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Effect of spraying with manganese and adding phosphate fertilizer on some indicators of vegetative growth and yield of bean plants (Phaseolus vulgaris L.)

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Abstract: A field experiment was conducted for the agricultural season (2019-2020) in Abu Gharq area to study the effect of different levels of manganese spraying (manganese sulfate) and different levels of phosphate fertilizer in some growth and yield of Phaseolus vulgaris L., the local cultivar, in a factorial experiment with a complete randomized block design RCBD, with three replications .The first factor included spraying 3 concentrations of manganese (0, 20, 40 mg.L^{-1}) and the second factor with 3 levels of phosphate fertilization (0, 50, 100 kg phosphorous.ha^{-1}) and their interaction, The results indicated a significant superiority of spraying with the element manganese at a concentration of 40 mg.L^{-1}, and it gave the highest significant mean in the traits of plant height, leaf area, dry weight, percentage of nitrogen and phosphorous in leaves, number of pods per plant, number of seeds per pod, the weight of 100 seeds, total yield, protein and carbohydrates percentage in seeds, While the treatment of adding phosphorous at a concentration of 100 kg.phosphorous.ha-1 gave the highest significant average for the above traits.

Keywords: manganese, phosphate, vegetative growth, bean plants, Phaseolus vulgaris L.

1. INTRODUCTION

Recent studies have tended to find methods for the purpose of adopting them in preparing plants with nutrients in order to increase production and improve quality by reducing the obstacles and problems facing the lack of availability of elements in the soil by spraying these elements in the form of diluted solutions on the vegetative system (Mohammed, 2012). Foliar nutrition is one of the most important methods to supply plants with their needs of nutrients, as many researches and studies have proven the possibility of supplying plants with various nutrients by spraying them with solutions of these elements in a method that ensures complete or complementary nutrition for all nutrients that are absorbed by the roots. As it was found that the absorption of nutrients by the leaves in the first degree and other plant parts in the second degree is usually more rapid and efficient than absorption. Through the roots, especially when soil conditions are not suitable for absorption, such as the pH of the soil, or as a result of the contradiction between nutrients or as a result of the chemical fixation of the elements in the soil (Al-Hashimi et al., 2016), Manganese is one of the elements necessary for the formation of fats, where it contributes to the activation of the enzyme carboxylase

