

Original Research Article

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## Seed Yield and Nutrient Content of Mungbean and Soil Nutrient Status as Influenced by Application of Micronutrients Mixture in a Alfisol

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### ABSTRACT

The lower productivity of pulses in India is largely due to cultivation of pulses on marginal and sub-marginal lands as main crop or after the harvest of main cereal crop with less or no fertilizer application. Such cultivation practices not only results in lowering of soil fertility and productivity also results in grains low in mineral nutrient elements, consumption of such grains may cause serious health issue in human beings. Keeping these points in view the experiment was laid out in RCBD with twelve treatments including control, RDF alone, RDF + water spray / soil / foliar (Fe, Mn, Zn, Cu and B) application, RDF + seed treatment with MM + Mo and RDF + soil application of deficient micronutrients (Zn and B). Results revealed that application of RDF + foliar application of MM at 30 and 45 DAS recorded significantly higher nutrient content of Fe, Mn, Zn, Cu and B in mungbean seeds, which was 77.44, 80.9, 65.77, 30.68 and 65.39 per cent, respectively higher over control and 43.99, 66.2, 17.90, 21.16 and 20.94 percent, respectively higher over soil application of MM. The soil DTPA extractable iron, zinc and boron content was highest in the treatment receiving soil application of micronutrients mixture along with RDF. The increased availability of micronutrients in the soil significantly improved the nutrient content and grain yield (1140.84 kg ha<sup>-1</sup>) of mungbean with the foliar and soil application of micronutrients.

#### Keywords

Mungbean,  
Micronutrients mixture  
(MM), Soil application,  
Foliar application, Seed  
treatment, Nutrient  
content

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### Introduction

India is recognised as the principal producer, consumer, processor and importer of pulses in the world. Paradoxically, the country pulse production has reached at 19.5 million tonnes from the acreage of 24.5 million hectares. Expectedly, as the countries domestic requirements would be around 26.50 mt by 2030, it necessitates stepping up of production by almost 7.0 mt of additional produce. Pulses are rich source of protein and they maintain

soil fertility through biological nitrogen fixation in soil and thus play a vital role in sustainability. The reasons for decreasing productivity are due to decreasing soil fertility especially macro and micronutrients, imbalanced use of fertilizer and occurrences of physiological disorders factors such as inefficient partitioning of assimilates, poor pod setting, excessive flower abscission and lack of nutrients during the critical stages of crop growth leading to nutrient stress, poor growth and productivity were found to be some of the yield barriers of pulse crop.

Supplies of nutrients are more important in pulses because early flowering altered the source-sink relationship due to rapid translocation of nutrients from leaves to the developing pods. The diets of over two-thirds of the world's population lack in one or more essential mineral elements. This can be remedied through increasing the concentrations and/or bioavailability of mineral elements in produce. To overcome these constraints, nutrition through foliar feeding play a vital role in pulse production by stimulating root development, nodulation, energy transformation, various metabolic processes and increasing pod setting and thereby increasing the yield and also increasing the soil fertility through application besides increasing the content in grains. Foliar spray is one of the most efficient ways of supplying essential nutrients to a growing crop.

### **Materials and Methods**

The field experiment was conducted at College of Agriculture, V.C. Farm, Mandya situated in the Agro Climatic Zone-6, Southern Dry Zone, Karnataka. It lies between 76°49'08" E longitude and 12°34'03" N latitude with 697 meters above mean sea level. The twelve treatments combinations including T<sub>1</sub>: Absolute control, T<sub>2</sub>: Only RDF, T<sub>3</sub>: T<sub>2</sub>+water spray, T<sub>4</sub>: T<sub>2</sub>+foliar application of MM at 30 DAS, T<sub>5</sub>: T<sub>2</sub>+foliar application of MM at 45 DAS, T<sub>6</sub>: T<sub>2</sub>+foliar application of MM at 30 & 45DAS, T<sub>7</sub>: T<sub>2</sub>+foliar application of deficient MM at 30 DAS, T<sub>8</sub>: T<sub>2</sub>+Mo seed treatment + foliar application of deficient MM at 30 DAS, T<sub>9</sub>: T<sub>2</sub>+soil application of MM, T<sub>10</sub>: T<sub>2</sub> +soil application of deficient MM, T<sub>11</sub>: T<sub>2</sub>+Mo seed treatment + soil application of deficient MM, T<sub>12</sub>: T<sub>2</sub>+Mo seed treatment + MM seed treatment. All twelve treatments combinations were replicated three times in Randomized block design.

