Role of foliar application of Micronutrients on growth and yield of Pulses - A review

Abstract

~~Although~~ pulses respond positively ~~strongly~~ to micronutrients application, particularly during the reproductive stages, but their application is still uncommon. The ~~results of the~~ current review~~study also~~ suggest that foliar application of Zn, Fe or Mo ~~application~~ had a favourable impact on growth indicators and grain yield~~.~~, protein content, total and active nodule counts, and yield components plant^{-1}. Molybdenum is essential for the development of nodule tissue and ~~an~~ increase in N_2 fixation, both of which are necessary for Rhizobium to increase the nitrogen fixation process.

Comment [M1]: Rhizobium is a bacterium, how it influences and affect nutrient?? This statement need clarification.

Key words: *Iron, Molybdenum, Pulses, Yield, Zinc*

Introduction

Comment [M2]: Why are you just focusing on three micronutrients??

Pulsesare the main source of protein particularly for vegetarians and contribute about 14 per cent of the total protein of an Indian average diet (Meena *et al.*, 2013).The production and consumption of pulses, sometimes referred to as food legumes, is second only to cereals in India.The word pulse is derived from the Latin word Puls means pottage i.e., seed boiled to make porridge or thick soup. Pulse is a rich source of dietary protein (25%), energy, minerals and vitamins for the vegetarian population. As a vital source of both human and animal food and animal feed, it is also crucial for maintaining soil fertility(Kavya *et al.*, 2021).

In addition to crop productivity, micronutrients also improve the amount of crude protein, amino acids, total lipids, energy value, and other nutrients in chickpea, soybean, black gramme, etc. Foliar fertilisation is the most efficient way to raise output, and research has shown that it can increase yield by 12 to 25% when compared to conventional fertilisation(Deshmukh *et al.*, 2017).

Iron is an essential key enzymes Co-factor which performs different function in breakdown of hormone and also take part in many chemical reactions takes place in plants (Kerkeb and Connolly, 2006).Iron is required for the formation of chlorophyll even though it is not a component of it. As a result, a lack of chlorophyll causes iron deficiency and chlorotic plants(Katyal and Randhawa, 1983).

Zinc has been the micronutrient that crops, especially pulses, have required in sufficient amounts (Yashona *et al*., 2018). Zinc in plants required for biosynthesis of hormone (Kudi *et al*., 2018). Zinc is essential for metabolism and participates in the production of nodules, which fix nitrogen(Patel *et al*., 2011). Zinc is a crucial component of RNA polymers and gives ribosomes their structural integrity(Yashona *et al*., 2018). Since Zn is required for the synthesis of tryptophan (Brown *et al*., 1993; Alloway, 2004), ~~Zn is a precursor of IAA, a metal that is also involved in the synthesis of the vital growth hormone Auxin(Brennan, 2005).~~ Zinc is required for pollen function and fertilization (Ali *et al*., 2017).

Comment [M3]: Which hormone??

Comment [M4]: Can you explain what metabolism?? And what is role of Zn in that metabolism?

The availability of Molybdenum in soil has been shown to enhance the production of leguminous crops (Chandra *et. al*., 2020). Molybdenum, which is essential for several metabolic activities and regulates ascorbate-glutathione in plants. Plants deficient in molybdenum have lower quantities of chlorophyll and abnormal changes to their chloroplasts(Nasar *et al*., 2017). The synthesis of the nitrate reductase enzyme and the symbiotic nitrogen fixation in legumes depend on the crucial micronutrient molybdenum (Williams and Fraustoda Silva, 2002; Roy *et al*., 2006). Molybdenum increases plant height, number of branches and pods plant^{-1}, number of seeds plant^{-1} and nodule production in legume crops. It also enhances yield quality(Togay *et al*., 2008).

~~RESULT AND DISCUSSION~~

Effect on plant height:

Stoyanova and Doncheva (2002) reported that~~The end result was the longest plant ever because of the buildup of zinc fertiliser in plant tissues, which changes important developmental processes like photosynthesis and chlorophyll biosynthesis~~. Alam *et al.* (2010) reported i~~I~~n an earlier trial, the longest plant was produced with a 2.5 kg Zn ha^{-1} application. The height of the plants was strongly impacted by the application of 10 kg Zn ha^{-1} (47.76 cm and 47.88 cm) in summer mungbean. (Ram and Kattiyar, 2013). El Sayed Hameda *et al*., (2012) reported that the By applying a combination of microelements to the leaves of pea plants, the yield components indicated by plant height were significantly increased.Zinc in auxin mixture (Basavarajeswari *et al*., 2018). The plant height of the pigeonpea crop was increased by applying 5 mg kg^{-1} Zn added to the soil(Dube *et al*., 2001).Some enzymes with significant roles in cell division and lengthening were activated by zinc, and as a result, the stem height increased(Seifi Nadergoli *et al*., 2011). Habbasha *et al*. (2013) observed 0.2% $ZnSO_4$ application to chickpea at seed filling stage result in significantly higher plant height

