



Yield influence of flax (*Linum usitatissimum* L.) by foliar application of nitrobenzene, urea and incorporation of FYM

Rajkamal Patel^{1*}, N K Patel¹, Himanshu Patel²

¹Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

²Department of Soil Science and Agricultural Chemistry, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

Abstract

A field experiment was conducted at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during *Rabi* 2015-16. The soil of the experimental field was clay in texture (*Vertisols*), neutral in pH (6.68), normal in EC (0.18 m mhos m⁻¹ at 25°C), medium in organic carbon (0.50%) and had low in available nitrogen (226 kg ha⁻¹), medium in phosphorus (12.64 kg ha⁻¹), and high in available potassium (367 kg ha⁻¹) contents. The linseed var. 'RLC-92' sown on 22nd Nov, 2015 using experimental techniques of factorial randomized block design with three replications and eighteen treatments. The treatment consisted of two seed rate *viz.* 25 kg ha⁻¹ (S1), 30 kg ha⁻¹ (S2), three nutrient management *viz.* RDF 60:30:30 N, P₂O₅ & K₂O Kg ha⁻¹ (N1), RDF + Incorporation of FYM @ 5 t ha⁻¹ (N2), RDF + FYM placement in rows @ 5 t ha⁻¹ (N3) and three foliar of water spray at 15, 40, 65 and 90 DAS (F1), foliar spray of Nitrobenzene @ 0.06% at 15, 40, 65 and 90 DAS (F2) and foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F3). Recommended agronomic practices were followed for raising linseed. The crop was harvested on 12th March, 2016 for seed yield purpose.

A field experiment was conducted at the Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, (C.G.) during *Rabi* 2015-16. The soil of the experimental field was clay in texture (*Vertisols*), neutral in pH (6.68), normal in EC (0.18 m mhos m⁻¹ at 25°C), medium in organic carbon (0.50%) and had low in available nitrogen (226 kg ha⁻¹), medium in phosphorus (12.64 kg ha⁻¹), and high in available potassium (367 kg ha⁻¹) contents. The linseed var. 'RLC-92' sown on 22nd Nov, 2015 using experimental techniques of factorial randomized block design with three replications and eighteen treatments. The treatment consisted of two seed rate *viz.* 25 kg ha⁻¹ (S1), 30 kg ha⁻¹ (S2), three nutrient management *viz.* RDF 60:30:30 N, P₂O₅ & K₂O Kg ha⁻¹ (N1), RDF + Incorporation of FYM @ 5 t ha⁻¹ (N2), RDF + FYM placement in rows @ 5 t ha⁻¹ (N3) and three foliar of water spray at 15, 40, 65 and 90 DAS (F1), foliar spray of Nitrobenzene @ 0.06% at 15, 40, 65 and 90 DAS (F2) and foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F3). Recommended agronomic practices were followed for raising linseed. The crop was harvested on 12th March, 2016 for seed yield purpose.

The application of RDF + FYM placement in rows @ 5 t ha⁻¹ (N₃) recorded higher growth parameter *viz.* plant height 78.92 cm, 87.06 cm, and 88.44 cm at 60, 90 DAS and at harvest, respectively, yield attributes *viz.* seed yield (2100 kg ha⁻¹), stover yield (4885 kg ha⁻¹) and energy input, net gain energy and energy output - input ratio (1039.34). The uptake of N, P and K were also observed significantly higher in the same treatment *viz.* 52.55, 18.36 and 77.24 kg ha⁻¹ respectively. In case of foliar spray, application of 2% urea at 15, 40, 65 and 90 DAS (F₃) gave higher growth parameter *viz.* plant height 78.92 cm, 86.89 cm and 88.37 cm at 60, 90DAS and at harvest, respectively, yield attributes *viz.* seed yield (2089 kg ha⁻¹), stover yield (4772 kg ha⁻¹) and seed production efficiency (246.99). However, it was statistically at par with the application of foliar spray of 0.06% Nitrobenzene at 15, 40, 65 and 90 DAS (F2). The uptake of N, P and K were also observed significantly higher in the same treatment *viz.* 50.99, 18.13 and 75.57 kg ha⁻¹ respectively. Interaction among seed rate 30 kg ha⁻¹ (S₂) X RDF 60:30:30 N:P:K kg ha⁻¹ (N₁) with foliar application of 2% urea at 15, 40, 65 and 90 DAS (F₃) (S₂ X N₁ X F₃) recorded the higher value of seed production efficiency.

