Effect of spraying with magnesium and Vet-Org on the qualitative and quantitative characteristics of two hybrids of red cabbage

Wurood Fadhil Mohammed Faisal* Adnan Ghazi Salman Alnussairawi*
*Department of Horticulture and Land Scape, College of Agriculture, University of Diyala, Iraq
*Corresponding author email: 1E-mail: warudfadel@uodiyala.edu.iq
2E-mail: adnanghazi@uodiyala.edu.iq

Abstract

. the experiment was conducted in a private field in Al-Khalis District in Diyala Governorate during the 2023-2024 agricultural season. The treatment was carried out using three concentrations of magnesium oxide (0-2000-4000) mgL-1 (Mg1,Mg2,Mg3) Three concentrations of organic fertilizer (0-5-10) ml/l-1, at intervals of 21 days between each spray O1,O2,O3), a period of 21 days between one spraying and the next on some qualitative characteristics vegetative traits of two Red Cabbage hybrids, Red Cabbage The results showed that the hybrid V1 outperformed some of the studied parameters, such as leaf carbohydrate content, vitamin C, sulfur, and anthocyanin. As for spraying with magnesium oxide, the treatment spraying by using magnesium oxide 4000 mgL-1, which has a higher carbohydrate content in the leaves, vitamin C Sulfur and Anthocyanin, while the comparison Mg1 treatment gave the lowest values for the studied treatment. Spraying with organic fertilizer VIT-ORG-VG, the treatment O3 was superior in some traits leaves content of carbohydrates, vitamin C Sulfur and Anthocyanin, while the comparison O1treatment gave the lowest values for the studied treatment. The twice interaction treatment V1+Mg3 ,V1+O3 and Mg3+O3 showed superiority in all studied traits. In addition, the triple interaction treatment V1+Mg3+O3 showed the highest values in all studied methods.

Keywords: Red Cabbage, organic fertilizer, magnesium oxide, Cultivar

.1 Introduction

Red Cabbage (Brassica oleraceae var. capitata f. rubra) is winter leafy vegetable crops belonging to the Brassicaceae family. Its red or purple color is due to the presence of anthocyanin pigment, which is a powerful antioxidant and also contains flavonoids (10). The concentration of anthocyanin in red cabbage is 322 mg100 g-1 (22). Red cabbage have ten times the amount of vitamin A and double the amount of iron as green cabbage, which is what draws the most customers in terms of nutritional value(21). As a result of its antioxidant content, it reduces the risk of diseases such as ulcers, diabetes, cancer, premature aging, and Alzheimer's disease. It also helps in losing weight, boosting the immune system, and detoxifying the body (21.(

Magnesium, an essential element for plant growth plays a vital role throughout the entire life cycles of plants (3). In plant growth, magnesium is a crucial component of the chlorophyll molecule (14). Chlorophyll serves as the "energy factory" of plants, responsible for absorbing light energy during photosynthesis. Magnesium is a key component in this factory; without it, chlorophyll synthesis is significantly hindered (5). With adequate magnesium, plant leaves can effectively perform photosynthesis, continuously converting carbon dioxide and water into organic compounds like glucose,

ISSN 2072-3857

thus providing the necessary energy and materials for plant growth. Additionally, Mg acts as an activator of various enzymes (20) and participates in numerous physiological and biochemical reactions in plants, including cell division and protein synthesis. During ripening, magnesium is transferred to the fruit; magnesium deficiency can lead to uneven fruit size, reduced sweetness, and color deterioration, adversely affecting the market value of crops. Magnesium ions help to maintain the structural stability of the chlorophyll–protein complexes (17). Therefore, the strategy of using soil Mg application is not ideal, and the utilization rates of Mg fertilizer from the soil to the roots are low. Thus, foliar Mg fertilization provides a new and effective way of delivering nutritional supplements. A search of the literature revealed that foliar fertilization of crops has many advantages, such as rapid nutrient absorption, better fertilizer efficiency, a high nutrient utilization rate, effective dilution management, avoidance of nutrient degradation, a reduction in environmental pollution, and greater resilience under unfavourable conditions (18.(

