

Original Research Article

Effect of Biofertilizer and Fertility Levels on Growth Characters of Mungbean under Mid Hills of Himachal Pradesh

ABSTRACT

Biofertilizers are tiny living organisms that can enrich the quality of the soil. These organisms have a positive impact on positively impact, plant growth, making making them healthier and more productive. One of the great things about biofertilizers is that they are environmentally friendly. Unlike some chemical fertilizers, they don't do no harm the environment. This makes them a good choice for sustainable farming practices. Another advantage of using biofertilizers is that they are cost-effective. One of their most important roles is maintaining the long term fertility of the soil soil's long-term fertility. Over time, chemical fertilizers can deplete the soil of its natural nutrients. Biofertilizers, on the other hand, work in harmony with the soil, helping to keep it healthy and productive for years to come. So, if you want to increase your soil's productivity and do so in an environmentally friendly and cost-effective way, using biofertilizers is smart and intelligent. Present-The present investigation, titled Effect of Biofertilizer and Fertility Levels on Growth Characters of Mungbean under Mid-hills of Himachal Pradesh was conducted during the kharif season of 2022 at the Chamelti Agriculture Farm, MS Swaminathan School of Agriculture, Shoolini University, Solan, Himachal Pradesh. The soil of the experimental site was sandy loam in texture, slightly alkaline in reaction in reaction with EC in a safe range, medium in organic carbon, available nitrogen, and potassium and high in available phosphorus. The field experiment was laid out in randomized block design comprising ten treatments *viz.* (T₁) control, (T₂) 100% RDF, (T₃) 75% RDF + seed treatment with liquid biofertilizer, (T₄) 100% RDF + seed treatment with liquid biofertilizer, (T₅) 75% RDF + seed treatment with solid biofertilizer, (T₆) 100% RDF + seed treatment with solid biofertilizer, (T₇) 75% RDF + soil application with liquid biofertilizer, (T₈) 100% RDF + soil application with liquid biofertilizer, (T₉) 75% RDF + soil application with solid biofertilizer and (T₁₀) 100% RDF + soil application with solid biofertilizer with three replications. Recommended-The recommended dose of nitrogen, phosphorus and potassium (20:40:20 kg ha⁻¹) through urea, SSP and MOP at the time of sowingsowing. Biofertilizers applied for seed treatment is 10 ml kg⁻¹ of seed and for the soil application take 10 g of solid biofertilizer for 1 kg ha⁻¹ of seed and mixed are 10 ml kg⁻¹ of seed, and for the soil application, take 10 g of solid biofertilizer for 1 kg ha⁻¹ of seed and mix with 100 kg of FYM. Pusa Baisakhi variety of

mungbean was used for sowing. Other crop management practices were followed as per the recommendation of the area.

Significantly higher growth characteristics (plant height, no. of branches, no. of trifoliolate leaves and dry matter accumulation) were observed with (T₈) 100% RDF + soil application of liquid biofertilizer ~~and was. They were~~ on par with (T₁₀) 100% RDF + soil application of solid biofertilizer over ~~the~~ rest of the treatments. The treatments (T₆) 100% RDF + seed treatment with solid biofertilizer were statistically similar to (T₄) 100% RDF + seed treatment with liquid biofertilizer, followed by treatments T₇, T₃ and T₂. Thus, ~~the~~ study suggests that mungbean can be successfully grown under ~~the~~ Mid-hills of Himachal Pradesh on (T₈) 100% RDF + soil application of liquid biofertilizer.

