European Scholar Journal (ESJ)
Available Online at: https://www.scholarzest.com
Vol. 4 No.10, October 2023
ISSN: 2660-5562

EFFECT OF ADDING GROWTH INHIBITORS ON THE QUALITATIVE CHARACTERISTICS OF MICROTUBERS OF FOUR POTATO VARIETIES IN VITRO

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Article history:
Received: 11th August 2023
Accepted: 10th September 2023
Published: 11th October 2023

Abstract:
The experiment was carried out in the plant tissue culture laboratory of the Nakheel Garden Tissue Agriculture Co., Ltd., Baghdad, for the period from March 2022 to November 2022. Its purpose was to study the effect of adding different concentrations of paclobutrazol and coumarin on the qualitative characteristics of fine tubers and four varieties of potatoes, as the experiment included four Treatments of all paclobutrazol and coumarin, which are as follows: four levels of paclobutrazol at concentrations (0, 3, 6, and 9 mg L), respectively, and four levels of coumarin at concentrations (0, 10, 15, and 20 mg L), respectively, and four varieties of potatoes, as follows (Arizona and Burren). (Hermiz and Spunta) and analyzed the evidence from the first experiment as a factorial experiment using a completely randomized design (CRD). Adding paclobutrazol at a concentration of 3 mg. L to the MS nutrient medium led to a significant increase in the percentage of carbohydrates. Estimation of the effectiveness of the peroxidase enzyme. Percentage of reducing sugars. Percentage of protein and nitrogen in the fine tubers. Adding coumarin at a concentration of 10 mg per liter to the MS nutrient medium led to a significant increase in the percentage of carbohydrates. Estimation of the effectiveness. Peroxidase enzyme, percentage of reducing sugars, percentage of protein and nitrogen in fine tubers. The interaction between paclobutrazol and coumarin, paclobutrazol and varieties, coumarin and varieties, and the triple interaction led to a significant increase in most of the traits studied.

Keywords: Potatoes, in vitro, microtubers.

1. INTRODUCTION

Potato (Solanum tuberosum L) belongs to the Solanaceae family, which includes more than (2000) species and (90) genera. It is considered one of the most important and widely used vegetable crops and tops the list of tuber crops (Hassan 1999). Several modern methods were used to produce potato seeds, the most important of which was the technology of plant tissue culture. Thanks to this technology, it became possible to secure seed seeds represented by fine tubers due to their important characteristics as well as their freedom from viral pathogens, as these tubers are characterized by being small in size and with diameters of 10-23 mm. With a weight of 0.2-2 grams, it is more suitable for commercial purposes and is easy to store and transport. (Nivaa, 2001). The process of microtuber formation is affected by various factors. Plant growth regulators are among the means that play an important role in the formation of microtubers. The hormonal effect varies according to the variety and type of hormone used. Microtubers, including growth inhibitors, have been used in the process of seed production for the purpose of stimulating the formation of microtubers and accelerating germination. The process of multiplication and reducing costs, as it is possible to produce fine seedlings and tubers in a large number and in a specific time (Al-Maarri, 2019). Determine the best level of growth inhibitors paclobutrazol and coumarin and find out the best interaction between them in increasing some qualitative characteristics of microtubers in vitro

2. MATERIALS AND METHODS.

The histological experiment was carried out in the plant tissue culture laboratory of the company Nakheel Paradise for Tissue Agriculture Ltd. - Baghdad for the period from March 2022 to November 2022. The purpose of the study was to produce fine tubers. Four varieties of potatoes were used in the study, two of which were taken from The fabric available at Nakheel Paradise Company, which is widely cultivated in the country, is the Arizona and Burren varieties, while the

fabric of the other two varieties, Spuntas Hermiz, was obtained from a Dutch company and included four levels of paclobutrazol at concentrations (0), 3, 6, and 9 mg/L, respectively, and four levels of coumarin. At concentrations of (0), 10, 15 and 20 mg. (1) liter, respectively, and measurements were taken from the fine tubers using the following methods. In the percentage of carbohydrates, the method of Josyin (1970) was followed, and in estimating the activity of the peroxidase enzyme, the method of Nezih (1985) was followed, and the percentage of reducing sugars was followed by the method of Josyan (1970), and the percentage Percent Protein Method (1970) .A.0.A.C. Basis of dry weight and nitrogen in fine tubers (Haynes 1980).

