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NUTRIENT UPTAKE, YIELD AND NUTRIENT AVAILABILITY BY LINSEED AS AFFECTED BY NANO-UREA FOLIAR APPLICATION IN RED AND YELLOW SOIL

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ABSTRACT

A field experiment was conducted during *rabi* season of 2021-2022 to study the effect of different doses and application methods of nitrogenous fertilizer on nutrient uptake, economics and yield of linseed. The experiment was laid out in Split plot Design with main plot treatments consisting of soil application of 100 % (N_1), 75% (N_2), 50% (N_3) and 25% (N_4) N in two splits 50% as basal application and 50 % as top dressing and subplot treatments consisting of foliar application of different doses of nitrogenous fertilizers as follows, F_1 – Water spray, F_2 – One spray of nano-urea @ 3ml/lit at flower initiation stage, F_3 – Two sprays of nano-urea @ 3ml/lit at flower initiation and capsule development stage, F_4 – One spray of 2% Urea at flower initiation stage and F_5 – Two sprays of 2% Urea at flower initiation and capsule development stage as foliar application. Soil application of 100 % N (N_1) and supplemental nitrogen management with foliar application of two sprays of nano-urea @3ml/lit at flowering stage and capsule developmental stage (F_3) was found to record significantly highest seed and straw yield, B:C ratio, nitrogen use efficiency, N(%) content in grain and straw content and NPK uptake in grain and straw compare to the rest of the treatments.

Key words : Linseed, Nutrient uptake, Nano-urea, Foliar application, Nitrogen use efficiency.

Introduction

Oil seeds play an essential role in India's agricultural economy. Linseed (*Linum usitatissimum* L.) is India's most significant oilseed crop, second after rapeseed-mustard (*rabi*) in terms of area and production. Linseed may be farmed for both human consumption and linen production (Pohare and Raundal, 2017).

Due to the limited availability of inputs like as insecticides and fertiliser, linseed production is mostly limited to marginal and sub-marginal fields, which results in low crop yields. It is typically grown as a relay crop under the utera method of farming in North India in order to take advantage of the fertility of the residual soil moisture of the region. The major cause of decline in productivity of linseed is inadequate management methods. The crop yield may be affected by an NPKS deficiency at any stage throughout the crop's growth. Considering that it is one of the most significant crop management strategies that has been shown to influence crop output, NPKS fertilisation is especially significant in this regard (Dordas, 2010).

Furthermore, since nutrients may be supplied directly to plant tissues during critical stages of growth, foliar fertilisation is found to be more rapid, target-oriented, and eco-friendly than soil fertilisation. Since foliar spray does not expose nutrients to the different losses that arise from soil application, it is extremely effective in terms of absorption. It would be a financially feasible technology and a major cultivation cost saver if foliar spray of nitrogen could be used to lower the dose. Applications of split nitrogen (N) fertiliser can be a significant component of a profitable, sustainable and productive nutrient management strategy. Farmers can improve fertiliser efficiency, encourage optimal yields and reduce nutrient loss by splitting the total nitrogen into two or more applications. The capacity of a plant to make the best use of the N that is available in order to maximise productivity is known as nitrogen use efficiency, or NUE. It comprises the efficiency of N absorption, utilisation, or acquisition, measured as the ratio of output (grain N and plant N) and input (total soil N). This concept seems to be the most appropriate since the primary purpose of developing high NUE plants is to reduce N application under field conditions, this seems to be most appropriate definition (Moll *et al.*, 1982).

The current study was also planned and executed with different doses and application methods of fertilizer on yield.

