

## Response of growth, yield and its quality of violet carrot to fertilization with poultry manure, spraying with Brassinolide and Reishi mushroom extract

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### Abstract

A factorial experiment was conducted with three factors (3×3×3) and three replicates within a split-plot arrangement and applying a randomized complete block design (RCBD) for the fall season 2023-2024. The first factor is poultry manure at three levels (0, 5000 and 10000) kg per hectare. The second factor is spraying plants with Barasinolide growth regulator at three concentrations (0, 1 and 2) mg/L. The third factor is spraying plants with Reishi mushroom extract, which is prepared by the aqueous extraction method at three concentrations (0%, 5% and 10%). The plants are sprayed twice, the first time after the appearance of three true leaves, where the parasinolide growth regulator is sprayed first, and after three days the mushroom extract is sprayed, and the second spray is twenty days after the first spray. Decomposed poultry manure was distributed randomly on the main plots before planting. Adding poultry manure increased plant height, number of leaves, anthocyanin and sugar content. Spraying with brassinolide growth regulator also increased plant height, root weight of purple carrots, anthocyanin and sugar content. Spraying with aqueous extract of Reishi mushroom also increased anthocyanin and sugar content. All additions improved the vegetative and quantitative characteristics and the total production of purple carrots.

**Keywords.** Violet carrot. Poultry manure. Barasinolide. Reishi mushroom extract

### Introduction

Carrots are a preferred produce among Iraqi consumers. In addition to their high nutritional value and antioxidants. Therefore, there has been a research trend in recent years to focus on their cultivation and reproductive biology to increase production and improve quality (Al-Khafaji and Al-Jubouri, 2024; Al-Khafaji and Al-Jubouri, 2024b). Studies have shown that the use of organic fertilizer leads to plant productivity being close to that obtained with chemical fertilization (Motavalli *et al.*, 1989; Sadiq *et al.*, 2016; Dheyab *et al.*, 2025; Al-Jubouri *et al.*, 2025). This is because organic matter has a direct effect on the natural, chemical and biological properties of the soil (Shaker and Abdul Rasool, 2023). It is responsible for the exchange capacity of the soil, in addition to its effect on the acidity of the soil, its regulatory capacity, soil fertility, and supplying plants with the necessary nutrients released from organic compounds when they decompose, and supplying microorganisms with energy and important elements in building their bodies. Organic matter also increases biological activity within the root spread area because it contains some beneficial microbes that activate vital processes, in addition to being considered one of the natural improvers that play an important and effective role in improving the general properties of the soil (Enaad and Kashkool, 2022) Excessive use of chemical fertilizers leads to an increase in the percentage of salts in the soil and exacerbates the problem of environmental pollution, especially when irrigated with saline water. Therefore, it has become necessary to search for environmentally clean and suitable alternatives such as poultry manure. Poultry manure is a good organic fertilizer that contains a high percentage of N, P and K, which the plant needs. Poultry manure improves soil fertility and also increases the soil's ability to retain water (Desksissa *et al.*, 2008; Farad *et al.*, 2009)

*Ganoderma lucidum*, also known as reishi mushroom, is used in traditional Asian medicine for its medicinal properties. In recent years, its potential benefits in agriculture have been studied. Research studies have shown that *Ganoderma* extracts can be used as a plant growth promoter, improving the yield and quality of vegetables and fruits. Studies also suggest that it can enhance the stress tolerance of plants (Shukla *et al.*, 2005) and improve their ability to withstand drought, high temperatures, and diseases. In addition, it can also be used as a natural pesticide. There are several studies that have investigated the effects of *Ganoderma* on various crops, including what was found Postemsky *et al.* (2016) when they used Reishi mushroom extracts as a material in the manufacture of biodegradable containers that were evaluated for planting seeds of multiple vegetable plants. It affected the germination of 15 out of 17 plant species and also led to improved seedling growth, especially tomato seedlings. Adding poultry manure to the soil has given a significant increase in the percentage of nutrients in the soil of N, P, K and Zn and an increase in the amount of sweet potato yield. Nguyen (2010) explained that the organic matter prepared from poultry manure has a significant effect on the physical condition of the soil such as increasing the pores of the soil, which increases aeration and water movement in clay soils, and vice versa, increases the cohesion of sandy soils, which increases their water retention. Also, the use of poultry manure for a long period is likely to change the biological and chemical properties of the soil. Whalen *et al.* (2006), Yong *et al.* (2004), and Maxime Merlin *et al.* (2020) found that adding poultry manure to carrot plants at a rate of 2500 kg/ha-1 led to a significant increase in the yield and root content of carbohydrates, carotenoids and calcium compared to the mineral fertilization treatment.