Organic nutrients is the basis that must be laid to raise the productive value of agricultural lands and reduce environmental pollution resulting from the use of chemical fertilizers. Foliar fertilization with nutrients can be used to improve the nutritional status of the plant and is the fastest way to compensate for nutrient reduction and soil fertility. The productivity and quality of red cabbage are affected by the contents of nitrogen, phosphorus and potassium which regulate the enzymatic activity in converting carbon to glucose (7). Nitrogen is one of the main macronutrients for promoting growth and increase yield (9) The formation of amino acids, nucleic acids, chlorophyll, and the production of enzymes and coenzymes are some of the essential roles that nitrogen plays in plants(8). It also function to synthesize and store compounds that protect against osmotic stress, such as proline, glycine, betaine, and sugars, which enhance the plant's hydration status, provide protection from sunlight, and maintain water in plant tissues (16) Spraying two varieties of Arugula Egyptian and Syrian with nutrients led to a significant difference in the number of leaves and leaf areas of the plants compared to control (4). The results of a study conducted by (6) showed that spraying the organic nutrient Amirich Reef in the growth and production of two varieties of cabbage, Copenhagen market and Ruby queen, showed that the spraying treatment of the Copenhagen market variety was superior and recorded the highest value in plant height and leaf area, while the highest value of total chlorophyll was for the spraying treatment of the Ruby queen variety (6) so this field studies was conducted to compare the two red cabbage hybrids in their response to the community conditions in the region, and to know the effect of spraying magnesium oxide and VIT-ORG-VG on the growth and yield of two hybrids.

.2 Materials and Methods

To study the effects of foliar spraying magnesium oxide and organic fertilizer VIT-ORG-VG on the growth and chemical traits of two Red Cabbage cultivars, a field experiment was conducted at the private field within Al-Khalis district-Diyala Governorate. during the 2023-2024 agricultural season. Field divided in to 6 terrace the width was 1m then, distance between one terrace and another is 0.8 m, drip irrigation pipes were extended. The seedlings were planted in each experimental unit in two lines, each line containing 5 plants. The

ISSN 2072-3857

distance between the lines was 0.6 m and between the seedlings was 0.4 m, so the number of plants in the experimental unit was 10 plants and the total number of experimental units was 54 experimental units. Three different concentrations of magnesium oxide 0, 2000 and 4000 mg L-1 (Mg1, Mg2, Mg3) and three different concentration of organic fertilizer VIT-ORG-VG 0, 5 and 10 ml L-1(O1, O2, O3) were sprayed on two red cabbage cultivars, Red Cabbage Redline (V1) and Gemusesamen (V2).The solutions were applied to the plants three times during the growing season. The seedlings were sprayed for the first time 21 days after planting, and then repeated for the second time after 21 days spraying process for the second treatment was carried out 48 hours after the first treatment to prevent interference between the two treatment.

2.1 Statistical Analysis

The experiment was carried out according to a split plot design in R.C.B.D of a factorial experiment with three factors and three replicates, put organic fertilizer on main plots, magnesium on sub-plots and hybrids on sub-sub-plots. The results were analyzed using the SAS program and the differences between the means were compared according to Duncan's polynomial test at a probability level of 0.05.

2.2 Studied Traits

Yield Traits

- Average Head Weight (kg): Determined by dividing the total weight of the heads in the experimental unit by their number .
- Total yield (tons hectare-1): According to the total yield from the beginning of harvest to the end of harvest for each experimental unit.

Chemical Traits

- Head Leaves content of carbohydrates(mg 100g-1 (

Carbohydrate content was estimated according to the method of (13) A spectrophotometer at a wavelength of 550 nm. The carbohydrate content of the leaves was calculated by projecting the readings onto the standard curve prepared using glucose.