The soil was sandy loam in texture with 75.03,

18.2, and 6.77 per cent sand, silt and clay, respectively and bulk density of 1.5 Mg m<sup>-3</sup>. The soil was neutral in reaction (pH 7.21) and low in soluble salts (0.16 dS m<sup>-1</sup>). The soil was low in organic carbon (4.8 g kg<sup>-1</sup>), available nitrogen (151.2 kg ha<sup>-1</sup>) and available P<sub>2</sub>O<sub>5</sub> (9.64 kg ha<sup>-1</sup>), while it was medium in K<sub>2</sub>O (202.944 kg ha<sup>-1</sup>) and high in sulphur (15.67 mg kg<sup>-1</sup>). The exchangeable calcium and magnesium content of soil was 3.4 and 2.5 meq 100 g<sup>-1</sup>, respectively. The DTPA extractable micronutrient content viz., zinc, iron, copper manganese and boron were 0.52, 7.82, 0.41, 8.62 and 0.46 mg kg<sup>-1</sup>, respectively. Zn and B content were below the critical limit. Mungbean variety KKM-3 was sown at 30cm row and 10 cm plant to plant apart. Recommended dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O for greengram is 20:50:50 kg ha<sup>-1</sup> was supplied with urea, single super phosphate and murate of potash respectively and micronutries like Fe, Mn, Zn, Cu, B and Mo was applied in the form of iron sulphate, manganese sulphate, zinc sulphate, copper sulphate, borax and ammonium molybdate, respectively. To reduce weed infestation one hand weeding was done at 25 days after sowing. In all 4 irrigations were given at different stages of crop growth to fulfill the water requirement. To control the whitefly (*Bemisia tabaci*), Roger 30 EC @ 1.0 litre ha<sup>-1</sup> was uniformly sprayed at vegetative growth stage of the crop. Crop was harvested at physiological maturity. Observations were recorded at harvest in order to assess the effect of micronutrients mixture on seed yield and nutrient content. The nutrient content in mungbean was assessed after digestion by following standard protocol. Micronutrient cations (Fe, Mn, Zn and Cu) from soil were extracted with DTPA extractant (0.005 M Diethylene Triamine Penta Acetic acid + 0.01 M CaCl<sub>2</sub> + 0.1 M Triethanolamine) buffered to pH 7.3 at 1:2 soil to extractant ratio as described by Lindsay and Norvell (1978). The concentration of these cations was determined by atomic absorption

spectrophotometer under suitable measuring conditions (Page *et al.*, 1982).

### **Micronutrients mixture composition**

Among the micronutrients, Zn and B were found to be deficient in the experimental soil. Besides these two nutrients other micronutrients (Fe, Mn, Cu, Mo) were also used in the micronutrients mixture preparation. The proportion of salts used along with per cent nutrient content is presented in Table 1.

### **Results and Discussion**

#### **Effect of micronutrient mixture on yield of crop**

Significantly superior yield of 1140.84 kg ha<sup>-1</sup> was registered in RDF + foliar application of micronutrients mixture at 30 and 45 DAS followed by 1064.56 kg ha<sup>-1</sup> with the application of RDF + soil application of micronutrients mixture (Fig. 1). Suggesting the foliage supplementation of micronutrients as basal enhances the early vigour and thus helps in better growth and yield parameters. Similarly, foliar application at later stages is responsible for translocation of assimilates to sink thus resulting in higher nutrient content in grains. It may be attributed to the enhanced growth as a result of supply of micronutrients two times. Significantly higher stover yield of 2483.86 kg ha<sup>-1</sup> was recorded due to soil application of RDF+MM followed by 2386.63 and 2333.13 kg ha<sup>-1</sup> due to T<sub>10</sub> (RDF + soil application of deficient micronutrients) and T<sub>6</sub> (RDF + foliar application of MM at 30 and 45 DAS) respectively compared to control (1831.97 kg ha<sup>-1</sup>). The higher yield obtained with application of micronutrients along with RDF might be due to increased availability of nutrients in balanced proportion. Similar increase in the productivity of pulses with the foliar spray of Zn, Fe, B, Mn and Mo was reported by Savithri (2001).

