Content list available at http://epubs.icar.org.in, www.kiran.nic.in; ISSN: 0970-6429

Indian Journal of Hill Farming

June 2016, Volume 29, Issue 1, Page 1-5

Response of Fertility Levels and Seeding Rates on Production Potential and Moisture Use Efficiency of Linseed under Foot Hill Condition of Nagaland

Rakesh Kumar* • Bidyut C. Deka

ICAR RC for NEH Region, Nagaland Centre Jharnapani, Medziphema 797 106, Nagaland

ARTICLE INFO

Article history:
Received 5 January 2016
Revision Received 17 January 2016
Accepted 18 January 2016

Key words:
consumptive use, economics, fertility levels, linseed, seed rates, yield

ABSTRACT

Field experiments as carried out during the *rabi* season of 2010-11 and 2011-12 at Agricultural Research Farm of ICAR RC for NEH Region, Jharnapani to study the effect of fertility levels and seeding rates on productivity, profitability and moisture use efficiency of linseed under the rainfed condition of Nagaland. The yield and economics of linseed crop were significantly increased up to the application of 80-60-60-40 kg NPKS ha^{-1} but it was statistically at par with 60-45-45-30 kg NPKS ha^{-1}. Highest moisture depletion, consumptive use, moisture efficiency, total and effective rainfall use efficiency was recorded under the application of 80-60-60-40 kg NPKS ha^{-1}. Similarly, the maximum seed yield, economics, moisture use efficiency was also obtained with the plant density of 35 kg seed rate ha^{-1}.

1. Introduction

Linseed (*Linum usitatissimum* L.) is considered as the most important industrial oil seed crop of India stands next to rapeseed-mustard in *rabi* oil seed in terms of area and production. It is grown either for oil extracted from seed or fiber from the stem. The oil content of linseed varies from 37-43% and very part of the plant is utilized commercially either directly or after processing. Most of the oil is used in the industry for manufacturing of paints, varnishes, ink, soaps and small fraction of used for edible purposes. To sustain the linseed production, there is need to develop appropriate agronomic practices to obtain the higher crop yield. In dryland area, fertilization especially nitrogen, phosphorus, potassium and sulphur are the key factors that determines the crop yield and quality (Singh *et al.*, 2007). The seed rate has profound influence on cultivation of field crops including oilseeds also. To obtain the maximum yield, optimum plant population is the pre-requisite that can be maintained only by sowing of appropriate seed rates. This is an important constituent for determining the extent of growth, development and finally yields of the crop. Therefore, the fertility levels and seed rates are the major factors for increasing the productivity and profitability of linseed. Hence, the present study was carried out to evaluate the effect of fertility levels and seeding rates on productivity, profitability and moisture use efficiency of linseed in rainfed condition of Nagaland.

2. 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 at 25.45^0 N latitude 93.53^0 E longitudes with mean altitude of 281 m above mean sea level. 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^{-1}) and K_2O (148.7 kg ha^{-1}) and moderate in available P_2O_5 (12.8 kg ha^{-1}) and sulphur (15.6 kg ha^{-1}). Experiment was conducted in split plot design consisting of four fertility levels *viz*. control, 40-30-30-20, 60-45-45-30 and 80-60-60-40 kg NPKS ha^{-1} were kept in main-plots and three seeding rates *viz*. 25, 30 and 35 kg ha^{-1} were allotted in sub-plots and replicated thrice. Nutrient doses of NPKS were supplied through urea

*Correspondence author: rakeshbhu08@gmail.com

(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 dose of N and full amount of P, K and S were applied as basal and remaining half dose 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 using the spacing of 30 cm ×10 cm. The plant to plant distance of 10 cm was maintained by thinning at 15 days after sowing. The total rainfall 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 recorded during the crop growing period was 30.3^0C, 29.1^0C and 8.2^0C, 10.2^0C, respectively in 2010-11 and 2012-12. Plants from the 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^{-1}. The straw yield was computed by subtracting the seed yield from the bundle weight. The soil moisture content on weight basis was determined with thermo-gravimetric method using the post hole auger at sowing during crop growth at regular interval and at harvest at various soil layer *viz*. 0-15, 15-30 and 30-60 cm soil depth. It was converted into soil water content on volume basis by multiplying bulk density of the respective soil layers and depths as calculated. The amount of water use by crop (CU) was computed in mm by summing up the value of soil moisture depletion from profile and effective rainfall by the following formula:

$$CU = ER + \sum_{i=l}^{n} \frac{Mb_i - Me_{ii}}{100} \times D_{ii} \times d_i$$

Where CU: consumptive use (mm); ER = effective rainfall (mm); Me_i= soil moisture content (gravimetric) at end of the period in i^{th} layer; Mb_i= soil moisture content at the beginning to period in i^{th} layer D_i= Depth of the i^{th} soil layer (mm) d_i= bulk density (g cc^{-1}) of i^{th} layer, n= number of layer; and ∑= summation. The water use efficiency (WUE) of crop was workout by the methods described by Viets (1962). Total rainfall and effective rainfall use efficiency was calculated by using following formulas (Devasenapathy *et al.,* 2008).