(Abu Dhahi and Younes, 1988) and also has a role in activating the enzyme necessary dehydrogenase in the TCA cycle (Tricarboxylic acid) and works on the oxidation of Indole Acetic Acid (IAA) through the oxidase enzyme,In addition to its role in raising the proportion of vitamin C and regulating the osmotic effort of plant cells, as well as raising the efficiency of the plant to resist frost and early flowering, as it is one of the necessary elements for the process of photosynthesis,As it participates with chloride in the process of photolysis of water (phytolysis) and obtaining electrons and hydrogen ions, to form the energy complex ATP and reducing, + NADP to NADPH + H in light reactions (light or photo-reactions).or the so-called Hill-reaction (Al-Nuaimi, 1999), and it also has an effective role in raising the efficiency of the plant to benefit from potassium fertilizers that are added to the soil (Al-Alousi, 2002). Barney (2007) showed that manganese is associated with the activity of 35 enzymes inside the plant and participates in the reduction of nitrates inside the plant and also has a role in providing cationic acids in the Krebs cycle of respiration that is associated with the ammonia resulting from nitrate reduction to form amino acids, which are the cornerstone of protein formation (Idris, 2009), The addition of manganese increases the plant's ability to absorb nitrogen, which is important in raising the efficiency of the plant to benefit from the use of water, and it also has an important role in the production of chlorophyll, although it is not included in its composition, in addition to its role in the oxidation and reduction processes inside the plant and also in the process of electronic flow. The light reactions of photosynthesis, and its deficiency leads to damage to the coroplast (2010, Taiz).Abbas et al., 2011, when they applied manganese to the leaves of different soybean cultivars at a concentration of 100 $mg.L^{-1}$, showed that there was a significant increase in traits of the number of pods, fertility percentage, the weight of 100 seeds, number of seeds per pod, total seed yield, oil and protein content in seeds. Saleh, 2012, showed that the addition of micro-elements such as iron, zinc and manganese by spraying on soybean leaves led to a significant increase in the indicators of vegetative growth and seed yield, whether by spraying them individually or in combinations and Al-Hashemi et al., 2016 showed that spraying manganese on soybean plants at a concentration of 100 mg.L-1 led to a significant increase in plant height, number of branches, leaf area, number of pods, their height from the ground, and seed yield. Phosphorous is one of the basic and necessary nutrients for plant growth because of its direct role in most biological processes .Phosphorous is involved in the process of forming and dividing living cells and in the transfer of genetic traits, being one of the components of DNA and RNA. It also enters with proteins in the formation of cellular membranes such as the plasma membrane and the gap membrane, as well as its role in increasing the yield and improving its quality and early ripening of fruits. It helps in the formation of the lateral roots of some plants and root hairs and strengthening the stems to reduce lodging crop and resistance to some diseases (Al-Nuaimi, 1999), (Havlin et al., 1999) and (Tisdale et al., 1997).Abdel-Amir, 2011, indicated that the use of phosphate fertilizer at a concentration of 120 kg of a phosphorous per hectare with the bacterial inoculum of bean plant led to a significant increase in the traits of root, yield and protein percentage compared to the treatment of no addition of phosphate fertilizer and no inoculum and Shahid and Mahmoud, 2014 when using the percentage of phosphorous to nitrogen at the concentration (20: 250 $mg.L^{-1}$) gave the highest number of roots from Mung bean in one cutting, and Jassem et al., 2016 confirmed that spraying phosphorous on the leaves of the broad bean plant at a concentration of 3000 mg $.L^{-1}$.It led to a significant increase in the traits of plant height and number of branches, and the concentration of 2000 $mg.L^{-1}$ gave a significant increase in the traits of pod length and green pod weight.

2. MATERIALS AND METHODS

A field experiment was conducted for the autumn season 2019 to study the effect of 3 levels of manganese spray (0, 20, 40 mg. manganese L^{-1}) and its source is manganese sulfate MnSO4, and 3 levels of phosphate fertilizer added (0, 50, 100 kg. $^{-1}$), In some indicators of vegetative growth and yield of the bean plant (*Phaseolus vulgaris L*.), the local cultivar. The land of the field was tillage with a flip-up plow, two perpendicular plows, then it was smoothed, leveled, and divided into terraces with a length of (3) m, the distance between them is (75) cm.Calibration irrigation was conducted before planting the seeds to determine the planting line, where the seeds were sown on 15/9/2019 and in pits at a distance of 30 cm between one pit and another, placing 2-3 seeds for each pit. After germination, they were thinned to one plant. Agricultural service operations were conducted as recommended from the beginning of the cultivation process until the end of the harvesting operations, where nitrogen fertilization was conducted using urea (46% nitrogen) and potassium fertilization using potassium sulfate (41.5% k_2O) according to its recommendations, lightening and weeding.The hoeing was done, and the irrigation process was taking place whenever needed. As for the phosphate fertilizer, it was used as a fertilizer (tri-superphosphate 21% P2O5) and it was added when preparing the experimental ground (Mutlab et al., 1989).Several random samples were taken from the field soil and from several areas of it at a depth of (0-30) cm, where they were mixed to estimate some of its properties, as the soil texture was estimated according to the method of Jackson (1958) and the determination of nitrogen according to the method of Black (1965), and phosphorous according to the method of Olsen et al (1954) The pH value was estimated according to Black (1965) and EC according to Richards (1954) as shown in Table (1).The plants were harvested on 25/4/2020 and the plant traits were studied, which included the average traits of 5 plants from the center of each experimental unit, which are plant height, plant leaf area, chlorophyll content of leaves, plant dry weight, number of pods per plant, pod weight and weight of 100 seeds. The yield of one plant and the content of the seeds of protein and carbohydrates. The experiment was conducted by the design of completely randomized sectors and the differences between the means were compared using the LSD test with a probability of 5%, according to the methods provided by (Al-Rawi and Khalaf Allah, 2000).

