



(RESEARCH ARTICLE)



Effect of Fertility Levels, Biofertilizers and Stress Mitigating Chemicals on Nutrient status of plant and soil and Economics of Mungbean (*Vigna radiata* L.)

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Abstract

A two-year field study was conducted during the *khariif* seasons of 2023 and 2024 in Jaipur, Rajasthan, to evaluate the effect of fertility levels, biofertilizers and stress mitigating chemicals on nutrient status of plant and soil and economics of mungbean [*Vigna radiata* (L.) Wilczek]. The experiment was laid out in a split-plot design with three replications, comprising 36 treatment combinations. Main plots received four fertility levels: control, 50%, 75%, and 100% of the recommended dose of fertilizer (RDF). Sub-plots were assigned nine combinations of biofertilizers (*Rhizobium*, phosphate-solubilizing bacteria (PSB) and stress-mitigating foliar sprays of thiourea (500 ppm) or salicylic acid (200 ppm).

Pooled analysis revealed that 100% RDF resulted in the highest grain protein content (25.29%), protein yield (228.67 kg ha⁻¹), and maximum nitrogen, phosphorus, and potassium (NPK) concentration and uptake. Economically, 100% RDF generated the greatest gross returns (₹77,778 ha⁻¹) and net returns (₹49,352 ha⁻¹), which were statistically at par with the 75% RDF treatment. However, the highest benefit-cost (B:C) ratio of 1.81 was recorded under 75% RDF, statistically comparable to the 100% RDF level.

Among sub-plot treatments, the integrated application of *Rhizobium* + PSB + salicylic acid (200 ppm) proved most effective, yielding the highest seed protein content (24.98%), protein yield (224.76 kg ha⁻¹), NPK uptake, and economic returns, including a peak B:C ratio of 1.93. These outcomes were statistically equivalent to those obtained with *Rhizobium* + PSB + thiourea (500 ppm). The study demonstrates that while 100% RDF maximizes productivity, 75% RDF offers better economic efficiency, and supplementing *Rhizobium* and PSB with either salicylic acid or thiourea synergistically enhances crop performance and profitability in mungbean.

Keywords: Mungbean; *Rhizobium*; Biofertilizers; Salicylic acid; Benefit-cost ratio; Split-plot design

1. Introduction

Mungbean (*Vigna radiata* (L.) Wilczek) ranks as the third most important pulse crop in India, following chickpea and pigeonpea. It is predominantly cultivated in the country's arid and semi-arid zones (Kumawat *et al.*, 2009). In India, mungbean is about 14% of the total area under pulse cultivation and contributes nearly 7% to the overall pulse production, with a usual yield of 363 kg per hectare (Singh *et al.*, 2014). Mungbean is cultivated yearly, though the largest area is covered during the *khariif* season. However, with increasing awareness of its benefits, the area under summer mungbean cultivation is steadily rising. In certain production zones, farmers utilize mungbean as a summer

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green manure crop to enhance soil fertility. Nutritionally, mungbean contains about 25–28% protein, 1.0–1.5% fat, 3.5–4.5% fiber, and 60–65% carbohydrates. It is also rich in lysine, ascorbic acid, potassium, iron (Fe), phosphorus (P), and calcium (Ca), making it highly nutritious with notable antioxidant properties. Owing to its high digestibility, palatability, and good market value, mungbean plays a significant role in strengthening India agricultural economy (Singh *et al.*, 2013).

Fertilizers are among the most vital inputs in modern agriculture, crucial for enhancing crop growth and productivity. Although legumes generally require less nitrogen than phosphorus, both nutrients are essential for realizing the full genetic potential of the crop. The application of nitrogen and phosphorus, either individually or together, has a significant impact on boosting yield and improving the quality of mungbean (Meena *et al.*, 2014). Nitrogen is an essential macronutrient, serving as a fundamental constituent of proteins and chlorophyll while playing a critical role in numerous plant metabolic pathways. Phosphorus, an integral part of nucleic acids, promotes root development and enhances nodule formation and activity in legumes. On the other hand, biofertilizers have gained importance as an eco-friendly and sustainable alternative. They are not only economically viable but also improve soil health and environmental quality over time. For small and medium-scale farmers, biofertilizers serve as an efficient and cost-effective option compared to conventional chemical fertilizers (Mishra *et al.*, 2013). Biofertilizers consist of beneficial microorganisms such as bacteria, fungi, and algae that act differently from chemical fertilizers. Their primary function is to enhance soil fertility by fixing atmospheric nitrogen into forms that plants can absorb and by improving the accessibility of essential nutrients in the soil. This eco-friendly method boosts crop productivity while maintaining soil health, avoiding the environmental degradation and soil imbalance often caused by excessive use of chemical fertilizers (Sood *et al.*, 2023).