- Head Leaves content of vitamin C (mg 100 ml-1 fresh weight(

Vitamin C was estimated using titrating with 1,2-Dichloro Phenol Ind Phenol dye according to the method of (19.(

- Head Leaves content of Sulfur(ppm): Sulfur was estimated by the turbidity method using barium sulfate solution (23.(
- Head leaves content of Anthocyanin(mg100g-1): were determined according to by (19.(

.3 Results & Discussion

Yield traits

3.1Average Head Weight (kg:(

The results in table 1 showed there is no significant difference between the two cultivars of head weight. The results in same table showed that no significant effect of spraying with magnesium oxide and organic fertilizer VIT-ORG-VG on head weight

The combination between V1+Mg3 treatment have achieved the highest values 1.787kg, compared with V2+Mg1 treatment recording 1.479kg. The combination between V1+O3 treatment recorded the highest values of plant height 1.754kg, while the combination of V2+O1 treatment recorded the lowest values 1.427kg. Moreover, the interaction treatment between Mg3+O3 recorded the highest values 1.869kg, while the Mg1+O1 treatment recorded the lowest values 1.358kg. The results of the same table show a significant effect of the plant height when the triple interaction among cultivar and

ISSN 2072-3857

magnesium with the organic fertilizer VIT-ORG-VG, as the plants of the treatment V1+Mg3+O3 outperformed 1.899kg, while the lowest plant height was for the treatment V2+Mg1+O1 reaching 1.356kg .

Table 1: Effect of spraying magnesium oxide and organic nutrient VIT-ORG-VG and their interaction on head weight (kg) of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	1.360 e	1.356 e	1.358 c
	Mg2	1.671 a-e	1.653 a-e	1.662 b
	Mg3	1.734 a-d	1.718 a-d	1.726 ab
O2	Mg1	1.406 cde	1.391 de	1.398 c
	Mg2	1.751 abc	1.746 abc	1.748 ab
	Mg3	1.753 abc	1.752 abc	1.752 ab
O3	Mg1	1.519 b-e	1.518 b-e	1.518 bc
	Mg2	1.812 ab	1.791 ab	1.801 a
	Mg3	1.899 a	1.840 ab	1.869 a
				Means of O
V X O	O1	1.616 a	1.427 b	1.521 A
	O2	1.692 a	1.680 a	1.686 A
	O3	1.754 a	1.720 a	1.737 A
				Means of Mg
V X Mg	Mg1	1.618 ab	1.479 b	1.548 A
	Mg2	1.687 a	1.620 ab	1.653 A
	Mg3	1.787 a	1.697 a	1.742 A
Means of hybrids		1.697 A	1.598 A	

3.2Total yield (t ha-1(

Table 2 has indicated that no significant difference between two hybrid in total yield. The differences between the magnesium oxide treatments and organic nutrient spray treatment did not reach the level of significance .

According to the same table, a total yield of 53.20 t ha-1 was achieved with an interaction treatment consisting of V1+Mg3, as compared to 44.03 t ha-1 total yield with an interaction treatment consisting of V2+Mg1. The interaction treatment consisting of V1+O3 achieved a higher value of total yield which was 52.21 t ha-1, as compared to 42.47 t ha-1 at the interaction treatment V2+O1 total yield. The interaction treatment between magnesium and organic fertilizer Mg3+O3 achieved a significant superiority in total yield, as the highest average total yield was 55.64 t ha-1 , while the lowest total yield was 40.42t ha-1 in the interaction treatment Mg1+O1. The results of the same table show a significant effect of the total yield when the triple interaction among hybrids and magnesium with the organic fertilizer, as the plants of the treatment V1+Mg3+O3 outperformed of 56.51 t ha-1, and the lowest total yield was for the treatment V2+Mg1+O1 reaching 40.36 tha-1

ISSN 2072-3857

Table 2: Effect of spraying magnesium oxide and organic nutrient VIT-ORG-VG and their interaction on total yield(t ha-1) of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	40.49 e	40.36 e	40.42 c
	Mg2	49.74 a-e	49.19 a-e	49.46 b
	Mg3	51.62 a-d	51.13 a-d	51.37 ab
O2	Mg1	41.86 cde	41.39 de	41.62 c
	Mg2	52.11 abc	51.97 abc	52.04 ab
	Mg3	52.19 abc	52.14 abc	52.16 ab
O3	Mg1	45.22 b-e	45.18 b-e	45.20 bc
	Mg2	53.92 ab	53.31 ab	53.61 a
	Mg3	56.51 a	54.77 ab	55.64 a
				Means of O
V X O	O1	48.10 a	42.47 b	45.28 A
	O2	50.37 a	50.00 A	50.18 A
	O3	52.21 a	51.21 a	51.71 A
				Means of Mg
V X Mg	Mg1	48.17 ab	44.03 b	46.10 A
	Mg2	50.21 a	48.23 ab	49.22 A
	Mg3	53.20 a	50.52 a	51.86 A
Means of hybrids		50.52 **A**	47.59 **A**	

