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Response of Faba Bean and Cauliflower Crops to Different Application Methods and Concentrations of Molybdenum under Salt Affected Soils Conditions

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ABSTRACT

Two experiments were conducted at the experimental farm, Sakha Agric. Research Station (30.51^{o}N and 31 05^{o}E during 2020/2021 autumn and winter seasons. The first is pot experiment and the second is field experiment. The objectives of the present study were to investigate the effect of different molybdenum (Mo) concentration and its application methods on faba bean (*Vicia faba*) and cauliflower (*Brassica oleracea*), as plants yield and quality differ with Mo under salt affected soil conditions. Split plot design was used with three replicates. The main plots were assigned to 2 applications methods of (soil and foliar application). The subplots divided to six concentrations of Mo for soil application (0.0, 0.7, 1.4, 2.1, 2.8 and 3.5 mg kg^{-1}), and another six concentrations for foliar spray (0.0, 3, 6, 9, 12 and 15 mg L^{-1}). The obtained results can be summarized as: the perfect concentration of Mo for faba bean and cauliflower on yield pods, head and shoot were 1.4 mg kg^{-1} in the soil application and 6 mg L^{-1} in the foliar application. The higher concentration showed toxicity effects. Increasing Mo concentration in the soil application or in foliar application led to increase Mo concentration in the plant dry matter. Mo concentration in the edible parts of two crops was less than the harmful concentration.

1. INTRODUCTION

Fertilization is a major practice of the crops production. Micronutrients are most important for crops growth production and quality. Molybdenum (Mo) is essential for (nearly) all biological systems. The metal is biologically inactive unless it is complexes by a special cofactor. The main source of molybdenum to the arable soils is the pollution with others fertilizers or application as fertilizer. Recently fertilizer factories have high attention to produce high quality fertilizers without pollution, so the sources of Mo in the arable soils is decrease, in addition to the antagonism between Mo and other ions under the saline - sodic soil conditions. Nutrient uptake and use efficiency in salt affected soils is low due to salt stress and negative interactions with cations and anions present in high concentrations. Hence, a higher amount of nutrients is necessary in salt affected soils compared to normal soils according to **Fageria *et al*. (2011)**. Molybdenum is directly related to metabolic function of nitrogen in the plant through nitrate reductase enzyme that reduces the nitrate to nitrite and this is the first step of the incorporation of nitrogen to proteins **(Bambara and Ndakidemi, 2010)**. Molybdenum occurs in the earth's crust and in soils in extremely small quantities. The average concentration of this element in the lithosphere is about 2 mg kg^{-1} and in soils it typically ranges from 0.2 to 5 mg kg^{-1} and approximately 2 mg kg^{-1} as an average. Two of most important factors affecting the availability of Mo are soil pH and the amount of aluminum and iron oxides in soil. Phosphorus enhances the absorption and translocation of Mo by plants. High levels of SO_4^{-2} in the rooting media depress Mo uptake by plants. Both copper and manganese have been observed to act antagonistically on Mo uptake. The nitrate form of nitrogen apparently encourages Mo uptake by plants **(Tisdale *et al.*, 2007)**. Crops that are very sensitive to insufficient Mo are the legumes, crucifers (broccoli, Brussels sprouts, cauliflower, rapeseed, etc.) and citrus. Other crops that are also sensitive to a low Mo supply are beet, cotton, lettuce spinach, sweet corn, sweet potatoes and tomatoes **(Elsharkawy *et al*., 2015)**. Faba beans *(Vicia faba,* L.*)* are the third most important legume after soya (*Glycine max*) and pea (*Pisum sativum*). Similar to other legumes, it contains high amount of lysine rich protein (one of the essential amino acids), carbohydrates and other essential micronutrients. It can also be entitled as the cheapest source of protein (**Rahate *et al.*, 2021)**. Through its role in fixation of N by legumes, Mo not only has a significant impact on the yield of the crop but increased the content of protein, chlorophyll, vitamins and yield **(Głowacka *et al*., 2019; Rana *et al*., 2020)**. Cauliflower (*Brassica oleracea*) is one of the highest antioxidative activity vegetables because of its high content of phytochemicals, such as glucosinolates, vitamins, phenolic compounds and fibers, which are principals for digestive system health, cauliflower have enormous nutritional and medicinal values due to its high contents of vitamins; i.e., C, K, B5 and B6, dietary fibers, folic acid, and minerals such as K, Mg, P, Zn and Fe **(Hossain *et al.*, 2018)**. There are varietal differences in the susceptibility of crops to Mo deficiency. The differential susceptibility of cauliflower varieties to Mo deficiency is seemingly unrelated to requirement for the nutrient, but rather in their ability to extract soil Mo **(Mengel and Kirkiby, 1987)**. The highest significant cauliflower values of curd fresh weight, curd diameter, curd dry matter and curd yield were observed in plants received Mo at 50ppm. The response of all cauliflower quality parameters was significantly affected by foliar application of Mo. The maximum content of ascorbic acid, carbohydrates, and sulfur were recorded with foliar application of Mo at 50ppm molybdenum treatments had high vegetative grow the comparing with no treated plants (**Ali *et al.*, 2019)**.

