

Influence of nitrogen and phosphorus application on the yield, and oil content of linseed (*Linum usitatissimum*)

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ABSTRACT

A field experiment was conducted on sandy-loam soil during the winter (*rabi*) seasons of 1986-88, to study the effect of different levels of nitrogen (0, 40, 80 and 120 kg N/ha) and phosphorus (0, 20 and 40 kg P₂O₅/ha) on yield attributes, yield, quality of linseed (*Linum usitatissimum* L.), and uptake of N and P. Though the grain yield as well as the yield attributes increased significantly with increasing levels of N and P up to the maximum levels except the effect of P on 1,000-grain weight, 80 kg N and 40 kg P₂O₅/ha were optimum. Significant level of recovery in crop was up to 40 kg N and 40 kg P/ha. However, uptake of N was noted up to 80 kg N and 40 kg P₂O₅/ha. Crude protein content increased significantly with an increase in level of N and P. Application of N significantly affected the iodine value.

Considering high cost and low availability of nitrogenous and phosphatic fertilizers in developing countries, efficient utilization of N and P in linseed (*Linum usitatissimum* L.) which gets low priority in N and P fertilizer allocation compared to other crops like wheat, maize, rice, has to be worked out. This experiment was conducted to study the influence of different levels of N and P on the growth, yield and oil content of linseed under irrigated conditions of western Uttar Pradesh.

MATERIALS AND METHODS

The field experiment was conducted in randomized block design during the winter (*rabi*) seasons of 1986-88 at Lakhaoti. The treatments comprised 4 levels of N (0, 40, 80 and 120 kg/ha) and 3 levels of P₂O₅ (0, 20 and 40 kg/ha) with 4 replications. The soil

was sandy loam in texture, having 0.35% organic carbon, 140 kg/ha available N, 15 kg/ha available P₂O₅ and 119 kg/ha available K₂O, with pH 7.8. The climate of Bulandshahr is subtropical. Rainfall during winter 1986-87 and 1987-88 was 90 and 42 mm respectively, whereas the range of temperature varied from 5 to 33.8°C and 7 to 32.56°C during 2 successive seasons. The crop was sown 30 cm apart with a seed rate of 30 kg/ha. The fertilizer application was done as per treatments, with half dose of N and full dose of P at sowing as basal and remaining half dose of N was top-dressed in splits, at the time of first irrigation and blooming stage. The crop was harvested after 185 days.

Nitrogen content of seed and straw was determined with microkjeldahl's method. The N content was multiplied by 6.25 for

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Table 1. Yield attributes and grain yield (q/ha) of linseed as influenced by N and P fertilization

Treatment	Capsules/ plant		Seeds/ capsule		Grain yield/ plant (g)		1,000-grain weight (g)		Grain yield (q/ha)	
	A	B	A	B	A	B	A	B	A	B
<i>N (kg/ha)</i>										
0	32.50	29.00	4.20	3.50	10.10	9.30	9.00	8.60	10.82	10.43
40	57.20	57.00	6.60	5.80	12.60	11.90	9.40	9.40	13.67	13.13
80	69.60	70.40	8.80	8.80	19.90	19.30	9.60	9.50	15.79	14.77
CD ($P = 0.05$)	1.60	2.10	0.20	0.80	0.50	1.70	0.20	0.20	0.63	0.89
<i>P (kg/ha)</i>										
0	54.50	55.30	6.80	6.50	16.10	15.50	8.90	9.20	12.57	12.41
20	58.50	57.50	7.50	7.00	16.40	15.60	9.50	9.23	14.57	13.27
40	63.50	61.40	8.30	8.00	18.70	18.20	9.70	9.30	15.94	15.00
CD ($P = 0.05$)	1.40	1.80	0.30	0.70	0.44	1.40	NS	NS	0.55	0.78

A, 1986-87; B, 1987-88

calculating crude protein (%) in seeds. The P content was determined through adopting vanado-molybdophoric yellow colour method. Uptake of N and P by seed and straw was determined by multiplying yield (q/ha) with the N and P contents in seed and straw.

Recovery of applied N and P was calculated as follows:

$$\text{Total N recovery (\%)} = \frac{\text{Total N uptake in treated plot} - \text{Total N uptake in control plot}}{\text{Amount of N applied}} \times 100$$

$$\text{Total P recovery (\%)} = \frac{\text{Total P uptake in treated plot} - \text{Total P uptake in control plot}}{\text{Amount of P applied}} \times 100$$

Another 5 g seed sample was taken for determining oil (%) by Soxhlet-extraction method (AOCS, 1944). Using petroleum ether as a solvent, iodine value of oil was calculated by Haness iodine method (AOAC, 1965).

