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Response of inorganic and organic fertilizers on yield potential of pigeon pea (*Cajanus cajan* L.)

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Abstract

The present study was conducted to elucidate the impact of diverse organic and inorganic fertilizers on the growth dynamics and productivity of the pigeon pea variety IPA 203. The field experiment was carried out at the Department of Agronomy, School of Agriculture Research and Technology, Sardar Patel University, Balaghat (M.P.) during the Kharif season of 2023. Employing a Randomized Block Design (RBD), the trial comprised 12 treatments, each replicated thrice. The treatment structure included T₀ (Control), T₁ (100% RDF [NPK: 30:50:30 kg/ha]), T₂ (100% Farmyard Manure (FYM)), T₃ (100% Vermicompost (VC)), T₄ (100% Poultry Manure (PM)), T₅ (75% VC + 25% FYM), T₆ (75% PM + 25% VC), T₇ (75% PM + 25% FYM), T₈ (50% VC + 50% FYM), T₉ (50% PM + 50% VC), T₁₀ (50% PM + 50% FYM), and T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM). The findings of the investigation unequivocally demonstrated that the integration of organic and inorganic fertilizers significantly augmented the growth parameters and yield attributes of pigeon pea. Among the tested treatments, T₁ (100% RDF-NPK at 30:50:30 kg/ha) exhibited superior agronomic performance, producing the tallest plants, the highest number of branches, an elevated nodule count, and the greatest seed and stover yields. The highest seed yield per hectare (21.01 q/ha), and test weight (10.47 g) were recorded under T₁, underscoring the pivotal role of balanced nutrient supply in facilitating vigorous vegetative growth and optimizing seed production. Notably, the organic treatment T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM) demonstrated commendable performance, yielding a plant height of 100.98 cm at 60 DAS, 27.56 branches per plant at 60 DAS, 14.00 nodules per plant, a test weight of 10.20 g, and a total seed yield of 20.69 q/ha. The synergistic action of FYM, VC, and PM in T₁₁ contributed to enhanced soil fertility, microbial activity, and nutrient availability, thereby fostering robust plant growth and productivity. Furthermore, T₁₁ recorded the highest harvest index (29.51%), reflecting the efficient translocation of assimilates towards reproductive growth. From an economic standpoint, both T₁ and T₁₁ exhibited the highest net returns and benefit-cost ratios, establishing themselves as the most financially viable nutrient management strategies for pigeon pea cultivation. Therefore, a strategic integration of inorganic and organic fertilizers is recommended to maximize productivity and profitability. Beyond the sole application of RDF, the incorporation of 33.33% FYM + 33.33% VC + 33.33% PM and 50% VC + 50% FYM is advocated to enhance crop performance and ensure sustainable pigeon pea production under the agro-climatic conditions of Balaghat (M.P.).

Keywords: Benefit cost ratio, harvest index, vermicompost, poultry manure pigeon Pea

Introduction

Pigeon pea (*Cajanus cajan* L. Huth), a hardy leguminous crop, is distinguished by its deep-rooting system and remarkable drought resilience. It constitutes a crucial source of dietary protein across several nations, particularly India. Notable for its nitrogen-fixing ability through symbiosis with rhizobium and its capacity to extract moisture from deeper soil strata, pigeon pea thrives in tropical and subtropical regions worldwide. It is extensively cultivated across South Asia, Southeast Asia, Africa, Latin America, and the Caribbean (Kingwell-Banham and Fuller, 2014) [13]. As a perennial species within the Fabaceae family, it is indigenous to the Eastern Hemisphere (Upadhyaya *et al.*, 2013) [22]. Its exceptional drought tolerance renders it a dietary staple in arid and semi-arid regions (ICRISAT). Pigeon pea seeds serve as an economical and nutrient-rich complement to staple cereals such as maize, wheat, and rice, forming a dietary cornerstone in numerous African, Asian, and South American nations. They provide a balanced composition of proteins, carbohydrates, essential minerals, and B-complex vitamins, making them indispensable in vegetarian diets. When consumed alongside cereals, pigeon pea enhances

