

Using Poultry Manure, Brassinolides, and Reishi Mushrooms to Improve the Quality of Purple Carrot Roots

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ABSTRACT

This research aims to study effect of poultry manure, brassinolide growth regulator, and reishi mushroom aqueous extract. A randomized complete block design (RCBD) and split plot arrangement was conducted with three factors (3 x 3 x 3) and three replicates. The experiment was conducted during the fall season of 2023-2024. The first factor was decomposed poultry manure at three levels (0, 5,000, and 10,000) kg ha⁻¹. The second factor was spraying plants with the brassinolide growth regulator at three concentrations (0, 1, and 2) mg L⁻¹. The third factor was spraying plants with the reishi mushroom extract, which is prepared by the aqueous extraction method, at three concentrations (0%, 5%, and 10%). Decomposed poultry manure is distributed randomly over the main plots before planting. The addition of poultry manure, the growth regulator brassinolide, and an aqueous extract of reishi mushrooms increased phosphorus, protein, vitamin C, beta-carotene, leucine, and threonine, thereby improving the quality characteristics of purple carrots.

Keywords: beta-carotene, fertilizer, growth regulator, leucine, organic, threonine, Vitamin C



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INTRODUCTION

Purple carrot (*Daucus carota*) is a biennial, tap rooted vegetable of the family Apiaceae. It is genetically linked to the ordinary orange carrot, but has purple colouring due to an increased presence of certain antioxidants. Purple colored carrot is an excellent source of dietary fiber, vitamin C, potassium and manganese and a good source of vitamin K and vitamin A, carbohydrate and natural antioxidants lutein and β -carotene. They also include phenolics, such as anthocyanins, and essential amino acids like leucine, threonine, and arginine. Eating purple carrots regularly is very healthy; they balance core body weight, prevent ovulation, and lead to a low-carb effect, if eaten in the form of fiber, which supports weight loss, diabetes by slows down the digestion of carbohydrates and reduces the risk of certain cancers and cardiovascular diseases. They're a great anti-inflammatory, great for your eyes, amazing for circulation, and support the management of chronic illnesses. (To improve the quality of purple

carrot roots, three factors were used: poultry manure, brassinolide growth regulator, and aqueous extract of reishi mushroom.) Researches have demonstrated that comparable yields could be obtained when organic fertilizers are applied in comparison to those using chemical fertilizers (Motavalli, et al. 1989, Roy & Barman, 2015). Organic matter also contributes to the physical, chemical and biological (Moridi, et al./ 2021, Zhang et al. 2022) attributes of the soil give Organic matter (OM). It has a predominant effect in controlling the soil's cation exchange capacity, soil acidity, 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 rhizosphere because it contains some beneficial microbes that stimulate vital processes. In addition, it is considered one of the natural improvers that

play an important and effective role in improving the general properties of the soil (Fatima, et al. 2022). Excessive use of chemical fertilizers leads to an increase in the percentage of salts in the soil and an exacerbation of the problem of environmental pollution, especially when irrigated with saline water (Hossain, et al. 2022). Therefore, it has become necessary to search for environmentally clean and suitable alternatives such as poultry manure. Poultry manure is considered a good organic fertilizer that contains a high percentage of N, P, and K, which plants need. Poultry fertilizer improves soil fertility and also increases the soil's ability to retain water (Kobierski, et al. 2017). Adding poultry manure to the soil significantly increased the percentage of nutrients in the soil, including N, P, K, and Zn, and increased the sweet potato yield. (Zhang, et al. 2024) showed that the organic matter prepared from poultry manure has a significant effect on the physical condition of the soil, such as increasing soil pores, which increases aeration and water movement in clayey soils, and conversely, increasing the cohesion of sandy soils, which increases their water retention. Long-term application of poultry manure can also lead to alterations in the soil's biological and chemical properties (Whalen, et al. 2006, Yong, et al. 2004). Moreover, a study by (Maxime Merlin, et al. 2020) reported that applying poultry manure at a rate of 2500 kg ha⁻¹ to carrot plants significantly increased yield, carbohydrate, carotenoids, and calcium in roots compared to mineral fertilizer treatments. Brassinosteroid (BRs) are a class of essential plant hormones, it is function in many physiological processes associated with plant growth and development. They control many cell and metabolic activities such as cell division and expansion, biosynthesis of cell wall constituents, and synthesis of DNA, RNA, proteins and distribution of photosynthates to plant organs. BRs are also involved in pollen tube elongation, vascular differentiation, adventitious root formation, flowering time, seed development and germination, and improve plant tolerance to biotic and abiotic stresses. Furthermore, n-alkanols inhibit senescence and act in other

