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Response of Nitrogen, Phosphorus and Potassium Levels on Linseed (*Linum usitatissimum* L.)

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ABSTRACT
The present investigation was conducted during rabi 2011- 2012 at Agronomy farm, College of Agriculture, Pune-5. The experiment was laid out in randomized block design (Factorial) with three level each of nitrogen (N_1:40, N_2:60, N_3:80 kg ha $^{-1}$)), phosphorus (P_1: 15, P_2: 30, P_3: 45 kg ha $^{-1}$) and potassium (K_1: 0, K_2: 15, K_3: 30 kg ha $^{-1}$) replicated twice. Chemical studies the nutrient concentrations as influenced by different treatments viz., N, P and K content (%) in seed and straw, N, P and K uptake by seed , straw and crop (kg ha^{-1}) and available N, P and K in soil (kg ha^{-1}) after harvest of crop. The mean concentration of nitrogen, phosphorus, potassium in linseed seed were 4.63, 0.84 and 0.85 per cent, while in straw 1.06, 0.54 and 1.03 per cent, respectively. Total N, P and K uptake (kg ha^{-1}) by seed, straw and crop were increased significantly due to application of 80:45:30 NPK kg ha^{-1} and Available N, P and K (kg ha^{-1}) in soil after harvest was higher at application of 80kg ha^{-1} nitrogen, 45 kg ha^{-1} phosphorus and 30 kg ha^{-1} potassium over lower levels of fertilizer application.
Keywords: NPK, Rabi, Linseed

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INTRODUCTION

Linseed (Linum usitatissimum L.) is one of the oldest oilseed crop cultivated for its seed and fiber. Linseed is one of the important *rabi* oilseed crop of India. It is an industrial crop cultivated for its seeds, fibers and oil. All parts of the plant have extensive and varied uses. Fibers obtained from the stem are known for their length, strength and beauty. The oil content of seed varies from 32 to 46 per cent. Linseed oil is found to be comprised of 5 major fatty acids, *viz.,* palmitic, stearic, oleic, linoleic and linolenic.

Every part of the linseed plant is utilized commercially either directly or after processing. The linseed oil primarily goes to industries for manufacture of paints, varnish, oil cloth, linoleum and pad ink. Linseed oil possesses a very healthy fatty acid profile, particularly, Omega-3 (Alpha Linolenic Acid), the richest source only in linseed (58 per cent). ALA provides beneficial effects in numerous clinical conditions such as, cardiovascular disease, inflammatory disorders, immune function and cancer etc.

The productivity of linseed is low compared to world's productivity, though there is ample scope for its increased production through optimum use of fertilizer. Linseed responds to N, P and K nutrients very well. The beneficial effect of N, P and K in increasing growth attributes of linseed was reported by several workers (Jain *et al.*, 1989). Studies on direct effect of N, P and K fertilization on the uptake of nutrients by crops have been found to be helpful in economizing fertilizer use.

MATERIALS AND METHODS

An experiment was conducted at, Agronomy farm, College of Agriculture, Pune during the year of 2011-12 in *rabi* season. The soil of experiment field was clay loam in texture, normal in reaction (pH 7.7) with low available nitrogen (175.4 kg ha^{-1}), medium available phosphorus (29.46 kg ha^{-1}) and high available potassium (460.00 kg ha^{-1}).

The experiment was laid out in randomized block design (Factorial) with three level each of nitrogen (N_1 :40, N_2 :60, N_3 :80 kg ha $^{-1}$)), phosphorus (P_1: 15, P_2: 30, P_3: 45 kg ha $^{-1}$) and potassium (K_1: 0, K_2: 15, K_3: 30 kg ha $^{-1}$) replicated twice. The gross and net plot sizes were 4.00 x 3.00 m^2 and 3.50 x 2.40 m^2 , respectively. The linseed variety PKVNL- 260 was sown on 3rd December, 2012 with spacing of 30 x 5 cm^2.

