Bangladesh J. Bot. **46**(1): 67-71, 2017 (March)

PRODUCTION POTENTIAL, QUALITY AND NUTRIENT UPTAKE OF LINSEED AS INFLUENCED BY FERTILITY LEVELS AND SEEDING RATES UNDER THE FOOT HILL CONDITION OF NAGALAND

RAKESH KUMAR*

ICAR RC NEH Region Nagaland Centre Jharnapani-797 106, Nagaland, India

Key words: Economics, Fertility levels, Linseed, Nutrient uptake, Quality, Seed rates

Abstract

Effects of fertility levels and seeding rates on productivity, quality and nutrient uptake of linseed under rainfed condition were studied. Results revealed that the seed yield, nutrient content and uptake (NPKS) were significantly increased up to the application of 80-60-60-40 kg NPKS/ha although it was statistically at par with 60-45-45-30 kg NPKS/ha. With respect to the seeding rates, the maximum seed yield, quality and nutrient uptake were obtained with the plant density of 35 kg seed rate/ha.

Introduction

Linseed (*Linum usitatissimum* L.) is a major winter oilseed crop next to rapeseed-mustard of India with respect to area and production. The cultivation of linseed is restricted mostly to the marginal and sub-marginal land with limited supply of inputs *viz.* fertilizer and pesticides resulting in lower crop yield (Meena *et al*. 2011a). Among the agro-techniques that can increase its productivity is the judicious application of nutrients especially NPKS, are the key factors that decide the crop yield and quality (Singh *et al.* 2007a). The yield of linseed can be increased over the prevailing practices in rainfed condition with managing the inputs *viz.* fertilizer, weed control and plant protection and out of these fertilizer application is the most effective (Meena *et al.* 2011b). To obtain the maximum yield, optimum plant population is the pre-requisite that can be maintained only by sowing appropriate seed rates (Kumar and Deka 2016). This factor is directly related to the competition involved by the plant population for nutrient, moisture, air and light (Kumar *et al*.2015). This is an important constituent for determining the growth, development and finally crop yield (Kumar and Kumawat 2014). Hence, the present study was carried out to evaluate the effect of fertility levels and seed rates on productivity, nutrient uptake and quality of linseed in foot hill condition of Nagaland.

Materials and Methods

A field experiment was conducted at Agricultural Research Farm of Indian Council of Agricultural Research, Jharnapani, Medziphema in two consecutive *rabi* seasons of 2010-11 and 2011-12. The experimental site was located between 25.45^0 N latitude 93.53^0 E longitude with mean altitude of 281 m above the sea level. The soil of the experimental field (0-15 cm) was sandy loam and acidic in reaction (pH 5.3), high in organic carbon (0.85%), low in available N (215.3 kg/ha) and K_2O (148.7 kg/ha) and moderate in available P_2O_5 (12.8 kg/ha) and sulphur (15.6 kg/ha). The experiment was conducted in split plot design consisting four fertility levels viz. control, 40-30-30-20, 60-45-45-30 and 80-60-60-40 kg NPKS/ha were kept in main-plots and three seed rates *viz.* 25, 30 and 35 kg/ha in sub-plots and replicated thrice. The nutrient doses of NPKS were applied through urea (46% N), di-ammonium phosphate (18% N and 46% P_2O_5), muriate of potash (60% K_2O) and elemental sulphur (99.7% S). Half doses of N and full amount

*Author for correspondence: rakeshbhu08@gmail.com. Scientist, SS (Agronomy), Division of Crop Research, ICAR Research Complex for Eastern Region Patna-800 014, Bihar, India.