The objectives of the present study are to investigate Mo concentrations and Mo application methods on faba bean and cauliflower as plants yield and quality under salt affected soil conditions.

2. MATERIALS AND METHODS

Two experiments were conducted at Experimental farm, Sakha Agric. Res. Station (30.51^{o}N and 31 05^{o}E during 2020/2021 autumn and winter seasons. One pot experiment and the other one was field experiment.

2.1 The pot experiment

This experiment was conducted under wire house in the open conditions to investigate the critical concentration of molybdenum on cauliflower (*Brassica oleracea*, Var. Eris) plants as high need and faba bean (*Vicia faba,* Var. Rena mora) as low need plants growth and symptoms of the deficiency, perfect and toxicity. Faba bean seeds were sown and cauliflower seedlings were transplanted on 1st August, 2020 and irrigated. One plant of cauliflower and two plants of faba bean per pot were done. Every pot has a 30 cm diameter and 30 cm height contain 10 kg washed sand. Irrigation with equal quantities of nutrient solution contains all the essential macro and micro nutrients except molybdenum was done. The content of nutrient solution was 250, 50, 200, 110, 45, 115, 65, 3, 1, 0.6, 0.2 and 0.2 mg L^{-1} of N, P, K_2O, Ca, Mg, S, Cl, Fe, Mn, Zn, Cu and B, respectively. The experimental treatments were arranged in split plot design was used with four replicates. The main plots were assigned by two application methods i.e. soil application and foliar spraying. The sub plots were assigned by 6 molybdenum levels as shown in Table 1.

Molybdenum source was ammonium molybdate 54% Mo and was diluted 10 times to be its concentration 5.4% with using Jawar flour (1:9) ammonium molybdate with stable quantity flour in paper package in the root zone.

Table 1: The experimental concentration of molybdenum in both soil and foliar applications for two tested plants

Concentrations of Mo level	Soil application mg kg^{-1}	Foliar spraying mg L^{-1}
1	0	0
2	0.7	3
3	1.4	6
4	2.1	9
5	2.8	12
6	3.5	15

After the end of the pot experiments 15 November and make sure from the concentration of the soil and foliar application include deficiency, perfect and toxicity concentration a field experiment with the same concentrations and application methods were conducted.

2.2 The Field experiments

A field experiment was carried out at Sakha Agricultural Research Station farm during the winter season 2020/2021 to make sure the results of the pots experiment. Surface (0-30 cm) soil samples were collected from the field to determine some physical and chemical, characteristics according to **Black *et al.* (1965)** and **Jackson (1973)**. It`s clear from the results of soil analysis that the experimental soil was saline sodic soils; where EC more than 4, pH higher than 8.5 and SAR more than 15. Some physical and chemical properties of the experimental soil are presented in Table 2.