3.3Head Leaves content of carbohydrates(mg 100g-1(

Table 3 showed the cultivars significantly affected on leaves content of carbohydrates , as the V1 cultivar plants were superior to the V2 cultivar plants, with a carbohydrates content of 54.14 and 52.18 mg 100g-1 respectively. According to table the magnesium oxide Mg3 spraying treatment was superior in increasing the carbohydrates content, which reached 56.12 mg 100g-1, compared to the control treatment Mg1, which gave the lowest carbohydrates content, reached 50.49 mg 100g-1. The organic nutrient spray treatment at O3 significantly increased the carbohydrates which was 57.34 mg 100g-1, while the control treatment O1 gave lowest values 48.76 mg 100g-1 .

A carbohydrates content 57.13 mg 100g-1 was achieved with an interaction treatment consisting of V1+Mg3, as compared to 49.78 mg 100g-1 with V2+Mg1 treatment. The interaction treatment consisting of V1+O3 achieved a higher value of carbohydrates content which was 58.60 mg 100g-1, as compared to 48.21mg 100g-1 at the interaction treatmentV2+O1.The interaction treatment consisting of Mg3+O3 achieved a higher value of carbohydrates content which was 60.13 mg 100g-1, as compared to 46.63 mg 100g-1at the interaction treatment Mg1+O1 mg 100g-1. The triple interaction among hybrids and magnesium with the organic fertilizer, as the plants of the treatment V1+Mg3+O3 outperformed of 61.16 mg 100g-1, and the lowest value was for the

ISSN 2072-3857

treatment V2+Mg1+O1 reaching 46.19 mg 100g-1.

Table 3: Effect of spraying magnesium oxide and organic nutrient VIT-ORG-VG and their interaction on leaves content of carbohydrates of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	47.07 i	46.19 i	46.63 h
	Mg2	49.40 h	47.29 i	48.34 g
	Mg3	52.32 ef	50.28 gh	51.30 e
O2	Mg1	51.32 fg	49.10 h	50.21 f
	Mg2	54.34 d	51.79 ef	53.06 d
	Mg3	57.92 b	55.92 c	56.92 b
O3	Mg1	56.09 c	53.18 de	54.63 c
	Mg2	58.57 b	55.93 c	57.25 b
	Mg3	61.16 a	59.11 b	60.13 a
				Means of O
V X O	O1	49.30 e	48.21 f	48.76 C
	O2	54.52 c	52.27 d	53.40 B
	O3	58.60 a	56.07 b	57.34 A
				Means of Mg
V X Mg	Mg1	51.20 d	49.78 e	50.49 C
	Mg2	54.10 c	51.67 d	52.88 B
	Mg3	57.13 a	55.10 b	56.12 A
Means of hybrids		54.14 A	52.18 B	

3.4Head Leaves content of vitamin C (mg 100 ml-1 fresh weight(

Table 4 showed the cultivars significantly affected on leaves content of vitamin C , as the V1 cultivar plants were superior to the V2 cultivar plants, with a vitamin C content of 63.61and 61.19 mg 100ml-1 fresh weight respectively. Spraying with magnesium oxide significantly affectedthe same trait, as the Mg3 treatment was superior with a vitamin C content of 67.49 mg 100ml-1 fresh weight, while the lowest content was for the comparison treatment Mg1, reaching 57.78 mg 100ml-1 fresh weight. The results showed a significant effect of spraying organic nutrient VIT-ORG-VG on the vitamin C content of red cabbage leaves. The highest content was for the O3 treatment, reaching 67.14 mg 100ml-1 fresh weight, while the lowest content was for the control treatment O1, reaching 57.48 mg 100ml-1 fresh weight .

