FOLIAR APPLICATION OF IRON AND POTASSIUM ENHANCES GROWTH AND YIELD OF MUNG BEAN (*Vigna radita* L.)

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ABSTRACT

A field experiment was conducted in factorial layout in RCBD in three replications in order to study the effect of potassium and iron on growth and productivity of this crop. The results showed that potassium significantly enhanced all growth and yield characters while the effect of Iron (Fe) was less significant than K but it has accumulative effect which was significant and clear in plant yield. It can be concluded that nutrients must be added as a foliar application as they have progressive effect on growth as well as yield of mung bean. The high concentrations of those two elements were superior to low concentrations, especially in terms of Fe. Therefore it can be recommended to use higher concentrations of them and widen the growth and yield character in future studies.

Keywords: Foliar application, Potassium, Iron, Mung bean.

INTRODUCTION

As world population grows dramatically accompanied by food shortages, there is a demand for increasing food production. In order to cope with this problem, many strategies have been used, such as balancing plant nutrition with different fertilizers and using suitable crops that can be utilized by human and animals such as legumes. Mung bean (Vigna radiata L.) is a summer short season legume; it is grown in tropical and subtropical regions (Fooladivanda *et al.,* 2014).However it can be used mainly as green fodder. Its seeds can also be used in animal nutrition as well as human feeding in some developing countries. Mung bean plants also can be used to improve soil characteristics. Protein concentration is ranged 19-29%, carbohydrates concentration62-65%, oil concentration1-1.5% and fibres 3.5-4.5% (Afzal *et al.,* 2006). Despite the importance of this crop, its productivity is still very low in Iraq compared to world production. However, researchers should investigate all possible methods that would lead to increasing the productivity of this crop. One of the forefronts

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strategies is to apply the necessary nutrients whose deficit might negatively affect the crop growth, and the most efficient way to recover deficient nutrients is to spray a solution containing the different nutrients on the canopy of plants (foliar application). The foliar application is one of the best techniques because plants can fully utilise fertilizers, and these cause less environmental pollution (Das, 1999; Barik *et al.,* 1994). Therefore, foliar application is a very good implement for enriching plants; they can uptake nutrients through their leaves considerably faster than roots (Tahir *et al.,* 2014). Potassium (K) is one of the necessary nutrients for plant growth and productivity. K can activate more than 75 enzymes which in turn contribute to various important biological processes in plants. Plants normally require this element to produce energy in form of ATP that contributes in photosynthesis by transferring carbohydrates from source to sink. K also plays an important role in protein synthesis (Cuellar *et al.,* 2010;Yadav *et al.* , 2002). Dobermann and Cassman (2002) have reported that K plays an important role in the direct and indirect activation of more than 120 enzymes responsible for energy usage, nitrogen assimilation and respiration. However, iron (Fe) plays an essential and necessary role in activation of many enzymes which can be co-factors or activators in respiration, such as cytochrome oxidase, catalase and peroxidase. Fe is important in the antioxidant defence system in plants, and it can helps in nucleic acids assimilation. Although Fe is not one of the chlorophyll structures, its deficit can cause yellowing of the plant (Nozoye *et al.,* 2011; Yadav *et al.,* 2002).In addition, its main component of nitrogenase enzyme is responsible for nitrogen fixation. Therefore, it is considered necessary for plant development and its deficit leads to malfunction in photosynthesis in plants (Kumawat *et al.,* 2006). Accordingly, a field experiment has been conducted in order to investigate the effect of foliar application by K and Fe in mung bean growth and yield.

MATERIALS AND METHODS

A field experiment was conducted in Al-Nassaf region, Fallujah-Anbar, Iraq during the spring season of 2013 in order to study the effect of foliar application of iron and potassium in the growth and yield of the Mung bean. Factorial experiments were carried out in Randomized Complete Block design (RCBD) with three replicates. The two factors were three levels of potassium sulphate K_2SO_4 (41.5% K) (0, 2000, 4000 mg $K.L^{-1}$) and three levels of Ferrous sulphate FeSO4.7H2O (20% Fe) (0, 100, 200 mg $Fe.L^{-1}$). Nutrients were applied three times on mung bean plants. The first application was applied during the vegetative stage; the second was applied during the flowering stage, while the third application was applied at the beginning of pods formation. The washing liquid was added in a concentration of 1.5 $cm^3.L^{-1}$in order to reduce the surface tension of the water and enhance the efficiency of the nutrients absorption (Abu Dhahi *et al.,* 2002). The control treatment plants were sprayed with only water. The experimental unit's area is 3*3 m, each plot consisted of four rows with 70 cm distance between rows and the distance between each two plants is 25 cm. Phosphate fertilizer (P_2O_5 46%) was added to the soil before sowing time in average of 75 P Kg.ha^{-1}(Al-Fahdawi, 2004) and the nitrogen fertilizer as urea (46% N) in average of 40 kg N.ha^{-1}. The urea was added two times. The first one was add at the sowing date and the second half was added during the flowering stage for all plots equally for all treatments (Epstein, 1972; Ali, 2012).The seeds of mung bean were sown in the spring season at 01-04-2013 in holes in the upper third of each furrow, at a depth of 2-3 Cm. The irrigation was applied regularly depending on the soil moisture and plant status. After the plants got 3-4 leaves, one plant was placed in each hole. The weeds also were treated by taking them out during the growing season. Five plants from the middle rows were randomly taken in order to study the following traits:

1- Plant height (cm): it was measured from the soil surface to the top of the main stem.
2- Number of branches per plant: the mean number of branches on the main stem was counted.
3- Number of pods per plant: The mean number of pods on the five plants was counted.
4- 100-seeds weight (gm): after harvesting all plants in one plot the seeds were mixed, then 100 seeds were randomly taken and counted and weighed.
5- The yield (gm.plant^{-1}): the mean yield of the five plants was calculated.
6- Biological yield (tonne.ha^{-1}): the dry weight of the five plants was calculated in each experimental unit.

Data was statistically analysed as balanced ANOVA using Minitab v.15 software, and the significant differences between the means were found according to LSD at ($P<0.05$). Computer based software, statistics, and Microsoft Excel were used for statistical analysis and blotting graphs.

RESULTS AND DISCUSSION

Experimental data and its statistical analysis have shown a significant effect of K almost in all traits, while Fe did not have that clear of a significant effect on most of them, although the trend was increasing positively but not significantly. However the accumulated effect of Fe was clear and significant in plant yield, which was 8.14 gm.plant^{-1} (Figure 5) when plants were treated with 200 mg.L^{-1}. The results revealed that there is a significant increase in plant height according to increasing of K concentrations from 0 to 4000 mg.L^{-1}. However, plant heights did not show significant response to low concentrations of Fe, but did respond to high concentrations of Fe (Figure 1).

As for the interaction between K and Fe, there was a significant effect on the treatment of highest concentrations of K and Fe on plant height (Table 1). Plant height trait has a significant correlation coefficient with all traits under study, except to 100-seed weight (Table 2).The positive effect of K in increasing plant height belongs to its biochemical role in activation of photosynthesis and transfers its products to active growth sites in addition to its role in activation and elongation of meristemic cell division through ideal cell wall extension (Ali *et al.,* 2005). The results were consistent with the findings of Hussain et al (2011); they have reported that K levels have led to significant changes in mung bean plant heights. As for Fe, it has a main role in oxidation and reduction reactions in plants, as well as its contribution in chlorophyll synthesis, and these have led to increase the average of cells division and elongation (Pingoliya *et al.,* 2014).

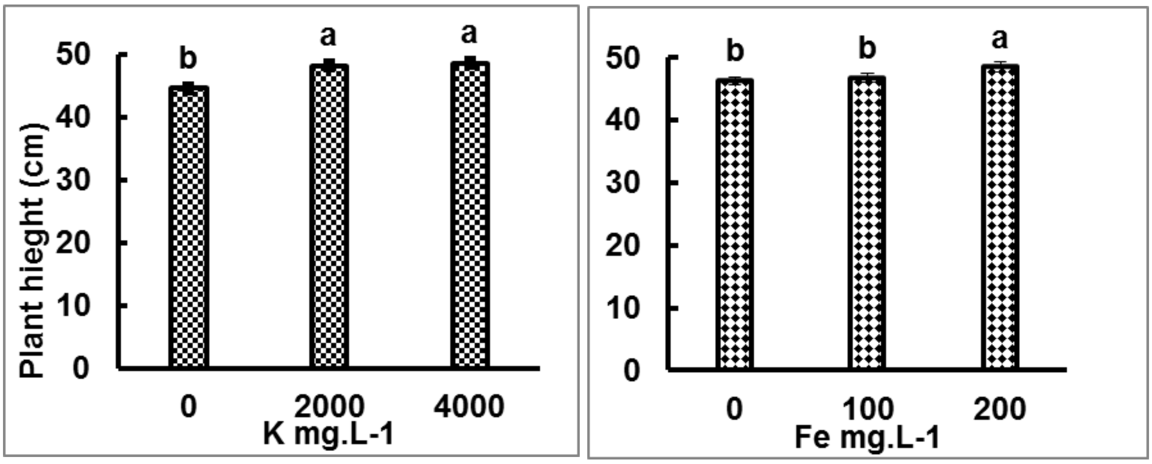

Figure 1.*Effect of foliar application of potassium (K) and iron (Fe) on plant height (cm). LSD$_{(0.05)}$: K= 1.67, Fe= 1.67, Error bars are represented as standard error (mean±SE)*