Brassinosteroids (BRs) are one of the plant hormones and were first discovered by the scientist Mitchell through examining the pollen grains of about 60 plant species (Mitchell *et al.*, 1970) and he called them Brassins (Al-Khafaji, 2014; Montoya *et al.*, 2005). Brassinosteroids are a basic hormone in most of the physiological functions of plants and are important in the growth and development of the plant. They also regulate a number of cellular and physiological processes that occur in the plant, such as cell division and elongation, the biosynthesis of cell wall components, the synthesis of DNA and RNA, and 10 different proteins, the distribution of metabolites to plant organs, the growth of the pollen tube, and differentiation. The vascular system of the plant, the formation of lateral roots, flowering, seed production and germination, resistance to biotic and abiotic stresses, delaying aging, and other pro (Bajguz and Hayat, 2009)

### Materials and methods

To study the effect of fertilization with poultry waste and spraying with brassinosteroid growth regulator and reishi mushroom extract and their interactions on the growth and yield of purple carrots and their content of plant pigments, the experiment was carried out in one of the fields of the College of Agricultural Engineering Sciences / University of Baghdad Al-Jadriyah for the autumn agricultural season 2023-2024 at Station (A) where the trepanation process was carried out and after a week the weeds were controlled and then the soil was turned over and then the second plowing process was carried out and the field was divided and terraces were made and poultry manure was added and mixed with the soil in the experimental units. The decomposed poultry manure was distributed randomly to the main plots and the combination of the two factors of spraying with both brassinosteroids and reishi mushrooms (equal importance) was distributed to the secondary plots within the main plots and then a drip irrigation system was made and then the seeds were planted. The area of the experimental unit was 1 x 2 m<sup>2</sup> and planted in three lines with a distance between the lines of 20 cm and a distance

### Study factors

- 1- The first factor is poultry manure at three levels (0, 5000 and 10000) kg per hectare. The levels are added to the soil before planting
- 2- The second factor is the Barasinolide growth regulator, sprayed at three concentrations (0, 1 and 2) mg/L. One month after planting and the appearance of three true leaves, the first spraying process was carried out, and the second spraying was carried out 20 days after the first spray
- 3- The third factor is the aqueous extract of the reishi mushroom *Ganoderma lucidum*, sprayed at three concentrations (0%, 5% and 10%), and three days after spraying the Barasinolide growth regulator, the second spraying was carried out 20 days after the first spraying between plants of 5 cm. After planting, the thinning and weeding process was carried out (Bajguz and Hayat, 2009)

**Characteristics studied**

- 1- Plant height (cm)
- 2- Number of leaves
- 3- Root weight in purple carrots
- 4- Anthocyanin pigment determination (mg/100g fresh weight)
- 5- Measurement of total sugar concentration in roots

