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Effect of micronutrients and different levels of macronutrients with *Rhizobium* on yield and yield attributes of mung bean

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Abstract

A field experiment entitled "Effect of micronutrients application over different levels of RDF on performance of mung bean (*Vigna radiata* L. Wilczek)" was carried at CRC, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.) India, during *Zaid* 2019. The soil of the experimental field was well drained, sandy loam in texture and slightly alkaline in reaction. It was low in organic carbon, low in available nitrogen, medium in available phosphorus and potassium. Total twenty treatment combinations comprised of five levels of RDF (N₁: Control, N₂: only *Rhizobium*, N₃: 75% RDF + *Rhizobium*, N₄: 100% RDF, N₅: 100% RDF + *Rhizobium*) in main plot and four levels of micronutrients spray (M₁: Only water spray, M₂: Fe (0.5% solution), M₃: Mo (0.05% solution), M₄: Fe + Mo (0.5% solution & 0.05% solution), in sub plot were tested with split plot design in three replications. The finding revealed that yield attributes and yields of mung bean was influenced significantly by the different levels of RDF as well as foliar spray of Iron and Molybdenum. Application of 100% RDF + *Rhizobium* recorded significantly higher yield and yield attributes of mung bean. Foliar spray of Iron @ 0.5% + Molybdenum @ 0.05% at 25 and 45 DAS also recorded the highest value of yield attributes and yields of mung bean, which was significantly higher than control. On an averages 115% increase in grain yield was recorded with 100% RDF + *Rhizobium* followed by two spray of micronutrients (Fe + Mo @ 0.5% + 0.05%) at 25 and 45 DAS.

Keywords: Mung bean, micronutrients, *Rhizobium*

1. Introduction

Mung bean (*Vigna radiata* L.) is one of the most popular short duration pulse crops of India, it occupies third place after chickpea and pigeon pea. Mung bean is an excellent source of high quality protein and contains about 22-25% protein, 1.0-1.5% oil, 3.5-4.5% fibre, 4.8% ash and 62-65% carbohydrates on dry weight basis. It is easily digestible and hence it is suitable for all age group of peoples. Ascorbic acid is synthesized in sprouted seeds of mung bean with increment in riboflavin and thiamine. Mung bean sprouts are a rich source of vitamin C (8 mg/100 g) (Calloway, 1994) [4]. India is the largest producer and consumer of pulses in the world. Total area under pulses in world is about 85.4 million ha. with annual production of 87.4 million tons and productivity of 1023 kg/ha. In India, pulses were cultivated in more than 29 million ha of area and recorded a highest ever production of 25.23 million tons with 841 kg/ha productivity. India ranks first in area and production of pulses with 34% and 26% of world, respectively. The growth rate in pulse production during 2018-19 was more than 9 per cent. The area, production and productivity of mung bean was 4.26 million ha, 2.1 million tons and 472 kg/ha respectively during 2019 (Anonymous, 2020) [2]. Mung bean is primarily a native of India and central Asia may be a secondary centre. In north India, it is grown in summer season because of its shorter duration. Mung bean is grown in marginal lands with limited inputs due to which it faces a number of abiotic stresses thereby causing tremendous yield loss (Singh and Singh, 2011) [9]. Pulses are mainly grown in low fertile land therefore productivity is poor. Generally, in pulse crop farmer mainly apply urea/di-ammonium phosphate (DAP) resulting soil fertility is decline continuously. Apart from primary macronutrient deficiency, the deficiency of secondary macronutrient,

micronutrient particularly of sulphur, zinc iron & molybdenum are also emerging and it is being a limiting factor. The management of nutrient is one of the important factors that greatly affect the growth, development and yield of pulses. Imbalanced nutrition or no fertilizer application, poor plant protection measures, and lack of high yielding varieties are the main inhibitors. The management of fertilizer is the important one that greatly affects the growth attributes and yield of this crop. Pulses although fix atmospheric N₂ by symbiotic means, but application of nitrogenous fertilizer as starter or initial dose becomes helpful in increasing the growth and yield of legume crops (Ardeshana *et al.*, 1993) [3]. Nitrogen is most useful for pulse crops because it is a major component of protein (Anon., 2005) [1]. Being a drought tolerant crop, mung bean is mostly growing in rainfed areas of the country where yield level is very low. Application of micronutrients in small quantity has resulted in 40- 120 per cent increase in grain yield, indicating that it is not the single nutrient deficiency is limiting the productivity of pulses rather multi micronutrients deficiencies are quite often the reasons for low productivity. The multimicronutrients mixture facilitate the application of the wide range of plant nutrients in the proportion and to suit the specific requirements of a crop in different stages of growth, and are more relevant under specific nutrient management practices. However, micronutrients 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. (Divyashree *et al.*, 2018) [5] In the absence of micronutrients, plant shows physiological disorders which