#### **Effect of micronutrients mixture on nutrient content in mungbean**

Application of micronutrients mixture significantly influenced the micronutrient content of mungbean grain. Iron content in control was 84.10 mg kg<sup>-1</sup> which increased significantly to 149.23 mg kg<sup>-1</sup> due to application of RDF + foliar spray of MM at 30 and 45 DAS (T<sub>6</sub>). The highest concentration of iron in stover was recorded in T<sub>6</sub> (720.39 mg kg<sup>-1</sup>), followed by T<sub>4</sub> (696.90 mg kg<sup>-1</sup>) treatment compared to other treatments. Similar results were observed by Kumawat *et al.*, (2006) The manganese content of grain in control was 7.28 mg kg<sup>-1</sup> which increased significantly to 13.18 mg kg<sup>-1</sup> due to application of RDF + foliar spray of MM at 45 DAS. Similarly, highest concentration of manganese in stover was noticed in T<sub>6</sub> (90.84 mg kg<sup>-1</sup>) due to application of RDF + foliar spray of micronutrients mixture at 30 and 45 DAS followed by T<sub>8</sub> (86.67 mg kg<sup>-1</sup>) and on par with T<sub>5</sub>. Similar reports were observed by Parker *et al.*, (1981)

The zinc content in grain varied from 19.49 to 32.31 mg kg<sup>-1</sup> in control and RDF + foliar spray of MM at 30 and 45 DAS, respectively and it was significantly higher compared to all other treatments. The zinc concentration in stover varied significantly due to application of micronutrients mixture. Similar reports were observed by Tripathi *et al.*, (1997) Copper content of grain in control plot was 11.34 mg kg<sup>-1</sup> which increased significantly to 14.78 mg kg<sup>-1</sup> due to application of RDF + foliar spray of MM at 30 and 45 DAS. Application of RDF + foliar spray of micronutrients mixture at 30 and 45 DAS (T<sub>6</sub>) significantly increased the copper content (15.57 mg kg<sup>-1</sup>) in grain compared to all other treatments except T<sub>5</sub>. The boron content in mungbean grain in control was significantly lower than that recorded in T<sub>6</sub> (57.64 mg kg<sup>-1</sup>) and T<sub>4</sub> (55.29 mg kg<sup>-1</sup>). While in stover, the B content recorded in T<sub>6</sub>, T<sub>5</sub>, T<sub>9</sub> and T<sub>10</sub>

treatments were statistically at par with each other but differed significantly with other treatments. Similar increase in B content were observed by Oplinger *et al.*, (1993). Among the treatments receiving micronutrients mixture at 30 DAS (T<sub>4</sub>) and 45 DAS (T<sub>5</sub>) micronutrient content in grains recorded highest in @ 30DAS. Results revealed that application of RDF +foliar application of MM at 30 and 45 DAS recorded significantly higher nutrient content of Fe, Mn, Zn, Cu and B in mungbean grains, which was 77.44, 80.9, 65.77, 30.68 and 65.39 per cent, respectively higher over control and 43.99, 66.2, 17.90, 21.16 and 20.94 per cent, respectively higher over soil application of MM. It may be attributed to these micronutrients are required in the early stage of the crop for crop growth and metabolism activities. The improvement in the nutrients use efficiency could be attributed to an enhancement in absorption and assimilation of the micronutrients which provided balanced nutrition to the crop for higher growth and thereby nutrients content which ultimately resulted into higher yield of the crop.