essential biological processes. A study conducted by (Que, et al. 2017, Zeng, et al. 2023) Spraying carrot leaves with a concentration of 0.5 mg/L of the growth regulator brassinolide led to an increase in plant height and the number of leaves, thus affecting the growth and development of roots. A recent study conducted by (Yong, et al. 2004) showed that spraying brassinolide on carrot leaves led to an increase in the plant growth rate and improved root quality. Concentrations of (0.1 and 0.2 ml/L) of the growth regulator were used, and it was found that the concentration of 0.1 ml/L enhances root growth, plant height, and the number of leaves, and increases the sugar content in the roots). Reishi mushroom, also known as *Ganoderma lucidum* is the common symbol of longevity, and has always been used for its medicinal properties. It has been increasingly noticed for possible uses in the field of agriculture. It has been found that extracts of *Ganoderma* applied to vegetables and fruits can serve as plant growth stimulants and help to increase the yield and quality. (Zhu, et al. 2012) In addition, research has shown that these extracts are able to increase the resistance of the plant to stress (Singh, et al. 2018) for instance, in drought, high temperature, and disease stress conditions. (Deng, et al. 2023) Apart from their growth enhancement activities, *G. lucidum* extracts have been found to be promising natural biopesticides. (Zhang, et al. 2019) Several studies have investigated the effects of *Ganoderma* on various crops. Postemsky et al (Postemsky, et al. 2016) found that when reishi mushroom extracts were used as a material in the manufacture of biodegradable containers for growing multiple vegetable seeds, they affected the germination of 15 out of 17 plant species. It also improved seedling growth and quality, particularly for tomato seedlings. 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 indicate that they can enhance plant stress tolerance (Wang, et al. 2021) and improve their ability to withstand drought, high temperatures, and diseases. Additionally, they

can also be used as a natural pesticide. A research study was designed to use aqueous Reishi mushroom extract in a greenhouse. The study showed that treating eggplant roots with Ganoderma extracts (CFs) for 30 minutes reduced the level of *M. incognita* infection and enhanced eggplant growth. The highest percentage of increase was achieved in plant height, fresh weight, dry weight, total chlorophyll, carotenoids, and yield/plant ratio (Fatima, et al. 2022).

MATERIALS AND METHODS

To investigate the effects of Poultry manure fertilization, foliar application of the Brassinosteroid growth regulator, and Reishi mushroom extract—as well as their interactions—on the quality characteristics of Purple carrot roots, a field experiment was carried out during the 2023–2024 fall growing season at Field Station A, College of Agricultural Engineering Sciences, University of Baghdad, located in Al-Jadriyah. The field preparation process began with leveling, followed a week later by weed control, plowing, and a second tillage operation. The field was then divided into experimental units, and raised beds were formed. Decomposed Poultry manure was applied and mixed into the soil of each experimental unit. The Poultry manure treatments were randomly assigned to the main plots, while the combinations of Brassinosteroid and Reishi mushroom extract sprays (considered of equal importance) were distributed within the subplots nested in the main plots. A drip irrigation system was installed, after which the seeds were sown. Each experimental unit had a size of 1×2 m², and planting was done in three rows with a spacing of 20 cm between rows and 5 cm between plants within rows. After sowing, thinning and weeding operations were carried out

Study Factors

1. First factor – Poultry manure: Applied at three levels (0, 5000, and 10,000 kg ha⁻¹). The manure was incorporated into the soil before planting.

