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Effect of Fertilizer With Potassium Humate and the Method of Addition to the Growth and Yield of Red Cabbage

Pengaruh Pupuk Kalium Humate dan Cara Penambahannya terhadap Pertumbuhan dan Hasil Kubis Merah

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Abstract

Background: The application of potassium humate has been recognized for its potential to enhance plant growth and yield due to its nutrient enrichment properties. **Specific Background:** Despite extensive research on various fertilizers, the specific effects of potassium humate on red cabbage (Ruby King cultivar) growth and yield, especially concerning the method of application, remain underexplored. **Knowledge Gap:** Limited studies have addressed the comparative impact of foliar spraying versus soil addition of potassium humate on cabbage vegetative growth and yield characteristics. **Aims:** This study aimed to evaluate the effects of different concentrations of potassium humate (0, 50, 100, 150 g.l-1) and application methods (foliar spraying and soil addition) on the growth and yield of red cabbage. **Results:** A randomized complete block design (RCBD) with three replications was implemented during the 2022-2023 agricultural season. Significant improvements in vegetative growth and yield were observed with the highest concentration (150 g.l-1) of foliar spraying. Key vegetative and yield parameters, such as plant height, stem length, number of leaves, leaf chlorophyll content, average head weight, and total yield, were positively influenced. **Novelty:** This study uniquely highlights the superior efficacy of foliar spraying with potassium humate at 150 g.l-1 over soil addition, providing insights into optimizing fertilization strategies for red cabbage. **Implications:** The findings advocate for the use of potassium humate, particularly via foliar spraying, as a beneficial organic fertilizer to enhance red cabbage growth and yield. This practice could lead to improved agricultural productivity and better tolerance of plants to environmental stresses, supporting sustainable agriculture initiatives.

Highlights:

Superior Growth: Foliar spraying with 150 g.l-1 potassium humate boosts growth.

Yield Increase: Highest humate concentration yields maximum red cabbage.

Effective Strategy: Foliar spraying outperforms soil addition for fertilization.

Keywords: Potassium humate, foliar spraying, red cabbage, vegetative growth, yield

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Introduction

One of the most important green vegetables grown throughout the winter months in Iraq is *Brassica oleracea* var. *capitata* L. This plant is from the Cruciferae family and comes from the eastern Mediterranean, where it grows well in cool, damp weather. Growers grow cabbage for the heads that form when the leaves wrap around the large terminal bud. You can consume the leaves fresh, pickled, or cooked (Matlob et al., 1989). There are three types of cabbage that produce heads: the red cabbage, the white cabbage, and the wrinkled cabbage (Koomen, 1976). The first and second types are the most common in the world, as cabbage The red color of cabbage sets it apart from other varieties, and its high nutritional and medicinal value stems from the presence of anthocyanin pigment. Its red color can be used in preparing distinctive salad dishes. It also contains valuable calories and proteins and contains enzymes and compounds. It stimulates the metabolism process, so it is used as a suitable food for weight loss, dissolves fat in the body, and reduces the level of cholesterol in the blood (Al-Rawahi et al., 2004). Therefore, work must be done to increase the productivity of the cabbage crop, both horizontally and vertically, by studying all the environmental and genetic factors that affect the crop. The fertilization factor is regarded as one of the most significant factors that influence the quantity of the crop. Given the great recent interest in preserving the environment and improving the quality and quantity of the product, the importance of using organic fertilizers (whether in addition to the soil or spraying on the leaves) has emerged as the indispensable basis for preserving soil fertility, which provides the nutrients that the plant needs, and reduces the risks of using chemicals resulting from environmental pollution (Aron, 2001). Consequently, it enhances the physical, chemical, and biological properties of the soil by supplying the soil with the necessary levels of organic matter (Abu Al-Rayyan, 2010). The plant structure was originally characterized by abundant vegetative growth (Kuepper, 2003), and therefore adding humic acids to the soil leads to enriching it with nutrients and increasing resistance. To drought and heat, which is a major factor for the growth of the tuber group that is tolerant to it (Sen and Kingman, 1973). Ertan (2007) found that adding humic acid to soil increased plant growth, dry weight, fruit weight, yield, and total dissolved solids in tomato juice when spraying it at a concentration of 20 ml/L multiple times. Yassar et al (2009) It was also obtained that when humic acid was added to the soil or sprayed, the highest average fruit weight, early yield and total yield of pepper plants was when sprayed at a rate of 20 ml.L-1 three sprays. Humic acids enhance plant resistance to salt stress. It is generally noted that the field soil has a degree of reaction that tends to be alkaline, which makes some microelements such as iron, manganese, and boron not ready for absorption by the plant Abu Dahi and Al-Younis (1988). Organic fertilizers that contain humic substances, which are natural substances. Amendments aiming to increase soil organic matter are linked to improving the physical, chemical, and biological properties of the soil and the plant, with the growth of cabbage plants being influenced by various factors, including the use of organic fertilizers. Humic compounds are of great importance in plant nutrition because they increase the release of nutrients, increase the cation exchange capacity of ions, and increase the readiness of microelements. Acids are a category of humic compounds that are obtained by extracting them with solvents or alkaline solutions. They exist as dark-colored solutions or granules (Masalat and Musleh, 2012). One kind of organic matter that is produced as organic matter breaks down is humic acid. Permeability is increased by humic acid, according to studies. It improves the absorption of nutrients and fortifies cell membranes (Kaya et al., 2005). It also leads to improved plant growth. It was pointed out by (Durer and Peacock, 1997). The importance of humus comes because it helps the work of enzymes and activates them in the plant. It increases and acts as an organic catalyst in processes. Increased vitality leads to increased plant growth, encourages root growth and absorption of water and nutrients, and contributes to increasing the efficiency of the photosynthesis process (Robert and Beatty, 2003). According to Abbas and Hammad (2016), the use of humic acid by spraying resulted in enhanced vegetative growth characteristics in some vegetable crops. Foliar spraying was utilized in studies to show how organic nutrients affect vegetable plant growth and production. Turhan (2019) found that feeding cauliflower plants with humic acid at (1 and 2) g.l-1 increased their height in Turkey. The market yield and yield total per unit area were both increased as a result of the plant, the quantity of foliage, and the concentration of 2 g.l-1. According to Al-Bayati (2019), it was found in Babylon that adding 5 ml.L-1 of humic acid to a plant raised its height, the number of leaves, the weight of the flower center, and its overall mass production. To enhance the productivity of a unit area and produce a crop that is free of harmful chemicals in the Nineveh Governorate, humic acid is employed in varying concentrations and two methods of addition: foliar spraying and soil addition.

