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Effect of nutrient management on growth and yield of linseed

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Abstract
A field experiment entitled "Integrated nutrient management in linseed (*Linum usitatissimum* L.)" was conducted during *rabi* season of 2022-2023 at Agronomy Farm, College of Agriculture, Nagpur. The experiment was laid out in randomized block design with seven treatments replicated thrice. The treatments consisted of T_1 - 100% RDN (control), T_2 - 75% RDN + 25% RDN through Vermicompost, T_3 - 75% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}, T_4 - 75% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia, T_5 - 100% RDN + 25% RDN through Vermicompost, T_6 - 100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} and T_7 - 100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia. Result revealed that T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly higher plant height, number of branches $plant^{-1}$ and dry matter accumulation $plant^{-1}$ over rest of the treatments but was at par with treatment T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). Yield attributing character *viz*., number of capsules $plant^{-1}$, number of seeds $capsule^{-1}$, seed and straw yield $plant^{-1}$ & seed and straw yield kg ha^{-1} of linseed were also significantly higher with T_7 over rest of the treatments but was at par with T_6.

Keywords: Linseed, organic manure, inorganic fertilizer, vermicompost, consortia, growth, yield

Introduction
Linseed (*Linum usitatissimum* L.) is one of the important *rabi* oilseed crop of India belongs to linaceae family and genus Linum. Linseed contains high level of lignin, Omega-3 and Omega-6 fatty acid possesses anti-cancer properties and studies found reduced growth in specific types of tumors. Initial studies suggest benefit with certain types of breast and prostate cancer.
Vermicompost (VC) a product of activity of earthworm is widely used as organic manure in crop production. It is rich source of several plant nutrients, beneficial microorganism like N-fixers, biologically active metabolites, particularly gibberellins, cytokinins, auxins, group B vitamins and several enzymes like lipase, cellulase, chitinase, urease dehydrogenase and nitrogenase Bano *et al*., (1987) [1].
The role of sulphur on yield and quality improvement of linseed is well established as sulphur is key constituent of oilseeds and directly involved in formation of fatty acids in oil compounds. It is a constituent of three amino acids which contain S are methionine (21% S), cysteine (26% S) and cystine (27% S) and these are building blocks of proteins. Hence, it is a vital for protein production (Tandon, 2011 and Marschner, 2011) [8, 7].
NPK consortium used as liquid biofertilizer which contained nitrogen fixing (*Azotobacter chroococcum, Azospirillum lipoferum*), phosphate solubilizing and potash mobilizing native bacteria (*Bacillus* spp). It is used as seed treatment (3-5 ml kg^{-1} seed), soil application (1 L ha^{-1}) and seedling treatment (3-5 ml L^{-1}) & with drip irrigation (1 L ha^{-1}) Jangid *et al*., (2022) [4].

Materials and Methods
The present field investigation was carried out during *rabi*, 2022-2023 to study the integrated nutrient management in linseed (*Linum usitatissimum* L.) during *rabi* season at Agronomy Farm, College of Agriculture, Nagpur, Maharashtra State, India. The experimental soil was vertisol, fairly uniform and levelled. It was low in available nitrogen and available phosphorous, very high in available potassium and slightly alkaline in reaction.

Experiment was laid out in randomized block design with three replications and 7 treatments. The experiment included treatments of organic and inorganic sources of T_1 - 100% RDN (control), T_2 - 75% RDN + 25% RDN through Vermicompost, T_3 - 75% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}, T_4 - 75% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia, T_5 - 100% RDN + 25% RDN through Vermicompost, T_6 - 100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} and T_7 - 100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia. The seed was sown at 30 x 5 cm spacing. The gross and net plot size were 3.60 x 2.40 m^2 and 3.00 x 2.20 m^2, respectively.

Results and Discussion

A) Growth attributes

Plant stand

The data revealed that various treatments had non-significant influence on emergence count and final plant stand thereby indicating uniform emergence and persistence throughout the crop growth period under various parameters study.

Plant height (cm)

Table 1 showed that the mean plant height of linseed at 30 DAS was non significant. The treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly higher plant height of 33.10, 45.13 and 45.13 cm at 60 DAS, 90 DAS and at harvest, respectively over rest of treatments. However, it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might be due to additional supply of nutrients through treatment which increased the nutrient uptake and better translocation of nutrients. Similar results were also obtained by Kumar & Yadav (2022) [5].

Number of branches $plant^{-1}$

Table 1 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly higher number of branches $plant^{-1}$ (4.13) at harvest and it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might be due to improved growth of morphological character like plant height resulted in more number of branches $plant^{-1}$. Similar results were also obtained by Kumavat *et al*., (2020) [9].

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

Table 1 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly maximum dry matter accumulation of 5.60 and 7.43 g $plant^{-1}$ at 90 DAS and at harvest, respectively as compared to other treatments. However it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might be due to higher doses of fertilizer application increased the dry matter $plant^{-1}$ by increased metabolic processes in plant resulting greater meristimatic activities and apical growth there by increased branches $plant^{-1}$ and plant height which ultimately resulted in improved dry matter accumulation Similar findings were also reported by Kumar and Yadav (2022) [5].