3. RESULTS

1. Percentage of carbohydrates (%)

It is clear from Table 1 that there are significant effects of the paclobutrazol addition treatments on the percentage of carbohydrates in the fine tubers. The highest percentage of carbohydrates was found to be 11.56 when 3 mg/L was added, with an increase rate of 39.61 compared to the addition treatment at a concentration of 9 mg/L, which gave the lowest percentage of 8.28. There were effects Significant when adding coumarin in the proportion of carbohydrates to fine tubers, as the treatment of adding coumarin at a concentration of 10 mg per liter excelled in recording the highest percentage, reaching 11.34, with an increase rate of 28.71% compared to the treatment of 20 mg per liter of coumarin, which gave the lowest percentage, reaching 8.81. In the same table, the Arizona variety was significantly superior to the rest of the varieties in recording the highest percentage of carbohydrates for fine tubers, which amounted to 10.00, with an increase rate of 1.41%, compared to the Spunta variety, which gave the lowest percentage of 9.86, which does not differ significantly from the rest of the varieties. In the interaction between paclobutrazol and coumarin, the interaction treatment was superior to paclobutrazol at a concentration of 3 mg. liter with coumarin at a concentration of 10 mg/L recorded the highest percentage of carbohydrates in the fine tubers, reaching 12.95, with an increase rate of 154.92% compared to the treatment without addition, which gave the lowest percentage, reaching 5.08. In the interaction between paclobutrazol and the types, the treatment of adding paclobutrazol at a concentration of 3 mg was superior. A liter with the Hermiz variety recorded the highest percentage of carbohydrates in fine tubers, amounting to 11.77, with an increase rate of 49.74% compared to the treatment of adding paclobutrazol at a concentration of 9 mg. liter with the Hermiz variety recording the highest percentage of carbohydrates in the fine tubers, reaching 11.53, with an increase rate of 34.69% compared to the treatment of adding coumarin at a concentration of 20 mg. liter with the Hermiz variety, which gave the lowest percentage of 8.56. In the triple interaction between paclobutrazol, coumarin, and the varieties, the interaction treatment between paclobutrazol at a concentration of 3 mg/L with coumarin at a concentration of 10 mg/L with the Hermiz variety was superior in recording the highest percentage of carbohydrates in the fine tubers, amounting to 13.29, compared to the treatment without the addition. Paclobutrazol with coumarin with the Spunta variety, which gave the lowest percentage of carbohydrates in tubers 1 1- The minute was 4.97.

Table 1. Effect of adding different concentrations of paclobutrazol and coumarin and their interaction on the percentage of carbohydrates in fine tubers of four potato varieties (%)

Interaction Varieties and Paclobutrazol	Coumarin (mg l^{-1})				Paclobutrazol (mg l^{-1})	Varieties
	20	15	10	0		
9.90 h	11.78 q	11.45 s	11.23 w	5.62 i^{--}	0	Arizona
11.55 b	9.66 n^{-}	12.79 f	12.97 d	10.78 b^{-}	3	
9.96 f	7.44 c^{--}	9.28 q^{-}	12.63 i	10.48 c^{-}	6	
8.60 m	6.46 f^{--}	8.78 t^{-}	9.07 r^{-}	10.11 g^{-}	9	
9.95 g	11.90 o	11.56 r	11.23 v	5.10 k^{--}	0	Burren
11.55 c	9.81 l^{-}	12.66 h	12.86 e	10.85 z	3	
9.86 i	7.47 b^{--}	9.32 p^{-}	12.19 k	10.44 d^{-}	6	
8.25 o	6.20 g^{--}	8.08 y^{-}	8.76 u^{-}	9.94 j^{-}	9	
10.15 e	12.14 l	11.92 n	11.44 t	5.11 j^{--}	0	Hermiz
11.77 a	9.72 m^{-}	13.17 b	13.29 a	10.89 y	3	
9.74 l	6.76 e^{--}	8.82 s^{-}	13.08 c	10.30 f^{-}	6	
7.86 p	5.62 h^{--}	7.54 z^{-}	8.32 w^{-}	9.94 i^{-}	9	
9.81 k	11.87 p	11.33 u	11.06 x	4.97 l^{--}	0	Spunta
11.41 d	9.85 k^{-}	12.29 j	12.68 g	10.82 a^{-}	3	
9.83 j	7.49 a^{--}	9.40 o^{-}	12.01 m	10.41 e^{-}	6	
8.43 n	6.80 d^{--}	8.15 x^{-}	8.69 v^{-}	10.06 h^{-}	9	
Averages Varieties	**Coumarin (mg l^{-1})**				**Interaction Varieties and Coumarin**	
	20	15	10	0		
10.00 A	8.83 o	10.57 e	11.48 b	9.13 i	Arizona	Varieties
9.89 B	8.85 n	10.40 f	11.26 c	9.08 j	Burren	
9.87 B	8.56 p	10.36 g	11.53 a	9.06 l	Hermiz	
9.86 B	9.00 m	10.30 h	11.11 d	9.07 k	Spunta	
Averages Paclobutrazol	**Coumarin (mg l^{-1})**				**Interaction Paclobutrazol and Coumarin**	
	20	15	10	0		
9.95 B	11.92 d	11.56 e	11.24 f	5.08 p	0	Paclobutrazol (mg l^{-1})
11.56 A	9.76 j	12.73 b	12.95 a	10.84 g	3	
9.84 C	7.29 n	9.20 k	12.48 c	10.41 h	6	
8.28 D	6.27 o	8.14 m	8.71 l	10.01 i	9	
	8.81 D	10.40 B	11.34 A	9.08 C	Averages Coumarin	

