Maximizing Productivity and Profitability of Green Gram (*Vigna radiata* L.) through Fertility Levels and Bio fertilizers

ABSTRACT

A field experiment was conducted at the Crop Research Centre, School of Agriculture, ITM University Gwalior (M.P.) during the Kharif season of 2023 to evaluate the maximizing productivity and profitability of green gram (*Vigna radiata* L.) through fertility levels and biofertilizers. The experiment was laid out in a randomized block design with 10 treatmentcombinationsand each treatment was replicated thrice. The results revealed that the application of 100% RDF + RSI (10 g kg^{-1}) + PSB & KSB (5 kg ha^{-1} each) had significantly improved the growth attributes viz., Plant height, number of branches, dry matter accumulation, Leaf area index and number of nodules $plant^{-1}$ of green gram over rest of the treatments. However, the higher grain yield (1424.71 kg ha^{-1}), straw yield (3206.13 kg ha^{-1})and biological (4630.84 kg ha^{-1}) yield was recorded with the treatment 100% RDF + RSI (10 g kg^{-1}) + PSB & KSB (5 kg ha^{-1} each) which was being at par with 100% RDF + RSI (10 g kg^{-1}) + PSB 5 kg ha^{-1} soil application,while the lowest grain yield and straw yield wererecorded in control.

Key words: Green gram, Rhizobium, KSB, NPK,PSBand yield.

INTRODUCTION

Green gram is a unique leguminous crop that plays an important role in agriculture and nutrition. Because of its great nutritional value and capacity to adapt to a variety of climates, this humble but adaptable plant has been cultivated for centuries around the world, especially in Asia and Africa. Green gram has the capacity to fix nitrogen in the soil and it is not only a staple food for millions of people but also an essential part of sustainable farming operations. The green gram is a very nutrient-dense legume with several health advantages. A 100-gram serving of cooked and boiled green gram without salt provides approximately 105 calories, 7.02 grams of protein, and 19.15 grams of carbohydrates and 7.6 grams of dietary fiber. This nutritional powerhouse is prized for its high protein content, making it an excellent plant-based protein source for vegetarians and vegans. Additionally, it contains essential vitamins and minerals, including vitamin C, thiamin (B1), riboflavin (B2), folate (B9), iron, magnesium, and potassium, which are vital for overall health. Its richness in dietary fiber further supports digestion. The green gram's versatility and exceptional nutrient profile make it a valuable addition to a balanced diet. Globally, green gram was grown on a total area of 7.5 million hectares during 2022–23. India holds the distinction of being the largest producer of green gram, accounting for 65% of the global cultivation area and 54% of production Kumari et al., (2023). The crop occupies approximately 4.34 million hectares in India, resulting in a production of 2.12 million metric tons and a productivity rate of 489 kg per hectare Anonymous, (2020). Madhya Pradesh, a key state in India for green gram cultivation, dedicates around 0.4 million hectares to its cultivation. The state contributes a substantial portion of India's production, ranging from about 0.2 to 0.3 million metric tons annually. Productivity in Madhya Pradesh, like in other parts of India, falls within the range of 500 to 700 kg per hectare, influenced by various factors, including weather conditions and farming practices Anonymous, (2022). Rhizobium is a soil bacterium that plays a crucial role in the growth of green gram, which helps in nitrogen fixation, root nodule formation and promoting soil fertility.According to Rajkhowa *et al.* (2003) and Gull *et al.* (2004), phosphorus-solubilising bacteria (PSB) play a crucial role in converting chemically fixed insoluble phosphate into a form that plants can readily utilize. Higher agricultural yields are the result of this conversion process.Similarly, potassium and zinc solubilising bacteria are responsible for mobilizing potassium and zinc in the soil, thereby promoting higher yields in green gram crops. Rhizobium, KSB, and PSB are used in combination their effects synergize to create a powerful and harmonious impact on green gram cultivation. The result is not only higher yields, with increased biomass and more extensive root systems, but also improved disease resistance and overall plant health. Moreover, this integrated approach aligns with sustainable agriculture practices by reducing the reliance on synthetic fertilizers and contributing to environmentally friendly and resource-efficient farming methods.

