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Impact of Spraying the Shots Parts with Ascorbic Acid on the Concentration of Some Mineral Nutrients in *Vicia faba* Treated with Heavy Metals

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ABSTRACT

This study aimed examine the impact of Ascorbic acid spraying once and twice at concentrations 250 and 500 mg/L on the concentration of some nutrients in the seeds of the bean plant (*Vicia faba* L.) grown on soils contaminated with nickel at concentrations 30 and 60 and lead at concentrations 300, 600 mg/kg soil.The results showed that soil treated with 600 mg/kg lead has a significant decrease of concentration of magnesium, phosphorous, potassium and chloride in the seeds of the bean plants which amounted to 1.16 , 1.121, 4.113 and 0.071 mg/g, respectively compared to the control group. It was also found that spraying the vegetative parts of the bean plant with 250 mg/L ascorbic acid twice was attributed to increasing of magnesium significantly in the seeds of the bean plant, which amounted to 4.00 mg/g. otherwise, spraying with the same concentration, but once, led to a significant increase in phosphorous concentration, which reached 1.335 mg/g. The results also showed that one-time spraying of 500 mg/L ascorbic acid led to a significant increase in chloride concentration, which amounted to 0.395 mg/g compared to the control group. The results show that lead treatment had a more negative effect on the concentration of nutrients compared to the effect of nickel. It was found that spraying with ascorbic acid at a concentration of 250 mg/L was significantly superior to the concentration of 500 mg/L of magnesium, phosphorous, potassium and chloride in the seeds of bean plants. Also, spraying with ascorbic acid once was superior to spraying twice with the concentration of both magnesium and chloride.

Keywords: ascorbic acid, bean plant, heavy metals, magnesium and phosphorous.

INTRODUCTION

The presence of heavy metals is a concern for food safety through its effect on plants and thus its impact on human life. These minerals come naturally from rocks, volcanoes and various weathering processes (Ghiyasi et al., 2010) in addition to industrial and agricultural sources as a result of the tremendous development in these two fields (Vardhan et al., 2019). Although living organisms need some of these elements in small quantities, they become toxic when their concentration exceeds the permissible limits. Heavy metals are often associated with pollution and toxicity (Madhu and Sadagopan, 2020). High levels of heavy metals present in the soil can straightway affect the vital systems in it. It also indirectly affects human and animal health through its transmission through the food chain. A person can also be exposed to heavy metals in the soil directly through contact, inhalation or ingestion, and then transmitted to the different parts of the body by the blood (Azeh et al., 2019). As for plants, high concentrations of heavy metals inhibit growth and the appearance of toxic symptoms on them (Moustaka et al., 2016). Nickel is one of the heavy elements that have a beneficial role in the growth of plants when they are in low concentrations, and its deficiency can lead to the accumulation of urea at toxic levels inside the plant body, which consequently leads to damage to the ends of the plant leaf, in addition to

the role of nickel in the important physiological processes of the plant (Fabiano et al. al., 2015). Nickel is an element that is naturally present in the earth's crust in addition to its presence in sea water (Ali et al., 2018). It is also added to the environment through steel mills and the manufacture of batteries and electronic devices (Akhtar et al., 2004). As for lead, it is one of the heavy metals that is of no importance to the plant and the process of absorbing it from the environment is easy and accumulates in the different plant parts. The process of transferring lead into the plant depends on the pH, particle size, and various physical and chemical factors (Farouk and Muhammad, 2018). It is easily absorbed by plant roots (Marschner, 2011). The environment is polluted with lead through the use of fertilizers, automobile exhaust, and various human and industrial activities (Saleem et al., 2018), in addition to lead smelting, paint, batteries and pipes containing lead (Karri et al., 2008). Lead affects plants through its effect on the morphological characteristics, physiological processes and chemistry of life in plants (Pourrut et al., 2011). As for ascorbic acid, it is a molecule with high potential, as it has a great role as an antioxidant with reason of its great ability of electron donation to a large number of reactions involving enzymatic and non-enzymes (Gilli and Tuteja, 2010). It is also of great importance in the growth of plants and increase the resistance of plants to unsuitable environmental conditions.