Table (1) Some characteristics of the soil of the study field

3. RESULTS AND DISCUSSION

1- Plant height and leaf area

Table 2. indicates that there are significant differences between the study treatments in the effect on the traits of plant height and leaf area. The treatment of manganese spraying at a concentration of 40 mg.L^{-1} was excelled and it gave the highest mean of plant height and leaf area, which were 43.57 cm and 895.43 cm^2 respectively, compared to the non-spray treatment, which gave the lowest mean of 37.67 cm and 832.70 cm^2 respectively. As for the addition of phosphate fertilizer, the treatment was excelled on adding 100 kg.ha^{-1} and gave the highest average of 43.10 cm and 892.97 cm^2 respectively for the two traits compared to the treatment without addition, which gave the lowest average of 37.67 cm and 838.13 cm^2 ,While the combination (spraying with manganese 40 mg.L^{-1} + phosphate fertilizer 100 kg.ha^{-1}) gave the highest average plant height of 47.5 cm and the highest average leaf area amounted to 976.1 cm^2 respectively compared to the non-manganese treatment and not

adding phosphate fertilizer, which gave the lowest average of 36.4 cm and 822.3 cm 2 for the two traits respectively.

Table (2) Effect of foliar spraying with manganese and the addition of phosphate fertilizer on plant height and leaf area

The leaf area(cm2)					**plant height cm**				**Phosphate fertilization kg.H-1**
Manganese mg.L^{-1}					**Manganese mg.L^{-1}**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
838.13	**851.9**	**840.2**	**822.3**		**37.67**	**39.4**	**37.2**	**36.4**	**0**
845.60	**858.3**	**842.9**	**835.6**		**40.13**	**43.8**	**39.1**	**37.5**	**50**
892.97	**976.1**	**862.6**	**840.2**		**43.10**	**47.5**	**42.7**	**39.1**	**010**
	895.43	**848.57**	**832.70**			**43.57**	**39.67**	**37.67**	**average**
Manganese: 45.26 Phosphorous: 45.26 Interaction: 90.52					**Manganese: 2.78 Phosphorous: 2.7 Interaction:5.56**				**LSD *.05***

2- The content of the leaves of chlorophyll and the dry matter of the plant

Table 3. indicates that there are significant differences between the study treatments in the effect on the two traits of chlorophyll in leaves and the percentage of the dry weight of the plant. The treatment of manganese element with a concentration of 40 mg.L^{-1} was excelled and gave the highest average of chlorophyll 38.53 spad and 32.37 g, respectively, compared to the treatment not spraying, which gave the lowest average of 33.90 spad and 26.57 g, respectively, As for the addition of phosphate fertilizer, the adding 100 kg.ha^{-1} treatment was excelled and gave the highest average of 38.90 spad and 32.53 g respectively for the two traits compared to the treatment without addition, which gave the lowest average of 33.30 spad and 25.83 g respectively,While the combination (spraying with manganese 40 mg.L^{-1} + phosphate fertilizer 100 kg.ha^{-1}) gave the highest average of chlorophyll amounted to 42.8 spad and the highest average of dry matter reached 37.5 g respectively compared to the treatment of no manganese spray and no addition of phosphate fertilizer, which gave the lowest average It reached 31.2 spad and 24.9 g for the two traits, respectively.