The use of stress-alleviating chemicals has significant role in enhancing crop tolerance to unfavourable environmental conditions. Thiourea, a sulfur-containing compound with a –SH (sulfhydryl) group, is recognized for its strong bioefficacy in plants. The foliar application of thiourea promotes plant growth, improves physiological efficiency, and enhances dry matter partitioning, contributing to increased grain yield (Sarita *et al.*, 2019). Salicylic acid (SA), an endogenous phenolic phytohormone, acts as a critical signalling molecule in the induction of abiotic stress tolerance. It is integral to the regulation of developmental processes and the uptake and translocation of ions. The beneficial physiological effects of SA are primarily attributed to its role in augmenting CO₂ assimilation, enhancing photosynthetic efficiency, and improving mineral nutrient uptake under stress conditions (Kumawat *et al.*, 2014). These signalling molecules trigger multiple signal transduction pathways that help plants cope with and recover from stress conditions. However, the precise physiological and biochemical mechanisms through which salicylic acid (SA) enhances plant tolerance to adverse environments are not yet fully understood. Integrating such stress-mitigating compounds with appropriate fertilizer regimes may offer an effective management approach to improve crop resilience and productivity. This is particularly important under conditions of limited soil moisture or unpredictable weather, where crop responses to fertilizer application can vary significantly (Lakhana *et al.*, 2005). Thiourea functions as an effective bioregulator, demonstrating significant potential to enhance crop productivity under abiotic stresses like high temperature and drought. Its positive impact on seed yield and associated traits under such conditions is well-established (Kumawat *et al.*, 2014).

2. Materials and Methods

A field experiment was conducted during the *khari* seasons of 2023 and 2024 at the Agricultural Research Farm of the School of Agriculture, Suresh Gyan Vihar University, located in Jaipur, India. The soil at the experimental site was classified as loamy in texture. Initial soil analysis for the two consecutive years revealed a pH of 8.3 and 8.2, organic carbon content of 0.14% and 0.13%, and the following available nutrient status: nitrogen (126.5 and 128.5 kg ha⁻¹), phosphorus (16.7 and 17.2 kg ha⁻¹), potassium (176.6 and 178.2 kg ha⁻¹), and sulfur (8.47 and 9.40 mg kg⁻¹ soil), respectively. The study was laid out in a split-plot design with three replications, comprising 36 treatment combinations in total. Four fertility levels were assigned to the main plots: (i) control (no fertilizer), (ii) 50% of the recommended dose of fertilizer (RDF), (iii) 75% RDF, and (iv) 100% RDF. Nine treatments involving biofertilizers and stress-mitigating chemicals were randomized in the sub-plots: (i) *Rhizobium*, (ii) *Rhizobium* + thiourea (500 ppm), (iii) *Rhizobium* + salicylic acid (200 ppm), (iv) Phosphate-solubilizing bacteria (PSB), (v) PSB + thiourea (500 ppm), (vi) PSB + salicylic acid (200 ppm), (vii) *Rhizobium* + PSB (viii) *Rhizobium* + PSB + thiourea (500 ppm) and (ix) *Rhizobium* + PSB + salicylic acid (200 ppm). The mungbean variety 'RMG 975' was sown at a seed rate of 20 kg ha⁻¹ using a spacing of between 30 cm rows and 10 cm plants. The proposed dose of NPKS 20-50-50-25 kg ha⁻¹ were used via urea, Diammonium phosphate (DAP), muriate of potash (MOP), and elemental S, respectively. Crop was grown totally based on rainfall. The foliar application of Thiourea solution of 500 mg L⁻¹ and Salicylic acid 200 mg L⁻¹ was applied at flower initiation and pod formation stage. Knapsack sprayer with a flat fan nozzle was used for foliar application. To control the attack of insects, application of insecticides such as 0.5% monocrotophos @1.5 ml litre⁻¹ water and chloropyriphos 50% @ 2 ml litre⁻¹

water, respectively. All recommended agronomic practices, excluding the experimental variables, were maintained uniformly across all plots.

