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Influence of Iron and Zinc on Nodulations in Mung Bean Crop

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ABSTRACT

A filed experiment was carried out at Agricultural Research Station Kohat under rain fed conditions during spring 2017, to study the effect of iron and zinc on nodulation of mung bean (*Vigna radiate* L.) Mung bean cultivar KM^{-1} was used as a test crop. The treatments were three levels of iron (0, 2 and 5 kg ha^{-1}) and three levels of zinc (0, 5 and 10 kg ha^{-1}). Application of various levels of both iron and zinc significantly increased the nodules number as well as nodules weight. Maximum no of nodules plant^{-1} of 32 were noticed at application of Fe at 5 kg ha^{-1}, similarly Zn application also improved the no of nodules plant^{-1} linearly from 24 at 0 kg ha^{-1} to 30 at 10 kg ha^{-1}. The interaction effect of Fe and Zn was not significantly affecting the number of nodules in mung bean plants. Maximum weight of 0.61 gm was recorded at 5 kg ha^{-1} Fe application and 0.57gm at 10 kg ha^{-1} Zn application.

Keywords: Nodules, mung bean, Fe, Zn.

INTRODUCTION

Nitrogen is one of the most abundant element in our universe (78.08 % V/V), moreover nitrogen is the primary component needed for each and every plant for their healthy life cycle. However plants utilize nitrogen in ammonium form so it has to be converted either biologically or chemically before being incorporated by the plants. Although chemical fertilizer industries brought a huge revolution in fixation of nitrogen by preparing fertilizers through Haber-Bosch process and contributing in more crop production, but the huge cost of chemical fertilizers as well as several environmental issues divert the attention of many researcher that still there is a need of biological nitrogen fixation (Sprent and Sprent, 1990).

Crops like legumes are also possess the ability to fix atmospheric nitrogen with the help of soil bacteria known as Rizobium through symbiotic association. These Rizobium bacteria housed in the roots of legumes and developed nodules in the roots. The relation exist between higher plant and bacteria is symbiotic and it is critical to see legitimately the ideal conditions for this obsession to give full advantages to the plant (Stacy *et al.,* 1992, Walsh, 1995).

Mung bean (*Vigna radiata* L.) belongs to family Fabaceae and a well known crop of Pakistan enriched in proteins and fibers,

however the distinctive feature of mung bean is the root nodules containing nitrogen fixing bacteria Rizobium which in turn improve soil fertility (Ashraf *et al.,* 2003). Sharar *et al* (2001) concluded that on average annually mung bean can fix about 300 kg ha^{-1} atmospheric nitrogen. In Pakistan Punjab produced about 80 % of the total production of mung bean, and comes after soya bean as second drought resistance crop (Ali *et al*., 2001). Despite of its importance mung bean got little attention in Pakistan and yet there is a lot of work to do in improving the quality and quantity of mung bean crop.

Like macro nutrients, micro nutrients also play a key role in plant development, their deficiency in soil is a dominant problem worldwide (Singh, 2009). Physiological processes of crops like respiration and photosynthesis are incomplete without micro nutrients and results in lower yield (Marschner, 1995; Mengel *et al.,* 2001).

Tisdale *et al*., 1985 concluded that iron content both in soil and plants are high than S content and even P. Despite of its higher concentration in soil yet its availability is low for plants and hence Fe deficiency is a common problem (Nozoye, *et al*., 2011). So far the role of iron in nodulation and symbiotic nitrogen fixation is not clear, however many investigator reported poor nodulation in absence of Fe on chickpea and lentil plants (Rai, *et al*., 1984) , French bean (Hemantaranjan, *et al*., 1986) and (Rai, *et al*., 1982), but these reports failed to explain the initiation of nodules and development. Iron is a key part of several key proteins like nitrogenase, leghaemoglobin and ferredoxin (Pingolya, *et al*., 2014). Brear *at al., (*2013) reported that deficiency of iron reduced the initiation as well as development of nodules in legumes. Therefore the deficiency of iron in legumes is a clear sign of nitrogen deficiency too.

Zinc is a basic micro nutrient and performs several key roles in plant nutritional system and its deficiency significantly reduced the productivity. Many investigators reported Zn deficiency in Pakistani soils. Khattak *et al.*, 1995 reported that 37% of fields are deficient in zinc.

The importance of Zn for nodulation was also reported by various researchers Shukla *et al*. 1982 reported that Zn nutrition is essential and paramount for Rizobium activity to fix nitrogen. Similarly Rashid *et al.(*2009) also reported more weight of nodules with application of Zn. Maximum nodulation was reported in french bean at application of 5 mg Fe and Zn kg^{-1} (Hemantaranjan *et al*., 1986).