Numbers with similar symbols and letters are not significantly different from each other according to the Duncan test at the 5% probability level.

2-Estimation of the effectiveness of the peroxidase enzyme (gramabsorption unit)

The results in Table 2 indicate that the paclobutrazol addition coefficient were significantly superior in estimating the peroxidase enzyme in the fine tubers, as the highest estimate of the enzyme in the fine tubers was observed, amounting to 27.58 absorption units (g) when adding 3 mg. liter, with an increase of 15.83% compared to the 9 mg addition treatment. liter, which gave the lowest estimate of the enzyme in the small tuber, which amounted to 23.81 absorption units (gm), and there were significant differences when adding coumarin in the estimation of the peroxidase enzyme in the small tuber, as the addition treatment at a concentration of 10 mg/L excelled in giving the highest estimate of the enzyme in the small tuber, which amounted to 27.43 absorption units. gm, an increase of 12.60% compared to the treatment without the addition of coumarin and the treatment with the addition of 20 mg/L, which gave the lowest estimate of the enzyme in the fine tuber, which amounted to 24.36 gm absorption units. In the same table, the highest estimate of the enzyme in the fine tuber of the Heramiz variety was 26.5 absorption units (AU) gm, an increase of 7.06% compared to the Burren variety, which gave the lowest estimate of the enzyme in the fine tuber of 24.78 absorption units. Gloom. The intervention treatment was superior to paclobutrazol at a concentration of 3 mg. liter with coumarin at a concentration of 10 mg. Liter recorded the highest estimate of the enzyme in the small tuber, amounting to 29.57 absorption units. gm, with an increase rate of 57.53 compared to the treatment without addition, which gave the lowest estimate of the enzyme in the microtuber, which amounted to 18.77 absorption units gm. In the interaction between paclobutrazol and the varieties, the treatment of adding 3 mg per 1 paclobutrazol with the Hermiz variety was superior in recording an estimate of the enzyme in the microtuber, which amounted to 28.50. Absorption unit.gm, with an increase rate of 26.21 compared to the interaction treatment between paclobutrazol at a concentration of 9 mg/L and the variety Burren, which gave the lowest estimate of the enzyme in the fine tuber amounting to 22.58 absorption units/g. As for the interaction of coumarin with the varieties, the interaction treatment between coumarin at a concentration of 10 mg/L with the variety Hermiz was superior. In recording the highest estimate of the enzyme in the fine tuber, which amounted to 28.42 absorption units per gm, with an increase rate of 22.50%, compared to the

interaction treatment between coumarin at a concentration of 20 mg per liter and the variety Burren, which gave the lowest estimate of the enzyme in the fine tuber, which amounted to 23.20 absorption units per gm. And in the triple interaction between... Paclobutrazol, Coumarin, and Varieties: The interaction treatment between paclobutrazol at a concentration of 3 mg/L and coumarin at a concentration of 10 mg/L was superior to the Hermiz variety in recording the highest estimate of the enzyme in the microtuber, amounting to 30.69 absorption units. gm, with an increase rate of 64.73% compared to the treatment without the addition of paclobutrazol and coumarin, with the variety Burren, which gave the lowest estimate of the enzyme in the fine tuber of 18.63 gm absorption unit.