Materials and Methods

The research trial was laid out in field of Western Section of Research Farm, Birsa Agricultural University, Kanke, Ranchi during *rabi* 2021 on the Linseed variety Priyam. The global position of the site was situated in sub-humid belt at the latitude of 23º17′ North and longitude of 85º19′ East at an altitude of 625 m from mean sea level (MSL) in Jharkhand. The average annual rainfall of this place is 1397.7 mm concentrated mostly from June to September. The mean annual maximum and minimum temperatures are 42.4°C and 2.2°C, respectively. Soils of the experimental site were Red-yellow-light grey catenary soil association group. The available soil status N, P and K were 227, 36 and 160.2 kg/ha. The experiment was laid out in a Split Plot design with 2 replications. In the main plot, 4 nitrogen management practices (50%N as basal+50% as top dressing at 20 DAS), *viz*. 100% N (N_1); 75% N(N_2); 50% N(N_3) and 25% (N_4), while five nitrogen management through nano-urea, *viz.*, water spray (F_1); one spray of nano-urea @ 3ml/litre of water at flower initiation stage (F_2), two sprays of nano-urea @ 3ml/litre of water at flower initiation and capsule development stage (F_3), one spray of 2% urea at flower initiation stage (F_4) and two sprays of 2% urea at flower initiation and capsule development stage (F_5) were taken in sub-plots. The dose of RDF was 30:20:20 (N: P_2O_5:K_2O kg/ha) at basal dose through urea, single super phosphate and murate of potash, respectively. Nutrient content in soil like N was calculated by Alkaline permanganate method (Subbaiah and Asijo, 1956), P content determined by Olsen's Method (Olsen's *et al.*, 1954) and K content determined from Neutral Normal Ammonium Acetate (Hanway and Heidel, 1952). Seed and straw yield were recorded after manual threshing and converted into kg/ha. Seed and straw were dried, processed and analysed for N, P, K and S content for working out the nutrient uptake. Nitrogen content in plant sample was determined by Kjeldahl method (Jackson, 1973). Phosphorus was estimated by following spectrophotometric method (Tandon, 2009). Potassium content in the samples was determined by atomic absorption spectrophotometer (Singh *et al.*, 2007).

Nitrogen use Efficiency (NUE) of the crop was calculated by taking the difference of nitrogen uptake (kg/ha) between treated plot and control plot with respect to Nitrogen applied (kg).

$$\text{NUE} = \frac{\text{Nitrogen uptake by treated plot (kg/ha)} - \text{Nitrogen uptake by control plot (kg/ha)}}{\text{Quantity of nitrogen applied (kg/ha)}}$$

The data were subjected to statistical analysis to examine the treatment effect in split plot design according to Gomez and Gomez (1984).

Results and Discussion

A perusal of data presented in Table 1, Figs. 1, 2 and 3 revealed that application of 100% nitrogen resulted in the highest seed yield (1442.21 kg/ha), straw yield (2652.06 Kg/ha) and BC ratio (1.71) among the various nitrogen levels tested, which were comparable to treatment applied with 75% N. The lowest seed yield (880.12 Kg/ha), straw yield (1810.52 Kg/ha) and BC ratio (0.04) was observed with application of 25% nitrogen. However, harvest index was found to be non-significant. There are several factors that directly or indirectly influence yield and BC ratio. Directly, the main factors are the number of capsules per plant, the number of seeds per capsule, test weight in grams and test weight per plant in grams. Indirectly, growth attributes such as dry matter production per plant and its distribution to various plant parts can also influence yield and ultimately BC ratio. This observation is consistent with studies conducted by Sujatha and Gangadhara Rao (2019) and Navya *et al.* (2022).

Effect of various nitrogen management practices

Among the nitrogen management practices, treatment with two sprays of nano-urea @ 3ml /litre of water each at flower initiation stage and capsule development stage produced the highest seed yield (1364.86 kg/ha), straw yield (2507.44 kg/ha) and BC ratio (1.49) followed by one spray of nano-urea @ 3ml /litre of water at flower initiation stage. The increase in yield of linseed could be due to foliar application of nano fertilizers offer a higher surface area due to the tiny particle size, which provides more surface area to facilitate different metabolic functions in the plant system as a result of more

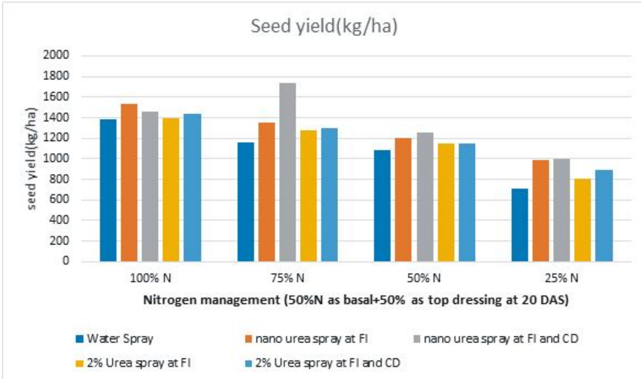

Fig. 1 : Effect of nitrogen management on Seed yield (kg/ha).