The effect of the two nutrients was similar on a number of branches per plants. The addition of both elements significantly increased the number of branches compared to control (Figure 2). However there was no significant effect of the interaction between the two nutrients (Table 1). The increase in branches per plant has led to increase in both pods per plant as well as biological yield as it correlated with those two traits (Table 2). The highest concentrations of K and Fe gave a number of branches per plant of 6.76 and 6.43 respectively. This increase in branches per plant is due to the availability of K on the leaves' surfaces in most of the growth stages. That has led to K content increases in plant parts and this activates meristemic cell growth such as lateral tissues, which can lead to this increase in branches per plant (Malik *et al.,* 2012)

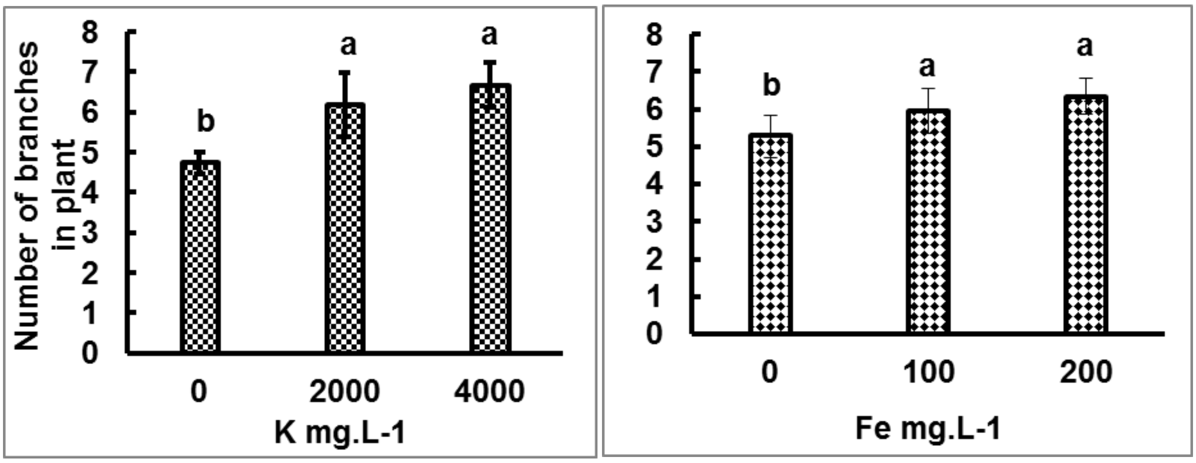

Figure 2.*Effect of foliar applicationof potassium (K) and Iron (Fe) on number of branches per plant of mung bean.LSD$_{(0.05)}$: K= 1.24, Fe= 1.24, Error bars are represented as standard error (mean±SE)*

The results presented in Figure 3 showed that K application has led to significant increase in pod numbers per plant according to the increase in K concentration, while there was no significant effect of Fe on the number of pods per plant, as well as the interaction between the two elements (Table 1). The highest number of pods per plant has been achieved when plants were treated with 4000 mg.L-1 (31.81 pods. Plant^{-1}) and this was also significantly different from that plants were treated with 2000 mg.L-1. This increase in pods per plant is due to the increase in the number of plant height and branches per plant (Table 2). However, the increasing of number of branches will lead to an increase in the photosynthesis area, eventually enhancing photosynthesis efficiency and carbohydrates translocation to reproductive meristems (Ali *et al.*, 2005). Ihsan *et al.* (2013)has reported that there was a significant increase in the number of pods per plant according to the increase in K levels in Mung bean plants.

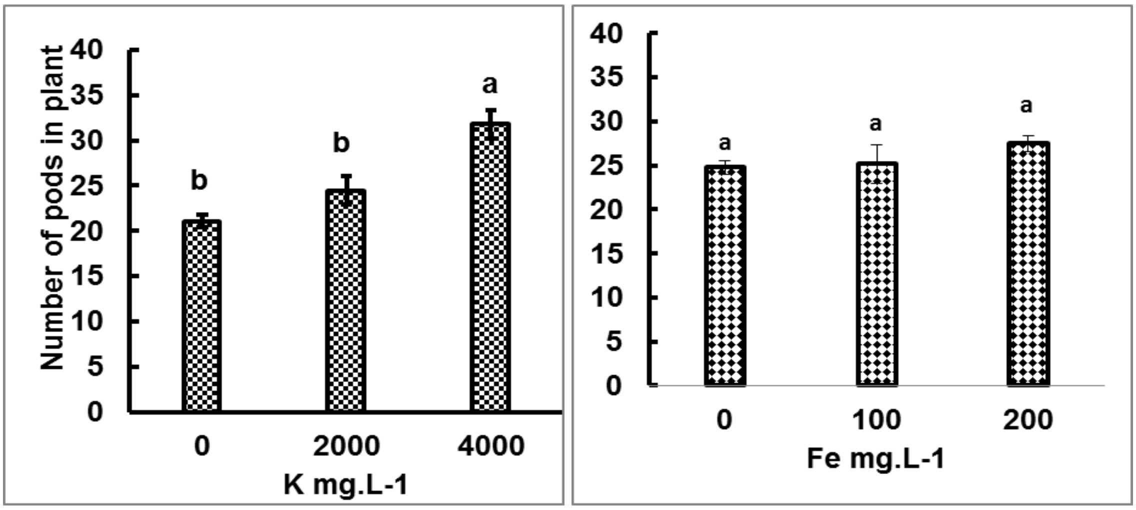

Figure 3.*Effect of foliar applicationof potassium (K) and Iron (Fe) on number of pods per plant of mung bean.LSD$_{(0.05)}$: K= 3.57, Fe= 3.57, Error bars are represented as standard error (mean±SE)*