Table 2. The effect of adding different concentrations of paclobutrazol and coumarin and their interaction on the activity of the peroxidase enzyme in the fine tubers of four potato varieties (absorption unit.gm-1)

Interaction Varieties and Paclobutrazol	Coumarin (mg l^{-1})				Paclobutrazol (mg l^{-1})	Varieties
	20	15	10	0		
25.37 i	27.69 q	27.52 r	27.36 s	18.90 i^{--}	0	Arizona
27.58 b	25.22 m^{-}	29.04 g	29.40 d	26.65 b^{-}	3	
25.73 g	22.94 a^{--}	24.87 p^{-}	28.66 j	26.45 c^{-}	6	
24.15 n	21.91 e^{--}	23.74 w^{-}	24.61 s^{-}	26.35 e^{-}	9	
24.94 k	27.33 t	27.04 v	26.75 z	18.63 l^{--}	0	Burren
27.00 d	23.84 v^{-}	28.92 h	29.33 e	25.89 j^{-}	3	
24.62 m	21.58 f^{--}	23.44 y^{-}	28.08 m	25.36 k^{-}	6	
22.58 p	20.05 h^{--}	22.38 d^{--}	23.06 z^{-}	24.82 q^{-}	9	
26.06 f	29.18 f	28.34 k	27.89 o	18.84 j^{--}	0	Hermiz
28.50 a	26.22 g^{-}	30.08 b	30.69 a	27.02 w	3	
26.75 e	24.41 t^{-}	26.00 h^{-}	29.86 c	26.71 a^{-}	6	
24.85 l	22.71 c^{--}	25.06 o^{-}	25.24 l^{-}	26.37 d^{-}	9	
25.18 j	27.74 p	27.28 u	27.01 x	18.71 k^{--}	0	Spunta
27.28 c	25.10 n^{-}	28.32 l	28.86 i	26.85 y	3	
25.46 h	22.77 b^{--}	24.71 r^{-}	28.01 n	26.34 f^{-}	6	
23.67 o	21.07 g^{--}	23.51 x^{-}	24.19 u^{-}	25.92 i^{-}	9	
Averages Varieties	**Coumarin (mg l^{-1})**				**Interaction Varieties and Coumarin**	
	20	15	10	0		
25.70 B	24.44 m	26.29 f	27.51 b	24.59 k	Arizona	Varieties
24.78 D	23.20 p	25.45 i	26.81 e	23.67 o	Burren	
26.53 A	25.63 h	27.37 c	28.42 a	24.74 j	Hermiz	
25.39 C	24.17 n	25.95 g	27.02 d	24.45 l	Spunta	
Averages Paclobutrazol	**Coumarin (mg l^{-1})**				**Interaction Paclobutrazol and Coumarin**	
	20	15	10	0		
25.38 C	27.98 d	27.54 e	27.25 f	18.77 p	0	Paclobutrazol (mg l^{-1})
27.58 A	25.10 j	29.09 b	29.57 a	26.60 g	3	
25.63 B	22.93 n	24.76 k	28.65 c	26.22 h	6	
23.81 D	21.43 o	23.67 m	24.27 l	25.86 i	9	
	24.36 C	26.26 B	27.43 A	24.36 C	**Averages Coumarin**	

Numbers with similar symbols and letters are not significantly different from each other according to the Duncan test at the 5% probability level.

3. Reducing sugars percentage (%)

The results in Table 3 showed that the paclobutrazol addition treatments were significantly superior in the percentage of reducing sugars in the microtuber, as the highest percentage in the microtuber was observed, reaching 27.37 when 3 mg L was added, with an increase rate of 31.96% compared to the 9 mg L addition treatment, which gave the lowest percentage in the tuber. The minute was 20.74. There were significant differences when adding coumarin in the percentage of reducing sugars in the small tuber, as the addition treatment at a concentration of 10 mg/L was superior in giving the highest percentage in the small tuber, amounting to 27.10, with an increase rate of 25.17% compared to the addition treatment at a concentration of 10 mg/L, which gave the lowest percentage in the tuber. The minute was 21.65. In the same table, the Spunta variety was significantly superior in the percentage of reducing sugars in the small tuber, as the highest percentage in the small tuber was observed for the Spunta variety, which amounted to 24.70,

