



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 863-868
Received: 09-06-2026
Accepted: 12-07-2026

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Influence of organic and inorganic fertilizers on yield potential of linseed (*Linum Usitatissimum* L.)

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8k.6342>

Abstract

The present study was conducted to evaluate the impact of varying levels of inorganic and organic fertilizers on the growth and productivity of the linseed variety BLS-4. The experiment was carried out during the rabi season of 2023 at the Agronomy Research Field, School of Agriculture Research and Technology, Sardar Patel University, Balaghat (M.P.). A Randomized Block Design (RBD) with 12 treatment combinations and three replications per treatment was employed. The treatments consisted of T₁ (Control); T₂ (20:10:30 kg NPK ha⁻¹); T₃ (30:15:40 kg NPK ha⁻¹); T₄ (40:20:50 kg NPK ha⁻¹); T₅ (50:25:60 kg NPK ha⁻¹); T₆ (60:30:70 kg NPK ha⁻¹); T₇ (FYM 5.0 MT ha⁻¹); T₈ (FYM 3.75 MT ha⁻¹); T₉ (FYM 2.5 MT ha⁻¹); T₁₀ (Vermicompost 3.00 MT ha⁻¹); T₁₁ (Vermicompost 2.25 MT ha⁻¹); and T₁₂ (Vermicompost 1.50 MT ha⁻¹). The findings of this investigation unequivocally demonstrated that T₃ (30:15:40 kg NPK ha⁻¹) exhibited superior vegetative growth parameters, including plant height (26.44 cm, 44.80 cm, and 69.55 cm at 30, 60, and 90 DAS, respectively), number of branches per plant (8.89 at 90 DAS), and shoot weight, recording 159.67 g at 90 DAS. Furthermore, T₃ recorded the highest yield attributes, such as the number of capsules per plant (65.77), seed yield (642.62 kg ha⁻¹), net return (₹25,390 per hectare), and a benefit-cost ratio of 1.70. Given these results, the application of NPK at 30:15:40 kg ha⁻¹ emerges as a promising strategy to enhance linseed productivity under the agro-climatic conditions of Balaghat, Madhya Pradesh.

Keywords: Benefit cost ratio, linseed, npk, net return, urea and vermicompost.

Introduction

Oilseeds, the principal source of vegetable oils, rank second only to food grains in their significance to the Indian economy, accounting for approximately 10% of the country's cultivated land and contributing substantially to the total agricultural output. Given the current per capita consumption of fats and oils at 8.5 kg per annum and its projected escalation, the demand for vegetable oilseeds is estimated to reach nearly 34 million tonnes by 2030. Notably, rapeseed-mustard is anticipated to contribute approximately 14 million tonnes to meet the annual domestic demand. Over the past three decades, the oilseeds sector has expanded at an annual growth rate of 4.1%, surpassing the growth of livestock products and other agricultural commodities. This dynamism has positioned the sector as one of the most robust components of global agriculture. Despite facing challenges such as erratic weather patterns and global price fluctuations, domestic oilseed production has demonstrated resilience, catering to the escalating national demand. However, from 2010 to 2019, the growth rates in the area under cultivation, production, and yield of oilseeds have exhibited a decline in contrast to the period spanning 1986 to 1998. As per the Directorate of Oilseed Development, Ministry of Agriculture and Farmers Welfare, Government of India (2020-21), oilseeds account for 13% of the gross cropped area, contribute 3% to the Gross National Product (GNP), and represent 10% of the total value of agricultural commodities. A significant portion approximately 72% of oilseed cultivation is undertaken under rainfed conditions by marginal and small-scale farmers. Linseed (*Linum usitatissimum* L.), commonly known as flax, is among the most ancient, cultivated crops, valued for its oil, fibre, and seeds. Distinct from other oilseeds, linseed produces technical-grade vegetable oil and superior-quality fibre known for its exceptional strength and durability. With an oil content ranging from 35% to 45%, linseed is notably rich in omega-3 fatty acids, particularly alpha-linolenic acid (ALA). These bioactive compounds play a crucial role in reducing triglyceride levels, thereby mitigating

