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Impact of organic and biofertilizers on yield potential of blackgram (*Vigna Mungo* [L.] hepper)

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Abstract

The present inquiry was meticulously undertaken to elucidate the impact of diverse combinations of organic amendments and biofertilizers on the growth dynamics and yield attributes of black gram (*Vigna mungo*) cultivar Shekher-2. The experimental study was conducted at the Agronomy Field of the School of Agriculture Research and Technology, Sardar Patel University, Balaghat, Madhya Pradesh, during the Kharif season of 2024. The investigation was structured in a Randomized Block Design (RBD), incorporating eight treatment regimes, each replicated thrice. The treatment compositions were as follows: T₁ (Control), T₂ (10.0 MT FYM ha⁻¹), T₃ (2.5 MT Vermicompost ha⁻¹), T₄ (1.0 MT Poultry Manure ha⁻¹), T₅ (5.0 MT FYM + 5 kg Rhizobium ha⁻¹), T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹), T₇ (0.5 MT Poultry Manure + 5 kg Rhizobium ha⁻¹), and T₈ (1.25 MT FYM + 0.62 MT Vermicompost + 0.25 MT Poultry Manure + 5 kg Rhizobium ha⁻¹). The findings unequivocally demonstrated that T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹) significantly augmented vegetative growth, evidenced by an enhanced plant stature (57.29 cm) and a greater number of primary branches per plant (14.67). Furthermore, this treatment markedly improved yield-contributing parameters, including a higher pod count per plant (22.31), superior seed yield (9.31 q ha⁻¹), an optimal seed index (3.86), and an elevated harvest index of 31.89%. Additionally, T₆ yielded the maximum net economic return of ₹70,808 ha⁻¹, coupled with the most favourable benefit-cost ratio of 3.29. Consequently, the application of vermicompost along with rhizobium at elevated levels is advocated to optimize the agronomic performance and yield potential of black gram under the agro-climatic conditions of Balaghat, Madhya Pradesh.

Keywords: Benefit cost ratio, black gram, fym, poultry manure, *rhizobium*, vermicompost.

Introduction

Black gram, botanically classified as *Vigna mungo* [(L.) Hepper], is commonly referred to as urdbean or mash and traces its domestication lineage to *Vigna mungo* var. *sylvestris*. This leguminous grain crop is an abundant source of phosphoric acid and calcium, endowed with a diverse spectrum of essential nutrients. Owing to its inherent fermentative properties, it is extensively utilized in the preparation of fermented food products. Cultivated both as a sole crop and an intercrop, black gram serves as a pivotal short-duration legume in Indian agriculture, offering a highly digestible protein source while concurrently enhancing soil fertility through symbiotic nitrogen fixation. The seeds are primarily consumed as staple food, while their dehulled and split form, commonly known as dhal in Hindi, is widely used in culinary applications. Black gram embodies a well-balanced nutritional composition, comprising 20-25% protein, nearly threefold the protein content of cereals, alongside 40-47% starch, and a complement of ash, fats, carbohydrates, and essential vitamins. It is believed to have originated in India, which remains the world's largest producer and consumer of this crop. Black gram is an annual, self-pollinated leguminous species belonging to the Leguminosae family, subfamily Papilionoidea, with a chromosome number 2n = 2x = 22 (Khan *et al.*, 2020) ^[11]. In India, the total cultivated area, production, and productivity of black gram stand at 4.807 million hectares, 2.739 million tonnes, and 570 kg/ha, respectively. The principal urdbean-producing states include Madhya Pradesh, Rajasthan, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, and Bihar. In Uttar Pradesh, black gram spans an area of 0.589 million hectares, with a production output of 0.311 million tonnes and an average productivity of 528 kg/ha, thereby contributing 12% of the total land under black gram

