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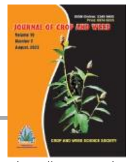

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# Production performance of mungbean (*Vigna radiata*) as influenced by nutrient management under temperate conditions of Kashmir valley

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## ABSTRACT

*An experiment entitled, "Production Performance of Mungbean (Vigna radiata L.) as Influenced by Integrated Nutrient Management under Temperate Conditions of Kashmir Valley" was carried out at the Research Farm, Division of Agronomy, Shere Kashmir University of Agricultural Sciences and Technology of SKUAST-Kashmir, Wadura (Kharif, 2018). The soil of the experimental field was silty clay loam soil, reaction is natural (pH7.31), normal electrical conductivity (0.36 dS/m), medium organic carbon percentage (0.88%), available nitrogen (316.47 kg N/ha), available phosphorus (18.73 kg P/ha) and available potassium (248.62 kg K ha$^{-1}$). The experiment was laid out in a RBD with ten treatment combinations replicated thrice. The experimental results revealed that treatment The highest values of plant height (92.9 cm), LAI (4.76), dry matter accumulation (189.13g/m$^2$) and nodule number (23.53) were achieved in treatment $T_6$ (100% RDF+V.C+BF.) Similarly, Yield attributes viz., the Number of branches per plant (5.96), the Number of pods per plant (20.78), seeds per pod (11.4) and100-seed weight (3.92) were significantly superior in treatment $T_6$ (100%RDF+V.C+BF followed by $T_{10}$. $T_6$ had significantly higher seed yield (9.29 q/ha), straw yield (16.62 q/ha), biological yield (25.91 q/ha), and harvesting index (35.85) than $T_{10}$. The highest N, P and K content in grain (3.93, 0.61, 2.13) and stover (3.18, 0.23, 2.97) was found in $T_6$. Significantly, the highest protein content (24.56 %) and protein yield (228.16 kg/ha) were recorded in $T_6$. Treatment $T_5$ (100% RDF+BF) brought out the maximum net return of Rs 62853 with a benefit-cost ratio of 2.75, followed by $T_9$ (75% RDF+BF) fetching Rs 61732 with the highest benefit-cost ratio of 2.83. Based upon results, it may be inferred that application of treatment $T_5$ (100%RDF+BF) and $T_9$ (75%RDF+BF) treatments is found most promising in terms of economic returns.*

***Keywords*:** Green gram, integrated nutrient management, vermicompost, PSB, rhizobium

India, which accounts for around one-third of the global area and one-fourth of the global output, is world's largest producer of pulses. Mung beans are grown on roughly 3.0 million hectares of land in India, producing 1.1 million tonnes overall with average yield of 3.20 q/ha (Verma *et al*., 2017). In a crop rotation method for crops in dried agricultural farming zones, Mungbean has significant potential (Ashraf *et al*., 2003). It is grown using a variety of farming techniques, such as Intercropping, Sole cropping, Relay cropping and Multiple cropping, where it is planted using leftover moisture after cereals. It is the best option for a contingent crop since it is a short-duration crop, especially given the circumstances in the Kashmir valley.

Although it is generally a crop for the rainy season, early-maturing types have been shown to be perfect for the spring and summer. Greater rooting depth aids in acquiring stored water from varied depths when Mungbean is cultivated in Rainfed settings, improving grain production stability. Due to production of Mung bean in low-fertility marginal and sub-marginal soils where little attention is devoted to sufficient fertilisation, this crop's productivity is very poor (Saravanan *et al.*, 2013). A significant decrease in production has also been documented in summer Greengram plants when fertilizers are not used (Singh and Sekhon, 2008).

Chemical fertilizers are essential for providing the crop with the nutrients it requires, but their imbalance and continued usage have a negative impact on the chemical, physical and biological properties of the soil, making agricultural production less sustainable and polluting the environment (Virmani, 1994). There is urgent need to decrease the use of chemical fertilizers and subsequently increase the use of organic since chemical fertilizers are no longer viable for farmers to purchase due to rising energy prices. On the other hand, because of their poor nutritional status, use of organics alone cannot provide a remarkable rise in crop yields (Subba Rao and Tilak, 1977).