cardiovascular risks, and exhibit potential efficacy against rheumatoid arthritis. Linseed oil contains omega-3 fatty acids in a ratio threefold higher than omega-6 fatty acids. Furthermore, linseed seeds contain approximately 36% protein, of which 85% is digestible. The residual oil cake, a by-product of oil extraction, serves as an essential feed supplement for dairy and meat-producing animals, thereby enhancing milk and meat yields. The linseed crop in India covers an estimated area of 1.82 lakh hectares, yielding approximately 1.22 lakh tonnes, with an average productivity of 671 kg/ha for the year 2019-20 (Anonymous, 2020). Owing to its high iodine value exceeding 180 linseed oil is regarded as the most suitable vegetable oil for applications such as painting and varnishing, owing to its excellent drying properties. Consequently, a significant proportion of the global linseed production is allocated for industrial use. Despite its classification as an inedible oil, approximately 20% of the linseed produced in India is utilized for dietary purposes, particularly in states like Madhya Pradesh, Uttar Pradesh, Bihar, and Chhattisgarh. Uttar Pradesh is a prominent linseed-producing state, with linseed cultivation extending over 26.90 thousand hectares, yielding 17.89 thousand tonnes, and recording an average productivity of 150 kg/ha (Anonymous, 2021). The state accounts for 9% of the total oilseed cultivation area and contributes 6.29% to the overall oilseed production in India. Predominantly cultivated on marginal and sub-marginal soils under rainfed conditions, linseed is frequently grown as a relay (utera) crop during the rabi season (Agrawal *et al.*, 2014)^[1]. Additionally, linseed is often cultivated as an intercrop to optimize land use efficiency. The application of farmyard manure (FYM) in conjunction with inorganic fertilizers significantly enhances soil structure, water retention capacity, and overall system productivity. Organic nutrient sources applied to preceding crops confer substantial residual benefits to succeeding crops, promoting long-term agricultural sustainability (Hegde & Dwivedi, 1992). Conservation tillage systems have been shown to exert notable positive effects on various physical and chemical soil properties (Ismail *et al.*, 1994)^[7]. Organic amendments in agriculture primarily encompass plant and animal waste materials, which undergo decomposition to release essential nutrients. The practice of incorporating organic residues into agricultural systems is as old as agriculture itself, historically serving as a means to enhance soil fertility and crop productivity. Manures are organic amendments derived from the decomposition of animal, human, and plant residues, supplying a spectrum of phytonutrients in complex organic forms. In contrast, fertilizers whether natural or synthetic are formulated to provide essential plant nutrients in a readily available form. Although fertilizers exhibit a higher nutrient concentration per unit, manures offer distinct agronomic advantages, including improvements in soil structure, microbial activity, and long-term soil fertility. Unlike high-analysis fertilizers, organic manures contribute to a gradual and sustained nutrient release, ensuring prolonged soil fertility and enhanced crop health. Farmyard manure, a composite of cow dung, urine, straw, and other organic materials, plays a pivotal role in augmenting soil fertility. While its initial nitrogen availability is limited, the decomposition process gradually enriches the nitrogen content, ensuring sustained nutrient release. The combination of cow dung and urine furnishes a balanced nutrient profile for plant growth. The phosphorus and potassium content of farmyard manure is comparable to that of synthetic fertilizers, making it a viable alternative for nutrient management. Typically, well-decomposed farmyard manure contains approximately 0.5% nitrogen (N), 0.2% phosphate (P_2O_5), and 0.5% potassium (K_2O). Moreover,