of P, K and S were applied as basal and remaining half doses of N applied in two equal splits i.e. at maximum branching and flowering stage. A promising crop linseed cv. Parvati was sown at a depth of 3.0 cm manually in furrow with the spacing of 30 cm ×10 cm. The crop was sown on 4th and 7th November in 2010 and 2011 and harvested on 3rd and 8th March of 2011 and 2012, respectively. Total rainfall was received throughout the south-west monsoon in 2010-11 and 2011-12 was 64.7 and 107.4 mm, respectively. The maximum and minimum temperature were recorded during the crop growing period was 30.3, 29.1^{0}C and 8.2, 10.2^{0}C, respectively in 2010-11 and 2012-12. Plants from net plot area were harvested, tagged, bundled and dried under the sun and weighed for bundle weight. Seed and straw yield were recorded after manual threshing and converted into kg/ha. Seed and straw were dried, processed and analyzed 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 and sulphur was estimated by following spectrophotometric method (Tandon 2009). Potassium content in the samples was determined by atomic absorption spectrophotometer (Singh *et al.* 2007b). The data on yield, quality, nutrient content and uptake were subjected to statistical analysis to examine the treatment effect in split plot design according to Gomez and Gomez (1984). The LSD was used to test the significant difference between various means at $p < 0.05$. The significance of differences among means was compared by using DMRT when F-values were significant.

Results and Discussion

Seed and straw yield of linseed were affected significantly due to different fertility levels (Table 1). The highest seed and straw yield recorded at 80-60-40-40 kg NPKS/ha, which were 24.2 and 20.1 per cent higher over 40-30-30-20 kg/ha. This may be ascribed due to overall improvement in plant vigour and production of sufficient photosynthates owing to higher availability of NPKS resulting in better yield attributes *viz.* capsules/plant, seeds/capsule, 1000-seed weight was finally reflected to seed yield. Increase in yields due to increasing levels of NPKS application in linseed was also reported by Meena *et al*. (2011c) and Kumar and Kumar (2015).

Table 1. Effects of fertility levels and seeding rates on yield, economics and quality of linseed (Pooled data of 2 years).

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Oil content (g/100 g seed)	Iodine value
Fertility levels (NPKS kg/ha)				
40-30-30-20	683^{a}	2177^{a}	39.60^{b}	176.16^{b}
60-45-45-30	795^{b}	2538^{b}	37.61^{a}	168.96^{a}
80-60-60-40	848^{c}	2615^{c}	36.59^{a}	167.28^{a}
SEm	19	39	0.49	2.29
LSD (p = 0.05)	56	113	1.44	6.73
Seeding rates (kg/ha)				
25	633^{a}	2044^{a}	39.72^{b}	172.28^{a}
30	724^{b}	2275^{b}	38.91^{b}	176.32^{a}
35	778^{c}	2448^{c}	37.34^{a}	175.88^{a}
SEm	16	33	0.43	1.99
LSD (p = 0.05)	48	98	1.25	NS

Similarly, seed and straw yield of linseed were influenced significantly by seeding rates. The highest seed yield (778 kg/ha) and straw yield (2448 kg/ha) was recorded with 35 kg seed rate/ha followed by 30 kg seed rate/ha (724 and 2275 kg/ha) and the lowest was recorded in plots with plant density of 25 kg seed rate/ha (633 and 2044 kg/ha). The magnitude of increase of seed and straw yield was to the extent of 22.9 and 19.8 per cent with 35 kg seed rate/ha over 25 kg seed rate/ha. This might be due to most of the growth and yield attributing were favourably influenced by lower seed rates although on the contrary yield profile was higher under relatively higher seed rates of 35 kg/ha (Kumar *et al*. 2009). Biomass production increased correspondingly with increasing seeding rates up to 35 kg/ha was reported by Kumar and Kumawat (2014) and Kumar and Deka (2016).

Table 2. Effects of fertility levels and seeding rates on NPKS content (g/100 g seed/straw) of linseed (Pooled data of 2 years).