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For the aforementioned reasons, it is essential to develop green grain by combining organic, inorganic, and bio fertilizers. In addition to enhancing the physical characteristics of the soil, integrating Organic Manures and inorganic fertilizer materials has been proven to be effective in sustaining greater crop yield and providing stability in crop output (Verma *et al*., 2012). A sustainable, abundant supply of micronutrients, N, P, and K is vermicompost. Some of the worms' secretions and the related bacteria work as growth boosters in vermicompost

Ram Swaroop and Ramawatar (2012) define bio-fertilizers as organic substances containing living microorganisms derived from plant roots or cultivated soil that aid in the fixation of atmospheric $N_2$, the solubilization of phosphorus, the stimulation of growth hormones, and the enhancement of agricultural nutrients, plant morphology, and chlorophyll content (Ram Swaroop and Ramawatar, 2012). They may reduce the dosage of chemical fertiliser by 25–50% and are inexpensive and environmentally benign inputs (Pattanayak *et al.,* 2007).

Saving between 20 and 40 kilogrammes N $ha^{-1}$ may result in savings of between 20 and 40 kg N $ha^{-1}$. Phosphate-solubilizing bacteria (PSB) are more essential because they help in the transition of complicated and solid organic phosphorous into simple and soluble forms. Field pea seeds that have had phosphate solubilizing bacteria injected into them have an increase in nodulation, crop growth, nutrient availability, nutrient absorption, and crop production (Srivastava and Ahlawat, 1995).

The urgent need is to develop an integrated plant nutrition system that uses chemical fertilizers, bio-fertilizers and Organic Manures in a balanced manner. There is very little data on the effects of integrating the use of chemical fertilizers, bio-fertilizers, and organic manures on the morphology and production of mung bean plants (Meena and Sharma, 2013). Current study, named "Production Performance of Mungbean (*Vigna radiata* L.) as Influenced by Integrated Nutrient Management in Temperate Conditions of the Kashmir Valley," has been carried out keeping in mind the aforementioned facts.

At the Agronomy Research Farm, Faculty of Agriculture, SKUAST-K, Wadura, Sopore, a field experiment was carried out in *kharif* 2018. The farm is situated at an elevation of 1524 m above mean sea level in the Research Farm, SKUAST-Kashmir. Baramulla has a moderate climate with a mean annual precipitation of 904mm. From mid-June to mid-September, the area is known for its scorching summers, with July and August being the warmest months. Figure1 shows the meteorological measurements made throughout the crop-growing period (23rd–40th SMW of *kharif* 2018). The weekly mean maximum temperature ($T_{max}$) was 28.6 ºC (ranging from 22.7 to 31.9ºC) and the weekly mean minimum temperature ($T_{min}$) was 14.4 ºC (ranging from 5.4 to 18.7 ºC). During the crop season, 340.2 mm of rain fell in total (RF), or roughly 38% of the typical annual precipitation. The average relative humidity stayed within the range of 55.9% (RH min.) and 80.4%. (RHmax). During the time period, 6.8 hours of sunshine per day on average were measured (ranging from 1.2 – 9.7 hours). In July, when there were more instances of rainfall, shorter periods of sunshine hours persisted more.

The soil in the experiment field had a silty clay loam texture, reaction was natural, and had medium levels of available N (164 kg $ha^{-1}$), P (235 kg $ha^{-1}$), K (28.5 kg $ha^{-1}$), and organic carbon (0.45%). The pH of the soil in the experimental field was 7.31, and its electrical conductivity was 0.36 dS/m. There were 10 treatments consisting of $T_2$ (2.5 t $ha^{-1}$ VC + BF), $T_3$ (100 % RDF), $T_4$ (100% RDF +VC) $T_5$ (100 % RDF + BF), $T_6$ (100% RDF + VC + BF), $T_7$ (75%RDF), $T_8$ (75% RDF + V.C), $T_9$ (75% RDF+BF).$T_{10}$ (75 % RDF+ V.C+ BF) besides an absolute control ($T_1$). The experiment was laid out in RBD with three replications.