**Results**

**Plant height**

The results in Table (1) showed that the treatment of adding poultry waste (P1) was significantly superior and led to an increase in plant height, as the height reached 82.81 cm compared to the comparison treatment (P0), which gave 77.93 cm. The treatment of spraying with brassinolide (B2) was also significantly superior and gave the highest rate of 83.96 cm compared to the comparison treatment, which gave the lowest rate of 79.56 cm. As for the treatment of reishi mushroom (G), it did not give any increase. As for the interaction treatment (P1B2G0) and (P1B0G2), they gave the highest significant superiority of 90.67 and 89.00 cm, respectively, compared to the comparison treatment, which gave the lowest rate of 69.00 cm. The interaction treatment P1B2 gave a significant superiority of 85.44 cm compared to the comparison treatment, which gave the lowest rate of 72.77 cm. The two treatments gave The P1G0 and P2G2 overlap significantly outperformed the comparison treatment, which gave 78.89 cm, by 87.22 and 83.67 cm, respectively. The B2G0 overlap treatment outperformed and gave the highest rate of 87 cm, by 87 cm, compared to the comparison treatment, which gave 78.56 cm.

**Table 1.** Effect of adding poultry waste and spraying with brassinolide and reishi mushroom on the height of purple carrot plant (cm)

		Season 2023-2024			
Poultry waste(P)	Spraying with brassinolide (B)	Reishi mushroom (G)			P*B
		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	
P <sub>0</sub>	B <sub>0</sub>	69.00	74.00	75.33	72.77
	B <sub>1</sub>	80.67	78.33	75.00	78.00
	B <sub>2</sub>	87.00	85.67	76.33	83.00
P <sub>1</sub>	B <sub>0</sub>	83.00	81.67	82.00	82.22
	B <sub>1</sub>	88.00	75.33	79.00	80.77
	B <sub>2</sub>	90.67	80.00	85.67	85.44
P <sub>2</sub>	B <sub>0</sub>	83.67	78.33	89.00	83.66
	B <sub>1</sub>	77.33	81.33	79.00	79.22
	B <sub>2</sub>	83.33	84.00	83.00	83.44
L.S.D (0.05)			9.04		2.83
P*G		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P
P <sub>0</sub>		78.89	79.33	75.56	77.93
P <sub>1</sub>		87.22	79.00	82.22	82.81
P <sub>2</sub>		81.44	81.22	83.67	82.11
L.S.D (0.05)			2.83		1.63
B*G		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	B
B <sub>0</sub>		78.56	78.00	82.11	79.56
B <sub>1</sub>		82.00	78.33	77.67	79.33
B <sub>2</sub>		87.00	83.22	81.67	83.96
L.S.D (0.05)			2.83		
G		82.52	79.85	80.48	1.63
L.S.D (0.05)			N.S		

**Number of leaves:**

The results in Table(2) showed that the treatment of adding poultry manure (P1) was significantly superior and led to an increase in the number of leaves, as the number of leaves reached 10.30 compared to the comparison treatment (P0), which gave 9.62. Also, the treatment of spraying with the aqueous extract of the feather fungus (G1) was significantly superior and gave 10.19 leaves compared to the comparison treatment, which gave 9.43 leaves. The interaction treatment (P1B1G1) was significantly superior and gave 12 leaves compared to the comparison treatment, which gave the lowest rate of 7.67 leaves. The interaction treatment P1B1 gave a significant superiority of 11.11 leaves compared to the comparison treatment, which gave the lowest rate of 9.11. The interaction treatment P1G2 gave 10.44 leaves and was significantly superior compared to the comparison treatment, which gave 8.68. The B1G1 overlap treatment excelled and gave the highest rate of 10.67 papers compared to the comparison treatment which gave 8.78 papers.

