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SG Aiholli
M. Sc. Scholar, Agronomy Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

SC Wadile
Associate Professor, Agronomy Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

PM Jagtap
M. Sc. Scholar, Agronomy Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

PP Pawar
Associate Professor, Agronomy Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

VP Bhalerao
Professor, Soil Science Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

RT Surywanshi
Assistant Professor, Bajara Research Scheme, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

Corresponding Author:
SG Aiholli
M. Sc. Scholar, Agronomy Section, College of Agriculture, Dhule, MPKV, Rahuri, Maharashtra, India

Effect of integrated nutrient management on growth, yield and economics performance of pigeon pea (*Cajanus cajan* L. Millsp.)

SG Aiholli, SC Wadile, PM Jagtap, PP Pawar, VP Bhalerao and RT Surywanshi

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Abstract
The present field experiment was conducted during the *kharif* season of 2024 at the Agronomy farm, College of Agriculture, Dhule, Maharashtra. The experiment was laid out in randomized block design (RBD) with thirteen treatments and replicated three time. There were thirteen treatments *viz.*, (T_1)- Absolute control (No fertilizer), (T_2)- RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}, (T_3) - GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5 t ha^{-1}), (T_4)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}, (T_5)- 75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_6)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) -100% RDN through Vermicompost, (T_8)- 100% RDN through FYM, (T_9)- 100% RDN through Neem cake, (T_{10}) - 75% of N through Vermicompost + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11})- 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12})- 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage and (T_{13})- 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. The different growth characters of pigeon pea like plant height, number of primary branches $plant^{-1}$, number of secondary branches $plant^{-1}$ and dry matter $plant^{-1}$ recorded significantly maximum due to the application of treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) which was at par with all other treatments except (T_1)- Absolute control (No fertilizer), (T_2)- RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}, (T_4)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} and (T_5)- 75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. The yield attributing characters of pigeon pea like number of pods $plant^{-1}$, number of seed pod^{-1}, seed yield $plant^{-1}$ and test weight were recorded significantly higher in treatment application of GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}) (T_3). However, significantly higher seed yield and straw yield were obtained from application of the treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}) which was at par with all other treatments except (T_1) - Absolute control (No fertilizer), (T_2)- RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}, (T_4)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} and (T_5)- 75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Lowest seed yield and straw yield observed in Absolute control (T_1).

Keywords: Integrated nutrient management, pigeon pea, micronutrient, organic manure, growth and yield

Introduction
Pigeon pea [*Cajanus cajan* L. Mill Sp.] is one among the protein-rich legumes of semi-arid tropics predominantly cultivated under rainfed situations. Pigeon pea commonly known as Red gram or Arhar or Tur in India. A significant reduction in grain yield is caused by soil moisture deficit during critical growth stages, such as flowering and pod development (Sharma *et al.*, 2012) [18]. One such approach involves the use of different integrated nutrient management systems, which can help conserve soil, protect the environment, and optimize the farmer's limited resources. It has been reported by Reddy *et al.*, (2011) [15] that the integration of inorganic, organic, and bio-fertilizers is essential for achieving higher pigeon pea yields and

reducing production costs. The basic principle of integrated nutrient management is to maintain soil fertility, sustain agriculture, and improve farmers' profitability by using mineral fertilizers, organic manures, green manures, and crop residues in a judicious and efficient manner. The imbalance of nutrients in the soil is being caused by the continuous use of only chemical fertilizers in intensive cropping systems, which is adversely affecting soil health and crop yields. In pulses, the limited nitrogen fixation by legume- rhizobium symbiosis is the result of mineral nutrient deficiencies. There is deficiency of both macronutrients as well as micronutrients (Zn, Fe, B, Mo etc.) take place which inhibits or limits the legume production (Bhuiyan *et al.,* 1999) [2]. Among the micronutrients Zn, Fe and B are supposed to improve the yield appreciably and foliar spray of micronutrients proved to be economical in pulses (Anitha *et al.,* 2004) [1]. The productivity of pigeon pea is influenced by multiple factors, among which integrated nutrient management plays a crucial role.