dietary protein intake, offering a nutritional profile comparable to other high-protein sources like whey and soy (Akporthor *et al.*, 2006) [12]. Beyond its nutritional significance, pigeon pea exhibits medicinal attributes due to its abundance of polyphenols and flavonoids, compounds known for their therapeutic potential (Singh *et al.*, 2016) [16]. Studies further underscore its role in human health, with evidence linking its consumption to a diminished risk of various chronic ailments (Singh and Basu, 2012) [17]. Pigeon pea, a long-duration pulse crop, thrives predominantly in nutrient-deficient soils under rainfed conditions, exhibiting remarkable adaptability to low-input and challenging agro-ecosystems. It holds immense dietary significance among pulses, serving as a vital protein source. The grain composition of pigeon pea includes 23.3% protein, 3.5% minerals, and 57.6% carbohydrates, delivering an energy value of 335 kcal per 100 grams. While its dry split dhal is a dietary staple, tender green seeds are consumed as vegetables, and its stems and roots serve as a sustainable source of fuelwood. The suboptimal yield of pigeon pea is not solely attributable to its cultivation on sub-marginal lands but is also exacerbated by inadequate crop management and soil moisture deficits during critical phenological stages, such as flowering and pod development, which precipitate substantial reductions in grain yield (Pandey *et al.*, 2015) [14]. Furthermore, the indiscriminate and imbalanced application of fertilizers has led to diminished productivity, soil fertility degradation, and the emergence of multifaceted nutrient deficiencies. Integrating farmyard manure (FYM) with inorganic fertilizers ameliorates soil structure, augments water retention capacity, and enhances overall agroecosystem productivity. The residual effects of organic nutrient amendments in preceding crops confer significant benefits to succeeding crops, thereby ensuring long-term sustainability in agricultural production systems. Empirical studies conducted by Ismail *et al.* (1994) [11] underscore the profound influence of conservation tillage on improving the physical and chemical properties of soil. Organic inputs, encompassing plant and animal-derived residues, serve as vital nutrient reservoirs that undergo mineralization through microbial decomposition. The tradition of employing organic matter, such as animal, human, and plant waste, to augment crop productivity dates back to the advent of agriculture. Manures, derived from the decomposition of biological residues, encapsulate an array of essential nutrients in complex organic matrices, whereas fertilizers—whether naturally sourced or synthetically manufactured—are explicitly designed to supply crops with readily available nutrients. While fertilizers provide a higher nutrient concentration per unit, manures, despite their relatively lower nutrient content, exert a more profound and enduring impact on soil fertility and crop health by fostering soil microbial diversity and improving soil physicochemical attributes. Vermicomposting, an advanced organic waste management practice involving the cultivation of earthworms for the bioconversion of organic matter, yields Vermicompost, a nutrient-dense organic amendment. This biofertilizer is enriched with essential macronutrients, including nitrogen (2-3%), phosphorus (1.55-2.25%), and potassium (1.85-2.25%), along with a plethora of micronutrients, beneficial soil microbiota, plant growth hormones, and enzymatic compounds. Research by Tiwari and Singh (2021) [19] corroborates that Vermicompost not only enhances plant growth and vigour but also fortifies plants against pest infestations and disease outbreaks. Consequently, it emerges as a crucial component in sustaining soil fertility and bolstering plant development across both agricultural and horticultural landscapes. In recent years, the integration of

biostimulants in agronomic practices has gained prominence, particularly within organic farming paradigms, further underscoring their pivotal role in enhancing crop resilience and productivity.

Materials and Methods

This study aimed to explore how varying levels of organic and inorganic fertilizers on growth and yield of pigeonpea variety IPA-203. 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 Rabi 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 consisted of T₀ (Control), T₁ (100% RDF [NPK: 30:50:30 kg/ha]), T₂ (100% Farmyard Manure (FYM)), T₃ (100% Vermicompost (VC)), T₄ (100% Poultry Manure (PM)), T₅ (75% VC + 25% FYM), T₆ (75% PM + 25% VC), T₇ (75% PM + 25% FYM), T₈ (50% VC + 50% FYM), T₉ (50% PM + 50% VC), T₁₀ (50% PM + 50% FYM), and T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM) each replicated thrice. The height of five randomly selected grafted plants from each plot was measured in centimeters using a meter scale, from the ground level to the tip of the shoot, at 20, 40, and 60 days after sowing (DAS). The average plant height for each replication was recorded and subjected to statistical analysis. Similarly, the total number of trifoliate leaves that emerged in plants was counted at 20, 40, and 60 DAS and documented accordingly. The number of branches per plant was determined by counting branches in randomly selected plants from each plot at 40 and 60 DAS. The average number of branches per plant for each replication was then recorded and analyzed statistically. To assess root nodulation, plants were uprooted at 35 DAS, and the total number of root nodules formed was counted and documented. Additionally, the number of flower pods set per plant was counted and recorded to determine the number of pods per plant for each treatment and replication. The collected data was subjected to statistical analysis. The 1000-seed weight was measured using a physical balance from seeds obtained from five randomly selected plants, and the average weight was recorded and analyzed statistically. The total seed yield/hectare was calculated by unitary method formula given below:

$$\text{Seed Yield per plot} = \frac{\text{Total seed yield}}{\text{Number of plots}}$$

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

Harvest index was computed by using following formula as suggested by Singh and Stoskoff (1971) [18]. The harvest index was worked out by using following formula:

$$\text{Seed yield (g)} = \frac{\text{Total seed yield}}{\text{Number of plants}}$$

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

The statistical analysis was conducted using Fisher and Yates (1963) [9].