Table (3) Effect of foliar spraying with manganese and adding phosphate fertilizer on chlorophyll and dry weight of plants

Dry weight of the plant(g)					**chlorophyll leaves spsd**				**Phosphate fertilization kg.H-1**
Manganese mg.L^{-1}					**Manganese mg.L^{-1}**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
25.83	**27.2**	**25.4**	**24.9**		**33.30**	**35.2**	**33.5**	**31.2**	**0**
28.93	**32.4**	**28.1**	**26.3**		**35.90**	**37.6**	**35.3**	**34.8**	**50**
32.53	**37.5**	**31.6**	**28.5**		**38.90**	**42.8**	**38.2**	**35.7**	**100**
	32.37	**28.37**	**26.57**			**38.53**	**35.67**	**33.90**	**average**
Manganese: 3.56, Phosphorous: 3.56 Interaction: 7.12					**Manganese: 2.17 Phosphorous: 2.17 Interaction:4.34**				**LSD *.05***

The treatment of manganese element spraying with a concentration of 40 mg.L^{-1} excelled and gave the highest average of nitrogen and phosphorous, which amounted to 2.37% and 0.46%, compared to the treatment of no spray, which gave the lowest average of 1.83% and 0.41%.As for the addition of phosphate fertilizer, the treatment was excelled on the addition of 100 kg.ha^{-1} and gave the highest average of 2.47% and 0.46% respectively for the two traits compared to the treatment without addition, which gave the lowest average of 1.73% and 0.40%, While the combination (spraying with manganese 40 mg.L^{-1} + phosphate fertilizer 100 kg.ha-1) gave the highest average of nitrogen, 2.9%, and the highest average of phosphorous, which was 0.51%, compared to the treatment of not spraying manganese and not adding phosphate fertilizer, which gave the lowest average of 1.6 % and 0.39% for the two adjectives, respectively.

Table (4) Effect of foliar spraying with manganese and adding phosphate fertilizer on nitrogen and phosphorous percentage in leaves

Phosphorous concentration in leaves%					**Nitrogen concentration in leaves %**				**Phosphate fertilization kg.H-1**
Manganese mg.L^{-1}					**Manganese mg.L^{-1}**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
0.40	**0.43**	**0.39**	**0.39**		**1.73**	**1.9**	**1.7**	**1.6**	**0**
0.43	**0.45**	**0.43**	**0.41**		**2.00**	**2.3**	**1.9**	**1.8**	**50**
0.46	**0.51**	**0.44**	**0.42**		**2.47**	**2.9**	**2.4**	**2.1**	**100**
	0.46	**0.42**	**0.41**			**2.37**	**2.00**	**1.83**	**average**
Manganese: 0.03 Phosphorous: 0.03 Interaction: 0.06					**Manganese: 0.31 Phosphorous: 0.31 Interaction:0.62**				**LSD *.05***

3- The number of pods per plant and the number of seeds in the pod

Table 5. indicates that there are significant differences between the study treatments in the effect on the traits of the number of pods per plant and the number of seeds per pod,The treatment of manganese element with a concentration of 40 mg.L^{-1} was excelled and gave the highest average number of pods and the number of seeds, which amounted to 25.50 pods and 5.40 seeds, compared to the non-spray treatment, which gave the lowest average of 20.53 pods and 4.13 seeds.As for the addition of phosphate fertilizer, the treatment was excelled on the addition of 100 kg.ha^{-1} and gave the highest average of 24.97 pods and 5.43 seeds respectively for the two traits compared to the treatment without addition, which gave the lowest average of 21.47 pods and 4.17 seeds. While the combination (spraying with manganese 40 mg.L^{-1} + phosphate fertilizer 100 kg.ha^{-1}) gave the highest average number of pods that reached 28.6 pods and the highest average number of seeds reached 6.4 seeds compared to the treatment of no manganese spray and no addition of phosphate fertilizer, which gave the lowest average It reached 19.2 pods and 3.8 seeds for the two traits, respectively.

