# Effect of soil and foliar application of zinc and iron on yield, nutrient content and quality of summer mungbean

## Abstract

The culinary value of mungbean (*Vigna radiata* L.) makes it one of the most valuable pulses. The enhanced and inorganic farming method of India has been able to attract special attention from scientists and growers. The crucial aspect in pulse productivity is the use of the proper micronutrients in the appropriate proportions. Therefore, the field experiment was carried out at RRTTSS, Kirei, Sundargarh during summer season 2021. Experiment consists of eight treatment replicated thrice with RBD. The results revealed that seed yield (521 kg $ha^{-1}$), stover yield (1307 kg $ha^{-1}$), gross returns (Rs. 36470/ha), net returns (Rs. 8020/ha) and benefit cost ratio (1.28) and nutrient content N (3.86% & 1.25% in seed and stover), P (0.45% & 0.19% in seed & stover), K (0.65% & 1.88% in seed and stover) were recorded significantly highest under the treatment of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ foliar spray at flower initiation stage along with RDF and FYM. Highest Zn content (51.01 ppm) in seed and (17.43 ppm) in stover was obtained in $T_3$- $T_1$+ 0.5% $ZnSO_4$ FI & PI stage. The maximum iron content in seed (117.50 ppm) as well as in stover (84.97 ppm) was observed in $T_5$ - $T_1$+ 0.5% $FeSO_4$ at FI & PI stage.

**Keywords:** Zinc, iron, foliar application, mungbean, yield and nutrient content.

## INTRODUCTION

India is a major pulse-growing country, accounting for around one-third of total global pulse cultivation area and one-fourth of total global production. Pulses are an important part of the Indian diet, providing roughly 30% of daily protein. Mungbean (*Vigna radiata* L.) is the most important crop of the South-East Asia and particularly the Indian sub-continent. It is also known as green gram, golden gram and chop suey bean. Mungbeans are commonly grown for human use (as fresh sprouts or dried beans), but they can also be used as a green manure crop and cattle forage. It is a popular pulse crop with excellent nutritional value. Its grain contains 24.2% protein, 60.4% carbohydrate and 1.3% fat. It is a short-season crop that can be cultivated three times per year *i.e* in kharif, rabi and summer seasons. It also helps to maintain and improve soil fertility by allowing root nodules to fix atmospheric nitrogen in the soil.

Micronutrients are essential for plant growth and crop sustainability. Zinc and iron are important micronutrients that aid in the production of auxin, regulate starch and chlorophyll formation, root development, cytochrome biosynthesis, and leaf cuticle synthesis, respectively. Iron regulates the function of chlorophyll development and energy transfer within the plant system, as well as the activation of several enzymes required for plant formation. The objective of the study was to see how different nutrient management practices of micronutrients (Zn and Fe) affected yield qualities and mungbean yield.

### MATERIALS AND METHODS

The field experiment was conducted during summer of 2021 on sandy loam soil at the field of Regional Research and Technology Transfer Sub Station (RRTTSS), Kirei, Sundargarh, Odisha to investigate the influence of zinc and iron on growth, yield and nutrient uptake of mungbean. The eight treatments combinations including $T_1$-

control (RDF: 20-40-20 kg/ha and FYM 5 $tha^{-1}$), $T_2$ - $T_1$+ 0.5% $ZnSO_4$ FI, $T_3$ - $T_1$+ 0.5% $ZnSO_4$ FI & PI, $T_4$ - $T_1$+ 0.5% $FeSO_4$ FI, $T_5$ - $T_1$+ 0.5% $FeSO_4$ FI & PI, $T_6$ - $T_1$+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI, $T_7$ - $T_1$+ 25 $kgha^{-1}$ $ZnSO_4$ soil application, $T_8$ - $T_1$+ 50 $kgha^{-1}$ $FeSO_4$ soil application. All the eight treatments combinations were replicated thrice in randomized block design (RBD). The soil in the experimental field was acidic in nature (pH 5.7), had low available nitrogen (145.41 kg $ha^{-1}$), medium available phosphorus (35.13 kg $ha^{-1}$), low available potassium (71.68 kg $ha^{-1}$), and low zinc and iron concentration (0.53 and 4.23 ppm, respectively).