Therefore, keeping in view, the nutritional importance of iron and zinc on nitrogen fixation by mung bean crop, a field experiment was carried out at Kohat Research Station, to investigate the effect of Zn and Fe levels on nodulation in mung bean crop.

MATERIALS AND METHODS

A filed experiment was carried out at Agricultural Research Station Kohat under rain fed conditions during spring 2014, to study the effect of iron and zinc on, nodulation of mung bean (*Vigna radiate* L.) Mung bean cultivar KM^{-1} was used as a test crop. The mung bean seeds were sown in randomized complete design with split plot arrangement and replicated three times. Size of the plot was 3 x 5 m^2. Each plot was comprised of 10 rows containing row to row distance of 30 cm and plant to plant distance was of 20 cm. Different levels of iron at the rate of 0, 2 and 5 kg ha^{-1} and zinc at the rate of 0, 5 and 10 kg ha^{-1} were applied in the form of iron sulfate and zinc sulfate, respectively. A basal dose of 25 N, 60 P_2O_5 and 60 K_2O kg ha^{-1} was applied in the form of urea, di-ammonium phosphate and potassium sulfate before sowing. Before fertilizer application a composite soil sample was collected for the determination of physio-chemical characteristics and desired nutrients status for the test soil. All the agronomic and culture practices were performed. . Data on the following parameters were recorded during field and laboratory investigations:

Nodulation

Data on nodules numbers and nodules weights were recorded at appropriate time (between maximum plant biomass and flowering stage). Five plants were selected randomly from each treatment and carefully uprooted along with soil to avoid damage the roots. Then it was placed in plastic bucket containing water and washes carefully the roots. After washing nodule numbers were counted on each plant roots. After that nodules were removed from plant roots and weighed by an electronic balance.

Soil Analysis

A composite soil sample was taken before the experiment and was examined for various physico-chemical properties of under study soil.

The following treatments were used in the experiment:

T1= Fe= 0 kg ha^{-1}, Zn= 0 kg ha^{-1}
T2= Fe= 0 kg ha^{-1}, Zn= 5 kg ha^{-1}
T3= Fe= 0 kg ha^{-1}, Zn= 10 kg ha^{-1}
T4= Fe= 2 kg ha^{-1}, Zn= 0 kg ha^{-1}
T5= Fe= 2 kg ha^{-1}, Zn= 5 kg ha^{-1}
T6= Fe= 2 kg ha^{-1}, Zn= 10 kg ha^{-1}
T7= Fe= 5 kg ha^{-1}, Zn= 0 kg ha^{-1}
T8= Fe= 5 kg ha^{-1}, Zn= 5 kg ha^{-1}
T9= Fe= 5 kg ha^{-1}, Zn= 10 kg ha^{-1}

Statistical analysis

The statistical analysis of data were carried out by conducting ANOVA technique and RCB design with split plot arrangement for the experiment using Statistix 8.1 software. After that LSD test of significance was used to compare the treatment differences at $P<0.05$ level of probability Jan *et al.*, (2009).

RESULT AND DISCUSSIONS

The physio-chemical attributes of the soil revealed that soil was sandy loam with alkaline in reaction, low in organic matter, calcareous in nature , the zinc and iron content were found low to optimum level (Table 1).

Table 1: Physico-chemical characteristics of soil before mung bean sowing.

Physico-chemical properties	Units	Values
Sand	%	55
Silt	%	25
Clay	%	20
Textural Class		Sandy loam
Organic matter	%	0.72
pH	-	7.75
Lime	%	6.2
EC	m mhos	260
Total nitrogen	%	0.04
Iron	ug g^{-1}	1.51
Zinc	ug g^{-1}	0.59

