**Effect of Integrated Nutrient Management on Yield, Quality and Economics of Linseed (*Linum usitatissimum* L.)**

**Abstract**

A Field experiment was conducted during the *Rabi season* of 2023-24 at crop research centre of ITM University Gwalior, (M.P.) India, to evaluate the “Effect of Integrated Nutrient Management on Yield, Quality and Economics of Linseed”. The experiment followed a Randomized block design (RBD) with three replications. The experiment consisting of ten treatments combinations *viz.*, Control, RDF NPKS (60:40:30:40 kg ha-1 ), N (60 kg ha-1), NP (60:40 kg ha-1 ), NPK (60:40:30 kg ha-1 ), N (60 kg ha-1) + 5 t ha-1 FYM, NP (60:40 kg ha-1) + 5 t ha-1FYM, N (60 kg ha-1) + 2 t ha-1 Vermicompost, NP (60:40 kg ha-1 ) + 2 t ha-1 Vermicompost and N (60 kg ha-1 ) + 5 t ha-1FYM + 1 t ha-1Vermicompost. The soil of the experimental field was slightly alkaline in nature having pH 8.3, EC 0.35 dSm-1, low in organic carbon (0.35 %), available nitrogen (211 kg ha-1) and medium in available phosphorus (13.0 kg ha-1) and Potassium (247 kg ha-1). The results revealed that the application of 60kgN ha-1 with the 5 t ha-1 FYM and 1 t ha-1Vermicompost recorded higher yield and quality parameters of the linseed crop. Among the treatment, the highest net return (₹42644) and benefit cost ratio (1.71) was recorded with the treatment of T10 (60kgN ha-1 with the 5t ha-1 FYM and 1 t ha-1Vermicompost).

 **Keywords:** Economics, INM, linseed, oil content, protein content and yield.

**Introduction**

Linseed is one of the most versatile and useful crops also known as flaxseed. It is cultivated in more than 30 countries as a commercial or subsistence crop. The current worldwide acreage of linseed is 3.27 million hectares with a total annual production of 3.18 million tonnes and productivity of 975.10 kg/ha. India holds fifth rank in area with 320 thousand hectares with annual production of 174 thousand tonnes and productivity of 543.80 kg/ha (FAOSTAT, 2020). Linseed plant is an abundant source of both edible and nonedible oil. Industrial oil is an important ingredient for paint, varnish, and stain manufacturing. It is used in soaps, inks and the production of linoleum. It’s also used in the animal care products, earthen floors, animal feed, industrial lubricant, leather treatment, oil cloth, particle detectors, textiles, wood preservation, seasoning of cookware. Edible linseed oil is used for human consumption and contains alpha-linolenic acid (ALA), a polyunsaturated fatty acid that provides nutritional and health benefits.

The utilization of organic manures as a nutrient source has been in use since the beginning of established agriculture, but after the induction of prevalent utilization of inorganic fertilizers, the bulky organic manures were deemed as a second alternative of nutrients. In order to safeguard the environment and health of soil-plant-human from further degradation, again we should choose for less use of chemical fertilizers and shift from chemical to biological agriculture to nourish the crop. Subsequently, to sustain the agriculture and soil fruitfulness, organic manures and various other organic materials got importance as constituents of plant nutrient management. Bulky organic manures provide most of the essential plant nutrients (instead to one or two nutrients by chemical fertilizers) beside enhancing the soil carbon stock and improving soil physical and biological conditions. In this respect, the use of FYM, poultry manure, vermicomposting as an organic source is an imperative tool which is of increasing interest of farmers and governmental bodies due to its amazing crop advantages. Organic manures promoted the strong health promoter which helps to fulfil our basic object of reducing the usage of inorganic fertilizers, restoring organic matter in soil, enhancing nutrient use efficiency and maintaining soil quality while improving the crop yield and production economics. Addition of FYM, poultry manure and vermicompost to the soil system also improves the physical conditions including soil structure, porosity, reduces compaction & crusting and overall increases water holding capacity of the soil. Besides, proper supply of nitrogenous fertilizers is also needed as it affects the root development, resulting in improved crop yield and nutrient use pattern in linseed.