MATERIALS AND METHODS

The seeds of the bean plant were provided by local agricultural shops in the city of Mosul / Iraq. Seeds planted on 10/11/2023 by 5 seeds/pot, and the anvils were arranged randomly under the conditions of the greenhouse. The soil used in this study was treated with 30 and 60 mg/kg nickel, 300 and 600 m/kg lead. The soil was treated with these elements by mixing it with five kg of soil and then placing it in pots with a capacity of 7 kg. To ensure that the elements mix with the soil well (note that the soil pH used for cultivation was 7.5). The vegetative parts of the bean plant were also sprayed with ascorbic acid at concentrations 250 and 500 mg/l after 30 days of planting the plants. After 45 days, a group of bean plants was sprayed for the second time with ascorbic acid with the same concentrations, the control group was also sprayed for each treatment. After the plants reached the stage of maturity and the watercress was formed, the plants were harvested by 3 replications per treatment.

ESTIMATION OF NUTRIENTS

Magnesium, potassium, phosphorous and chloride were measured in the beans of bean plants after the plants reached the stage of maturity. Then the bean seeds were taken and dried in the oven, after which these seeds were ground. Then half a gram of each sample was taken and digested by wet digestion method (Chapman and Partt, 1961)) and it was estimated as follows:

1. Magnesium (Mg) according to the method of smearing with Fresnite and potassium K using a flame photometer as mentioned in (Richard, 1954).
2. Phosphorous using tin chloride method, using a Spectrophotometer, as stated in (APHA, 1998).
3. Chloride Cl using Mohr's method by slapping with silver nitrate as mentioned in (Johnson and Ulrich, 1959).

The results were analyzed and differences compared using Duncan's New Multiple Range Test (Antar, 2010).

RESULTS AND DISCUSSION

Magnesium

Table 1 shows that soil treatment with 30,60 mg/kg of nickel and 300,600 mg/kg of lead. As can be seen from the table the concentration of magnesium was significantly decreased in the seeds when treated with nickel and lead. Further were treatment with lead 600 mg/kg was the most effective, as the concentration of magnesium reached 1.16 mg/g. The reason for this might be due to lead effect which affects the water balance process and the absorption of nutrients through its effect on plant hormones and on the composition of plasma membranes (Farouk and Muhammad, 2018). Whereas, spraying plants with ascorbic acid once at a concentration of 500 mg/l, and when spraying twice with 250 mg/l, led to an increase in magnesium concentration. However, the increase was not significant compared to the control treatment, and it amounted to 3.88 and 4.00 mg / g,

respectively. This might be the role of ascorbic acid in protecting plant cells and tissues, which increases their ability to absorb nutrients (Luma et al., 2020) and act as an antioxidant, by eliminating the accumulated ROS directly and indirectly, thus reducing the harmful effects of oxidative processes and increasing the protection of plants exposed to different stresses (Elkelish et al., 2020).The table also shows that spraying the growing bean plants with 30 mg/kg nickel-treated soils with 250 mg/l ascorbic acid for one time recovered the concentration of magnesium in the seeds of the plant 2.28 mg/g compared to non-sprayed plants with ascorbic acid. In terms of the type of element, it was found treating with lead showed greater decrease magnesium concentration in the seeds than nickel, reaching 1.657 mg/g. It was also observed that the concentration of magnesium 2.277 mg/g significantly increased in the seeds when sprayed with 250 mg/l due to ascorbic acid effect. In terms of the number of spraying times, it was found that no statistical difference in magnesium concentration in the seeds of the bean plants when sprayed once or twice.

Phosphorous

Table 2 shows a significant decrease in the phosphorous in the seeds of bean plants when treated with 300 and 600 mg/kg soil of lead, the concentration of phosphate was 1.150 and 1.211, respectively. This result is line with (Muhammad et al., 2020) who found that exposure of maize plant parts to high concentrations of nickel decreased phosphorous concentration significantly compared to control group. Also, exposure to heavy metals causes various physiological changes in plants, including disturbances in the transport of nutrients, water imbalance, respiration, carbon absorption, enzyme activity (Singh et al., 2015) and the biosynthesis of photosynthetic pigments and impeding these pigments in entering the photosynthesis process (Chen et al., 2019). It was also found that spraying beans plants with 250) and 500 once and at concentration 250 twice ascorbic acid increased in phosphorous concentration significantly in seeds, reaching to 1.335, 1.326 and 1.309 mg/g., respectively. This is due to the fact that treatment with ascorbic acid reduced the

Table 1. The impact of spraying of ascorbic acid on the concentration of Mg (mg/gm) in the seeds of the bean plants grown in soil treated with Ni and Pb