MATERIALS AND METHODS

A field experiment was conducted during the kharifseason of 2023 at CRC-1, School of Agriculture, ITM University Gwalior (M.P.), which is situated at (26.1378▪ N, 78.2082▪ E and at an altitude of about 197 m above mean sea level). The soil texture of the experimental field was sandy loam, with a bulk density of 1.52 mg m^{-3}, pH of 7.78, EC 0.44 ds m^{-1} and an organic carbon content of 0.43%. The soil contains 198.6 kg ha^{-1} nitrogen, 15.85 kg ha^{-1} phosphorus and 229.6 kg ha^{-1} potassium. The experiment was laid out in a randomized block design with ten treatments, which includes RDF (100%) Control, 100% RDF (20:40:20), 100% RDF + RSI (10 g kg^{-1}), 100% RDF + RSI at (10 g kg^{-1}), 100% RDF + RSI (10 g kg^{-1}) + PSB 5 kg ha^{-1} soil application, 100% RDF + RSI (10 g kg^{-1}) + KSB 5 kg ha^{-1} soil application, 100% RDF + RSI (10 g kg^{-1}) + PSB & KSB (5 kg ha^{-1} each), 75% RDF + RSI (10 g kg^{-1}) + PSB (5 kg ha^{-1} soil application), 75% RDF + RSI (10 g kg^{-1}) + KSB 5 kg ha^{-1} (soil application) and 75% RDF + RSI (15 g kg^{-1}) + PSB + KSB

(5kg have each),and replicated thrice. The mean rainfall and evaporation during the crop period were 166 mm and 252 mm, respectively, from July to September. The mean morning and evening relative humidity are nearly constant at over 84.9% and 61.27%, respectively, while the mean temperature minimum and maximum are nearly constant at over 25.990 °C and 34.220 °C during the crop period, respectively. The recommended doses of nutrients were supplied through urea, di-ammonium phosphate and muriate of potash. A starter dose of nitrogen and a full dose of phosphorus and potassium as per treatment were applied at sowing time. Seeds were treated with biofertilizers (Rhizobium, PSB, and KSB) as per standard procedure and were sown after drying for six hours under shade. Moong bean cultivar "PDM-139" was sown at 30 cm × 10 cm spacing during the last week of July with a seed rate of 15 kg ha^{-1}.

Result and Discussion

Growth attributes:

The experimental data reveals that the plant height (cm), number of branches $plant^{-1}$, dry matter accumulation (g m^{-2}) number of nodules $plant^{-1}$and leaf area index (LAI) were significantly affected due to different treatments. However, the application of100% RDF + RSI (10 g kg^{-1}) + PSB & KSB (5 kg ha^{-1} each)recorded significantly higherplant height (53.53 cm), number of branches $plant^{-1}$ (12.08), dry matter accumulation (309.22 g m^{-2}), number of nodules $plant^{-1}$ (65.85) and leaf area index (5.02) which was found at par with100% RDF + RSI (10 g kg^{-1}) + PSB 5 kg ha^{-1} soil applicationcompared to all the treatments. The significantly lower growth parameters were recorded with the control. This may be due to the application of PSB + Rhizobium, which will help to increases the availability of nutrients like nitrogen, phosphorus and potassium. The increased nutritional availability resulted in an increase in physiological processes such as cell elongation, cell division and the creation of meristematic tissues, which will help to improve growth characteristics. Similarresults were also reported by Dongare *et al.* (2016),Hussain *et al.* (2011) and Singh and Kumar (2016).