3. Results and Discussion

3.1. Nutrient status of plant and soil

3.1.1. Effect of Fertility Levels

Data revealed that maximum protein content (25.29%) and its yield (228.67 kg ha⁻¹) were observed when 100% RDF used followed by application of 75% RDF in pooled analysis (Fig. 1). The increase in protein content due to fertility levels improved the nitrogen content of the mungbean. Similarly, protein yield, a product of seed yield and seed protein content, exhibited a comparable increase with higher fertility application. These results align with earlier findings in mungbean (Singh and Pareek, 2003) and green gram (Yakadri *et al.*, 2004). Furthermore, progressive fertility levels significantly enhanced the concentration (%) and total uptake (kg ha⁻¹) of nitrogen, phosphorus, and potassium in both seed and straw across individual years and pooled data (Table 1). The maximum nutrient content [N (4.04 % in grain; 1.52 % in straw); P (0.472 % in grain; 0.220 % in straw); K (0.810 % in grain; 1.70 % in straw)]; and their uptake [N (36.59 kg ha⁻¹ by grain; 32.25 kg ha⁻¹ by straw); P (4.27 kg ha⁻¹ by grain; 4.66 kg ha⁻¹ by straw); K (7.34 kg ha⁻¹ by grain; 36.02 kg ha⁻¹ by straw) were recorded significantly with the application of 100 % RDF which remained at par with the application of 75 % RDF in pooled analysis. This enhancement is likely due to an improved nutrient environment in the rhizosphere and plant system, which promotes the efficient translocation of nitrogen (N), phosphorus (P), and potassium (K) to various plant tissues. Since nutrient uptake is a function of both tissue nutrient concentration and biomass production, the increased uptake observed can be attributed to the positive influence of N and P fertilization on crop growth and yield. These findings are consistent with previous reports in green gram (Mondal *et al.*, 2005) and in urdbean and mungbean (Srinivasarao and Ali, 2006).

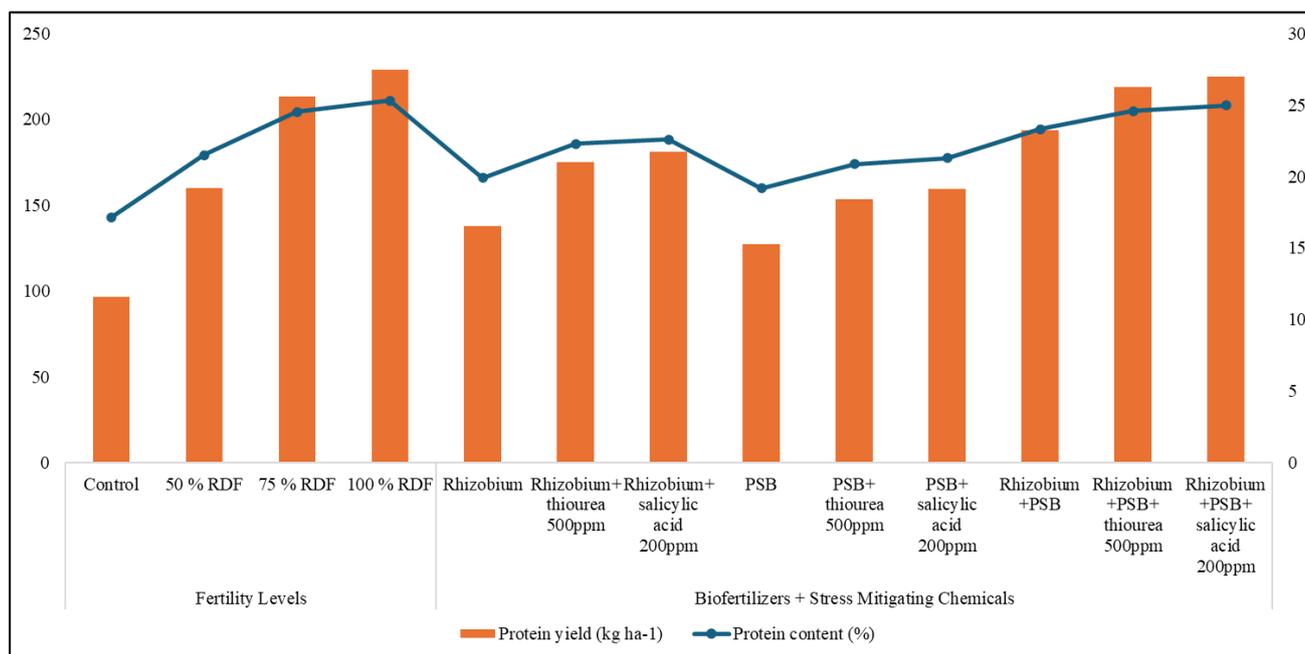


Figure 1 Effect of fertility levels, biofertilizers and stress mitigating chemicals on protein content (%) and protein yield (kg/ha) of mungbean (Pooled)

