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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(10): 1833-1836

www.thepharmajournal.com
Received: 24-07-2021
Accepted: 27-08-2021

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Effect of Nitrogen and Phosphorus levels on growth and yield of Linseed (*Linum usitatissimum* L.)

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DOI: https://doi.org/10.22271/tpi.2021.v10.i10z.8442

Abstract

A field experiment was conducted to determine the "Effect of Nitrogen and Phosphorus levels on growth and yield of Linseed (*Linum usitatissimum* L.)" (*var* NEELAM) with 9 treatments in the *Rabi* season 2020 – 2021 with the different levels of Nitrogen (45, 60, 75 kg/ha) and Phosphrous (20, 40, 60 kg/ha) at Crop Research Farm, Department of Agronomy, Faculty of Agriculture, SHUATS, Prayagraj, Uttar Pradesh. Results revealed that higher plant height (96.00 cm), plant dry weight (12.84 g), number of branches per plant (5.81), Number of capsule plant^{-1} (45.36), Number of seeds capsule^{-1} (9.46), 1000 grain weight (8.93 g), Seed yield (1.20 t/ha), Stover yield (2.84 t/ha), highest gross return (90,800.00 INR/ha), net returns (50,327.00 INR/ha) and benefit cost ratio (1.24) were obtained by the application of 75 kg Nitrogen/ha + 60 kg Phosphorus/ha. The successive increase in fertilizer levels of nitrogen and phosphorus increased the higher growth and yield attributes.

Keywords: *Linseed, Nitrogen, Phosphorus, Growth and Yield*

1. Introduction

Oilseeds play a vital role in human life. Among these, linseed enjoys an important place, being used for domestic, industrial and medicinal purposes. In India, linseed has been cultivated from pre-historic times. Linseed is basically an industrial oilseed crop and its each and every part is endowed with commercial and medicinal importance. Linseed occupies a greater importance among oilseeds owing to its various uses and special qualities (Meena *et al.,* 2011) [10]. Tolerance to biotic and abiotic stresses is a very important characteristic of this crop.

Linseed (*Linum usitassimum* L.) also known as flax is a member of genus *Linum* in the family Linaceae. Linseed is a self-pollinated crop widely adapted to temperate climate of the word. On a very small scale, the seed is directly used for edible purposes and about 20 % of the total oil is used by the farmers. India is the second largest (21.21 %) linseed growing country in the world after Canada and production-wise it ranks fourth (8.20 %) in the world after Canada (40.51 %), China (18.68 %), and USA (10.89 %). At present, linseed is cultivated in about 4.36 lakh hectares with contribution of 1.67 lakh tones to the annual oilseed production of the country. The average productivity of linseed is 671 kg/ha (2019-20). Edible linseed oil is used for human consumption and contains α- linolenic acid (ALA) a poly unsaturated fatty acid that has nutritional and health benefits, apart from ALA, linseed is widely used as nutritional and functional food in the western world due to its high contents of therapeutic health promoting sustains such as omega-3 fatty acid which helps to reduce the risk of cardiovascular disease and cancer.

Nitrogen is a structural component of chlorophyll and protein therefore adequate supply of nitrogen is beneficial for both carbohydrates and protein metabolism (Lawania *et al*., 2015) [9]. An excess or imbalance of this nutrient in relation to others, like phosphorus, can prolong the growing period and delay crop maturity. Excess supply of nitrogen also results in poorly developed root system and low root/shoot ratio. An adequate supply of nitrogen is associated with vigorous vegetative growth and dark green colour. It promotes cell division and cell enlargement, resulting in more leaf area and thus insuring better growth, development, plant vigour and yield (Patel *et al*., 2017) [11]. Similarly, phosphorus is an important plant nutrient which help in growth and development of a plant and ultimately improved crop yield. It involves in many biochemical function in physiological system of a plant. It is essential part of skeleton of plasma membrane, nucleic acid, many co – enzymes and phosporylated compound. It also stimulates fruit setting and seed formation (Yawalkar *et al*., 2002) [18].

It also play important role in energy transfer in plant body and formation of reproductive organ of plant. In contrast to nitrogen, excess supply of phosphorus results in increased root growth compared with shoot growth (Devedee *et al*., 2018) [2]. So the good supply of phosphorus is usually associated with increased root density and proliferation, which aid in extensive exploration and supply of nutrient and water to the growing plant parts, resulting in increased growth and yield traits. The greater uptake of nutrients like nitrogen and phosphorus might have increased the photosynthetic and carbohydrate synthesis and then translocation to different parts for promoting meristematic development in potential apical buds and intercalary meristem which ultimately increased root and shoot development in terms of all the growth and yield parameters.