Table 1: Growth parameters of green gram as influenced by fertility levels and bio fertilizer

Treatments	Plant height (cm)	No. of Branches/plant	Dry matter accumulation (g/m^2)	No. of Nodules/plant	Leaf Area Index
T_1	31.22	7.1	240.22	40.05	3.15

T_2	40.27	8.72	265.99	53.51	3.72
T_3	40.68	8.81	285.01	56.08	3.76
T_4	46.03	10.44	293.35	62.75	4.1
T_5	52.29	12.05	299.74	64.32	4.61
T_6	45.43	10.3	293.03	62.02	4.08
T_7	53.53	12.08	309.22	65.85	5.02
T_8	45.38	9.8	289.95	61.96	4.03
T_9	44.93	9.1	285.87	61.41	3.82
T_{10}	45.13	9.29	287.93	61.64	3.85
SE(m)±	1.99	0.54	5.23	0.74	0.18
C.D.	5.92	1.61	15.55	2.21	0.55

Yield and Yield attributes:

The higher number of pods plant^{-1}(39.14), Pod length (4.49 cm), number of seeds pod^{-1}(9.34), grain yield (1424.71 kg ha^{-1}), strove yield (3206.13 kg ha^{-1}) and biological yield (4630.84 kg ha^{-1}) were recorded with the application 100% RDF + RSI (10 g kg^{-1}) + PSB & KSB (5 kg ha^{-1} each)and found at par with 100% RDF + RSI (10 g kg^{-1}) + PSB 5 kg ha^{-1} soil applicationcompared to all the treatments. However, control recorded a lower number of pods plant^{-1}, pod length, number of seeds pod^{-1}, grain yield, strove yield and biological yield. An increase in yield and yield attributes in the present investigation mainly due to the enhanced availability of nitrogen and phosphorus resulted in a well-developed root system with higher nitrogen-fixing capacity, resulting in better plant development and better photosynthate diversion to sink development. The grain and straw yield of green gram significantly increased where the seed was inoculated with PSB + Rhizobium. Plant height, number of branches per plant, leaf area index (LAI), dry matter accumulation per plant in various plant parts, number of pods per plant, number of grains per pod and test weight (1000 seed weight) all increased significantly with bio-fertilizers. Similar findings were also found by Yadav *et al.* (2007), Hussain *et al.* (2011), Khandelwal *et al.* (2012) and Bahadur and Tiwari (2014).

Table 2: Yield attributes and yields of green gram influenced by fertility levels and bio fertilizer

Treatment	No. ofpods/plant	Pod length (cm)	Seeds/pod	Yield (kg/ha)		
				Grain	**Strove**	**Biological**
T_1	28.31	2.43	4.63	900.08	1665.69	2565.77
T_2	34.58	3.05	6.19	1066.54	2023.02	3089.56

T_3	34.87	3.08	6.28	1086.25	2099.54	3185.79
T_4	38.11	3.99	7.74	1207.8	2592.54	3800.34
T_5	38.14	4.47	9.19	1371.21	2934.38	4305.59
T_6	37.88	3.95	7.52	1145.35	2514.86	3660.21
T_7	39.14	4.49	9.34	1424.71	3206.13	4630.84
T_8	37.43	3.55	7.21	1124.66	2418.74	3543.4
T_9	35.44	3.29	6.92	1100.05	2236.12	3336.17
T_{10}	35.74	3.52	7.01	1117.56	2324.75	3442.31
SE(m)±	0.34	0.16	0.5	50.07	111.66	135.1
C.D.	1.02	0.49	1.48	148.78	331.75	401.58

Conclusion:

On the basis of the experimental findings, it can be concluded that the application of 100% RDF + RSI (10 g kg^{-1}) + PSB 5 kg ha^{-1} soil application resulted in higher plant height (cm), number of branches $plant^{-1}$, dry matter accumulation (g m^{-2}) number of nodules $plant^{-1}$ and leaf area index (LAI), number of pods $plant^{-1}$, pod length, number of seeds pod^{-1}, grain yield, strove yield and biological yield over rest of the treatments.

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