The results presented in Figure 4 showed that K had a significant effect on 100-seed weight of mung bean when it has been added at high concentrations (4000 mg.L^{-1}). Also it has been shown that Fe was not effective in this trait, as well as its interaction with K (Table 1).This is attributed to the increase in photosynthesis efficiency which has been reflected in increasing in carbohydrates synthesis leading to an increase in seed weight. It has also been reported that the weight of 100 seed are function to the average of photosynthesis (Malik *et al.,* 2012; Ihsan *et al.,* 2013; Hussain *et al.,* 2011).

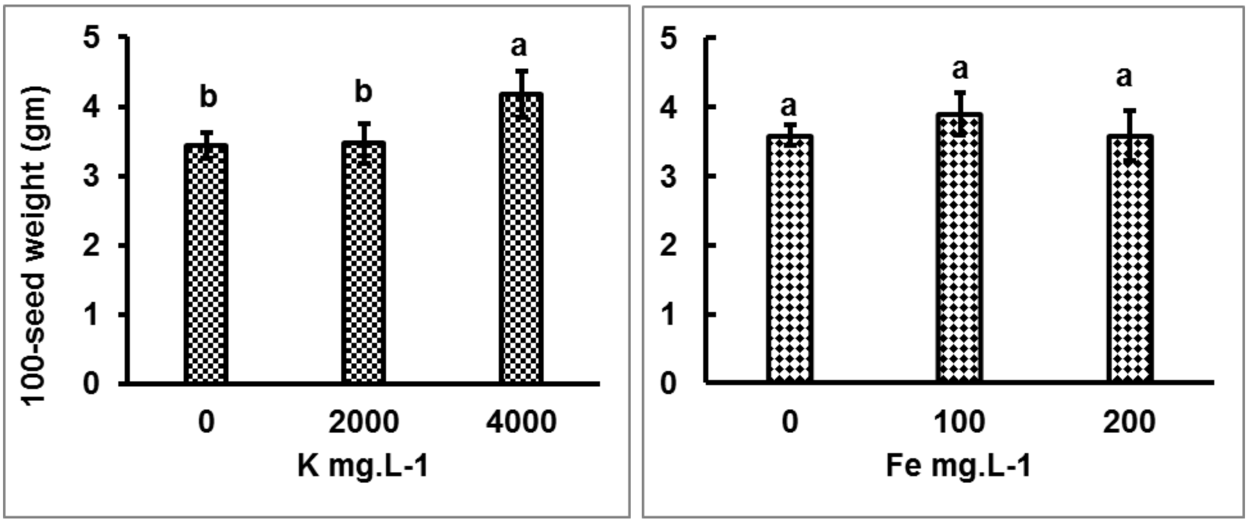

Figure 4.*Effect of foliar applicationof potassium (K) and Iron (Fe) on 100-seed weight (gm) of mung bean.LSD$_{(0.05)}$: K= 0.36, Fe= 0.36, Error bars are represented as standard error (mean±SE)*

Potassium addition has very positive effects on plant yield, as the yield of plants increased according to the increase in the concentration of K. Highest plant yield was achieved when plants were treated with 4000 K mg.L^{-1} (8.27 gm.$plant^{-1}$), which is a significantly different yield of plant from those that were treated with 2000 K mg.L^{-1}, which gave 6.75 gm.$plant^{-1}$ which also were significantly different from control plants (Figure 5). The positive role of K is due to its effect on number of pods per plants and 100-seed weight reflected in plant yield; these results are consistent with Malik et al. (2012) and Hussain et al.(2011). However, Fe addition in high concentration has increased the plant yield significantly in comparison with low concentration and control plants (Figure 5).

