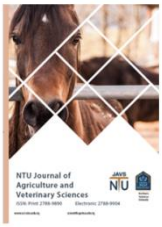
NTU Journal of Agricultural and Veterinary Sciences (2024) 4 (3) : 152-156
DOI: https://doi.org/10.56286/ntujavs.v2i2

IRAQI Academic Scientific Journals

P-ISSN: 2788-9890 E-ISSN: 2788-9904
NTU Journal of Agricultural and Veterinary Sciences
Available online at: https://journals.ntu.edu.iq/index.php/NTU-JAVS/index



Effect Of Spraying Zinc On Growth And Production Of Two Cultivars Of Potato Plant *Solanum tuberosum* L.

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Article Informations

Received: 16-03- 2024,
Accepted: 21-06-2024,
Published online: 28-09-2024

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Key Words:
Potato, Zinc spraying,Cultivars, Elbeida, Laperla, foliar fertilization.

A B S T R A C T

A field experiment was conducted during the spring growing season of 2023 in Horticulture and Landscape Design / College of Agriculture and Forestry / University of Mosul to determine the effect of spraying zinc on growth and production of two cultivars of potato plant (*Solanum tuberosum* L.). Our experimentation consisted of two factors, the first one was two cultivars of imported potatoes (Elbeida and Laperla), the second included spraying plants with zinc at three concentrations (0, 500 and 750 mg.l^{-1}), 6 treatments (2 x 3) included in this study and three replicates. The experimentation was carried out using a factorial experiment according to a Randomized complete block design (RCBD). The experiment results confirmed that Laperla cultivar significantly superior compared to Elbeida cultivar in most of the studied traits, and spraying plants with 500 mg.l^{-1} of zinc recorded best values compared with 750 mg.l^{-1} of zinc.

Introduction

Potato (*Solanum tuberosum* L.) is a plant that is cultivated as an important crop in all countries. According to [1] 100 g of raw potato offers 80 kilo calories of energy and comprises 18.5 g carbohydrate, 2.1 g protein, 1.5 g dietary fiber, 17 mg vitamin C, 11 mg riboflavin, 1.2 mg niacin, and 13 mg calcium. Potato is also high in phytochemicals (251.12 mg g^{-1}) [2], antioxidants (596 mg 100 g^{-1}), potassium (430 mg 100 g^{-1}), and low cholesterol [3].

Potatoes are also the main food in many regions of the world and play a major role in the global sustainable food system [4]. According to the data of the Central Statistical Organization of Iraq in 2021, the cultivated area in Iraq reached 76,673 dunum, with a production rate of 466,126 tons per cultivated area, and the productivity of one dunum reached 6,079 tons.dunum^{-1} When comparing the cultivated area and quantity of production with the areas cultivated globally and their production, we notice a reduction in local production, which requires studying the reasons and expanding the cultivation of the crop and trying to raise productivity using several techniques and methods and improving the nutritional status of the plant. Among these methods is the introduction of new cultivars and fertilization with zinc by spraying on vegetative crops in order to improve growth, increase production and improve quality.

Many studies have confirmed the importance of zinc, as this element is involved in the synthesis of many enzymes necessary for the assimilation of proteins, such as glycodehydrogenase, which is an essential element for the formation of tryptophan, which is the amino acid from which indole acetic acid (IAA) is formed. It also plays an important role in the process of oxidation of sugars in plants and has a major role. In the formation of chlorophyll and in the process of photosynthesis, it has a role in vital processes, as it participates in the formation of starch [5]. This element also increases the plant's ability to absorb many of the nutrients that the plant needs from the soil [6].

Materials and Methods

The experiment was conducted in the University of Mosul, during the spring growing season of 2023. The land was prepared for planting, and the direction of the planting was from north to south. The experimental unit included two lines 1.5 meters long, and the distance between one and another was 0.75 m. The tubers were planted manually at a distance of 25 cm between tubers, with 12 plants for each experimental unit hole, then put the tubers inside the hole in the ground to a depth of 10-12 cm, then cover the tubers with soil.

The experiment included two factors, two imported potato cultivars (Elbeida and Laperla), and zinc spraying in three concentrations:
0 , 500 and 750 mg.l^{-1}. The experiment was carried out in the field using a factorial experiment according to a Randomized complete block design (RCBD), and statistical analysis of the results was adopted using the SAS program [7] and the Duncan multiple range test to test the means at a probability level of ≥ 0.05 [8].