Faba bean seeds were sown and cauliflower seedlings were transplanted on 1st December 2020. The plot area was 10.5 m^2 in both crops (5 ridges x 0.6 m width and 3.5 m long). Plants were sown in one side of the ridges in faba bean 20 cm apart between hills, while in cauliflower 33 cm apart between seedlings. The micro plot area contains 88 plants in faba bean, while it contains 54 plants in cauliflower. Split plot design was used with three replicates.

Table 2: Some physical, chemical and nutritional properties of the experimental soil at Sakha Station during winter season of 2020/2021

Particle size distribution		Soluble anions, meq/L	
Sand	26%	HCO_3	3.13
Silt	20%	Cl	40
Clay	54%	SO_4	20.73
Soil texture	Clayey	Soluble cations, meq/L	
EC (soil past extract)	6.34 dS/m	K	3.1
pH (1:2.5) susp.	8.8	Na	52.6
ESP	21.43		
SAR	26.04	Ca	5.16
O.M	1.59%	Mg	3.0
Available nutrients mg.kg^{-1}			
N	18		
P	5		
K	210		
Mo	*ND		

* ND: not determined

The main plots were assigned with two application methods of soil application and foliar spraying. The sub plots were assigned by 6 molybdenum concentrations for soil application and 6 concentrations for foliar spraying. Molybdenum concentrations of the soil application were 0, 0.7, 1.4, 2.1, 2.8 and 3.5 mg kg^{-1}soil. This equal 0, 3.24, 6.48, 9.72, 12.96 and 16.20 gm ammonium molybdate per plot. In faba bean every weight of ammonium molybdate per plot divided into 44 paper package, one between two plants. Another side of the plant package contains 3.46 gm ammonium nitrate + 2.8 gm mono ammonium phosphate + 2.8 gm potassium sulphate. In cauliflower every weight of ammonium molybdate divided into 27 paper package like the previous in faba bean. But the other side paper package contains 21 gm ammonium nitrate + 4.2 gm mono ammonium phosphate + 4.2 gm potassium sulphate. Foliar spraying was conducted using 6 concentrations of Mo i.e 0, 3, 6, 9, 12 and 15 mg Mo L^{-1} in the spraying solution, and repeated 4 times every 10 days, where the first was carried out at 30 days from sowing.

At harvesting, seeds and shoot of faba bean, head and shoot of cauliflower and root of each treatment were air dried for 3 days and after that they were oven dried at 70 ^{o}C for 24 hours then they were grinded thoroughly and kept for chemical analysis. Plant samples were wet digested using sulfuric acid and H_2O_2 procedure according to **Chapman and Pratt (1961)**. Molybdenum was extracted from the collected soil samples by EDTA, ammonium acetate method according to **Jackson (1973)**. Molybdenum in the plant digestion and soil extracts were measured by Inductively Coupled Plasma Spectrometry (ICP) (Ultima 2 jy plasma). Nitrate was determined in cauliflower heads and shoots, faba bean seeds and shoots for molybdenum treatments by extracting with 2% acitic acid and nitrate was measured calorimetrically using spectrophotometer according to **Jackson (1973)**. Soil pH values were determined in 1:2.5 soil: water suspension by pH meter, EC was determined in soil paste extract according to **Page *et al*., (1982)**. Soluble cations and anions were measured in the soil paste extract according to **Jackson (1973)**. Available nitrogen was extracted of the soil samples by 1M KCl and measured by Kjledhl method according to **Jackson (1973)**. Available phosphorus was extracted by 0.5 N sodium bicarbonate and calorimetrically determined using spectrophotometer (spectro20) according to **Jackson (1973)**. Available potassium was extracted by 1M ammonium acetate and determined by Flam photo meter **(Jackson, 1973)**. The obtained results were statistically analyzed in randomized block at split plot design according to **Gomiz and Gomiz (1982)** using SPSS program and means were compared by LSD test.