2. Second factor – Brassinolide growth regulator: sprayed at three concentrations (0, 1, and 2) mg/L-1. The first spray is 10 days

after the thinning process, and the second spray is 20 days after the first spray.

3. Third factor - was the aqueous extract of the reishi mushroom, *Ganoderma lucidum*. It was sprayed at three concentrations (0%, 5%, and 10%), three days after the parasinolide growth regulator was sprayed. The second spray was carried out 20 days after the first spray

Measured Traits

1. Phosphorus percentage (%) in purple carrot roots According to the method (Postemsky, et al. 2016)

2. Protein percentage (%) in purple carrot roots According to the Jackson method (Kim, et al. 1999), the percentages of net protein were calculated (Moridi, et al. 2021).

3. The determination of vitamin C (mg/100g fresh weight) in purple carrot roots by (Abbas, & Abbas 1992)

4. The determination of beta-carotene (mg/100g fresh weight) by (Olsen, & Sommers, 1982)

5. Leucine concentration (ppm) in purple carrot roots by (Dahl-Lassen, Et al. 2018)

6. Threonine concentration (ppm) in purple carrot roots by (Dahl-Lassen, Et al. 2018)

RESULTS AND DISCUSSION

Phosphorus percentage in purple carrot roots: The results in Table (1) show that the treatment of adding poultry manure (P2) was significantly superior and led to an increase in phosphorus in the roots by 0.2551% compared to the control treatment (P0), which gave 0.2364%. The spraying treatment with brassinolide (B2) was also significantly superior and gave the highest rate of 0.2534% compared to the control treatment, which gave the lowest rate of 0.2050%. The spraying treatment with the aqueous extract of the feather mushroom (G2) was superior and gave 0.2375% compared to the control treatment, which gave 0.2283%. The three interaction treatments (P0B2G2) (P0B2G0) and (p1B0G0) were superior and gave the highest significant superiority of 0.3730, 0.3613 and 0.3450%, respectively, compared to the control treatment, which gave the lowest rate. 0.1850%. P2B1 interaction treatment gave a significant superiority of 0.2873% compared to the control treatment, which gave the lowest

rate of 0.1944%. The interaction treatment (P2G0) also exhibited a significant improvement with a phosphorus percentage of 0.2851% compared to the control (0.2219%). Finally, the (B2G2) interaction treatment

resulted in the highest recorded average of 0.2809%, significantly surpassing its corresponding control treatment which showed 0.1923%.

Table 1. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on the phosphorus percentage in purple carrot roots

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023 Reishi mushroom (G)			
		G ₀	G ₁	G ₂	P*B
P ₀	B ₀	0.1850	0.2087	0.1897	0.1944
	B ₁	0.3293	0.2310	0.1947	0.2517
	B ₂	0.3613	0.2650	0.3730	0.3331
P ₁	B ₀	0.3450	0.2130	0.2467	0.2682
	B ₁	0.1993	0.2833	0.1933	0.2253
	B ₂	0.2597	0.2050	0.2307	0.2318
P ₂	B ₀	0.2870	0.2010	0.2097	0.2326
	B ₁	0.3243	0.2767	0.2610	0.2873
	B ₂	0.2440	0.2530	0.2390	0.2453
L.S.D (0.05)			0.02518		0.01454
P*G		G ₀	G ₁	G ₂	P
	P ₀	0.2219	0.2349	0.2524	0.2364
	P ₁	0.2680	0.2338	0.2236	0.2418
	P ₂	0.2851	0.2436	0.2366	0.2551
L.S.D (0.05)			0.01454		0.00839
B*G		G ₀	G ₁	G ₂	B
	B ₀	0.1923	0.2076	0.2153	0.2050
	B ₁	0.2543	0.2637	0.2163	0.2447
	B ₂	0.2383	0.2410	0.2809	0.2534
L.S.D (0.05)			0.01454		0.00839
G		0.2283	0.2374	0.2375	
L.S.D (0.05)			0.00839		