The V1+Mg3 treatment was superior, with the highest vitamin C content being 68.69 mg 100ml-1 fresh weight, and the lowest content being 56.39 mg 100ml-1 fresh weight for the control treatment for theV2+Mg1 treatment. Also, the interaction betweenV1+O3 treatment was superior with the highest vitamin C content of 68.20 mg 100ml-1 fresh weight and the lowest content of 56.17mg 100ml-1 fresh weight for the V2+O1 treatment. The characteristic was significantly impacted by the interaction between magnesium oxide and

the cultivars, as the treatment of Mg3+O3 was superior, with the highest vitamin C content of 71.29 mg 100ml-1 fresh weight and the lowest vitamin C content of 52.23 mg 100ml-1 fresh weight for the Mg1+O1 treatment. The interaction had a significant effect on leaf content of vitamin C, the V1+Mg3+O3 treatment outperformed all treatments, recording the highest vitamin C content of 72.17 mg100ml-1 fresh weight. In contrast the V2+Mg1+O1 treatment recorded the lowest content amounting to 51.30 mg 100ml-1 fresh weigh.

Table 4: Effect of spraying magnesium and organic nutrient VIT-ORG-VG and their interaction on Leaves content of vitamin C (mg 100 ml-1 fresh weight) of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	53.17 i	51.30 m	52.23 h
	Mg2	58.24 j	55.48 k	56.86 g
	Mg3	64.97 f	61.73 h	63.35 d
O2	Mg1	59.52 i	56.01 k	57.76 f
	Mg2	63.11 g	61.17 h	62.14 e
	Mg3	68.92 c	66.76 e	67.84 b
O3	Mg1	64.82 f	61.88 h	63.35 d
	Mg2	67.60 d	65.94 e	66.77 c
	Mg3	72.17 a	70.41 b	71.29 a
				Means of O
V X O	O1	58.79 e	56.17 f	57.48 C
	O2	63.85 c	61.31 d	62.58 B
	O3	68.20 a	66.08 b	67.14 A
				Means of Mg
V X Mg	Mg1	59.17 e	56.39 f	57.78 C
	Mg2	62.98 c	60.86 d	61.92 B
	Mg3	68.69 a	66.30 b	67.49 A
Means of hybrids		63.61 A	61.19 B	

3.5Leaves content of Sulfur(ppm (

The results in Table 5 showed the cultivars significantly affected on leaves content of Sulfur, as the V1 cultivar plants were superior to the V2 cultivar plants, with a Sulfur content of 103.8 and 95.03 ppm respectively. Spraying with magnesium oxide significantly affectedthe same trait, as the Mg3 treatment was superior with a Sulfur content of 110.7 ppm, while the lowest content was for the comparison treatment Mg1, reaching 87.67 ppm. The results showed a significant effect of spraying organic nutrient VIT-ORG-VG on the Sulfur content, the highest content was for the O3 treatment, reaching 111.6 ppm, while the lowest content was for the control treatment O1, reaching 85.72 ppm

The V1+Mg3 treatment was superior, with the highest Sulfur content being 115.4 ppm,

ISSN 2072-3857

and the lowest content being 83.73 ppm for the control treatment for theV2+Mg1 treatment. Also, the interaction betweenV1+O3 treatment was superior with the highest Sulfur content of 116.9 ppm and the lowest content of 82.22 ppm for the V2+O1 treatment. The characteristic was significantly impacted by the interaction between magnesium oxide and the organic nutrient VIT-ORG-VG, as the treatment of Mg3+O3 was superior, with the highest Sulfur content of 123.9 ppm and the lowest Sulfur content of 75.84 ppm for the Mg1+O1 treatment. The interaction had a significant effect on leaf content of Sulfur, theV1+Mg3+O3 treatment outperformed all treatments, recording the highest Sulfur content of 130. ppm. In contrast the V2+Mg1+O1 treatment recorded the lowest content amounting to 71.92 ppm.