cultivation and 11% of the national pulse production share (DES, 2022). Farmyard manure (FYM) primarily comprises decomposed cow dung, cow urine, straw, and other dairy waste products. While a modest fraction of its nitrogen (N) content is readily available, the bulk of nitrogen is released gradually as the organic matter decomposes. The combination of cow dung and urine provides a balanced nutrient supply to plants, with the availability of potassium (K) and phosphorus (P) from FYM being comparable to inorganic fertilizers. Typically, well-decomposed FYM contains 0.5% N, 0.2% P₂O₅, and 0.5% K₂O, significantly enhancing soil phosphorus availability. Moreover, FYM not only contributes to soil P enrichment but also influences the solubility of applied phosphorus fertilizers, thereby augmenting nutrient accessibility (Singh, 2019) ^[19]. The integration of organic manure alongside chemical fertilizers is widely acknowledged as a superior agronomic strategy to sustain yields under intensive cropping systems. Biofertilizers, comprising living microorganisms, facilitate plant growth by colonizing the rhizosphere or plant tissues, thereby enhancing the bioavailability of primary nutrients. They function through biological nitrogen fixation, phosphorus solubilization, and synthesis of phytohormones, promoting overall plant vigour. Among the most commonly utilized biofertilizers, *Rhizobium* is particularly beneficial for leguminous crops such as groundnut and soybean, contributing to a 10-35% yield increase and supplementing 50-200 kg N ha⁻¹. Additionally, phosphate-solubilizing bacteria (PSB) play a vital role in enhancing phosphorus availability, improving crop yield by 5-30% (Kumar, 2018) ^[15]. Inoculating pulse grains with an appropriate *Rhizobium* strain substantially enriches soil fertility (Sasidhar *et al.*, 2022) ^[17], stimulates legume productivity (Jangir *et al.*, 2016) ^[10], and serves as a more cost-effective alternative to synthetic nitrogen fertilizers (Heisnam *et al.*, 2017) ^[9]. Vermicompost, a bio-organic amendment derived from earthworm-mediated decomposition, is enriched with macro- and micronutrients, exhibiting 2-3% nitrogen, 1.55-2.25% phosphorus, and 1.85-2.25% potassium. Furthermore, it harbours an array of beneficial soil microbes, growth hormones, vitamins, and hydrolytic enzymes such as proteases, amylases, lipases, cellulases, and chitinases, which persist in decomposing organic residues even post-excretion. Vermicomposting is recognized as an advanced biotechnological intervention that transforms agro-industrial waste into high-value organic inputs, fostering soil structure improvement and fertility enhancement within organic farming systems. The efficacy of vermicompost in sustaining soil health and crop productivity has been well-documented (Barik *et al.*, 2011) ^[12]. Poultry manure, characterized by rapid fermentation, undergoes 50% nitrogen volatilization within 30 days if left exposed. It surpasses other bulky organic manures in nitrogen (3.03%) and phosphorus (2.63%) content, with a potassium concentration of 1.4% K₂O. Research on poultry manure application has demonstrated its efficacy in improving soil fertility, enhancing nutrient bioavailability, and augmenting plant growth and yield attributes, as observed in Cole rabi (Yadav *et al.*, 2020) ^[21]. The high organic matter content of poultry manure renders it an invaluable soil amendment, optimizing nutrient cycling and bolstering agricultural sustainability. Conducting a trial to assess the impact of organic and biofertilizers on the yield potential of black gram is imperative for evaluating sustainable agronomic practices that enhance crop productivity while preserving soil health. Black gram, a nutritionally significant pulse crop, plays a crucial role in India's food security. While conventional chemical fertilizers

have contributed to increased yields, their prolonged use often leads to soil degradation, necessitating alternative approaches that ensure long-term fertility. Organic and biofertilizers present an ecologically viable solution, fostering beneficial soil microbiota, enhancing nutrient bioavailability, and fortifying crops against biotic and abiotic stresses. This study seeks to quantify the yield advantages of these inputs, generating empirical evidence to support their wider adoption, reduce reliance on synthetic fertilizers, and advance sustainable agricultural practices in harmony with environmental conservation. In light of these considerations, the present investigation was undertaken with the following objectives: To identify the most effective combination of organic and biofertilizers for optimizing the growth and yield of black gram and to evaluate the economic viability of the treatments and their potential for large-scale adoption.