On June 22nd, 2018, the crop variety Shalimar-Moong-1 was sowed with a 30 cm row spacing. Before two hours of planting, seedlings were inoculated with Rhizobium and PSB according to the treatments utilising liquid formulations of the two bacteria. At the time of crop planting, the full recommended amount of nitrogen, phosphorous, and potassium (30:60:30 N P K kg ha) was administered below the seeds in the forms of urea, DAP, and MOP, respectively. Pendimethalin 30 EC was applied evenly using a Knapsack spray pump at a rate of 0.75 l *a.i.* in 600 l of water $ha^{-1}$ to suppress weeds two days after planting. When necessary, from sowing through crop harvest, intercultural activities and plant protection measures were implemented in accordance with the prescribed package of methods. At 45 days following seeding, hoeing-cum weeding was carried out manually to reduce weed competition. Two pickings of the ripened pods—whose colour had changed from green to golden brown—were used to gather the produce from the net plot. The plants and pods were taken out during the final harvesting, and the harvested produce from each plot was spread out individually on tarpaulin sheets to dry in the sun before being bashed with sticks. To make it clean, the straw was taken out and the seed was winnowed. The collected product was finished off by treating the chosen pods with threshing as necessary. The normal practices were followed for collecting information on the Moong bean's yield characteristics, grain yield, and straw yield. Analysis of variance (ANOVA) suited for randomised block designs was used to statistically assess the experimental outcomes, and the treatment means were compared using the least significant difference (LSD) test at the 5% level of significance (Cochran and Cox, 1957).

### *Yield and yield attributes*

### *No. of branches per plant*

Table 1 presents the information on how different integrated nutrient management treatments have an impact on branches and plants. Data showed that when all of the treatments were compared to the control, there was a significant influence of the treatments (T1). T6 (100%RDF+VC+BF) had the most branches per plant (5.9), followed by T10 (75% RDF+VC+BF), with a superiority of (68.8) and (41.0) percent above the control, respectively. It is also clear that there is a considerable difference between the control group and the other treatments. Verma *et al*., 2017 identified similar tendencies.

### *Pods per plant*

According to the data on pods produced per plant provided in Table 1, there was a significant difference between $T_1$(control) and the other treatments. It was also found that there was a vivid significant difference in pods /plant in T3 (100% RDF) and T6 (100% RDF+V.C+BF). Similarly, in T7 (75% RDF) and T10(75% RDF+V.C+BF). The maximum number of pods per plant (20.8) were found in $T_6$ (100% RDF+VC+BF) followed by (19.6) in T10 (75% RDF+VC+BF and the minimum number of pods (12.5) were observed in T1 (control). There were 66.7 and 57.3 percent more pods per plant in comparison to control, respectively. The use of integrated fertility levels significantly increased their yield attributes. These investigations' findings concur with those of Chaudhari *et al.*, (2017).

### *Number of seeds pod$^{-1}$*

According to the data on the quantity of seeds/pod in Table 1, there was a significant difference between T1 (control) and the other treatments. The highest number of seeds per pod (11.4) was found in T6, followed by (10.4) in T10. T1 had the fewest seeds per pod (6.7). In comparison to control, there were 69.4 and 55.4% more seeds per pod, respectively. It's possible that Rhizobium inoculation improved the quantity of seeds produced per pod through improving root growth and nutrient availability. These investigations' results concur with those of Tomar et al., (1994).

### *100- seed weight (g)*

The results from Table 1 revealed a significant variation in 100 seed weight as influenced by different "inorganic and organic treatments" between $T_1$ (control) and all other treatments. T6 (100% RDF+VC+BF) had the highest 100 seed weight (3.9), followed by T10 (75% RDF+V.C+BF) (3.8). Both treatments were statistically equivalent.

### *Seed yield (q ha$^{-1}$)*

Table 2 displays the seed yield data. As regards the comparison of control with the rest of the treatments, the data showed that the $T_1$ (control) treatment produced less seed yield when compared to the rest of the treatments. Statistically, there were significant differences between control and the rest of the treatments.

The statistics show that all treatments had a significant influence on seed yield. T6 (100% RDF+VC+BF) had the highest seed yield (9.2 q ha$^{-1}$), followed by T10 (75% RDF+VC+BF) and $T_1$ (control), with superiorities of (122.8) and (116.8) percent over the control, respectively.