RESULTS AND DISCUSSION

Chemical studies

Nutrient concentration

The nutrient concentrations as influenced by different treatments. The mean concentration of nitrogen, phosphorus, potassium in linseed seed were 4.63, 0.84 and 0.85 per cent, while in straw 1.06, 0.54 and 1.03 per cent, respectively.

Effect of nitrogen levels The effect of N levels *viz*., 40, 60 and 80 kg ha^{-1} on NPK content in seed and straw were statistically non significant. Numerically, the nutrient concentration in seed and straw were not showed considerable differences.

Effect of phosphorus levels

The P levels *viz*., 15, 30 and 45 kg ha^{-1} were statistically non significant in seed and straw. Numerically the nutrient concentration was not showed considerable difference in nutrient concentration of seed and straw.

Effect of potassium levels

The effect of K levels *viz*., 0, 15 and 30 kg ha^{-1} were statistically non significant. Numerically, the nutrient concentration of seed and straw was not showed considerable differences.

Interaction effects The interactions effect nitrogen, phosphorus and potassium levels were statistically non significant for nutrient concentration in seed and straw by linseed.

Total nutrient uptake

The data on mean total uptake of nitrogen, phosphorus and potassium by linseed plant at harvest as influenced by the different treatments.

The mean total uptake of nitrogen, phosphorus and potassium were 96.42, 26.94 and 40.79 kg ha^{-1}, respectively.

Effect of nitrogen levels

The total uptake of nitrogen, phosphorus and potassium was influenced significantly by N levels. Significantly higher total nitrogen, phosphorus and potassium uptake were registered in N level of 80 kg ha^{-1} over rest of N levels. The higher nutrients uptake with N level 80 kg ha^{-1} was might be due to higher N availability. The similar results were reported by Chourasia *et al* . (1992), Dixit and Sharma (1993),Vashishtha, (1993), Agrawal *et al.*(1994), Jain *et al*. (1997) and Sharma and Hunsingi, (1996).

Effect of phosphorus levels

The total uptake of nitrogen, phosphorus and potassium was influenced significantly by P levels. Significantly the highest total nitrogen, phosphorus and potassium uptake were registered with 45 kg ha^{-1} whereas, it was significantly minimum with 15 kg ha^{-1}. The higher nutrients uptake in P level 45 kg ha^{-1} was might be due to higher P availability. The similar results were reported by Vashishtha, (1993) and Jain *et al*. (1997).

Effect of potassium levels

The total uptake of nitrogen, phosphorus and potassium was influenced significantly by K levels. Total nitrogen, phosphorus and potassium uptake by plant were increased progressively with each successive increase in potash levels. Increased in nutrients uptake by plants due to higher levels of potash might be due to higher K availability. Similar results were observed by Dixit and Sharma (1993), Agrawal *et al*. 1994 and Jain *et al*. (1997).

Interaction effects

The interactions effect of nitrogen, phosphorus and potassium levels were statistically non significant for nutrient removal by seed, straw and total uptake by linseed.

Nutrient status of soil

The data in respect of available of nitrogen, phosphorus and potassium in soil after harvest as influenced by the different treatments are presented in Table 23 and graphically depicted in Fig.8.The mean total available nitrogen, phosphorus and potassium after harvest were 131.94, 24.01 and 428.50 kg ha^{-1}, respectively.

Effect of nitrogen levels

The nutrient status of soil was influenced significantly due to N levels. The available residual nitrogen, phosphorus and potassium were registered significantly maximum in N level 80 kg ha^{-1}. Whereas, these were significantly lower with 40 kg N ha^{-1}.This might be due to more availability of nitrogen, phosphorus and potassium in soil at higher level of nitrogen i.e. 80 kg ha^{-1} and reflects in more uptake and higher yield.