When nutrients are taken up by the plant, the localization within the plant depends on multiple metabolic interactions that differ among plant species and varieties. The responses also firstly depend on specific plant-micronutrient interactions and on the nutrients, as interactions between nutrients that are combined can have positive as well as neutral or even negative effects on yields and nutrient use efficiencies (Rietra *et al.*, 2015). Furthermore, nutrients are distributed over different plant organs and can be re-localized when plants require higher concentrations during certain development stages, such as increased transport to grains as they fill. Whether the micronutrients are actually (re-) located in the part of the plant which is consumed depends on the crop (variety). In rice for example, Zn is localized in protein bodies in the outer layer of the grains (Duffner *et al.*, 2014). Other crops like wheat allocate Zn in the consumed part of the grain (endosperm) (Ajiboye *et al.*, 2015) (Fig. 2).

**Fig.1** Effect of micronutrient mixture application on grain and stover yield of mungbean

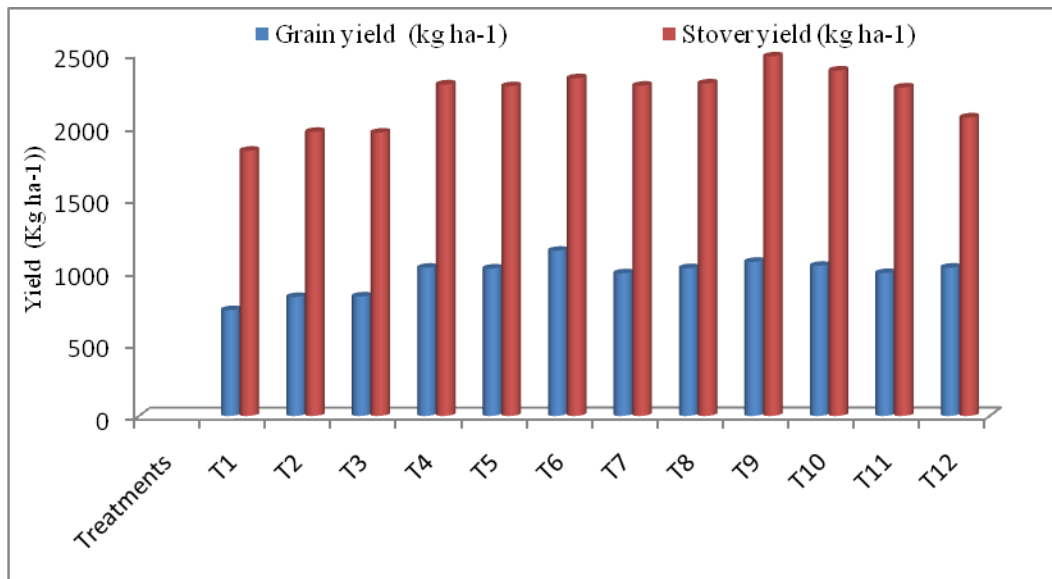


Fig.2 Micronutrient content in grain as influenced by application of micronutrients mixture

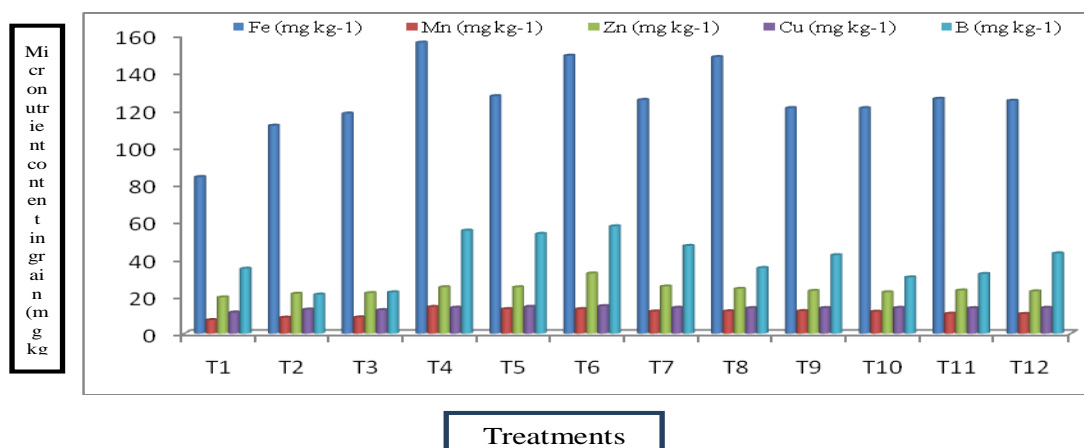


Table.1 Micronutrient carrier and quantity used for soil and foliar application and seed treatment