Material and Methods

This study aimed to understand the effect of different combinations of organic and biofertilizers on growth and yield of black gram variety Shekher-2. The research was conducted at the Student Research Farm within the Department of Agronomy at the School of Agriculture Science Technology and Research, Sardar Patel University, Balaghat, Madhya Pradesh, during the Kharif season of 2023, detailing the materials utilized and the methodologies employed throughout the investigation. Balaghat District is situated in the south-eastern region of the Satpura Range and the upper Wainganga River valley, spanning from 21°19' to 22°24' north latitude and 79°31' to 81°30' east longitude. The treatments were The treatments consisted of T₁ (Control), T₂ (10.0 MT FYM ha⁻¹), T₃ (2.5 MT Vermicompost ha⁻¹), T₄ (1.0 MT Poultry Manure ha⁻¹), T₅ (5.0 MT FYM + 5 kg *Rhizobium* ha⁻¹), T₆ (1.25 MT Vermicompost + 5 kg *Rhizobium* ha⁻¹), T₇ (0.5 MT Poultry Manure + 5 kg *Rhizobium* ha⁻¹), and T₈ (1.25 MT FYM + 0.62 MT Vermicompost + 0.25 MT Poultry Manure + 5 kg *Rhizobium* ha⁻¹). Five randomly selected plants were measured for height from the ground to the top of the plant at maturity. The number of branches per plant was determined by counting the branches on five randomly chosen plants that grew from the main shoot, and the average was calculated to represent the number of branches per plant. During harvesting, the number of branches per plant was recorded. Days to 50% flowering was recorded as the total number of days from sowing until 50% of the plants in the plot began to bloom. Days to 50% pod setting was defined as the interval between sowing and the stage when 50% of the plants in a row had set pods. Days to maturity represented the number of days from sowing until all plants in the plot reached physiological maturity. At harvest, the total number of pods from five randomly selected plants in each plot was manually counted. Seeds per pod were recorded by counting seeds from pods collected from five randomly chosen plants and averaging the values. Pod length was measured in centimeters from five pods randomly taken from five selected plants, and the average was calculated. The 100-seed weight was determined by randomly selecting 100 seeds from the total seed yield of tagged plants, weighing them in grams after threshing and sun drying, and computing the mean value. The yield was calculated by weighing the total seed yield per plot. The readings for all the harvest per plot were recorded. The total seed yield/hectare was calculated by unitary method formula given below:

$$\text{Seed yield per hectare} = \frac{\text{Seed Yield per plot}}{\text{Size of individual plot}} \times 10,000 \text{ m}^2$$

Harvest index was computed by using following formula as suggested by Singh and Stoskoff (1971) ^[20]. The harvest index was worked out by using following formula: Harvest index (%)

$$= \frac{\text{Seed yield (g)}}{\text{Biological yield (g)}} \times 100$$

The statistical analysis was conducted using Fisher and Yates (1967).

Results and discussion

Shekher-2, an exceptionally early maturing selection, is believed to have originated at HAU, Hissar. This black gram variety exhibits medium-tall, open, and semi-spreading plant architecture. Its pods are typically yellow with dark green streaks, while the seeds are small and light brown. Over the past 30 years, intensive agricultural practices in India, particularly the widespread adoption of high-yielding crop varieties, have significantly depleted soil nutrients. Additionally, the indiscriminate use of chemical fertilizers has contributed to soil degradation and a decline in soil organic carbon levels. Farmyard manure (FYM) remains a primary organic nutrient source for field crops; however, its limited availability poses a significant challenge to sustainable nutrient management. Nitrogen plays a crucial role in various metabolic processes, including protein synthesis and chlorophyll formation. Both nitrogen (N) and phosphorus (P) are essential for root development, influencing root activity and overall plant growth in crops such as cowpea. The application of nitrogen, including as a starter dose, supports early seedling growth before nitrogen fixation begins in the roots. Plants that receive organic nitrogen during the vegetative phase tend to develop larger canopies by the flowering stage compared to those relying solely on symbiotic nitrogen fixation. Phosphorus, a fundamental component of plant metabolism, is involved in key physiological processes such as photosynthesis and respiration. Potassium, on the other hand, enhances plant growth by reducing transpiration, improving water absorption, and increasing resilience under drought conditions (Nazneen *et al.*, 2022) ^[16]. Vermicompost, a valuable organic alternative to conventional fertilizers, plays a vital role in organic farming by improving soil biology, enhancing water retention, and loosening soil structure. It promotes microbial activity, supports root establishment, and helps regulate soil pH, particularly in acidic soils, thereby fostering optimal plant growth (Kirubashre *et al.*, 2023) ^[12].