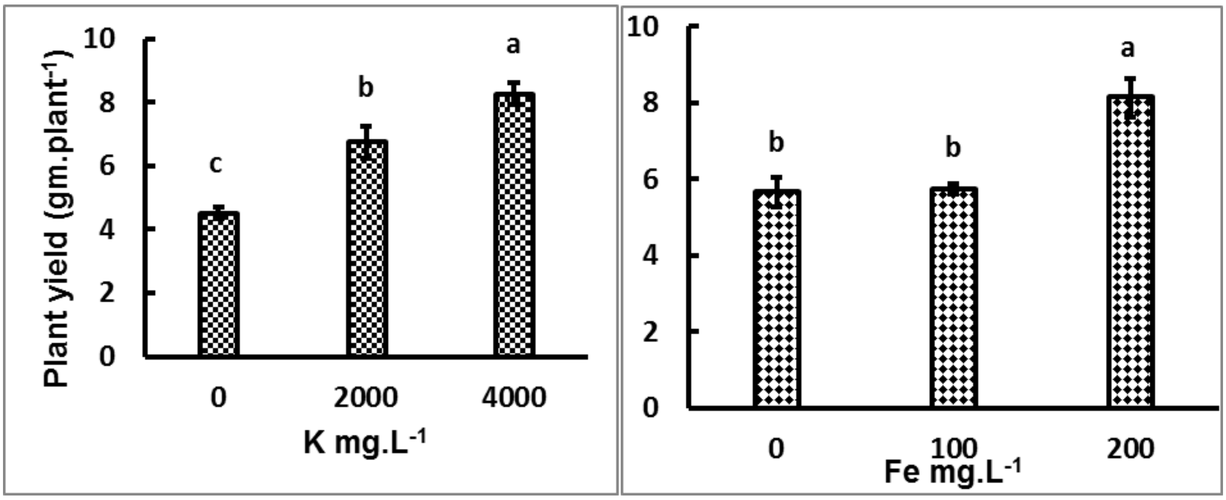

Figure 5.***Effect of foliar applicationof potassium (K) and Iron (Fe) on plant yield (gm.plamt^{-1}) of mung bean.LSD$_{(0.05)}$: K= 0.84, Fe= 0.84, Error bars are represented as standard error (mean±SE)***

The results presented in Figure 6 showed that there is no significant effect of Fe on biological yield of mung bean plants, although it was increasing according to increased Fe concentrations. However the application of K has very significant effects on biological yield (tonne.ha^{-1}). The treatment of 4000 K mg.L^{-1} was superior as it gave 1.99 tonne.ha^{-1} which was significantly different from 2000 K mg.L^{-1} which gave 1.66 tonne.ha^{-1} which also was significantly different from control plants that gave 1.19 tonne.ha^{-1}. It might be attributed to the significant effect of K on plant height, number of branches per plant, and plant yield (Table 2).

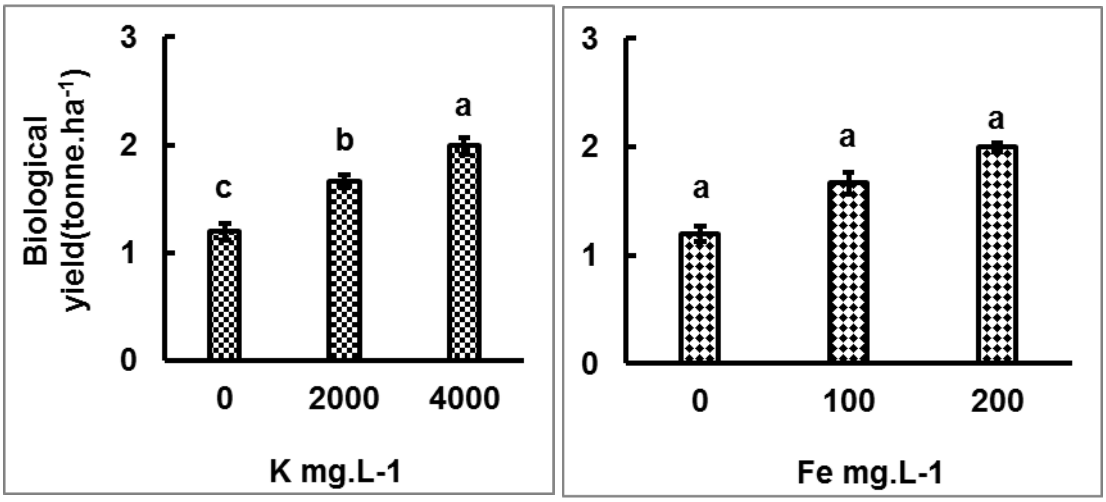

Figure 6.***Effect of foliar applicationof potassium (K) and Iron (Fe) on Biological yield (tonne.ha^{-1}) of mung bean.LSD$_{(0.05)}$: K= 0.17, Fe= 0.17, Error bars are represented as standard error (mean±SE).***

Table 1.*The effect of the interaction between K and Fe on mung bean growth and yield traits.*