B) Yield attributes

Number of capsules $plant^{-1}$

Table 2 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly maximum number of capsules $plant^{-1}$ (78.21) over all other tratments, but it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might due to beneficial effect of nutrients particularly N and S in nutrient management in readily available for which were supplied through RDN, Vermicompost and Consortia and Sulphur. Similar findings were also reported by Dubey *et al*., (2015) [3].

Number of seeds $capsules^{-1}$

Table 2 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly maximum number of seeds $capsules^{-1}$ (8.40) over all other treatments, but it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might due to balanced use of fertilizer in soil which increased their availability in soil. Similar findings were also reported by Bonde and Gawande (2017) [2].

Seed yield (kg ha^{-1})

Table 2 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly maximum seeds yield (1336.33 kg ha^{-1}) over all other treatments, but it was at par with T_6 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1}). This is might due to adequate supply of nutrient element at the right time from organic and inorganic sources which help optimum dry matter partitioning from the source to sink during reproductive stage of plant consequently increase the seed yield. Adequate supply of nitrogen as it helps in better capturing of sunlight for photosynthesis, which also increases the sink potential of plants. Similar findings were also reported by Jangid *et al*., (2022) [4].

Straw yield (kg ha^{-1})

Table 2 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded significantly maximum straw yield (2495 kg ha^{-1}) over all other tratments, but it was at par with T_6 (100% RDN + 25% RDN thr ough Vermicompost + 30 kg S ha^{-1}). This is might due to adequate supply of nutrient element at the right time from organic and inorganic sources which help optimum dry matter partitioning from the source to sink during reproductive stage of plant consequently increase the seed yield. Adequate supply of nitrogen as it helps in better capturing of sunlight for photosynthesis, which also increases the sink potential of plants. Similar findings were also reported by Bonde and Gawande (2017) [2], Jangid *et al*., (2022) [4].

Test weight (g)

Table 2 showed that the treatment T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) recorded highest test weight (7.92 g) while the lowest test weight (7.33 g) was found in T_1 (100% RDN).

Table 1: Growth of linseed as influenced by various treatments

Treatments	Plant population		Plant height (cm)				Number of branches plant^{-1}				Dry matter accumulations (g plant^{-1})			
	Emergence count ha^{-1}	Final count ha^{-1}	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1	648383	646464	15.08	24.47	38.27	38.27	1.31	1.40	3.33	3.33	1.36	2.28	4.28	5.78
T_2	650908	648383	15.53	26.87	39.20	39.20	1.42	1.50	3.37	3.37	1.39	2.38	4.38	5.88
T_3	652019	649241	15.98	29.20	40.90	40.90	1.49	1.56	3.57	3.57	1.47	2.58	4.75	6.25
T_4	652828	650807	16.24	30.00	42.27	42.27	1.51	1.65	3.60	3.60	1.55	2.73	5.04	6.54
T_5	651514	648484	15.66	28.87	40.40	40.40	1.43	1.53	3.53	3.53	1.40	2.41	4.58	6.08
T_6	654191	652676	16.27	32.40	43.67	43.67	1.55	1.93	4.03	4.03	1.77	3.33	5.33	7.33
T_7	655454	652929	16.83	33.10	45.13	45.13	1.59	2.03	4.13	4.13	1.96	3.60	5.60	7.43
S.E(m) ±	1345	1391	0.47	0.71	0.71	0.71	0.07	0.12	0.14	0.14	0.13	0.16	0.18	0.21
CD at 5%	NS	NS	NS	2.18	2.19	2.19	NS	0.37	0.43	0.43	NS	0.48	0.55	0.65
GM	652185	649855	15.94	29.27	41.40	41.40	1.47	1.66	3.65	3.65	1.56	2.76	4.85	6.47

Table 2: Yield attributes and yield of linseed as influenced by various treatments

Treatments	No. of capsules plant^{-1}	No. of seeds capsules^{-1}	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Test weight (g)
T_1	61.56	6.47	1007.00	1920.00	7.33
T_2	63.92	6.78	1064.00	1990.00	7.37
T_3	69.77	7.38	1174.00	2240.00	7.53
T_4	72.10	7.54	1209.00	2318.00	7.63
T_5	66.62	7.27	1088.00	2093.00	7.43
T_6	76.52	8.08	1258.00	2415.00	7.80
T_7	78.21	8.40	1336.33	2495.00	7.92
S.E(m) ±	0.55	0.11	27.08	30.56	0.13
CD at 5%	1.70	0.34	83.43	94.16	NS
GM	69.81	7.42	1162.33	2210.14	7.57

Conclusion

Based on the result of one year experimentation, it can be concluded that the application of T_7 (100% RDN + 25% RDN through Vermicompost + 30 kg S ha^{-1} + Consortia) produces higher growth and growth attributes, yield and yield attributes of linseed.

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