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Influence of tillage and nutrient management on growth performance of linseed

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Abstract
A field trial was conducted during the *rabi* season of 2024 on Linseed at AICRP on Linseed farm, College of Agriculture, Nagpur to study the effect of tillage and nutrient management on growth and yield of linseed. The soil at the experimental site was clayey in texture and slightly alkaline (pH 7.30), containing medium organic carbon (0.52%). It was low in available nitrogen (265.11 kg ha^{-1}), medium in phosphorus availability (23.33 kg ha^{-1}), and high in available potassium (330.62 kg ha^{-1}). The experiment was conducted in a split-plot design comprising three tillage practices and four nutrient management treatments, resulting in 12 treatment combinations, replicated thrice. The treatments consisted of main plot included three tillage practices Conventional tillage (T_1), Reduced tillage, (T2) and Zero tillage (T_3) and subplot consisted of four nutrient management 100% RDF (N_1), 100% RDF with seed treatment using a microbial consortium (Biomix) (N_2), 100% RDF with foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) @ 5 ml/litre of water and at capsule development (70-80 DAS) @ 10 ml/litre of water (N_3), and 100% RDF with both seed treatment using Biomix and foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) and capsule development (70-80 DAS) (N_4). Plant height (cm), number of branches per plant, number days to 50% flowering, and dry matter accumulation per plant (g) were significantly higher under conventional tillage, T_1 (cultivator twice followed by one rotavator). In terms of nutrient management, N_4 (100% RDF with seed treatment using Biomix and foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) and capsule development (70-80 DAS) recorded the highest values for these parameters. The interaction effect between tillage and nutrient management was non-significant for all traits evaluated.

Keywords: Linseed, tillage, nutrient management, growth, growth attributes

Introduction
Linseed is the most important oilseed crop in India, stands next to rapeseed and mustard among all winter season (*rabi*) oilseed crops in terms of area and production. It serves as a significant source of both industrial and edible oil as well as fiber. The crop is rich in essential fatty acids with 75% polyunsaturated fatty acids, including 57% alpha-linolenic acid (an omega-3 fatty acid) and 16% linoleic acid (an omega-6 fatty acid) (Morris, 2005) [14]. Linseed is largely cultivated on marginal and sub-marginal lands under rainfed conditions, often grown as utera (relay) during the *rabi* season (Agrawal *et al.* 1986) [2]. It is one of the oldest *rabi* oilseed crops under cultivation.

India accounts for about 10.81% of the global area and 5.30% of global production of linseed. Within the country, linseed covers 1,72,710 ha, producing 99,070 tonnes with an average yield of 574 kg ha^{-1} (Anonymous, 2018-19) [5]. In Maharashtra, the crop occupies 8,700 ha with a production of 2,600 tonnes and an average productivity of 299 kg ha^{-1}. In the Vidarbha region, it is cultivated on 6,570 ha, producing 2,120 tonnes with a productivity of 323 kg ha^{-1} (Anonymous, 2019-20) [5].

Tillage is a fundamental requirement in crop production, as it influences the efficient use of inputs such as water, fertilizers, and other resources. In conventional agricultural systems characterized by intensive tillage, clean cultivation, monocropping, unbalanced fertilizer application, and improper irrigation practices, soil organic matter gradually declines. This leads

to pollution and the loss of valuable plant nutrients. Proper management of crop residues and soil organic matter is therefore essential for sustaining soil fertility and productivity.

Tillage plays a vital role in linseed cultivation as it affects soil condition, crop establishment and yield. A well-prepared seedbed is crucial for the shallow-rooted linseed crop to achieve uniform germination and vigorous early growth. Conventional tillage facilitates soil loosening and efficient nutrient incorporation, making it suitable for compact soils.

Nitrogen, phosphorus and potassium are essential for improving linseed yield and quality. Nitrogen supports metabolic processes, phosphorus promotes cell division, flowering and seed development, while potassium contributes to overall plant growth (Jaga and Upadhyay, 2013) [9]. Enhancing productivity requires high-yielding cultivars and improved practices such as nitrogen fertilization, foliar urea application, and micronutrient mixtures containing Fe, Zn and Mn (Hussein, 2007) [8]. Balanced nutrient application, particularly N, P, and K, is critical for yield improvement (Singh *et al*. 2013) [15].

Materials and Methods

A field experiment was carried out during the 2024 *rabi* season at All India Coordinated Research Centre on Linseed, College of Agriculture, Nagpur to investigate the effects of tillage and nutrient management on growth and yield of linseed. The soil at the experimental site was clayey in texture and slightly alkaline (pH 7.30), containing medium organic carbon (0.52%). It was low in available nitrogen (266.11 kg ha^{-1}), medium in phosphorus availability (23.33 kg ha^{-1}), and high in available potassium (330.62 kg ha^{-1}). Three replications and twelve treatment combinations were employed in the split plot design experiment. The three tillage treatments were T_1 - Conventional tillage, T_2 - Reduced tillage, and T_3 - Zero tillage and the four nutrient management were N_1 - 100% RDF, N_2 - 100% RDF with seed treatment using a microbial consortium (Biomix), N_3 - 100% RDF with foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) @ 5 ml/litre of water and at capsule development (70-80 DAS) @ 10 ml/litre of water, and N_4 - 100% RDF with both seed treatment using Biomix and foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) and capsule development (70-80 DAS). A complete dose of phosphorus and 60% nitrogen and 30% phosphorus treated as a basal dressing. Data on growth qualities were collected from five randomly chosen plants from each net plot during the crop growth period (November to March). The current market price of linseed was used to calculate the cost of cultivation and conduct economic research. The typical procedure described for split plot design (Gomez and Gomez, 1984) [7] was used to statistically analyze the data. Wherever the effect was significant, the crucial difference was calculated and statistical significance was assessed using the F-value at the 0.05% level of probability.