**Materials and Methods -**

The experiment was carried out during the *Rabi season* of 2023-24 at the at crop research center-1 (CRC-1) of ITM University Gwalior (M.P.) India (latitude of 26º13’ North and longitude 78º19’ East with an altitude of 211.52 meters above mean sea level). The experiment followed a Randomized block design (RBD) with three replications. The experiment consisting of ten treatments combinations *viz.*, Control, RDF NPKS (60:40:30:40 kg ha-1 ), N (60 kg ha-1), NP (60:40 kg ha-1 ), NPK (60:40:30 kg ha-1 ), N (60 kg ha-1) + 5 t ha-1 FYM, NP (60:40 kg ha-1) + 5 t ha-1FYM, N (60 kg ha-1) + 2 t ha-1 Vermicompost, NP (60:40 kg ha-1 ) + 2 t ha-1 Vermicompost and N (60 kg ha-1 ) + 5 t ha-1FYM + 1 t ha-1Vermicompost. The soil of the experimental field was slightly alkaline in nature having pH 8.3, EC 0.35 dSm-1, low in organic carbon (0.35 %), available nitrogen (211 kg ha-1) and medium in available phosphorus (13.0 kg ha-1) and Potassium (247 kg ha-1). The maximum and minimum temperature ranged from 15.6 to 33.6°C and 5.3 to 15.4°C, respectively during crop-growing period. The gross plot size of each experimental unit was 5 m × 4 m. A basal dose of 80 kg N, 26.2 kg P, 33.3 kg and sulphur to supply the prescribed doses of S were applied at the time of sowing. Nitrogen, phosphorus and potassium were applied through urea, di-ammonium, phosphate and muriate of potash respectively. Half dose of N and full of P and K were applied basal. The remaining N was top-dressed after the first irrigation, i.e. 30 days after sowing. Linseed was shown on 30 October in both years, keeping row-to row distance 25 cm, with a seed rate of 30 kg/ha.

**Results and Discussion**

The higher grain yield (890.77 kg/ha) and stover yield (2026.93 kg/ha) was recorded with the application of (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost), which was *at par* to the yield of treatment T9 (RDF N 60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost (845.44 kg/ha), while the lowest was found in control. The maximum harvest index (30.53%) was recorded under the application of treatment, T10 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost), which was on par with T9 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost) (T9, 30.50%). FYM with vermicompost directly increased crop yields either by acceleration of respiratory process, by increasing cell permeability, hormone growth action or combination of all he processes *viz.,* release of nutrients, increasing availability of nutrients and improving soil physical, chemical and biological properties. The beneficial effect of FYM on linseed yield is well documented by Rasool *et al.* (2013), Dubey *et al.,* (2015) and Alam *et al*., (2021). Most of the pathways are dependent on enzyme and co-enzymes, which are synthesized by these mineral nutrients such as sulphur, boron, major nutrients (NPK) and FYM. Better translocation of photosynthate from source to sink enabled better growth and yield attributing parameters and finally the seed yield of crop.

**Table 1:** Effect of integrated nutrient application on yield of linseed

|  |  |  |
| --- | --- | --- |
| **Treatment** | **Yield (Kg ha-1)** | **Harvest index (%)** |
| **Grain** | **Stover** | **Biological** |
| **Control** | 450.29 | 1188.02 | 1638.31 | 27.47 |
| **NPKS (60:40:30:40 kg ha-1)** | 631.80 | 1453.60 | 2085.40 | 30.27 |
| **N (60 kg ha-1)** | 560.77 | 1309.39 | 1870.16 | 29.98 |
| **NP (60:40 kg ha-1)** | 593.48 | 1377.94 | 1971.42 | 30.09 |
| **NPK (60:40:30 kg ha-1)** | 614.29 | 1417.15 | 2031.44 | 30.23 |
| **N (60 kg ha-1) + 5 t ha-1FYM** | 693.89 | 1597.18 | 2291.07 | 30.28 |
| **NP (60:40 kg ha-1) + 5 t ha-1FYM** | 719.58 | 1653.08 | 2372.66 | 30.32 |
| **N (60 kg ha-1) + 2 t ha-1Vermi** | 742.03 | 1703.77 | 2445.80 | 30.34 |
| **NP (60:40 kg ha-1) + 2 t ha-1Vermi** | 845.44 | 1929.06 | 2774.50 | 30.50 |
| **N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1 Vermicompost** | 890.77 | 2026.93 | 2917.70 | 30.53 |
| **SE(m)±** | 33.24 | 77.90 | 111.04 | 0.12 |
| **CD (P=0.05)** | 98.77 | 231.48 | 329.93 | - |