Nodules Number

Number of nodules as influenced by different levels of Fe and Zn are presented in table 2. Both Fe and Zn applied levels significantly increased the no of nodules. Based on result the maximum no of nodules $plant^{-1}$ of 32 were noticed at application of Fe at 5 kg ha^{-1}, similarly Zn application also improved the no of nodules $plant^{-1}$ linearly from 24 at 0 kg ha^{-1} to 30 at 10 kg ha^{-1}. The interaction effect of Fe and Zn was not significantly affecting the number of nodules in mung bean plants. The maximum, 35 nodules $plant^{-1}$ was observed at plot receiving Fe and Zn 5 kg ha^{-1} and 10 kg ha^{-1} respectively and 20 nodules $plant^{-1}$ at control. Our results was in lined with the published literature it has an established criterion that Fe has dominant effect on nodule formation which ultimately increased the no of nodules $plant^{-1}$. Brear *at al.,* (2013) reported that iron deficiency reduced initiation and development of nodules, similarly poor nodulation in chickpea was also reported by (Rai, Singh & Prasad, 1982) and lentil (Rai *et al*., 1984). Hemantaranjan & Garg (1986) found that iron application to French bean grown on an iron deficient soil increased nodule number and postulated that Fe effect on nodule initiation is important. Amara (1998) concluded that micronutrients (Zn, B, Fe, Mo) increased the microbial counts in the rhizosphere and thus increased nodule number. Ahmad *et al*., (2013) reported that the application of

micronutrients (Zn, Fe & Mo) along with *Rhizobium* improved nodulation and yield of mung bean. As nodules are the residing place for nitrogen fixing bacteria so it enhances nitrogen fixation in legumes crops.

Table2: Number of Nodules per plant of mung bean as affected by different levels of Iron and Zinc

Zn Levels (kg ha^{-1})	Fe Levels (kg ha^{-1})			Mean
	0	2	5	
0	20	23	29	24 ^{c}
5	23	27	33	28 ^{b}
10	25	30	35	30 ^{a}
Mean	23^{c}	27^{b}	32^{a}	

Table 3: Weight of Nodules (in grams) of mung bean as affected by different levels of Iron and Zinc

Zn Levels (kg ha^{-1})	Fe Levels (kg ha^{-1})			Mean
	0	2	5	
0	20	23	29	24 ^{c}
5	23	27	33	28 ^{b}
10	25	30	35	30 ^{a}
Mean	23^{c}	27^{b}	32^{a}	

Weight of Nodules (gm)

The weight of nodules increased simultaneously with the application of both Fe and Zn levels (Table3). Maximum weight of 0.61 gm was recorded at 5 kg ha^{-1} Fe application and 0.57 at 10 kg ha^{-1} Zn application. As in table 2, it was cleared that Fe application speed up the nodule formation which on other hand also increased its weight which is not strange. Our results was also supported by many researchers Upadhyay *et al.*(2015) also resulted increased in weight of nodules with the application of Zn. More nodules formation is associated with Zn application (Ghildiyal *et al.* 1974).It is an established criterion that Fe deficient crop appeared nitrogen deficiency. The interaction of Fe and Zn levels was also significantly increases the weight of nodules. The maximum weight of 0.67 gm was at full dose of Fe and Zn 0.31 gm was observed in control (Table3). Our results were in lined with published literature, Kobraee *et al.*, (2011) stated that Zn application significantly increased the nodules number and ultimately weight. Ahmad *et al*. (2013) reported that the application of micronutrients (Zn, Fe & Mo) along with *Rhizobium* improved nodulation and yield of mung bean. Balachander *et al,*(2003) reported that Fe application significantly increased the number and weight of nodules. Abdulameer (2010) conformed that Zn application enhance nodulation which ultimately improve nodules biomass.

CONCLUSION

From the investigation it was concluded that application of Fe and Zn at the rate of 5 and 10 kg ha^{-1} respectively significantly enhanced the number and weight of nodules of mung bean.

REFRENCES

Abdulameer, A. S. (2011). Impact of rhizobial strains mixture, phosphorus and zinc applications in nodulation and yield of bean (phaseolus vulgaris L.). *Baghdad Sci. J.* 1(8): 358-364.

Abdur, R. (2009). Micronutrient (Zn) role in stimulating root nodules and yield of chickpea. *Pakistan Journal of Scientific and Industrial Research*, *52*(2), 80-83.

Ahmad, I., Akhtar, M. J., Asghar, H. N., and Khalid, M. (2013). Influence of rhizobium applied in combination with micronutrients on mungbean. *Pakistan Journal of Life and Social Sciences*, 11(1): 53-59

Ali, A., Nadeem, M. A., Tayyab, M., Tahir, M. and Sohail, M. (2001). R. Determining suitable planting geometry for two mungbean (*Vignaradiata*L.) cultivars under Faisalabad conditions. *Pak. J. Biol. Sci*. 4: 344-450.

Amara, M. A. T. (1998). Soybean response to inoculation with biofertilizer and fertilization with micronutrients in calcareous soil. The Desert Institute Bulletin (Egypt), 48: 75-92.

Ashraf, M., Mueen-Ud-Din, M., Warrich, N. (2003). Production efficiency of mungbean (Vigna radiata L) as affected by seed inoculation and NPK application. *Int. J. Agric. Biol*. 179–180.