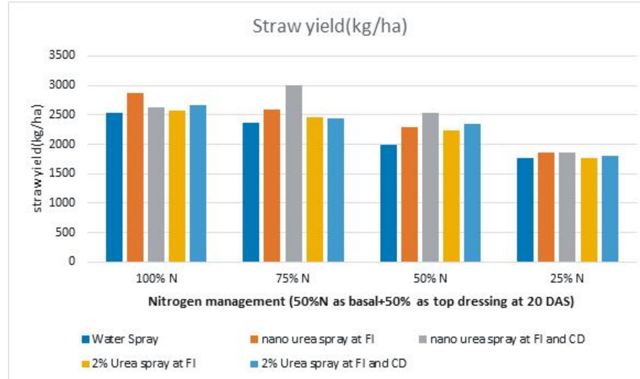

Fig. 2 : Effect of nitrogen management on straw yield (kg/ha).

Table 1 : Effect of different doses of nitrogenous fertilizer and application methods on seed, straw yield, harvest index, BC ratio and NUE of Linseed during *rabi* 2021-2022.

Treatments	Yield (kg/ha)		Harvest Index (%)	BC ratio	Nitrogen Use-Efficiency (NUE)
	Seed	Straw			
A. Nitrogen level					
N1:100% N	1442.21	2652.06	35.24	1.71	2.46
N2:75% N	1365.88	2571.70	34.59	1.58	2.98
N3:50% N	1167.79	2277.72	33.96	1.23	3.30
N4:25% N	880.12	1810.52	32.63	0.70	3.37
SEm±	22.48	46.46	0.81	0.04	0.14
CD(P=0.05)	101.17	209.08	3.65	0.17	0.61
B. Foliar nitrogen management practices					
F1: Water spray	1083.83	2160.61	33.07	1.10	1.93
F2: One spray of nano-urea @ 3ml/ litre of water at flower initiation stage	1269.58	2401.09	34.58	1.39	3.49
F3: Two sprays of nano-urea @ 3ml /litre of water each at flower initiation stage and capsule development stage	1364.86	2507.44	35.16	1.49	4.03
F4: One spray of 2% urea at flower initiation stage	1156.54	2260.45	33.68	1.24	2.72
F5: Two sprays of 2% urea at flower initiation and capsule development stage	1195.17	2310.43	34.04	1.30	2.99
SEm±	32.78	65.99	0.86	0.06	0.13
CD(P=0.05)	98.27	197.85	2.59	0.17	0.40

photosynthates being produced. These results are in line with the results reported by Midde *et al*. (2022) and Ajitkumar *et al*. (2021).

Effect of different treatments on Nitrogen Use-Efficiency (NUE)

Mean data of Nitrogen Use-Efficiency are presented in Table 1 with significant differences due to nitrogen management through soil application was recorded highest with the application of 25% N (3.37) followed by application of 50% N (3.3). This might be a result of the plant using the supplied nitrogen rapidly, effectively, and promptly. A lesser amount of nitrogen applied over a longer period resulted in effective utilization. Zhao *et al*. (2013) reported similar results that increase in Nitrogen Use-

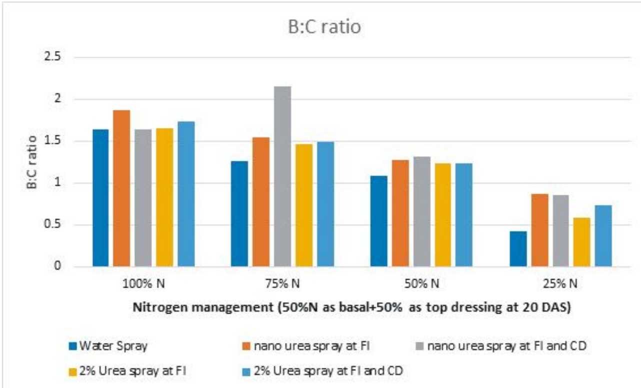

Fig. 3 : Effect of nitrogen management on B:C ratio of Linseed.