Keywords: Flax, growth parameters, nutrient content nitrobenzene and urea spray

Introduction

Among the oilseeds, linseed or flax (*Linum usitatissimum* L.) is one of the oldest crops, grown in almost all countries of world for oil, fibre and seed purpose. Linseed is unique among oilseeds for its technical grade vegetable oil producing ability and fibre (good quality having high strength and durability) production. Linseed contains 35-45% oil. Linseed oil is suitable for human consumption and is used as a nutritional supplement. It is rich in omega-3 fatty acids, especially alpha-linolenic acid that was beneficial for heart disease, inflammatory bowel disease, arthritis and a variety of other health conditions. (Anonymous, 2015) [1]. ISOR (2015) [8] has projected the demand for the year 2020 and 2050 is 14.57 and 24.10 kg

year⁻¹ respectively. Chhattisgarh is one of the important linseed growing state of India, where it is cultivated in about 0.026 million hectare area with a production of 0.011 million tones but its productivity is low in Chhattisgarh (423 kg ha⁻¹) and national (498 kg ha⁻¹) compared to global productivity (877 kg ha⁻¹) (Anonymous, 2015) [1]. Among the agro-techniques, judicious application of nutrients, particularly the nitrogen, phosphorus and potash play the important role for increasing linseed productivity (Singh *et al.*, 2013) [15]. An application of fertilizer is considered imperative for increasing crop production. Long-time studies being carried out at several locations in India indicated that application of all the needy nutrients through chemical fertilizers have deleterious effect on soil health

leading to unsustainable yields (Jaga and Upadhyay, 2013)^[9]. Therefore; there is a need to improve nutrient supply system in terms of integrated nutrient management involving the use of chemical fertilizers in conjunction with FYM. Balanced fertilizer is the application of essential plant nutrients in light proportion and in optimum quantity for a specific soil crop condition. Chhattisgarh having third highest yield gap between improved technology and farmer's practice in irrigated condition is found after Uttar Pradesh and Himachal Pradesh (Singh *et al.*, 2015)^[16]. The major reason for low productivity of linseed may be due to adoption of primitive sowing method like *Utera* and farmers having poor knowledge with regards to INM and perpetual scarcity of basic agro-inputs like improved seed, fertilizers etc. Among the agro-techniques, judicious application of seed rates, nutrients, particularly the nitrogen, phosphorus and potash play the important role for increasing linseed productivity (Singh *et al.*, 2013)^[15]. Therefore; there is a need to improve nutrient supply system in terms of integrated nutrient management involving the use of chemical fertilizers in conjunction with foliar application of nutrients to the plants has been successfully used in correction of nutrient deficiency (Hsu and Ashmead, 1984), and quickly counter a mineral unbalance that would inhibit plant metabolism. Nitrobenzene is a combination of nitrogen and plants growth regulators that act as a plant energizer, flowering stimulant and yield booster (Aziz and Miah, 2009)^[2]. Energy use in agriculture has been increasing in response to increasing population, limited supply of arable land and a desire for higher standards of living (Kizilaslan, 2009)^[11]. Energy output and net energy are crucial parameters when the availability of arable land is the limiting factor for crop production (Tabata baeefar *et al.*, 2009). Efficient use of energy is one of the principal requirements for sustainable agricultural productions which helps to achieve increased production and productivity; and contributes to the economy, profitability and competitiveness of agriculture sustainability in rural areas (Ozkanand Karadeniz 2007)^[14].

Materials and Methods

The study area

A field experiment was conducted during *Rabi* season of 2015-16 at the Instructional *cum* Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (21°4' N latitude, 81°35' E longitude and 290.20 meter above mean sea level) under Chhattisgarh plains (Agro climatic zones of India). The experiment was laid out in factorial randomized block design with three replications and eighteen treatments. The treatment consisted of two seed rate *viz.* 25 kg ha⁻¹ (S₁), 30 kg ha⁻¹ (S₂), three nutrient management *viz.* RDF 60:30:30 N, P₂O₅ & K₂O Kg ha⁻¹ (N₁), RDF + Incorporation of FYM @ 5 t ha⁻¹ (N₂), RDF + FYM placement in rows @ 5 t ha⁻¹ (N₃) and three foliar spray, water spray at 15, 40, 65 and 90 DAS (F₁), foliar spray of Nitrobenzene @ 0.06% at 15, 40, 65 and 90 DAS (F₂) and foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F₃). Linseed (cv: *RLC-92*) was planted on 22nd November, 2015 and were harvested on 12th March, 2016. All the recommended agronomic management practices were followed except for the treatments. During the investigation, cumulative rainfall was 16.1 mm while average minimum and maximum temperature, morning and evening relative humidity, evaporation and sunshine *viz.* 15.5 °C, 30.4 °C, 83.4%, 36.8%, 3.3 mm and 6.0 hours,

