Nutrient uptake, Yield and Quality of Linseed (*Linum usitatissimum* L.) as affected by Fertility Levels and Seed Rates in Dryland Condition of Eastern Uttar Pradesh

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Abstract

A field trial was conducted during the *rabi* season of 2006 and 2007 at the Agronomic Research farm,, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to assess the nutrient uptake, yield and quality of linseed as affected by fertility levels and seed rates in dryland condition of Eastern Uttar Pradesh in randomized block design with three replication. Results revealed that increase in fertility levels significantly increased N, P, K, S concentration in grain and straw, oil content, oil yield, protein content, protein yield. Increase in fertility levels resulted in significant increase in both seed and straw yield. However in case of seed rate, increase in seed rate significantly increase grain yield from 20kg to 30kg ha^{-1} but with further increase in seed rate, grain yield decreased while the straw yield was maximum with 40 kg seed rate. Increase in seed rate resulted significant decrease in oil content in grain. Total oil yield was increased with increase in seed rate upto 30 kg ha^{-1} after that it started to decrease. The NPKS content in seed and straw was significantly decreased with increased seed rate and found maximum with 20 kg seed rate.

1. Introduction

Linseed *(Linum usitatissimum* L.) is an important and well-known oilseed as well as fiber crop of India and mostly growing states are Madhya Pradesh, Maharashtra, Uttar Pradesh, Bihar, Rajasthan, Orissa, Karnataka, West Bengal, Assam, Andhra Pradesh, Himachal Pradesh, Jammu & Kashmir, Punjab and Nagaland. Madhya Pradesh and Uttar Pradesh together contribute about 70 per cent of the national linseed production.. Its seed contain 20-25 % protein and 30-40 % oil along with mineral elements like phosphorus. Linseed occupies a greater importance among oilseeds owing to its various uses and special qualities. It is grown mainly for seed used for extracting oil in rainfed conditions and has excellent dyeing oil used in manufacturing paints and varnishes, oilcloth, waterproof fabrics, linoleum and as edible oil in some areas. Linseed cake is a very good manure and animal feed. Linseed straw produces fibre of good quality and is also used in making paper and plastics for which it is also known as plastic crop. The reasons for low yield are poor soil fertility, inadequate use of fertilizer and traditional crop management practices. Among them, the nutrient imbalance appears to be the major reason. Application of N along with adequate amount of phosphorus improved the seed yield of linseed. Results revealed stated that linseed showed a great response to NPK application under the different agro-climatic conditions .The present study was therefore designed to evaluate the performance of different fertility levels and seed rate on growth, yield and quality of linseed.

2. Materials and Methods

A field experiment was carried out during the *rabi* season of 2006-07 and 2007-08 at the research farm, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi under the dryland condition of eastern parts of Uttar Pradesh . The soil of the experimental site is sandy clay loam in texture with low nitrogen, medium phosphorus, high potassium availability and slightly alkaline in reaction (pH 8.2). The experimental plots comprised of 4 different fertility levels (kg ha^{-1}) N: P: K: S i.e. no fertilizer/ Control (F_0), 20:10:10:10 (F_1), 40:20:20:20 (F_2) and 60: 30: 30: 30 (F_3) and three seed rates i.e., & 20 (S_1), 30 (S_2) and 40 (S_3) kg ha^{-1} and were replicated thrice laid out in randomized block design. A basal application of N,P and K were applied at the time of sowing and S was thoroughly mixed in the form of elemental sulphur 15 days before sowing at about 10 cm depth (as per treatment). Linseed cv. Garima was sown manually in furrow with maintaining the optimum plant spacing 30×10 cm. However, all the other intercultural operations were done for weed management and as per crop requirement. Dithane M-45@ 2 kg ha^{-1} and Rogor 30 EC@ 1 lt ha^{-1} were applied at the pod formation stage of crop to protect from rust and wilt attacks severity. The crop was harvested when the stem turned yellow and capsules began to dry. After complete sun drying, threshing was done and stover yield was calculated by substracting seed yield from bundle weight. In order to assess the effects of various treatments, periodically observations were taken The crop was harvested when the stem turned yellow and capsules began to dry. Seed yield was calculated on plot basis and was converted into kg ha^{-1}. For the quality study in linseed oil content, oil yield, protein content and protein yield were also determined with the suitable methods in laboratory. Oil content was determined by the Soxhlets extractor using petroleum ether as extractant while the protein content were determined by multiplying seed nitrogen content (%) with 6.25 (AOAC-1970). However, the protein yield was worked out by multiplying the seed yield and protein per cent in seed. The data collected was analysed by applying the standard statistical procedures.

