Effect of Potassium and Iron Levels on Growth and Yield of Kharif Rice Bean (Vigna umbellata L.)

Padachala Swathi¹, Shikha Singh, M.R. Meshram, K.J. Sanjay, Kimudu Girisha, Dudekula Dileep

ABSTRACT
Background: Rice bean (Vigna umbellata L.) has recently been notified as a promising pulse crop. It is grown for green manure, green fodder and pulses. Potassium plays a major role in increasing the legume yield and yield components, besides provides tolerance to stress such as high-low temperature and drought. Similarly, iron is important for chlorophyll synthesis and is a key component of the nitrogenase enzyme, which is important for nitrogen fixation.

Methods: A field experiment was conducted during kharif season of 2020 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P). India. Study the "Effect of potassium and iron levels on growth and yield of kharif Rice bean (Vigna umbellata L.)." The present experiment was laid out in randomized block design (RBD).

Result: The results revealed that the application of 20 kg K2O/ha + 15 kg Fe/ha recorded maximum plant height (111.17 cm), branches per plant (23.40), nodules per plant at 60 DAS (35.67), plant dry weight (41.33 g/plant), pods per plant (26.20), seeds per pod (7.93), seed yield (1.67 t/ha), stover yield (3.95 t/ha), harvest index (29.69%), net return (Rs 81,155.6/ha) and B: C ratio (2.43). It can be concluded that 20 kg K2O/ha + 15 kg Fe/ha was found more productive as well as economic for Rice bean.

Key words: Growth, Iron, Potassium, Rice bean, Yield.

INTRODUCTION
Rice bean [Vigna umbellata (Thumb.) Ohwi and Ohashii] was originated from Indochina and was domesticated in Thailand and neighboring areas. It is a multipurpose crop considered as a neglected and underutilized it is grown for multi uses, including green manure, green fodder and pulse. In India, rice bean cultivation is popular in the North-Eastern hills, the Eastern and Western Ghats, Punjab, Uttar Pradesh, Rajasthan and parts of Himachal Pradesh (Arora et al., 1980). Rice bean is a versatile legume that can grow in humid subtropical to warm and cool temperature climates. It is suited to areas with annual rainfall ranging from 1000 to 1500 mm but it is also tolerant to drought. Rice bean requires a short day length to produce seeds. It has high yield potential and under good management practices yields of up to 28 q/ha have been recorded (Mukherjee et al., 1980).

As a legume crop, it is effective in Nitrogen fixation in the soils, thus improve the soil fertility that has a positive effect in increasing the production of followed crops. Rice bean offers good scope for increasing pulse production. In addition, it is also a valuable fodder crop. In this sense, cultivation of rice bean is considered to be important in contributing towards food and nutritional security and utilize uncultivated marginal land (Gautam 2007).

Potassium is described as the quality element for crop production. Potassium application increases the pulses pest resistance and improves seed yield and quality (Srinivasarao et al., 2003). Potassium acts like a spark-plug for the activation over 60 enzymes in the plant system. Potassium is a key nutrient in the plants tolerance to stress such as high-low temperature and drought. It has a critical role in osmo-regulation of water use in plants and most importantly controls opening and closing of stomata which affect transpiration cooling and carbon dioxide uptake for photosynthesis (Marschner, 2002). It increase the growth of meristematic tissue, activates some enzymatic reactions, aids in nitrogen metabolism and the synthesis of proteins. Iron is the most important micronutrient for pulse crops. Iron deficiency decreases the nodule formation, nitrogenase activity; it leads less nitrogen in the shoots of legumes and also has a negative impact on crop yield. Considering above points iron application is important for legume crops. The application of Fe singly or in combination with other element in various groups increased pod bearing, branching and test weight of pulses. Iron helps in the formation of chlorophyll...
and it is an important constituent of the enzyme nitrogenase, which is necessary for nitrogen fixation (Yadav et al., 2002). It has an essential role in nucleic acid metabolism, also activates number of enzymes in plant metabolism (Kumar et al., 2009). Therefore the main objectives of present study was to evaluate the effect of potassium and iron levels on growth and yield of *Vigna umbellata* L.