respectively. Composite soil samples from 0-20 cm depth were collected from ten randomly selected places in the experimental area, prior to start of the field experiment, to evaluate the nutrient status of the soil, with the help of soil auger. Composite samples remain about 250 g and then it was used for analysis of the initial status of the physical and chemical properties of the soil and results of soil analysis was clayey in texture, neutral in pH (6.68), normal in EC (0.18) and had low in available N (226 kg ha⁻¹), medium in available P (12.64 kg ha⁻¹), high in available K (367 kg ha⁻¹) and medium organic carbon (0.50%). Nutrient content N, P and K in seed and stover were also analyzed by using standard procedure. Kumar *et al.* (2015)^[12].

Results and Discussion

The data shown in Table 1 and Table 2 and Fig 1 and Fig 2 revealed that growth, yield attributing character and yield were significantly affected due to nutrient management and foliar spray. Between seed rates, no significant difference was observed in growth and yield of linseed. Among nutrient management, the application of Recommended dose of fertilizer (RDF) + FYM placement in rows @ rate of 5 t ha⁻¹ (N₃) gave highest plant population, plant height, CGR, RGR, seed yield (kg ha⁻¹) and stover yield (kg ha⁻¹). Among nutrient management, the application of RDF + FYM placement in rows @ rate of 5 t ha⁻¹ (N₃) gave significantly highest seed yield (2100 kg ha⁻¹). Application of RDF 60:30:30 N:P:K kg ha⁻¹ (N₁) recorded lowest seed yield (1794 kg ha⁻¹). It is possible with the application of RDF + FYM placement in rows @ rate of 5 t ha⁻¹ due to that NPK application along with FYM placement with rows, application of FYM to linseed improving the overall fertility status of the soil, vigorous plant growth might have produced more photosynthetic. Efficient partitioning of accumulated photosynthesis, enhanced yield attributes which ultimately increased the seed yield. Similar observations were noted by Delesa and Choferie (2015)^[3]. In case of the foliar spray, application of 2% urea at 15, 40, 65 and 90 DAS (F₃) recorded significantly highest seed yield (2089 kg ha⁻¹). Whereas application of water spray (F₁) gave the lowest seed yield (1806 kg ha⁻¹). The application of Recommended dose of fertilizer (RDF) gave, lowest plant population, plant height, seed yield (kg ha⁻¹) and stover yield (kg ha⁻¹), that is might be due to application of NPK along with FYM placement with rows, application of FYM to linseed improving the overall fertility status of the soil, vigorous plant growth might have produced more photosynthetic. Efficient partitioning of accumulated photosynthesis, enhanced yield attributes which ultimately increased the seed yield. Similar observations were noted by Delesa and Choferie (2015)^[3]. The similar result has been reported by Khare *et al.* (1996)^[10] that the increase in yield attributing characters of linseed with the application of major nutrient and secondary nutrient (S). Interaction effects of nutrient managements and foliar spray on seed yield were found significant difference. The application of RDF + FYM placement in rows @ 5 t ha⁻¹ (N₃) with foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F₃) recorded significantly highest seed yield (2325 kg ha⁻¹) than other treatments. The lowest seed yield (1695 kg ha⁻¹) was noted under RDF 60:30:30 N:P:K kg ha⁻¹ X water spray (N₁ X F₁). Interaction effects of seed rate, nutrient managements and foliar spray on seeds yield were found significant and data

are presented in Table 4.15. The interaction of application of seed rate 30 kg ha⁻¹ (S₂), RDF + FYM placement in rows @ 5 t ha⁻¹ (N₃) with foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F₃) recorded significantly highest seed yield (2344 kg ha⁻¹) than other treatments. But it was found at par to interaction between applications of seed rate 25 kg ha⁻¹ X application of RDF + FYM placement in rows @ 5 t ha⁻¹ X foliar spray of 2% urea at 15, 40, 65 and 90 DAS (S₁ X N₃ X F₃). The lowest seed yield (1533 kg ha⁻¹) was noted under applications of seed rate 25 kg ha⁻¹ X RDF 60:30:30 N:P:K kg ha⁻¹ X water spray (S₁ X N₁ X F₁). In case of the foliar spray, application of 2% urea at 15, 40, 65 and 90 DAS (F₃) recorded highest plant population, plant height, CGR, RGR, seed yield (kg ha⁻¹) and stover yield (kg ha⁻¹). Whereas application of water spray (F₁) gavethe lowestplant population, lowest plant height, CGR, RGR, seed yield (kg ha⁻¹) and stover yield (kg ha⁻¹). Physiological activities like chlorophyll content and total photosynthetic pigments in leaves were significantly increased with increasing nitrogen level. Foliar nutrient application of urea remarkably improved growth traits, that studies revealed by El-Kadyet al. (2010) [5].