Methods

The experiment was carried out in the vegetable field (Department of Horticulture and Landscape Engineering, College of Agriculture and Forestry, University of Mosul) during the 2022-2023 agricultural season to find out how addition technique and potassium humate fertilization affected the growth and yield of red cabbage. The experiment used the Ruby King cultivar and was designed using a completely randomized design (RCBD) with three replications. The spraying treatment was with humic acid at a concentration of (0, 50, 100, 150) g.l-1, and the method of addition was (foliar spraying and addition to the soil), and the seedlings were planted on 10/15/2022 in two rows, the length of each row was 2 m. Each experimental unit was planted with 10 plants, with a 20 cm spacing between them. The application of each agricultural practice, including irrigation, weeding, and hoeing, was consistent across all treatments (Muttalib, 1989). For every plant in the experimental unit, heads were manually removed in the first month after the conclusion of head development, and measures of vegetative growth were noted. From each experimental unit, five plants were selected in order to quantify yield and vegetative growth: 1.

Height of plant (cm/plant). A measuring tape was used to measure the distance from the soil surface to the longest leaf.

2- Stem length (cm): The measurement was recorded from the area of the stem that produces leaves.

3- Number of leaves per sheet. Plant-1 Marketable and non-marketable plant (leaf/plant-1).

4- Leg diameter mm. Plant-1: The electronic device (vernia) was used.

5- Relative leaf chlorophyll content (SPAD): Total chlorophyll was estimated using a 502 chlorophyll meter (SPAD), a device of Japanese origin. The measurement was performed in the field at a rate of 5 readings/plant.6- Average weight of one head (g): To get the average head weight, the head weight of five plants per experimental unit was measured and divided by the total number of heads. Marketable head weight, kg.Plant-1 and Weight of the total non-marketable head, kg.Plant-1.

7- The thickness of the leaf neck is mm. Plant-1. The electronic device (Vernia) was used.

8- Yield per plant (kg. plant-1): In order to calculate the rate, the productivity of the experimental unit was determined and then divided by the total number of plants.

9- Total yield of heads (tons.h-1): It was determined using the equation below:

<p style="font-size: 1.2em;">Total yield (tons ha⁻¹) =</p>	$\frac{\text{experimental unit yield (tons)} \times 10000}{\text{Experimental unit area (m}^2\text{)}}$
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Figure 1.