Materials and Methods

The experiment was performed at the Agronomy farm, College of Agriculture, Dhule, Maharashtra. The soil of experimental field was clays in texture, medium in nitrogen, medium in phosphorus and very rich in potassium. The pigeon pea variety Phule Trupti was selected for the study purpose. The experiment was laid out in randomized block design (RBD) with thirteen treatments and replicated three time. There were thirteen treatments *viz.*, (T_1)- Absolute control (No fertilizer), (T_2)- RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}, (T_3) - GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}), (T_4)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}, (T_5)- 75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_6)- 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) -100% RDN through Vermicompost, (T_8)- 100% RDN through FYM, (T_9)- 100% RDN through Neem cake, (T_{10})- 75% of N through Vermicompost + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11})- 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12})- 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage and (T_{13})- 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Pigeon pea was sown on 25th June 2024 and harvested on 28th December 2024. Treatments were set based on integrated nutrient management in pigeon pea through inorganic fertilizers, FYM, vermicompost, neem cake and micronutrients, these treatments were compared with RDF (25: 50: 00 N: P_2O_5: K_2O kg ha^{-1}) and Absolute control.

Results and Discussion

Growth parameters

Plant height

A significantly effect of integrated nutrient management was observed on plant height at all growth stages till harvest stage. Among the applied treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) recorded the highest plant height (240.89 cm) as compared to other treatments at the time of harvest. However it was at par with treatment (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Significantly the lowest plant height (222.01 cm) observed in absolute control plot (T_1). The similar trend was observed in each duration. This might be attributed to the fact that integrated nutrient management with (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) are characterized balanced application of inorganic and organic nutrient sources allowing the nutrient availability to be matched with the plant's requirements and improving the crop's absorption pattern. The result are consonance with the results of Kumawat *et al.* (2017) [8], Pal *et al.* (2016) [9], Kale (2017) [6] and Tyagi and Singh (2019) [23].

Number of primary branches plant^{-1}

Among the applied treatment, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) recorded the highest number of primary branches $plant^{-1}$ (8.80) as compared to other treatments at the time of harvest. However it was at par with treatment (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Significantly the lowest number of primary branches $plant^{-1}$ (5.93) observed in absolute control plot (T_1). The similar trend was observed in each duration. The results were conformity with those reported by Pandey *et al*., (2013) [11], Saakshi *et al*., (2020) [16] and Shiva kumar (2022) [19].

Dry matter $plant^{-1}$ (g)

Among the applied treatment, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) recorded the highest number of dry matter accumulation (g) $plant^{-1}$ (227.08 gm) as compared to other treatments at the time of harvest. However it was at par with treatment (T_6) 75% GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN

through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Significantly the lowest dry matter accumulation (g) $plant^{-1}$ (178.38 gm) observed in absolute control plot (T_1). The similar trend was observed in each duration. The dry matter production and its accumulation in different parts of plant achieved only with the development of vegetative growth mainly due to plant height, number of primary and secondary branches. This might be due to the improvement in growth indices with integrated nutrient management treatments was mainly attributed that the application of GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) which can supply N, P, K nutrients. The results are associates with the results of Pal *et al.,* (2016) [9] and Raula (2022) [14].

Yield attributes

No. of pods $plant^{-1}$

Among the different treatments (T_3) a significantly higher number of pods $plant^{-1}$ (362.81) was recorded under (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) when compared to other treatments. Furthermore, this treatment was at par with (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Lower number of pods $plant^{-1}$ observed in treatment (T_1) Absolute control that was 245.45 as compared to all other treatments A similar higher number of pods $plant^{-1}$ was reported by Sharma *et al.,* (2009) [17] and Kumawat *et al.,* (2017) [8].

Number of seeds pod^{-1}

The treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) recorded significantly higher number of seeds pod^{-1} (4.86) than all the other treatments, but at par with (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Lower number of seeds observed in treatment (T_1) Absolute control that was 3.56 as compared to all other treatments. A similar higher number of seeds pod^{-1} was reported by Somashekar (2017) [20] and Kumawat *et al.,* (2017) [8].