Results and Discussion

In 2024, India surpassed China to become the world's most populous country, with its population expected to grow from 1.38 billion to nearly 1.5 billion by 2030. This demographic expansion necessitates a rise in food production from 309

million tonnes in 2020-21 to 345 million tonnes by 2030 (Sharma, 2021) ^[15]. Given that India possesses only 2.4% of the world's land while supporting 18% of the global population, small and marginal farmers play a crucial role in ensuring food security. However, feeding this growing population is challenging due to climate change, water scarcity, and the decreasing availability of arable land. Organic fertilizers present a viable solution for improving environmental sustainability and plant growth. Derived from composted animal manure, human waste, household refuse, municipal and agricultural residues, and plant material, organic fertilizers enhance soil organic matter (SOM), soil structure, and nutrient availability while boosting microbial activity, ultimately increasing crop productivity. Additionally, they improve soil cation exchange capacity (CEC), moisture retention, and modify the characteristics of acidic soils and soil fauna community structure (Zhou *et al.*, 2022) ^[23]. The application of organic fertilizers also promotes the stability and formation of earthworm populations by providing stable nutrients from manure following aerobic fermentation. In contrast, prolonged use of chemical fertilizers depletes SOM, leading to soil acidification, crust formation, and disruption of microbial communities. The integration of organic fertilizers reduces dependency on synthetic inputs, thereby enhancing soil health, environmental quality, and agricultural productivity (Bertrand *et al.*, 2015) ^[5]. Organic fertilizers play a vital role in revitalizing soil due to their high SOM and nutrient content. Their application can potentially reduce chemical fertilizer usage by 50%, lowering production costs while improving soil fertility for enhanced crop yields. Rich in both micro and macronutrients, organic fertilizers serve as a crucial nitrogen source for crops. Various studies highlight the positive effects of farmyard manure, slurry, and compost in increasing the yield and quality of crops like tomatoes, maize, and rice. Moreover, organic fertilizers enhance the physicochemical and biological properties of soil, ensuring better nutrient availability and supporting sustainable agro ecosystems. Animal waste remains the largest source of organic manure worldwide, with poultry and pig manure also contributing significantly. The rising demand for milk and beef has led to a 5% increase in cattle production, subsequently increasing the availability of cattle manure, a valuable input for soil fertility and environmental sustainability (Ahmed *et al.*, 2016) ^[1]. Globally, animal manure contributes between 81.5 to 128.3 Tg y⁻¹ of nitrogen, serving as a sustainable source of essential nutrients like nitrogen, phosphorus, and potassium (NPK).

A) Growth parameters

1. Plant height and number of trifoliate leaves per plant.

The highest height of plant (28.64, 62.32 and 102.40 cm) observed at 20, 40 and 60 DAS respectively (table 1), with treatment T₁ (100% RDF-NPK: 30:50:30 kg/ha) leading the results. Treatment T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM) followed closely, for height of plant with 26.42, 61.60 and 100.98 cm at the same intervals while T₈ (50% VC + 50% FYM) coming next with 24.80, 57.60 and 97.04 cm. In contrast, the T₀ (control) exhibited the lowest plant height of 18.60, 41.69 and 80.90 cm observed at 20, 40 and 60 DAS respectively. Among the treatments, the highest number of trifoliate leaves—25.65, 36.97, and 50.19 at 20, 40, and 60 DAS, respectively—was achieved under treatment T₁ (100% RDF-NPK: 30:50:30 kg/ha). Close behind was treatment T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM), which recorded 23.90, 35.48, and 47.86 leaves at the corresponding intervals. Treatment T₈ (50% VC + 50% FYM) ranked third, with 22.86, 34.67, and 46.48 leaves.

Conversely, the control (T₀) exhibited the lowest trifoliate leaf count, with 18.31, 30.61, and 42.78 leaves recorded at 20, 40, and 60 DAS, respectively. The improved plant height and number of trifoliate leaves observed in pigeon pea treated with 100% RDF-NPK (30:50:30 kg/ha) can be attributed to the balanced nutrient supply provided by the full dose of essential macronutrients—nitrogen, phosphorus, and potassium. These nutrients are crucial for promoting vegetative growth, enhancing cell division, and improving photosynthesis, which directly contributes to better plant stature and leaf development. Among organic treatments, the combination of 33.33% FYM + 33.33% VC + 33.33% PM (T₁₁) exhibited optimal growth. This balanced mix of organic fertilizers likely ensured a steady release of nutrients over time, improving soil structure and microbial activity. The organic matter from FYM enhances soil fertility, while vermicompost (VC) and poultry manure (PM) provide essential micro and macronutrients, further supporting plant growth. This synergy between organic inputs promotes healthier root development and increases nutrient availability, leading to better vegetative growth and more trifoliate leaves. The combination of 50% VC + 50% FYM (T₈) also performed well, providing adequate organic matter and nutrients, although the absence of PM may have slightly limited the results compared to T₁₁. Nonetheless, these organic fertilizers significantly outperformed other treatments in supporting vegetative growth and leaf production. Bellitürk *et al.*, 2015 ^[4]; and Du *et al.*, 2020 ^[8] also reported findings that were similar.