Table 1 Effect of fertility levels, biofertilizers and stress mitigating chemicals on Nutrient content and their uptake by mungbean (Pooled)

Treatment	N content (%)		N uptake (kg ha ⁻¹)		P content (%)		P uptake (kg ha ⁻¹)		K content (%)		K uptake (kg ha ⁻¹)	
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Fertility Levels												
Control	2.74	1.03	15.46	17.46	0.320	0.149	1.81	2.52	0.550	1.16	3.10	19.53
50 % RDF	3.44	1.30	25.57	25.02	0.402	0.187	2.99	3.61	0.689	1.45	5.13	27.96
75 % RDF	3.92	1.48	34.11	30.68	0.458	0.214	3.98	4.43	0.786	1.65	6.84	34.27
100 % RDF	4.04	1.52	36.59	32.25	0.472	0.220	4.27	4.66	0.810	1.70	7.34	36.02
SEm±	0.03	0.01	0.48	0.42	0.004	0.002	0.06	0.06	0.006	0.01	0.10	0.47
CD (P=0.05)	0.10	0.04	1.48	1.31	0.012	0.005	0.17	0.19	0.019	0.04	0.30	1.46
Biofertilizers + Stress Mitigating Chemicals												
<i>Rhizobium</i>	3.18	1.20	22.02	22.53	0.372	0.173	2.57	3.25	0.638	1.34	4.42	25.18
<i>Rhizobium</i> + thiourea 500ppm	3.56	1.34	28.03	26.49	0.416	0.194	3.27	3.82	0.715	1.50	5.62	29.60
<i>Rhizobium</i> + salicylic acid 200ppm	3.62	1.36	28.98	27.09	0.422	0.197	3.39	3.91	0.725	1.52	5.81	30.27
PSB	3.07	1.16	20.33	21.39	0.358	0.167	2.37	3.09	0.615	1.29	4.08	23.92
PSB+ thiourea 500ppm	3.34	1.26	24.53	24.25	0.390	0.182	2.87	3.50	0.670	1.41	4.92	27.10
PSB+ salicylic acid 200ppm	3.41	1.29	25.50	24.85	0.398	0.186	2.98	3.59	0.683	1.44	5.12	27.77
<i>Rhizobium</i> +PSB	3.73	1.41	31.00	28.36	0.436	0.203	3.62	4.09	0.747	1.57	6.22	31.69
<i>Rhizobium</i> +PSB+ thiourea 500ppm	3.93	1.48	35.03	30.86	0.459	0.214	4.09	4.45	0.788	1.66	7.02	34.47
<i>Rhizobium</i> +PSB+ salicylic acid 200ppm	3.98	1.50	35.96	31.37	0.465	0.217	4.20	4.53	0.799	1.68	7.21	35.04
SEm±	0.02	0.01	0.33	0.22	0.002	0.001	0.04	0.03	0.004	0.008	0.07	0.24
CD (P=0.05)	0.05	0.02	0.94	0.60	0.007	0.003	0.11	0.09	0.011	0.022	0.19	0.68

Furthermore, the different levels of fertility significantly enhanced the available nutrient (kg ha⁻¹) viz., NPKS after harvest of the mungbean (Fig. 2). The maximum available nutrient (219.40 kg ha⁻¹ N; 17.55 kg ha⁻¹ P; 224.70 kg ha⁻¹ K and 21.38 mg kg⁻¹ S) were observed with the use of 100% RDF which was almost same as 75% RDF in pooled analysis. The result of the current research is in views of reports of Sasode (2008) in green gram and Rathore *et al.* (2015) in urdbean.