Growth parameters

Plant height and number of branches per plant.

The tallest plants, reaching a height of 57.29 cm, were observed in treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹), outperforming all others. Treatment T₈ (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha⁻¹) produced slightly shorter plants, measuring 54.32 cm at maturity. In contrast, the control group (T₁) recorded the lowest plant height at 45.07 cm, with the other treatments showing intermediate growth patterns. The highest number of branches per plant, totalling 14.67, was recorded in treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹), with treatment T₈ (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha⁻¹) following closely at 13.92 branches. In contrast, the control treatment (T₁) showed the fewest branches per plant, with only 9.14. The superior performance in plant height and number of primary branches in black gram (table 1) observed in treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹) can be attributed to the

synergistic effects of vermicompost and Rhizobium. Vermicompost is rich in essential nutrients, growth hormones, and beneficial microorganisms, which enhance soil structure, nutrient availability, and root development. These improvements promote robust vegetative growth, resulting in taller plants and more branching. Rhizobium inoculation further boosts nitrogen fixation, meeting the nitrogen demands of the crop efficiently. This enhanced nitrogen availability is crucial for promoting vegetative growth, while the gradual nutrient release from vermicompost ensures a consistent supply throughout the growth period. The combined effects of organic matter enrichment, improved soil microbial activity, and optimized nutrient uptake contribute to enhanced plant growth and development, surpassing other treatment combinations that may lack the same level of nutrient synchronization and microbial benefits. Chongre *et al.*, (2019) ^[3] worked to find out the effect of graded levels of potassium and micronutrients on yield, quality and nutrient uptake in Pigeon pea through soil and foliar and concluded that application of 100% NP + 50 kg K₂O ha⁻¹ + Grade-I improved plant height, branching in plants.

Days to 50% flowering, 50% pod setting and days to maturity

Treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹) resulted in the shortest time to 50% flowering, with plants taking only 38.18 days, followed by treatment T₈ (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha⁻¹), which required 40.00 days. In contrast, the control group (T₁) exhibited the longest duration to 50% flowering at 43.77 days. Regarding pod setting, treatment T₆ reached 50% pod setting in the shortest time, 50.33 days, with T₈ following at 51.23 days. The control (T₁) again had the longest period, requiring 55.33 days. Finally, days to maturity were minimized in treatment T₆ at 68.74 days, closely followed by T₈ at 69.33 days, while the control (T₁) took the longest, maturing in 73.67 days. The improved earliness in days to 50% flowering and pod setting, alongside earlier maturity (table 1) in black gram under treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹), is due to the effective combination of vermicompost and Rhizobium. Vermicompost enhances soil fertility and supplies essential nutrients in a readily available form, accelerating plant metabolic activities and physiological processes. This leads to faster vegetative growth and earlier initiation of reproductive stages. Additionally, vermicompost boosts microbial activity, which improves nutrient mineralization and uptake efficiency. Rhizobium inoculation enhances biological nitrogen fixation, supplying a continuous nitrogen source critical for early flowering and pod setting. The consistent and balanced nutrient supply from these organic amendments supports optimal plant development, leading to more productive clusters and reduced time to maturity. This synchronization of nutrient release and efficient nitrogen availability provides a growth advantage over other treatments lacking such a harmonious nutrient balance. Choudhary *et al.*, (2017) ^[4] reported from study on effect of bio fertilizers on growth and yield of black gram under the Arid zone of Rajasthan. The result showed that significant earlier flowering and maturity was found in T₅ (Biofertilizer + Black-gram IT1956) with 980kg/ha.