2. Number of branches per plant and number of nodules per plant

Among the treatments (table 2), the highest number of branches—22.48 and 27.56 branches at 40, and 60 DAS, respectively—was achieved under treatment T₁ (100% RDF-NPK: 30:50:30 kg/ha). Close behind was treatment T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM), which recorded 22.33 and 26.23 branches at the corresponding intervals. Treatment T₈ (50% VC + 50% FYM) ranked third, with 20.67 and 26.22 branches. Conversely, the control (T₀) exhibited the lowest branch count, with 10.67 and 16.23 branches recorded at 40, and 60 DAS, respectively. Among the treatments, the highest number of nodules—14.33 nodules were achieved under treatment T₁ (100% RDF-NPK: 30:50:30 kg/ha). Atpar was treatment T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM), which recorded 14.00 nodules followed by T₈ (50% VC + 50% FYM) ranking third, with 12.83 nodules. Conversely, the control (T₀) exhibited the lowest nodules count, with 8.33 nodules recorded at 35 DAS. The increased number of branches and nodules per plant in pigeon pea treated with 100% RDF-NPK (30:50:30 kg/ha) is attributed to the comprehensive nutrient supply from balanced doses of nitrogen, phosphorus, and potassium. Nitrogen promotes vegetative growth and branching, while phosphorus enhances root development, ensuring better nodule formation. Potassium aids in overall plant vigour and stress tolerance, leading to a more robust root system and increased branching. Among the organic treatments, the combination of 33.33% FYM + 33.33% VC + 33.33% PM (T₁₁) performed best, as it provided a well-rounded mix of nutrients that enhanced soil health, microbial activity, and nutrient cycling. The organic matter from FYM improves soil structure, facilitating better root expansion, while vermicompost and poultry manure supply essential micronutrients and growth-promoting hormones that foster branching and nodule formation. This organic synergy leads to a more extensive root system capable of supporting more branches and nodules. The treatment

with 50% VC + 50% FYM (T_8) also showed good results, though the lack of poultry manure may have slightly limited the response compared to T_{11} . Nonetheless, these organic inputs still improved root and shoot development, contributing to better branching and nodule formation. Tejasvi and Kumar 2012 ^[21]; Dhaliwal *et al.*, 2019 ^[7]; and Du *et al.*, 2020 ^[8] also reported findings that were similar.

B) Yield parameters

1. Number of pods per plant and seeds per pod

Among the treatments (table 2), T_1 (100% RDF-NPK: 30:50:30 kg/ha) recorded the highest number of pods, with 22.67 pods per plant. Closely comparable was T_{11} (33.33% FYM + 33.33% VC + 33.33% PM), which produced 22.00 pods per plant, followed by T_8 (50% VC + 50% FYM) with 21.00 pods, securing the third position. In contrast, the control treatment (T_0) demonstrated the lowest pod count, with only 15.00 pods per plant. Among the treatments, T_1 (100% RDF-NPK: 30:50:30 kg/ha) recorded the highest number of seeds per pod, with 8.33 seeds per pod. At par with T_{11} (33.33% FYM + 33.33% VC + 33.33% PM), which produced 8.33 seeds per pod, followed by T_8 (50% VC + 50% FYM) with 8.00 seeds, securing the third position. In contrast, the control treatment (T_0) demonstrated the lowest seed count, with only 5.00 seeds per pod. The increased number of pods per plant, seeds per pod in pigeon pea treated with 100% RDF-NPK (30:50:30 kg/ha) can be attributed to the optimal nutrient balance provided, particularly in nitrogen, phosphorus, and potassium. Nitrogen plays a crucial role in promoting the development of flowers and pods, while phosphorus is essential for enhancing flowering and seed setting. Potassium contributes to improved photosynthetic efficiency, facilitating better nutrient transport and utilization, which directly results in higher pod production and seed yield. Among the organic treatments, the mixture of 33.33% FYM, 33.33% VC, and 33.33% PM (T_{11}) proved to be the most effective. The organic matter from FYM enhances soil structure and water retention, fostering an environment conducive to root growth and nutrient uptake. Additionally, vermicompost and poultry manure increase nutrient availability, boost microbial activity, and stimulate plant growth hormones, all of which support improved flowering, pod formation, and seed setting, leading to a rise in pod and seed counts per plant. The combination of 50% VC and 50% FYM (T_8) also yielded favourable outcomes; however, the lack of poultry manure may have restricted some growth-enhancing factors. Nevertheless, the organic inputs in T_8 still contributed to enhanced overall plant productivity, resulting in a notable increase in pods per plant, seeds per pod, and seed yield compared to other treatments. Similar findings were reported by Tejasvi and Kumar 2012 ^[21]; Gadi *et al.*, 2017 ^[10]; Bhavya *et al.*, 2018 ^[6] and Kumar *et al.*, 2021 ^[12].