The highest oil content (40.53%) was recorded under the application of treatment, T10 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost), which was on par with T9 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost (40.52 %). The highest protein content (20.35 %) was recorded under the application of treatment, T10 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost), which was on par with T9 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost (20.34 %). Highest oil yield might be due to better synthesis of sulphur containing amino acids and fatty acid biosynthesis (especially the step of conversion of Acetyl CO-A to Melonyl CO-A) resulting from increased activity of thiokinase enzyme which depends upon sulphur supply. Similar results were reported by Akbari *et al.* (2011) and Parmar *et al*., (2020).

**Table 2: Effect of integrated nutrient application on protein content, oil content and economics of linseed**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatment** | **Content (%)** | **Cost of cultivation****(**₹ ha-1**)** | **Gross return****(**₹ ha-1**)** | **Net return****(**₹ ha-1**)** | **B. C ratio** |
| **Protein** | **Oil** |
| **Control** | 18.32 | 37.50 | 21709.5 | 35333.5 | 13624.0 | 0.63 |
| **NPKS (60:40:30:40 kg ha-1)** | 20.19 | 40.29 | 27132.5 | 48083.2 | 20950.7 | 0.77 |
| **N (60 kg ha-1)** | 19.99 | 39.98 | 22490.7 | 42811.9 | 20321.2 | 0.90 |
| **NP (60:40 kg ha-1)** | 20.06 | 40.10 | 24487.1 | 45254.4 | 20767.3 | 0.85 |
| **NPK (60:40:30 kg ha-1)** | 20.15 | 40.23 | 25134.5 | 46777.4 | 21642.9 | 0.86 |
| **N (60 kg ha-1) + 5 t ha-1FYM** | 20.19 | 40.28 | 23490.7 | 52813.7 | 29322.9 | 1.25 |
| **NP (60:40 kg ha-1) + 5 t ha-1FYM** | 20.21 | 40.32 | 25487.1 | 54746.4 | 29259.2 | 1.15 |
| **N (60 kg ha-1) + 2 t ha-1Vermi** | 20.23 | 40.34 | 23990.7 | 56448.2 | 32457.4 | 1.35 |
| **NP (60:40 kg ha-1) + 2 t ha-1Vermi** | 20.34 | 40.52 | 25987.1 | 64229.8 | 38242.7 | 1.47 |
| **N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1 Vermicompost** | 20.35 | 40.53 | 24990.7 | 67634.7 | 42644.0 | 1.71 |
| **SE(m)±** | 0.35 | 1.06 | - | - | - | - |
| **CD (P=0.05)** | 1.04 | 3.18 | - | - | - | - |

The highest net monetary return (₹42644.00 Rs/ha) was recorded under the application of treatment, T10 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost) which was on par with T9 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost (38242.71Rs/ha). The highest B: C ratio (1.71) was recorded under the application of treatment, T10 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1 Vermicompost), which was on par with T9 (RDF N (60 kg ha-1) + 5 t ha-1FYM + 1 t ha-1Vermicompost (1.47). Similar study was found by Kaushal and Umrao (2020) and Singh *et al*. (2020).

**Conclusion:**

Application of 60 kg N ha-1 with the 5t ha-1 FYM and 1 t ha-1 vermicompost enhances linseed seed yield, oil content, and economic indices which remained *at par* with (N:P, 60:40 kg ha-1) with 2 t ha-1 vermicompost. Thus, integrated and balanced application of organic and inorganic sources of nutrients has resulted in high monetary returns of linseed and is necessary for sustaining linseed yields in sandy loam soils of north-eastern India in the rabi season that is emerging as a profitable crop.

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