Table 5: Effect of spraying magnesium oxide and organic nutrient VIT-ORG-VG and their interaction on leaves content of Sulfur (ppm) of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	79.75 i	71.92 j	75.84 h
	Mg2	88.94 g	80.72 i	84.83 g
	Mg3	98.97 e	94.02 f	96.49 e
O2	Mg1	92.69 f	84.22 h	88.45 f
	Mg2	106.7 c	98.69 e	102.7 c
	Mg3	116.6 b	106.8 c	111.7 b
O3	Mg1	102.3 d	95.07 f	98.71 d
	Mg2	117.6 b	106.8 c	112.2 b
	Mg3	130.7 a	117.0 b	123.9 a
				Means of O
V X O	O1	89.22 d	82.22 e	85.72 C
	O2	105.3 b	96.57 c	100.9 B
	O3	116.9 a	106.3 b	111.6 A
				Means of Mg
V X Mg	Mg1	91.60 d	83.73 e	87.67 C
	Mg2	104.4 b	95.41 c	99.93 B
	Mg3	115.4 a	105.9 b	110.7 A
Means of hybrids		103.8 A	95.03 B	

3.6Leaves content of Anthocyanin(mg100g-1(The results in Table 6 showed the cultivars significantly affected on leaves content of anthocyanin, as the V1 cultivar plants were superior to the V2 cultivar plants, with a anthocyanin content of 352.7mg100g-1 and 332.2mg100g-1 respectively. Spraying with magnesium oxide significantly affectedthe same trait, as the Mg3 treatment was superior with a anthocyanin content of 390.6mg100g-1, while the lowest content was for the comparison treatment Mg1, reaching 290.8 mg 100g-1. The results showed a significant effect of spraying organic nutrient VIT-ORG-VG on the anthocyanin content, the highest content

ISSN 2072-3857

was for the O3 treatment, reaching 442.4mg 100g-1,while the lowest content was for the control treatment O1, reaching 249.1mg 100g-1 .

The V1+Mg3 treatment was superior, with the highest anthocyanin content being 402.7 mg 100g-1, and the lowest content being 280.7mg 100g-1 for the control treatment for theV2+Mg1 treatment. Also, the interaction betweenV1+O3 treatment was superior with the highest anthocyanin content of 453.1mg 100g-1 and the lowest content of 240.5mg100g-1 for the V2+O1 treatment. The characteristic was significantly impacted by the interaction between magnesium oxide and organic nutrient VIT-ORG-VG, as the treatment of Mg3+O3 was superior, with the highest anthocyanin content of 485.6 mg 100g-1 and the lowest anthocyanin content of 188.7mg 100g-1 for the Mg1+O1 treatment. The interaction had a significant effect on leaf content of anthocyanin, theV1+Mg3+O3 treatment outperformed all treatments, recording the highest anthocyanin content of 495.7mg 100g-1. In contrast the V2+Mg1+O1 treatment recorded the lowest content amounting to 175.7mg 100g-1.

Table 5: Effect of spraying magnesium oxide and organic nutrient VIT-ORG-VG and their interaction on leaves content of anthocyanin(mg100g-1) of two red cabbage hybrids.

Organic nutrient	Magnesium oxide	`Red cabbage hybrids		Mg X O
		V1	V2	
O1	Mg1	201.7 n	175.7 o	188.7 h
	Mg2	262.2 i	247.9 m	255.0 g
	Mg3	309.3 j	298.1 jk	303.7 e
O2	Mg1	298.0 jk	285.8 k	291.9 f
	Mg2	340.9 h	325.2 i	333.0 d
	Mg3	403.0 e	362.2 g	382.6 c
O3	Mg1	403.0 e	380.8 f	391.9 c
	Mg2	460.5 c	439.2 d	449.8 b
	Mg3	495.7 a	475.4 b	485.6 a
				Means of O
V X O	O1	257.7 e	240.5 f	249.1 C
	O2	347.3 c	324.4 d	335.8 B
	O3	453.1 a	431.8 b	442.4 A
				Means of Mg
V X Mg	Mg1	257.7 e	280.7 f	290.8 C
	Mg2	347.3 c	337.4 d	346.0 B
	Mg3	453.1 a	378.6 b	390.6 A
Means of hybrids		352.7 A	332.2 B	

ISSN 2072-3857

.4 Discussion

The superiority of the Red Cabbage Redline F1(V1) variety in some vegetative growth indicators may be due to its genetic linked to genes compared to the (V2) Gemusesamen Vegetable Seed variety. There are genes responsible for the absorption of each of the nutrients, and the amount of the element absorbed by the plant is determined through the type of gene, whether dominant or recessive (2). Moreover (1) mentioned in their studies that genotypes have a high variation. The presence of significant differences between genotypes indicates that they are genetically different, due to genetic factors that control the characteristic .