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Table (5) Effect of foliar spraying with manganese and the addition of phosphate fertilizer on the traits of the number of pods and the number of seeds in the pod

Number of seeds per pod					**The number of pods per plant**				**Phosphate fertilization kg.H-1**
Manganese mg.L^{-1}					**Manganese mg.L^{-1}**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
4.17	**4.5**	**4.2**	**3.8**		**21.47**	**23.8**	**21.4**	**19.2**	**0**
4.70	**5.3**	**4.7**	**4.1**		**22.53**	**24.1**	**22.6**	**20.9**	**50**
5.43	**6.4**	**5.4**	**4.5**		**24.97**	**28.6**	**24.8**	**21.5**	**100**
	5.40	**4.77**	**4.13**			**25.50**	**22.93**	**20.53**	**average**
Manganese: 0.51 Phosphorous: 0.51 Interaction:1.02					**Manganese: 2.23 Phosphorous: 2.23 Interaction:4.46**				**LSD *.05***

5- The weight of 100 seeds and the yield of one plant

Table 6. indicates that there are significant differences between the study treatments in the effect on the traits of the weight of 100 seeds and yield of one plant.The treatment of manganese element with a concentration of 40 mg.L^{-1} was excelled and gave the highest average weight of 100 seeds and plant yield which reached 30.93 g and 43.80 g compared to the non-spray treatment which gave the lowest average of 27.43 g and 23.48 g, As for the addition of phosphate fertilizer, the adding 100 kg.ha^{-1} treatment was excelled and gave the highest average of 31.27 g and 43.83 g respectively for the two traits compared to the treatment without addition, which gave the lowest average of 26.90 g and 24.35 g,While the combination (spraying with manganese 40 mgL^{-1} + phosphate fertilizer 100 kg.ha^{-1}) gave the highest average weight of 100 seeds amounted to 33.8 g and the highest average plant yield reached 61.17 g compared to the treatment of not spraying manganese and not adding phosphate fertilizer, which gave less The average was 25.7 g and 18.75 g for the two traits, respectively.

Table (6) Effect of foliar spraying with manganese and the addition of phosphate fertilizer on 100-seed weight and plant yield

plant yield(g)					**Weight of 100 g of seeds**				**Phosphate fertilization kg.H-1**
Manganese mg.L^{-1}					**Manganese mg.L^{-1}**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
24.35	**30.20**	**24.09**	**18.75**		**26.90**	**28.2**	**26.8**	**25.7**	**0**
31.51	**39.34**	**31.44**	**23.74**		**29.37**	**30.8**	**29.6**	**27.7**	**50**
43.83	**61.87**	**41.65**	**27.96**		**31.27**	**33.8**	**31.1**	**28.9**	**100**
	43.80	**32.39**	**23.48**			**30.93**	**29.17**	**27.43**	**average**
Manganese: 7.25 Phosphorous: 7.25 Interaction: 14.50					**Manganese: 2.35 Phosphorous: 2.35 Interaction:4.70**				**LSD *.05***

6- The percentage of protein and carbohydrates in the seeds

Table 7. indicates that there are significant differences between the study treatments in the effect on the percentage of protein and carbohydrates in the seeds,The treatment of

manganese with a concentration of 40 mg.L^{-1} was excelled and gave the highest average of protein and carbohydrates, which amounted to 24.80% and 32.57%, compared to the non-spray treatment, which gave the lowest average of 19.70% and 27.37%.As for the addition of phosphate fertilizer, the addition of 100 kg.ha^{-1} treatment was excelled and gave the highest average of 25.27% and 33.13%, respectively, for the two traits, compared to the treatment without addition, which gave the lowest average of 19.83% and 27.67%, While the combination (spraying with manganese 40 mg.L^{-1} + phosphate fertilizer 100 kg.ha-1) gave the highest average protein amount of 28.9% and the highest average carbohydrate amounted to 36.1% compared to the treatment without manganese spray and not adding phosphate fertilizer, which gave the lowest average of 18.6 % and 25.1% for the two traits, respectively.