eventually lead to low crop yield and fair quality. Foliar spraying is a new method for crop feeding in which micronutrients in the form of liquid are used into leaves (Nasiri *et al.*, 2010) [7]. Foliar application of micronutrient is more beneficial than soil application.

2. Method and Material

The field experiment was conducted at CRC, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.), located at latitude of 29° 04' North and longitude of 77° 42' East with an elevation of 228 meters above the mean sea level. The Meerut area lies in the heart of Western Uttar Pradesh and has sub-tropical climate. The experimental site has an even topography with good drainage system in the farm. The area receives mean annual rainfall of 845 mm, of which 80-90 per cent is received from June to September. The mean minimum temperature reaches as low as 3 °C in winters, while during summer the mean maximum temperature varies from 43-45°C in the month of May. The mean relative humidity varied between 44.1 to 89.9 percent. Whereas, total amount of rainfall received during crop period was 11.4 mm (Figure-1). The trial was laid out in Split Plot Design with total twenty treatment combinations comprised of five levels of RDF (N₁: Control, N₂: only *Rhizobium*, N₃: 75% RDF + *Rhizobium*, N₄: 100% RDF, N₅: 100% RDF + *Rhizobium*) in main plot and four levels of micronutrient spray (M₁: Only water spray, M₂: Fe (0.5% solution), M₃: Mo (0.05% solution), M₄: Fe + Mo (0.5% & 0.05% solution), in sub plot.

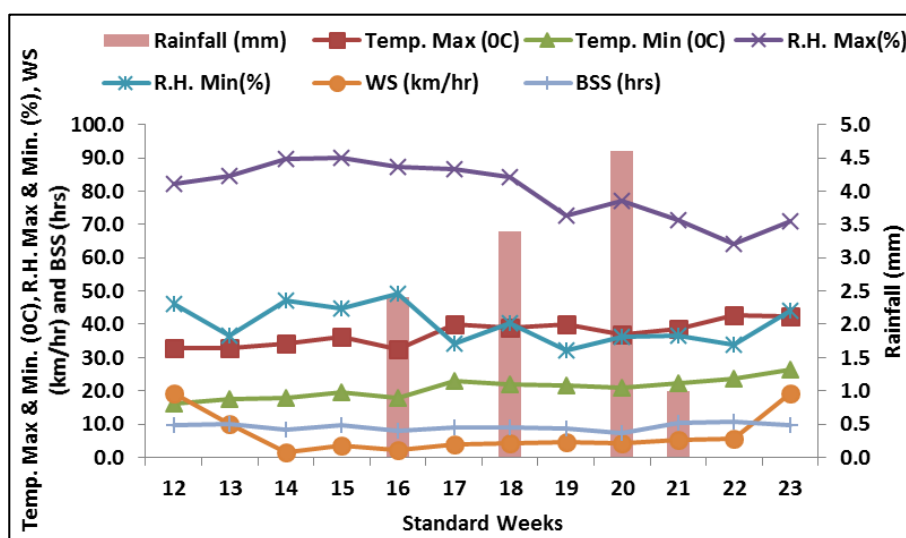


Fig 1: Mean weekly agro-meteorological data during the crop growing season (Zaid - 2019)

3. Result and Discussion

3.1 Yield Attributes

The mean data on pod length had significant effect on different levels of RDF and micronutrient applications. The highest pod length (8.1 cm) was recorded with 100% RDF + *Rhizobium*, which was statistically at par to 100% RDF and 75% RDF + *Rhizobium* and significantly higher than rest of the main plot treatments. Foliar application of micronutrient had also significant effect on pod length. Among the micronutrient treatment the highest pod length (8.6 cm) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution) which was significantly higher than rest of the treatments. Number of pod plant⁻¹ had also significant effect on different levels of RDF and micronutrient