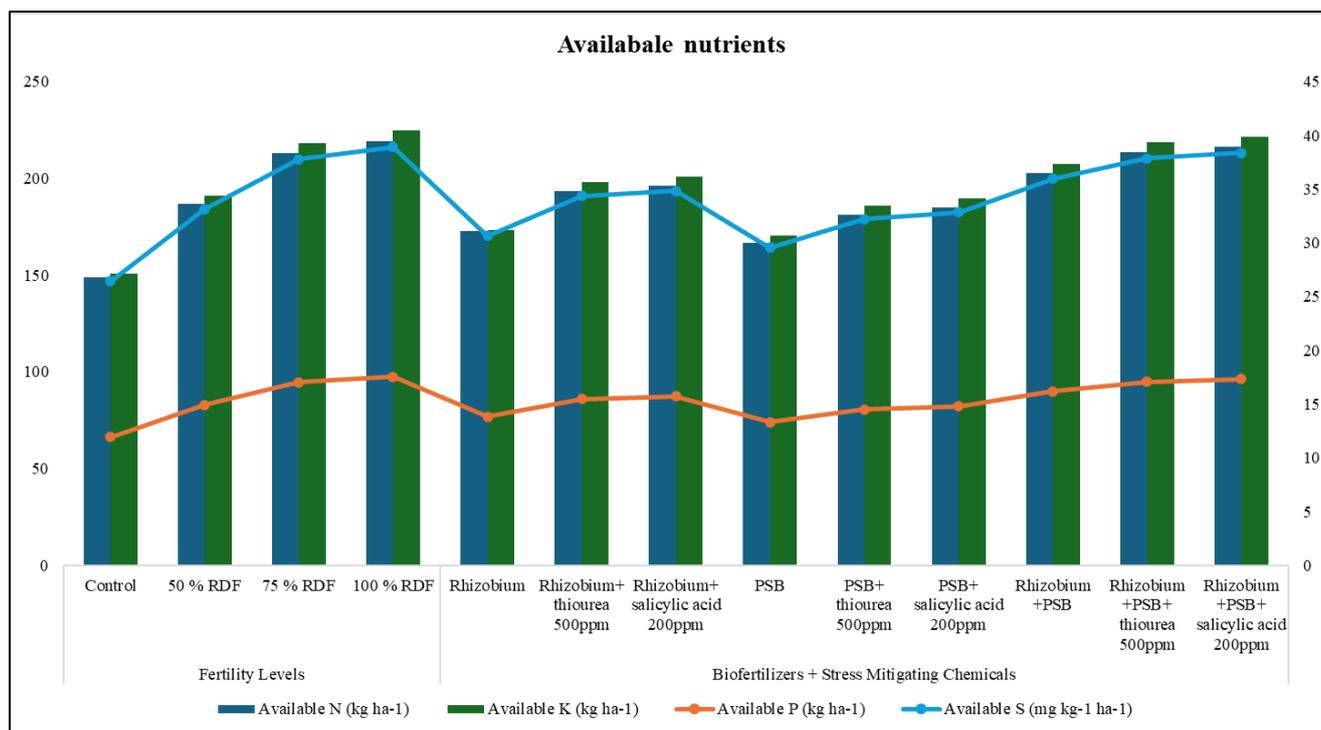


Figure 2 Effect of fertility levels, biofertilizers and stress mitigating chemicals on available nutrients after harvest of mungbean (pooled)

3.1.2. Effect of biofertilizers and stress mitigating chemicals

The application of various biofertilizer and stress-mitigating chemical treatments significantly improved seed quality parameters, notably protein content (%) and protein yield (kg ha⁻¹). Across both experimental years and in the pooled analysis, the highest values for grain protein content, protein yield, nitrogen (N), phosphorus (P), and potassium (K) concentration in grain and straw, as well as their total accumulation, were recorded with the combined treatment of *Rhizobium* + PSB + salicylic acid (200 ppm). This was closely followed by the treatment consisting of *Rhizobium* + PSB + thiourea (500 ppm). The increase in protein content due to the *Rhizobium* improved the nitrogen content of the mungbean. Further, the protein production, which is a function of seed yield and protein content in seed recorded a similar increase with application of *Rhizobium* +PSB+ salicylic acid 200 ppm. Seed inoculation with *Rhizobium* and phosphate-solubilizing bacteria (PSB) significantly increased nitrogen and phosphorus concentrations in both grain and straw. This improvement can be attributed to enhanced biological nitrogen fixation facilitated by *Rhizobium*, which subsequently promotes greater nutrient absorption and assimilation by the plant. Consequently, higher N and P accumulation was observed in the crop. Nutrient uptake and removal, however, depend on the complex interaction between soil conditions, crop genotype, and the type and quantity of nutrients supplied (Prasad *et al.*, 2014 and Pramanik *et al.*, 2014). The beneficial effects of salicylic acid (SA) can be linked to its ability to enhance CO₂ assimilation, improve the photosynthetic rate, and increase mineral uptake in plants subjected to stress. In response to environmental stresses, plants produce various signalling molecules that initiate complex signal transduction pathways. Some of these pathways help activate defence mechanisms and physiological adjustments that enable the plant to tolerate and recover from stress conditions. The findings of this study align with previous research by Kuttimani and Velayutham (2011) on green gram.