Regarding the effectiveness of magnesium in improving the yield traits of two red cabbage hybrids, the increase in some trails was related to the role of magnesium in the synthesis of chlorophyll molecules. The role of this element is known to be in the activation of many enzymes associated with carbohydrate metabolism, including hexokinase, glucokinase, galactokinase, and fructokinase, along with the role of magnesium in proteins. Also, it acts as an activator of the enzymes involved in nucleic acids and works to stabilize ribosomes which are important for protein synthesis. Thus, its deficiency works to separate those ribosomes into smaller units (15) enzyme activation was facilitated and involved more CO2 fixation in the Calvin cycle, it participates in the process of nitrate reduction in plants, thereby increasing the amount of assimilates for vegetative growth which in turn contributed to increasing the weight of the heads and thus increasing the yield (11 (

Spraying with organic fertilizer VIT-ORG-VG is attributed to its composition rich in amino acids that directly enter into the metabolic processes of building proteins, enzymes, growth hormones, and the formation of chlorophyll and cytochromes essential for the processes of carbon metabolism and respiration, which increases the activity of division and elongation of plant cells and thus increases vegetative growth (12). Which increased the accumulation of carbon metabolism products, which in turn contributed to increasing the weight of the heads and thus increasing the yield (6) The fertilizer also contains nitrogen, which is one of the main macronutrients for enhancing growth(9). It seems that the genetic makeup that contains good traits for vegetative growth and the spraying of organic nutrients and magnesium oxide contributed to improving the vegetative growth index, and this is consistent with what was mentioned(16. (

Conclusions

-1 The hybrids V1 is the best at improving most of the studied traits .

-2 Spraying magnesium oxide at a concentration of 4000 mgl-1 (Mg3) led to improving most of the traits.

-3 organic nutrient VIT-ORG-VG at a concentration of 10 ml l-1 is the best and most effective in improving most of the traits.

-4 The binary interaction between V1+Mg3 treatment, V1+O3 treatment Mg3+O3 treatment and V1+Mg3+O3 treatment gave the best results for all the studied traits.

Conflict of Interest

There is no conflict of interest between the authors.

Acknowledgements

Thanks to the College of Agriculture, University of Diyala, and I would like to thank Dr Adnan Ghazi Salman Alnussairawi for the support in this research.

References

[1]Abbas, S. H. (2023). Effect of Planting Dates on Stability of New Rice Genotypes Traits Grown in Iraqi Conditions. Basrah Journal of Agricultural Sciences, 36(2), 1-16.

[2]Abu Dahi, Y. M.(1989). Practical plant nutrition .Handbook ,Mosul University press.

[3]Ahmed, N., Zhang, B., Bozdar, B., Chachar, S., Rai, M., Li, J., and Tu, P. (2023). The power of magnesium: unlocking the potential for increased yield, quality, and stress tolerance of horticultural crops. Frontiers in plant science, 14, 1285512.

[4]AL-Doghachi, E. H. A. and Al- Saadawi, F. W. O. (2013). Responses Two Cultivars of Eruca sativa Mill. to Plant Density and Spraying with Bio Health on Growth, Seeds and Oil Yield. Kufa Journal for Agricultural Science.5(2):34-55.

[5] Ali, M. M., Hu, X., Chao, P., Ali, S., Akram, M. T., Naveed, W. A., and Chen, F. (2024). Magnesium's impact on fruit quality of loquat: Insights into sugar and acid dynamics. Scientia Horticulturae, 328, 112972.

