, which amounted to 0.21 mg kg-1, compared to the treatment with the silver cover, which recorded the highest value, which amounted to 0.35 mg kg-1, with an increase rate of 67%.

As for the treatment, the method of adding nano zinc oxide outperformed the comparison treatment, giving a lower value of 0.19 mg kg-1 when compared to the spray treatment at a concentration of 50 mg L-1, which reached 0.34 mg kg-1, with an increase rate of 79% .

As for the bilateral interference treatment, the comparison treatment (WZ0) was superior in nitrate content by 0.13 mg/kg-1 when compared to the treatment of covering with silver cover and spraying at a concentration of 50 mg/L (SZ1) by 0.41 mg/kg-1.

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Table (7) The effect of mulching and the addition of Nano-zinc oxide and their interactions in estimating the percentage of nitrate in the heads (mg kg-1)of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	0.16 i	0.32 c	0.30 d	0.25 c
Silver (S)	0.25 ef	0.41 a	0.38 b	0.35 a
Black (B)	0.21 h	0.37 b	0.34 c	0.29 b
Without Mulching (W)	0.13 j	0.26 e	0.23 g	0.21 d
Rate Nano-zinc oxide	0.19 c	0.34 a	0.31 b	

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05.(

Percentage of Ascorbic acid (mg g -1(

The data in Table 8 showed a significant superiority in the single treatments and the binary interaction, where the silver mulch treatment recorded the highest value in the percentage of ascorbic acid at about 13.15 mg g-1 and an increase rate of 9.03% compared to the control treatment, which amounted to 12.06 mg g-1. As for the treatment of adding nano zinc oxide, we note that the spraying treatment with a concentration of 50 mg L-1 was superior to 14.26 mg g-1, with an increase rate of 34.78% compared to the treatment without addition (comparison), which was 10.58 mg g-1. As for the interaction between the implemented treatments, we note a significant superiority of the treatment of covering the soil with silver mulch and spraying at a concentration of 50 mg L-1, which amounted to 14.63 mg g-1, with an increase rate of 44.42 compared to the comparison treatment, which amounted to 10.13 mg g-1.

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Table (8) The effect of mulching and the addition of Nano-zinc oxide and their interactions in estimating the percentage of ascorbic acid (mg g -1)of the red cabbage plant.

mulch type	Nano-zinc oxide			Rate Mulching
	0	50	100	
Red (R)	10.37 j	14.09 cd	13.08 fg	12.24 c
Silver (S)	11.11 h	14.63 a	13.17 ef	13.15 a
Black (B)	10.72 i	14.32 bc	13.27 e	12.65 b
Without Mulching (W)	10.13 k	14.00 d	12.70 g	12.06 d
Rate Nano-zinc oxide	10.58 c	14.26 a	13.06 b	-

* Different alphabets in the same column show significant difference using Duncan's Multiple Range test (P≤ 0.05.(

Conclusion

-1It is clear from the results of the statistical analysis that the treatment of covering the soil with silver cover was superior in most of the chemical characteristics represented by the percentage of nitrogen, proteins, concentration of anthocyanin pigment in the heads, and ascorbic acid, as shown in Tables(1, 5, 6, 8). Increasing the efficiency of roots in absorbing water and nutrients from the soil as a result of reducing the weeding process that causes mechanical damage to the crop roots [11].and [7]. And its positive impact on increasing the efficiency of roots in absorbing water and nutrients from the soil, thus increasing the amount of carbohydrate accumulation, which is a primary source of nitrogenous materials through the formation of organic acids, which led to an increase in the percentage of nitrogen and potassium in the leaves [22 .[

-2While the black cover treatment showed superiority in the percentage of zinc, Table 4, and the reason is attributed to the ability of the black cover to improve the efficiency of the roots to absorb nutrients to provide the cover with a suitable environment for the formation of the root system by eliminating weeds and preventing competition for the growth space and nutrients in the soil and raising the soil temperature and maintaining good moisture around the perimeter of the plant's roots spread [18.[

-3While the control treatment (without zinc addition) and the control treatment (without mulching) were superior in nitrate content, recording the lowest value as shown in Table

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7. This may be due to the low nitrogen content in this treatment as shown in Table 1. Nitrate - NO3 is a compound consisting of one nitrogen atom and three oxygen atoms.

-4As for the treatment of the method of adding nano zinc oxide, it was shown that the treatment of spraying nano zinc oxide at a concentration of 50 mg L-1 was superior in most chemical properties. The reason may be due to the role of zinc, which is one of the micronutrients that meet the plant's needs in small quantities, and the properties of nano-fertilizers, such as the small size of their particles and the ease with which they can enter plant cells when sprayed, and in the formation of amino acids that play a role in the process of regulating the movement of ions and nutrients within the plant. Nano fertilizers provide a large surface area for metabolic reactions and lead to an increase in the leaf nutrient content as a result of an increase in the rate of photosynthesis [23.[

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