Effect of element		Control	Sprayed once Mg/l		Sprayed twice Mg/l		Element type effect
		0.0	250	500	250	500	
		3.84 a	3.32 ab	3.88 a	4.00 a	3.40 ab	
Ni Mg/kg soil	30	1.30 ef	2.28 b	2.16 c	1.88 d	1.50 e	1.706 a
	60	1.20 e	1.80 d	1.32 ef	2.14 b	1.48 e	
Pb Mg/kg soil	300	1.20 g	2.04 bc	2.02 bc	2.13 b	2.00 bc	1.657 ab
	600	1.16 g	1.50 e	1.48 e	1.68 de	1.36 ef	
Effect of ascorbic acid concentration			2.277 a	2.060 b			
Number of time sprayed effect			2.180 a		2.157 ab		

Table 2. The impact of spraying of ascorbic acid on the concentration of P (mg/gm) in the seeds of the bean plants grown in soil treated with Ni and Pb

Effect of element		Control	Sprayed once Mg/l		Sprayed twice Mg/l		Element type effect
		0.0	250	500	250	500	
		.231 bc1	.335 a1	.326 a1	.309 a1	.286 ab1	
Ni Mg/kg soil	30	.190 c1	.299 ab1	.275 ab1	.297 ab1	.280 ab1	.249 a1
	60	.183 c1	.244 b1	.206 c1	.252 b1	.260 b1	
Pb Mg/kg soil	300	.150 d1	.289 ab1	.209 c1	.277 ab1	.200 c1	.216 a1
	600	.121 e1	.242 b1	.204 c1	.237 b1	.234 bc1	
Effect of ascorbic acid concentration			.278 a1	.248 b1			
Number of time sprayed effect			1.263 a		.263 a1		

harmful effects of heavy metals enhancing the enzymes activity that are for necessary plants ability to resist the effects of heavy metals, this might be reflected positively in the growth of plants (Saud et al., 2018). It was also noted that spraying growing bean plants with 30 mg/kg nickel-treated soil with 250 mg/l of ascorbic acid for one time led to a significant increase in phosphorous concentration in the seeds of the plant 1.299 mg/g compared to the beans grown in soil treated with heavy metals only. Furthermore, the treatment with lead element has decreased the concentration of phosphorous in the seeds 1.216 mg/g compared to the nickel element in terms of element type. Regarding to the concentration of ascorbic acid, it was found that spraying of 250 mg/l of ascorbic acid was significantly higher than 500 mg/l 1.278 mg/gm. However, there were no Statistical difference between the groups sprayed once and groups sprayed twice.

Potassium

Table 3 shows the treatment of soil with30 and 60 of nickel and with300 and 600) mg/kg soil of lead decreased potassium concentration significantly compared control group in bean seeds, which reached 7.181, 6.976 and 7.795, 4.113 mg/g, respectively. This is consistent with what was found by (Al-Rashedy, 2021) that the exposure of plants to the influence of heavy elements bring about a decrease in potassium concentration in plants. This may be due to the similarity between the major nutrients with some heavy elements, which leads to competition between these nutrients and the heavy elements, thus preventing and impeding the absorption of nutrients (Ain et al., 2016). As a result of the negative effects of heavy toxic elements on root growth and penetration into the soil (Shahzad et al., 2018). It was also observed that spraying plants with ascorbic acid once and twice at two concentrations 250 and 500 mg/l did not lead to an increase in potassium in the seeds. However, it led to a significant increase when compared with plants grown in soil treated with heavy metals only. The highest concentration of potassium appeared in the seeds of plants that were sprayed with ascorbic acid twice, and reached 18,204 mg/g of 500 mg/l of ascorbic acid. It may be due to the beneficial role of ascorbic acid in many physiological processes in plants such as cell division (Podgórska et al., 2017). Ascorbic acid also protects proteins and lipids and improves growth, photosynthesis and transpiration (Akram et al., 2017), which may have a significant role in increasing the uptake of nutrients by plants. It was also found that spraying growing bean plants with in 30 mg/kg nickel-treated soils with ascorbic acid at a concentration of 250 mg/l twice increased potassium concentration significantly in the plant seeds, which reached 14,844 mg/g compared to a concentration of Potassium in the beans of bean plants grown in soils treated with heavy metals only.