**MATERIALS AND METHODS**

A field experiment was conducted during *kharif* season of 2020 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) which is located at 25°39’42"N latitude, 81°67’56" E longitude and 98 m altitude above the mean sea level. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH7.1) analyzed by using glass electrode pH meter, low in organic carbon (0.28%) by rapid titration method (Sparks, 1996), available nitrogen (225 kg/ha) estimated by alkaline permanganate method by Subbiah and Asija (1956), available phosphorous (19.50 kg/ha) by Olsen’s method (Nelson and Sommer, 1982) and available K (213.7 kg/ha) analyzed by Flame photometry (Jackson, 1973).

**Experimental design and treatment combination**

The present investigation was laid out in randomized block design (RBD) comprised of combinations of three levels of K₂O 10, 20, 30 kg/ha and three levels of Fe i.e. 5, 10 and 15 kg/ha. The source of potassium and iron were MOP and FeSO₄.

**Crop management**

Rice bean variety (RBL-6) sown on 3rd July 2020 at the rate of 35 kg/ha. This variety is resistant to viral, fungal and bacterial diseases. Seeds of this variety are green in colour and are resistant to insect pests. The variety matures within 105 days and gives 1.7 t/ha of average yield. The recommended dose of fertilizer 20-30-20 kg N-P-K/ha. The nutrient sources were Urea, SSP, MOP and FeSO₄ were applied as basal at the time of sowing to fulfill the requirement of Nitrogen, Phosphorous, Potassium and Iron.

Two irrigations were given, first irrigation was given at 15 DAS due to very less rainfall in month of July and the second irrigation was done before flowering stage. One hand weeding was done manually with *khurpi* at 30 DAS. This was done to remove all weeds from the field in order to check any form of initial crop weed competition.

**Statistical analysis**

The data recorded for different characteristics were subjected to statistical analysis by adopting the method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010).

**RESULTS AND DISCUSSION**

**Effect of potassium and iron levels on plant height of rice bean**

The plant height was recorded at 15, 30, 45, 60, 75, 90
DAS and at harvest with increase in crop age the plant height also increased (Table 1). At harvest, highest plant height (111.17 cm) was recorded with application of 20 kg K\textsubscript{2}O/ha + 15 kg Fe/ha which was significantly superior over all the treatments except with application of 20 Kg K\textsubscript{2}O/ha + 10 Kg Fe/ha (109.50 cm) and 30 Kg K\textsubscript{2}O/ha + 15 Kg Fe/ha (107.17 cm) which were statistically at par with 20 kg K\textsubscript{2}O/ha + 15 Kg Fe/ha. Plant height was significantly affected by different levels of potassium and iron levels plays a crucial role in meristematic growth. It may be due to its effect on the synthesis of phyto hormones. Among various plant hormones, cytokinin plays an important role in growth of plant specially plant height. Similar findings have been reported by Brar et al. (2004) and Singh et al. (2016).

Effect of potassium and iron levels on number of branches/plant of rice bean

Number of branches per plant was increased with crop age upto harvest. The number of branches per plant were recorded at 15, 30, 45, 60, 75, 90 DAS and at harvest are tabulated in Table 1. At harvest, maximum number of branches (23.40) was recorded with application of 20 Kg K\textsubscript{2}O/ha + 15 Kg Fe/ha which was significantly superior over all the treatments except with application of 20 Kg K\textsubscript{2}O/ha + 10 Kg Fe/ha (21.80) and 30 Kg K\textsubscript{2}O/ha + 15 Kg Fe/ha (21.67) which were statistically at par with 20 Kg K\textsubscript{2}O/ha +15 Kg Fe/ha. Increase in number of branches/plant might be due to application of potassium which helps cell division and cell expansion and increase the availability of nitrogen and phosphorous resulting in better plant growth and more number of branches /plant. Similar results were also obtained Ali et al. (2007) and Thesiya et al. (2013).