3. RESULTS AND DISCUSSION

3.1 The pot experiment

Data in Table 3 indicate that Mo foliar spraying had the higher plant weight of cauliflower (1274.15) gm/plant and faba bean (196.07) gm/plant. This may be due to foliar application in different physiological stages was more effective in Mo absorption. These results are agreed with **Elsharkawy *et al.* (2015)** and **Rashwan *et al.* (2021)**.

Analysis of variance showed highly significant differences between the molybdenum levels (Table 4). Plant weight of cauliflower was increased gradually with increasing Mo levels up to level of (2.1 mg Mo ka-1in the soil application or 9 mgL-1in the foliar), after that increasing Mo levels gradually decreased cauliflower plant weight, where the lowest value was obtained with level of (3.5 mg kg^{-1} or 15 mg L^{-1}). In the faba bean the increases in the dry plant weight related to Mo levels was up to level of (1.4 mg Mo ka^{-1} in the soil application or 6 mg L^{-1} in the foliar), after that increasing Mo levels led to decrease dry plant weight. This means that the level of 2.1 mg kg^{-1} soil application or 9 mg L^{-1} foliar spraying is perfect for cauliflower plant. Mo concentration lower than that level in considered Mo deficiency, which is not application for plants and above that level is toxicity to plants.

Table 3: Effect of Mo application methods on plant weight (g/plant) of cauliflower and faba bean

Application methods	The cultivated plant	
	Cauliflower, g/plant	Faba bean, g/plant
Soil application	1251.11	173.03
foliar spray	1274.15	196.07
F test	**	**

As for faba bean, the level of 1.4 mg kg^{-1} soil application and 6 mg L^{-1} foliar spraying is perfect. At lower levels it`s Mo deficiency, and more than that level is toxic to plants. These results are agreed with **Kandil *et al*. (2013)**

Table 4: Effect of Mo concentrations on plant weight (gm/plant) of cauliflower and faba bean

Concentrations number		The cultivated plant	
Soil application mg kg^{-1}	Foliar spray mg L^{-1}	Cauliflower, g/plant	Faba bean g/plant
0	0	1145.7	179.8
0.7	3.0	1256.8	210.8
1.4	6.0	1389.8	214.6
2.1	9.0	1499.9	191.1
2.8	12.0	1262.4	168.5
3.5	15.0	1020.9	142.2
F test		**	**
L.S.D		32.5	3.1
F test method x concentratio		**	**

Data in Table 5 show that, the interaction between Mo application methods and concentrations on plant weight of cauliflower and dry plant weight of faba bean. The results illustrate that level of 2.1 mg kg^{-1} in the soil application was the perfect concentration for cauliflower, while in the faba bean the perfect level was 1.4 mg kg^{-1}. The levels lower than these doses were considered as deficit condition, while higher levels caused plant toxicity. In the foliar spraying the perfect concentration was 9 mg L^{-1} for cauliflower and 6 mg L^{-1} for faba bean.

Methods in the pot and field experiment, foliar application were the best in the pot experiment. Unlike application for plants and above that level is toxic to plants. As for faba bean, the level of 1.4 mg kg^{-1} soil application and 6 mg L^{-1} foliar spraying is perfect. At lower levels it`s Mo deficiency, and more than that level is toxic to plants. These results are agreed with **Kandil *et al.*, (2013)**.

3.2 The field experiment

Data tabulated in Table 6 showed that added Mo as soil application was superior to foliar application. Where the highest values of faba bean fresh yield (6.7 t fed^{-1}) and fresh shoot yield (1.4 t fed^{-1}) obtained with the soil application. In comparison between the application methods in the pot and field experiments, foliar application was the best in the pot experiment. Unlike the soil application was the best in the field experiment. This may be due to the washed sandy soil in the pots had low cation exchange capacity and in the field the soil was clayey in texture had high cation exchange capacity. These results are agree with those obtained by **Sary *et al.*, (2020)** and **Michel *et al.*, (2020)**.