3. Results and Discussion

3.1. Effect of fertility levels

Increase in fertility levels significantly increases yield attributes like plant height, branches plant^{-1}, dry matter accumulation plant^{-1}, capsule palnt^{-1}, seeds capsule^{-1}, 1000-seed weight along with seed and straw yield (Table 1). It was observed that with increase in fertility levels from F_0 to F_3 there was increase in growth parameters and yield attributes and was maximum with F_3 (60 kg N, 30 kg P, 30 kg K and 30 kg S) fertility level due to higher uptake of nutrient by plant in both grain and straw (Table 3). When applied in soil, 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, hence, their concentration increase less than as compared to K in straw and grain. It is possible that at higher levels of NPKS application, vigorous plant growth might have produced more photosynthates. Efficient partitioning of accumulated photosynthates, enhanced yield attributes which ultimately increased the seed yield. Application of NPKS might exert flower initiation and seeds capsules^{-1} by increasing the rate of photosynthesis and transport of source to sink sites. Therefore, supply of NPKS must be adequate at reproductive phase in order to obtain maximum yield. Lack of NPKS at flower initiation stage reduces potential seed number and test weight, which are determined at this stage. The favorable effect of NPKS application on yield attributing characters *viz.*, capsules plant^{-1}, seeds capsule^{-1}, 1000-seed weight and seed yield plant^{-1} was finally reflected to seed yield. As such, seed yield ha^{-1} increased significantly upto 60 kg N, 30 kg P, 30 kg K and 30 kg S (F_3). These results corroborate the findings of Singh et al. (2000). The higher stover yield was recorded at higher rates of NPKS application. This could be attributed to the increased plant height, branching and dry matter accumulation

Table 1: Effect of fertility levels and seed rates on growth, yield attributes and quality of seeds (Pooled data of two years)

Treatments	1	2	3	4	5	6	7	8	9	10	11	12
Fertility levels (N:P:K:S kg ha^{-1})												
control	36.27	2.54	2.56	25.11	8.89	7.20	5.81	15.12	36.58	2.12	17.38	1.15
20:10:10:10	41.51	3.30	2.69	34.44	9.00	7.31	8.08	21.02	37.60	3.03	21.19	1.71
40:20:20:20	43.53	3.69	2.76	40.78	9.00	7.36	8.72	22.66	39.59	3.42	22.75	1.88
60:30:30:30	44.32	4.16	2.85	45.11	9.22	7.37	8.89	23.14	40.37	3.58	22.05	1.95
SEm±	0.23	0.09	0.01	0.24	0.06	0.01	0.002	0.01	0.11	0.004	1.22	0.003
CD (*p*=0.05)	0.69	0.28	0.02	0.71	0.19	0.02	0.007	0.02	0.33	0.010	3.59	0.010
Seed rates (kg ha^{-1})												
20	43.31	4.01	2.75	44.25	9.17	7.42	7.45	18.61	39.79	2.97	20.52	1.66
30	41.44	3.41	2.71	36.67	9.00	7.32	8.11	21.08	38.49	3.14	21.03	1.72
40	39.48	2.85	2.65	28.17	8.98	7.20	8.06	21.76	37.33	3.02	20.23	1.64
SEm±	0.20	0.08	0.01	0.21	0.06	0.02	0.002	0.005	0.10	0.003	1.06	0.003
CD (*p*=0.05)	0.60	0.25	0.02	0.62	0.16	0.02	0.004	0.015	0.29	0.009	3.11	0.009