FYM enhances soil phosphorus availability and influences the solubility of applied phosphorus when used in conjunction with inorganic phosphorus fertilizers. It is imperative to recognize that neither organic amendments nor synthetic fertilizers alone can sustain high-yielding, intensive agricultural systems. An integrated approach, combining both organic and inorganic nutrient sources, is essential for ensuring long-term agricultural productivity and sustainability (Singh, 2019)^[17]. Vermicompost, an organic amendment derived through the decomposition of organic materials facilitated by earthworms such as *Eisenia foetida* and *Lumbricus rubellus*, represents a highly effective soil amendment. The vermicomposting process entails the bioconversion of organic waste into a nutrient-rich substrate through microbial and enzymatic activity within the earthworm gut. The resultant vermicompost is characterized by elevated concentrations of essential macro- and micronutrients, beneficial soil microorganisms, and plant growth regulators. Chemically, vermicompost comprises nitrogen (2-3%), potassium (1.852.25%), and phosphorus (1.55-2.25%), alongside vital micronutrients and bioactive compounds. The presence of plant growth hormones and enzymes further enhances its agronomic efficacy. Scientifically, vermicompost has been validated as an effective growth promoter, conferring resistance against pests and diseases (Tiwari & Singh, 2021)^[18, 20]. This makes vermicompost an indispensable component in sustainable agricultural systems, particularly within organic farming frameworks.

Material and Methods

This study aimed to explore how varying levels of organic and inorganic fertilizers on growth and yield of linseed variety BLS-4. 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 were The treatments consisted of T₁ (Control); T₂ (20:10:30 kg NPK ha⁻¹); T₃ (30:15:40 kg NPK ha⁻¹); T₄ (40:20:50 kg NPK ha⁻¹); T₅ (50:25:60 kg NPK ha⁻¹); T₆ (60:30:70 kg NPK ha⁻¹); T₇ (FYM 5.0 MT ha⁻¹); T₈ (FYM 3.75 MT ha⁻¹); T₉ (FYM 2.5 MT ha⁻¹); T₁₀ (Vermicompost 3.00 MT ha⁻¹); T₁₁ (Vermicompost 2.25 MT ha⁻¹); and T₁₂ (Vermicompost 1.50 MT ha⁻¹). A measuring tape was employed to determine the height of five randomly selected plants per plot at 30, 60, and 90 days after sowing (DAS), measuring from the soil surface to the leaf apex. The recorded plant heights for each replication were meticulously documented and subjected to statistical analysis.

Similarly, the number of branches was enumerated in randomly chosen plants from each plot at the aforementioned intervals, with the average branch count per plant computed for each replication and analyzed statistically. The fresh shoot weight of five randomly selected plants (excluding roots) per plot was measured in grams using an electronic balance at 30, 60, and 90 DAS. The mean fresh shoot weight for each replication was calculated and statistically examined. To determine the dry matter accumulation, the same harvested plants used for fresh weight assessment were initially sun-dried and subsequently oven-dried at 70°C for 24 hours. The resultant dry weight of these five plants per plot was recorded using an electronic balance, and the average dry shoot weight for each replication was derived and analyzed statistically. The number of capsules per plant, a crucial yield-attributing

parameter, was enumerated from the selected plants post-harvest for each treatment and replication. The recorded data were systematically analyzed. Additionally, the 1000-seed weight was determined using a precision balance from seeds obtained from five randomly selected plants. The mean seed weight was computed and subjected to statistical evaluation. 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:

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

Seed yield per hectare = Size of individual plot X 10,000 m²

Harvest index was computed by using following formula as suggested by Singh and Stoskoff (1971)^[19]. The harvest index was worked out by using following

$$\text{Seed yield (g)}$$

formula: Harvest index (%) = Biological yield (g) X 100

The statistical analysis was conducted using Fisher and Yates (1967)^[5].