Protein percentage in roots

The results in Table (2) show that the treatment of adding poultry manure (P2) was significantly superior and gave 4.065% of protein compared to the control treatment (P0), which gave 3.133%. Also, the treatment of spraying with brassinolide B1 was significantly superior and gave 3.790% compared to the control treatment B0, which gave 3.221%. The foliar application of the aqueous extract of Ganoderma lucidum (G2) led to an increase in protein percentage to 3.639% compared with that obtained with the control (3.567%). The treatment interaction P1B2G0 had significant increase in protein

percentage to 4.640% that was significantly higher than the lowest average 2.600% obtained in the control treatment.. The interaction treatment P2B1 gave a significant superiority of 4.221% compared to the control treatment, which gave the lowest rate of 2.700%. The interaction treatment (P2G1) also resulted in a significantly higher protein percentage of 4.164% compared to the control (3.299%). Finally, the (B1G0) interaction treatment recorded the highest protein percentage of 4.000%, significantly surpassing its corresponding control treatment which showed 2.801%.

Table 2. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on protein percentages in purple carrot roots

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023			
		Reishi mushroom (G)			P*B
		G ₀	G ₁	G ₂	
P ₀	B ₀	2.600	2.667	2.833	2.700
	B ₁	3.987	3.117	3.067	3.390
	B ₂	3.310	3.347	3.267	3.308
P ₁	B ₀	2.850	3.327	3.433	3.203
	B ₁	3.763	4.017	3.497	3.759
	B ₂	4.640	3.577	3.830	4.016
P ₂	B ₀	3.600	4.123	4.203	3.976
	B ₁	4.250	4.123	4.290	4.221
	B ₂	3.750	4.247	3.997	3.998
L.S.D (0.05)			0.315		0.182
P*G		G ₀	G ₁	G ₂	P
	P ₀	3.299	3.043	3.056	3.133
	P ₁	3.751	3.640	3.587	3.659
	P ₂	3.867	4.164	4.163	4.065
L.S.D (0.05)			0.1817		0.1049
B*G		G ₀	G ₁	G ₂	B
	B ₀	2.8017	3.372	3.490	3.221
	B ₁	4.000	3.752	3.618	3.790
	B ₂	3.900	3.723	3.698	3.774
L.S.D (0.05)			0.182		0.105
G		3.567	3.616	3.639	
L.S.D (0.05)			0.105		

Vitamin C: The results in Table (3) show that the treatment of adding poultry manure (P1) was significantly superior and gave 53.71 (mg. 100g fresh weight) and also the spraying treatment with brassinolide B1 was superior and gave 47.79 (mg. 100g fresh weight) compared to the control treatment B0 which gave 46.61. As for the spraying treatment with the aqueous extract of the reishi mushroom (G2), it was significantly superior and gave 49.41 (mg. 100g fresh weight) compared to the control treatment which gave 43.06 (mg. 100g fresh weight) Among The interaction

treatments, P1B0G1 had the highest value of 69.53 mg 100 g⁻¹; while the control P0B0G0 had the lowest of 32.30 mg 100 g⁻¹. Similarly, P1B0G1 interaction exhibited significantly greater than control with 57.80 mg 100 g⁻¹ and 35.48 mg 100 g⁻¹ respectively. The P1G2 treatment also presented a significant increase at 60.38 mg 100 g⁻¹, in comparison with the control (34.54 mg 100 g⁻¹). Finally, the B1G2 interaction significantly increased vitamin C concentration to 52.04 mg 100 g⁻¹ compared with the control treatment (43.29 mg 100 g⁻¹).