Micronutrient salts used	Micronutrient percent in a mixture for soil application	Micronutrient for foliar application (g /ha)	Micronutrient percent in mixture for seed treatment
Fe <sub>2</sub> SO <sub>4</sub> .7H <sub>2</sub> O	0.80	80.32	0.4
MnSO <sub>4</sub> .5 H <sub>2</sub> O	0.97	65.08	0.3
ZnSO <sub>4</sub> .7H <sub>2</sub> O	2.26	67.85	0.2
CuSO <sub>4</sub> .7H <sub>2</sub> O	0.50	25.43	0.1
Borax/solubur	0.34	8.73	0.05
Ammonium molybdate	-	-	0.01

Table.2 Iron, manganese, zinc, copper and boron (mg kg<sup>-1</sup>) contents in mungbean grain and stover as influenced by application of micronutrients mixture

Treatments	Fe(mg kg <sup>-1</sup> )		Mn(mg kg <sup>-1</sup> )		Zn(mg kg <sup>-1</sup> )		Cu (mg kg <sup>-1</sup> )		B(mg kg <sup>-1</sup> )	
	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover	Grain	Stover
T <sub>1</sub>	84.10	341.82	7.28	54.63	19.49	32.59	11.34	7.04	34.85	36.89
T <sub>2</sub>	111.64	413.99	8.60	57.61	21.43	35.78	12.92	9.31	20.99	46.45
T <sub>3</sub>	118.19	421.69	8.73	64.75	21.80	36.94	12.65	10.67	22.22	47.73
T <sub>4</sub>	156.22	696.90	14.32	82.33	24.97	42.98	13.95	12.43	55.29	52.42
T <sub>5</sub>	127.51	565.48	13.18	84.97	24.92	45.83	14.41	13.88	53.55	64.32
T <sub>6</sub>	149.23	720.39	13.17	90.84	32.31	48.94	14.78	15.57	57.64	66.63
T <sub>7</sub>	125.49	517.51	11.90	73.10	25.34	37.27	13.90	12.73	47.13	56.61
T <sub>8</sub>	148.51	571.52	11.99	86.67	24.09	43.77	13.70	13.18	35.24	50.86
T <sub>9</sub>	121.10	483.52	12.10	73.95	22.98	44.65	13.74	12.17	42.15	63.94
T <sub>10</sub>	121.07	427.35	11.79	75.62	22.26	37.88	13.83	11.50	30.21	62.46
T <sub>11</sub>	126.12	424.54	10.69	83.00	23.20	34.88	13.66	12.48	32.05	60.32
T <sub>12</sub>	125.07	428.21	10.56	78.38	22.73	38.56	13.87	12.13	43.11	54.52
SEm±	8.93	32.68	0.44	2.36	1.20	1.17	0.46	0.64	1.20	1.62
CD (p=0.05)	26.53	97.07	1.32	7.01	3.57	3.48	1.38	1.89	3.57	4.81

**Table.3** Correlation matrix between grain nutrient content (mg kg<sup>-1</sup>) and yield (Kg ha<sup>-1</sup>)

Parameter	Yield	Fe	Mn	Zn	Cu	B
<b>Yield</b>	1					
<b>Fe</b>	0.77*	1				
<b>Mn</b>	0.88**	0.85**	1			
<b>Zn</b>	0.74*	0.72*	0.70*	1		
<b>Cu</b>	0.94**	0.80*	0.88**	0.78*	1	
<b>B</b>	0.66*	0.56	0.78*	0.72*	0.64*	1

\*Significant at 5% level. \*\*Significant at 1% level

**Table.4** DTPA extractable iron, manganese, zinc, copper and hot water soluble boron (mg kg<sup>-1</sup>) content of soil as influenced by application of micronutrients mixture