Yield parameters

Number of pods per plant, pod length and seeds per pod

The highest number of pods per plant was recorded in treatment T₆ (1.25 MT Vermicompost + 5 kg Rhizobium ha⁻¹), yielding 22.31 pods, with treatment T₈ (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha⁻¹) following closely at 21.95

Pods. In contrast, the control treatment (T_1) produced the fewest pods, with only 15.22 per plant. The longest pod length, measuring 4.09 cm, was also achieved with treatment T_6 , while T_8 matched this measurement at 4.09 cm. The control group (T_1) had the shortest pod length at 3.55 cm. Additionally, the maximum number of seeds per pod, 6.73, was observed in treatment T_6 , with T_8 producing 6.53 seeds per pod. The control treatment (T_1) recorded the fewest seeds per pod, with only 5.07. The higher number of pods per plant, increased pod length, and more seeds per pod in black gram (table 2) under treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}) result from the enhanced nutrient availability and soil health promoted by this combination. Vermicompost provides a rich source of macro- and micronutrients, humic substances, and growth-promoting hormones, which collectively support robust reproductive development and pod formation. The improved soil structure and moisture retention capacity from organic matter addition further facilitate nutrient uptake and plant vigour. Rhizobium inoculation ensures efficient nitrogen fixation, supplying essential nitrogen that enhances photosynthesis and supports the energy demands for reproductive growth. The synergistic effect of vermicompost and Rhizobium fosters optimal nutrient distribution, leading to longer pods and a higher seed count. In contrast, treatments lacking this precise nutrient balance or microbial support may not achieve the same level of reproductive success, resulting in fewer and smaller pods with fewer seeds. Choudhary *et al.*, (2017) ^[4] reported from study on effect of bio fertilizers on growth and yield of black gram under the Arid zone of Rajasthan. The result showed that significant length of pod, number of seeds per pod, number of pods per plant. The highest number of pods per plant was found in T_5 (Biofertilizer + Black-gram IT1956) with 980kg/ha. Singh *et al.*, (2021) carried out experiment in Randomized Block Design with nine treatments each replicated thrice on the basis of one year experimentation. Vermicompost 6 t/ha + 3% Panchagavya (30, 45 DAS) was recorded significantly higher pods/plant (26.67), Seeds/pod (10.33), Test weight (37.56 g), Seed yield (1098.18 kg/ha as compared to other treatments.

Test weight and yield per hectare

The highest seed index, at 3.86 grams, was achieved with treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}), closely followed by T_8 (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha^{-1}) at 3.61 grams. In contrast, the lowest seed index of 2.98 grams was recorded in the control treatment (T_1). Regarding seed yield per hectare, treatment T_6 again led with 9.31 q/ha, trailed by T_8 at 9.05 q/ha, whereas the control yielded only 4.87 q/ha. Similarly, the highest straw yield per hectare was observed in treatment T_6 at 19.89 q/ha, with T_8 yielding 18.45 q/ha, while the control had the lowest yield at 11.79 q/ha. The superior test weight, seed yield, and straw yield per hectare (table 2) in black gram under treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}), can be attributed to the enhanced nutrient uptake and improved soil health resulting from this optimal combination of organic amendments and biofertilizers. The nutrient-rich vermicompost provides essential elements necessary for seed development, while its organic matter content enhances soil structure and microbial activity, fostering a conducive environment for root growth. This leads to improved access to water and nutrients, facilitating robust plant growth and higher biomass accumulation. The Rhizobium inoculation further optimizes nitrogen fixation, ensuring that plants have sufficient nitrogen to support vigorous growth and development. Consequently, the combined effects of these amendments not only increase individual plant yields but also enhance overall

productivity per hectare by promoting healthy plant growth and maximizing resource utilization, setting T_6 apart from other treatment combinations. Anasuyamma *et al.*, (2022) ^[1] studied effect of organic manures and inorganic fertilizers on the growth and yield of Black gram. The results obtained that the T_4 with the application of Vermicompost 1t/ha + RDF (100%) - 20:40:20 NPK kg/ha was recorded significantly pods per plant (36.33), seeds per pod (7.00), test weight (37.14 g), grain yield (1294 kg/ha). The results obtained with the treatment of T_3 with the Application of Vermicompost 1 t/ha + RDF (75%)- 15:30:15 NPK kg /ha was recorded significantly maximum crop growth rate (11.07 g/m²/day) and relative growth rate (0.04 g/g/day).