Table 3. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on vitamin C concentration (mg 100 g⁻¹ fresh weight) in purple carrot

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023 Reishi mushroom (G)			
		G ₀	G ₁	G ₂	P*B
P ₀	B ₀	32.30	36.67	37.47	35.48
	B ₁	37.67	55.63	40.40	44.57
	B ₂	33.67	38.80	36.30	36.26
P ₁	B ₀	47.23	69.53	56.63	57.80
	B ₁	42.20	41.40	67.20	50.27
	B ₂	53.80	48.13	57.30	53.08
P ₂	B ₀	50.33	41.70	47.63	46.56
	B ₁	47.50	49.60	48.53	48.54
	B ₂	42.83	52.73	53.27	49.81
L.S.D (0.05)			7.85		4.53
P*G		G ₀	G ₁	G ₂	P
P ₀		34.54	43.70	38.06	38.77
P ₁		47.74	53.02	60.38	53.71
P ₂		46.89	48.01	49.81	48.24
L.S.D (0.05)			4.53		2.62
B*G		G ₀	G ₁	G ₂	B
B ₀		43.29	49.30	47.24	46.61
B ₁		42.46	48.88	52.04	47.79
B ₂		43.43	46.56	48.96	46.31
L.S.D _(0.05)			4.53		2.62
G		43.06	48.24	49.41	
L.S.D _(0.05)			2.62		

β-carotene in roots (mg/100g fresh weight):

The results shown in Table (4) show that there was a significant increase in the β-carotene concentration of the purple carrot roots due to application of poultry manure (P₂), with a value at 3.306 mg /100 g fresh weight compared to 3.046 mg/100 g fresh weight for the control P₀. Moreover, the foliar application of brassinolide B₂ (2 mg/L) significantly increased the level of beta-carotene and reached the maximum average (3.310 mg/100 g fresh weight). Likewise, foliar application of *Ganoderma lucidum* extract (concentration G₂ (10 %) resulted in a marked increase of beta-carotene content reaching 3.461 mg/100 fresh weight. The interaction P₂B₁G₁ produced the

highest beta-carotene content of 3.973 mg/100 g fresh weight, which was significantly higher than the control treatment with 2.331mg/100 g fresh weight. The combined P₂B₂ also exhibited a marked increment with 3.533 mg 100 g fresh weight. Additionally, the interaction P₂G₁ produced a beta-carotene content of 3.444 mg/100 g fresh weight that was statistically higher than control value 2.863 mg/100 g fresh weight. Finally, the B₂G₂ interaction showed the highest statistically significant value of 3.686 mg/100 g fresh weight, compared with control treatment, reporting the value of 2.895 mg/100 g fresh weight.

Table 4. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on β -carotene content in roots of purple carrot

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023			
		Reishi mushroom (G)			
		G ₀	G ₁	G ₂	P*B
P ₀	B ₀	2.334	3.380	3.110	2.941
	B ₁	3.260	3.270	3.530	3.353
	B ₂	3.100	2.920	3.647	3.222
P ₁	B ₀	3.437	3.200	2.800	3.146
	B ₁	3.270	3.007	3.440	3.239
	B ₂	3.413	2.653	3.457	3.174
P ₂	B ₀	3.607	3.013	3.670	3.430
	B ₁	2.350	3.973	2.540	2.954
	B ₂	3.300	3.347	3.953	3.533
L.S.D (0.05)			0.151		0.087
P*G		G ₀	G ₁	G ₂	P
P ₀		2.863	3.190	3.086	3.046
P ₁		3.373	2.953	3.232	3.186
P ₂		3.086	3.444	3.388	3.306
L.S.D (0.05)			0.0871		0.0503
B*G		G ₀	G ₁	G ₂	B
B ₀		2.895	3.198	3.127	3.073
B ₁		2.960	3.417	3.170	3.182
B ₂		3.271	2.973	3.686	3.310
L.S.D _(0.05)			0.087		0.0503
G		3.042	3.196	3.461	
L.S.D _(0.05)			0.0503		