2. Seed yield; Straw yield; test weight and harvest index

Among the treatments (table 3), T_1 (100% RDF-NPK: 30:50:30 kg/ha) recorded the highest test weight, with 10.47 grams. At par with T_{11} (33.33% FYM + 33.33% VC + 33.33% PM), which produced 10.20 grams, followed by T_8 (50% VC + 50% FYM) with 9.74 grams, securing the third position. In contrast, the control treatment (T_0) demonstrated the lowest test weight, with only 7.87 grams. Among the treatments, T_1 (100% RDF-NPK: 30:50:30 kg/ha) recorded the highest seed and stover yield, with 21.01 and 51.01 q/ha respectively. At par with T_{11} (33.33% FYM + 33.33% VC + 33.33% PM), which produced 20.69 q/ha for seed yield and 49.43 for stover, followed by T_8 (50% VC +

50% FYM) with 19.19 and 48.78 q/ha respectively, securing the third position. In contrast, the control treatment (T_0) demonstrated the lowest seed and stover yield, with only 8.04 and 39.82 q/ha respectively. Among the treatments, T_{11} (33.33% FYM + 33.33% VC + 33.33% PM) recorded the highest harvest index, with 29.51%. At par with T_1 (100% RDF-NPK: 30:50:30 kg/ha), which produced 29.16%, followed by T_9 (50% PM + 50% FYM) with 29.83%, securing the third position. In contrast, the control treatment (T_0) demonstrated the lowest harvest index, with only 16.81%. The enhanced seed yield, straw yield, test weight, and harvest index observed in pigeon pea treated with 100% RDF-NPK (30:50:30 kg/ha) can be linked to the well-balanced and sufficient provision of vital nutrients. Nitrogen fosters vigorous vegetative growth and optimal pod development, phosphorus supports flowering and seed formation, while potassium plays a crucial role in effective photosynthesis, water management, and nutrient absorption. These elements collectively enhance plant growth, increase seed production, and elevate the harvest index, which represents the ratio of seed yield to total biomass. The balanced nutrient supply from RDF-NPK also facilitates improved seed filling and overall plant health, resulting in greater test weight and seed yield per plant. Among the organic treatments, the blend of 33.33% FYM + 33.33% VC + 33.33% PM (T_{11}) yielded the best results. The organic components in this treatment enhance soil structure, water retention, and nutrient availability through microbial activity and the gradual release of organic matter. The combined nutrient input from FYM, vermicompost, and poultry manure encourages better vegetative growth, an increase in pod numbers, and improved seed setting, leading to higher seed yield and test weight. Furthermore, this combination aids in maintaining soil fertility and enhances microbial activity, which further promotes overall plant health and productivity. The treatment with 50% VC + 50% FYM (T_8) also demonstrated positive outcomes, although its slightly lower diversity in organic inputs compared to T_{11} may have restricted its full potential regarding yield and harvest index. Nevertheless, it still resulted in significant improvements in seed and straw yield, test weight, and harvest index compared to other organic treatments. Findings were in accordance with findings of Armin *et al.*, 2016 ^[3]; Gadi *et al.*, 2017 ^[10]; Bhavya *et al.*, 2018 ^[6] and Kumar *et al.*, 2021 ^[12].

C) Economics parameters

Maximum cost of cultivation (table 4) was recorded in treatment T_1 (100% RDF [NPK: 30:50:30 kg/ha]) with (Rs 41,182 ha⁻¹) followed by T_4 (100% Poultry Manure) having Rs 40,900 ha⁻¹ and the minimum (Rs 37,100 ha⁻¹) was recorded in treatment T_0 (Control). Maximum gross returns were recorded in treatment T_1 (100% RDF [NPK: 30:50:30 kg/ha]) with (Rs 1,89,060 ha⁻¹) followed by T_{11} (33.33% FYM + 33.33% VC + 33.33% PM) having Rs 1,86,210 ha⁻¹ and the minimum (Rs 72,360 ha⁻¹) was recorded in treatment T_0 (Control). Maximum net returns were recorded in treatment T_1 (100% RDF [NPK: 30:50:30 kg/ha]) with (Rs 1,47,878 ha⁻¹) followed by T_{11} (33.33% FYM + 33.33% VC + 33.33% PM) having Rs 1,45,993 ha⁻¹ and the minimum (Rs 35,260 ha⁻¹) was recorded in treatment T_0 (Control). Highest benefit cost ratio was recorded in treatment T_{11} (33.33% FYM + 33.33% VC + 33.33% PM) with 4.63 followed by T_1 (100% RDF [NPK: 30:50:30 kg/ha]) having 4.59 and the minimum (1.95) was recorded in treatment T_0 (Control). Similar findings were reported by Bhavya *et al.*, 2018 ^[6] and Tadewos *et al.*, 2021 ^[20].