Effect of phosphorus levels

The nutrient status of soil was influenced significantly due to P levels. The available residual nitrogen, phosphorus and potassium were registered significantly maximum in P level of 45 kg ha^{-1}. Whereas, significantly lowest available nitrogen, phosphorus and potassium in soil were recorded in P level 15 kg

ha^{-1}. might be due to more availability of nitrogen, phosphorus and potassium in soil at P level of 45 kg ha^{-1} which reflects in more uptake and higher yield.

Effect of potassium levels

The nutrient status of soil was influenced significantly due to k levels. The available residual nitrogen, phosphorus and potassium were registered significantly maximum in K level 30 kg K_2O ha^{-1}. Whereas, significantly lower nitrogen, phosphorus and potassium content in soil were recorded in K levels of 0 kg ha^{-1}. This difference might be due to more availability of nitrogen, phosphorus and potassium under higher level of potash resulted in more uptake and higher yield.

Interaction effects

The interaction effect among nitrogen, phosphorus and potassium levels were statistically non significant for available residual soil nitrogen, phosphorus and potassium.

Table 1. Total N, P and K content (%) in seed and straw as influenced by different treatments

Treatment	NPK content in seed (%)			NPK content in straw (%)		
Nitrogen levels (kg ha^{-1})	**N**	**P**	**K**	**N**	**P**	**K**
N_1 : 40	4.45	0.79	0.81	0.97	0.50	1.01
N_2 : 60	4.64	0.84	0.86	1.08	0.55	1.04
N_3 : 80	4.81	0.87	0.89	1.14	0.57	1.06
S.E. m ±	0.008	0.003	0.001	0.001	0.001	0.001
C.D. at 5%	NS	NS	NS	NS	NS	NS
Phosphorus levels (kg ha^{-1})						
P_1 : 15	4.59	0.82	0.84	1.04	0.53	1.02
P_2 : 30	4.63	0.84	0.85	1.06	0.54	1.03
P_3 : 45	4.67	0.85	0.86	1.09	0.55	1.05
S.E. m ±	0.008	0.003	0.001	0.001	0.001	0.001

Table 2. Total N, P and K uptake (kg ha^{-1}) by seed, straw and crop as influenced by different treatments

C.D. at 5%	NS	NS	NS	NS	NS	NS
Potassium levels (kg ha^{-1})						
K_1 : 0	4.62	0.83	0.85	1.05	0.53	1.03
K_2 : 15	4.63	0.84	0.85	1.06	0.54	1.04
K_3 : 30	4.64	0.84	0.85	1.07	0.54	1.04
S.E. m ±	0.008	0.003	0.001	0.001	0.001	0.001
C.D. at 5%	NS	NS	NS	NS	NS	NS
Interaction						
N x P	NS	NS	NS	NS	NS	NS
N x K	NS	NS	NS	NS	NS	NS
P x K	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	NS	NS	NS	NS
General Mean	4.63	0.84	0.85	1.06	0.54	1.03

Table 2. Total N, P and K uptake (kg ha^{-1}) by seed, straw and crop as influenced by different treatments

Treatment	NPK uptake by seed			NPK uptake by straw			Total NPK uptake by crop		
Nitrogen levels (kg ha^{-1})	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
N_1 : 40	49.08	8.71	8.93	23.03	11.87	23.98	72.11	20.58	32.73
N_2 : 60	70.66	12.79	13.09	30.14	15.35	29.02	100.80	28.14	42.11
N_3 : 80	82.87	14.99	15.33	34.90	17.45	32.45	117.77	32.44	47.78
S.E. m ±	0.93	0.26	0.24	0.48	0.16	0.41	0.94	0.28	0.60
C.D. at 5%	2.80	0.78	0.73	1.44	0.48	1.25	2.84	0.86	1.80
Phosphorus levels (kg ha^{-1})									
P_1 : 15	58.24	10.39	10.65	26.04	13.27	25.54	84.28	23.66	36.19
P_2 : 30	66.81	12.12	12.26	29.28	14.92	28.45	96.09	27.04	40.71
P_3 : 45	76.49	13.92	14.08	32.26	16.28	31.08	108.75	30.20	45.16
S.E. m ±	0.93	0.26	0.24	0.48	0.16	0.41	0.94	0.28	0.60
C.D. at 5%	2.80	0.78	0.73	1.44	0.48	1.25	2.84	0.86	1.80
Potassium levels (kg ha^{-1})									
K_1 : 0	56.82	10.20	10.04	26.25	13.25	25.75	83.07	23.45	35.79
K_2 : 15	66.44	12.05	12.99	29.68	15.12	29.12	96.12	27.17	42.11