RESULTS AND DISCUSSION

Effect of N

Seed yield of linseed increased significantly with an increase in N level (Table 1). This was due to significant increase in the yield-attributing characters like capsules/plant and 1,000-grain yield during both the years. The results confirm the findings of Ram (1982). Protein (%) in the seeds also increased significantly with the increasing level of N during both the seasons, except 80 kg N/ha during 1986-87. However, the oil (%) and their iodine values increased significantly only up to 40 kg N/ha (Table 2). But remained at par with 80 kg N/ha during 1986-87. Ram (1982) also obtained the similar results regarding the iodine value in linseed.

Table 2. Qualitative characteristics of seed and oil of linseed as influenced by N and P fertilization

Treatment	Protein (%)		Oil (%)		Iodine number	
	1986-87	1987-88	1986-87	1987-88	1986-87	1987-88
<i>N (kg/ha)</i>						
0	16.60	15.73	43.83	44.00	156.70	153.20
40	21.20	20.97	45.80	44.92	198.80	196.50
80	23.28	22.69	45.35	44.58	178.80	190.80
120	24.12	23.08	44.11	43.83	176.80	175.60
CD (P = 0.05)	0.75	1.24	0.45	NS	18.59	3.98
<i>P (kg/ha)</i>						
0	19.90	19.64	44.38	44.25	172.80	171.30
20	21.16	20.65	47.47	44.44	181.50	184.80
40	22.83	21.53	45.48	44.31	179.20	180.50
CD (P = 0.05)	0.65	1.07	0.39	NS	NS	NS

Effect of P

Seed yield of linseed increased significantly with an increase in P level. This was mainly due to significantly higher number of capsules/plant and seed/capsule and higher seed yield/plant.

The oil (%) increased significantly only during 1986-87 up to 20 kg P_2O_5 /ha, but with further increase in the P level decreased the value (Table 2). This confirms the results of Singh *et al.* (1988). However, the protein (%) increased significantly up to 40 kg P_2O_5 /ha during both the years.

N uptake

Maximum uptake of N was at 120 kg N/ha, which may be due to the increased yield of grain and straw (Table 1). Similarly, phosphorus levels also enhanced the uptake of nitrogen, as also reported by Ivanove *et al.* (1985).

P uptake

Higher dose of P @ 40 kg/ha increased the uptake of P (Table 3).

Increased N uptake with 80 kg N and 40

kg P/ha (Table 4) was recorded due to the synergistic effect of N and P on the uptake of N which increased the seed yield (Ivanove *et al.* 1985).

Effect on N recovery

The maximum recovery of N was found at 40 kg N/ha. However, lower recovery of N was observed at higher doses of N, which could be attributed to proportionate losses through leaching and run-off (Table 3).

Effect of P

The highest recovery of N was found at 40 kg P_2O_5 /ha during both the years. This may be due to the availability of P to the crop plants by proliferating the roots, resulting in higher uptake of N (Table 3).

Interaction effect

Combination of N @ 40 kg and P @ 40 kg/ha increased the recovery of N. This may be due to complementary favourable interaction effect of N and P on the crop (Table 4).

It was concluded that the grain yield and protein (%) increase with the application of

Table 3. Total uptake and recovery (%) of applied nitrogen and phosphorus as influenced by different treatments

Treatment	N uptake (kg/ha)		P uptake (kg/ha)		N recovery (%)		P recovery (%)	
	1986-87	1987-88	1986-87	1987-88	1986-87	1987-88	1986-87	1987-88
<i>N (kg/ha)</i>								
0	30.18	29.67	5.37	5.27			45.50	47.50
40	50.37	49.84	6.53	6.65	50.25	53.33	46.50	49.50
80	65.88	66.52	6.49	6.62	43.42	46.33	47.00	50.50
120	75.88	75.00	6.46	6.55	37.37	38.76	48.21	50.50
CD (P = 0.05)	2.94	3.66	1.08	1.33	4.91	6.76		
<i>P (kg/ha)</i>								
0	46.28	45.58	3.85	4.89	39.46	33.66		
20	55.65	55.55	5.51	6.33	43.44	56.60	56.50	50.00
40	64.79	65.26	7.49	7.52	45.50	49.00	56.05	49.20
CD (P = 0.05)	2.55	2.91	0.94	1.20	4.11	6.78		

Table 4. Total uptake of N (kg/ha) by seed and straw of linseed as influenced by the interaction of different levels of N and P (kg/ha)

Nitrogen	Phosphorus					
	1986-87			1987-88		
	0	20	40	0	20	40
0	26.26	31.00	33.28	24.38	30.42	34.22
40	39.38	50.23	61.50	39.94	50.32	61.25
80	51.31	63.23	82.87	51.57	63.84	84.15
120	63.16	78.13	81.49	68.42	77.60	81.42
CD (P = 0.05)			3.20			5.82

120 kg N and 40 kg P_2O_5 /ha, whereas the oil content and iodine increase up to 40 kg N and 20 kg P_2O_5 /ha.

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