applications. The highest number of pod plant⁻¹ was recorded with 100% RDF + *Rhizobium* (13.5), which was statistically at par to 100% RDF and significantly higher than rest of the main plot treatments. Among the micronutrient treatment the highest number of pod plant⁻¹ (14.1) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution) which was significantly higher than rest of the treatments. The highest number of grains pod⁻¹ (7.4) was recorded with 100% RDF + *Rhizobium*, which was statistically at par to 100% RDF and 75% RDF + *Rhizobium* and significantly higher than rest of the main plot treatments. Among the micronutrient treatment the highest number of grains pod⁻¹ (7.5) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution) which was significant

higher than rest of the treatments. Whereas the lowest number of grains pod^{-1} (5.1) was recorded with control. Grain yield plant^{-1} had significant effect on different levels of RDF and micronutrient applications. The highest grain yield plant^{-1} (3.5 g) was recorded with 100% RDF + *Rhizobium*, which was significantly higher than rest of the main plot treatments. On an average 67, 48, 33 and 24% increase in grain yield plant^{-1} was recorded with 100% RDF + *Rhizobium*, 100% RDF, 75% RDF + *Rhizobium* and only *Rhizobium* over control, respectively. Among the micronutrient treatment the highest grain yield plant^{-1} (3.6 g) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution) which was significant higher than rest of the treatments. The highest test weight (34.8 g) was calculated with 100% RDF + *Rhizobium*, which was statistically at par to 100% RDF and 75% RDF + *Rhizobium* and significantly higher than rest of the main plot treatments. Foliar application of micronutrient had also significant effect on test weight. The highest test weight (34.5 g) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution) among the micronutrient treatment which was significantly higher than rest of the treatments. Whereas the lowest test weight (31.6 g) was recorded with control. It may be due to macro and micro nutrients and better sink capacity performed more no. of pod plant^{-1} , no. of grain pod^{-1} , grain wt. (g) plant^{-1} and 1000- grain weight (g). The yield attributes are decided by genetic makeup of the crop and variety, but the agronomic manipulation also affects them to a great extent.

3.2 Grain Yield

Grain yield (q ha^{-1}) had significant effect on different levels of RDF and micronutrient applications. The highest grain yield (11.6 q ha^{-1}) was recorded with 100% RDF + *Rhizobium* which was significantly higher than the rest of the main plot treatments. On an average 73, 52, 48 and 16% higher grain yield was recorded with 100% RDF + *Rhizobium*, 100% RDF, 75% RDF + *Rhizobium* and only *Rhizobium* over control respectively. Whereas, the lowest grain yield (6.7 q ha^{-1}) was recorded with control, which was significantly lower than rest of the treatments. Among the micronutrient treatments the highest grain yield (11.9 q ha^{-1}) of mung bean was recorded with application of Fe + Mo (0.5% & 0.05% solution)

followed by Fe (0.5% solution) and Mo (0.05% solution). Whereas the lowest grain yield (6.8 q ha^{-1}) was recorded with control. About 75, 23 and 27% increases in grain yield over control was recorded by foliar application of Fe + Mo (0.5% & 0.05% solution). Similar findings were also reported by Sarita *et al.* (2019)^[8].

3.3 Straw Yield

Straw yield had significant effect on different levels of RDF and micronutrient applications. The highest straw yield was recorded with 100% RDF + *Rhizobium* (36.5 q ha^{-1}), which was statistically at par to 100% RDF and 75% RDF + *Rhizobium* and significantly higher than rest of the main plot treatments. On an average 70, 58, 44 and 28% increase in straw yield was recorded with 100% RDF + *Rhizobium*, 100% RDF, 75% RDF + *Rhizobium* and only *Rhizobium* over control, respectively. Whereas the lowest straw yield (21.5 q ha^{-1}) was recorded with control, which was significantly lower than rest of the treatments. Foliar application of micronutrient had also significant effect on straw yield. Among the micronutrient treatment the highest straw yield (37.2 q ha^{-1}) of mungbean was recorded with application of Fe + Mo (0.5% & 0.05% solution) which was significant higher than rest of the treatments. Whereas the lowest straw yield (24.5 q ha^{-1}) was recorded with control. On an average 52, 11 and 19% increases in straw yield over control was recorded by foliar application of Fe + Mo (0.5% & 0.05% solution). This finding confirms the results of Mahilane *et al.* (2018)^[6].