The data also inferred that organic fertiliser like vermicompost and biofertilizers like *Rhizobium* and *Phosphorus Solubilizing Bacteria* in integration with RDF caused a significant variation in yield while comparing $T_3$ (100% RDF) with T6 (100% RDF+VC+BF) and $T_7$ (75% RDF) with $T_{10}$ (75% RDF+VC+BF). There was also a substantial difference noticed between $T_2$ (VC+BF) and T3 (100%RDF), $T_2$ and $T_4$ (100%RDF) with an incremental increase of (35.8) and (57.3) percent in yield, respectively, over $T_2$ (sole organic treatment VC+BF). A perusal of the data indicated that treatments $T_3$ and $T_4$, $T_3$ and $T_5$, and $T_3$, and $T_6$ showed a significant difference when compared with each other. Similarly, not only $T_7$ and $T_{10}$ were significantly different from each other, but $T_7$ and $T_8$, $T_9$ and $T_{10}$ were also significantly different from each other, except $T_7$ and T9, which were at par. Increased seed output might be attributed to vigorous plant development and dry matter production, which led in improved fruiting, blooming, and pod formation and, as a result, had a positive influence on seed yield. The findings of this study correspond with those of Srivastava and Ahlawat, (1995) and Geletu and Mekonnen, (2018).

### *Stover yield (q ha$^{-1}$)*

A review of the data in (Table 2) indicated that all of the treatments differed significantly from T1 (control). According to the data, T6 (100% RDF+VC+BF) produced the highest stover yield (16.6), followed by T10 (75% RDF+VC+BF) and T4 (100% RDF+VC) showing 55.0, 55.1, and 54.1 percent increase over control, respectively, while T1 had the lowest stover yield (10.5). Both of these treatments were significant when compared with each other. Application of the recommended dose ($T_3$) has an edge in stover yield over $T_2$ (Vermicompost + Biofertilizer) alone, but when integrated with VC or BF, recorded a sharp increase over RDF in $T_3$ (100%RDF) and $T_7$ (75% RDF).

**Table 1: Influence of integrated nutrient management on number of branches plant$^{-1}$, number of pods plant$^{-1}$ and seeds pod$^{-1}$ in mungbean**

| Treatment | No. of primary branches plant$^{-1}$ | No. of pods plant$^{-1}$ | No. of seeds pod$^{-1}$ | 100 seed weight (g) |
|---|---|---|---|---|
| $T_1$(control) | 3.5 | 12.5 | 6.7 | 3.3 |
| $T_2$(V.C+BF) | 4.9 | 16.0 | 9.6 | 3.6 |
| $T_3$ (100%RDF) | 5.1 | 17.9 | 11.0 | 3.7 |
| $T_4$(100%RDF+V.C) | 5.5 | 18.2 | 10.6 | 3.8 |
| $T_5$(100%RDF+BF) | 5.4 | 18.2 | 11.2 | 3.8 |
| $T_6$(100%RDF+V.C+BF) | 5.9 | 20.8 | 11.4 | 3.9 |
| $T_7$(75%RDF) | 4.6 | 16.7 | 9.4 | 3.6 |
| $T_8$(75%RDF+V.C) | 4.8 | 18.4 | 10.4 | 3.8 |
| $T_9$(75%RDF+BF) | 4.9 | 17.4 | 9.5 | 3.7 |
| $T_{10}$(75%RDF+V.C+BF) | 4.9 | 19.6 | 10.4 | 3.8 |
| **S.Em(±)** | **0.38** | **0.97** | **0.88** | **0.10** |
| **LSD(0.05)** | **1.1** | **2.9** | **2.5** | **0.29** |

**Table 2: Influence of integrated nutrient management on average seed yield, stover yield, biological yield and harvest index of mungbean**

| Treatment | Seed yield (q ha$^{-1}$) | Stover yield (q ha$^{-1}$) | Biological yield (q ha$^{-1}$) | Harvest index (%) |
|---|---|---|---|---|
| $T_1$(control) | 4.1 | 10.5 | 14.7 | 28.2 |
| $T_2$(V.C+BF) | 5.5 | 12.7 | 18.3 | 30.2 |
| $T_3$ (100%RDF) | 7.5 | 14.0 | 21.5 | 34.8 |
| $T_4$(100%RDF+V.C) | 8.7 | 16.3 | 25.0 | 34.7 |
| $T_5$(100%RDF+BF) | 8.1 | 15.4 | 23.5 | 34.4 |
| $T_6$(100%RDF+V.C+BF) | 9.2 | 16.6 | 25.9 | 35.8 |
| $T_7$(75%RDF) | 7.2 | 13.7 | 20.9 | 34.4 |
| $T_8$(75%RDF+V.C) | 8.2 | 15.5 | 23.7 | 34.6 |
| $T_9$(75%RDF+BF) | 7.9 | 15.0 | 22.9 | 34.4 |
| $T_{10}$(75%RDF+V.C+BF) | 9.0 | 16.4 | 25.4 | 35.5 |
| **S.Em (±)** | **0.30** | **0.27** | **0.49** | **0.42** |
| **LSD (0.05)** | **0.90** | **0.81** | **1.4** | **1.2** |

