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Effect of Seeds Soaking with Molybdenum, Spraying with Selenium and Interaction Between them on Growth and Yield of Green Peas (*Pisum sativum* L.)

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Abstract : An experiment was conducted during the winter season 2018-2019 at Abu Al-Khaseeb district, Basrah province, Iraq to study the effect of soaking seed with molybdenum (Ammonium molybdate) at a four concentration (0,5, 10 and15) mg.L^{-1} and plant spraying with selenium (Sodium selenite) at a three concentration (0, 10 and 20 mg.L^{-1}) on growth and yield of green peas. Split plot design according to complete Block randomized design was used with three replicates. The results were showed that the soaking and spraying of plants with molybdenum and selenium respectively were significantly superior in the number of branches, root nodules, pods, the yield of plant pods and fresh seeds compared to the control. While the spraying with selenium had a significant effect on the number of leaves. The interaction between molybdenum and selenium had a significant effect on leaves area, the number of leaves, root nodules and pods, the yield of pod and fresh seeds plants treated with molybdenum and selenium at 10 mg.L^{-1} for each other had to get the highest yield of green pods and fresh seeds 118.6 and 287.0 gm, respectively.

Keywords: Pea plants, Molybdenum, Selenium, Vegetative growth, Qualitative yield, Legumes.

Introduction

Peas (*Pisum sativum* L.) is considered as one of the important legumes crop. The cultivation of peas in Iraq is in the central and northern regions. The cultivated area for 2015 is estimated at 250 hectares with a total production of 1000 tons and a production rate is4 tons per hectare which is relatively low (Arab Organization for Agricultural Development, 2016). Production can be achieved through fertilization because of its significant effect in regulating the nutritional status of plants, especially molybdenum and selenium. Several studies have pointed to the importance of molybdenum in the plant, which is an essential component in many important enzymes such as nitrogenase enzyme and nitrate reductase enzyme, nitratreductase, xanthin dehydrogenase reduction enzyme and sulphate oxidase enzyme sulphate oxidase. Also besides, it is important in the plant metabolism and in increasing of root nodes, their weight, growth characteristics and yield (Said *et al*., 1991). Pea plants are considered one of the medium-sensitive plants (Mass & Hoffiman, 1976). Increased salinity above 3.4 ds.m^{-1}has negative effects on the growth of shoot, root,

flowers and yield (Whiting & Wilson, 2003). Therefore, the cultivation of the pea plant in the saline-affected lands, need to treat them with selenium. Selenium is considered a rare element that has an effective role to increase the activity of enzymatic antioxidants which act as a co-factor for these antioxidants, especially Glutathione and Peroxidase enzymes (Hassannzzuman & Fujita, 2010). As well as, it's an association with amino acids such as methionine and cysteine to formation selenium proteins Selenoprotiens which can tolerate cellular membranes for environmental stresses and prevent the Demolition of Denaturation compounds metabolism of protein plants (El-Missry, 2012). Therefore, this study was aimed at response extent of pea plant to both components and their effect in yield parameters and qualitative qualities and the impact of the interaction between the two factors of the study and its impact on growth parameters and yield.