Conclusion

The flax yield was recorded maximum when crop was sown with higher seed rate i.e. 30 kg ha⁻¹(S₂) and applied with RDF + FYM placement in rows (N₃) combined with foliar application of 2% urea and nitrobenzene @ 0.06% at 15, 40, 65 and 90 DAS (F₂) and foliar spray of 2% urea at 15, 40, 65 and 90 DAS (F₃). In terms of seed production

efficiencythe maximum value was obtained with interaction among seed rate 30 kg ha⁻¹ (S₂) X RDF 60:30:30 N:P:K kg ha⁻¹ (N₁) X application of 2% urea at 15, 40, 65 and 90 DAS (F₃) (S₂ X N₁ X F₃)than others.

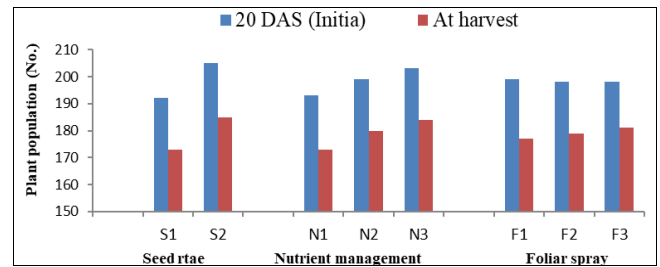


Fig 1: Plant population of linseed as influenced by seed rate, nutrient management and foliar spray

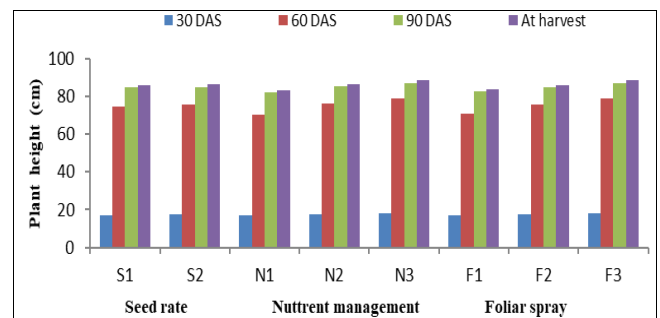


Fig 2: Plant height (cm) of linseed as influenced by seed rate, nutrient management and foliar spray

Table1. Flax yield, stover yield and harvest index of linseed as influenced by different treatments

Treatment		Flax yield (kg ha ⁻¹)	Stover yield (kg ha ⁻¹)	Harvest index (%)
Seed rate				
S ₁	25 kg ha ⁻¹	1934	4340	45
S ₂	30 kg ha ⁻¹	1971	4470	44
SE m±		21.11	63.28	0.92
CD (P=0.05)		NS	NS	NS
Nutrient Management				
N ₁	RDF (60:30:30 N:P:K kg ha ⁻¹)	1794	3978	45
N ₂	RDF + Incorporation of FYM @ 5 t ha ⁻¹	1963	4351	46
N ₃	RDF + FYM placement in rows @ 5 t ha ⁻¹	2100	4885	43
SE m±		25.85	77.50	1.13
CD (P=0.05)		74.48	223.28	NS
Foliar spray				
F ₁	Water spray	1806	4022	45
F ₂	Foliar spray of 0.06% Nitrobenzene at 15, 40, 65 and 90 DAS	1961	4420	45
F ₃	Foliar spray of 2% urea at 15, 40, 65 and 90 DAS	2089	4772	44
SE m±		25.85	77.50	1.13
CD (P=0.05)		74.4	223.28	NS
Interaction		S	S	NS

Table 2: Table 4.14: Interaction effect of nutrients and foliar spray on flax yield of linseed

Treatment		Flax yield (kg ha ⁻¹)			
		Foliar spray			
		F1	F2	F3	Mean
Nutrient management					
N ₁	RDF (60:30:30 N:P:K kg ha ⁻¹)	1695	1806	1881	1794
N ₂	RDF + Incorporation of FYM @ 5 t ha ⁻¹	1850	1978	2062	1963
N ₃	RDF + FYM placement in rows @ 5 t ha ⁻¹	1873	2099	2325	2100
Mean		1806	1961	2090	
SE m±		44.78			
CD (P=0.05)		129.00			