K ($mg.L^{-1}$)	Fe ($mg.L^{-1}$)	Plant height (cm)	Number of branches ($branch.plant^{-1}$)	Number of pods ($pod.plant^{-1}$)	100-seed weight (gm)	Plant yield ($gm.plant^{-1}$)	Biological yield ($tonne.ha^{-1}$)
	0	44.29^{cd}	4.56	19.28	3.54	3.59	1.16
0	100	45.79^{bcd}	4.40	21.60	3.60	3.89	1.22
	200	43.77^{d}	5.25	22.35	3.16	6.05	1.19
	0	47.75^{b}	5.35	21.84	3.22	5.83	1.89
2000	100	46.39^{bcd}	6.12	22.17	3.48	5.72	1.33
	200	50.57^{a}	7.03	29.46	3.71	8.71	1.75
	0	46.71^{bc}	5.94	33.11	4.01	7.54	2.03
4000	100	48.08^{ab}	7.34	31.64	4.62	7.62	1.96
	200	51.07^{a}	6.74	30.68	3.90	9.66	1.98
L.S.D (0.05)		2.90	N.S	N.S	N.S	N.S	N.S

Table 2.*Coefficient of correlation estimated between all traits under study.*

Traits	1	2	3	4	5	6
Plant height (1)	1					
Number of branches (2)	0.757853*	1				
Number of pods (3)	0.657796*	0.795938*	1			
100-seed weight (4)	0.425405	0.635114	0.772259*	1		
Plant yield (5)	0.826471*	0.873854	0.855374*	0.469694	1	
Biological yield (6)	0.751026*	0.703436*	0.829999*	0.570303	0.782876*	1

(*) Significant at 0.05.

The role of nutrients has been proved in many crops, as the deficiency of nutrients in various crops results in drastic reduction in crop yield. The nutrients play a crucial role in enzyme activities such as cytochrome oxidase, catalase and peroxidase(Al-Issawi *et al.,* 2013).There are two forms of iron (Fe^{+3} and Fe^{+2}); the most common Fe on the earth's crust is Fe^{+3}, but the form Fe^{+2} is a physiologically significant form of iron in plants. This form also is relatively soluble and easy to be oxidized to Fe^{+3}, which then precipitates. Although there is between 4000-273000 ppm Fe in the surface soil, the amount available is just between 0.36-174 ppm. Therefore the deficiency of it is a limiting factor for plant growth and can affect crop yield adversely (Kobayashi and Nishizawa, 2012). Mundra and Bhati (1991) reported that the Fe enhanced the number of branches per plant, which was consistent with current results. He attributed this to the accumulation of dry matter as well as nodules per pant. It suggests that increasing the nodules per plant might increase the fixation of nitrogen, which in turn might increase the growth of the plant. This speculation has been proved by Shukla and Shukla (1994) as they proved that more nodules lead to increasing N_2 fixation in chickpeas. While Singh *et al.* (1998) have found that Fe significantly enhanced mung bean plant height, the number of branches per plant and dry matter. In addition, they proved that there was no difference between soil applied or foliar application of Fe. Balachandar *et al*.(2003) reported that the application increased most of the growth traits as well as yield components. It has also been reported that Fe increased the chlorophyll contents of mung bean, Therefore that will lead to an increase of photosynthesis products which can be reflected in the growth and yield of plants. It has been reported that the application of Fe, whether it was soil or foliar application, increased the yield and it is components in Mung bean (Thappu *et al.,* 2003; Salam *et al.,* 2004; Mevada *et al.,* 2005), suggesting that Fe positively influences the nodules number and weight of mung bean, leading to an increase in the efficiency of plant in growth and yield. Fe is not only affecting growth and yield of the plant itself, but it has a big role in uptake of other nutrients (e.g. Zn, Mn, Mo, Cu, N. K…) (Sharma *et al.,* 2010; Mundra and Bhati, 1991; Kumar *et al.,* 2009), leading eventually to an increase in growth and yield of the plants. All mentioned reports are supporting findings here that Fe has increased plant height and number of branches which eventually leads to an increase in yield (Figure 5).The application of K on leaves during vegetative growth is essential in maintenance of osmotic potential and water uptake and had a significant effect on stomatal closure, which increased tolerance to water stress (Epstein, 1972) therefore the application of K is supporting growth and productivity of Mung bean in hot and dry environment of Anbar. In addition, K is involved in activation of a wide range of enzymes which regulate the most important processes in plants (e.g. photosynthesis, water use efficiency and movement of nitrogen and protein synthesis) (Hung *et al.,* 2002). It has been reported that K application increases the availability of other macro nutrients such as N and P in mung bean, which can in turn enhance plant yield and its components (Sahai, 2004). From the presented results it was clear that K enhanced all growth and yield traits. Such improvements can be attributed to the positive role of K on metabolism and biological activity and its simulating effect on photosynthetic pigments, as well as enzyme activity which in turn activates the growth of plants (Tausz *et al.,* 2004; Tausz *et al.,* 2004).It can be concluded that the application of nutrients through foliar application is very useful as compared with soil application. Potassium showed very positive significant effects on all growth and yield traits, while Fe showed significance in some of growth and yield traits and plant yield. However, it has an accumulated effect on plant yield, hence it has increasing not significant effect on the traits but the effect was significant on the yield. Therefore and based on presented results it can be recommended to use higher concentrations of K and Fe, as they showed increases in growth and yield. In addition, it is recommended to study more traits related with nodules formation and enzyme activities in plants.