Seed yield $plant^{-1}$ (g)

The treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) recorded significantly higher number of seed yield $plant^{-1}$ (65.89 g) than all the other treatments, but at par with (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. The numerically lower seed yield $plant^{-1}$ of pigeon pea was registered by Absolute control (T_1) no fertilizer given treatment contain 27.82 g. Koushal *et al.,* (2011) [7] and Hajari *et al*., (2015) [5] reported similar results.

Test weight (100 seed weight)

The treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) have significantly recorded higher test weight 13.21 g than all other treatments. Which was at par with (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Lowest test weight observed in Absolute control (T_1) 10.67g no fertilizer given treatment. Koushal *et al.,* (2011) [7] and Hajari *et al*., (2015) [5] reported similar results.

Grain yield (qt ha^{-1})

The application of integrated nutrient management had significantly effect on grain yield. Data pertaining of yield recorded and presented in Table 3. Among the applied treatment, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) recorded the highest grain yield (22.09 qt ha^{-1}) as compared to other treatments. However it was at par with treatment (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. Significantly the lowest grain yield (10.26 qt ha^{-1}) observed in absolute control plot (T_1). Gholve *et al.*, (2005) [3], and Hajari *et al.*, (2015) [5] with application of Vermicompost Pandey *et al.*, (2015) [10], Sharma *et al.*, (2012) [18] and Patil and Padmani (2007) [12], with application of FYM also reported similar results. Subhash (2021) also found significant results with application of GRDF, gave higher seed yield. The increase in the yield attributing characters by integrated nutrient management treatments might be due to the addition of nitrogen as well as other nutrients and growth-promoting substances through organic manure (Tejalben *et al*., 2017) [22].

Straw yield (qt ha^{-1})

The application of integrated nutrient management had significantly effect on straw yield. Data pertaining of yield recorded and presented in Table 3. Among the applied treatment, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) recorded the highest straw yield (71.22 qt ha^{-1}**)** as compared to other treatments. However it was at par with treatment (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_7) 100% RDN through Vermicompost, (T_8) 100% RDN through FYM, (T_9) 100% RDN through Neem cake, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{11}) 75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{12}) 75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage, (T_{13}) 75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage.. Significantly the lowest straw yield (34.56 qt ha^{-1}) observed in absolute control plot (T_1).

The straw yield was higher with application of GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5t ha^{-1}) was due to better growth parameters and higher accumulation of dry matter in stem parts that contributed for the higher straw yield production. Similar combined application of fertilizers, manures and micronutrients were found significant by workers viz., Verma *et al.*, (2022) [24] and Gupta *et al.*, (2022) [4].

Economics

Cost of cultivation

Among the different integrated nutrient management treatments, (T_{10}) 75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage (₹ 69540 ha^{-1}) maximum cost of cultivation compared to all the other treatments followed by (₹ 66469 ha^{-1}, ₹ 63050 ha^{-1}, ₹ 62086 ha^{-1}) (T_7, T_5, T_{11}) and the lowest cost of cultivation was observed in (T_1) Absolute control (No fertilizer) (₹ 46654 ha^{-1}) as compared to other treatments. The above results are associates with the results of Phonglosa *et al.*, (2022) [13] and Gupta *et al.*, (2022) [4].

Gross monetary returns

Among the different integrated nutrient management treatments, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}) recorded higher gross returns (₹ 173902 ha^{-1}) compared to all the other integrated nutrient treatments followed by treatment (₹ 171938 ha^{-1}) (T_6) 75% GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. While, the absolute control treatment (T_1) recorded lowest gross returns of (₹ 80919 ha^{-1}).

Net returns

Among the integrated nutrient management treatments, (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}) recorded higher net returns (₹ 111982 ha^{-1}) as compared to remaining treatments followed by treatment (₹ 110786 ha^{-1}) (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage. The absolute control treatment (T_1) recorded lowest net returns (₹ 34265 ha^{-1}) when compared to other treatments. The results are conformity with the findings of Patil and Padmani (2007) [12] and Phonglosa *et al.*, (2022) [13].