**Table 2.** Effect of adding poultry waste and spraying with brassinolide and reishi mushroom on the number of leaves in purple carrots

		Season 2023-2024			
Poultry waste(P)	Spraying with brassinolide(B)	(G) Reishi mushroom			P*B
		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	
P <sub>0</sub>	B <sub>0</sub>	7.67	9.33	10.33	9.11
	B <sub>1</sub>	9.33	10.00	9.00	9.44
	B <sub>2</sub>	9.57	11.33	10.00	10.30
P <sub>1</sub>	B <sub>0</sub>	9.67	9.67	10.67	10.0
	B <sub>1</sub>	11.33	12.00	10.00	11.11
	B <sub>2</sub>	9.67	9.00	10.67	9.78
P <sub>2</sub>	B <sub>0</sub>	9.00	10.33	9.33	9.55
	B <sub>1</sub>	9.67	10.00	9.33	9.66
	B <sub>2</sub>	9.00	10.00	10.67	9.89
L.S.D (0.05)			1.68		0.97

<b>P*G</b>	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P
P <sub>0</sub>	8.86	10.22	9.78	9.62
P <sub>1</sub>	10.22	10.22	10.44	10.30
P <sub>2</sub>	9.22	10.11	9.78	9.70
<b>L.S.D (0.05)</b>		0.97		0.56
<b>B*G</b>	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	B
<b>L.S.D (0.05)</b>	8.78	9.78	10.11	9.56
B <sub>1</sub>	10.11	10.67	9.44	10.07
B <sub>2</sub>	9.41	10.11	10.44	9.99
<b>L.S.D (0.05)</b>		0.97		
<b>G</b>	<b>9.43</b>	<b>10.19</b>	<b>10.00</b>	<b>0.56</b>
<b>L.S.D (0.05)</b>		0.56		

**Root weight:**

The results in Table (3) showed that the spraying treatment with brassinolide (B2) was significantly superior and led to an increase in root weight of 99.4 g compared to the comparison treatment, which gave 91.3 g, and the interaction treatment (P0B2G1) was significantly superior and gave 108.3 g compared to the comparison treatment, which gave the lowest rate of 68.0 g, and the interaction treatment P0B2 gave a significant superiority of 103.56 g compared to the comparison treatment, which gave the lowest rate of 90.33 g, and the interaction treatment P0G2 gave 103.6 g and was significantly superior compared to the comparison treatment, which gave 90.3 g, and the interaction treatment B1G0 was superior and gave the highest rate of 103.2 g compared to the comparison treatment, which gave 87.1 g.

**Table 3.** Effect of adding poultry waste and spraying with brassinolide and reishi mushroom on root weight (g) in purple carrots

Poultry waste (P)	Spraying with brassinolide (B)	Season 2023-2024 (G) Reishi mushroom			
		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P*B
P <sub>0</sub>	B <sub>0</sub>	68.0	102.0	101.0	90.33
	B <sub>1</sub>	106.0	96.0	99.0	100.33
	B <sub>2</sub>	104.7	108.3	97.7	103.56
P <sub>1</sub>	B <sub>0</sub>	92.7	99.0	86.0	92.56
	B <sub>1</sub>	106.7	80.0	100.7	95.8
	B <sub>2</sub>	113.0	99.0	98.0	103.33
P <sub>2</sub>	B <sub>0</sub>	100.7	91.0	81.0	90.90
	B <sub>1</sub>	97.0	101.0	107.0	101.66
	B <sub>2</sub>	87.0	90.0	97.0	91.3
<b>L.S.D (0.05)</b>		9.06		5.23	
<b>P*G</b>	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P	
P <sub>0</sub>	90.3	100.3	103.6	98.1	
P <sub>1</sub>	92.6	95.8	103.3	97.2	
P <sub>2</sub>	90.9	101.7	91.3	94.6	
<b>L.S.D (0.05)</b>		5.23		N.S	
<b>B*G</b>	G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	B	
B <sub>0</sub>	87.1	97.3	89.3	91.3	
B <sub>1</sub>	103.2	92.3	102.2	99.3	
B <sub>2</sub>	101.6	99.1	97.6	99.4	
<b>L.S.D (0.05)</b>		5.23			
<b>G</b>	97.3	96.3	96.4	3.02	
<b>L.S.D (0.05)</b>		N.S			