Biological yield and harvest index

The highest biological yield, reaching 29.20 q/ha, was recorded in treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}), followed by treatment T_8 (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha^{-1}), which produced 27.50 q/ha. In contrast, the control treatment (T_1) showed the lowest biological yield of 16.66 q/ha. The maximum harvest index, 34.74%, was observed in treatment T_3 (2.5 MT Vermicompost ha^{-1}), which was statistically on par with T_2 (10.0 MT FYM ha^{-1}) at 33.47%. The control group (T_1) had the lowest harvest index at 29.38%. The remarkable biological yield and harvest index (table 2) observed in black gram under treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}) can be primarily attributed to the synergistic effects of vermicompost and Rhizobium on plant growth and development. Vermicompost enriches the soil with essential nutrients, enhances soil structure, and improves water retention capacity, which collectively contribute to increased vegetative and reproductive growth. The nutrient availability from vermicompost promotes healthy root development, enabling plants to absorb nutrients more efficiently, thus leading to greater biomass accumulation. Moreover, the addition of Rhizobium not only improves nitrogen availability through biological fixation but also enhances overall plant vigour and growth. This increased nitrogen supply directly influences photosynthesis and energy production, essential for pod and seed development. The higher biological yield, driven by improved plant growth, is complemented by a favourable harvest index, reflecting the efficiency of resource allocation towards reproductive structures. Consequently, the integration of vermicompost and Rhizobium creates an optimal growth environment, facilitating the production of more biomass while maximizing the proportion of yield derived from economically valuable parts of the plant, resulting in a higher harvest index compared to other treatments. Ghannam *et al.*, (2022) ^[8]; Muwal and Dhaked (2022) ^[14] and Dangmei *et al.*, (2023) ^[15] came up with similar conclusions.

Economics parameters

The highest gross returns, amounting to Rs 1,01,733 ha^{-1} , were recorded in treatment T_6 (1.25 MT Vermicompost + 5 kg Rhizobium ha^{-1}), followed by treatment T_8 (1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg Rhizobium ha^{-1}), which yielded Rs 98,750 ha^{-1} . The control treatment (T_1) had the lowest gross returns at Rs 53,494 ha^{-1} . Similarly, the maximum net returns were observed in treatment T_6 at Rs 70,808 ha^{-1} , with T_8 close behind at Rs 67,391 ha^{-1} , while the control treatment recorded the minimum net returns of Rs 24,819 ha^{-1} . The highest benefit-cost ratio of 3.29 was achieved with treatment T_6 , followed by 3.15 in treatment T_8 (table 3). The control treatment (T_1) had the lowest benefit-cost ratio of 1.87. Similar findings were reported by Kumari *et al.* (2023) ^[13].

Table 1: Effect of different combination of organic and biofertilizers on growth and earliness parameters of black gram

Treatment Symbols	Treatment combination	Plant height (cm)	No of branches per plant	Days to 50% flowering	Days to 50% pod setting	Days to maturity
T ₁	Control	45.07	9.14	43.77	55.33	73.67
T ₂	10.0 MT FYM ha ⁻¹	51.20	11.87	40.67	53.33	71.11
T ₃	2.5 MT Vermicompost ha ⁻¹	53.43	13.67	41.11	52.00	69.46
T ₄	1.0 MT Poultry Manure ha ⁻¹	44.37	13.33	41.00	54.18	71.04
T ₅	5.0 MT FYM + 5 kg <i>Rhizobium</i> ha ⁻¹	49.94	12.80	41.99	52.62	70.42
T ₆	1.25 MT Vermicompost + 5 kg <i>Rhizobium</i> ha ⁻¹	57.29	14.67	38.18	50.33	68.74
T ₇	0.5MT Poultry Manure + 5 kg <i>Rhizobium</i> ha ⁻¹	48.53	10.33	42.67	52.08	70.67
T ₈	1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg <i>Rhizobium</i> ha ⁻¹	54.32	13.92	40.00	51.23	69.33
CD _{0.05}		4.64	1.72	2.90	3.26	3.85
SE. m (±)		1.53	0.57	0.96	1.08	1.27