Treatments	Fe (mg kg <sup>-1</sup> )	Mn (mg kg <sup>-1</sup> )	Zn (mg kg <sup>-1</sup> )	Cu (mg kg <sup>-1</sup> )	B (mg kg <sup>-1</sup> )
<b>T<sub>1</sub></b>	7.21	8.17	0.43	0.38	0.41
<b>T<sub>2</sub></b>	7.44	8.21	0.66	0.43	0.42
<b>T<sub>3</sub></b>	7.77	8.28	0.63	0.44	0.42
<b>T<sub>4</sub></b>	7.48	8.22	0.87	0.47	0.47
<b>T<sub>5</sub></b>	7.66	8.43	0.86	0.43	0.41
<b>T<sub>6</sub></b>	7.85	8.39	0.86	0.45	0.59
<b>T<sub>7</sub></b>	7.61	8.31	0.85	0.47	0.49
<b>T<sub>8</sub></b>	7.76	8.63	0.89	0.40	0.49
<b>T<sub>9</sub></b>	9.50	8.88	1.10	0.51	0.77
<b>T<sub>10</sub></b>	8.11	8.74	0.93	0.49	0.61
<b>T<sub>11</sub></b>	7.95	8.43	0.91	0.47	0.65
<b>T<sub>12</sub></b>	7.47	8.37	0.81	0.41	0.42
<b>SEM±</b>	0.34	0.39	0.03	0.03	0.03
<b>CD (p=0.05)</b>	1.00	NS	0.08	NS	0.09

Correlation matrix of nutrient content in grain and yield indicated the importance of micronutrient mixture application (Table 3).

The grain nutrient content and crop yield were significantly and positively correlated. With increased micronutrient content in grain increased crop yield was observed.

The correlation between iron, manganese, zinc, copper and boron content in grain and crop yield was +0.77, +0.88, +0.74, 0.94 and +0.66

**Effect of micronutrients mixture on micronutrient availability in soil (DTPA extractable Fe, Mn, Zn, Cu and Hot water soluble B)**

The data on soil micronutrient status is represented in the Table 2. The DTPA extractable Fe content in soil at harvest was significantly higher in T<sub>9</sub> (9.50 mg kg<sup>-1</sup>) due to RDF + soil application of MM treatment than control (7.21 mg kg<sup>-1</sup>) and to all other treatments. Similar results were observed by Kumawat *et al.*, (2006). The manganese



content did not record significant variation due to different treatments. However, the highest available manganese content of soil was recorded in T<sub>9</sub> (8.88 mg kg<sup>-1</sup>) due to RDF + soil application of MM treatment than control (8.17 mg kg<sup>-1</sup>).

The data clearly indicates that DTPA- Zn content significantly varied due to treatments. Significantly higher zinc content of soil was recorded in T<sub>9</sub> (1.10 mg kg<sup>-1</sup>) due to RDF + soil application of MM treatment than control (0.43 mg kg<sup>-1</sup>) and other treatments (Table 4). The effect of application of RDF and micronutrients mixture on available copper was non-significant at harvest. However, the highest copper concentration at harvest of crop was recorded in T<sub>9</sub> (0.51 mg kg<sup>-1</sup>) due to application of RDF + soil application of MM over control. The effect of application of RDF and micronutrients mixture on available boron was significant at harvest. The results revealed that the available boron ranging from 0.41 to 0.77 mg kg<sup>-1</sup> due to treatments. The highest concentration of boron 0.77 mg kg<sup>-1</sup> was recorded in T<sub>9</sub> treatment followed by T<sub>11</sub> (0.65 mg kg<sup>-1</sup>) compared to control and other treatments. Application of micronutrients through fertilizer improves the soil fertility and productivity by increasing the nutrient availability in the soil and yield of the crop. Due to residual soil fertility the nutrients availability increased to the subsequent crop thereby increasing the yield similar reports were reported by Kannan *et al.*, (2014).

Foliar or soil application of micronutrients mixture along with RDF significantly increased the yield and yield attributes, nutrient concentration in grain. The nutrient content in both grain and stover increased significantly with the application RDF + foliar application of micronutrients mixture followed by soil application of RDF + micronutrients mixture. Soil application of micronutrients mixture along with RDF

significantly increased available macro and micronutrients there by increased the soil fertility level. Significantly higher available N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B were noticed due to soil application of RDF + micronutrients mixture.

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