Keywords: Biofertilizer, mungbean, growth, fertility

1. INTRODUCTION

One of the significant agricultural researchers is finding ways to reduce reliance on costly agrochemicals and chemical fertilizers. These chemicals have detrimental effects on both the environment and human health. Chemical fertilizers are primarily used to replenish the nitrogen content in the soil, but they come with significant drawbacks. They are ~~not only expensive when used in large quantities but also~~ expensive when used in large quantities and pose a ~~serious~~ severe environmental threat due to their contamination. This challenge reflects the urgent need for alternative, more sustainable approaches to agriculture. It underscores the importance of finding eco-friendly, cost-effective solutions that benefit our environment and human well-being (Dai *et al.*, 2004). Biofertilizers play a vital role in enhancing plant nutrition. They ~~have the~~ ~~then~~ uniquely convert atmospheric nitrogen into a form that plants can readily use. Moreover, they are both cost-effective and environmentally sustainable sources of essential nutrients, complementing ~~the use of~~ chemical fertilizers. These help to reduce the dependency on chemical fertilizers, contributing to the cause of sustainable agriculture (Rana *et al.*, 2013). Regarding biofertilizers, we refer to microbial inoculants containing potent strains of microorganisms capable of solubilizing phosphate and fixing nitrogen in the soil. These microorganisms, found in biofertilizers, are organic products of living cells. They remarkably convert essential elements from inaccessible sources into forms that plants can easily absorb and utilize. To amplify their beneficial impact, biofertilizers are often incorporated into the soil, enriching it with a greater more significant population of these microorganisms. This acceleration of microbial processes ~~serves to significantly enhance the availability of nutrients, ensuring that plants can efficiently~~

~~assimilate them for increase the~~ significantly enhances the availability of nutrients, providing that ~~plants can efficiently incorporate them to boost~~growth (Vessey, 2003).

Mungbean, a legume plant, establishes a symbiotic relationship with Rhizobia, allowing it to fix atmospheric nitrogen. This process contributes a substantial amount of biomass and nitrogen to the soil. This nitrogen fixation fulfils its own nitrogen needs and benefits subsequent crops. This ability to fix nitrogen is crucial in maintaining the soil's nitrogen balance and enhancing its physical and biological properties. Mungbean can serve as a valuable cover crop before or after cereal crops in rotation, making it an asset for soil enhancement. Using synthetic fertilizers has brought about a concerning situation, resulting in air, water, and soil pollution. This pollution not only affects the immediate environment but also has broader consequences. Contaminated soil and water sources harm microorganisms and eco-friendly insects, which are natural allies in maintaining crop health. This, in turn, leaves crops vulnerable to diseases and ultimately reduces ~~the fertility of the soil~~soil fertility.

In contrast, biofertilizers emerge as a sustainable and ~~environmental~~environmentally friendly solution. They offer economic viability and contribute positively to the ecosystem over time. Small and average-sized farmers find them particularly beneficial compared to chemical fertilizers, as they can be both efficient and cost-effective (Mishra *et al.*, 2013). Biofertilizers are ~~essentially~~microorganisms, such as bacteria, fungi and algal strains, that function differently from chemical fertilizers. Their ~~key-crucial~~role lies in improving soil fertility by converting atmospheric nitrogen into a usable form and enhancing the quality of nutrients available in the soil. This natural approach increases crop yields without the environmental harm associated with chemical fertilizers, which disrupts the soil balance.

Agriculture holds immense importance in the Indian economy, driving growth and development. ~~The adoption of eco friendly practices like biofertilizers becomes even more critical, as they not only benefit farmers but also~~Adopting eco-friendly practices like biofertilizers becomes even more critical, as they not only benefit farmers but also become even more crucial, as they benefit farmers and safeguard the environment upon which agriculture relies. ~~In India, Mungbean, also known as moong or green gram, belongs to the Fabaceae family~~Family ~~and the Fabaceae family in India~~. These ~~small~~tiny, green seeds are remarkably rich in protein content. Mungbean is a crop that thrives in a relatively short growing season and is well-suited to warmer and drier climates. This legume is cultivated throughout India due to its adaptability and widespread popularity. ~~Mungbean Mungbeans are not only cost-effective but also~~also cost-effective and serve as a valuable source of protein, making them a staple in

many diets. In light of these attributes, [our experiment aimed](#) to enhance the productivity of this crop. We sought to achieve this goal by applying eco-friendly biofertilizers (Dixit, 2013).