Balachander, P., Nagarajan, P., Gunasekaran, S. 2003. Effect of organic amendments and micronutrients on nodulation and yield of black gram in acid soil. *Legumes Res*. 26: 192-195.

Brear, E. M., Day, D. A., & Smith, P. M. C. (2013). Iron: an essential micronutrient for the legume-rhizobium symbiosis. *Frontiers in plant science*, *4*, 359.

Ghildiyal, M. C., Saini, A. D., & Sirohi, G. S. (1975). Effect of zinc on nodulation and yield of two mung varieties. *Indian J. Plant Physiol*, *18*, 12-15.

Hemantaranjan, A., & Garg, O. K. (1986). Introduction of nitrogen-fixing nodules through iron and zinc fertilization in the nonnodule-forming French bean (phaseolus vulgaris L.).

Hemantaranjan, A., and Garg, O. K. (1986). Introduction of nitrogenfixing nodules through iron and zinc fertilization in the non-noduleforming French bean (Phaseolus vulgaris L.). J. Plant Nutri. 9(3-7): 281-288.

Khattak, J. K. 1995. Micronutrients in Pakistan. Agriculture. Pakistan Agricultura research council, Islamabad and department of sol science NWFP Agriculture. University Peshawar 135

Kobraee, S., Shamsi, K., & Ekhtiari, S. (2011). Soybean nodulation and chlorophyll concentration (SPAD value) affected by some of micronutrients. *Annals of Biological Research*, *2*(2), 414-422.

Marschner, H. 1995. Mineral Nutrition of Higher Plants, 2nd edn. Academic Press, London, UK.

Mengel, K., Kirkby, E. A., Kosegarten, H., Appel, T. 2001. Principles of Plant Nutrition. Kluwer Academic Publishers, Dordrecht, the Netherlands

Nozoye, T., Nagasaka, S., Kobayashi, T., Takahashi, M., Sato, Y., Uozumi, T., Nakanishi, H., Nishizawa, N. K. 2011. Phytosiderophone efflux transporters are crucial for iron acquisition in graminaceous plants. *J. Bio. Chem*., 286: 5446-5454.

Pingoliya, K. K., Dotaniya, M. L., & Lata, M. (2014). Effect of iron on yield, quality and nutrient uptake of chickpea (Cicer arietinum L.). *Afr. J. Agric. Res*, 9(37): 2841-2845.

Rai, R., Prasad, V., Choudhury, S. K. and Sinha, N. P. (1984). Iron nutrition and symbiotic N2-fixation of lentil (lens culinaris) genotypes in calcareous soil. J. Plant nutri. 7(1-5): 399-405.

Rai, R., Singh, S., and Prasad, V. 1982. Efleet of presstnudatnetid pyrite on symbiotic N fixation, active iron contents of nodules, grain yield and quality of chickpea {*Cicerarietimim* L.) genotypes in calcareous soil. *J. Plant Nutri*. 5: 905 913.

Sharar, M. S., Ayub, M., Nadeem, M. A. and Noori, S. A. 2001.Effect of different row spacing and seeding densities on the growth and yield of gram (*Cicerarietinum*L.). *Pak. J. Agric. Sci*. 38: 51-53.

Shukla, U. C., & Yadav, O. P. (1982). Effect of phosphorus and zinc on nodulation and nitrogen fixation in chickpea (Cicer arietinum L.). *Plant and Soil*, *65*(2), 239-248.

Singh, M. V. 2009. Micronutrient nutritional problems in soils of India and improvement for human and animal health. *Indian J. Fert*. 5 (4), 11–16 (19–28 & 56).

Sprent, J. I., & Sprent, P. (1990). Nitrogen fixing organisms: Pure and applied aspects. *Nitrogen fixing organisms: pure and applied aspects.*

Stacey, G., Burris, R. H., & Evans, H. J. (1992). Biological nitrogen fixation. Chapman and Hall, New York. *Biological nitrogen fixation. Chapman and Hall, New York.*

Tisdale, S. L., Nelson, W. S., Beaton, J. D. 1985. Soil fertility and fertilizers. Mcmillan Publishers Company, New York.

Upadhyay, R. G., & Singh, A. (2016). Effect of nitrogen and zinc on nodulation, growth and yield of cowpea (Vigna

unguiculata). *Legume Research-An International Journal*, *39*(1), 149-151.

Walsh, K. B. (1995). Physiology of the legume nodule and its response to stress. *Soil Biology and Biochemistry*, *27*(4-5), 637-655.