Materials & Methods

An experiment was conducted during the winter season 2018-2019 in one of the orchards of Abu Al-Khaseeb district, Hamdan region, 8 km southern Basrah province. Analysis was carried out in the laboratories of the department of soil science and water resources, college of Agriculture, University of Basrah as shown in Table (1). In the current study, seed soaking treatment with Molybdenum was considered as the main factor. Molybdenum used in the form of ammonium molybdate $(NH4)_6Mo_7O_{24}$. $4H_2O$) at four concentrations (0, 5, 10 and 15) $mg.L^{-1}$ for 6 hours. Whereas leaves spray with selenium was considered as a secondary factor which was in Sodium Selenate form (Na_2SeO_3) that used in three concentrations (0,10and20) $mg.L^{-1}$ at the rate of three sprays. The first one was in the stage of shoots growth after 30 days of planting, and the second and third sprays were separated by two weeks between each spray. The total of experimental units was 3 × 3 × 4 = 36 units. The land has been prepared by plowing, smoothing, levelling and design into 12 lines, the length of each one was 10 m and the distance between each one was 1.5 m that divided into three experimental units. The length of the experimental unit is 3 m, the number of hollows in each experimental units was 12 hollow and the distance between the hollows was 25 cm .The number of plants in each line was 24 plants. The lines were drilled at a depth of 25 cm and fertilized with decomposing animal manure (cow's residues) and triple super phosphate fertilizer (44% P_2O_5) at the rate of 6 $tons.dm^{-1}$ and 40 $kg.dm^{-1}$ respectively. A drip irrigation system with RO water was established for irrigation. Syrian type of pea seeds was depended on this study. Three seeds were laid in one hole and covered with a thin layer of Dutch-made Potgrono. After germination, plants were reduced to two plants per hole to reach to a plant density of 11,733 per plants. All agricultural service operations were carried out to produce the crop including hoeing, weeding, irrigation, fertilization, consolidation and maintenance of the drip system. Planting lines in all experiment units were sterilized similarly prior to planting with fungicide (proton) and insecticides (Matlub *et al*., 1989). The plants were fertilized by the Fertigation method with irrigation water continuously and in three stages: The first one by adding 1 $kg.ton^{-1}$ of urea fertilizer (46%N) in water during the vegetative growth stage. The second one by utilize1 $kg.ton^{-1}$ of NPK (10.15.25) during the flowering growth stage and the third one by use1 $kg.ton^{-1}$of NPK (20.20.20) during the set flowering stage. A

preventive program was adopted to control insects and fungal diseases by use the insecticide Diazinon to control ants at a rate of 3 $g.m^{-2}$. The soil was sterilized with fungicide Proton at a rate of 2.5 g. $L^{-1}$for three times; the interval between one and the other was 21 days.

Table (1): Physical and chemical characteristics of experimental soil and irrigation water.

Soil properties		Units	Values
pH		-	7.55
EC		$ds.m^{-1}$	13.83
Total Nitrogen		mg. kg^{-1}	84
Total phosphorus		mg. kg^{-1}	42
Total potassium		mg. kg^{-1}	101.30
Soil structure	Sand	%	2.8
	Silt	%	76.2
	Clay	%	21
Soil Texture		-	Silt loam
water properties		Units	Values
pH		-	7.78
EC		$ds.m^{-1}$	0.055

The studied characteristics

Indications of vegetative growth

Samples from four plants were taken randomly for each experimental unit at the end of the season to measure below:

1- Number of branches. $Plant^{-1}$

2- The total number of leaves. $Plant^{-1}$

3-Leaf area: The Leaf area was calculated using the gravimetric method, according to Morsi *et al*. (1968).

4- Number of root nodules

Indications of qualitative yield

1- Number of pods. $plant^{-1}$

2- Weight of the pod (g)

3 - Yield of one plant from the green pods

4 - Yield of one plant from the Fresh seeds

Results & Discussion

Table (2) shows that soaking of pea seeds with molybdenum significantly affected the number of branches, leaves and root nodules.$plant^{-1}$. High concentration (15 $mg.L^{-1}$) of molybdenum showed a significant positive effect in the number of branches and leaves with an increase (23.12, 15.16, 12.63) % and (30.70, 15, 44 and 22.77) % respectively compared to the control and 5 and 10 $mg.L^{-1}$. whilst 5 $mg.L^{-1}$ exceeded significantly in the number of leaves on the comparison treatment with an increase of 13.21%. As well as the molybdenum significantly in the number of root nodules.$Plant^{-1}$ where the concentration exceeded 5 mg. L^{-1} significantly compared with control treatment and other concentrations increased by 87.07, 25.15 and 23.23%, respectively, while the concentration was 10 $mg.L^{-1}$was significantly higher than the concentration of 15 $mg.L^{-1}$, an increase of