2. MATERIALS AND METHODS

The fieldwork was done in the *kharif* season of 2022 at Shoolini University Chamelti Agriculture Farm, which is part of the MS Swaminathan School of Agriculture and is situated at a latitude $30^{\circ} 85'67.30$ N and longitude $77^{\circ} 13'20.38$ E and an elevation of 1284 meters above mean sea level (AMSL). The field experiment was laid out in ~~randomized~~ [randomised](#) block design comprising ten treatments *viz.* (T₁) control, (T₂) 100% RDF, (T₃) 75% RDF + seed treatment with liquid biofertilizer, (T₄) 100% RDF + seed treatment with liquid biofertilizer, (T₅) 75% RDF + seed treatment with solid biofertilizer, (T₆) 100% RDF + seed treatment with solid biofertilizer, (T₇) 75% RDF + soil application with liquid biofertilizer, (T₈) 100% RDF + soil application with liquid biofertilizer, (T₉) 75% RDF + soil application with solid biofertilizer and (T₁₀) 100% RDF + soil application with solid biofertilizer with three replications. The soil of [the](#) experimental field was sandy loam in texture, slightly alkaline in reaction with EC in safer range, medium in organic carbon, available nitrogen, potassium and high in available phosphorus (Table 1). Recommended dose of nitrogen, phosphorus and potassium (20:40:20 kg ha⁻¹) through urea, SSP and MOP at sowing time. The mungbean variety Pusa baisakhi was sown on 16th June, 2022 at a row spacing of 30 × 10 cm using [a](#) seed rate of 12 kg ha⁻¹ and [a R](#)recommended dose of nitrogen, phosphorus and potassium (20:40:20 kg ha⁻¹) ~~were was~~ applied through urea, SSP and MOP at the time of sowing. All the data were subjected to analysis of variance (ANOVA) as per the standard procedures. The comparison of treatment means was made by critical difference (RBD) at $p=0.05$.

Table 1. Properties of soil

Soil type	pH	EC (dS m ⁻¹)	OC (%)	Available N (kg ha ⁻¹)	Available P (kg ha ⁻¹)	Available k (kg ha ⁻¹)
Sandy loam	6.69	0.20	0.52	298.01	27.12	260.09

3. RESULTS AND DISCUSSIONS

3.1 Plant height (cm)

The results of the study reveal ~~that~~ significant differences among all the treatments. On plant height (Table 2), plants treated with (T₈) 100% RDF + soil application of liquid biofertilizer exhibited significantly higher plant height (23.99 cm) over the rest of the treatments at 30 DAS. This performance was at par with applying (T₁₀) 100% RDF + soil application of solid biofertilizer (17.16 cm). Furthermore, the treatments (T₆) 100% RDF + seed treatment with solid biofertilizer were statistically similar to (T₄) 100% RDF + seed treatment with liquid biofertilizer, followed by treatments T₇, T₃ and T₂. However, the lowest plant height was observed under (T₁) control (17.16 cm), and the same trend was followed at 60 DAS and ~~at~~ harvest. This might be due to the combined application of biofertilizer with fertilizer, increased availability of ~~major significant~~ nutrients to ~~plant plants~~ due to enhanced early root growth and cell multiplication, leading to more absorption of other nutrients from deeper ~~layers of soil soil layers~~, ultimately resulting in increased plant growth attributes. The synergistic effect of *Rhizobium*, PSB and KSB, as discussed above, might have increased the plant height in the present investigation due to increased nitrogenous activity and available phosphorus status of soil. Similar finding was reported by Yadav et al. (2017), Meena et al. (2015) Yadav et al. (2017) and Meena et al. (2015) reported a similar finding.

The application of NPK with biofertilizer has boosted the availability of essential nutrients to plants. This is achieved by stimulating early root growth and cell multiplication, which enhances the absorption of additional nutrients from deeper soil layers (Pandey *et al.*, 2019).

3.2 Number of branches plant⁻¹

Data on the number of branches plant⁻¹ at 60 DAS and at the time of harvest showed a significant difference in Table 3. At 60 DAS, a significantly higher number of branches (7.53 plant⁻¹) was observed with the treatment (T₈) 100% RDF + soil application of liquid biofertilizer which was statistically at par with the application of (T₁₀) 100% RDF + soil application of solid biofertilizer (7.27 plant⁻¹). Moreover, treatments (T₆) 100% RDF + seed treatment with solid biofertilizer was found statistically at par with (T₄) 100% RDF + seed treatment with liquid biofertilizer followed by treatment T₇, T₃ and T₂. However, the lowest number of branches (4.93 plant⁻¹) was observed under (T₁) control. Similar A similar trend was noted ~~under~~ at the harvest stage. This might be due to an increase in the number of branches plant⁻¹ which may be attributed to robust vegetative expansion, facilitated by the provision of nitrogen through fertilizers and inoculants, which ultimately increase the total branches. These discoveries align harmoniously with the earlier findings of Hussain *et al.* (2011) and Jat *et al.*

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(2012), as they reported a substantial increase in the total number of branches with biofertilizer applications.