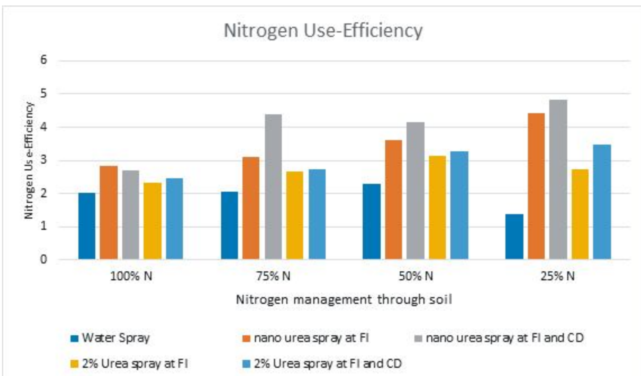

Fig. 4 : Effect of nitrogen management on Nitrogen Use-Efficiency (NUE).

Efficiency (NUE) is due to improved nutrient utilization and reduced nutrient loss.

Supplemental nitrogen management through foliar application was found to be significantly highest with the application of two sprays of nano-urea @ 3ml/lit at flower initiation and capsule development stage (4.03) followed by one spray of nano-urea @ 3ml /litre of water at flower initiation stage (3.49). The results aligned with the research of Al-Juthery *et al* (2019), which showed that using a nano nitrogen fertilizer with 25% nitrogen resulted in a higher Nitrogen Use-Efficiency (NUE) of 97.43% compared to traditional NPK fertilizer with an NUE of 52.27%.

Available N, P_2O_5 and K_2O (kg/ha) in soil at harvest of linseed

Available N, P_2O_5 and K_2O were non-significantly reduced in every treatment as compare to their initial values (N-227 kg/ha, P_2O_5-36kg/ha and K_2O-160.2 kg/ha, respectively). The results (Table 2) clearly revealed that application of 100% nitrogen recorded maximum available nitrogen in soil whereas 25% N application was associated with higher availability of phosphorous and potassium. Among different treatments of nano nitrogen fertilizers, the higher available nitrogen, phosphorus and potassium in soil was observed with water spray application. These observations support the work reported Tiwari *et al.* (2018) and Meena *et al.* (2023).

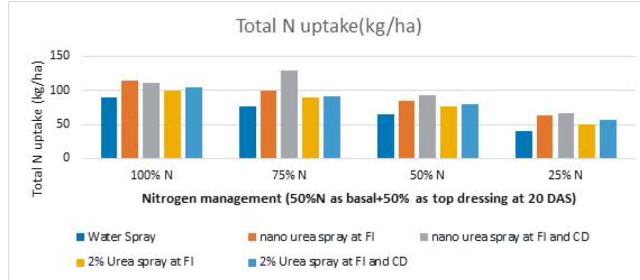

Fig. 5 : Effect of nitrogen management on total N uptake by Linseed.

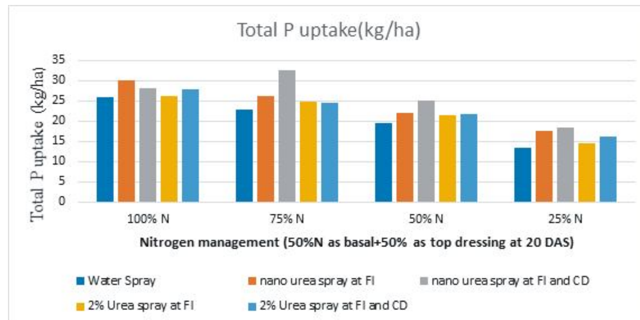

Fig. 6 : Effect of nitrogen management on total P uptake by Linseed.

NPK (%) content in grain and straw of Linseed

Data presented in Table 3 reveals that there was no significant difference among the treatments regarding phosphorous, potassium, except nitrogen. Different nitrogen levels significantly influenced N, P and K content in grain as well as straw. Application of 30-20-20 kg NPK/ha improved nutrient content (NPK) in grain and straw, which increased by 20.2 per cent and 17.8 per cent over 7.5-20-20 kg/ha, respectively. However, foliar application did not have a significant impact on NPK content (%) in grain and straw. Manikandan and Subramanian (2016) reported that highest N content was registered in roots of maize plants fertilized with nanozeourea (0.32 %), while urea fertilized plants had only 0.26%. On the other hand, zeourea fertilized plants had the highest N content of 0.78%, which is significantly different from the rest of the treatments. These results are in close conformity with the findings of Meena *et al.* (2011).