Studied Traits

- Plant height (cm.plant^{-1})
- Number of aerial stems (stem.plant^{-1})
- Leaves area (cm^2.leaf^{-1})
- tubers Number (tuber.plant^{-1})
- Tuber weight (g.tuber^{-1})
- Total yield per plant (g.plant^{-1})
- Total yield of tubers (tons.ha^{-1})
- Tuber content of zinc (mg.l^{-1})

The measurement was carried out on six plants from each experimental unit, then the average for vegetative growth characteristics was extracted 10 days after the last zinc spray. While the yield traits were measured on all plants of the experimental unit, the qualitative yield traits were measured on six tubers taken randomly for each experimental unit, after which the average was extracted for each trait.

Disscusion

The results show that Elbeida cultivar significantly superior over the Laperla cultivar in the plant hight as shown in Table (1), as plant hight reached 71.66 cm.plant^{-1} and 67.95 cm.plant^{-1} in both cultivars, respectively. While for number of aerial stems of plant in Table (2) there was no significant effect between the two cultivars. As for the effect of spraying with zinc, the results of the table (1) and (2) show that there was no significant differences between all concentrations used in the both plant hight and number of aerial stems of plant. As for the interactions between cultivars and zinc on plant hight, the highest value founded in the case of the control plants of the Elbeida cultivar which reached 71.78 cm.plant^{-1}. The best value on number of aerial stems of plant was 5.24 stem.plant^{-1} recorded when spraying Elbeida cultivar with 500 mg.l^{-1}.

Table 1. Effect of zinc , cultivars & their interactions on plant height (cm.plant^{-1})

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	71.78 a	69.50 ab	70.64 a
500	71.52 a	67.59 b	69.56 a
750	71.63 a	66.73 b	69.18 a
Mean effect of cultivars	71.66 a	67.95 b	

Table 2. Effect of zinc , cultivars and their interactions on number of aerial stems of plant (stem.plant^{-1}).

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	4.82 ab	4.58 b	4.70 a
500	5.24 a	4.82 ab	5.03 a
750	5.01 ab	5.03 ab	5.02 a
Mean effect of cultivars	5.04 a	4.82 a	

The results of Table (3) show that Laperla cultivar significantly superior over the Elbeida cultivar in leaves area, reached 47.46 cm^2.leaf^{-1} in Elbeida cultivar, while spraying plants with zinc did not differ significantly in all it's cocentrations. In the interactions between cultivars and zinc, the highest value founded in Laperla cultivar when sprayed with 750 mg.l^{-1} of zinc reached 49.60 cm^2.leaf^{-1} in this trait.

Table 3. Effect of zinc , cultivars and their interactions on leaves area (cm^2.leaf^{-1})

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	41.25 b	46.52 ab	.4389 a
500	42.35 b	46.23 ab	44.29 a
750	42.29 b	49.60 a	45.95 a
Mean effect of cultivars	41.98 b	47.46 a	

The results shown in Table (4) indicates that Laperla cultivar significantly superior over Elbeida cultivar in number of tubers reached 11.12 tuber.plant^{-1}, while spraying with 500 mg.l^{-1} of zinc gave the best value in number of tubers reaching 10.58 tuber.plant^{-1} in the mentioned trait. As for interactions between cultivars and zinc on number of tubers, results confirmed that the Laperla variety combined with spraying at 500 mg.l^{-1} recorded highest number of tubers, amounting to 11.49 tuber.plant^{-1}.

Table (5) results indicates that there were no significant differences between cultivars in tuber weight. In other hand, spraying with 500 mg.l^{-1} of zinc produced the highest tuber weight amounting 149.95 g.tuber^{-1} in this traits.

Moving to interactions between cultivars and zinc, the highest value in the tuber weight reached 153.11 g.tuber^{-1} in the Elbeida cultivar with the use of 500 mg.l^{-1} concentration of zinc in this trait.

Table 4. Effect of zinc, cultivars and their interactions on number of tubers (tuber.plant^{-1}).

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	9.04 c	10.84 b	9.94 b
500	9.68 c	11.49 a	10.58 a
750	9.68 c	11.01 ab	10.35 ab
Mean effect of cultivars	9.48 b	11.12 a	

Table 5. Effect of zinc, cultivars and their interactions on tuber weight (g.tuber^{-1}).

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	133.30 c	146.85 ab	140.07 b
500	153.11 a	146.80 ab	149.95 a
750	139.13 bc	139.35 bc	139.24 b
Mean effect of cultivars	141.86 a	144.34 a	

The results in Tables (6) show that the used cultivars Elbeida and Laperla have significant effects on yield of one plant, where Laperla cultivar were significantly superior compared to Elbeida cultivar in this trait, as the yield of one plant in the superior cultivar reached 1605.86 g.plant^{-1}.

Regarding the effect of zinc, the concentration of 500 mg.l^{-1} of zinc produced the highest yield per plant, amounting to 1582.33 g.plant^{-1}.