3.3 Number of trifoliolate leaves plant⁻¹

Data on the number of trifoliolate leaves at 30, 60 and at harvest are shown in Table 4.

The outcomes show a significant distinction between all treatments. At 30 DAS, a significantly higher number of trifoliolate leaves (4.85) was observed with the application of (T₈) 100% RDF + soil application of liquid biofertilizer which was statistically at par with the treatment of (T₁₀) 100% RDF + soil application of solid biofertilizer (4.49). Moreover, treatments (T₆) 100% RDF + seed treatment with solid biofertilizer was found statistically at par with (T₄) 100% RDF + seed treatment with liquid biofertilizer followed by treatment T₇, T₃ and T₂. However, the lowest number of trifoliolate leaves (2.80) was observed under (T₁) control. Similar trend was noted under 60 DAS and at harvest. This may be attributed to the beneficial impact of dual inoculation of biofertilizer with fertilizer on the plants, which involves supplementing them with additional nitrogen from the atmosphere and converting insoluble phosphorus into an accessible form. This increased availability of phosphorus promotes nitrogen fixation and the rate of photosynthesis, ultimately resulting in improved growth and eventually leads to an increase in trifoliolate leaves Rajkhowa *et al.* (2003) and Patel *et al.* (2003).

3.4 Dry matter accumulation plant⁻¹ (g)

Dry matter accumulation is a vital index indicating the crop's photosynthetic efficiency, ultimately influencing crop yield. The data on the effect of biofertilizer and fertility levels of mungbean on the dry matter accumulation recorded at 30, 60 DAS and at harvest Table 5. At 30 DAS, significantly higher dry matter accumulation was observed (5.90 g) under (T₈) 100% RDF + soil application of liquid biofertilizer, which was statistically at par with treatment (T₁₀) 100% RDF + soil application of solid biofertilizer (5.74 g).

Moreover, treatment (T₆) 100% RDF + seed treatment with solid biofertilizer was found statistically at par with (T₄) 100% RDF + seed treatment with liquid biofertilizer followed by treatment T₇, T₃ and T₂. However, the lowest dry matter accumulation (4.19) was observed under (T₁) control. Similar trend was noted under 60 DAS and at harvest. This might be due to the presence of biofertilizer with fertilizer appears to have played a pivotal role in facilitating the crop's efficient utilization of the available nutrients.

be due to biofertilizer with fertilizer because biofertilizer with fertiliser has played a pivotal role in facilitating the crop's efficient utilisation. This, in turn, has led to robust vegetative growth in mungbean, ~~leads~~ leading to the maximum potential of solar radiation. Consequently, this utilization solar energy has had a ~~favorable~~ favourable impact on the rate of photosynthesis, resulting in a ~~greater~~ significant accumulation of photosynthates and, ultimately, a substantial increase in dry matter accumulation Rajkhowa *et al.*(2003).

Conclusions

When the soil was treated with liquid ~~biofertilizer~~ biofertiliser, biofertiliser showed a significant increase ~~in the~~ growth parameter of the plant mungbean (*Vigna radiata*). It is concluded that applying 100% RDF + soil application with liquid ~~biofertilizer~~ biofertiliser is the most efficient nutrient management to obtain better growth in the Mid-hills of Himachal Pradesh.

Treatments	Plant height (cm)
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Table 2. Plant height (cm) of mungbean as influenced by ~~biofertilizer~~ biofertiliser and fertility levels at periodic intervals

	30 DAS	60 DAS	At harvest
T ₁ : Control	17.16	41.74	44.69
T ₂ : 100% RDF	22.22	50.46	52.70
T ₃ : 75% RDF + Seed treatment with liquid biofertilizer	22.25	50.50	53.50
T ₄ : 100% RDF + Seed treatment with liquid biofertilizer	22.55	54.52	60.85
T ₅ : 75% RDF + Seed treatment with solid biofertilizer	19.69	50.01	52.01
T ₆ : 100% RDF + Seed treatment with solid biofertilizer	22.37	54.40	57.43
T ₇ : 75% RDF + Soil application of liquid biofertilizer	21.27	50.54	53.74
T ₈ : 100% RDF + Soil application with liquid biofertilizer	23.99	58.82	65.82
T ₉ : 75% RDF + Soil application of solid biofertilizer	20.37	50.42	52.47
T ₁₀ : 100% RDF + Soil application of solid biofertilizer	22.74	56.79	61.45
SEm±	0.39	1.34	1.64
LSD (<i>p</i> = 0.05)	1.16	3.97	4.86