**Estimation of anthocyanin pigment (mg/100g fresh weight)**

The results in Table (4) showed that The treatment of adding poultry manure led to a significant increase in the content of anthocyanin pigment in the roots, as the treatment of adding poultry manure P3 was significantly superior to the control treatment and gave the highest value of 308.5 (mg/100g fresh weight) compared to the control treatment (P1), which gave the lowest value of 169.2 (mg/100g fresh weight). The treatment of spraying with brassinolide (B3) also led to a non-significant superiority in the content of anthocyanin pigment in the roots of the purple carrot plant and gave the highest rate of 263.9 (mg/100g fresh weight) compared to the control treatment (B1), which gave the lowest rate of 237.1 (mg/100g fresh weight). The spraying treatment with the aqueous extract of the Reishi mushroom (G3) was significantly superior and gave 276.1 (mg/100g fresh weight) compared to the comparison treatment which gave 255.1 (mg/100g fresh weight). As for the interaction treatment (P2B0G2), it gave the highest rate of 350.8 (mg/100g fresh weight) and was significantly superior compared to the comparison treatment which gave the lowest rate of 103.0 (mg/100g fresh weight). The interaction treatment P2B2 gave a significant superiority of 316.6 (mg/100g fresh weight) compared to the comparison treatment which gave the lowest rate of 119.1 (mg/100g fresh weight). The interaction treatment P2G2 gave the highest significant rate 330.0 (mg/100g fresh weight) compared to the comparison treatment, which gave 161.6 (mg/100g fresh weight). The B1G2 interaction treatment was superior and gave the highest significant rate of 286.0 (mg/100g fresh weight) compared to the comparison treatment, which gave 245.8 (mg/100g fresh weight).

**Table 4.** Effect of adding poultry waste and spraying with brassinolide and reishi mushroom on the determination of anthocyanin pigment (mg/100g fresh weight) in purple carrots.

Poultry waste (P)	Spraying with brassinolide (B)	Season 2023-2024			
		(G) Reishi mushroom			P*B
		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	
P <sub>0</sub>	B <sub>0</sub>	103.0	107.0	147.2	119.1
	B <sub>1</sub>	181.8	190.8	236.7	203.1
	B <sub>2</sub>	199.9	153.9	202.9	185.6
P <sub>1</sub>	B <sub>0</sub>	318.0	231.1	302.6	283.9
	B <sub>1</sub>	261.4	268.4	306.5	278.7
	B <sub>2</sub>	273.4	296.2	299.1	289.6
P <sub>2</sub>	B <sub>0</sub>	316.5	257.4	350.8	308.2
	B <sub>1</sub>	320.4	267.2	314.8	300.8
	B <sub>2</sub>	321.7	303.5	324.4	316.6
<b>L.S.D (0.05)</b>			78.82		42.57
<b>P*G</b>		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P
	P <sub>0</sub>	161.6	150.6	195.6	169.2
	P <sub>1</sub>	284.3	265.2	302.7	284.1
	P <sub>2</sub>	319.5	276.0	330.0	308.5
<b>L.S.D (0.05)</b>			43.0		25.08
<b>B*G</b>		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	B
	B <sub>0</sub>	245.8	198.5	266.9	237.1
	B <sub>1</sub>	254.5	242.1	286.0	260.9
	B <sub>2</sub>	265.0	251.2	275.5	263.9
<b>L.S.D (0.05)</b>			47.60		
<b>G</b>		255.1	230.6	276.1	N.S
<b>L.S.D (0.05)</b>			N.S		