NPK uptake by grain and straw

Table 4 and Figs. 5, 6 and 7 represents the data on NPK uptake by grain and straw which recorded significant differences with the application of full dose of 100% N as soil application followed by 75% N compared to the rest of the treatments. Variation was found with supplemental nitrogen through foliar application was

Table 2 : Effect of different doses of nitrogenous fertilizer and application methods on NPK (Kg/ha) after harvest of crop in soil during *rabi* 2021-2022

Treatments	Available nutrient status (kg/ha)		
	N	P_2O_5	K_2O
A. Nitrogen level			
N_1:100% N	223.31	37.05	149.37
N_2:75% N	221.40	38.46	150.99
N_3:50% N	218.28	39.61	155.66
N_4:25% N	217.31	40.56	161.82
SEm±	2.91	2.51	9.08
CD (P=0.05)	NS	NS	NS
B. Foliar nitrogen management practices			
F_1: Water spray	223.64	40.27	158.16
F_2: One spray of nano-urea @ 3ml /litre of water at flower initiation stage	218.94	38.51	153.31
F_3: Two sprays of nano-urea @ 3ml /litre of water each at flower initiation stage and capsule development stage	216.53	37.39	150.79
F_4: One spray of 2% urea at flower initiation stage	221.45	39.49	155.85
F_5: Two sprays of 2% urea at flower initiation and capsule development stage	219.82	38.93	154.18
SEm±	5.67	1.12	3.02
CD (P=0.05)	17.00	3.37	NS

Table 3 : Effect of different doses of nitrogenous fertilizer and application methods on NPK (%) content in seed and straw of Linseed during *rabi* 2021-2022.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	Grain	Straw	Grain	Straw	Grain	Straw
A. Nitrogen level						
N_1:100% N	5.11	1.136	0.87	0.570	0.92	1.190
N_2:75% N	4.98	1.110	0.86	0.560	0.91	1.186
N_3:50% N	4.72	1.062	0.83	0.540	0.89	1.184
N_4:25% N	4.25	0.964	0.79	0.500	0.86	1.168
SEm±	0.06	0.017	0.02	0.014	0.01	0.030
CD(P=0.05)	0.25	0.077	NS	NS	NS	NS
B. Foliar nitrogen management practices						
F1: Water spray	4.21	0.973	0.80	0.538	0.86	1.143
F2: One spray of nano-urea @ 3ml /litre of water at flower initiation stage	5.00	1.090	0.86	0.539	0.91	1.200
F3: Two sprays of nano-urea @ 3ml /litre of water each at flower initiation stage and capsule development stage	5.14	1.143	0.87	0.568	0.93	1.213
F4: One spray of 2% urea at flower initiation stage	4.71	1.058	0.82	0.534	0.88	1.168
F5: Two sprays of 2% urea at flower initiation and capsule development stage	4.77	1.078	0.84	0.535	0.90	1.188
SEm±	0.10	0.019	0.02	0.011	0.02	0.022
CD (P=0.05)	0.30	0.06	NS	NS	NS	NS

Table 4 : Effect of different doses of nitrogenous fertilizer and application methods on nutrient uptake by grain and straw during *rabi* 2021-2022.