Table 5: The interaction effect between Mo application methods and concentrations on plant weight (gm/plant) of cauliflower and faba bean

Methods	Added con.	Cauliflower (g/plant)	Faba bean (g/plant)
Soil application (mg kg^{-1})	0	1133.8	162.5
	0.7	1264.7	185.8
	1.4	1399.3	214.3
	2.1	1500.1	187.1
	2.8	1241.4	159.4
	3.5	967.2	128.7
Foliar spray (mg L^{-1})	0	1157.7	197.1
	3.0	1248.9	235.9
	6.0	1380.2	214.9
	9.0	1499.8	195.1
	12.0	1283.4	177.5
	15.0	1074.6	155.6
F test		**	**
L.S.D		45.9	4.4

Table 6: Effect of molybdenum application methods on faba bean fresh and dry yields of shoots and pods (t fed^{-1})

Methods	Fresh pods yield	Dry pods yield	Fresh shoot yield	Dry shoot yield
Soil application	6.7	1.3	1.4	0.5
Foliar spray	4.9	0.9	1.1	0.3
F test	**	**	**	**

Data in Table 7 showed that the perfect concentration of Mo for faba bean, Fresh pods yield, dry yield, fresh shoot yield and dry shoot yield was 1.4 mg kg^{-1} in the soil application. While, it was 6 mg L^{-1} in the foliar application. The concentration more than this shows toxicity. This results are agree with those of **Głowacka *et al.*, (2019)**.

Table 7: Effect of Mo concentrations on faba bean fresh, dry yields ($ton.fed^{-1}$) and fresh, dry shoot yields ($ton.fed^{-1}$)

Concentrations		fresh yield (t/ fed)	dry yield (t /fed)	fresh shoot yield (t/ fed)	dry shoot yield (t /fed)
Soil application (mg/ kg)	Foliar spray (mg/L)				
0	0	6.1	1.1	1.4	0.4
0.7	3	6.8	1.2	1.5	0.5
1.4	6	6.9	1.3	1.5	0.5
2.1	9	6.1	1.2	1.3	0.4
2.8	12	5.1	1.1	1.1	0.3
3.5	15	3.9	0.9	1	0.3
F test		**	**	**	**
L.S.D		0.082	0.086	0.087	0.036

Data tabulated in Table 8 showed that added Mo as soil application have a superior increase in the yield than foliar application, where the highest values of cauliflower fresh biomass (30.4 t fed^{-1}), fresh head weight (14.6 t fed^{-1}) and fresh shoot weight (15.8 t fed^{-1}) were obtained with the soil application. In the comparison between the application methods in the pot and field experiments, foliar application was the best in the pot experiment. Unlike the soil application was the best in the field experiment. This may be due to the soil in the pot was washed sand had low cation exchange capacity and in the field the soil was clayey in texture had high cation exchange capacity. These results are agree with those obtained by **Singh *et al.* (2017)** and **Hossain *et al.* (2018)**.

Table 8: Effect of Mo application methods on cauliflower (fresh and dry) biomass and shoot weights (t. fed^{-1})

Methods	Fresh biomass	Dry biomass	Head weight	Shoot weight
Soil application	30.4	1.9	14.6	15.8
Foliar spray	22.9	1.4	11.8	11.1
F test	**	**	**	**

Data in Table 9 show that, the perfect concentration of Mo for cauliflower fresh biomass, dry biomass, head weight and shoot weight was 1.4 mg kg^{-1} in the soil application, while it was 6 mg L^{-1} in the foliar application. The concentration rather than this show toxicity. This results are agree with **Rihan *et al.*, (2014)**.