Table 2: Effect of different combination of organic and biofertilizers on yield parameters in black gram

Treatment Symbols	Treatment combination	No of pods per plant	Pod length (cm)	No of seeds per pod	Seed index (g)	Seed and straw yield per hectare (q/ha)	Straw yield per hectare (q/ha)	Biological yield (q/ha)	Harvest index (%)
T ₁	Control	15.22	3.55	5.07	2.98	4.87	11.79	16.66	29.38
T ₂	10.0 MT FYM ha ⁻¹	16.45	3.41	5.15	3.25	6.90	13.70	20.60	33.47
T ₃	2.5 MT Vermicompost ha ⁻¹	18.71	3.75	5.66	3.40	8.36	15.71	24.07	34.74
T ₄	1.0 MT Poultry Manure ha ⁻¹	16.76	3.46	5.61	3.13	6.02	15.23	21.25	28.34
T ₅	5.0 MT FYM + 5 kg <i>Rhizobium</i> ha ⁻¹	20.73	3.92	6.07	3.75	7.23	17.33	24.56	29.46
T ₆	1.25 MT Vermicompost + 5 kg <i>Rhizobium</i> ha ⁻¹	22.31	4.09	6.73	3.86	9.31	19.89	29.20	31.89
T ₇	0.5MT Poultry Manure + 5 kg <i>Rhizobium</i> ha ⁻¹	20.64	3.72	5.33	3.36	6.26	16.68	22.93	27.29
T ₈	1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg <i>Rhizobium</i> ha ⁻¹	21.95	4.09	6.53	3.61	9.05	18.45	27.50	32.92
CD _{0.05}		2.03	0.50	1.03	0.46	0.48	1.36	1.22	3.25
SE. m (±)		0.67	0.16	0.34	0.15	0.16	0.45	0.40	6.01

Table 3: Economics as influenced by different treatments applied in Black gram

Treatment Symbols	Treatment combination	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	BC ratio
T ₁	Control	28,675	53,494	24,819	1.87
T ₂	10.0 MT FYM ha ⁻¹	34,675	75,156	40,481	2.17
T ₃	2.5 MT Vermicompost ha ⁻¹	30,675	90,956	60,281	2.97
T ₄	1.0 MT Poultry Manure ha ⁻¹	29,425	66,222	36,797	2.25
T ₅	5.0 MT FYM + 5 kg <i>Rhizobium</i> ha ⁻¹	32,925	79,380	46,455	2.41
T ₆	1.25 MT Vermicompost + 5 kg <i>Rhizobium</i> ha ⁻¹	30,925	1,01,733	70,808	3.29
T ₇	0.5MT Poultry Manure + 5 kg <i>Rhizobium</i> ha ⁻¹	30,300	69,030	38,730	2.28
T ₈	1.25 MT FYM + 0.62 MT VC + 0.25 MT PM + 5 kg <i>Rhizobium</i> ha ⁻¹	31,359	98,750	67,391	3.15
Selling price of Black gram: Rs 105/kg Selling price of straw: Rs 2/kg					

Conclusion

The overall results obtained from this present investigation clearly revealed that the application of T₆ (1.25 MT Vermicompost + 5 kg *Rhizobium* ha⁻¹) showed the better performance for vegetative growth viz., plant height (57.29 cm), number of branches per plant (14.67 branches), yield attributes like number of pods per plant (22.31 pods), seed yield (9.31 q/ha), highest seed index, at 3.86 and better harvest index (31.89%) of Black gram. T₆ also recorded highest net return of Rs 70,808 ha⁻¹ and benefit cost ratio of 3.29. Thus, use of potassium at higher dose may be suggested for higher crop productivity along with over all betterment of black gram under Balaghat (M.P.) conditions.

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