with an increase rate of 4.70% compared to the Arizona variety, which gave the lowest percentage in the small tuber, which amounted to 23.59. The interaction treatment of paclobutrazol at a concentration of 3 mg/l with coumarin at a concentration of 10 mg was superior. liter recorded the highest percentage of reducing sugars in the fine tuber, amounting to 32.06, with an increase rate of 95.36%, compared to the treatment without addition, which gave the lowest percentage in the fine tuber, amounting to 16.41. In the interaction between paclobutrazol and the types, the treatment with the addition of 3 mg was superior. A liter of paclobutrazol with the Hermiz variety recorded the highest percentage of reducing sugars in the fine tuber, amounting to 27.85, with an increase rate of 37.73 compared to the interaction treatment between paclobutrazol at a concentration of 9 mg. liter with the Hermiz variety, which gave the lowest percentage of tuber fines, amounting to 20.22. As for the interaction of coumarins with the varieties, the interaction treatment between coumarins at a concentration of 10 mg was superior. L with the Spunta variety recording the highest percentage of reducing sugars in the fine tuber, which amounted to 27.56, with an increase rate of 30.18 compared to the coumarin interaction treatment at a concentration of 20 mg L with the Arizona variety, which gave the lowest percentage in the fine tuber, which amounted to 21.17. In the triple interaction between paclobutrazol, coumarin and the two types, the interaction treatment between paclobutrazol at a concentration of 3 mg was superior. liter with coumarin at a concentration of 10 mg per liter with the variety Hermiz recorded the highest percentage of reducing sugars in the fine tuber, amounting to 33.48, with an increase rate of 107.05 compared to the treatment without the addition of paclobutrazol with coumarin, with the variety Arizona, which gave the lowest percentage in the fine tuber, amounting to 16.17.

Table 3. Effect of adding different concentrations of paclobutrazol and coumarin and their interaction on the percentage of reducing sugars in fine tubers of four potato varieties (%)

Interaction Varieties and Paclobutrazol	Coumarin (mg l^{-1})				Paclobutrazol (mg l^{-1})	Varieties
	20	15	10	0		
23.87 h	27.56 p	26.23 t	25.50 v	16.17 l^{--}	0	Arizona
27.21 c	21.66 p^{-}	30.39 f	32.40 b	24.39 b^{-}	3	
23.01 l	18.44 $d^{- -}$	21.15 s^{-}	28.62 l	23.84 d^{-}	6	
20.28 o	17.00 $h^{- -}$	20.05 z^{-}	20.83 w^{-}	23.26 i^{-}	9	
24.22 g	28.38 n	26.52 r	25.30 x	16.69 i^{--}	0	Burren
26.76 d	21.55 r^{-}	30.29 g	31.50 d	23.72 e^{-}	3	
23.30 k	18.99 $c^{- -}$	21.13 t^{-}	29.45 j	23.63 g^{-}	6	
20.66 n	18.17 $f^{- -}$	20.39 x^{-}	20.88 v^{-}	23.19 j^{-}	9	
23.33 j	26.41 s	25.47 w	25.14 z	16.32 $k^{- -}$	0	Hermiz
27.85 a	21.80 n^{-}	31.77 c	33.48 a	24.34 c^{-}	3	
23.44 i	19.22 $b^{- -}$	21.69 o^{-}	29.43 k	23.42 h^{-}	6	
20.22 p	17.31 g^{--}	20.23 y^{-}	20.93 u^{-}	22.40 m^{-}	9	
24.96 e	28.42 m	27.75 o	27.20 q	25.85 u	0	Spunta
27.66 b	23.69 f^{-}	30.24 h	30.86 e	16.48 j^{--}	3	
24.36 f	19.61 a^{--}	23.07 k^{-}	29.51 i	25.24 y	6	
21.82 m	18.27 e^{--}	21.63 q^{-}	22.66 l^{-}	24.72 a^{-}	9	
Averages Varieties	Coumarin (mg l^{-1})				Interaction Varieties and Coumarin	
	20	15	10	0		
23.59 C	21.17 p	24.45 h	26.84 c	21.92 k	Arizona	Varieties
23.73 B	21.77 m	24.58 g	26.78 d	21.81 l	Burren	
23.70 B	21.19 o	24.79 f	27.24 b	21.62 n	Hermiz	
24.70 A	22.50 j	25.68 e	27.56 a	23.07 i	Spunta	
Averages Paclobutrazol	Coumarin (mg l^{-1})				Interaction Paclobutrazol and Coumarin	
	20	15	10	0		
24.09 B	27.70 d	26.49 e	25.79 f	16.41 p	0	Paclobutrazol (mg l^{-1})
27.37 A	22.18 j	30.67 b	32.06 a	24.57 g	3	
23.52 C	19.06 n	21.76 k	29.25 c	24.03 h	6	
20.74 D	17.69 o	20.58 m	21.32 l	23.39 i	9	
	21.65 D	24.87 B	27.10 A	22.10 C	Averages Coumarin	

Numbers with similar symbols and letters are not significantly different from each other according to the Duncan test at the 5% probability level.