**Table 3: Influence of integrated nutrient management onrelative economics of mungbean**

| Treatments | Total cost of cultivation (Rs ha$^{-1}$) | Gross returns (Rs ha$^{-1}$) | Net returns (Rs ha$^{-1}$) | Benefit-Cost Ratio |
|---|---|---|---|---|
| $T_1$(control) | 18600 | 44874 | 26274 | 1.41 |
| $T_2$(V.C+BF) | 38660 | 59110 | 20450 | 0.52 |
| $T_3$ (100%RDF) | 22822 | 79306 | 56484 | 2.47 |
| $T_4$(100%RDF+V.C) | 42822 | 91893 | 49071 | 1.14 |
| $T_5$(100%RDF+BF) | 22882 | 85735 | 62853 | 2.75 |
| $T_6$(100%RDF+V.C+BF) | 42882 | 97886 | 55004 | 1.28 |
| $T_7$(75%RDF) | 21711 | 76116 | 54405 | 2.50 |
| $T_8$(75%RDF+V.C) | 41711 | 86753 | 45042 | 1.08 |
| $T_9$(75%RDF+BF) | 21771 | 83503 | 61732 | 2.83 |
| $T_{10}$(75%RDF+V.C+BF) | 41771 | 95320 | 53549 | 1.28 |

**Cost of inputs**: Cost of Tractorization = Rs 4000/ha, seed=Rs 80/kg, Urea=Rs 660/q, DAP=Rs 2600 /q, Mop= Rs 1560/q, Labour = Rs 225/day, Vermicompost =Rs 800 /q, Biofertilizer = Rs 60/kg, **Cost of outputs:** seed=Rs 100 /kg, stover=Rs 3/kg

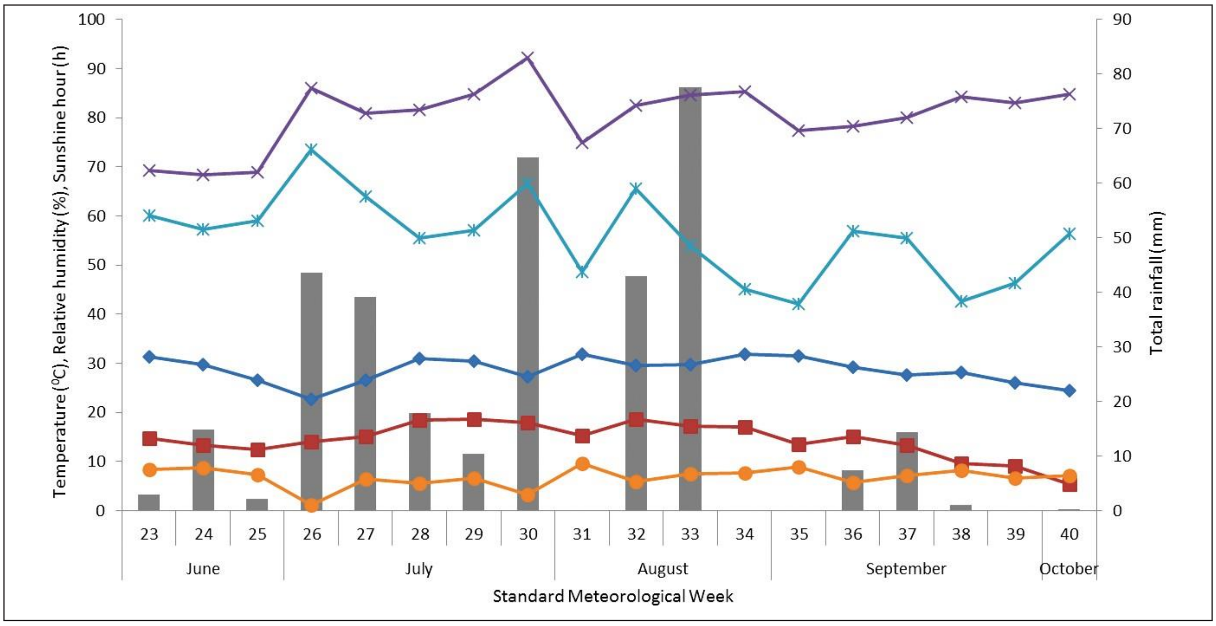


**Fig. 1: Meteorological data during crop period *kharif*, 2018**

Higher stover production might be attributed to increased dry matter and leaf area index. Yadav, (2001) and Rajkhowa *et al*., (2001) achieved similar results.