49.47%. While Soaking with molybdenum did not lead to significant differences in the leaf area. The significant increase in shoot growth parameters may be attributed to the role of molybdenum in increasing the efficiency of nitrogen stabilization which leads to increase the number of root nodules. This result is consistent to the results that obtained by Das *et al*. (2015) on the pea plant. Malik *et al*. (2011) found on plant mung bean. Khan *et al*. (2014) for Chickpea and Hirpara *et al*. (2017) for peanut plant. The increasing efficiency of the root nodules as a result of its primary action in the nitrogenase enzyme and the reductase Nitrate enzyme that exists between the root nodules (Al-Saidi, 2005), which is contributed to the increase of plant-ready nitrogen and its absorption by the plant, which leads to an increase in the number of branches and leaves. Several people found the same results including Zilanirabbi *et al*. (2007) and Das *et al*. (2015) in pea, Elkhatib (2009) and Kandil *et al*. (2013) in beans, Gad & Abdel-moez (2013) and Eisa & Ali (2014) on cowpea. The spraying with selenium showed significant differences in the number of branches and root nodules and leaf area Whereas the concentration exceeded 20 $mg.L^{-1}$ significantly in the number of branches and root nodules compared with the control treatment and concentration 10 mg. $L^{-1}$with an increment percentage of 17.59 and 12.95% and 3.35 and 120.45, respectively, while a concentration exceeded 10 $mg.L^{-1}$ significantly in the number of root nodules compared to the control treatment with an increment percentage of 113.30%,. While the selenium spraying treatments increased the leaf area as the concentration of 10 $mg.L^{-1}$ significantly compared to the control treatment with an increment percentage of 13.61%. while, selenium had no significant effect on the number of leaves. The same table shows that selenium foliar spray has a significant effect in increasing the number of branches, leaf area and the number of root nodules. The increase may be due to the positive role of selenium as an antioxidant, It is work as assistant factor for a large number of antioxidant enzymes, such as the enzyme glutathione peroxide (GP_X) and catalase (CAT), these two enzymes have a role in the transformation of the toxic hydrogen peroxide produced by environmental stresses into H_2O water molecules (Ren *et al*., 2009), which reduces the oxidative stress caused by environmental stresses such drought and salinity (Hasanuzzaman & Fujite, 2011; Hasanuzzaman *et al*., 2011; Abul-Soud & Abd-Elrahman, 2016; Al-Abdullah, 2018). In addition, selenium acts as a binding factor between amino acids, especially selenomethionine and selenocysteine acid, where they have the ability to bind to other amino acids, which increases the activity of DNA and RNA and this activity increases the amplitude, growth, division and cellular differentiation (Hatfield *et al*., 2012; Castillo-Godina *et al*., 2016). In addition to the role of selenium in regulating the metabolism of carbohydrates through oxidation and reduction reactions that may have some catalytic effects in the formation of root nodules (Owusu-Sekyere *et al*., 2013), these results are consistent with what obtained by some researchers (Kovacs, 2016; Abdel-Aziz & Geeth, 2017; Boghdady *et al*., 2017; Al-Kazzaz *et al*., 2017; Al-Kazzaz, 2018; Shedeed *et al*., 2018) in Pea. For the interaction between two factors, it showed a significant effect on the number of leaves, root nodules and leaf area as the concentration 15 mg. L^{-1} of molybdenum and the concentration 20 mg. $L^{-1}$of selenium. The highest number of leaves have been obtained

50.00 leaf, from the interaction between 10 mg.L^{-1} of molybdenum and spray with 20 mg.L^{-1} of selenium which caused an increase in the number of root nodules for 23.33 nodules. While the plant non-soaked seeds with Molybdenum and sprayed with selenium at 10 mg concentration giving the highest leaf area of the plant which was 36.08 dcm^{-2}.plant. While the control treatment gave

Table (2): Effect of molybdenum soaking (Mo), selenium leaf spraying (Se) and interactions between them in some vegetative growth parameter.