Results and Discussion

BLS-4 is an exceptionally early maturing linseed selection developed at JNKVV. This genotype exhibits a medium stature with an open, semi-spreading growth habit. Its flowers typically range in hue from violet to sky blue, while the seeds are diminutive in size and light brown in colour. Farmyard manure (FYM) serves as a principal organic fertilizer for field crops; however, its widespread application is hindered by limited availability, posing a considerable challenge to its efficacy as a nutrient source. Nitrogen plays a pivotal role in various metabolic processes fundamental to plant development, serving as an essential constituent of proteins and chlorophyll (Meena *et al.*, 2014)^[13]. Both nitrogen and phosphorus exert a profound influence on root activity and the establishment of cowpea root architecture. The initial availability of nitrogenous compounds facilitates robust seedling establishment before the onset of biological nitrogen fixation. Plants supplemented with organic nitrogen during their vegetative phase exhibit significantly greater biomass accumulation by the time of flowering than those dependent solely on symbiotic nitrogen fixation. Phosphorus, a vital element in plant metabolism, constitutes a key component of numerous organic molecules and is indispensable for photosynthesis, respiration, and other physiological functions. Potassium, on the other hand, modulates plant growth both directly and indirectly. Its application mitigates excessive transpiration, enhances water uptake, and optimizes internal physiological conditions, thereby augmenting drought tolerance (Nazneen *et al.*, 2022)^[14]. Vermicompost emerges as a highly efficacious organic fertilizer and a viable alternative to conventional agrochemicals in organic farming systems. Its incorporation markedly improves soil biological properties, enhances water retention capacity, and fosters a loose, porous soil structure conducive to root proliferation. Moreover, vermicompost plays a crucial role in regulating soil pH in acidic environments, thereby stimulating microbial activity and enriching soil fertility (Kirubashre *et al.*, 2023)^[11].

Growth parameters

Plant height and number of branches per plant

The maximum height of plants measured 26.44 cm, 44.80 cm, and 69.55 cm at 30, 60, and 90 DAS, respectively, with treatment T₃

(30:15:40 Kg NPK ha⁻¹) among all treatments studied. Treatment T₄ (40:20:50 Kg NPK ha⁻¹) followed closely, yielding heights of 24.64 cm, 42.83 cm, and 68.81 cm at the same intervals. In contrast, the control group (T₁) exhibited the shortest heights of 17.86 cm, 30.54 cm, and 49.71 cm at 30, 60, and 90 DAS, respectively, while the other treatments displayed moderate growth patterns. The highest number of branches per plant, recorded at 5.01, 7.28, and 8.89 branches, was achieved with treatment T₃ (30:15:40 Kg NPK ha⁻¹) at 30, 60, and 90 days after sowing (DAS). This was followed by treatment T₄ (40:20:50 Kg NPK ha⁻¹), which resulted in 4.86, 6.98, and 8.34 branches at the same intervals. In contrast, the lowest number of branches per plant, measuring 1.37, 3.93, and 5.68 branches, was recorded in the control group (T₁). The superior plant height and number of branches (table 1) observed in T₃ (30:15:40 kg NPK per hectare) in the linseed crop can be attributed to the balanced nutrient supply that meets the crop's developmental requirements more effectively than other treatments. Nitrogen (N) at an optimal level enhances vegetative growth, promoting cell division and elongation, while phosphorus (P) plays a critical role in root development, which facilitates better nutrient uptake. Potassium (K) contributes to overall plant vigour and stress tolerance, aiding in consistent growth. The specific NPK ratio in T₃ likely ensures a synchronized nutrient release, fostering uniform and sustained growth. In contrast, treatments relying on organic fertilizers may have slower nutrient mineralization rates, which can limit immediate availability, while other inorganic treatments may not have the optimal NPK balance for maximal growth. This tailored nutrient approach in T₃ supports a robust growth habit, culminating in superior plant height compared to all other treatments. Findings were in accordance with conclusions by Kaushal and Umrao (2020)^[10]; Singh *et al.*, (2021)^[18].