Table 1: Effect of different organic and inorganic fertilizers on plant height and number of trifoliolate leaves per plant of pigeon pea

Treatment Symbols	Treatment combination	Plant height (cm)			No of trifoliolate leaves per plant		
		At 20 DAS	At 40 DAS	At 60 DAS	At 20 DAS	At 40 DAS	At 60 DAS
T ₀	Control	18.60	41.69	80.90	18.31	30.61	42.78
T ₁	100% RDF [NPK: 30:50:30 kg/ha]	28.64	62.32	102.40	25.65	36.97	50.19
T ₂	100% Farmyard manure (FYM)	23.82	46.80	87.62	23.27	33.30	45.48
T ₃	100% Vermicompost (VC)	22.93	47.07	81.68	23.17	33.52	45.69
T ₄	100% Poultry Manure (PM)	23.02	55.17	86.94	22.18	34.48	46.65
T ₅	75% VC + 25% FYM	20.72	43.48	88.42	20.87	33.17	45.35
T ₆	75% PM + 25% VC	22.70	55.76	93.34	22.53	34.83	47.00
T ₇	75% PM + 25% FYM	24.73	56.12	95.54	20.53	32.83	45.00
T ₈	50% VC + 50% FYM	24.80	57.60	97.04	22.86	34.67	46.48
T ₉	50% PM + 50% VC	22.76	53.01	91.68	19.48	31.78	43.23
T ₁₀	50% PM + 50% FYM	23.79	51.76	92.83	21.47	33.77	45.95
T ₁₁	33.33% FYM + 33.33% VC + 33.33% PM	26.42	61.60	100.98	23.90	35.48	47.86
CD _{0.05}		2.17	3.43	4.21	2.80	NS	3.58
SE. m ($\pm$)		0.74	1.17	1.43	0.95	-	1.22

Table 2: Effect of different organic and inorganic fertilizers on number of branches, root nodules, pods per plant and seeds per pod of pigeon pea

Treatment Symbols	Treatment combination	No of branches per plant		No of root nodules per plant	No of pods per plant	No of seeds per pod
		At 40 DAS	At 60 DAS			
T ₀	Control	10.67	16.23	8.33	15.00	5.00
T ₁	100% RDF [NPK: 30:50:30 kg/ha]	22.48	27.56	14.33	22.67	8.33
T ₂	100% Farmyard manure (FYM)	18.00	23.56	9.33	17.00	7.00
T ₃	100% Vermicompost (VC)	16.00	21.56	9.67	17.33	7.33
T ₄	100% Poultry Manure (PM)	16.67	22.23	10.00	17.00	7.67
T ₅	75% VC + 25% FYM	15.67	21.27	12.17	18.00	7.33
T ₆	75% PM + 25% VC	20.00	25.71	10.00	20.33	7.33
T ₇	75% PM + 25% FYM	20.33	26.05	9.67	19.29	8.00
T ₈	50% VC + 50% FYM	20.67	26.22	12.83	21.00	8.00
T ₉	50% PM + 50% VC	20.33	26.05	10.00	18.67	7.33
T ₁₀	50% PM + 50% FYM	20.33	21.04	11.00	18.33	7.33
T ₁₁	33.33% FYM + 33.33% VC + 33.33% PM	22.33	26.23	14.00	22.00	8.33
CD _{0.05}		2.11	2.44	1.70	1.86	1.34
SE. m ($\pm$)		0.72	0.83	0.58	0.64	0.46

Table 3: Effect of different organic and inorganic fertilizers on yield parameters of pigeon pea

Treatment Symbols	Treatment combination	Seed yield (q/ha)	Stover yield (q/ha)	Test weight (grams)	Harvest index (%)
T ₀	Control	8.04	39.82	7.87	16.81
T ₁	100% RDF [NPK: 30:50:30 kg/ha]	21.01	51.01	10.47	29.16
T ₂	100% Farmyard manure (FYM)	16.99	44.46	8.32	27.68
T ₃	100% Vermicompost (VC)	16.79	45.11	8.51	27.12
T ₄	100% Poultry Manure (PM)	17.06	45.09	8.46	27.36
T ₅	75% VC + 25% FYM	16.50	45.59	9.44	26.57
T ₆	75% PM + 25% VC	18.42	46.19	9.57	28.50
T ₇	75% PM + 25% FYM	17.72	46.38	9.17	27.62
T ₈	50% VC + 50% FYM	19.19	48.78	9.74	28.24
T ₉	50% PM + 50% VC	18.45	45.71	8.87	28.79
T ₁₀	50% PM + 50% FYM	18.65	43.88	8.94	29.83
T ₁₁	33.33% FYM + 33.33% VC + 33.33% PM	20.69	49.43	10.20	29.51
CD _{0.05}		1.62	2.94	0.42	1.75
SE. m ($\pm$)		0.55	1.01	0.14	0.60