Treatments	Grain (Kg/ha)			Straw (Kg/ha)			Total (Kg/ha)		
	N	P	K	N	P	K	N	P	K
A. Nitrogen level									
N1:100% N	73.84	12.56	13.29	30.12	15.12	31.55	103.97	27.68	44.84
N2:75% N	68.49	11.78	12.52	28.66	14.42	30.56	97.16	26.20	43.08
N3:50% N	55.30	9.69	10.37	24.27	12.31	27.02	79.57	22.00	37.39
N4:25% N	37.82	7.01	7.60	17.49	9.04	21.17	55.30	16.05	28.76
SEm±	1.01	0.48	0.12	0.55	0.39	1.20	1.36	0.35	1.13
CD (P=0.05)	4.55	2.17	0.55	2.49	1.76	5.41	6.10	1.55	5.08
B. Foliar nitrogen management practices									
F1: Water spray	46.52	8.77	9.38	21.25	11.70	24.78	67.77	20.47	34.16
F2: One spray of nano-urea @ 3ml/ litre of water at flower initiation stage	64.10	10.89	11.63	26.39	13.06	28.82	90.49	23.95	40.45
F3: Two sprays of nano-urea @ 3ml/ litre of water each at flower initiation stage and capsule development stage	70.88	11.91	12.68	28.86	14.23	30.42	99.74	26.14	43.11
F4: One spray of 2% urea at flower initiation stage	55.22	9.59	10.24	24.12	12.17	26.41	79.34	21.76	36.64
F5: Two sprays of 2% urea at flower initiation and capsule development stage	57.59	10.13	10.79	25.06	12.45	27.44	82.65	22.58	38.23
SEm±	2.05	0.26	0.43	0.84	0.36	0.93	2.18	0.44	1.13
CD (P=0.05)	6.15	0.77	1.30	2.50	1.07	2.79	6.52	1.33	3.40

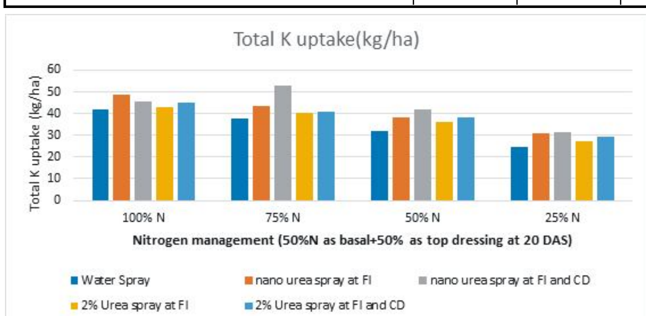

Fig. 7 : Effect of nitrogen management on total K uptake by Linseed.

recorded highest uptake in grain and straw with two sprays of nano-urea @ 3ml/lit at flower initiation stage and capsule development stage followed by one spray of nano-urea @ 3ml /litre of water at flower initiation stage. This might be due to increased rates of NPK application increased their uptake. These similar findings are lined with Ali *et al.* (2011), Lal *et al.* (2011) and Shaaban *et al.* (2012).

Conclusion

Based on one year of experimentation, it may be concluded that 75% of Nitrogen (22.5 kg/ha) and one spray of nano-urea @3ml/litre of water at flower initiation stage was found to have higher availability of nitrogen, nutrient uptake and was most productive and economical option for linseed production in Jharkhand.

Conflict of interest : The authors declare no conflict of interest.

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References

Ajithkumar, K., Kumar Y., Savitha A.S., Ajayakumar M.Y., Narayanaswamy C., Raliya R. and Bhat S.N. (2021). Effect of IFFCO nanofertilizer on growth, grain yield and managing turcicum leaf blight disease in maize. *Int. J. Plant Soil Sci.*, **33(16)**, 19-28.

Ali, S., Cheema M.A., Wahid M.A., Sattar A. and Saleem M.F. (2011). Comparitive production potential of linola and linseed under different nitrogen levels. *Crop and Environment*, **2(2)**, 33-36.

Al-Juthery, H.W., Habeeb K.H., Altaee F.J.K., Al-Taey D.K. and Altawaha A.R.M. (2019). Effect of foliar application of different sources of nanofertilizers on growth and yield of wheat. *Biosci. Res*., **15(4)**, 3988-3997.

Dordas, E. (2010). Variation of physiological determinants of yield in linseed in response to nitrogen fertilization. *Indian Crops Prod*., **31**, 455-465.

Gomez, K.A. and Gomez A.A. (1984). *Statistical Procedure for Agricultural Research*. 2nd Edn. John Wiley and Sons, New York. pp. 241-271.

Hanway, J.J. and Heidel H. (1952). Soil analysis method as used in Lowa state College Soil testing laboratory. *Lowa State College of Agriculture, Bulletin*, **57**, 1-31.