4. PROTEIN PERCENTAGE (%)

The results in Table 4 indicate that the paclobutrazol addition treatments are significantly superior in estimating the percentage of protein in the fine tubers, as the highest percentage of protein in the fine tubers is observed, reaching 15.31 when 3 mg/L is added, with an increase rate of 40.45% compared to the 9 mg/L addition treatment, which It gave the lowest percentage of protein in the small tubers, which amounted to 10.90. There were significant differences when adding coumarin at a concentration that gave the highest percentage of protein in the small tubers, which amounted to 14.96, with an increase percentage of 29.74 compared to the addition treatment of 20 mg. liter, which gave the lowest percentage of protein in the fine tubers, reaching 11.53. In the same table, the highest percentage of protein in the fine tubers of the Hermiz variety was 13.09 and the Arizona variety was 13.00, with an increase of 9.88% compared to the Spunta variety, which gave the lowest percentage of protein in the fine tubers of 12.65. The intervention treatment was superior to paclobutrazol at a concentration of 3 mg. 1 liter with coumarin at a concentration of 10 mg. liter recorded the highest percentage of protein in the fine tubers, amounting to 18.99, with an increase rate of 117.02% compared to the treatment without addition, which gave the lowest percentage of protein in the fine tubers, amounting to 8.75. In the interaction between paclobutrazol and the varieties, the treatment of adding 3 mg/L of paclobutrazol with the Hermiz variety was superior in recording the highest percentage of protein in the fine tubers, which amounted to 15.61, with an increase rate of 13.65% compared to the interaction treatment between paclobutrazol at a concentration of 9 mg/L with the Spunta variety, which gave the lowest percentage of protein in the fine tubers. It reached 10.69. As for the interaction of coumarins with varieties, the interaction treatment between coumarins at a concentration of 10 mg/L with the variety Hermiz excelled in recording the highest percentage of protein in the fine tubers, reaching 15.20, with an increase rate of 34.24 compared to the interaction treatment between coumarins at a concentration of 20 mg/L with the variety Burren, which gave the lowest percentage of protein in the tubers. The minute reached 11.33. In the triple interaction between paclobutrazol and coumarin and the types, the interaction treatment between paclobutrazol at a concentration of 3 mg/L and coumarin at a concentration of 10 mg was superior. liter with the Hermiz variety, which recorded the highest percentage of protein in the fine tubers, amounting to 19.62, with an increase rate of 131.64% compared to the treatment without the addition of paclobutrazol and coumarin, with the Spunta variety, which gave the lowest percentage of protein in the fine tubers, amounting to 8.47.

Table 4. Effect of adding different concentrations of paclobutrazol and coumarin and their interaction on the protein percentage of fine tubers of four potato varieties (%)

Interaction Varieties and Paclobutrazol	Coumarin (mg l^{-1})				Paclobutrazol (mg l^{-1})	Varieties
	20	15	10	0		
12.74 h	14.56 m	14.08 q	13.35 w	8.96 f^{--}	0	Arizona
15.45 b	11.99 k^{-}	17.68 d	19.02 b	13.12 y	3	
12.76 f	10.31 y^{-}	11.49 o^{-}	16.48 i	12.77 b^{-}	6	
11.07 m	9.79 b^{--}	10.70 t^{-}	11.23 q	12.58 d^{-}	9	
12.64 j	14.41 o	14.06 r	13.35 w	8.73 h^{--}	0	Burren
15.24 c	12.06 j^{-}	17.43 e	18.66 c	12.81 a^{-}	3	
12.75 g	9.98 a	11.73 l^{-}	16.73 g	12.56 e^{-}	6	
10.82 o	9.37 d^{--}	10.50 x^{-}	10.95 s^{-}	12.46 g^{-}	9	
13.06 e	14.81 l	14.56 n	14.02 s	8.85 g	0	Hermiz
15.61 a	12.27 h^{-}	17.02 f	19.62 a	13.52 u	3	
12.68 i	10.21 z^{-}	11.56 n^{-}	15.81 k	13.14 x	6	
11.05 n	9.50 c^{--}	10.60 v^{-}	11.35 p^{-}	12.75 c^{-}	9	
12.50 k	14.27 p	13.87 t	13.39 v	8.47 i^{--}	0	Spunta
14.94 d	11.68 m^{-}	16.58 h	18.66 c	12.83 z	3	
12.49 l	9.98 a^{--}	11.18 r^{-}	16.27 j	12.52 f^{-}	6	
10.69 p	9.37 e^{--}	10.52 w	10.62 u^{-}	12.25 i^{-}	9	
Averages Varieties	**Coumarin (mg l^{-1})**				**Interaction Varieties and Coumarin**	
	20	15	10	0		
13.00 A	11.66 l	13.49 e	15.02 b	11.86 j	Arizona	| Varieties
12.86 B	11.46 o	13.43 g	14.92 c	11.64 m	Burren	
13.09 A	11.70 k	13.43 f	15.20 a	12.06 i	Hermiz	
12.65 C	11.33 p	13.04 h	14.74 d	11.52 n	Spunta	
Averages Paclobutrazol	**Coumarin (mg l^{-1})**				**Interaction Paclobutrazol and Coumarin**	
	20	15	10	0		
12.73 B	14.51 d	14.14 e	13.53 f	8.75 p	0	Paclobutrazol (mg l^{-1})
15.31 A	12.00 j	17.18 b	18.99 a	13.07 g	3	
12.66 B	10.12 n	11.49 k	16.32 c	12.75 h	6	
10.90 C	9.51 o	10.58 m	11.04 l	12.51 i	9	
	11.53 D	13.34 B	14.96 A	11.76 C	Averages Coumarin	