3.4 Harvest Index

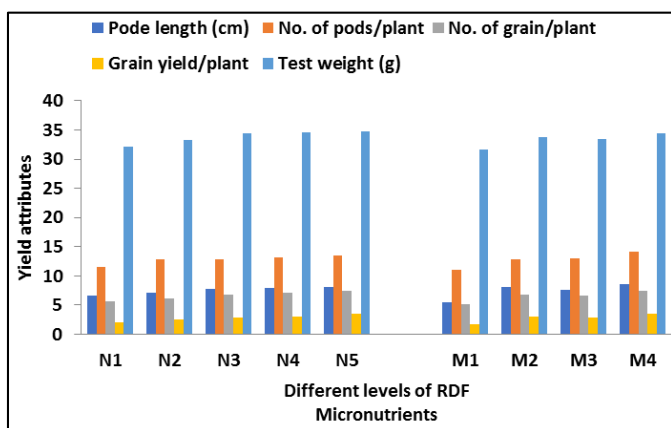
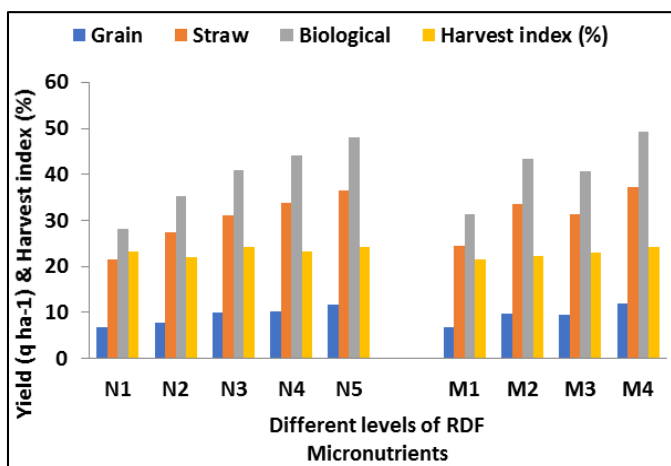
The highest harvest index (24.20%) was recorded with 100% RDF + *Rhizobium* which was significantly higher than rest of main plot treatments except 75% RDF + *Rhizobium*. Among the micronutrient treatment the highest harvest index (24.18%) of mung bean was calculated with application of Fe + Mo (0.5% & 0.05% solution) followed by Fe (0.5% solution) and Mo (0.05% solution). Whereas the lowest harvest index (21.65%) was recorded with control which significantly lower than rest of treatments. On an average 12, 8 and 5% increases in harvest index over control was recorded by foliar application of Fe + Mo (0.5% & 0.05% solution).

Table 1: Effect of micronutrients application over different levels of RDF on yield attributes

| Treatment | Yield attributes | | | | |
|---|------------------|---------------------------------|---------------------------------|---------------------------------------|----------------|
| | Pod length (cm) | No. of Pods plant^{-1} | No. of Grains pod^{-1} | Grain yield (g plant^{-1}) | Test weight(g) |
| Different levels of RDF | | | | | |
| N ₁ : Control | 6.7 | 11.6 | 5.6 | 2.1 | 32.1 |
| N ₂ : <i>Rhizobium</i> | 7.1 | 12.8 | 6.1 | 2.6 | 33.2 |
| N ₃ : 75% RDF + <i>Rhizobium</i> | 7.7 | 12.9 | 6.8 | 2.8 | 34.5 |
| N ₄ : 100% RDF | 7.9 | 13.1 | 7.1 | 3.1 | 34.6 |
| N ₅ : 100% RDF + <i>Rhizobium</i> | 8.1 | 13.5 | 7.4 | 3.5 | 34.8 |
| <i>SEm</i> (\pm) | 0.19 | 0.16 | 0.33 | 0.03 | 0.28 |
| <i>C.D.</i> ($P=0.05$) | 0.61 | 0.52 | 1.09 | 0.09 | 0.91 |
| Micronutrients | | | | | |
| M ₁ : Water spray* | 5.5 | 11.1 | 5.1 | 1.7 | 31.6 |
| M ₂ : Fe (0.5% solution)* | 8.1 | 12.9 | 6.8 | 3.0 | 33.7 |
| M ₃ : Mo (0.05% solution)* | 7.6 | 13.0 | 6.7 | 2.9 | 33.4 |
| M ₄ : Fe + Mo (0.5% & 0.05% solution)* | 8.6 | 14.1 | 7.5 | 3.6 | 34.5 |
| <i>SEm</i> (\pm) | 0.13 | 0.08 | 0.16 | 0.03 | 0.17 |
| <i>C.D.</i> ($P=0.05$) | 0.38 | 0.23 | 0.46 | 0.09 | 0.49 |