The combined application of biofertilizers and stress-mitigating chemicals significantly increased the post-harvest soil availability (kg ha⁻¹) of nitrogen, phosphorus, potassium, and sulfur (NPKS) in the mungbean crop (Fig. 2). The maximum available nutrient (216.32 kg ha⁻¹ N; 17.31 kg ha⁻¹ P; 221.55 kg ha⁻¹ K and 21.08 mg kg⁻¹ S) were observed with the application of *Rhizobium* +PSB+ salicylic acid 200 ppm followed by the next superior treatment *i.e.* the application of *Rhizobium* +PSB+ thiourea 500 ppm in pooled analysis. This improvement likely stems from atmospheric nitrogen fixation by *Rhizobium* bacteria, coupled with the gradual solubilization and release of phosphorus facilitated by phosphate-solubilizing bacteria (PSB) and applied phosphorus fertilizers. The synergistic effect of these biological and chemical processes appears to have progressively increased the pool of plant-available phosphorus in the soil (Pir *et al.*, 2009). These results are consistent with previous findings in groundnut (Singh *et al.*, 2018) and fenugreek (Leila *et al.*, 2014).

3.2. Economics

3.2.1. Effect of fertility Levels

The results indicated that the application of 100% RDF generated the highest gross returns (₹77,778 ha⁻¹) and net returns (₹49,352 ha⁻¹), which were statistically comparable to those from the 75% RDF treatment in the pooled analysis. However, the maximum benefit-cost (B:C) ratio of 1.81 was achieved with 75% RDF, a value equivalent to that of the 100% RDF application (Table 2). This superior economic return from 100% RDF can be attributed to its positive effect on yield attributes and overall grain yield. These findings align with previous studies in mungbean (Hussain *et al.*, 2012), green gram (Rathour *et al.*, 2015; Dongare *et al.*, 2016), and kabuli chickpea (Singh *et al.*, 2022).

Table 2 Effect of fertility levels, biofertilizers and stress mitigating chemicals on economics of mungbean (pooled)

Treatment	Gross Return (₹ ha ⁻¹)	Net Return (₹ ha ⁻¹)	B:C Ratio
Fertility Levels			
Control	50141	28612	1.33
50 % RDF	65024	39829	1.58
75 % RDF	75283	48457	1.81
100 % RDF	77778	49352	1.73
SEm±	580	580	0.02
CD (P=0.05)	1786	1786	0.06
Biofertilizers + Stress Mitigating Chemicals			
<i>Rhizobium</i>	59627	34605	1.36
<i>Rhizobium</i> + thiourea 500ppm	67637	42115	1.64
<i>Rhizobium</i> + salicylic acid 200ppm	68737	42867	1.64
PSB	57237	32175	1.26
PSB+ thiourea 500ppm	62977	37515	1.46
PSB+ salicylic acid 200ppm	64356	38546	1.48
<i>Rhizobium</i> +PSB	71151	45969	1.81
<i>Rhizobium</i> +PSB+ thiourea 500ppm	75346	49764	1.92
<i>Rhizobium</i> +PSB+ salicylic acid 200ppm	76440	50510	1.93
SEm±	393	393	0.01
CD (P=0.05)	1100	1100	0.04

3.2.2. Effect of biofertilizers and stress mitigating chemical

The integrated application of biofertilizers and stress-mitigating chemicals significantly improved the economic returns including gross returns (₹ ha⁻¹), net returns (₹ ha⁻¹), and benefit-cost (B: C) ratio in the pooled analysis of mungbean (Table 2). The highest values for gross returns (₹76,440 ha⁻¹), net returns (₹50,510 ha⁻¹), and B:C ratio (1.93) were recorded with the treatment combining *Rhizobium* + PSB + salicylic acid (200 ppm), which performed comparably to the *Rhizobium* + PSB + thiourea (500 ppm) treatment across both years and in the pooled data. This economic advantage likely resulted from the superior yield attributes and overall productivity achieved with the *Rhizobium* + PSB + salicylic acid (200 ppm) application. These observations are consistent with earlier reports in Indian mustard (Bharat *et al.*, 2016), mungbean (Verma *et al.*, 2017), and green gram (Devi, 2015).