Table 9: Effect of Mo concentrations on cauliflower (fresh and dry) biomass and shoot weights (ton/fed)

Concentrations		Fresh biomass t/fed	Dry biomass, t/fed	Head weight t/fed	Shoot weight t/fed
Soil application mg /kg	Foliar spray mg/ L				
0	0	22.2	1.5	11.4	10.8
0.7	3	26.8	1.7	13.9	12.8
1.4	6	33.9	1.9	16.5	17.3
2.1	9	28.7	1.7	14.4	14.3
2.8	12	25.7	1.5	12.6	13.1
3.5	15	22.6	1.4	10.4	12.2
F test		**	**	**	**
L.S.D		1.01	0.049	0.818	0.362
F test method x concentration		**	**	*	**

Data in Table 10 show that Mo soil application led to increase Mo concentration in the shoot (0.75 mg kg^{-1}) rather than the head (0.61 mg kg^{-1}). While the foliar application increased Mo concentration in the head (1.87 mg kg^{-1}) rather than the shoots (0.37 mg kg^{-1}). In faba bean foliar application increased Mo concentration in both seeds and shoots. This may be due to Mo absorption through the leaves anchorage the storage in the head and seeds. Similar results were reported by **Campo *et al.* (2009)**.

From the data in Table 10 clear that Mo concentration in the cauliflower heads and faba bean seeds less than the harm full concentration for the human health, where the critical concentration for Mo 0.9 mg kg^{-1} body weight day^{-1}, adult man 80 kg equal 72 mg Mo day^{-1} come from 38 kg cauliflower heads day^{-1} and from 4.8 kg faba bean seeds day^{-1} according to **Vyskočil and Viau (1999)**.

Table 10: Effect of application methods on Mo concentrations of cauliflower shoot and head (mg kg^{-1}) and faba bean seeds and shoot (mg kg^{-1})

	Cauliflower		Faba bean	
Application methods	Shoo	Hea	Seed	Shoo
Soil application	0.75	61.0	10.92	7.99
Foliar spray	0.37	1.87	15.09	8.38
F test	**	**	**	N.S

Data in Table 11 show that Mo concentrations (mg kg^{-1}) was increased gradually with increasing Mo concentration in both application methods in both cauliflower and faba bean. The lowest values were obtained with the control treatment, while the highest values were obtained with the highest concentration (3.5 mg.kg^{-1}) in the soil application and (15 mg kg^{-1}) in foliar application in the two crops.

Table 11: Effect of Mo concentration level on Molybdenum concentrations of cauliflower shoot and head (mg kg^{-1}) and faba bean seeds and shoot of (mg kg^{-1})

Concentrations		Cauliflower		Faba bean	
Soil application (mgkg^{-1})	Foliar spray (mgL^{-1})	Shoot	Head	Shoot	Head
0	0	0.10	0.15	8.83	2.21
0.7	3	0.15	0.18	10.08	4.50
1.4	6	0.28	0.51	12.50	5.06
2.1	9	0.41	0.93	13.56	6.65
2.8	12	0.83	1.53	14.33	9.03
3.5	15	1.61	4.15	18.73	17.68
F test		**	**	**	*
L.S.D		0.23	0.22	0.89	2.60
F test method x concentration		*	**	*	*

4. COCLUSION

It can be concluded that there has been Mo concentrations in the edible part for health care. The best concentration for the high yield and quality for the two crops was 1.4 mg kg^{-1} in the soil application, while it was 6 mg L^{-1} in the foliar application under the saline sodic soil conditions. Concentration of Mo in edible parts (cauliflower head and faba bean seed less than the harmful concentration for human and livestock. a response to molybdenum fertilization to improve the productivity and quality of edible crops, such as faba bean and cauliflower, under the salt affected soil conditions. In the sandy soils foliar spraying of Mo is better than soil application method.

5. REFERENCES

Ali, M.; E. Yousef and I., Nasef (2019). Cauliflower growth, yield and quality response to nitrogen fertilization and micronutrients foliar application in newly reclaimed areas. Journal of Plant Production, 10(3):317–325.

Bambara, S. and P. A. Ndakidemi (2010). The potential roles of lime and molybdenum on the growth, nitrogen fixation and assimilation of metabolites in nodulated legume: A special reference to *Phaseolus vulgaris* L. African J. Biotech., 8(17):2482-2489.