Fresh shoot weight and dry shoot weight

Maximum fresh shoot weight (9.22, 57.60 and 159.67 grams) was observed with treatment

T₃ (30:15:40 Kg NPK ha⁻¹) observed at 30, 60 and 90 DAS respectively followed by T₄

(40:20:50 Kg NPK ha⁻¹) with 8.41, 56.60 and 156.11 grams. Minimum fresh shoot weight (3.01, 21.33 and 85.26 grams) was observed in T₁ (Control) at 30, 60 and 90 DAS respectively. The highest dry shoot weight recorded was 3.39, 23.03 and 42.96 grams for treatment T₃ (30:15:40 Kg NPK ha⁻¹) at 30, 60, and 90 DAS, respectively. This was followed by treatment T₄ (40:20:50 Kg NPK ha⁻¹), which yielded 3.27, 22.65 and 41.10 grams. Conversely, the lowest dry shoot weight of 1.11, 8.42 and 22.93 grams was observed in the control group (T₁) at the same intervals. The increased fresh shoot weight, and dry shoot weight (table 2) in T₃ (30:15:40 kg NPK per hectare) for linseed can be credited to the balanced NPK application that aligns closely with the crop's physiological needs. Nitrogen (N) at this rate supports robust shoot growth by enhancing cell proliferation and photosynthetic efficiency, leading to greater biomass production. Phosphorus (P) is essential for energy transfer and root development, facilitating nutrient and water uptake critical for healthy shoot growth. Potassium (K) reinforces plant structure and improves water regulation, contributing to turgidity and overall fresh weight. The T₃ treatment likely ensures timely nutrient availability in a form that the crop can readily absorb, fostering continuous growth and shoot biomass accumulation. In contrast, treatments with organic sources may lack immediate nutrient release, and other inorganic treatments might not have the balanced nutrient distribution required for maximal shoot growth,

thus resulting in lower shoot weights. Similar findings were reported by Kaur and Kumar (2022) ^[9, 12].

Yield parameters

Number of capsules per plant and test weight

The highest capsules count (table 3) was recorded in treatment T₃ (30:15:40 Kg NPK ha⁻¹), yielding 65.77 capsules, followed closely by T₄ (40:20:50 Kg NPK ha⁻¹) with 63.80 capsules. In contrast, the control treatment T₁ resulted in the lowest capsules count, with only 37.10 capsules per plant. The maximum test weight (5.86 grams) was observed with treatment T₃ (30:15:40 Kg NPK ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) with 5.77 grams. Minimum test weight (4.26 grams) was observed in T₁ (control). The higher capsule count per plant and increased test weight (table 3) in T₃ (30:15:40 kg NPK per hectare) for linseed can be attributed to a well-balanced nutrient supply that fosters reproductive growth and seed development. Nitrogen (N) enhances vegetative growth and expands leaf area, which boosts photosynthesis and builds the energy reserves essential for capsule formation. Phosphorus (P) is vital for the processes of flowering and fruiting, facilitating the production of a greater number of capsules. Potassium (K) aids in the movement of photosynthates and supports seed filling, which directly influences test weight by enhancing seed size and density. The readily available nutrients in T₃ likely promote a balanced growth pattern, enabling the plant to efficiently allocate resources to reproductive structures. In contrast, organic treatments may not release nutrients rapidly enough, while other inorganic treatments might not provide the ideal nutrient ratio, leading to fewer capsules and lower test weights compared to those seen in T₃. Similar findings were reported by Jangid *et al.*, (2022) ^[8] and Rensang *et al.*, (2021) ^[16].