4. Conclusion

Based on this two-year study, it can be concluded that a fertility regime of 100% RDF, combined with the bio-stimulant treatment of *Rhizobium* + PSB + salicylic acid (200 ppm), constitutes an optimal integrated management strategy for mungbean cultivation. This combination maximized grain quality (protein content and yield), enhanced nutrient uptake (N, P, K), and delivered the highest economic returns in terms of gross and net income, alongside a superior benefit-cost ratio. While 100% RDF alone maximized absolute yields, 75% RDF proved more cost-effective. The dual biofertilizer inoculation (*Rhizobium* + PSB) with salicylic acid (or, alternatively, thiourea) consistently enhanced crop performance under both fertility levels, demonstrating the value of combining balanced fertilization with biological and chemical stress mitigation to improve productivity, nutrient efficiency, and farm profitability in mungbean.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

- [1] Ali, E.A. and Mahmoud, A.M. 2013. Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mungbean in sandy soil. *Asian Journal of Crop Science* 5 (1): 33-40.
- [2] Bharat, R. Samanta, A. Bazaya, B.R. Sharma, V. Gupta, M. Kour, S. Arya, V and Rai, P.K. 2016. Management of moisture stress in India mustard (*Brassica juncea* L.) under sub-tropical rainfed condition of north India. *The Ecoscan* 10(3&4): 443&447.
- [3] Devi, S., Patel, P.T. and Choudhary, K.M. 2015. Effect of SH- compounds on yield, protein and economics of summer greengram [*Vigna radiata* (L.) Wilczek] under moisture stress in north Gujarat conditions. *Legume Research* 38(4): 542-545.
- [4] Dongare, D.M., Pawar, G.R., Murumkar, S.B. and Chavan, D.A. 2016. To study the effect of different fertilizer and biofertilizer levels on growth and yield of summer greengram. *International Journal of Agricultural Sciences* 12(2):151-157.
- [5] Hussain, A., Ali, A. and Noorka, I. R. 2012. Phosphorus and rhizobium effect on nitrogen and phosphorus uptake in mungbean. *Journal of Agricultural Research* 50(1): 25-30.
- [6] Kumawat K., Shivran A.C. and kumawat, P. 2014. Effect of bioregulators and phosphorus on yield, economics, nutrient uptake and quality of mothbean [*Vigna aconitifolia* (jacq.) Marechal]. *Annals of Biology* 30(1): 98-101.
- [7] Kumawat, N., Sharma, O.P., Kumar, R. and Kumari, A., 2009. Response of organic manures, PSB and phosphorus fertilization on growth and yield of mungbean. *Environment and Ecology* 27 (4B): 2024-2027.
- [8] Kuttimani, R. and Velayutham, A. 2011. Foliar application of nutrients and growth regulators on yield and economics of greengram. *Madras Agricultural Journal* 98(4): 141-143.
- [9] Lakhana, R.C., Gupta, A.K., Shivran, A.C. and Shivran, R.K. 2005. Role of thiourea in improving the dry matter partitioning, yield and quality of pearl millet [*Pennisetum glaucum* (L.) R Br. emend. Stuntz]. *Annals of Agricultural Research* 26 (2): 218-223.
- [10] Leila, H.B.A., Leithy, S.M. and Gaballah, M.S. 2014. Role of exogenous salicylic acid on fenugreek [*Trigonella foenumgraecum* (L.) plants grown under salt environment. *International Journal of Academic Research* 6(2A): 21-26.
- [11] Meena, J. S., Verma, H.P. and Pincholi P. 2014. Effect of fertility levels and biofertilizers on yield, quality and economic of cowpea. *Agriculture for Sustainable Development* 2(2):162-164.