Table 3. Number of total branches plant⁻¹ of mungbean as influenced by biofertilizer and fertility levels at periodic intervals

Treatments	No of branches plant ⁻¹	
	60 DAS	At harvest
T ₁ : Control	4.93	5.19
T ₂ : 100% RDF	6.04	6.17
T ₃ : 75% RDF + Seed treatment with liquid biofertilizer	6.06	6.21
T ₄ : 100% RDF + Seed treatment with liquid biofertilizer	6.77	6.99
T ₅ : 75% RDF + Seed treatment with solid biofertilizer	5.92	5.98
T ₆ : 100% RDF + Seed treatment with solid biofertilizer	6.70	6.78
T ₇ : 75% RDF + Soil application of liquid biofertilizer	6.08	6.22
T ₈ : 100% RDF + Soil application with liquid biofertilizer	7.53	7.76
T ₉ : 75% RDF + Soil application of solid biofertilizer	5.96	6.00
T ₁₀ : 100% RDF + Soil application of solid biofertilizer	7.27	7.50
SEm±	0.23	0.25
LSD (<i>p</i> = 0.05)	0.67	0.75

Table 4. Number of trifoliolate leaves plant⁻¹ of mungbean as influenced by biofertilizer and fertility levels at periodic intervals

Treatments	Dry matter accumulation plant ⁻¹ (g)		
Treatments	Trifoliolate leaves plant ⁻¹		
	30 DAS	60 DAS	At harvest
T ₁ : Control	2.80	7.24	7.12
T ₂ : 100% RDF	3.50	8.76	8.61
T ₃ : 75% RDF + Seed treatment with liquid biofertilizer	3.52	8.79	8.63
T ₄ : 100% RDF + Seed treatment with liquid biofertilizer	4.17	9.66	9.48
T ₅ : 75% RDF + Seed treatment with solid biofertilizer	3.07	8.41	8.39
T ₆ : 100% RDF + Seed treatment with solid biofertilizer	4.12	9.57	9.43
T ₇ : 75% RDF + Soil application of liquid biofertilizer	3.53	8.80	8.64
T ₈ : 100% RDF + Soil application with liquid biofertilizer	4.85	10.68	10.60
T ₉ : 75% RDF + Soil application of solid biofertilizer	3.42	8.63	8.47
T ₁₀ : 100% RDF + Soil application of solid biofertilizer	4.49	10.57	10.36
SEm ±	0.21	0.27	0.28
LSD (<i>p</i> = 0.05)	0.62	0.81	0.83

	30 DAS	60 DAS	At harvest
T ₁ : Control	4.19	8.24	10.94
T ₂ : 100% RDF	4.76	9.00	11.13
T ₃ : 75% RDF + Seed treatment with liquid biofertilizer	4.77	9.03	11.15
T ₄ : 100% RDF + Seed treatment with liquid biofertilizer	5.29	9.75	12.01
T ₅ : 75% RDF + Seed treatment with solid biofertilizer	4.44	8.38	11.06
T ₆ : 100% RDF + Seed treatment with solid biofertilizer	5.18	9.10	11.96
T ₇ : 75% RDF + Soil application of liquid biofertilizer	4.78	9.05	11.17
T ₈ : 100% RDF + Soil application with liquid biofertilizer	5.90	10.67	12.98
T ₉ : 75% RDF + Soil application of solid biofertilizer	4.51	8.41	11.05
T ₁₀ : 100% RDF + Soil application of solid biofertilizer	5.74	10.31	12.22
SEm±	0.20	0.23	0.28
LSD (<i>p</i> = 0.05)	0.58	0.68	0.83

Table 5. Dry matter accumulation plant⁻¹ (g) of mungbean as influenced by biofertilizer and fertility levels at periodic intervals

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