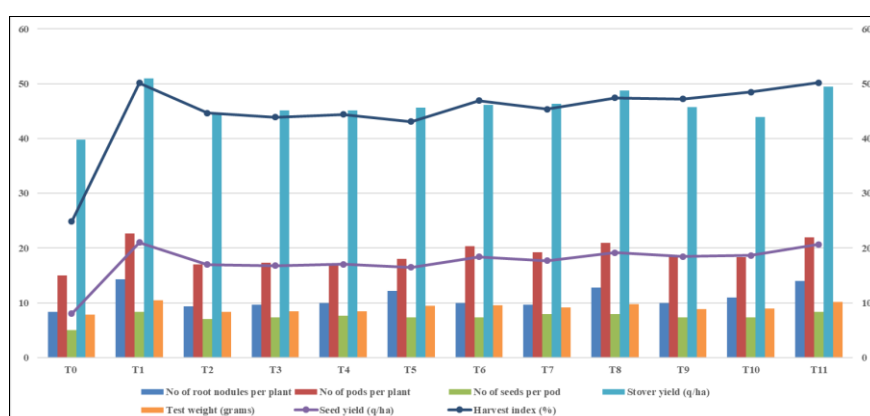
**Fig 1:** Graphical representation of effect of different organic and inorganic fertilizers on yield parameters of pigeon pea

Table 4: Economics as influenced by different treatments applied in pigeon pea

Treatment Symbols	Treatment combination	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	BC ratio
T ₀	Control	37,100	72,360	35,260	1.95
T ₁	100% RDF [NPK: 30:50:30 kg/ha]	41,182	1,89,060	1,47,878	4.59
T ₂	100% Farmyard manure (FYM)	40,700	1,52,880	1,12,180	3.76
T ₃	100% Vermicompost (VC)	39,300	1,51,110	1,11,810	3.85
T ₄	100% Poultry Manure (PM)	40,900	1,53,540	1,12,640	3.75
T ₅	75% VC + 25% FYM	39,350	1,48,470	1,09,120	3.77
T ₆	75% PM + 25% VC	40,500	1,65,780	1,25,280	4.09
T ₇	75% PM + 25% FYM	40,850	1,59,450	1,18,600	3.90
T ₈	50% VC + 50% FYM	40,000	1,72,680	1,32,680	4.32
T ₉	50% PM + 50% VC	40,100	1,66,050	1,25,950	4.14
T ₁₀	50% PM + 50% FYM	40,800	1,67,850	1,27,050	4.11
T ₁₁	33.33% FYM + 33.33% VC + 33.33% PM	40,217	1,86,210	1,45,993	4.63
Selling price of pigeon pea: Rs 90/kg					

Conclusion

The findings of this research clearly demonstrate that utilizing a combination of inorganic and organic fertilizers significantly enhances the growth and yield of pigeon pea. Among the various treatments, the 100% RDF-NPK (30:50:30 kg/ha) treatment (T₁) consistently showed superior results, producing the tallest plants, the highest number of branches, increased nodule counts, and better seed and stover yields. Specifically, T₁ achieved the highest test weight of 10.47 grams, highlighting its effective nutrient supply that fostered vigorous plant growth and optimal seed production. Organic treatments, especially T₁₁ (33.33% FYM + 33.33% VC + 33.33% PM), also yielded commendable results, nearly matching the inorganic treatment in growth metrics such as plant height (100.98 cm at 60 DAS), branches per plant (27.56 at 60 DAS), nodules per plant (14.00), test weight (10.20 grams), and a seed yield of 20.69 q/ha. The integrated nutrient supply from farmyard manure (FYM), vermicompost (VC), and poultry manure (PM) in T₁₁ improved soil fertility, microbial activity, and nutrient availability, resulting in enhanced growth and productivity. Additionally, T₁₁ achieved the highest harvest index at 29.51%, indicating effective biomass utilization for seed production. From an economic standpoint, both T₁ and T₁₁ provided the highest net returns and benefit-cost ratios, establishing them as the most financially viable options for pigeon pea cultivation. Therefore, adopting a balanced strategy that includes both inorganic and organic fertilizers can significantly boost productivity and profitability in pigeon pea farming.