Mungbean, IPM 02-14 variety was sown on $9^{th}$ February, 2021 in furrows at a spacing of 30×10 cm. Before sowing, seed @ 20 kg $ha^{-1}$ was treated with Vitavax power @ 2 g $kg^{-1}$ of seed. Five plants were chosen at random from each plot to record individual plant nutrient content in the leaves, shoot, root, and seed using various analyses. Standard procedures were used to conduct the soil analysis. At flower initiation and pod initiation, $ZnSO_4$ and $FeSO_4$ were applied as a 0.5% foliar treatment at both stages. At 20- and 35-days following seeding, hand weeding and hoeing were performed. Irrigation was started before the land was prepared, and it was repeated every 15 days after that. At the right time, important observations were recorded.

## RESULTS AND DISCUSSION

**Yield:** Seed yield (521 kg $ha^{-1}$) and stover yield (1307 kg $ha^{-1}$) was found to be higher with application of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage, that might be due to significant effect on yield attributing characters like number of pods bearing branches per plant, pods per plant and 1000-seeds weight. Similarly higher yield attributes and yield were noticed with the combined foliar spray of micro nutrients with zinc attributed to optimum availability of nutrients for luxurious crop growth and efficient partitioning of assimilates from source to sink. Higher stover yield of mungbean might be due to direct influence of zinc on auxin production which in turn enhanced the elongation processes of plant development. These results are in accordance with Awlad, H.M. et al. (2003) and Teixeira, I.R. et al. (2004), Kumawat, R.N. et al. (2006), Meena, K.K. et al. (2013) and Soni and Kushwaha (2020). Masih, A. et al. (2020), Prasanna, K.L. et al. (2013) and Choudhary, P. et al. (2014). Similar results higher yield and quality on maize crop was given by Satdev et al., (2020), and Peddapuli et al. (2022) in maize. Zinc application also might have increased the enzymatic activity which might have supported the translocation of assimilates towards the sink efficiently thereby resulting in increased yield. Similar results were reported by Broadly et al., (2007) and Swargiary et al. (2021).

**Economics:** The highest cost of cultivation (Rs.30095/ha) was observed in 50 kg $ha^{-1}$ $FeSO_4$ soil application. This was because of higher quantity of applied $FeSO_4$ as basal compared to foliar feeding treatments. Gross returns (Rs. 36470/ha) and net returns (Rs.8020/ha) and benefit cost ratio (1.28) was recorded highest under treatment 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage. Foliar application of 0.5% $ZnSO_4$ at flower initiation and 0.5% $ZnSO_4$ at flower initiation and pod initiation earned more net returns by Rs.7265/ha and Rs.6940/ha than control, however, all foliar fertilized treatment exhibited greater net returns over control. This increase in net return was due to significantly higher value of seed and stover yield as compared to cost of cultivation of corresponding treatment. The results were supported by Soni and Kushwaha (2020), Sharma, A. et al. (2018) and Sajid, M. et al. (2016).

**Nutrient content:** Soil and foliar application of $ZnSO_4$ and $FeSO_4$ significantly increased the N, P, K, Zn content by mungbean seed & stover. The highest N, P and K content was found with application of 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage N (3.86% & 1.25% in seed and stover), P (0.45% & 0.19% in seed & stover), K (0.65% & 1.88% in seed and stover). This might be due to increasing the cation exchange capacity of roots led to more absorption of nutrients from soil and further more translocation to different vegetative and reproductive parts which ultimately led to higher content in the seeds as well as in the stover of the mungbean. Similar results were also reported with soil application of zinc in fenugreek by Sammuria, R. (2007) and Saini, R.K. (2003) in mothbean. Soil application of zinc fertilizer resulted in higher zinc enrichment in mungbean grains were also reported by Haider, M.U. et al. (2018) and Kudi, S. et al. (2018).

Maximum Zn content (51.01 ppm) in seed and (17.43 ppm) in stover was obtained in application of 0.5% $ZnSO_4$ FI & PI stage. The more absorption of zinc and iron through foliar nutrition fulfill the unmet requirement of these nutrients from source to sink and thereby more content and uptake of these nutrients. These results are in line with those reported by Singh, V. et al. (2013), Tak, S. et al. (2014) and Solanki, D. et al. (2017) in mungbean.