Treatment			Number of branches	Number of leaves	Leaf area	Number of root nodules
Average effect of Mo Mg.L^{-1}		0	3.33	37.00	28.23	14.33
		5	3.56	41.89	25.62	17.66
		10	3.64	39.39	25.04	14.11
		15	4.10	48.36	24.85	9.44
L.S.D.0.05			0.39	3.61	N.S	2.32
Average effect of Se Mg.L^{-1}		0	3.41	41.77	23.95	6.99
		10	3.55	41.04	27.21	14.91
		20	4.01	42.17	26.64	15.41
L.S.D.0.05			0.45	N.S	2.73	1.64
Interaction between Mo and Se	0	0	2.91	17.66	17.22	5.00
		10	3.33	20.33	36.08	17.66
		20	3.75	7.33	31.39	20.33
	5	0	3.50	21.33	32.00	7.33
		10	3.38	7.00	18.36	21.33
		20	3.82	6.66	26.48	7.00
	10	0	3.27	12.33	23.85	6.66
		10	3.66	23.33	24.62	12.33
		20	3.99	9.00	26.65	23.33
	15	0	3.96	8.33	22.73	9.00
		10	3.83	11.00	29.77	8.33
		20	4.50	3.63	22.06	11.00
L.S.D.0.05			N.S	5.09	4.89	3.63

the lowest number of leaves33.25, root nodules 5 and leaf area 17.22 dcm^2.$plant^{-1}$. The interaction did not show a significant effect on the number of branches. As shown in table (3), molybdenum soaking significantly affected the number of pods and the yield of one plant of green pods and fresh seeds. where 10 mg.L^{-1} concentration caused significantly increase (29.26 and 12.62) and

(14.34 and35.72) % respectively. While the concentration 15 mg L^{-1} had significant increasing effect in the number of pods and the yield of each plant compared to the control treatment with an and increase 24.61 and 21.30%, respectively, Whilst, with 10 mg.L^{-1} concentration there was a significant increase in the plant yield of fresh seeds compared to the control treatment and both 5 and 15 mg. L^{-1}concentrations with an increase of (53.75, 23.72, 20.49) respectively. Also, the concentration exceeded (15.5) mg. L^{-1}significantly compared to the control treatment an increase of(27.60and 24.27), respectively. However, while Molybdenum soaking had no significant affected in the weight of the pod per plant. Table (3) shows that molybdenum soaking has significant effects in the increase in the number of pods and plant yield of green pods and fresh seeds.

Table (3): Effect of molybdenum soaking (Mo), selenium leaf spraying (Se) and interactions between them in some indications on the qualitative yield of pea plant.

Treatment			Number of pods	Weight of the pod (g)	Yield plant of pods (g)	Yield plant of seeds (g)
Average effect Mo (Mg.L^{-1})		0	32.70	5.99	196.2	69.2
		5	37.53	6.26	232.9	86.0
		10	42.27	6.33	266.3	106.4
		15	40.50	5.89	238.0	88.3
L.S.D.0.05			3.30	N.S	30.81	11.99
Average effect of Se (Mg.L^{-1})		0	34.72	6.00	207.1	80.7
		10	40.85	5.96	243.2	88.8
		20	39.37	6.39	249.7	92.9
L.S.D.0.05			2.33	N.S	18.09	8.23
Interaction between Mo and Se	0	0	29.57	5.76	170.2	57.6
		10	33.36	5.62	187.3	60.0
		20	35.17	6.58	231.0	90.1
	5	0	28.71	6.46	185.4	74.8
		10	48.31	5.87	283.4	96.4
		20	35.57	6.45	229.8	87.0
	10	0	44.21	5.77	254.8	104.4
		10	44.91	6.42	287.0	118.6
		20	37.69	6.82	257.2	96.2
	15	0	36.38	6.01	217.8	86.1
		10	36.83	5.94	215.2	80.3
		20	49.04	5.73	280.9	98.4
L.S.D.0.05			4.67	N.S	39.31	16.66