Regarding the interaction between cultivars and spraying with zinc, clearly from the presented results, the plants of Laperla cultivar treated with 500 mg.l^{-1} zinc gave the highest yield per plant, amounting to 1683.11 g.plant^{-1}.

The results shown in Table (7) declear that the plants of Laperla cultivar were significantly superior compared to the plants of the Elbeida cultivar on yield of tubers per unit area as it reached 85.646 tons.ha^{-1}. As for the effect of zinc, the concentration of 500 mg.l^{-1} of zinc gave the highest yield per unit area, amounting to 84,391 tons.ha^{-1}.

It was also noted in the interaction between cultivars and spraying with zinc, that the plants of Laperla cultivar treated with 500 mg.l^{-1} zinc gave the best yield per unit area, amounting to 89.766 tons.ha^{-1}.

Table 6. Effect of zinc, cultivars and their interactions on total yield per plant (g.plant^{-1})

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	1234.83 e	1596.38 ab	1415.61 b
500	1481.54 c	1683.11 a	1582.33 a
750	1349.86 d	1538.07 bc	1443.96 b
Mean effect of cultivars	1355.42 b	1605.86 a	

Table 7. Effect of zinc, cultivars and their interactions on total yield of tubers (tons.ha^{-1})

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	65.858 e	85.140 ab	75.499 b
500	79.016 c	89.766 a	84.391 a
750	71.993 d	82.030 bc	77.011 b
Mean effect of cultivars	72.290 b	85.646 a	

Table (8) data show that the zinc in the tubers was significantly affected by the cultivars used in the experiment, Elbeida and Laperla. The highest concentration of zinc was recorded in the Laperla cultivar, reaching 30.1380 mg.l^{-1}, with a significant superiority over the Elbeida cultivar, whose plant content of zinc was reduced to the lowest 22.5226 mg.l^{-1}. Significant effects also appeared when spraying with zinc, spraying with 750 mg.l^{-1} of zinc was significantly superior to the rest treatments, as it reached 34.304 mg.l^{-1}.

Through the results of the interaction between cultivars and spraying with zinc, the plants of the Laperla cultivar sprayed with a concentration of 750 mg.l^{-1} of zinc outperformed all interaction treatments, and the value of zinc in the tubers in this treatment reached 41.683 mg.l^{-1}.

Table 8. Effect of zinc, cultivars and their interactions on tuber content of zinc (mg.l^{-1})

Zinc concentrations mg.l^{-1}	Elbeida	Laperla	Mean effect Of Zinc
0	20.974 c	26.267 b	23.620 b
500	19.668 c	22.464 c	21.066 c
750	26.926 b	41.683 a	34.304 a
Mean effect of cultivars	22.5226 b	30.1380 a	

The significant differences between the two cultivars under our study in the growth, quantitative and qualitative yield traits is due to the genetic differences between the two cultivars, as these traits are controlled by the genetic genes of the cultivars. effecting of genes by the weather conditions surrounding the plant, caused the effectiveness of some genes in increasing the activity of the enzymes specific to the cultivar and thus the emergence of Significant differences between cultivars in growth, quantitative and qualitative yield traits. These results are in line with what was reported by [9, 10, 11, 12] which confirmed that there were significant differences in growth , quantitative and qualitative yield traits between the cultivars used in their studies.

It was also noted from the results that the use of zinc concentrations caused significant differences. The reason for this may be attributed to the fact that zinc is involved in many vital processes in plants, including stimulating oxidation processes in plant cells and increasing photosynthesis. Therefore, the concentration of solutes resulting from this process will increase, and it is necessary for Elongation processes in the cells, which cause vegetative growth increasing and then accumulation of carbohydrates increasing in the leaves. It also increases the ability of the plant to absorb many nutrients from the soil, which causes an increase in growth traits and thus yield traits. This result is consistent with what found by [13] in her study on potato plants is that the use of zinc sulfate led to a positive and significant increase in the vegetative growth and yield traits studied. Also, these results are in line with what was reported by [14, 15] which confirmed that there were significant differences in growth , quantitative and qualitative yield traits used in their studies.

Conclusions

The study confirmed the significant superiority of Laperla cultivar compared to Elbeida cultivar in most of the traits studied, this study recommends adopting the Laperla cultivar for growing potato crops in commercial production fields in Nineveh Governorate. While for zinc spraying, this study recommends adopting a concentration of 500 mg.l^{-1} of zinc, while conducting future studies using concentrations less than 500 mg.l^{-1} and comparing it with the superior concentration due to the significant effects on most of the traits compared to the other concentrations.

Competing Interests

The authors declare there are no competing interests.

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