Seed and straw yield per hectare

The maximum seed yield per hectare (642.62 kg/ha) was observed with treatment T₃ (30:15:40 Kg NPK ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) with 623.15 kg/ha. Minimum seed yield per hectare (213.26 kg/ha) was observed in T₁ (control). The maximum straw yield per hectare (902.30 kg/ha) was observed with treatment T₃ (30:15:40 Kg NPK ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) with 863.50 kg/ha. Minimum straw yield per hectare (471.00 kg/ha) was observed in T₁ (control). The superior seed and straw yield per hectare (table 3) in T₃ (30:15:40 kg NPK per hectare) for linseed is primarily due to the balanced nutrient availability that meets the crop's specific demands for growth and yield components. Nitrogen (N) supports vigorous vegetative growth and optimizes photosynthetic activity, which contributes directly to biomass accumulation, including straw production. Phosphorus (P) enhances root growth and energy transfer, crucial during reproductive stages, supporting both seed setting and development. Potassium (K) plays an important role in nutrient translocation and water regulation, improving overall plant health, seed filling, and straw strength. This specific NPK combination in T₃ ensures consistent nutrient release, promoting

both vegetative and reproductive growth, resulting in better seed and straw yield. Organic treatments may have slower nutrient mineralization, limiting immediate yield impact, while other inorganic treatments without the optimal NPK ratio fail to match the high yield efficiency seen in T₃. Similar findings were reported by Neware and Bobade (2018) ^[15] and Choudhary and Rai (2021) ^[4].

Biological yield and harvest index

The maximum biological yield (1544.92 kg/ha) was observed with treatment T₄ (30:15:40 Kg NPK ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) with 1486.65 kg/ha. Minimum biological yield (684.27 kg/ha) was observed in T₁ (control). The maximum harvest index (33.48%) was observed with treatment T₁₂ (Vermicompost 1.50 MT ha⁻¹) and at par with T₁₁ (Vermicompost 2.25 MT ha⁻¹) with 29.96%. Minimum Harvest index (18.46%) was observed in T₁ (control). The higher biological yield and harvest index (table 3) in T₃ (30:15:40 kg NPK per hectare) for linseed is attributed to a balanced NPK application that effectively meets the crop's overall growth requirements. Nitrogen (N) promotes vegetative growth and photosynthetic efficiency, increasing biomass production, while phosphorus (P) enhances root development, aiding nutrient uptake. Potassium (K) supports plant vigour and water regulation, contributing to a stronger and more extensive shoot system. This optimal nutrient balance leads to robust biomass accumulation, maximizing biological yield in T₃. Conversely, the superior harvest index observed in T₁₂ (vermicompost at 1.50 MT per hectare) can be attributed to the gradual release of nutrients, which supports a balanced growth pattern, favouring reproductive development over excessive vegetative growth. Vermicompost improves soil structure and microbial activity, promoting efficient nutrient use. This gradual nutrient release allows the plant to allocate resources efficiently toward seed production, enhancing the harvest index in T₁₂ over other treatments. Similar findings were reported by Neware and Bobade (2018) ^[15] and Jangid *et al.*, (2022) ^[8].

Economics parameters

Maximum cost of cultivation incurred (table 4) in treatment T₆ (60:30:70 Kg NPK ha⁻¹) with (Rs 38250 ha⁻¹) and the minimum (Rs 34350 ha⁻¹) was recorded in treatment T₁ (Control). Maximum gross returns were recorded in treatment T₃ (30:15:40 Kg NPK ha⁻¹) with (Rs 61,841 ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) having Rs 59,876 ha⁻¹ and the minimum (Rs 21,895 ha⁻¹) was recorded in treatment T₁ (Control). Maximum net returns were recorded in treatment T₃ (30:15:40 Kg NPK ha⁻¹) with (Rs 25,390 ha⁻¹) followed by T₄ (40:20:50 Kg NPK ha⁻¹) having Rs 22,842 ha⁻¹ and loss of Rs 12,462 ha⁻¹) was recorded in treatment T₁ (Control). Highest benefit cost ratio was recorded in treatment T₃ (30:15:40 Kg NPK ha⁻¹) with 1.70 followed by T₄ (40:20:50 Kg NPK ha⁻¹) having 1.62 and the minimum (0.64) was recorded in treatment T₁ (Control). Similar findings were reported by Kumar and Yadav (2022) ^[12].