References

- Ahmed K, Qadir G, Jami AR, Saqib AI, Nawaz MQ, Kamal MA, *et al.* Strategies for soil amelioration using sulphur in salt-affected soils. *Cercetări Agronomice în Moldova*. 2016;49:5-16.
- Akporhonor EE, Egwaikhide PA, Eguavoen IO. Effect of sprouting on *in vitro* digestibility of some locally consumed leguminous seeds. *Journal of Applied Sciences and Environmental Management*. 2006;10:55-58.
- Armin W, Ashraf-Uz-Zaman K, Zamil SS, Rabin MH, Bhadra AK, Khatun F. Combined effect of organic and inorganic fertilizers on the growth and yield of mungbean (Bari Mung 6). *International Journal of Scientific and Research Publications*. 2016;6(7):557.
- Bellitürk K, Shrestha P, Görres JH. The importance of phytoremediation of heavy metal contaminated soil using vermicompost for sustainable agriculture. *Rice Research: Open Access*. 2015;3:14.
- Bertrand M, Barot S, Blouin M, Whalen J, Oliveira T, Roger-Estrade J. Earthworm services for cropping systems: a review. *Agronomy for Sustainable Development*. 2015;35:553-567.
- Bhavya G, Chandra Shaker K, Jayasree G, Malla Reddy M. Nutrient uptake and yield of green gram (*Vigna radiata* L.) as influenced by phosphorus fertilization, organic manures and biofertilizers. *International Journal of Chemical Studies*. 2018;6(3):32-35.
- Dhaliwal SS, Naresh RK, Mandal A, Walia MK, Gupta RK, Singh R, *et al.* Effect of manures and fertilizers on soil physical properties, build-up of macro and micronutrients and uptake in soil under different cropping systems: a review. *Journal of Plant Nutrition*. 2019;42(20):73.
- Du Y, Cui B, Zhang Q, Wang Z, Sun J, Niu W. Effects of manure fertilizer on crop yield and soil properties in China: a meta-analysis. *Catena*. 2020;193:104617.
- Fisher RA, Yates F. Statistical tables for biological, agricultural and medical research. London: Oliver and Boyd; 1963. p. 143.
- Gadi P, Dawson J, Shankar M. Effect of different organic manures, inorganic fertilizers, and growth regulator on yield attributes and yield of green gram (*Vigna radiata* L.). *Hind Agricultural Research and Training Institute*. 2017;2(2):55-59.
- Ismail I, Blevins RL, Frye WW. Long-term no-tillage effects on soil properties and continuous corn yields. *Soil Science Society of America Journal*. 1994;58:193-198.
- Kumar SG, Dawson J, Pavithra BV. Effect of spacing and organic manures on growth and yield of greengram (*Vigna radiata* L.). *The Pharma Innovation Journal*. 2021;10(12):1612-1617.
- Kingwell-Banham E, Fuller DQ. Pigeon pea: origins and development. In: *Encyclopedia of Global Archaeology*. 2014. p. 5941-5944.
- Pandey IB, Pandey RK, Kumar R. Integrated nutrient management for enhancing productivity and profitability of long duration pigeon pea under rainfed condition. *Indian Journal of Agronomy*. 2015;60:436-442.
- Sharma M. The future of Indian agriculture. *Down to Earth*. 2021 Feb 4. <https://www.downtoearth.org.in>. Accessed 2021 Aug 10.
- Singh U, Praharaj CS, Singh SS, Singh NP. Biofortification of food crops. New Delhi: Springer India; 2016. p. 286-292.
- Singh J, Basu P. Non-nutritive bioactive compounds in pulses and their impact on human health: an overview. *Food and Nutrition Sciences*. 2012;3:1664-1672.
- Singh ID, Stoskoff YC. Harvest index in cereals. *Agronomy Journal*. 1971;63:224-226.

19. Tiwari H, Singh T. Response of organic manure and seed rate on growth, yield and quality of linseed (*Linum usitatissimum* L.). Indian Journal of Pure and Applied Biosciences. 2021;9(6):8-12.
20. Tadewos T, Ayalew T, Yoseph T. Effect of biological and chemical fertilizers combination on yield of mung bean (*Vigna radiata* L. Wilczek). International Journal of Plant and Soil Science. 2021;5(5):589-594.
21. Tejasvi A, Kumar S. Impact of fly ash on soil properties. National Academy Science Letters. 2012;35:13-16.
22. Upadhyaya HD, Sharma S, Reddy KN, Saxena R, Varshney RK, Gowda CLL. Pigeon pea. In: Genetic and genomic resources of grain legume improvement. 2013. p. 181-202.
23. Zhou Z, Zhang S, Jiang N, Xiu W, Zhao J, Yang D. Effects of organic fertilizer incorporation practices on crops yield, soil quality, and soil fauna feeding activity in the wheat-maize rotation system. Frontiers in Environmental Sciences. 2022;10:2292.