Treatment	N		P		K		S	
	g/100 g seed/straw							
	Seed	Straw	Seed	Straw	Seed	Straw	Seed	Straw
Fertility levels (NPKS kg/ha)								
Control	3.21^{a}	0.344^{a}	1.32^{a}	0.180^{a}	1.34^{a}	2.73^{a}	0.356^{a}	0.166^{a}
40-30-30-20	3.43^{b}	0.366^{b}	1.47^{b}	0.198^{b}	1.43^{b}	2.89^{b}	0.392^{b}	0.186^{b}
60-45-45-30	3.52^{c}	0.395^{c}	1.57^{c}	0.211^{c}	1.52^{c}	3.08^{c}	0.436^{c}	0.203^{c}
80-60-60-40	3.56^{c}	0.406^{c}	1.65^{c}	0.223^{c}	1.54^{c}	3.12^{c}	0.439^{c}	0.205^{c}
SEm	0.06	0.006	0.03	0.003	0.01	0.03	0.002	0.001
LSD (p = 0.05)	0.17	0.018	0.10	0.010	0.04	0.08	0.005	0.004
Seeding rates (kg/ha)								
25	3.61^{c}	0.412^{c}	1.59^{c}	0.215^{c}	1.49^{c}	3.09^{c}	0.428^{c}	0.200^{c}
30	3.44^{b}	0.370^{b}	1.50^{b}	0.202^{b}	1.45^{b}	2.95^{b}	0.405^{b}	0.192^{b}
35	3.25^{a}	0.351^{a}	1.42^{a}	0.192^{a}	1.42^{a}	2.83^{a}	0.384^{a}	0.178^{a}
SEm	0.05	0.005	0.03	0.003	0.01	0.02	0.001	0.001
LSD (p = 0.05)	0.15	0.015	0.08	0.009	0.03	0.07	0.004	0.003

The oil content was significantly higher with control over 80-60-60-40 kg NPKS/ha although it was recorded statistically at par with 60-45-45-30 kg NPKS/ha. The reduction in oil due to higher rate of nitrogen appears to be due to conversion of carbohydrates into protein (Singh *et al*. 2010). The oil yield increased significantly due to fertilizer application up to 80-60-60-40 kg NPKS/ha because of increased seed yield of linseed (Meena *et al*. 2011c).

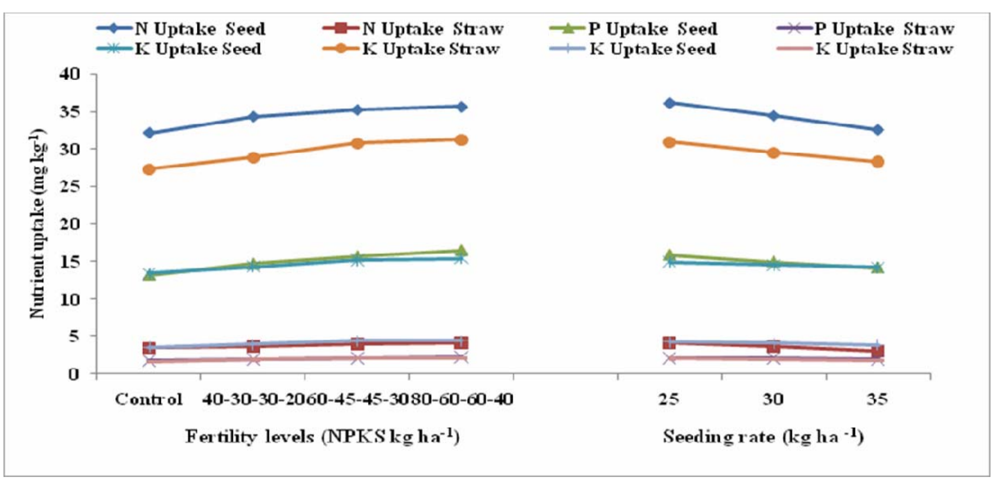

Fig. 1. Effects of fertility levels and seeding rates on nutrient uptake (mg/kg seed/straw) of linseed (Pooled data of 2 years).