Table 1: Effect of different levels of organic and inorganic fertilizers on plant height and number of branches of linseed

Symbol	Treatments	Pla	NT height (cm)		No of	branches per plant	
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T ₁	Control	17.86	30.54	49.71	1.37	3.93	5.68
T ₂	20:10:30 Kg. NPK ha ⁻¹	22.33	40.83	60.25	2.07	4.35	7.30
T ₃	30:15:40 Kg. NPK ha ⁻¹	26.44	44.80	69.55	5.01	7.28	8.89
T ₄	40:20:50 Kg. NPK ha ⁻¹	24.64	42.83	68.81	4.86	6.98	8.34
T ₅	50:25:60 Kg. NPK ha ⁻¹	23.39	42.27	68.06	4.23	6.76	8.05
T ₆	60:30:70 Kg. NPK ha ⁻¹	19.40	32.78	53.51	2.20	5.41	8.08
T ₇	FYM. 5.0 MT ha ⁻¹	20.20	38.11	51.88	3.12	5.57	7.95
T ₈	FYM. 3.75 MT ha ⁻¹	21.42	34.46	56.57	2.19	6.04	7.47
T ₉	FYM. 2.5 MT ha ⁻¹	19.70	35.91	53.17	2.48	5.44	7.29
T ₁₀	Vermicompost 3.00 MT ha ⁻¹	24.46	42.72	68.42	4.12	6.66	8.21
T ₁₁	Vermicompost 2.25 MT ha ⁻¹	21.10	34.15	50.52	2.27	4.87	7.42
T ₁₂	Vermicompost 1.50 MT ha ⁻¹	19.36	33.33	47.15	1.75	4.00	8.10
	SE. m (±)	0.39	0.68	0.93	0.15	0.28	0.24
	CD0.05	1.14	1.99	2.74	0.44	0.83	0.70

Table 2: Effect of different levels of organic and inorganic fertilizers on Fresh and dry shoot weight of linseed

Symbol	Treatments	Fresh shoot weight (g)			Dry shoot weight (G)		
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T ₁	Control	3.01	21.33	85.26	1.11	8.42	22.93
T ₂	20:10:30 Kg. NPK ha ⁻¹	7.18	36.79	102.52	2.63	14.51	27.59
T ₃	30:15:40 Kg. NPK ha ⁻¹	9.22	57.72	159.67	3.39	23.03	42.96
T ₄	40:20:50 Kg. NPK ha ⁻¹	8.41	56.60	156.11	3.27	22.65	41.10
T ₅	50:25:60 Kg. NPK ha ⁻¹	8.16	56.46	154.82	2.99	22.26	39.80
T ₆	60:30:70 Kg. NPK ha ⁻¹	5.11	32.43	114.18	1.89	12.79	30.73
T ₇	FYM. 5.0 MT ha ⁻¹	5.02	30.32	109.99	1.84	11.95	29.60
T ₈	FYM. 3.75 MT ha ⁻¹	5.14	34.52	100.94	1.89	13.60	27.17
T ₉	FYM. 2.5 MT ha ⁻¹	4.72	28.21	96.62	1.71	11.12	26.01
T ₁₀	Vermicompost 3.00 MT ha ⁻¹	8.01	47.92	141.63	2.94	18.89	38.14
T ₁₁	Vermicompost 2.25 MT ha ⁻¹	7.04	43.17	120.65	2.58	17.02	32.47
T ₁₂	Vermicompost 1.50 MT ha ⁻¹	6.95	42.59	120.31	2.14	16.73	29.24
	SE. m (±)	0.16	0.73	0.80	0.06	0.29	0.83
	CD0.05	0.47	2.13	2.34	0.18	0.86	2.44

Table 3: Effect of different levels of organic and inorganic fertilizers on Fresh and dry shoot weight of linseed