Numbers with similar symbols and letters are not significantly different from each other according to the Duncan test at the 5% probability level.

5. The percentage of nitrogen in the micro-tubers (%)

The results in Table 5 showed that the paclobutrazol addition coefficients were significantly superior in estimating the percentage of nitrogen in the micro-tubers, as the highest percentage of nitrogen in the micro-tubers was observed, reaching 1.74 when adding 3 mg/l, with an increase in percentage It reached 40.80% compared to the addition treatment of 9 mg/L, which gave the lowest percentage of nitrogen in the fine tubers, which amounted to 1.74. There were significant differences when adding coumarin at a concentration of 10 mg/L, which gave the highest percentage of nitrogen in the fine tubers, which amounted to 2.39, with an increase rate of 23.01% compared to the addition treatment of 20. amalgam. liter, which gave the lowest percentage of nitrogen in the fine tubers, reaching 1.84. In the same table, the highest percentage of nitrogen in the fine tubers of the Hermiz variety reached 2.09 and the Arizona variety reached 2.08, with an increase rate of 3.46% compared to the Spunta variety, which gave the lowest percentage of nitrogen in the fine tubers of 2.08. 2.02 The interaction treatment of paclobutrazol at a concentration of 3 mg/L with coumarin at a concentration of 10 mg was superior. liter recorded the highest percentage of nitrogen in the fine tubers, amounting to 3.03, with an increase rate of 116.42%, compared to the treatment without addition, which gave the lowest percentage of nitrogen in the fine tubers, amounting to 1.40. In the interaction between paclobutrazol and the varieties, the treatment of adding 3 mg/L to 1 paclobutrazol with the Hermiz variety was superior in recording the

highest percentage of nitrogen in the fine tubers, which amounted to 2.49, with an increase rate of 45.61 compared to the interaction treatment between paclobutrazol at a concentration of 9 mg/L with the Spunta variety, which gave the lowest percentage of nitrogen in the fine tubers. It reached 1.71. As for the interaction of coumarins with the types, the interaction treatment between coumarins at a concentration of 10 mg was superior. liter with the Hermiz variety in recording the highest percentage of nitrogen in the fine tubers, which amounted to 2.43, with an increase rate of 34.25% compared to the coumarin interaction treatment at a concentration of 20 mg. liter with the Spunta variety, which gave the lowest percentage of nitrogen in the fine tubers, reaching 1.81. In the triple interaction between paclobutrazol and coumarin and the varieties, the interaction treatment between paclobutrazol at a concentration of 3 mg/L and coumarin at a concentration of 10 mg/L was superior to the Hermiz variety in recording the highest percentage. For nitrogen in fine tubers, it reached 3.14, with an increase rate of 134.59% compared to the treatment without the addition of paclobutrazol and coumarin With the Spunta variety, which gave the lowest percentage of nitrogen in the tubers The minute was 1.35

Table 5. The effect of adding different concentrations of paclobutrazol and coumarin and their interaction on the percentage of microtuber nitrogen of four potato varieties (%)