Effect of potassium and iron levels on number of nodules/plant of rice bean

Number of nodules/plant increased with crop age up to 60 DAS and thereafter that it declined upto harvest. The number of nodules/plant embodied in Table 2. That showed at 60 DAS, highest number of nodules per plant (35.67) was observed with application of 20 Kg K\textsubscript{2}O/ha+ 15 Kg Fe/ha which was significantly superior over all the treatments except with application of 20 Kg K\textsubscript{2}O/ha + 10 Kg Fe/ha (33.87) which were statistically at par with 20 Kg K\textsubscript{2}O/ha +15 Kg Fe/ha. Different levels of potassium and iron were significantly influenced on number of nodules per plant were increased from 15-60 DAS. Increase potassium application increased the number of nodulation per plant (Goud et al., 2014). Iron is an essential nutrient for both host legume and root nodule bacteria, whereas limiting quantity have negative impact on nodulation. Iron and potassium has major role on symbiotic nitrogen fixation there by increase in the number of nodules. These findings were also confirmed the results obtained by Saini and Singh (2017).

Effect of potassium and iron levels on plant dry weight of rice bean

Dry weight of plant increased with crop age upto harvest. It was significantly influenced due to application of different

| Treatments | No. of nodules/plant | Plant dry weight (g/plant) |
|------------|----------------------|---------------------------|
| 10 kg K\textsubscript{2}O/ha + 5 kg Fe/ha | 4.60 | 8.67 |
| 20 kg K\textsubscript{2}O/ha + 5 kg Fe/ha | 4.73 | 9.00 |
| 30 kg K\textsubscript{2}O/ha + 5 kg Fe/ha | 6.07 | 10.40 |
| 10 kg K\textsubscript{2}O/ha + 10 kg Fe/ha | 4.47 | 7.60 |
| 30 kg K\textsubscript{2}O/ha + 10 kg Fe/ha | 4.93 | 8.93 |
| 20 kg K\textsubscript{2}O/ha + 15 kg Fe/ha | 4.67 | 9.33 |
| 30 kg K\textsubscript{2}O/ha + 15 kg Fe/ha | 4.80 | 10.13 |
| Se(Em2) | 0.16 | 0.26 |
| CD (P=0.05) | 0.06 | 0.20 |
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levels of potassium and iron except at 15 DAS. Application of 20 Kg K₂O/ha + 15 Kg Fe/ha, recorded maximum plant dry weight at harvest. The increase in plant dry weight might be ascribed to increase in rate of photosynthesis, leaf area and decrease in rate of respiration may be the reason of increase in dry weight of different parts of plants (Kumawat et al., 2005) and also iron helps in assimilates transportation to sinks by this directly influence on dry matter production. This may include increase in carbohydrate synthesis. Similar effect iron was observed in cowpea in sandy loam soil of Kerala by Anitha et al. (2005).

Effect of potassium and iron levels on yield attributes and yield of Rice bean

The yield attributes and yield of rice bean at harvest markedly influenced with potassium and iron (Table 3) represent significantly maximum number of pods/plant (26.20), maximum number of seeds/pod (7.93), maximum seed yield (1.67 t/ha), maximum stover yield (3.95 t/ha) were recorded with application of 20 Kg K₂O/ha + 15 Kg Fe/ha. Maximum harvest index (%) was obtained with application of 20 Kg K₂O/ha + 15Kg Fe/ha (29.69). The increase in yield and yield attributing parameters might be to the application of potassium and iron as basal application. The increase in yield described due to the application of potassium along with iron may be possibly due to increase in availability of soil nutrients and ultimately resulted in vigorous root development. This may be the plant leading to higher photosynthetic activity which results in better development of yield attributes and finally higher seed yield. These results were similar with findings of Burriro et al. (2015).