Results and Discussion

Growth attributes

Effect of Tillage

The plant height (cm), number of branches plant^{-1} and dry matter accumulation plant^{-1} were significantly highest under the conventional tillage (T_1) and at par with reduced tillage (T_2). Higher plant height under conventional tillage may be attributed to improve soil physical conditions through manipulation and pulverization, providing a favorable environment for germination, seedling emergence, oxygen supply, moisture retention, and nutrient availability. The fine seedbed preparation in conventional tillage promoted better root and shoot growth, resulting in a higher number of branches per plant compared to reduced and zero tillage, where branch numbers declined significantly. Conventional tillage also enhanced dry matter accumulation by creating favorable conditions for tissue differentiation, expansion, and growth, leading to taller plants with more leaves and branches. Similar findings obtained by Khan *et al.* (2014) [11], Kumar *et al.* (2016) [12], Kashyap *et al*. (2017) [10], Mishra *et al*. (2019) [13] and Devi *et al*. (2022) [6]. The number of days to 50% flowering, however, was not significantly affected by tillage treatments.

Effect of Nutrient management

Initial and final plant stand and number of days to 50% flowering of linseed were not significantly influenced by different nutrient management practices. The growth attributing characters *viz.*, plant height, number of branches plant^{-1} and dry matter accumulation plant^{-1} were found to be non-significant at 30 DAS. But these characters at 60 DAS, 90 DAS and at harvest, were found significantly superior under the treatment involving the application of the recommended dose of fertilizers (RDF) along with seed treatment using a microbial consortium (Biomix) and foliar application of micronutrients (PDKV Grade-II) at flower initiation (45-50 DAS) @ 5 ml/liter of water and at the capsule development stage (70-80 DAS) @ 10 ml/liter of water (N4), which was at par with 100% RDF along with foliar application of PDKV Grade-II at flower initiation (45-50 DAS) @ 5 ml/liter of water and at the capsule development stage (70-80 DAS) @ 10 ml/liter of water (N_3) to linseed. This could be attributed to timely micronutrient availability at key vegetative stages, which may have improved nutrient uptake and chlorophyll content, resulting in better growth. Similar findings were reported by Tahir *et al*. (2014) [16] Singh *et al*. (2020) [15], Kumar *et al*. (2019) [12] Alam *et al*. (2021) [3] and Abdullah *et al*. (2022) [1]. The number of days to 50% flowering, however, was not significantly affected by nutrient management.

Table 1: Mean of plant height (cm), Number of branches plant^{-1}, dry matter accumulation plant^{-1} (g) and number of days to 50% flowering as influenced by various treatments

Treatment	Plant height (cm)	Number of branches plant^{-1}	Dry matter accumulation plant^{-1}(g)	Number of days to 50% flowering
Maniplot- Tillage practices				
T_1-Conventional tillage (cultivator twice with once rotavator)	58.69	3.31	9.02	58.33
T_2-Reduce tillage (cultivator once)	55.81	2.91	8.60	57.75
T_3-Zero tillage	52.93	2.54	7.95	56.05
S.E. (m) ±	0.75	0.13	0.16	0.74
C.D. at 5%	2.94	0.49	0.64	NS
Sub-plot-Nutrient mangement				
N_1-100% RDF	53.10	2.49	8.16	56.10

N2-100%RDF + Seed treatment with microbial consortium	54.93	2.73	8.49	57.43
N3-100% RDF + Foliar application of micronutrient (PDKV Grade-II) at flower initiation (45-50 DAS) @ 5 ml/lit and capsule development stage (70-80DAS) @ 10 ml/lit water	56.92	3.00	8.59	57.54
100%RDF+Seed treatment with Microbial Consortium+ Foliar application of micronutrient (PDKV Grade-II) at flower initiation (45-50 DAS) @ 5 ml/lit and capsule development stage (70-80DAS) @ 10 ml/lit water	58.28	3.46	8.86	58.43
S.E. (m) ±	0.60	0.19	0.11	1.08
C.D. at 5%	1.85	0.57	0.35	NS
Interaction (T x N)				
S.E. (m) ±	1.04	0.19	0.19	1.87
C.D. at 5%	NS	NS	NS	NS
GM	55.81	2.9	8.52	57.38

Interaction effect

Interaction effect of different tillage practices and nutrient management practices to linseed was found to be non-significant in respect of growth attributing parameter (Table 1).

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