The table shows decreased potassium concentration significantly in the plant seeds when treated with lead element compared to treatment with nickel element as an effect of the type of element where it reached 10,868 mg/g. because of the effect of ascorbic acid concentration, spraying with 250 mg/l ascorbic acid showed a significant increase in potassium concentration in the seeds, reaching 13.691 mg/g compared to spraying at a concentration of 500 mg/l. Also, no significant differences were observed in the effect of the number of spraying times between spraying once or spraying twice on the potassium concentricity in the seeds.

Table 3. The impact of spraying of ascorbic acid on the concentration of K (mg/gm) in the seeds of the bean plants grown in soil treated with Ni and Pb

Effect of element		Control	Sprayed once Mg/l		Sprayed twice Mg/l		Element type effect
		0.0	250	500	250	500	
		20.658 a	17.385 b	16.976 b	14.726 c	18.204 b	
Ni Mg/kg soil	30	7.181 e	13.431 cd	10.363 d	14.844 c	11.885 de	11.308 a
	60	6.976 f	12.817 d	10.132 d	14.050 c	11.399 de	
Pb Mg/kg soil	300	7.795 e	13.635 cd	12.817 d	11.990 de	11.322 de	10.868 b
	600	4.113 g	12.840 d	11.999 de	11.191 de	10.978 d	
Effect of ascorbic acid concentration			13.691 a	12.608 b			
Number of time sprayed effect			13.239 a		13.059 a		

Table 4. The impact of spraying of ascorbic acid on the concentration of Cl (mg/gm) in the seeds of the bean plants grown in soil treated with Ni and Pb

Effect of element		Control	Sprayed once Mg/l		Sprayed twice Mg/l		Element type Effect
		0.0	250	500	250	500	
		1 a50.3	0.390 a	0.395 a	0.355 ab	0.380 a	
Ni Mg/kg soil	30	0.097 f	0.283 b	0.224 b	0.223 b	0.116 e	0.173 a
	60	0.081 f	0.230 b	0.221 b	0.142 d	0.108 e	
Pb Mg/kg soil	300	0.085 f	0.195 b	0.110 e	0.225 b	0.137 de	0.137 b
	600	0.071 g	0.150 d	0.100 e	0.177 cd	0.118 e	
Effect of ascorbic acid concentration			0.237 a	0.191 b			
Number of time sprayed effect			0.229 a		0.198 b		

Chloride

Table 4 shows a decreased chloride concentration significantly in the seeds of bean plants grown in soils contaminated with nickel and lead, according to the mentioned concentrations, where the leave The chloride in seeds is 0.097, 0.081 and 0.085, 0.071 mg/g, respectively. Exposure of plants to heavy metals for long periods may lead to damage to the photosynthesis process due to the influence of photosynthetic pigments, which may affect the absorption of nutrients (Houri et al., 2020). It was also noted that spraying the bean plants with ascorbic acid once and twice at the concentrations 250 and 500 mg/l function to an increase in the concentration of chloride in the plant seeds, but it did not reach the significant limits. And spraying at a concentration of 500 mg/l for one time gave the best result with a concentration of chloride, which reached 0.395 mg/g if you compare to the control group.

This may be because the important role of ascorbic acid in plant growth and thus affects many physiological processes and the absorption of nutrients in addition to its role in the process of cell division (Venkatesh and Park 2014). The spraying of growing bean plants with 30 mg/kg nickel-treated soil with 250 mg/l ascorbic acid for one time increased the concentration of chlorid significantly in the seeds of the bean plant, which reached 0.283 mg/g compared to a concentration of Chloride in the seeds of bean plants grown in soils treated with heavy metals only. Table 4 show that the contamination of soil with lead led to a significant decrease in the concentration of chloride in the seeds compared to the contaminated with nickel, which amounted to 0.137 mg/g as the effect of the type of element. As for studying the effect of the concentricity of ascorbic acid and the number of times of spraying with ascorbic acid, we notice from Table 4 that spraying with a concentration of 250 mg/l was significantly superior to spraying at a concentration of 500 mg/l, and spraying with ascorbic acid once was also significantly superior to Spraying twice, where the chloride in the bean seeds was 0.237 and 0.229, respectively.

CONCLUSION

The results of the following research showed that treatment of soil with nickel and lead, led to a significant decrease in the concentration of Magnesium, potassium, Phosphorous and Chloride in The seeds of the bean plant. Spraying the vegetative parts of the plant with ascorbic acid at two different concentrations leads to an increase in the above-mentioned elements. And spraying with ascorbic acid once was superior to spraying twice with the concentration of both magnesium and chloride.

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