Benefit cost ratio

Among the different integrated nutrient management in pigeon pea the benefit cost ratio was recorded highest in (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage (2.81) compared to other treatments followed by treatment T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1}) (2.80). The absolute control treatment (T_1) (1.73) which is least B:C ratio among the other treatments. The above results are associates with the results of Pandey *et al.*, (2015) [10], Gupta *et al.*, (2022) [4].

Conclusion

From above experiment it is concluded that, the treatment (T_3) GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1} + FYM 5 t ha^{-1}) showing highest growth parameters such plant height (cm), number of primary branches plant^{-1} and dry matter plant^{-1} (g) and higher yield parameters viz., number of pods plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1}, test weight (gm), grain yield, straw yield, gross monetary returns and net monetary returns respectively. The highest benefit cost ratio was recorded with application of treatment (T_6) 75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage followed by GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5 t ha^{-1}) by pigeon pea.

Table 1: Effect of integrated nutrient management on plant height (cm), number of primary branches plant^{-1} and dry matter plant^{-1} (g) of pigeon pea at harvest stage.

Tr. No.	Treatment details	Plant height (cm) at harvest	Number of primary branches plant^{-1} at harvest	Dry matter accumulation (gm) plant^{-1} at harvest
T_1	Absolute control (No fertilizer)	222.01	5.93	178.38
T_2	RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}	233.25	6.73	222.41
T_3	GRDF (25 N: 50 P2O5: 0 K2O kg ha^{-1} + FYM 5t ha^{-1})	240.89	8.80	227.08
T_4	75% GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}	229.49	5.76	212.23
T_5	75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	231.02	5.98	215.58
T_6	75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	239.58	8.12	226.74
T_7	100% RDN through Vermicompost	236.20	6.92	224.92
T_8	100% RDN through FYM	236.00	6.84	224.10
T_9	100% RDN through Neem cake	236.15	7.17	223.90
T_{10}	75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	238.56	7.72	225.35
T_{11}	75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	237.56	7.41	225.00
T_{12}	75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	237.16	7.35	224.87
T_{13}	75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	236.33	6.80	224.52
	S. Em ±	1.58	0.69	1.09
	C.D. at 5%	4.76	2.08	3.18

Table 2: Effect of integrated nutrient management on number of pods plant^{-1}, number of seeds pod^{-1}, seed yield plant^{-1}, test weight (gm), grain yield and straw yield of pigeon pea.

Tr. No.	Treatment details	Number of pods plant^{-1}	Number of seeds pod^{-1}	Seed yield plant^{-1}(g)	Test weight (g)	Grain yield (qt ha^{-1})	Straw yield (qt ha^{-1})
T_1	Absolute control (No fertilizer)	245.45	3.56	27.82	10.67	10.26	34.56
T_2	RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}	353.00	3.42	63.03	11.46	18.09	64.00
T_3	GRDF (25 N: 50 P2O5: 0 K2O kg ha^{-1} + FYM 5t ha^{-1})	362.81	4.86	65.89	13.21	22.09	71.22
T_4	75% GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}	347.44	3.62	56.83	11.08	17.00	62.38
T_5	75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	350.66	3.73	58.68	11.23	17.48	63.65
T_6	75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	361.11	4.70	64.89	12.82	21.84	70.46
T_7	100% RDN through Vermicompost	358.46	4.09	65.35	12.55	19.52	67.82
T_8	100% RDN through FYM	358.25	4.08	65.05	12.22	19.45	67.45
T_9	100% RDN through Neem cake	357.79	4.02	64.72	12.00	19.30	67.35
T_{10}	75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	360.73	4.70	63.89	12.77	20.32	69.86
T_{11}	75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	359.76	4.63	64.08	12.51	19.94	69.04
T_{12}	75% of N through Neem cake + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	359.12	4.33	64.33	12.30	19.70	68.46
T_{13}	75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	358.85	4.11	63.52	12.35	19.57	68.00
	S. Em ±	1.70	0.28	0.96	0.44	1.23	1.47
	C.D. at 5%	5.10	0.86	2.86	1.28	3.60	4.30