K_3 : 30	77.59	14.07	14.24	31.24	15.76	30.36	108.83	29.83	44.60
S.E. m ±	0.93	0.26	0.24	0.48	0.16	0.41	0.94	0.28	0.60
C.D. at 5%	2.80	0.78	0.73	1.44	0.48	1.25	2.84	0.86	1.80
Interaction									
N x P	NS	NS	NS	NS	NS	NS	NS	NS	NS
N x K	NS	NS	NS	NS	NS	NS	NS	NS	NS
P x K	NS	NS	NS	NS	NS	NS	NS	NS	NS
N x P x K	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	67.22	12.24	12.40	29.20	14.80	28.41	96.42	26.94	40.79

Table 3. Available N, P and K (kg ha^{-1}) in soil after harvest as influenced by different treatments

Treatment	**Nitrogen**	**Phosphorus**	**Potassium**
Nitrogen levels (kg ha^{-1})			
N_1 : 40	128.64	19.62	422.31
N_2 : 60	132.67	22.82	427.61
N_3 : 80	138.33	26.48	437.63
S.E. m ±	0.42	0.31	0.53
C.D. at 5%	1.27	0.94	1.60
Phosphorus levels (kg ha^{-1})			
P_1 : 15	127.16	20.92	417.73
P_2 : 30	134.35	24.47	428.81
P_3 : 45	140.69	27.48	439.59
S.E. m ±	0.42	0.31	0.53
C.D. at 5%	1.27	0.94	1.60
Potassium levels (kg ha^{-1})			
K_1 : 0	123.64	22.22	416.92
K_2 : 15	127.67	23.53	427.22
K_3 : 30	134.33	28.62	438.68
S.E. m ±	0.42	0.31	0.53
C.D. at 5%	1.27	0.94	1.60
Interaction			
N x P	NS	NS	NS
N x K	NS	NS	NS
P x K	NS	NS	NS
N x P x K	NS	NS	NS
General Mean	131.94	24.01	428.50

CONCLUSION

The N level 80 kg ha^{-1} recorded significant the maximum uptake of total nitrogen (117.77 kg ha^{-1}), phosphorus (32.44 kg ha^{-1}) and potassium (47.78 kg ha^{-1}) by linseed. After harvest of crop available soil nitrogen (138.33 kg ha^{-1}), phosphorus (26.48 kg ha^{-1}) and potassium (437.63 kg ha^{-1}) were significantly more with 80 kg ha^{-1} N level as compared with 60 kg $ha^{-1}$and 40 kg ha^{-1}.

The P level 45 kg ha^{-1} recorded the significantly maximum uptake of total nitrogen (108.75 kg ha^{-1}), phosphorus (30.20 kg ha^{-1}) and potassium (45.16 kg ha^{-1}) by linseed. After harvest of crop available soil nitrogen (140.69 kg ha^{-1}), phosphorus (27.48 kg ha^{-1}) and potassium (439.59 kg ha^{-1}) were significantly higher with 45 kg ha^{-1} over with 30 and 15 kg ha^{-1}.

The K level of 30 kg ha-1 recorded the significantly maximum uptake of total nitrogen (108.83 kg ha-1), phosphorus (29.83 kg ha-1) and potassium (44.60 kg ha-1) by linseed. After harvest of crop available soil nitrogen (134.33 kg ha-1), phosphorus (28.62 kg ha-1) and potassium (438.68 kg ha-1) were significantly more with 30 kg ha-1 K level over 15 and 0 kg ha-1.

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