Effect of potassium and iron levels on economics of Rice bean

Experimental results revealed that different levels of potassium and iron significantly increased the economics of Rice bean. Higher gross (INR 1,14,560.00/ha), net return (INR 81,155.60/ha) and benefit cost ratio (2.43) were recorded with the application of 20 Kg K₂O/ha + 15Kg Fe/ha. The increase in yield and yield attributing parameters might be to the application of potassium and iron as basal application. The increase in yield described due to the application of potassium along with iron may be possibly due to increase in availability of soil nutrients and ultimately resulted in vigorous root development. This may be the plant leading to higher photosynthetic activity which results in better development of yield attributes and finally higher seed yield. These results were similar with findings of Burriro et al. (2015).

CONCLUSION

The findings based on above research trial indicated that potassium and iron gave positive effect on growth and yield of rice bean. The treatment combination 20 kg K₂O/ha + 15 kg/ha Fe was found more productive (1.67 t/ha) as well as economically viable (INR 81,155.60/ha).

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Table 3: Effect of Potassium and Iron Levels on yield attributes, yield and economics of Rice bean.

| Treatments                        | No. of pods/plant | Seed yield index (%) | Harvest index (%) | Stover yield (t/ha) | Seed yield (t/ha) | Seed yield (t/ha) | Gross return (INR/ha) | Net return (INR/ha) | Benefit cost ratio | Total cost of cultivation (INR/ha) |
|-----------------------------------|-------------------|----------------------|-------------------|---------------------|-------------------|-------------------|----------------------|-------------------|-------------------|-----------------------------|
| 10 kg K₂O/ha + 5 kg Fe/ha         | 21.73             | 6.20                 | 1.13              | 3.47                | 3.47              | 24.51             | 31839.10             | 79053.30           | 47214.30           | 31839.10                    |
| 20 kg K₂O/ha + 5 kg Fe/ha         | 23.33             | 6.47                 | 1.33              | 3.37                | 3.37              | 29.10             | 32089.00             | 91873.30           | 59784.40           | 32089.00                    |
| 30 kg K₂O/ha + 5 kg Fe/ha         | 23.40             | 6.24                 | 0.99              | 3.62                | 3.62              | 22.45             | 32338.80             | 72020.00           | 29681.20           | 32338.80                    |
| 10 kg K₂O/ha + 10 kg Fe/ha        | 22.13             | 6.20                 | 1.02              | 3.33                | 3.33              | 23.39             | 32496.60             | 71330.30           | 39333.70           | 32496.60                    |
| 20 kg K₂O/ha + 10 kg Fe/ha        | 25.27             | 6.47                 | 0.97              | 3.45                | 3.45              | 21.64             | 32876.70             | 71330.30           | 59653.60           | 32876.70                    |
| 30 kg K₂O/ha + 10 kg Fe/ha        | 24.27             | 6.93                 | 1.27              | 3.95                | 3.95              | 26.80             | 33154.60             | 87960.00           | 58995.40           | 33154.60                    |
| 10 kg K₂O/ha + 15 kg Fe/ha        | 20.47             | 6.27                 | 1.27              | 3.95                | 3.95              | 24.85             | 33404.50             | 114560.00          | 81155.60           | 33404.50                    |
| 20 kg K₂O/ha + 15 kg Fe/ha        | 26.20             | 7.93                 | 1.67              | 3.60                | 3.60              | 28.38             | 32746.70             | 103800.00          | 71913.30           | 32746.70                    |
| 30 kg K₂O/ha + 15 kg Fe/ha        | 24.87             | 7.67                 | 1.49              | 3.60                | 3.60              | 29.69             | 32996.80             | 68840.00           | 37959.20           | 32996.80                    |
| SEM(±)                            | 0.56              | 0.22                 | 0.37              | NS                  | 0.22              | 1.43              | 4.24                 | 1.43              | 1.43              | 4.24                        |

Note: Minimum support price of grain 64.00 Rs/kg and stover 2.00 Rs/kg
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