Leucine concentration (ppm) in roots:

The data in Table (5) indicates that the application of poultry manure at the P₂ level (10,000 kg/ha) significantly increased leucine concentration in purple carrot roots, reaching a value of 8.360 ppm , compared to the control treatment P₀ (0 kg/ha), which recorded 5.782 ppm. The spraying treatment with brassinolide (B₂) was also significantly superior and gave the highest rate of 8.202 PPM compared to the control treatment which gave the lowest rate of 5.829 PPM. .Similarly, foliar spraying with Ganoderma lucidum extract at a concentration of G₂ (10%) also showed a statistically

significant increase, resulting in 7.723 ppm , compared to the control treatment G₀, which gave 6.179 ppm. The interaction treatments, P₂B₂G₂ gave the highest and most significant value of 9.700 PPM, compared to the control treatment P₀B₀G₀ at 4.183 PPM. The interaction P₂B₂ produced the highest value of leucine, 9.297 ppm which is significantly more compared to the control value 4.571 ppm. Interaction of P₂G₂ was significantly more than comparison treatment with a rate of 8.958 PPM and B₂G₂ interaction was significantly superior to the comparison treatment with the rate of 4.758 PPM.

Table 5. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on leucine concentration (PPM) in roots of purple carrot

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023			
		Reishi mushroom (G)			P*B
		G ₀	G ₁	G ₂	
P ₀	B ₀	4.183	4.330	5.200	4.571
	B ₁	4.893	6.200	6.780	5.958
	B ₂	5.693	7.180	7.580	6.818
P ₁	B ₀	4.650	5.887	6.940	5.826
	B ₁	6.007	6.460	6.997	6.488
	B ₂	7.900	8.440	9.133	8.491
P ₂	B ₀	5.440	7.740	8.093	7.091
	B ₁	8.193	8.800	9.080	8.691
	B ₂	8.650	9.540	9.700	9.297
L.S.D (0.05)			0.847		0.489
P*G		G ₀	G ₁	G ₂	P
	P ₀	4.923	5.903	6.520	5.782
	P ₁	6.186	6.929	7.690	6.935
	P ₂	7.428	8.693	8.958	8.360
L.S.D (0.05)			0.0871		0.0503
B*G		G ₀	G ₁	G ₂	B
	B ₀	4.758	5.986	6.744	5.829
	B ₁	6.364	7.153	7.619	7.046
	B ₂	7.414	8.387	8.804	8.202
L.S.D (0.05)			0.489		0.282
G		6.179	7.175	7.723	
L.S.D (0.05)			0.282		

Threonine concentration (ppm)

The results in Table (6) show that the treatment of adding poultry manure (P2) was significantly superior and led to an increase in threonine acid and gave 15.147 PPM compared to the control treatment (P0) which gave 12.087 PPM. The spraying treatment with brassinolide (B2) was also significantly superior and gave the highest rate of 14.404 PPM compared to the control treatment which gave the lowest rate of 12.195 PPM. The spraying treatment with the aqueous extract of the reishi mushroom G2 was significantly superior and gave 14.404 PPM compared to the control treatment which gave 12.670 PPM. As for the interaction treatment (P2B2G2), it

was significantly superior and gave the highest rate of 16.407 PPM compared to the control treatment which gave the lowest rate. 10.447 PPM and the P2B2 interaction treatment gave a significant superiority of 16.039 PPM compared to the comparison treatment, which gave a rate of 10.848 PPM. The P2G2 interaction treatment was significantly superior and gave the highest rate of 15.852 PPM compared to the comparison treatment, which gave 11.221 PPM. The B2G2 interaction treatment was superior and gave the highest significant rate of 15.609 PPM compared to the comparison treatment, which gave 11.033 PPM