Comment [M5]: Not cleared what the author want to say

(81.43 cm).Zn and Fe may have positive benefits when given topically because of their importance in respiration, photosynthesis, and other biochemical and physiological processes as well as their function in increasing yields(Rietra *et al*., 2017; Khan *et al*., 2022).The increment in plant height of cowpea with zinc spray (1 g L^{-1}) has been documented by (Salehin and Rahman 2012). The application of molybdenum to the leaves has a considerable impact on plant parameters, including plant height and biological performance.The result was in conformity with those of Manjili *et al*. (2014). Hazra and Tripathi (1998) observed that molybdenum application at the rate of 1.5 kg/ha increased forage in calcareous soil.Sahu *et al.* (2008)reportedthattheapplicationof$FeSO_4$at2kgha^{-1}significantly increased the growth characters over controlinchickpea.Thapu*etal.*(2003)concludedthattheapplication of micronutrients like Fe (as ferrous sulphateat 0.4%), Mn, Cu and Zn significantly increased the growthattributes in pea.

Comment [M6]: You need to explain first the need of micronutrients in plant growth, how they affect it, then you can give cross references. The discussion you have written is not written properly. Kindly rewrite it

Effect on number of nodulesplant^{-1}

Increased infection and rhizobial colonisation in the rhizosphere may be the source of the increased nodule count due to the increased availability of micronutrients(Meena *et al*., 2012).Chauhan *et al*. (2013) reported 91% higher nodulation in soybean under the application of Zn @ 5 kg ha^{-1} in consecutive years of study.Ram and Kattiyar (2013) found that the application of Zn @ 10 kg ha^{-1} to mungbean significantly increase the nodulation.Badar *et al*., (2015) “Molybdenum is essential for the development of nodule tissue and an increase in N2 fixation, both of which are necessary for Rhizobium to increase the nitrogen fixation process. Every bacterium that fixes nitrogen requires molybdenum since it is an essential component of the nitrogenase enzyme reported by Hirpara *et al*. (2019). Iron and molybdenum significantly enhanced nodules number in legumes crops (Brkics *et al*., 2004). An agreement with Tantawy *et al*. (2013) reported that Fe and Mo significantly increasednumber of active nodules in broad bean.

Effect on dry matter accumulation:

The production of straw was enhanced by applying multiple foliar sprays of various fertiliser mixtures at distinct growth stages. As previously documented, foliar treatment of macro and micronutrients boosted biological yield by Piri Issa *et al*., (2012). The improvement in nodulation might have resulted in a higher amount of nitrogen fixation and there by better vegetative growth and dry matter production” Balla *et al*. (2020).

Effect on protein content:

Zinc treatment to the leaves resulted in higher protein content as a result of improved physiological properties and protease enzyme activity Nandan *et al.* (2018), Usman *et al.* (2015) and Lokhande *et al*. (2018).Singh and Singh (2012) also reported 20.2% higher protein content in chickpea grain under the application of 10 kg Zn ha^{-1}. Khrogamy and Farnia (2009) on zinc application in chickpea revealed the fact that, the application of $ZnSO_4$ @ 20 kg ha^{-1} improved the protein content (24.02%) in chickpea.Imsande (1998) stated that iron had an important role in the synthesis of chlorophyll and also helpin the absorption of other nutrients.Oguz (2004) that increasing Mo application up to 6 g kg^{-1} considerably affected the protein content in chickpea. Roy *et al*. (2014) reported that the combined application of 5.5 kg Zn ha^{-1} + 0.1% Zn as foliar spray increased the seed crude protein by 26.9% over control.Sharma *et al.* (2010) reportedthat the treatment of chelated Fe (1 or 2 kg ha^{-1}) considerably enhanced the protein content in seed as well as all yield-contributing attributes in the pigeon pea crop.

Effect on yield attributes:

The beneficial effects of foliar nutrition of micro nutrients on mung bean were also reported by several researchers Kumawat *et al*. (2005). The micronutrients might have enhanced role in seed setting that resulted in improvement in no. of seeds pod^{-1}.