Table 2: Effect of micronutrients application over different levels of RDF on grain, straw, biological yield (q ha^{-1}) and harvest index (%)

| Treatment | Yield (q ha^{-1}) | | | Harvest index (%) |
|---|------------------------------|-------|------------|-------------------|
| | Grain | Straw | Biological | |
| Different levels of RDF | | | | |
| N ₁ : Control | 6.7 | 21.5 | 28.2 | 23.26 |
| N ₂ : <i>Rhizobium</i> | 7.8 | 27.5 | 35.3 | 22.09 |
| N ₃ : 75% RDF + <i>Rhizobium</i> | 9.9 | 31.0 | 40.9 | 24.12 |
| N ₄ : 100% RDF | 10.2 | 33.9 | 44.1 | 23.13 |
| N ₅ : 100% RDF + <i>Rhizobium</i> | 11.6 | 36.5 | 48.1 | 24.20 |
| SEm (\pm) | 0.36 | 2.23 | 2.05 | 0.04 |
| C.D. (P=0.05) | 1.17 | 7.25 | 6.67 | 0.13 |
| Micronutrients | | | | |
| M ₁ : Water spray* | 6.8 | 24.5 | 31.4 | 21.65 |
| M ₂ : Fe (0.5% solution)* | 9.7 | 33.6 | 43.5 | 22.30 |
| M ₃ : Mo (0.05% solution)* | 9.4 | 31.3 | 40.8 | 23.04 |
| M ₄ : Fe + Mo (0.5% & 0.05% solution)* | 11.9 | 37.2 | 49.2 | 24.18 |
| SEm (\pm) | 0.35 | 0.53 | 0.49 | 0.04 |
| C.D. (P=0.05) | 1.01 | 1.53 | 1.42 | 0.12 |

**Fig 2:** Effect of micronutrients application over different levels of RDF on yield attributes.**Fig 3:** Effect of micronutrients application over different levels of RDF on grain, straw, biological yield (q ha^{-1}) & harvest index (%).

Appreciable values of different yield attributes *viz.*, number of pods plant^{-1} (33.3), number of grains pod^{-1} (7.4) and grain yield plant^{-1} (3.5 g) test weight (34.80) were obtained with 100% RDF + *Rhizobium* followed by 100% RDF. Different levels of RDF were found to be significant on yield attributes of mung bean. 100% RDF + *Rhizobium* recorded significantly higher grain, straw and biological yields of mung bean, which were 11.6, 36.5 and 48.1 q/ha , respectively. The lowest harvest index of mung bean (23.26%) was noted under control, whereas, remarkably higher harvest index (24.2%) of mung bean was obtained under 100% RDF + *Rhizobium* but,

it was statistically at par with 75% RDF + *Rhizobium*. Yield attributes were significantly improved with the application of Fe + Mo (0.5% & 0.05% solution) followed by Fe (0.5% solution). Considerably the lowest all the above yield attributes were observed under control (only water spray). Different micronutrient treatments did not exert their significant variation on seed index (1000-grain weight) of mung bean, but numerically higher under Fe + Mo (0.5% & 0.05% solution). Contrasting results were obtained in yield of mung bean due to micronutrient treatments. Significantly the lowest grain yield (6.8 q ha^{-1}), straw yield, (22.5 q ha^{-1}) and biological yield (31.4 q ha^{-1}) were recorded under control. Moreover, Fe + Mo (0.5% & 0.05% solution) was obtained remarkably higher grain, stover and biological yields of mung bean, which were 11.9, 37.2 and 49.2 q ha^{-1} , respectively. Similarly, significantly higher harvest index of mung bean (24.18%) was registered under treatment Fe + Mo (0.5% & 0.05% solution) over control (only water spray).

4. Conclusion

On the perusal of findings, it was observed that the application of 100% RDF + *Rhizobium* and foliar spray of Fe @ 0.5% + Mo @ 0.05% at 25 and 45 DAS, alone or in combination produced the highest grain yield which was supported by significantly higher yield attributes. Therefore, it can be concluded that the application of 100% RDF + *Rhizobium* supplemented with two foliar spray of Iron @ 0.5% + Molybdenum @ 0.05% at 25 and 45 DAS will be beneficial to get the higher grain yield of mung bean (cv IPM-0203) under well drained, sandy loam soil of western UP.

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