REFERENCES

Abu Dhahi, Y.M., A. Lahmood and G. Al-Kawaz. 2002. Effect of foliar application in corn yield and its components. *Iraq Journal for Soil Sciences* 1: 122-138.

Afzal, M., M. Bakr, A. Hamid, M. Haque and M. Aktar. 2006. Adoption and seed production mechanisms of modern varieties of mungbean in Bangladesh. Improving income and nutrition by incorporating mungbean in cereal fallows in the Indo-Gangetic Plains of South Asia, DFID Mungbean Project for 2002–2004.

Al-Fahdawi, A.I.H. 2004. Effect of foliar application with potassium and phsophorus fertilizer in some of growth characters, yield and its components for several genotypes of Mung bean. University of Anbar. Anbar.Iraq .

Al-Issawi, M., H.Z. Rihan, W.A. Woldie, S. Burchett and M.P. Fuller. 2013. Exogenous application of molybdenum affects the expression of CBF14 and the development of frost tolerance in wheat. *Plant Physiology and Biochemistry* 63: 77-81.

Ali, A., M. Nadeem, M. Maqbool and M. Ejaz. 2005. Effect of different levels of Potash on growth, yield and protein contents of Mungbean varieties. *Pak. J. Agric. Res* 44: 121-126.

Ali, N.S. 2012. Fertilizers and their applicationsBaghdad University, Ministery of higher Education and Scientific Research-Iraq.

Balachandar, D., P. Nagarajan and S. Gunasekaran. 2003. Effect of organic amendments and micronutrients on nodulation and yield of blackgram in acid soil. *Legume Research-An International Journal* 26: 192-195.

Barik, A., P. na, J. Sunda and A. Mukherjee. 1994. Influence of nitrogen, phosphorus and potash fertilization on growth, yield and oil of Kharif groundnut. *Indian J. Agric. Sci*. 38: 105-111.

Cuellar, T., F. Pascaud, J.L. Verdeil, L. Torregrosa, A.F. Adam-Blondon and J.B. Thibaud. 2010. A grapevine Shaker inward K(+) channel activated by the calcineurin B-like calcium sensor 1-protein kinase CIPK23 network is expressed in grape berries under drought stress conditions. *The Plant Journal for Cell and Molecular Biology* 61: 58-69. doi:10.1111/j.1365-313X.2009.04029.x.

Das, P. 1999. Plants Nutrients. In: Manures and Fertilizers. 2nd Edition ed. Kalyani Publishers, New Dehli, India.

Dobermann, A. and K. Cassman. 2002. Plant nutrient management for enhanced productivity in intensive grain production systems of the United States and Asia. Progress in Plant Nutrition: Plenary Lectures of the XIV International Plant Nutrition Colloquium: 153-175.

Bussler, W. E Epstein.1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley and Sons, Inc., New York, London, Sydney, Toronto. *Zeitschrift für Pflanzenernährung und Bodenkunde* 132: 158-159.

Fooladivanda, Z., M. Hassanzadehdelouei and N. Zarifinia. 2014. Effects of Water Stress and Potassium on Quantity Traits of Two Varieties of Mung Bean (*Vigna Radiata* L.). Cercetari Agronomice in Moldova. p. 107.

Hung, T.N., T.N. Anh, B.W. Lee and J. Schoenau. 2002. Effects of Long-Term Fertilization for Cassava Production on Soil Nutrient Availability as Measured by Ion Exchange Membrane Probe and by Corn and Canola Nutrient Uptake. *Korean Journal of Crop Science* 47: 108-115.

Hussain, F., A. Malik, M. Haji and A. Malghani. 2011. Growth and yield response of two cultivars of mungbean (Vigna radiata L.) to different potassium levels. *J. Anim. Plant Sci* 21: 622-625.

Ihsan, M.Z., N. Shahzad, S. Kanwal, M. Naeem, A. Khaliq, F.S. El-Nakhlawy. 2013. Potassium as Foliar Supplementation Mitigates Moisture Induced Stresses in Mung bean (Vigna radiata L.) as Revealed by Growth, Photosynthesis, Gas Exchange Capacity and Zn Analysis of Shoot. *International Journal of Agronomy and Plant Production* 4: 3828-3835.

Kobayashi, T. and N.K. Nishizawa. 2012. Iron Uptake, Translocation, and Regulation in Higher Plants. *Annual Review of Plant Biology* 63: 131-152. doi:10.1146/annurev-arplant-042811-105522.

Kumar, V., K. Dwivedi and D. Tiwari. 2009. Effect of phosphorus and iron on yield and mineral nutrition in chickpea. *Annals of Plant and Soil Research* 11: 16-18.