The study's findings were statistically examined using the SAS (1998) software, and at the 0.05 probability level, the means were compared using Duncan's multinomial est (Al-Rawi and Khalfallah, 2000)

Result and Discussion

(1): The effect of fertilizer with potassium humate and the method of addition to the growth of red cabbage

treatments		Plant height cm.Plant-1	Stem length cm.Plant-1	Number of unmarketabl e leaves.Plant leaf-1	Number of leaves.Plant- 1	Stem diameter mm.Plant -1	Total chlorophyll %
adding To the soil foliar spraying	control 1	44.02	16.90	8.60	21.44	54.80	53.57
		b	Ab	B	c	c	b
	50	45.85	17.40	13.81	25.80	58.03	55.56
		B	A	a	a	a	b
	100	46.91	16.08	14.13	23.33	56.36	53.93
		ab	Ab	a	ab	ab	c
150	45.82	16.80	13.22	26.13	56.24	55.56	
	Ab	Ab	Ab	a	ab	b	
foliar spraying	control 1	46.40	16.90	10.9	20.88	54.00	53.99
		Ab	ab	ab	b	b	c
	50	44.55	17.88	13.82	23.7	53.23	56.55
		B	a	a	ab	b	a
	100	48.95	17.88	14.15	21.7	56.36	54.94
		a	a	a	b	ab	ab
	150	48.82	17.98	14.92	24.9	58.0	57.80
		a	A	ab	a	a	a

Table 1.

* Duncan's polyn test at the 0.05 probability level indicates that the averages for each component and interaction that share the same alphabetic letters do not differ significantly from one another.

(2): The effect of fertilizer with potassium humate and the method of addition to the growth yield of red cabbage

treatments		Marketable head weight, kg.Plant-1	Weight of the total non-marketable head, kg.Plant-1	Thickness of leaf neck mm.Plant-1	The experimental unit yield is kg.Plant-1	Total yield tons.hectare-1	
adding To the soil foliar spraying	control 1	1.74	2.580	78.24	17.40	4350	
		Ab	a	b	c	c	
	50	1.85	2.843	85.25	18.50	4625	
		Ab	a	a	b	b	
	100	1.93	2.981	85.41	19.30	4825	
		Ab	a	a	b	b	
	150	1.62	2.46	74.92	16.20	4050	
		Ab	a	c	ab	a b	
	foliar spraying	control 1	1.99	2.88	85.9	19.90	4975
			Ab	a	a	ab	a b
50		2.51	2.99	83.25	25.10	6275	
		A	a	a	a	a	
100		1.93	2.34	78.41	19.30	4825	
		Ab	a	b	ab	a b	
150		2.60	3.56	89.92	26.00	6500	
		A	a	a	a	a	

Table 2.

* Duncan's polyn test at the 0.05 probability level indicates that the averages for each component and interaction that share the same alphabetic letters do not differ significantly from one another.

Table (4) clearly shows that the addition of potassium humate had a significant effect on the vegetative growth characteristics and yield of cabbage plants, as spraying fertilizer at a level of 150 g/L-1 resulted in a significant superiority over the other treatments. The quantitative characteristics of the crop have increased as a result of the function of humic acid in potassium humate fertilizer in promoting vegetative growth. This, in turn, has resulted in a rise in the concentration of synthetic substances in the leaves and an increase in yield. The application of humic acid at a concentration of 5 mL-1 to a plant increased its height and leaf count, aligning with findings from Babylon (Al-Bayati, 2019), and also increased its combined mass, flower head weight, and plant weight. The current investigation's results agree with those of Hamza et al.'s (2009) research on cucumber plants which found that applying humic acid fertilizer to the foliage increased the quantity, weight, and total production of fruits. Humic acids enhance plant nutrient absorption by promoting element readiness and transport, particularly microelements, and enhancing microbial activity, allowing negative phosphate ions to be absorbed (Lutzow et al., 2006). The abundance of nutrients in soil improves water retention, leading to improved root development and plant growth. Humic acid derivatives, which increase cell membrane permeability, facilitate the movement of humic molecules into the cellular pathway (Fawcett, 1998). Moreover, humic acids reduce the activity of the enzyme (IAA oxidase), thus increasing the activity of auxin (IAA), which functions in promoting root and plant development growth. Moreover, humic acids increase the capacity of soil components to hold salt, therefore enabling the plant to withstand high quantities. High concentrations of this element provide defense against osmosis issues and toxicity (Stevenson, 1994).

Conclusion

The application of potassium humate to the soil significantly enhanced the vegetative growth and yield characteristics of the cabbage plant. Therefore, we recommend the use of organic fertilizers in general and potassium humate fertilizer in particular because it is a beneficial fertilizer for the soil that enriches it with nutrients, and potassium humate is considered an organic fertilizer as it increases the quality of the product and the plant's tolerance to drought, salinity stress, heat, cold, diseases, and pests

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