1: Plant height (cm); 2: Branches plant^{-1}; 3: Dry-matter accumulation Plant^{-1} (g); 4: Capsule plant^{-1}; 5: Seeds capsule^{-1}; 6: 1000-seed weight (g); 7: Grain yield (q ha^{-1}); 8: Straw yield (q ha^{-1}); 9: Oil content (%); 10: Oil yield (q ha^{-1}); 11: Protein content seed (q ha^{-1}); 12: Protein yield (q ha^{-1})

with increasing levels of NPKS application. This indicates that both seed and stover utilized the applied NPKS at almost the same level of efficiency. Similar results have been reported by Jaggi et al. (1993). In the present experimentation, application of NPKS caused favourable improvement in seed oil content as well as oil yield. Oil content increased significantly due to NPKS application over control, oil content in seed was maximum with fertility level F_3 (60 kg N, 30 kg P, 30 kg K and 30 kg S) ha^{-1}. Similar results have been reported by Dubey et al., (1999). Improvement in seed oil content with increasing rate of NPKS application might be due to the role of sulphur in the formation of acetyl co-A, a precursor compound for synthesis of long chain fatty acids. Increased oil content accompanied with higher seed yield at higher levels of sulphur application ultimately enhanced the oil yield. It is evident from the data presented in Table 1 that increasing levels of fertility from F_0 to F_3 (60 kg N, 30 kg P, 30 kg K, 30 kg S) ha^{-1} influenced seed protein content. The Nitrogen is the component of all amino acids and S is the component of cysteine, cystine, and methionine. So their availability increased to plant and resulted higher protein content in seed that resulted higher protein yield. These findings are in agreement with those of Chourasia et al. (1992).

3.2. Effect of seed rate

Increased production of primary and secondary branches $plant^{-1}$ at lower seed rates led to the production of higher number of capsules $plant^{-1}$ (Table 1). The lowest plant density at 20 kg seed rate also produced significantly bolder seeds than 30 and 40 kg seed ha^{-1}. It was further observed that seeds $capsule^{-1}$ though declined with increasing seed rate from 20 to 40 kg ha^{-1} accordingly, the seed yield $plant^{-1}$ followed the trend as capsules $plant^{-1}$ and test weight. However, the seed yield (q ha^{-1}), which is the function of seed yield $plant^{-1}$ and plant population was found to increase significantly between 20 and 30 kg seed rate but decline thereafter. Whereas, due to increasing plant density and biomass production the stover yield increased correspondingly with increasing seed rate but the difference between 30 and 40 kg seed rate was not significant. These results are in conformity with the finding of Tomar et al. (1993). Profound decrease in seed oil content of linseed was noticed with increasing seed rates from 20 to 40 kg ha^{-1}. These findings are in close conformity with findings of Kumar and Shastri (1984). Oil yield, which is the product of seed yield and seed oil content was found to increase significantly between 20 and 30 kg seed rate. However, beyond 30 kg seed ha^{-1} it declined at highest seed rate. On the contrary, seed protein content at 20 kg seed rate was significantly higher than 30 and 40 kg seed rates. However, because of the higher seed yield of linseed at 30 kg seed rate, the protein yield at this seed rate was significantly higher than 20 kg seed ha^{-1} and it also showed distinct superiority over 40 kg seed rate.

4. Conclusion

Increase in fertility levels significantly increased N, P, K, S concentration in grain and straw, oil content, oil yield, protein content, protein yield and also significant increase in seed and straw yield. However, increase in seed rate significantly increase grain yield from 20kg to 30kg ha^{-1} but further increase in seed rate decrease in grain yield but reverse in case of straw yield because it was maximum with 40 kg seed rate. Increase in seed rate resulted significant decrease in oil content in grain. Total oil yield was increased with increase seed rate upto 30 kg ha^{-1} after that it started to decrease. The NPKS content in seed and straw as significantly decreased with increased seed rate and found maximum with 20 kg seed rate.

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