Effect on number of podsplant^{-1}:

Kumar *et al*. (2014) reported that seed inoculation with zinc @ 5 kg ha^{-1} gave the significantly higher growth and yield attributes. Togay *et al*. (2008) reported that molybdenum increased pods plant^{-1}.Valenciano *et al*. (2010) showed pod numberplant^{-1} were greater with Zn application. Ram and Katiyar (2013) found that the application of 10 kg Zn ha^{-1} to mungbean resulted in significant improvement in the pod and seed number.In keeping with our findings, it was reported that micronutrient foliar spraying increased the number of pods plant^{-1} in lentil(Zeidan *et al*., 2006). Shah *et al*. (2016) concluded that the number of seeds pod^{-1} and number of pods plant^{-1} in pigeonpea significantly increase under the application of Zn @ 20 kg ha^{-1}.Increase of pods plant^{-1} using Zn spraying reported by Teixeira *et al*. (2004) in common bean. A decrease in flower shedding, a rise in pod formation, and the improvement of photosynthetic material distribution to these organs could all boost the pod plant^{-1}(Mady, 2009).

Effect on number of seeds pod^{-1}

Rizk and Abdo (2001) reported that yield components showed a highly significant increase with the application of Zn (0.2 or 0.4 g/l) compared to the control. The reports of other researchers that indicated the foliar application of Zn increased seeds pod^{-1} in common bean (Teixeira *et al*., 2004; Seifi Nadergholi *et al*., 2011; Nasri *et al*., 2011) and Faba bean (Bozorgi *et al*., 2011).Sarkar and Banik (1991) observed the molybdenum application significantly increased seeds pod^{-1}.

Seed yield

Zn application at the rate of 0.3% in combination with Fe increased seed yield and lead to the highest amounts of seed yield. Khrogamy and Farnia (2009) It was noted that seed output and total biomass in chickpea cultivars were significantly affected by the treatment of ZnSO4 @ 20 kg ha^{-1}. Ramakrishna *et al.* (2005) studied the effects of improved production technologies involving application of 10 kg Zn ha^{-1} and found increased pigeonpea yield.Patil *et al*. (2006) The application of $ZnSO_4$ @ 10 kg ha^{-1} yielded considerably greater grain (29.55 q ha^{-1}), stalk (95.81 t ha^{-1}), and bhusa yields (20.58 q ha^{-1}) when four different amounts of zinc (0, 10 and 20 kg ha^{-1}) were investigated to see how they affected pigeonpea growth and yield. Ibrahim and Ramadan (2015) indicated Zn spraying increased seed yield and growth of dry bean. Malik e*t al.* (2015) When the impact of zinc on mungbean growth and yield was examined, it was discovered that the treatment of 20 ppm zinc resulted in the highest seed yield plant^{-1} (78.20 g), compared to the control.Shah *et al.* (2016) demonstrated that the treatment with Zn @ 20 kg ha^{-1} had the highest pigeonpea yield. We discovered that the increase in bean seed yield brought on by Fe and Zn spraying was comparable to the others(Valenciano *et al*., 2010; Naseri Rad *et al*., 2014; Nasri *et al*., 2011) soybean (Heidarian *et al*., 2011) and Faba bean (Bozorgi *et al*., 2011). The grain yield of chickpea was significantly increased with the application of iron and molybdenum (Khan *et al*., 2014).Zinc fertilization had positive effect on the yield of pulses. Application of Zn @ 5 kgha^{-1} along with S @ 60 kgha^{-1} recorded 67% higher seed yield over control in mung bean (Mali *et al*., 2003).) Application of $FeSO_4$ @ 2 kgha^{-1} along with bio-fertilizer inoculation in chickpea led to higher grain and straw yields over control (Sahu *et al.*2008). Thapu*etal.*(2003)observedthattheapplicationof micronutrients like Fe (as $FeSO_4$ at 0.4%), Mn, Cu and Znsignificantly increased the grain yield in pea. Salam *et al.*(2004)conductedafieldexperimentatRaipur,Chhatisgarhandconcludedthattheseedyield of Urd bean under application of $FeSO_4$ at 2-20 kg Fe ha^{-1}wasmaximumovercontrol.Kumawat*etal.*(2006)observedthatthesoilapplicationofFeat25kgFeS

O_4 ha^{-1}recordedsignificantly higher seed and straw yield of summer mungbean. Kumar*etal.*(2009)conductedanexperimentatKanpur and results revealed that the application of 10 kgFe ha^{-1}increase the grain yield of chickpea by 17.3%over control.

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