***Biological yield (q ha$^{-1}$)***

A look at the data (Table 2) revealed that, similarly to seed and straw production. Different treatments resulted in a considerable increase in biological yield. There was a substantial difference between the control group and the other therapies used. T6 (100% RDF+VC+BF) had the greatest biological yield of (25.9 q ha$^{-1}$), T10 (75% RDF+VC+BF) had the second best biological yield of (25.4 q/ha), and T1 (control) had the lowest biological yield of (14.8), suggesting an increase of (75.6) and (72.5) percent above control. While comparing the different treatments, $T_3$ (100% RDF) and T7 (75% RDF) with the treatments $T_4$ (100% RDF+VC) and $T_5$ (100% RDF+BF), there was no significant difference between the two. However, there was a vivid and significant difference in biological yield between $T_3$ (100% RDF) and $T_6$ (100% RDF+VC+BF). A similar trend was observed in $T_3$ (100% RDF), $T_7$ (75%RDF), and $T_{10}$ (75% RDF+VC+BF). The cumulative effect of growth and yield attributes might have significantly increased biological yield. Rajkhowa et al. (2002) achieved comparable findings.

***Harvest index (%)***

The data presented in Table 2 revealed that there was a significant difference between $T_1$ (control) and all other treatments. T6 (100% RDF + VC+ BF) had the highest harvest index (35.8), followed by T10 (75% RDF+ VC+ BF) (35.5).

On examining the effect of inorganic fertilisers alone on $T_3$ (100% RDF), it was observed that there was a significant influence of treatments on the harvest index in $T_4$ (100% RDF+VC), $T_5$ (100% RDF+BF) and $T_6$ (100% RDF+VC+BF). Similarly, while comparing $T_7$ (75% RDF) and $T_{10}$ (75% RDF+VC+BF), there was a significant difference in harvest index. However, treatment T7 (75% RDF) was significantly different from T8 (75% RDF+VC), although T8 and T9 (75%RDF+BF) were statistically equivalent.

In Table 2, the comparison of control with the other treatments revealed that the T1 (control) treatment generated considerably less seed yield than the other treatments, demonstrating a definite impact of the different fertiliser treatments. Treatment T6 (100% RDF+VC+BF) produced the highest seed yield (9.2 q ha$^{-1}$), followed by treatment T10 (75% RDF+VC+BF) produced the second highest seed yield (9.4 q/ha), and treatment T1 (control) produced the lowest seed yield (4.17 q ha$^{-1}$) with superiorities of (122.7%) and (116.78%) over control.

***Economics***

The statistics (Table 3) clearly show that varied quantities of bio-fertilizers and fertility greatly boosted net returns above the control. Data demonstrated that all fertility treatments had a substantial impact on net returns over control. Treatment T5 (100% RDF+BF) produced the highest net returns (Rs 62853) with a benefit-cost ratio of 2.75, followed by T9 (75% RDF+BF) with the highest benefit-cost ratio (2.83) and superiority above absolute control.

However, when treatment T3 was compared with $T_4$, $T_5$ and $T_6$, treatments, there was a significant difference between them, indicating positive effects of treatments applied. This might be because biofertilizers resulted in much greater net returns than other treatments due to increased seed and straw yields and proportionately higher extra revenue. These findings are consistent with those of Meena *et al*. (2015) and Patel *et al.* (2016).

## CONCLUSIONS

Based on the results of a one-year experiment, it can be concluded that, among various levels of organic and inorganic fertilisers, conjunctive application of 100% RDF+vermicompost @ 2.5 t $ha^{-1}$ + seed inoculation of biofertilizers (*Rhizobium* + Phosphate solubilizing bacteria), in treatment T6, was the most promising treatment, yielding a significantly higher yield. However, better remunerative net returns from Mungbean were identified in treatment T9, with a benefit-cost ratio of 2.8, when compared to their matching solitary application of vermicompost, chemical fertiliser, or seed inoculation with biofertilizers.

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