Materials And Methods

The experiment was carried out during *Rabi* season of 2019 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad) which is located at 25° 24' 42" N latitude, 81° 50' 56" E longitude and 98 m altitude above the mean sea level. This area is situated on the right side of the river Yamuna by the side of Allahabad Rewa Road about 5 km away from Prayagraj city. The soil samples were collected randomly from 0 to 15 cm depth from 5 spots of the experimental field just before layout of experiment. The soil texture of the experimental site was sandy loam having available N (225 kg/ha) P (21.50 kg/ha), potassium (87.00 kg/ha) and organic carbon of soil was of 0.28 % with 7.4 available pH of soil. The experimental plot was layed out in randomized block design with having nine treatments which replicated three times with a suitable plot size was of 3m×3m. There were nine treatments combination used for this experiment are T_1: 45 kg/ha Nitrogen + 20 kg/ha Phosphorus, T_2: 45 kg/ha Nitrogen + 40 kg/ha Phosphorus, T_3: 45 kg/ha Nitrogen + 60 kg/ha Phosphorus, T_4: 60 kg/ha Nitrogen + 20 kg/ha Phosphorus, T_5: 60 kg/ha Nitrogen + 40 kg/ha Phosphorus, T_6: 60 kg/ha Nitrogen + 60 kg/ha Phosphorus, T_7: 75 kg/ha Nitrogen + 20 kg/ha Phosphorus, T_8: 75 kg/ha Nitrogen + 40 kg/ha Phosphorus, T_9: 75 kg/ha Nitrogen + 60 kg/ha Phosphorus. The Recommended dose of fertilizer is 60:30:20 kg/ha NPK. Fertilizer was applied at the time of sowing in the form of urea, SSP and MOP. The growth parameters were recorded at periodic intervals 20, 40, 60, 80 and at harvest from randomly selected plants from each treatment.

Results And Discussion

Growth Attributes

Data presented in table 1 revealed the effect of nitrogen and phosphorus levels on growth of linseed (*Linum usitatissimum* L.). The growth attributes that were considered in this experiment for observations were plant height (cm), number of branches per plant, dry weight (g/plant), Crop Growth Rate (CGR) (g/m²/day) and Relative Growth Rate (RGR) (g/g/day).

The growth parameters of linseed were significantly influenced with increasing the levels of nitrogen and phosphorus. The highest (96.00 cm) plant height was achieved in T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) which was significantly superior over all the treatment combination but T_8 (75 kg/ha Nitrogen + 40 kg/ha Phosphorus) and T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) was found to be statistically at par with T_9. Number of branches per plant and dry weight per plant were significantly influenced by the increasement of nitrogen and phosphorus levels. Maximum (5.81) branches per plant and highest (12.84 g/plant) dry weight were observed in T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) which was found superior however, T_8 (75 kg/ha Nitrogen + 40 kg/ha Phosphorus) and T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) are found statistically at par to T_9. In CGR, significantly highest (6.04 g/m²/day) CGR was recorded in T_1 (45 kg/ha Nitrogen + 20 kg/ha Phosphorus) which is superior over all treatments. In case of RGR, significantly maximum (0.017 g/g/day) RGR was reported in T_1 (45 kg/ha Nitrogen + 20 kg/ha Phosphorus) which is also superior over all treatments.

The increasing levels of nitrogen and phosphorus significantly increased the plant height, number of branches and dry weight. Initial stage of phosphorus helped in promoting root growth and better establishment of crop. Increased supply of phosphorus along with nitrogen might have improved the energy use efficiency of plants resulting in increased branching and vigorous growth at medium levels of nitrogen & phosphorus application reported by Kumar *et al*., (2016) [7, 8], Kalita *et al*., (2005) [5] and Saxena *et al*., (2005) [14]. Increased number of branches which might have resulted in higher photosynthetic activity and formation of more photosynthate resulted in better dry matter production plant^{-1} which was noticed by Patil *et al*., (2018) [13] and Sune *et al.*, (2006) [16]. The greater the application of nutrients might have increased the photosynthetic and carbohydrate synthesis and then translocation to different parts for promoting meristematic development in potential apical buds and intercalary meristem which ultimately increased root and shoot development in terms of all the growth parameters. These results are in confirmation with the findings of Bharat *et al.*, (2013) [1] and Meena *et al*., (2011) [10].