Kumawat, R., R. PS and P. N. 2006. Response of mung bean to sulphur and iron nutrition grown on calcareous soil of Western Rajasthan. *Indian J. Pulse Res.* 19: 228-230.

Malik, M.A., R.M. Rahman, S.S. Abbas and M.A. Cheema. 1999. Agro-Economic Expression of Mungbean Planted under Varying Levels of Phosphorus and Potash. *International Journal of Agriculture and Biology* 1 (4): 297-299.

Mevada, K., J. Patel and K. Patel. 2005. Effect of micronutrients on yield of urdbean. Indian Journal of Pulses Research 18: 214.

Mundra, S. and D. Bhati. 1991. Effect of iron, manganese and rhizobium inoculation on nutrient content and uptake by cowpea (vigna-unguiculata). Indian soc Agronomy indian agr res inst div Agronomy, new Delhi 110012, India. p. 294-296.

Nozoye, T., S. Nagasaka, T. Kobayashi, M. Takahashi, Y. Sato, Y. Sato. 2011. Phytosiderophore efflux transporters are crucial for iron acquisition in graminaceous plants. *The Journal of Biological Chemistry* 286: 5446-5454. doi:10.1074/jbc.M110.180026.

Pingoliya, K., M. Dotaniya and M. Lata. 2014. Effect of iron on yield, quality and nutrient uptake of chickpea (Cicer arietinum L.). *Afr. J. Agric. Res* 9: 2841-2845.

Sahai, V. 2004. Mineral Nutrients. Fundamentals of Soil. 3rd Edition. Kalyani Publishers, New Dehli, India: 151-155.

Salam, P., R. Rajput, P. Mishra and G. Shrivastawa. 2004. Effect of micronutrients fertilization on productivity potential of urdbean (Phaseolus mungo L.). *Annals of Agricultural Research* 25: 329-332.

Sharma, A., H. Nakul, B. Jelgeri and A. Surwenshi. 2010. Effect of micronutrients on growth, yield and yield components in pigeon pea (Cajanus cajan L.). *Res. J. Agric. Sci.* : 142-144.

Shukla, V. and I. Shukla. 1994. Effect of Fe, Mo, Zn and P on symbiotic nitrogen fixation of chickpea. *Indian J. Agric. Chem* 32: 118-123.

Singh, S., S. HK and D. TK. 1998. The effect of kind of micronutrients and their method of application of mung bean under zaid conditions. *Ann. Agric. Res* 19: 454-457.

Tahir, M., R. Maqbool, A. Majeed, A.u. Rehman and M.A. Zafar. 2014. Potential Of Foliar Applied Diammonium Phosphate (Dap) And Potassium (K) In Achieving Maximum Productivity And Quality Of Mash Bean (Vigna Mungo L.). *Scientia Agriculturae* 7: 147-149.

Tausz, M., W. Trummer, A. Wonisch, W. Goessler, D. Grill, M.S. Jiménez. 2004. A survey of foliar mineral nutrient concentrations of Pinus canariensis at field plots in Tenerife. *Forest Ecology and Management* 189: 49-55.

Thappu, U., P. Rai, C. Suresh and P. Pal. 2003. Effect of micronutrients on the growth and yield of pea in gangetic alluvial of West Bengal. *Environ. Ecol.* 21: 179-182.

Yadav, P., P. Kameriya and S. Rathore. 2002. Effect of phosphorus and iron fertilization on yield, protein content and nutrient uptake in mungbean on loamy sand soil. *Journal of the Indian Society of Soil Science* 50: 225-226.

التغذية الورقية بالحديد والبوتاسيوم لتحسين نمو وانتاجية محصول الماش

محمد حمدان عيدان العيساوي اسامة حسين مهيدي

قسم المحاصيل الحقلية- كلية الزراعة-جامعة الانبار- جمهورية العراق

المستخلص

نفذت تجربة عاملية في تصميم القطاعات العشوائية الكاملة وبثلاثة مكررات لغرض دراسة تأثير البوتاسيوم والحديد على نمو وانتاجية محصول الماش. بينت نتائج التجربة ان تاثير الحديد كان اقل معنوية من تاثير البوتاسيوم لكن كان له تاثير تراكمي في زيادة حاصل البذور بشكل معنوي. يمكن الاستنتاج من هذه النتائج بان المغذيات الصغرى تكون كفوءه اذا اضيفت على شكل تغذية ورقية لقابليتها على احداث تغيير معنوي في الصفات المدروسة. التركيز العالي من هذين العنصريين كان متفوقا في اغلب الصفات المدروسة وخصوصا الحديد. في الدراسات المستقبلية يمكن ان يوصى باستعمال تراكيز عالية منهما وكذلك زيادة عدد الصفات المدروسة.

الكلمات المفتاحية : التغذية الورقية، البوتاسيوم، الحديد، محصول الماش