Different NPKS levels significantly influenced N, P, K and S content in seed as well as straw and their uptake by crop (Table 2 and Fig.1, 2). Application of 80-60-60-40 kg NPKS/ha improved nutrient content (NPKS) in seed and straw, which increased by 3.8, 12.2, 7.7, 12.0 per cent and 10.9, 12.6, 8.0, 10.2 per cent over 40-30-30-20 kg/ha, respectively. These results are in close conformity with the findings of Meena *et al.* (2011a). Similarly, each level of NPKS increase significantly, increase nutrient uptake by crop (seed and straw) and total uptake up to the highest level *viz.* 80-60-60-40 kg NPKS/ha although it was statistically similar to 60-45-45-30 kg NPKS/ha and significantly superior to rest of the nutrient levels (Tables 2 and 3). The graded application of NPKS levels consistently increased content and removal of NPKS by crop (seed + straw) to an extent statistically significant. N, P, K and S uptake by seed increased by 28.7, 40.8, 26.9 and 39.8 per cent with 80-60-60-40 kg NPKS/ha over 40-30-30-20 kg/ha, respectively. The corresponding increase in N, P, K and S uptake by straw were 34.4, 36.4, 30.0 and 32.8 per cent. This may be due to higher nutrient applied and their availability increase to plant and start luxury consumption especially in case of K. The N, P and S are utilized for oil synthesis and dry matter production so their concentration increase less compare to K in straw and seed. Similarly, increased uptake of nutrients under balanced NPKS supply was due to many intricate factors enabling more root growth facilitating in better absorption of water and nutrient from the soil (Singh *et al.* 2013). Application of 80-60-45-45 kg NPKS kg/ha being at par with 60-45-40-30 kg NPKS kg/ha and gave the significantly lower iodine values over the control. Similar findings were also observed by Awasthi *et al.* (2011).

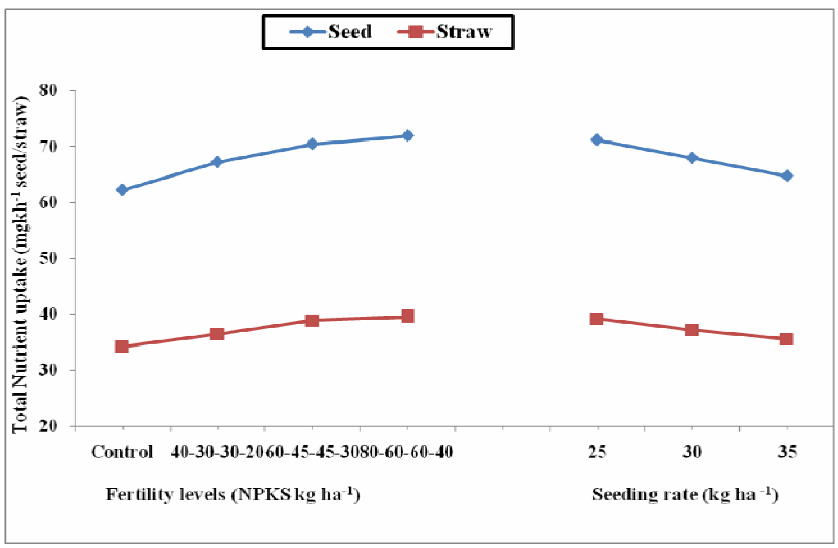

Fig. 2. Effects of fertility levels and seeding rates on total nutrient uptake (mg/kg seed/straw) of linseed (Pooled data of 2 years).

Increase in seed rate failed to result significant increased in N, P and S content in seed as well as straw except K, which differs markedly. In case of K content, higher plant density of 35 kg seed rate/ha resulted in maximum K content in seed and straw and recorded significantly superior than 25 kg but statistically similar to 30 kg seed rate/ha. These findings are in close conformity with findings of Singh *et al.* (2013). Increasing seed rate resulted in increase in NPKS uptake by seed and straw as well as total uptake. Plant density of 35 kg seed rate/ha observed significantly higher

N, K uptake by seed which was statistically at par with 30 kg seed rate/ha. Similarly, K uptake by straw also gave the highest total uptake and at par with 30 kg seed rate/ha. Whereas, N uptake by straw and P and K uptake by seed and straw failed to achieve significant difference. These findings are in conformity of Kumar and Kumawat (2014).