Yield Attributes

Data presented in table 2 indicated the effect of nitrogen and phosphorus levels on yield of linseed (*Linum usitatissimum* L.). The yield characters that were considered in this experiment are seeds/capsule (No.), capsules/plant (No.), test weight (g), seed yield (t/ha) and stover yield (t/ha).

The yield attributes of linseed were significantly influenced with increasing the levels of nitrogen and phosphorus. Significantly Maximum number of (9.46) seeds/capsule was obtained with the application of T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus). The highest (45.36) number of capsules/plant was recorded in T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) which was significantly superior over T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) and T_8 (75 kg/ha Nitrogen + 40 kg/ha Phosphorus). Significantly maximum (8.93 g) test weight of seed was found with application of highest treatment combination *i.e.* of T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) however, T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) and T_8 (75 kg/ha Nitrogen + 40 kg/ha Phosphorus) was found statistically at par with T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus). Highest (1.20 t/ha) seed yield was recorded in T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) which was significantly superior over T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) and T_8 (75 kg/ha Nitrogen + 40 kg/ha Phosphorus). In stover yield highest (2.84 t/ha) significant value was shown in T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus) while, T_6 (60 kg/ha Nitrogen + 60 kg/ha Phosphorus) and T_8 (75 kg/ha Nitrogen +

40 kg/ha Phosphorus) was found statistically at par with T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus).

Application of each increasing level of nitrogen and phosphorus significantly increased the number of seeds/ capsules, capsules/plant and test weight. Application of nitrogen & phosphorus might exert flower initiation and seeds/capsules by increasing the rate of photosynthesis and transport of source to sink sites. The tissue differentiation caused by nitrogen and phosphorus application resulted into greater production of flowers which later develops into capsules which is similar to the Kalita *et al*., (2005) [5] and Singh *et al.*, (2013) [15]. The higher yield of linseed can be ascribed due to higher values of growth parameters like plant height, number of branches plant^{-1}, and CGR which was reported by Kashyap *et al.*, (2018) [6]. The seed yield is increased due to overall improvement in plant vigour and production of sufficient photosynthates owing to higher availability of N & P resulting in better yield attributes *viz.* capsules/plant, seeds/capsule, 1000- seed weight was finally reflected to seed yield. Thereafter, the increase in fertilizer dose significantly improves stover yield, this might be due to higher supply of nutrients to the linseed crop upon use of fertilizer dose thereby resulting in better growth and development of the crop. The similar findings were also obtained Gupta *et al.*, (2017) [4] and Tanwar *et al.*, (2011) [17].

Economic Attributes

Data presented in table 3 shown the economics performance of different treatment combination which evaluation was based on cost of cultivation (INR/ha), gross return (INR/ha), net return (INR/ha) and benefit cost ratio (B: C). Highest cost of cultivation (40,473 INR/ha), gross return (90,800 INR/ha), net return (50,327 INR/ha) and benefit cost ratio (1.24) were found with the application of T_9 (75 kg/ha Nitrogen + 60 kg/ha Phosphorus). Increasing levels of nitrogen significantly increased the net returns and benefit cost ratio. This might be due to maximum recovery from application of nitrogen with less expenditure. The gross monetary return and net monetary returns were influenced variably due to different levels of fertilization. Application of nitrogen and phosphorus recorded higher GMR and NMR. It might be due to higher level of yield with increased with fertilizer application. Similar result was recorded by Gaikwad *et al*., (2020) [3] and Patel *et al*., (2012) [12]. Application of N & P recorded higher value of B: C ratio. Similar result obtained by Tanwar *et al*., (2011) [17] and Kumar and Deka, (2016) [7, 8].

Conclusion

On the basis of one season of experiment in linseed it may be concluded that the application of 75 kg Nitrogen/ha + 60 kg Phosphorus/ha showed superiority in growth and yield attributing characters such as seed yield (1.20 t/ha) and stover yield (2.84 t/ha) and as well as it is economically more profitable, hence it is more desirable and preferable to farmers.

Table 1: Effect of Nitrogen and Phosphorus Levels on Growth Parameters of Linseed (*Linum usitatissimum* L.)