This can be attributed to the important role of molybdenum in number of enzymes that have a critical role in the growth of the plant, including nitrogen enzyme that is responsible in the reducing of molecular nitrogen and convert it into a form absorbable by the plant as a result to increase the number of root nodules and thus increase the consumption and representation of nitrogen in many components and vital activities within the plant. Also besides, molybdenum has role in increase of chlorophyll production which cause increase the activity of photosynthesis (Abu Dahi & Al-Younis, 1988). This is reflected in the improvement of plant growth and leads to an increase in the number of pods as a result of the increment in the number of branches carrying the pods in the plant and the increase of the yield per plant and this is confirmed by Al-Jubouri (2015). There is a significant positive correlation relationship between the yield plant of peas and the number of pods and thus increase the overall productivity. Consequently, the total productivity of green pods, fresh seeds, dry matter and protein content in seeds were increased, which is in line with what confirmed by El-Hersh *et al*. (2011). That it exists a significant positive correlation relationship between seed yield and number of root nodules and a positive correlation relationship between the number of root nodules and nitrogen fixation in lentil plant. These results are consistent with what researchers have Tahir *et al*. (2014), Hidayatullah *et al*. (2016) in chickpea, and Al-Rikabi & Al-Jabouri (2017a,b) in bean plant. Also, we found that selenium spray with 10 and 20 $mg.L^{-1}$ caused significantly increasing in the number of pods and the yield of one plant of pods, compared to the control treatment with an increase of (13.39 and 17.65) and (20.56 and17.43) % respectively. While, there was no significant difference in the number of pods and the seeds yield of the plant between two concentrations. As well as the effect of 20 $mg.L^{-1}$of selenium spray concentration induced the increase of plants yield of fresh seeds compared to the control with an increase of 15.11%. However, this selenium concentration had not significantly affected in the weight of the pod per plant. Table (3) indicates that there was a significant increase in leaf spraying with selenium in the number of pods and the yield plant of green pods and fresh seeds. The increase was attributed to the role of selenium in increasing some of the vegetative growth indicators represented by the number of branches and leaf area and the increase in the number of root nodules formed due to its role in increasing the efficiency of photosynthesis process to involved in chloroplast enzymes and carbohydrate metabolism (Mazzafera, 1998), and its role in delaying the aging of leaves. Xue *et al*. (2001) and an increase in the activity of antioxidant enzymes (Timothy, 2001) thus, Improving the resistance of plants grown under saline stress conditions, which is positively reflected in the increase in yield. These results are consistent with the results obtained by Kovacs (2016) and Shedeed *et al*. (2018) in pea plant. The interaction between the two factors significantly affected the number of pods, the yield of pods and fresh seeds per one plant. The interaction between 15 $mg.L^{-1}$of molybdenum and 20 $mg.L^{-1}$of selenium showed the highest number of pods which was 49.04 pods. $Plant^{-1}$. While molybdenum-soaked plants with 5 $mg.L^{-1}$and 0 of selenium gave the lowest number of pods that was 28.71 pods. However, 10 mg of molybdenum and 10 mg of selenium per litter was a good interaction to obtain the highest yields of green pods and fresh seeds that were

287.0 and 118.6 g respectively compared to the interaction between the controls of both treatments which were170.2 and 57.6 g respectively.

Conclusions

The use of soaking of seeds with molybdenum and leaf spraying with selenium and their interaction increased some indicators of vegetative growth. This effect was reflected on the qualitative yield qualities in the pea plant as well as, soaking of seeds with molybdenum led to an increase in the number of leaves of the plant but did not increase the leaf area and the weight of the pod in the plant and leaf spraying with selenium increased the leaf area of the plant but did not increase the number of leaves and the weight of the pod in the plant**.**

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