- [12] Mishra, D.J., Singh, R., Mishra, U.K. and Shahi, S. K. 2013. Role of bio-fertilizer in organic agriculture: A review; Research Journal of Recent Sciences 2:239-41.
- [13] Mondal, S., Biswal, K.C. and Jana, P.K. 2005. Yield, economics, nutrient uptake and consumptive use of water by summer green gram [*Vigna radiata* (L.) Wilczek] as influenced by irrigation and phosphorus application. Legume Research 28(2): 131-133.
- [14] Pir, F.A., Nehvi, F.A., Das, S.A.A. and Alloaib, A. 2009. Integrated phosphorus management in mungbean in Kashmir valley. Trends in Bioscience 2(2): 25-26.
- [15] Pramanik, J. K., Chowdhary, A. K. M. S. H. and Uddin, F. M. J. 2014. Effect of Biofertilizer and Weeding on the Growth Characters and Seed Yield of Summer Mungbean. Journal of Environmental Science & Natural Resources 7: 87-92.
- [16] Prasad, S. K., Singh, M. K. and Singh, J. 2014. Response of rhizobium inoculation and phosphorus levels onmungbean (*Vigna radiata* L.) under guava-based agri-horti system. The Bioscan 9: 557-560.
- [17] Rathour, D.K., Gupta, A.K., Choudhary, R.R. and Sadhu, A.C. 2015. Effect of Integrated Phosphorus Management on growth, yield attributes and yield of Summer green gram (*Vigna radiata* L.). The Bioscan 10(1): 05-07.
- [18] Sarita, Sharma, O.P., Shukla, U.N., Yadav, S.K. and Kumawat, R. 2019. Effect of Fertility Levels and Stress Mitigating Chemicals on Nutrient Uptake, Yield and Quality of Mungbean [*Vigna radiata* (L.) Wilczek] under Loamy Sand Soil of Rajasthan. International Journal of Current Microbiology and Applied Sciences 8(5): 965-974.
- [19] Sasode, D.S. 2008. Response of green gram [*Vigna radiata* (L.) Wilczek] to fertility levels and sulphur sources application. Agricultural Science Digest 28(1): 18 21.
- [20] Singh, A., Srivastava, V.K., Meena, R.S., Kumar, S. and Kumar, S. 2013. Effect of biofertilizers and NP levels on growth parameters of greengram under custard apple based agri-horti system. Agriculture for Sustainable Development 1(1):60-63.
- [21] Singh, A.K., Singh, P.K., Kumar, M., Bordoloi, L.J. and Jha, A.K. 2014. Nutrient management for improving mungbean [*Vigna radiata* (L.) Wilczek] productivity in acidic soil of Northeast India. Indian Journal of Hill Farming 27(1): 37-41.
- [22] Singh, B. and Pareek, R.G. 2003. Effect of phosphorus and biofertilizers on growth and yield of mung bean. Indian Journal of Pulses Research 16(1): 31-33.
- [23] Singh, N., Joshi, E., Sasode, D.S., Sikarwar, R.S. and Rawat, G.S. 2018. Liquid bio fertilizer and inorganic effect on physiological, quality parameter and productivity of kharif Groundnut (*Arachis hypogaea* L.). International Journal of Current Microbiology and Applied Science 7(9): 729-735.
- [24] Singh, Q., Sekhon, H.S, Ram, H. and Sharma, P. 2022. Effect of farmyard manure, phosphorus and phosphate solubilizing bacteria on nodulation, growth and yield of kabuli chickpea. Journal of Food Legume 23(3-4): 226-229.
- [25] Sood, A., Bochalya, R.S., Choudhary, K., Shubham and Katoch, A. 2023. Effect of Biofertilizer and Fertility Levels on Growth Characters of Mungbean under Mid Hills of Himachal Pradesh, India. International Journal of Plant & Soil Science 35(20): 1271-1277.
- [26] Srinivasarao, C. and Ali, M. 2006. Response of nutrient uptake of urdbean and mungbean genotypes to optimum nutrient supply on nutrient deficient sandy loam soil. Journal of Food Legumes 19(2): 259-262.
- [27] Verma, G., Singh, M., Morya, J. and Kumawat, N. 2017. Effect of N, P and biofertilizers on growth attributes and yields of mungbean under semi-arid tract of central India. International Archives of Applied Sciences and Technology 8(2): 31-34.
- [28] Yakadri, M., Tahatikunta, R. and Latchanna, A. 2004. Dry matter production and nutrient uptake of green gram [*Vigna radiata* (L.) Wilczek.] as influenced by nitrogen and phosphorus during wet season. Legume Research 27: 58-61.