**Total sugars ratio in roots**

The results in Table (5) showed that the treatment of adding poultry waste (P2) was significantly superior and led to an increase in the percentage of total sugars and gave 9.96% compared to the comparison treatment (P0) which gave 7.66%. The spraying treatment with brassinolide (B2) was also significantly superior and gave the highest rate of 9.86% compared to the comparison treatment which gave the lowest rate of 7.53%. The spraying treatment with the aqueous extract of the reishi mushroom was significantly superior and gave 9% compared to the comparison treatment which gave 7.23%. As for the interaction treatment (P2B2G2), it was significantly superior and gave the highest rate of 13.00% compared to the comparison treatment which gave the lowest rate of 5.40%. The interaction treatment P2B2 gave a significant superiority of 10.60% compared to the comparison treatment which gave a rate of 6.43% and the P2G2 interaction treatment was superior and gave the highest rate of 13.30% compared to the comparison treatment, which gave 6.60% and the B2G2 interaction treatment was superior and gave the highest rate of 12.20% compared to the comparison treatment, which gave 7.13%

**Table 5.** Effect of adding poultry waste and spraying with brassinolide and reishi mushroom on the percentage of sugars (%) in the roots of purple carrots

Poultry waste (P)	Spraying with brassinolide (B)	Season 2023-2024			
		(G) Reishi mushroom			P*B
		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	
P <sub>0</sub>	B <sub>0</sub>	5.40	7.20	6.70	6.43
	B <sub>1</sub>	5.60	7.70	8.10	7.13
	B <sub>2</sub>	8.80	12.13	7.30	9.41
P <sub>1</sub>	B <sub>0</sub>	10.20	7.30	7.50	8.33
	B <sub>1</sub>	6.90	12.40	5.20	8.16
	B <sub>2</sub>	6.30	6.10	6.30	6.23
P <sub>2</sub>	B <sub>0</sub>	5.80	9.73	7.90	7.81
	B <sub>1</sub>	6.47	8.93	9.00	8.13
	B <sub>2</sub>	9.60	9.20	13.00	10.60
<b>L.S.D (0.05)</b>			0.91		0.52
<b>P*G</b>		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	P
	P <sub>0</sub>	6.60	9.01	7.37	7.66
	P <sub>1</sub>	7.80	8.60	6.33	7.58
	P <sub>2</sub>	7.29	9.29	13.30	9.96
<b>L.S.D (0.05)</b>			0.52		0.30
<b>B*G</b>		G <sub>0</sub>	G <sub>1</sub>	G <sub>2</sub>	B
	B <sub>0</sub>	<b>7.13</b>	<b>8.08</b>	<b>7.37</b>	<b>7.53</b>
	B <sub>1</sub>	<b>6.32</b>	<b>9.68</b>	<b>7.43</b>	<b>7.81</b>
	B <sub>2</sub>	<b>8.23</b>	<b>9.14</b>	<b>12.20</b>	<b>9.86</b>
<b>L.S.D (0.05)</b>			<b>0.52</b>		
<b>G</b>		7.23	8.97	9.00	0.30
<b>L.S.D (0.05)</b>			0.30		