Table 3: Economics of pigeon pea as influenced by different treatments

Treatment		Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T_1	Absolute control (No fertilizer)	46654	80919	34265	1.73
T_2	RDF (25 N: 50 P_2O_5: 0 K_2O) kg ha^{-1}	53475	142979	89504	2.67
T_3	GRDF (25 N: 50 P_2O_5: 0 K_2O kg ha^{-1}+ FYM 5t ha^{-1})	61920	173902	111982	2.80
T_4	75% GRDF + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}	56689	134588	77899	2.37
T_5	75% GRDF + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	57352	138339	80987	2.41
T_6	75% GRDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	61152	171938	110786	2.81
T_7	100% RDN through Vermicompost	66469	154158	87689	2.31
T_8	100% RDN through FYM	56304	153592	97288	2.72
T_9	100% RDN through Neem cake	56835	152450	95615	2.68
T_{10}	75% of N through Vermicompost + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1} + Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	69540	160402	90862	2.30
T_{11}	75% of N through FYM + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	62086	157451	95365	2.53
T_{12}	75% of N through Neem cake + Soil application of Multi-micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	61584	155581	93997	2.52
T_{13}	75% of RDF + Soil application of Multi- micronutrient Grade I @ 25 kg ha^{-1}+ Two foliar sprays of Phule Liquid Micro Grade II @ 1% at flowering and pod filling stage	60171	154553	94382	2.56
S. Em ±		_	655.65	840.00	_
C. D. @ 5%		_	1966.29	2520.31	_
General mean		59248	148527	89278	2.48

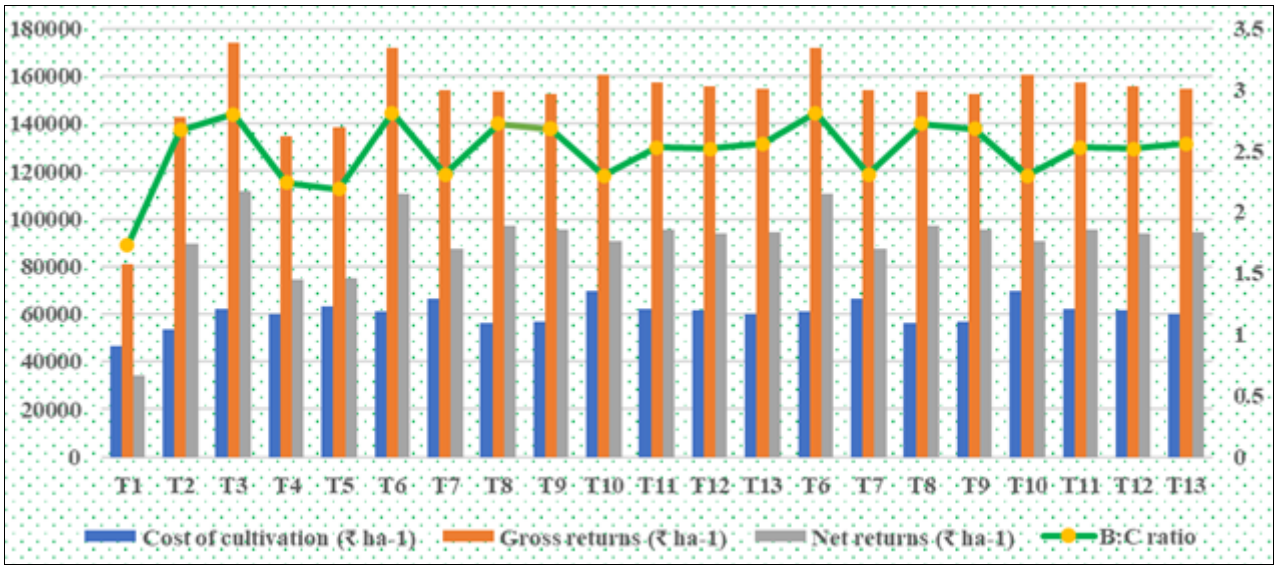

Fig 1: Economics of pigeon pea as influenced by different treatments

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