Interaction Varieties and Paclobutrazol	Coumarin (mg l^{-1})				Paclobutrazol (mg l^{-1})	Varieties
	20	15	10	0		
2.03 h	2.33 m	2.25 p	2.13 v	1.43 d^{--}	0	Arizona
2.47 b	1.92 j^{-}	2.83 d	3.04 b	2.10 x	3	
2.04 f	1.65 x^{-}	1.84 n^{-}	2.63 i	2.04 a^{-}	6	
1.77 m	1.56 a^{--}	1.71 s^{-}	1.79 p^{-}	2.01 c^{-}	9	
2.02 j	2.30 n	2.25 q	2.13 v	1.39 f^{--}	0	Burren
2.43 c	1.93 i^{-}	2.79 e	2.98 c	2.05 z	3	
2.04 g	1.59 z^{-}	1.87 k^{-}	2.67 g	2.01 d^{-}	6	
1.73 o	1.50 c^{--}	1.68 w^{-}	1.75 r^{-}	1.99 f^{-}	9	
2.09 e	2.37 l	2.33 m	2.24 r	1.41 e^{--}	0	Hermiz
2.49 a	1.96 g^{-}	2.72 f	3.14 a	2.16 t	3	
2.02 i	1.63 y^{-}	1.85 m^{-}	2.53 k	2.10 w	6	
1.76 n	1.52 b^{--}	1.69 u^{-}	1.81 o^{-}	2.04 b^{-}	9	
2.00 k	2.28 o	2.22 s	2.14 u	1.35 g^{--}	0	Spunta
2.39 d	1.87 l^{-}	2.65 h	2.98 c	2.05 y	3	
1.99 l	1.59 z^{-}	1.79 q^{-}	2.60 j	2.00 e^{-}	6	
1.71 p	1.50 c^{--}	1.68 v^{-}	1.70 t^{-}	1.96 h^{-}	9	
Averages Varieties	Coumarin (mg l^{-1})				Interaction Varieties and Coumarin	
	20	15	10	0		
2.08 A	1.86 l	2.15 e	2.40 b	1.89 j	Arizona	| Varieties
2.05 B	1.83 o	2.14 g	2.38 c	1.86 m	Burren	
2.09 A	1.87 k	2.15 f	2.43 a	1.93 i	Hermiz	
2.02 C	1.81 p	2.08 h	2.35 d	1.84 n	Spunta	
Averages Paclobutrazol	Coumarin (mg l^{-1})				Interaction Paclobutrazol and Coumarin	
	20	15	10	0		
2.03 B	2.32 d	2.26 e	2.16 f	1.40 p	0	Paclobutrazol (mg l^{-1})
2.45 A	1.92 j	2.74 b	3.03 a	2.09 g	3	
2.02 B	1.61 n	1.83 k	2.61 c	2.04 h	6	
1.74 C	1.52 o	1.69 m	1.76 l	2.00 i	9	
	1.84 D	2.13 B	2.39 A	1.88 C	Averages Coumarin	

Numbers with similar symbols and letters are not significantly different from each other according to the Duncan test at the 5% probability level.

The result Tables 1, 2, 3, 4 and 5 regarding the qualitative and chemical characteristics of micro-tubers. It is noted that an increase in carbohydrate metabolism is one of the plant's defensive means, and the use of growth inhibitors such as paclobutrazol and coumarin has led to a reduction in the height of the plant, which means optimal utilization of manufactured carbohydrates that lead to its increase, as well as It also increases the plant's absorption of nutrients.

The effectiveness of the peroxidase enzyme. An increase in the enzyme is observed at concentrations of the growth inhibitors paclobutrazol and coumarin. This effectiveness may be due to the increase in ROS in plant tissues in high quantities, which led to an increase in the effectiveness of this enzyme when stress occurs, as plants possess an anti-oxidation mechanism to reduce the negative effect of ROS compounds and when The concentration of ROS in the plant increases. Plant genes begin to address the situation by instructing the synthesis of antioxidant compounds, as enzymatic mechanisms work as an anti-ROS, including the peroxidase enzyme, as it removes the toxicity of free radicals. High regulation of this enzyme is necessary to keep the radicals under control (Mitter, 2002), and these agree. The increase in peroxidase, according to the findings of Zidane (2014). The decrease in reducing sugars in tubers exposed to stress, especially the high concentrations of paclobutrazol and coumarin, may be due to the accumulation of sugars and their accumulation in the vegetative growth as a result of the decomposition of starch and their slow flow through the bark due to the viscosity of the descending sap and thus the lack of access of sugars to the tubers. This is consistent with the findings of Al-Amiri (2007). The decrease in the percentage of protein when adding high concentrations of paclobutrazol and coumarin may be due to the breakdown of protein into amino acids under the influence of obstacles, or it may be due to the inability of the cells to synthesize protein due to their inability to form RAN (Ahmed, 1984) or to the weak ability of the roots to Nitrogen absorption and the lack of activity of Ribonuclease and Munal Nitrate Reductase enzymes, et al. 1997) and this is consistent with the findings of Al-Amiri (2007). It also appears that varieties differ in their ability to withstand stress, and that different varieties give different responses when exposed to various stress factors. This is due to genetic differences between varieties and thus their difference in tolerance to stress caused by growth obstacles (Al-Shammari, 2007).

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