Table 6. Effect of poultry manure application and foliar spraying with brassinolide and reishi mushroom extract on threonine concentration (PPM) in roots of purple carrot

poultry manure (P)	spraying with brassinolide (B)	Season 2024-2023			
		Reishi mushroom (G)			P*B
		G ₀	G ₁	G ₂	
P ₀	B ₀	10.447	10.657	11.440	10.848
	B ₁	11.200	12.327	13.040	12.189
	B ₂	12.017	13.537	14.123	13.226
P ₁	B ₀	10.983	12.147	13.257	12.129
	B ₁	12.387	12.820	13.923	13.043
	B ₂	14.753	15.450	16.297	15.500
P ₂	B ₀	11.670	14.137	15.017	13.608
	B ₁	15.217	16.037	16.133	15.796
	B ₂	15.360	16.350	16.407	16.039
L.S.D (0.05)			1.113		0.643
P*G		G ₀	G ₁	G ₂	P
	P ₀	11.221	12.173	12.868	12.087
	P ₁	12.708	13.472	14.492	13.557
	P ₂	14.082	15.508	15.852	15.147
L.S.D (0.05)			0.643		0.371
B*G		G ₀	G ₁	G ₂	B
	B ₀	11.033	12.313	13.238	12.195
	B ₁	12.934	13.728	14.366	13.676
	B ₂	14.043	15.112	15.609	14.404
L.S.D (0.05)			0.643		0.371
G		12.670	13.718	14.404	
L.S.D (0.05)			0.371		

Results in Table (1) indicate the percentage of phosphorus was increased by addition of poultry manure to soil. This is due to the fact that poultry manure is a major source of this element (Adekiya, et al. 2019, Deryqe, et al. 2016, Gyewali, et al. 2020). Furthermore, this fertilizer supplies plants with phosphorus in an organic form that is easily absorbed by plants. In addition, poultry manure improves soil fertility (Adekiya, et al. 2019, Hanshal. 2010., Kobierski, et al. 2017), and thus increases the uptake of soil available phosphorus. In this case, the phosphorus concentration in the roots of the carrot increases (Al-Hadethi, 2018) so that photosynthesis will be more, resulting in the production of sugars which are the source of synthesis of C-vitamin in Table 3. It also results in an increment of beta carotene (Table 4). Phosphorus is essential in the biosynthesis of beta-carotene as it participates in the biosynthesis of all carotenoids and beta-carotenes. Phosphorus is also a component of several enzymes that work to increase the concentration of beta-carotene (Zhang, et al.

2024). Poultry manure also contains high levels of nitrogen (Sadiq, et al. 2016) which helps in the formation of amino acids and increases protein percentage (Zhang, et al. 2022) (Table 2). Brassinosteroids are considered an essential hormone in most of the physiological functions of plants and are important in plant growth and development. They also regulate a number of cellular and physiological processes that occur in the plant, such as cell division and elongation, which helps in the growth of roots and increases their length and size (Wang, et al. 2021, Zeng, et al. 2023) which helps in the process of absorbing elements from the soil, including phosphorus, and thus increases the percentage of phosphorus in the roots (Table 1). Brassinolide also works as a stimulant for protein synthesis: this plant regulator works to activate signaling pathways that increase the synthesis of proteins (Table 2) and amino acids such as leucine and threonine (Bajguz, & Hayat. 2009) (Table 5,6). Brassinolide has a major role in stimulating the production of