Acknowledgment

Author is grateful to TSP Project for providing financial support for demonstrating the experiment for its wider cultivation by the tribal community of Nagaland. Author also thanks the Joint Director, ICAR RC Nagaland Centre, Jharnapani, for providing all the facilities to carry out the demonstration programme.

References

Awasthi UD, Dubey SD and Shripal 2011. Effect of nitrogen and moisture conservation practices on yield, uptake, water-use efficiency and quality of linseed (*Linum usitatissimum*). Indian J. Agric. Sci. **81**: 383-385.

Gomez KA and Gomez AA 1984. Statistical Procedure for Agricultural Research, 2nd Edn. John Wiley & Sons, New York. pp. 241-271.

Jackson ML 1973. Soil chemical analysis. New Delhi: Prentice Hall of India. pp. 151-157.

Kumar R and Deka BC 2016.Response of fertility levels and seeding rates on production potential and moisture use efficiency of linseed under foot hill condition of Nagaland. Indian J. Hill Farm. **29** (1): 1-5.

Kumar R and Kumar M 2015.Effect of fertility levels and seed rates on productivity, profitability and energetics of linseed (*Linum usitatissimum* L.) under foot hill condition of Nagaland. International J. Agric. Stat. Sci.**11** (S1): 275-280.

Kumar R and Kumawat N 2014.Effect of sowing dates, seed rates and integrated nutrition on productivity, profitability and nutrient uptake of summer mungbean in Eastern Himalaya. Archives Agron. Soil Sci. **60** (9):1207-1227, http://dx.doi.org /10.1080/03650340.2013.874559.

Kumar R, Deka BC and Ngachan SV 2015.Response of summer mungbean to sowing time, seed rates and integrated nutrient management. Legume Res. **38** (3):348-352, doi: 10.5958/0976-0571. 2015.00119.8.

Kumar R, Nandan R, Kumar V, Prasad S and Singh D 2009.Response of summer mungbean (*Vigna radiata*) cultivars to sowing time and seed rate. Indian J. Agric. Sci.**79** (4): 309-312.

Meena RL, Singh TK, Kumar R and Kumar P 2011b.Performance of linseed (*Linum usitatissimum* L.) to fertility levels and seed rates in dryland conditions of Eastern Uttar Pradesh. Env. Eco. **29** (2): 718-722.

Meena RL, Singh TK, Kumar R**,** Roy A and Om Hari 2011c. Production potential and economics of linseed (*Linum usitatissimum* L.) as influenced by fertility levels and seed rates in dryland conditions. Env. Eco. **29** (1A):456-458.

Meena RL, Singh TK, Kumar R, Singh AK and Om Hari 2011a.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.

Singh DN, Bohra JS and Singh JK.2013a.Influence of NPKS and variety on growth, yield and quality of irrigated linseed. Indian J. Agric. Sci. **83**: 456-458.

Singh RK, Singh Y, Singh AK**,** Kumar R and Singh VK.2010. Productivity and economics of mustard *(Brassica juncea)* varieties as influenced by different fertility levels under late sown condition. Indian J. Soil Cons. **38** (2): 121-124.

Singh T, Singh VK, Singh Y and Singh MK 2007b. Effect of sowing dates, seed rates and sulphur levels on growth, yield, quality and moisture use of rainfed linseed. Env. Eco. **25**: 978-982.

Tandon HLS 2009. Methods of Analysis of Soils, Plants, Waters, Fertilizers & Organic Manures. pp. 76-111.

(Manuscript received on 22 June, 2015; revised on 24 August, 2016)