[6]Al-lamy, K. A. M., Abeed, M. H., and Sakr, M. A. A. (2018). Effect of spraying organic nutrient Reef Amirich on growth and yield of two varieties of cabbage. Journal of Kerbala for Agricultural Sciences, 5(3), 116-123.

[7]Al-Shammari, A. M. A., and Hamdi, G. J.(2023).Genotype and foliar fertilization affect growth, production and accumulation of anthocyanin in red Cabbage. International Journal of Vegetable Science, 29(4), 337-347 .

[8]Alwan, O.K., G.J. Hamdi, and R.A. Maleh.(2023).Methyl jasmonate and type of fertilization affect growth, production and accumulation of sulforaphane in black radish taproot. Int. J. Veg. Sci. 29(2):178–194.

[9]Chun, J.-H., Y.-G. Kang, J.-H. Lee, Y.-U. Yun, T.K. Oh, and M.-H. Yoon.(2022). The combined effect of nitrogen and biochar amendments on the yield and glucosinolate contents of the Chinese cabbage. J King Saud Univ. Sci. 34(2):1–7. doi: 10.1016/j.jksus.2021.101799.

[10]Decoteau, D. R. (2000). Vegetable crops. Pearson. U. S. A.

[11]Devlin RM, Witham F. (1983). Plant Physiology. 4th ed. Available online.

[12]Hussein, M. A. (2016). Response of cauliflower plants to spray with nutrients solutions from different sources. Iraqi Journal of Agricultural Sciences, 47(5.(

[13]Joslyn, M. A. (1970). Physical, chemical, and instrumental methods of analysis. Methods in Food Analysis. 2nd ed. Academic press. New York and London.

[14] Meng, X., Bai, S., Wang, S., Pan, Y., Chen, K., Xie, K., and Guo, S. (2023). The sensitivity of photosynthesis to magnesium deficiency differs between rice (Oryza sativa L.) and cucumber (Cucumis sativus L.). Frontiers in Plant Science, 14, 1164866.

[15]Mengel K, Kirkby EA. 2001. Principles of Plant Nutrition, 5th Ed., Kluwer Academic Publishers. Ed., 849.

[16]Mutar, K. A., Salman, F. A., and Jaafar, H. S. (2020). Role of organic foliar fertilizer spraying in vegetative growth, yield and quality of two hybrids of cauliflower. Int. J. Agricult. Stat. Sci. Vol, 16(1), 1205-1208. Richards, L. A. (1954). Diagnosis and Improvement of. Saline and Alkali Soils. Handbook, 60, 129-134.

ISSN 2072-3857

[17]Pietrzykowska, M., Suorsa, M., Semchonok, D. A., Tikkanen, M., Boekema, E. J., Aro, E. M., and Jansson, S. (2014). The light-harvesting chlorophyll a/b binding proteins Lhcb1 and Lhcb2 play complementary roles during state transitions in Arabidopsis. The Plant Cell, 26(9), 3646-3660.

[18]Qin, H., Zhang, X., Tian, G., Liu, C., Xing, Y., Feng, Z., and Ge, S. (2024). Magnesium alleviates growth inhibition under low potassium by enhancing photosynthesis and carbon-nitrogen metabolism in apple plants. Plant Physiology and Biochemistry, 214, 108875.

[19]Ranganna, S.(1986).Hand Book of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGrawhill Education Publishing Limited, New Delhi.

[20]Rissler, H. M., Collakova, E., DellaPenna, D., Whelan, J., and Pogson, B. J. (2002). Chlorophyll biosynthesis. Expression of a second chl I gene of magnesium chelatase in Arabidopsis supports only limited chlorophyll synthesis. Plant physiology, 128(2), 770-779.

[21]Sarkar, D., and Rakshit, A. (2017). Red cabbage as potential functional food in the present perspective. Int. J. Bioresour. Sci, 4(1), 7-8

[22]Singh, S. A. U. R. A. B. H., & Devi, M. B. (2015). Vegetables as a potential source of nutraceuticals and phytochemicals: A review. Int. J. Med. Pharm. Sci, 5, 1-14.

[23]Verma, B.C.(1977). An improved turbid metric procedure for the determination of sulphate in plants and soils. Talanta 24:49-50.

ISSN 2072-3857