Table (7) The effect of foliar spraying with manganese and the addition of phosphate fertilizer on the seed protein and carbohydrates

Carbohydrates %					**seed protein %**				**Phosphate fertilization kg.H-1**
Manganese mg.l-1					**Manganese mg.l-1**				
average	**40**	**20**	**0**		**average**	**40**	**20**	**0**	
27.67	**29.5**	**28.4**	**25.1**		**19.83**	**21.4**	**19.5**	**18.6**	**0**
29.73	**32.1**	**29.8**	**27.3**		**22.00**	**24.1**	**22.6**	**19.3**	**50**
33.13	**36.1**	**33.6**	**29.7**		**25.27**	**28.9**	**25.7**	**21.2**	**10**
	32.57	**30.60**	**27.37**			**24.80**	**22.60**	**19.70**	**average**
Manganese: 1.89 Phosphorous: 1.89 Interaction:3.78					**Manganese: 1.41 Phosphorous: 1.41 interaction :2.82**				**LSD *.05***

Through the results presented in Tables (2-7), we notice a significantly excelled in the level of manganese spraying at a concentration of 40 mg.L^{-1} in increasing the traits of the studied bean plant compared to not spraying with this element or compared to spraying 20 mg.l-1 and this can be due to that of the elements necessary for the formation of fats, It contributes to the activation of the carboxylase enzyme and also has a role in activating the necessary enzyme dehydrogenase in the TCA cycle (Tricacarboxylic acid) and works on the oxidation of Indole Acetic Acid (IAA) through the oxidase enzyme, In addition to its role in raising the percentage of vitamin C and regulating the osmotic effort of plant cells, and also raising the efficiency of the plant to resist frost and early flowering,It is also one of the necessary elements for the process of photosynthesis, as it participates with chloride in the process of photolysis of water (photolysis).and obtaining electrons and hydrogen ions, to form the energy complex ATP, and reducing NADP + to NADPH++ H in light or photo-reactions, or what is called a (Hill- reaction),It also has an effective role in raising the efficiency of the plant to take advantage of potassium fertilizers that are added to the soil, and it may be associated with the effectiveness of 35 enzymes inside the plant and participate in the reduction of nitrates inside the plant, It also has a role in providing cationic acids in the Krebs cycle of respiration that is associated with ammonia resulting from the reduction of nitrates to form amino acids, which are the cornerstone of protein formation. The addition of manganese increases the plant's ability to absorb nitrogen, which is important in raising the efficiency of the plant to benefit from the use of water, and it also has an important role in the production of chlorophyll, although it is not included in its composition, in addition to its role in the oxidation and reduction processes inside the plant and also in the process of electronic flow.

The light reactions of photosynthesis, as well as its deficiency leads to damage to the coroplast and all of the above causes increase the indicators of vegetative growth and yield, its components and quality (Al-Nuaimi, 1999) and (Al-Alusi, 2002) and Barney (2007 and (Idris, 2009) and (2010, Taiz). The results of the same tables indicate the significantly excelled level of adding phosphate fertilizer at a concentration of 100 kg.ha-1 and for all the studied traits. This can be due to the fact that it is one of the basic and essential nutrients for plant growth because of its direct role in most vital processes. It participates in the decomposition of carbohydrates and the materials resulting from the photosynthesis process releasing the energy needed by the plant in its vital processes, and phosphorous enters the process of formation and division of living cells and the transfer of genetic traits, being one of the components of DNA and RNA.It also enters in the phospholipids, the enzymatic companions of NAD and NADP, and the energy compounds ATP and ADP. It also enters with proteins in the formation of cellular membranes such as the plasma membrane and the gap membrane.As well as its role in increasing the yield, improving its quality and early ripening of fruits, and helps in the formation of the lateral roots of some plants and root hairs and strengthening the stems to reduce the lodging of crops and resistance to some diseases, all of which are reflected in the increase in vegetative growth indicators, which is also reflected in the increase in yield and its components and quality (Al-Nuaimi, 1999), (Havlin et al., 1999) and (Tisdale et al., 1997).

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