Jackson, M.L. (1973). *Soil chemical analysis*. New Delhi: Prentice Hall of India. pp. 151-157.

Lal, M.R., Singh T.K., Rakesh K. and Pramod K. (2011). Nutrient uptake, yield and quality of linseed (*Linum usitatissimum* L.) as affected by fertility levels and seed rates in dry conditions of Eastern Uttar Pradesh. *Int. J. Bio-Resources Stress Manage*., **2(1)**, 83-85.

Manikandan, A. and Subramanian K.S. (2016), Evaluation of zeolite based nitrogen nano-fertilizers on maize growth, yield and quality on Inceptisols and Alfisols. *Int. J. Plant Soil Sci*., **9(4)**, 1-9.

Meena, A.K., Meena R.N., Singh R.K., Srivastava V.K. and Choudhary K. (2023). Growth and Nutrient Uptake of Indian Mustard as influenced by Residual effect of Green Leaf Manuring and Nitrogen Fertilization. *Biolog. Forum-An Int. J.*, **13(4)**, 271-274.

Meena, R.L., Singh T.K., Kumar R., Singh A.K. and Hari O. (2011). Performance of linseed (*Linum usitatissimum* L.) to fertility levels and seed rates in dryland conditions of eastern Uttar Pradesh. *Indian J. Soil Cons*., **39 (3)**, 230-235.

Midde, S., Perumal M.S., Murugan G., Sudhagar R., Mattepally V.S. and Reddy M. (2022). Evaluation of nano urea on growth and yield attributes of rice (*Oryza sativa* L.). *Chem. Sci. Rev. Lett.*, **11(42)**, 211-214.

Moll, R. H., Kamprath E.J. and Jackson W.A. (1982). Analysis and interpretation of factors, which contribute to efficiency of nitrogen utilization 1. *Agron. J.*, **74(3)**, 562-564.

Navya, K., Sai Kumar R., Krishna Chaitanya A. and Sampath O. (2022). Effect of nano nitrogen in conjunction with urea on growth and yield of mustard (*Brassica juncea* L.) in Northern Telangana Zone. *Biolog. Forum : An Int. J.*, **14(3)**, 95-99.

Olsen, S.R., Cole C.V., Watanable F.S. and Dean L.A. (1954). Estimating of phosphorus in soil by extraction with sodium bicarbonate, USDA Circular, 939.

Pohare, V.B. and Raundal P.U. (2017). Response of nitrogen, phosphorous and potassium levels on linseed (*Linum usitatissimum* L.). *Bull. Env. Pharmacol. Life Sci*., **6(3)**, 475-479.

Shaaban, S.H.A. and El-Nour A. (2012). Effect of different potassium sources on yield and nutrient uptake by flax (*Linum usitatissimum* L.) grown on loamy sand soil. *J. Appl. Sci. Res*., **8(3)**, 1525-1429.

Singh, T., Singh V.K., Singh Y. and Singh M.K. (2007). Effect of sowing dates, seed rates and sulphur levels on growth, yield, quality and moisture use of rainfed linseed. *Env. Eco*., **25**, 978-982.

Subbaiah, B.V. and Asijo G.L. (1956). A rapid procedure for determinations of available nitrogen in soil. *Curr. Sci*., **25**, 259-260.

Sujatha, V. and Gangadhararao S.V. (2019). Effect of foliar nutrition of nitrogen and potash on seed yield and economics of sesame (*Sesamum indicum* L.) in North Coastal zone of Andhra Pradesh. *Int. J. Chem. Stud.*, **7(6)**, 138-140.

Tandon, H.L.S. (2009). Methods of Analysis of Soils, Plants, Waters, Fertilizers and Organic Manures. pp. 76-111.

Tiwari, U.S., Dubey S.D., Pandey R.K. and Husain K. (2018). Effect of integrated nutrient management on yield, nutrient uptake and quality of Linseed (*Linum ustiatissimum* L) in central plane zone of UP. *J. Pharmacog. Phytochem.*, **7(4)**, 643-645.

Zhao, B., Dong S., Zhang J. and Liu P. (2013). Effects of controlled-release fertilizer on nitrogen use efficiency in summer maize. *PLOS One*, **8(8)**, 70569.