Black, C. A.; D. D. Evans; J. L. White; L. E. Ensminger and F. E. Clark (1569). “Methods of Soil Analysis” Part 2: Chemical and Microbiological Properties. American Society of Agronomy, Madison Inc., Madison, Wisconsin, USA, p. 1569.

Campo, R. J.; R. S. Araujo and M. Hungria (2009). Molybdenum-enriched soybean seeds enhance N accumulation, seed yield, and seed protein content in Brazil. Field Crop Res., 110(3):219–224.

Chapman, H. D. and P. F. Pratt (1961). Methods of analysis for soils, plants and waters. University of California, Los Angeles, USA, 60-61, 150-179.

Elsharkawy, G. A.; A. G., Mousa; H. H., Hegazi and M. Kotb (2015). The Influence of Subsurface Drip Irrigation and Molybdenum Application on Morphological and Yield Component of Two Common Bean Cultivars under Greenhouse Conditions. Egyptian J. of Horticulture, 42 (Issue 1); 557–576. https://doi.org/10.21608/ejoh.2015.1319

Fageria, N. K.; H. R., Gheyi and A. Moreira (2011). Nutrient bioavailability in salt affected soils. J. of Plant Nutrition, 34(7). https://doi.org/10.1080/01904167.2011.555578.

Głowacka, A.; T., Gruszecki; B. Szostak and S. Michałek (2019). The Response of Common Bean to Sulphur and Molybdenum Fertilization. International Journal of Agronomy, 2019. https://doi.org/10.1155/2019/3830712.

Gomez, K. A. and A. A. Gomez (1984). Statistical Procedures for Agricultural Research. John Willey and Sons. Inc. York.

Jackson, M. L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 498.

Kandil, H.; N., Gad and M. T. Abdelhamid (2013). Effects of different rates of phosphorus and molybdenum application on two varieties common bean of (*Phaseolus vulgaris* L.). J. Agric. Food Tech. 3(3): 8–16.

Hossain, M. F.; M. R. Uddin; M. R. Humauan and J. Hossain (2018). Effect of boron and molybdenum on seed production of cauliflower. Indian Journal of Horticulture, 59(2):177–180.

Mengel, K. and E. A. Kirkby (1987). Principles of Plant Nutrition (4th Ed.). International Potash Institute, Worblaufen-Bern, Switzerland.

Michel, D. C.; I. C. F. Vasques; G. D. C. R. Araújo; J. L. de Castro; L. L. R. de Assis; R. H. C. L. Dos Reis; M. L. de S. Silva and V. Faquim (2020). Influence of molybdenum doses in inoculation and mineral fertilization in cowpea beans. Bioscience J., 36(1):102–112.

Page, A. L. (1982). Methods of Soil Analysis (2nd Ed., Vol. 2). American Inc. Madison Wisconsin, USA.

Rahate, K. A.; M. Madhumita and P. K. Prabhakar (2021). Nutritional composition, anti-nutritional factors, pretreatments-cum-processing impact and food formulation potential of faba bean (*Vicia faba* L.): A comprehensive review LWT, 138, 110796. https: //doi.org/10.1016/J.LWT.2020.110796.

Rana, M. S.; C. X. Hu; M. Shaaban; M. Imran; J. Afzal; M. G. Moussa; A. M. Elyamine; P. Bhantana; M. H. Saleem; Syaifudin; M., M. Kamran; M. A. Shah and X. Sun (2020). Soil phosphorus transformation characteristics in response to molybdenum supply in leguminous crops. J. of Environmental Management, 268(May), 110610. https://doi.org/10.1016/j.jenvman.2020.110610.

Rashwan, E.; R. Faiyad and R. El-Mahdy (2021). Sustainable management of kidney bean plants by soil application of humic substances and foliar application of molybdenum. Environment, Biodiversity and Soil Security, https://doi.org/10.21608/jenvbs.2020.51641.1119.