Table 3: Interaction effect of seed rate, nutrients and foliar spray on flax yield of linseed

Treatment		Flax yield (kg ha ⁻¹)			
		Foliar spray			
		F1	F2	F3	Mean
Seed rate X Nutrient management					
S ₁ X N ₁	25 kg ha ⁻¹ X RDF (60:30:30 N:P:K kg ha ⁻¹)	1533	1881	1838	1751
S ₁ X N ₂	25 kg ha ⁻¹ X RDF + Incorporation of FYM	1880	1927	2035	1948
S ₁ X N ₃	25 kg ha ⁻¹ X RDF + FYM placement in rows	1910	2091	2306	2102
S ₂ X N ₁	30 kg ha ⁻¹ X RDF (60:30:30 N:P:K kg ha ⁻¹)	1858	1731	1923	1837
S ₂ X N ₂	30 kg ha ⁻¹ X RDF + Incorporation of FYM	1820	2028	2089	1979
S ₂ X N ₃	30 kg ha ⁻¹ X RDF + FYM placement in rows	1836	2107	2344	2096
Mean		1806	1961	2089	
SE m±		63.33			
CD (P=0.05)		182.44			

References

- Anonymous. Status paper on oilseeds. Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, 2015.
- Aziz MA, Miah MAM. Effect of the “flora” on the growth and yield of wet land rice. *J. Agric. Rural. Dev.*, 2009;7:9-13.
- Delesa A, Choferie A. Response of Linseed (*Linum usitatissimum* L.) to seed rates and seeding methods in South-Eastern highlands of Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 2015, 5(13).
- Devsenapathy P, Senthilkumar G, Shanmugam PM. Energy management in crop production. *Indian Journal of Agronomy*, 2009;54(1):80-90.
- El-Kady FA, Awad MM, Osman EBA. Effect of nitrogen fertilizer rates and foliar fertilization on growth, yield and yield components of sunflower. *Journal of Plant Production*, 2010;1(3):451-459.
- Heard JBB, Park R. Nutrient Uptake and Removal Values for Dry Beans, Soybeans and Sunflowers in Manitoba. Unpublished Report to Manitoba Soil Fertility Advisory Committee, 2006.
- Hus HH, Ashmead HD. Effect of urea and ammonium nitrate on the uptake of iron through leaves. *Journal of Plant Nutrition*, 1984;7(1-5):291.
- ISOR. Extended Summaries: National Seminar on Strategic interventions to enhance oilseeds production in India. February 19-21, 2015. Indian Society of Oilseeds Research, Hyderabad, 2015.
- Jaga PK, Upadhyay VB. *Effect of integrated management on Wheat– A review. Innovare Journal of Agricultural Science*, 2013, 1(1).
- Khare JP, Sharma RS, Sony NK. Effect of sulphur and antitranspirants on yield attributes, yield and nutrient uptake in rainfed linseed. *Journal of Oilseed Research*, 1996;13(2):182-186.
- Kizilaslan H. Input–output energy analysis of cherries production in Tokat Province of Turkey. *Applied Energy*, 2009;86:1354–1358.
- Kumar M, Mitra S, Tripathi MK, Naik MR, Naik RK, Jha A, et al. Energy and economics analysis for jute and allied fibre crops. *Technical Bulletin*, 2015, 26.
- Mittal JP, Dhawan KC. *Research manual on energy requirements in agricultural sectors*, New Delhi: ICAR, 1988, 20-23.
- Ozkan BC, Fert, Karadeniz CF. Energy and cost analysis for greenhouse and open-field grape production. *Energy*, 2007;32:1500–1504.
- Singh DN, Bohra JS, Singh JK. Influence of NPK, S and variety on growth, yield and quality of irrigated linseed (*Linum usitatissimum* L.). *Indian Journal of Agricultural Sciences*, 2013;83(4):456-458.
- Singh PK, Husain K, Tripathi UK, Malik YP, Dubey, SD, Singh A, et al. *Linseed: Technology for increasing production (fifth edition)*, Project coordinating unit (Linseed), CSAU&T, Kanpur, 2015.
- Tabatabaeefar A, Emamzadeh H, Varnamkhasti MG, Rahimizadeh R, Karimi M. Comparison of energy of tillage systems in wheat production. *Energy*, 2009;34(1):41-45.