Maximum iron content value in seed (117.50 ppm) as well as in stover (84.97 ppm) was observed in $T_5$ - $T_1$+ 0.5% $FeSO_4$ at FI & PI stage. Such increment in content of iron in seed and stover with the application of iron sulphate might be due to more availability in rhizosphere and absorption of iron resulting from application of these micronutrients. The increment in the zinc and iron content with the soil application of iron sulphate + zinc sulphate was noted by Bhamare, R.S. et al. (2018). The significant improvement in concentration of these nutrients coupled with seed and straw yield, increased the uptake of N, P, Zn and Fe significantly. Increased concentration of N, P, Zn and Fe with the application of iron fertilizer has also been reported by several researchers Kumawat, R.N. et al. (2006).

**Quality:** The maximum crude protein content in mungbean seed was recorded in 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ flower initiation stage (24.10%). Zn is an important component of lots of enzymes and plays an important role in metabolism of nitrogen, synthesizing proteins, nucleic acids and precursor of auxin. Effect of foliar application of zinc showed increased protein content due to enhanced physiological characteristics and protease enzyme activity Nandan, B. et al. (2018), Usman, M. et al. (2014) and Lokhande, P.B. et al. (2018). Imsande, J. (1998) stated that iron had an important role in the synthesis of chlorophyll and also helpsin the absorption of other nutrients. It is an important constitutes of chlorophyll and it regulates respiration, photosynthesis, nitrogen fixation, reduction of nitrates and sulphates and finally improves protein content of mungbean.

**Table 1 Effect of application of zinc and iron on yield and economics of summer mungbean**

| **Treatments** | **Seed yield (kg ha$^{-1}$)** | **Stover yield (kg ha$^{-1}$)** | **Cost of cultivation (Rs./ha)** | **Gross return (Rs./ha)** | **Net return (Rs./ha)** | **B:C** |
|---|---|---|---|---|---|---|
| $T_1$ - Control (RDF: 20-40-20 kg ha$^{-1}$ and FYM 5 t ha$^{-1}$) | 402.3 | 1074.7 | 27595 | 28140 | 545 | 1.02 |
| $T_2$ - $T_1$+ 0.5% $ZnSO_4$ FI | 502.3 | 1274.7 | 28200 | 35140 | 6940 | 1.25 |
| $T_3$ - $T_1$+ 0.5% $ZnSO_4$ FI & PI | 511.3 | 1296.0 | 28505 | 35770 | 7265 | 1.25 |

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|---|---|---|---|---|---|---|
| $T_4$ - $T_1$+ 0.5% $FeSO_4$ FI | 456.0 | 1178.7 | 28145 | 31920 | 3775 | 1.13 |
| $T_5$ - $T_1$+ 0.5% $FeSO_4$ FI & PI | 450.3 | 1169.0 | 28445 | 31500 | 3055 | 1.11 |
| $T_6$ - $T_1$+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI | 521.0 | 1307.0 | 28450 | 36470 | 8020 | 1.28 |
| $T_7$ - $T_1$+ 25 kg ha$^{-1}$ $ZnSO_4$ soil application | 446.7 | 1195.0 | 29645 | 31290 | 1645 | 1.06 |
| $T_8$ - $T_1$+ 50 kg ha$^{-1}$ $FeSO_4$ soil application | 439.0 | 1202.7 | 30095 | 30730 | 635 | 1.02 |
| SE (m)± | 9.63 | 12.20 | 8.12 | 623.80 | 618.03 | 0.02 |
| CD (P=0.05) | 28.60 | 36.25 | 24.88 | 1910.44 | 1892.78 | 0.06 |