Symbol	Treatments	No of capsules per plant	Test weight (g)	Seed yield per hectare (kg/ha)	Straw yield per hectare (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
T ₁	Control	37.10	4.26	213.26	471.00	684.27	18.46
T ₂	20:10:30 Kg. NPK ha ⁻¹	54.56	5.32	431.33	683.78	1115.11	23.98
T ₃	30:15:40 Kg. NPK ha ⁻¹	65.77	5.86	642.62	902.30	1544.92	25.83
T ₄	40:20:50 Kg. NPK ha ⁻¹	63.80	5.77	623.15	863.50	1486.65	26.27
T ₅	50:25:60 Kg. NPK ha ⁻¹	62.30	5.71	617.38	845.68	1463.06	26.48
T ₆	60:30:70 Kg. NPK ha ⁻¹	52.74	5.42	412.22	592.83	1005.05	25.80
T ₇	FYM. 5.0 MT ha ⁻¹	56.42	5.32	361.94	597.23	959.17	23.25
T ₈	FYM. 3.75 MT ha ⁻¹	52.88	5.22	279.57	599.04	878.60	18.92
T ₉	FYM. 2.5 MT ha ⁻¹	42.67	4.88	227.54	505.79	733.33	18.36
T ₁₀	Vermicompost 3.00 MT ha ⁻¹	61.54	5.37	608.52	807.19	1415.72	27.38
T ₁₁	Vermicompost 2.25 MT ha ⁻¹	58.86	5.03	502.39	587.19	1089.57	29.96
T ₁₂	Vermicompost 1.50 MT ha ⁻¹	57.00	4.96	502.57	545.27	1047.84	33.48
	SE. m (±)	1.19	0.09	4.37	10.21	9.07	0.60
	CD0.05	3.48	0.26	12.81	29.95	26.59	1.77

Table 4: Economics as influenced by different treatments applied in Linseed

Symbol	Treatments	Cost of cultivation (INR)	Gross Return (INR)	Net Return (INR)	BC ratio
T ₁	Control	34350	21,895	-12,455	0.64
T ₂	20:10:30 Kg. NPK ha ⁻¹	35838	42,133	6,295	1.18
T ₃	30:15:40 Kg. NPK ha ⁻¹	36451	61,841	25,390	1.70
T ₄	40:20:50 Kg. NPK ha ⁻¹	37034	59,876	22,842	1.62
T ₅	50:25:60 Kg. NPK ha ⁻¹	37626	59,242	21,616	1.57
T ₆	60:30:70 Kg. NPK ha ⁻¹	38250	39,781	1,531	1.04
T ₇	FYM. 5.0 MT ha ⁻¹	37350	35,543	-1,807	0.95
T ₈	FYM. 3.75 MT ha ⁻¹	36600	28,555	-8,045	0.78
T ₉	FYM. 2.5 MT ha ⁻¹	35850	23,388	-12,462	0.65
T ₁₀	Vermicompost 3.00 MT ha ⁻¹	37050	58,182	21,132	1.57
T ₁₁	Vermicompost 2.25 MT ha ⁻¹	36375	47,400	11,025	1.30
T ₁₂	Vermicompost 1.50 MT ha ⁻¹	35700	45,445	9,745	1.27

Conclusion

The overall results obtained from this present investigation clearly revealed that the application of T₃ (30:15:40 Kg NPK ha⁻¹) showed the better performance for vegetative growth viz., plant height (26.44 cm, 44.80 cm, and 69.55 cm at 30, 60, and 90 DAS, respectively), number of branches per plant (8.89 branches at 90 DAS), highest shoot weight, recording 159.67 grams at 90 DAS yield attributes like number of capsules per plant (65.77 capsules), seed yield (642.62 kg/ha) of Linseed. T₃ also recorded highest net return of Rs 25,390 per hectare and benefit cost ratio of 1.70. Thus, use of NPK at higher dose may be suggested for higher crop productivity along with over all betterment of linseed under Balaghat (M.P.) conditions.

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