Treatments	Plant height (cms) at harvest	No. of branches at harvest	Dry weight (g/plant) at harvest	Crop Growth Rate (g/m^2/day) 80-at harvest	Relative Growth Rate (g/g/day) 80-at harvest
T_1-45 kg/ha Nitrogen + 20 kg/ha Phosphorus	84.46	4.84	9.66	6.04	**0.023**
T_2 -45 kg/ha Nitrogen + 40 kg/ha Phosphorus	85.95	5.00	9.75	4.59	0.019
T_3 -45 kg/ha Nitrogen + 60 kg/ha Phosphorus	86.88	5.10	9.92	4.81	0.019
T_4 -60 kg/ha Nitrogen + 20 kg/ha Phosphorus	88.24	5.20	9.86	3.68	0.014
T_5 -60 kg/ha Nitrogen + 40 kg/ha Phosphorus	89.47	5.27	10.33	3.31	0.012
T_6 -60 kg/ha Nitrogen + 60 kg/ha Phosphorus	94.30	5.70	12.43	5.94	0.019
T_7 -75 kg/ha Nitrogen + 20 kg/ha Phosphorus	92.04	5.33	10.45	3.74	0.013
T_8 -75 kg/ha Nitrogen + 40 kg/ha Phosphorus	94.62	5.76	12.42	5.51	0.017
T_9 -75 kg/ha Nitrogen + 60 kg/ha Phosphorus	96.00	5.81	12.84	5.38	0.017
Sem (±)	0.69	0.04	0.16	0.53	0.00
C. D (p=0.05%)	2.08	0.13	0.49	1.58	0.01

Table 2: Effect of Nitrogen and Phosphorus Levels on Yield attributes of Linseed (*Linum usitatissimum* L.)

Treatments	Seeds/ Capsule	Capsules/ plant	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)
T_1-45 kg/ha Nitrogen + 20 kg/ha Phosphorus	7.20	35.48	7.00	0.82	1.89
T_2 -45 kg/ha Nitrogen + 40 kg/ha Phosphorus	7.16	37.14	6.90	0.82	2.07
T_3 -45 kg/ha Nitrogen + 60 kg/ha Phosphorus	7.30	38.62	7.10	0.89	2.33
T_4 -60 kg/ha Nitrogen + 20 kg/ha Phosphorus	7.63	40.09	7.15	0.92	2.25
T_5 -60 kg/ha Nitrogen + 40 kg/ha Phosphorus	7.86	41.92	7.61	0.93	2.34
T_6 -60 kg/ha Nitrogen + 60 kg/ha Phosphorus	8.96	43.96	8.00	1.12	2.62
T_7 -75 kg/ha Nitrogen + 20 kg/ha Phosphorus	8.33	42.90	7.66	1.01	2.36

T_8 -75 kg/ha Nitrogen + 40 kg/ha Phosphorus	9.33	44.48	8.16	1.13	2.78
T_9 -75 kg/ha Nitrogen + 60 kg/ha Phosphorus	9.46	45.36	8.93	1.20	2.84
Sem (±)	0.19	0.51	0.38	0.04	0.15
C. D (p=0.05%)	0.56	1.53	1.14	0.12	0.46

Table 3: Effect of Nitrogen and Phosphorus Levels on Economics of Linseed (*Linum usitatissimum* L.)

Treatments	Cost of cultivation (INR /ha)	Gross returns (INR /ha)	Net returns (INR /ha)	B: C ratio
T_1-45 kg/ha Nitrogen + 20 kg/ha Phosphorus	35,897.00	62,025.00	26,128.00	0.72
T_2 -45 kg/ha Nitrogen + 40 kg/ha Phosphorus	37,859.50	62,450.00	24,590.50	0.64
T_3 -45 kg/ha Nitrogen + 60 kg/ha Phosphorus	39,822.00	67,175.00	27,353.00	0.68
T_4 -60 kg/ha Nitrogen + 20 kg/ha Phosphorus	36,222.50	69,575.00	33,352.50	0.92
T_5 -60 kg/ha Nitrogen + 40 kg/ha Phosphorus	38,185.00	70,625.00	32,440.00	0.84
T_6 -60 kg/ha Nitrogen + 60 kg/ha Phosphorus	40,147.50	84,050.00	43,902.50	1.09
T_7 -75 kg/ha Nitrogen + 20 kg/ha Phosphorus	36,548.00	75,900.00	39,352.00	1.07
T_8 -75 kg/ha Nitrogen + 40 kg/ha Phosphorus	38,510.50	85,075.00	46,564.50	1.20
T_9 -75 kg/ha Nitrogen + 60 kg/ha Phosphorus	40,473.00	90,800.00	50,327.00	1.24

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