**Table 2 Effect of application of zinc and iron on nutrient (N, P and K) content of mungbean**

| Treatments | Nitrogen Content (%) | | Phosphorus content (%) | | Potassium content (%) | |
|---|---|---|---|---|---|---|
| | Seed | Stover | Seed | Stover | Seed | Stover |
| $T_1$ - Control (RDF: 20-40-20 kg ha$^{-1}$ and FYM 5 t ha$^{-1}$) | 3.58 | 0.81 | 0.33 | 0.16 | 0.55 | 1.57 |
| $T_2$ - $T_1$+ 0.5% $ZnSO_4$ FI | 3.81 | 1.17 | 0.38 | 0.18 | 0.61 | 1.84 |
| $T_3$ - $T_1$+ 0.5% $ZnSO_4$ FI & PI | 3.84 | 1.19 | 0.43 | 0.18 | 0.63 | 1.86 |
| $T_4$ - $T_1$+ 0.5% $FeSO_4$ FI | 3.64 | 0.95 | 0.37 | 0.16 | 0.56 | 1.70 |
| $T_5$ - $T_1$+ 0.5% $FeSO_4$ FI & PI | 3.72 | 1.01 | 0.36 | 0.17 | 0.60 | 1.74 |
| $T_6$ - $T_1$+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI | 3.86 | 1.25 | 0.45 | 0.19 | 0.65 | 1.88 |
| $T_7$ - $T_1$+ 25 kg ha$^{-1}$ $ZnSO_4$ soil application | 3.68 | 0.91 | 0.37 | 0.16 | 0.58 | 1.69 |
| $T_8$ - $T_1$+ 50 kg ha$^{-1}$ $FeSO_4$ soil application | 3.61 | 0.87 | 0.36 | 0.16 | 0.57 | 1.66 |
| SE (m)± | 0.03 | 0.03 | 0.02 | 0.002 | 0.02 | 0.01 |
| CD (P=0.05) | 0.08 | 0.09 | 0.06 | 0.006 | 0.05 | 0.03 |

**Table 3 Effect of application of zinc and iron on nutrient (Zn and Fe) and crude protein content of mungbean**

| Treatments | Zinc content (ppm) | | Iron content (ppm) | | Crude protein content |
|---|---|---|---|---|---|
| | Seed | Stover | Seed | Stover | Seed |
| $T_1$ - Control (RDF: 20-40-20 kg ha$^{-1}$ and FYM 5 t ha$^{-1}$) | 31.29 | 14.47 | 78.90 | 68.62 | 22.38 |
| $T_2$ - $T_1$+ 0.5% $ZnSO_4$ FI | 49.24 | 16.92 | 79.23 | 71.39 | 23.83 |
| $T_3$ - $T_1$+ 0.5% $ZnSO_4$ FI & PI | 51.01 | 17.43 | 80.47 | 78.77 | 23.98 |
| $T_4$ - $T_1$+ 0.5% $FeSO_4$ FI | 42.47 | 16.29 | 104.37 | 80.69 | 22.77 |
| $T_5$ - $T_1$+ 0.5% $FeSO_4$ FI & PI | 42.63 | 16.58 | 117.50 | 84.97 | 23.27 |
| $T_6$ - $T_1$+ 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ FI | 50.81 | 17.05 | 103.80 | 83.00 | 24.10 |
| $T_7$ - $T_1$+ 25 kg ha$^{-1}$ $ZnSO_4$ soil application | 44.08 | 16.04 | 82.10 | 75.23 | 22.98 |

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|---|---|---|---|---|---|
| $T_8$ - $T_1$+ 50 kg $ha^{-1}$ $FeSO_4$ soil application | 37.81 | 15.92 | 97.27 | 71.03 | 22.54 |
| SE (m)± | 1.89 | 0.19 | 2.49 | 1.08 | 0.17 |
| CD (P=0.05) | 5.61 | 0.55 | 7.40 | 3.20 | 0.50 |

## CONCLUSION

From the results of above experiment, it was concluded that foliar spray with 0.5% $ZnSO_4$ and 0.5% $FeSO_4$ at flower initiation stage along with RDF: 20-40-20 kg $ha^{-1}$ and FYM 5 t $ha^{-1}$ in summer mungbean produced maximum seed yield (521 kg $ha^{-1}$) and stover yield (1307 kg $ha^{-1}$) with maximum net return of Rs. 8020/ha and benefit cost ratio (1.28) because at this level we recorded maximum yield and of mungbean as compared to control. Foliar application of $ZnSO_4$ and $FeSO_4$ enhanced the Zn & Fe contents in mungbean grains, which significantly increased the seed quality.

**FUTURE SCOPE:**

1. Study of more precise work on date of planting/sowing under different agroclimatic zones.
2. Foliar nutrition on other pulses should be taken.

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