antioxidants through the production of phenolic compounds and vitamin C as a defensive mechanism for the plant, as it increases vitamin C (Zhang, et al. 2024). Table 3 Brassinolide also stimulates the biosynthesis pathway of carotenoids, activating the genes responsible for producing beta-carotene (Bajguz, & Hayat. 2009) Table 4: Reishi mushroom is rich in minerals such as phosphorus, potassium, magnesium, copper, and selenium (Sanodiya, et al. 2009, Zhang, et al. 2018). When its aqueous extract is used as a foliar spray, it is absorbed by the plant, increasing the percentage of phosphorus inside the plant, especially in the roots after it has been transferred to them. Reishi mushroom contains active compounds (such as polyphenols and polysaccharides) (Kim, et al. 1999) that improve the efficiency of the roots' absorption of mineral elements from the soil by stimulating enzyme activity or improving root health. Reishi mushroom also contains essential amino acids, including leucine and threonine, and growth-stimulating substances (Sanodiya, et al. 2009) that increase the protein percentage Tables 2, 5, and 6 in the plant. The reishi mushroom also contains high amounts of antioxidants, like polyphenols and polysaccharides, and these compounds cause the plant to produce more of its own antioxidants like vitamin C and beta- carotene, and their high concentration in the plant (Tables 3 and 4) is a plant defense against stress. Oxidation: The presence of antioxidants such as Reishi mushroom strengthens the plant's antioxidant action to scavenge free radicals, inducing an increase in the levels of antioxidant compounds, as in the case of vitamin C and beta-carotene in plant tissues by this priming (Wang, et al. 1997).

CONCLUSION

The findings indicate that all of the studied factors we considered (when tested individually) had a positive influence based on to their inherent ability to support plant development. Poultry manure as a source of nutritive elements and organic matter, and the growth hormone brassinolide as a stimulator of enzyme CO₂ assimilation and of cell division and elongation. Polysaccharides, triterpenoids and phenol compounds present in reishi

mushroom extract acted as biostimulants that facilitated the uptake of nutrients, mainly, nitrogen and phosphorus, via an increase in enzymatic activity in the root zone. The synergistic effect of organic fertilizer, fungal extract, and plant hormone was related with the combined application of these factors; one factor enhanced the effect of other components. The interaction resulted in led to a comprehensive enhancement in qualitative traits on the entire purple carrot plant level and in moral aspects also yielded a considerable improvement of the physiological performance and quality characteristics of its root.

CONFLICT OF INTEREST

The author declares that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

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استعمال سماد الدواجن والبراسينولايد والفطر الريشي لتحسين الصفات النوعية لجذور الجزر البنفسجي

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المستخلص

يهدف هذا البحث لدراسة تأثير سماد الدواجن، ومنظم النمو البراسينولايد، والمستخلص المائي للفطر الريشي، نُفذت تجربة وفق تصميم القطاعات العشوائية الكاملة (RCBD) مع ترتيب الألواح المنشقة، باستخدام ثلاثة عوامل ($3 \times 3 \times 3$) وثلاث مكررات، خلال الموسم الخريفي 2023-2024. تمثل العامل الأول في استخدام سماد الدواجن المتحلل بثلاثة مستويات (0، 5000، و10000) كغم هكتار⁻¹. أما العامل الثاني فكان رش النباتات بمنظم النمو البراسينولايد بثلاث تراكيز (0، 1، و2) ملغم لتر⁻¹. وتمثل العامل الثالث برش النباتات بمستخلص فطر الريشي المحضّر بطريقة الاستخلاص المائي بثلاث تراكيز (0%، 5%، و10%). يُوزع سماد الدواجن المتحلل عشوائيًا على القطع الرئيسية قبل الزراعة. أدى استخدام سماد الدواجن ومنظم النمو البراسينولايد والمستخلص المائي لفطر الريشي إلى زيادة تركيز الفسفور والبروتين وفيتامين C والبيتاكاروتين والليوسين والثريونين، مما ساهم في تحسين صفات الجودة للجزر البنفسجي.

الكلمات المفتاحية: بيتا كاروتين، منظم نمو، سماد عضوي، الليوسين، الثريونين، فيتامين C