## Discussion

The results in Table (1) plant height and Table (2) number of leaves showed that the treatment of adding poultry manure (P1) was significantly superior and led to an increase in plant height and an increase in the number of leaves due to the effect of decomposed poultry manure on plants in general and agricultural vegetables in particular because it is characterized by great benefits in improving growth, productivity and qualitative characteristics, as a result of its richness in nutritional and organic elements. Where poultry manure is rich in nitrogen and elements that support the building of green mass, such as phosphorus and potassium, and nitrogen supports the formation of amino acids and chlorophyll, which enhances cell division and stem extension. Nitrogen and phosphorus also stimulate the formation of lateral buds and leaf development (Al-Amiri *et al.*, 2014; Ahmed and Khalil, 2021; Al-Hadethi, 2018; Hanshal, 2010). As for the brassinolide treatment, it was shown in Table (1) Table (2) and Table (3) its effect on plant height, number of leaves and increased root weight comes through the hormone's action on stimulating cell division and elongation (Sharma and Kumar, 2020; Khan and Hussain, 2021). The results were shown in Table (2) Spraying the extract of the feather mushroom led to a significant increase in the number of leaves because it contains biologically active compounds that enhance plant growth. These compounds include polysaccharides, triterpenoids, and antioxidant compounds, which may stimulate the physiological processes of plants (Mensah *et al.*, 2018). The results are shown in Table (4) on the effect of adding decomposed poultry manure in increasing the percentage of anthocyanins, because poultry manure contains a high percentage of organic nitrogen, phosphorus, potassium, and trace elements (such as zinc and magnesium), which support plant growth and activate the vital pathways for anthocyanin production. Phosphorus and potassium also enhance the absorption of sugars and the enzyme activity associated with the synthesis of anthocyanins, such as the PAL enzyme (Al-Karwi, 2016). Brassinolide showed in Table (4) a significant increase in the percentage of anthocyanins, which is due to brassinolide stimulating the expression of genes responsible for the synthesis of anthocyanins, such as CHS (Chalcone Synthase), DFR (Dihydroflavonol Reductase), and UFGT (UDP-Glucose Flavonoid Glucosyltransferase). These pathways regulate transcription factor genes such as MYB/bHLH/WD40 (Peng *et al.*, 2011). In purple carrots, the brassinolide hormone activates the DcMYB7 gene associated with pigment formation. The brassinolide hormone also works synergistically with auxin and cytokinin to enhance the synthesis of anthocyanin. The treatment of the Reishi mushroom extract in Table (4) showed a significant superiority in the percentage of anthocyanin because the Reishi mushroom contains biologically active compounds such as polysaccharides, triterpenoids, and antioxidants, which stimulate physiological responses in the plant, including increasing the production of secondary compounds such as anthocyanin, as it stimulates metabolic pathways associated with the production of anthocyanin, which leads to an increase in its concentration in plant tissues. (Lou *et al.*, 2019). The results in Table (5) showed a significant increase in the percentage of sugars when adding decomposed poultry manure, due to the poultry manure containing important nutrients such as N, P, and K, in addition to organic materials that improve soil fertility and enhance plant growth. Consequently, these elements stimulate and increase photosynthesis, which leads to increased sugar production in the plant (Maxime Merlin *et al.*, 2020). Also, the spraying treatment with brassinolide significantly outperformed in Table (5) in increasing the percentage of sugars, due to the effective role played by the hormone in stimulating physiological and biochemical processes in the plant, as it enhances the efficiency of the photosynthesis process by increasing the activity of enzymes involved in the process, such as the enzyme (Rubisco). This leads to increased production of carbohydrates, such as glucose, which are transported and stored in the roots. Brassinolide also stimulates the activity of proteins responsible for transporting sugars from the leaves to the roots, such as sucrose transporters, and it also activates enzymes that work to convert simple carbohydrates into complex sugars, such as sucrose, which increases their accumulation in the roots. (Wang *et al.*, 2019) Also, the spraying treatment with the aqueous extract of the Reishi mushroom was significantly superior. This is due to the fact that the extracts of the Reishi mushroom contain compounds such as polysaccharides and triterpenoids, which act as bio-stimulants that enhance the absorption of nutrients such as nitrogen and phosphorus by increasing the activity of enzymes in the roots, which supports the manufacture of sugars and also improves the efficiency of the photosynthesis process by increasing the chlorophyll content, which leads to greater production of carbohydrates that are stored in the roots (Mensah *et al.*, 2018).

## Conclusion

Through the results, we see the effect of the factors, whether individually, they gave good results because these factors have the ability to provide the plant with elements and organic materials, such as poultry manure, stimulate enzymes, and increase cell division and elongation, such as the hormone brassinolide, such as the reishi mushroom, which contains polysaccharides and triterpenoids, which act as biostimulants that enhance the absorption of nutrients such as nitrogen and phosphorus by increasing the activity of enzymes in the roots. Combining these factors (organic fertilizer, fungal extract, the hormone may have a synergistic effect, with each factor enhancing the effect of the other factors, leading to an overall improvement in plant growth and physiological functions.

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