Rihan, H. Z.; M. Al-Issawi; M. Al Shamari; W. A. Woldie; Kiernan, M. and M. P. Fuller (2014). The effect of molybdenum on the molecular control of cold tolerance in cauliflower (Brassica oleracea var. botrytis) artificial seeds. Plant Cell, Tissue and Organ Culture, 118(2):215–228. https://doi.org/10.1007/ s11240-014-0475-7.

Sary, D. H.; E. M. Niel and N. M. Abdelhameid (2020). Effect of inoculation with biofertilizers and molybdenum on the growth and productivity of faba bean (*vicia faba* L.) grown in sandy soil under drip irrigation. Alexandria Science Exchange J., 41(1):105–121. https://doi.org/10.21608/ asejaiqjsae.2020.81530.

Singh, V.; Singh, A. K.; Raghuvanshi, T.; Singh, M. K.; Singh, V and Singh, U. (2017). Influence of Boron and Molybdenum on Growth, Yield and Quality of Cauliflower (*Brassica oleracea* L. var. botrytis). International Journal of Current Microbiology and Applied Sciences, 6(10), 3408–3414. https://doi.org/10.20546/ijcmas.2017.61 0.400

Tisdale S. L, J. L .Havlin. J. D. Beation and W. L. Nelson (2007). Soil Fertility and Fertilizer, An Introduction to Nutrient Management, 7th edition p: 221. Pearson Education Inc. Singapore.

Vyskočil, A. and C. Viau (1999). Assessment of molybdenum toxicity in humans. In Journal of Applied Toxicology, 19(3):185-192.

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استجابة نباتي الفول البلدي والقرنبيط لطرق إضافة وتركيزات مختلفة من الموليبدينم تحت ظروف الأراضي المتأثرة بالملوحة

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مجلة العلوم الزراعية والبيئية المستدامة

الكلمات المفتاحية:
الفول البلدي، القرنبيط،الموليبدينم،الملوحه، الرش الورقي، الاضافه للتربه

الملخص العربى

أجريت تجربتان في محطة البحوث الزراعية بسخا (٣٠,٥١ درجة شمالا في خط العرض و٣١,٠٥ درجة شرقا في خط الطول خلال فصلي الخريف والشتاء (٢٠٢٠/٢٠٢١).
الأولى تجربة اصص والثانية تجربة حقلية. تتمثل أهداف هذه الدراسة في دراسة مستويات تركيز الموليبدينم وطرق اضافة الموليبدينم على الفول البلدي والقرنبيط حيث أنه يختلف احتياج النبات من حيث انتاجيته وجودته لعنصر الموليبدينم تحت ظروف التربة المتأثرة بالاملاح تم استخدام تصميم القطع المنشقة مع ثلاث مكررات. وقد خصصت القطع الرئيسية لطريقتين الاضافة هي التربة والرش الورقي. وتنقسم هذه القطع الفرعية إلى ستة تركيزات للتربة (٠,٠، ٠,٧ مليغرام/كجم ١,٤ مليغرام/كجم، ٢,١ مليغرام/كجم، ٢,٨ مليغرام/كجم، ٣,٥ مليغرام/كجم)، وستة تركيزات أخرى رشا علي الأوراق (٠,٠، ٣ مليغرام/لتر، ٦ مليغرام/لتر، ٩ مليغرام/لتر، ١٢ مليغرام/لتر، ١٥ مليغرام/لتر).
ويمكن تلخيص النتائج التي تم الحصول عليها على النحو التالي:
كان التركيز المثالي للموليبدينم بالنسبة الفول البلدي والقرنبيط لانتاج القرون والرأس والمجموع الخضري هو ١,٤ ملغم/كجم في التربة. بينما كان ٦ مليغرام/لترفي رش الاوراق. التركيز الاعلي من هذا يظهر سمية. أدت زيادة تركيز الموليبدينم في التربة او الرش الورقي إلى زيادة الموليبدينم في المادة الجافة للنبات. لم يصل تركيز الموليبدينم الي الحدود الضارة للانسان والحيوان في كلا المحصولين.