Total rainfall use efficiency=

$$\frac{\text{Seed yield (kg ha}^{-1})}{\text{Total rainfall received during the cropping period (mm)}}$$

Effective rainfall use efficiency=

$$\frac{\text{Seed yield (kg ha}^{-1})}{\text{Effective rainfall received during the cropping period (mm)}}$$

The data on yield, economics and moisture use efficiency were subjected to the statistical analysis to examine treatment effects in split plot design. Fisher's least significant difference was used to test the significance of differences at P <0.05 (Gomez & Gomez 1984).

3. Results and Discussions

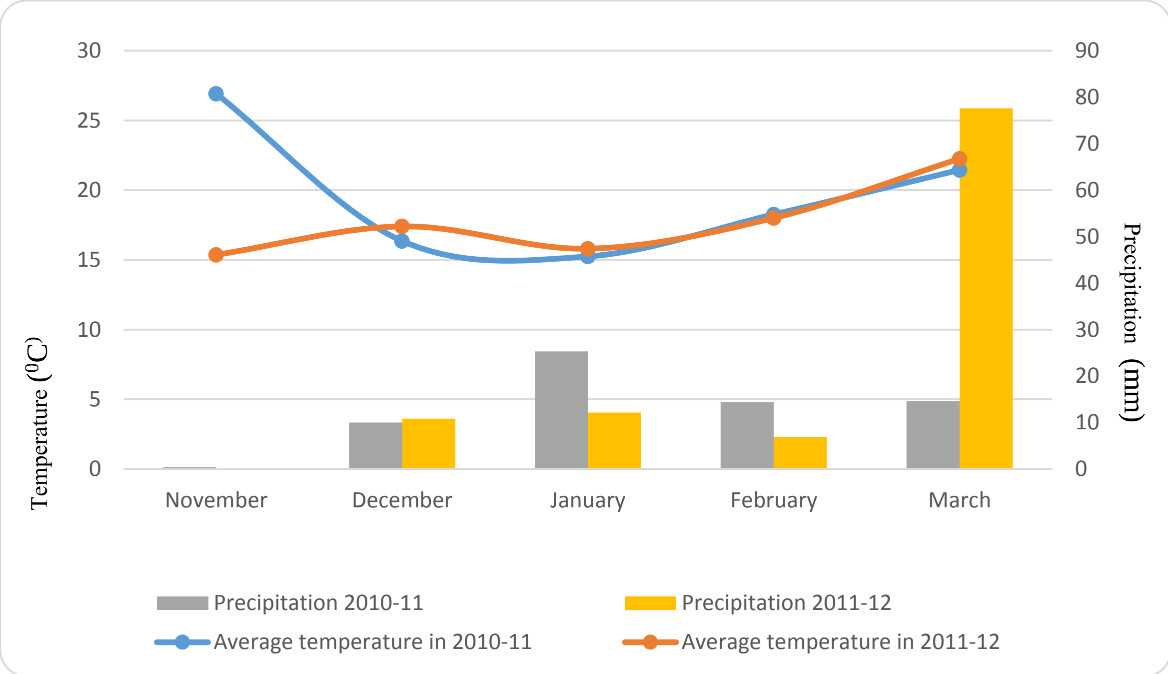
Effect of weather

The weather conditions prevailing during the crop season was found to be more or less conducive. The distribution of rainfall was more uniform during second year as compared to first year in cropping period. The cumulative rainfall received during period of investigation was 64.7 mm and 107.4 mm in the year 2010-2011 and 2011-12, respectively (Fig.1). Temperature is one of the major meteorological variable influencing germination, growth and development of crop plants in a given agro-climatic condition. The monthly mean maximum temperature ranged from 22.3 to 29.1^0C during 2010-11 and 20.9 to 29.7^0C during 2011-12. Monthly mean minimum temperature ranged from 8.2 ^{0}C to 13.8^0C in 2010-11 and 9.0 to 14.7^0C in 2009-10. However, the growth, yield attributes as well as seed yield of linseed were recorded comparatively better during the second year of the investigation. This would be attributed to better weather conditions *viz.* rainfall, temperature, relative humidity, more bright sunshine and lower soil evaporation rate in the second year, which led to increased nutrient uptake and photosynthetic efficiency and resulted in better crop performance and yield of the crop.

Yield parameters

The yield parameters viz. seed and straw yield of linseed were affected significantly due to different fertility levels (Table 1). The highest seed and straw yield was recorded with the application of 80-60-40-40 kg NPKS ha^{-1} which was 24.2 and 20.1 per cent higher over 40-30-30-20 kg NPKS ha^{-1}. This may be ascribed to the overall improvement in plant vigour and production of sufficient photosynthesis owing to higher availability of NPKS, resulting in better yield attributes *viz.* capsules $plant^{-1}$, seeds $capsule^{-1}$ and 1000-seed weight which in turn to higher seed yields. Increase in yield components due to increasing levels of NPKS application was also reported in linseed by Meena *et al*., (2011) and Singh *et al.,* (2013). Similarly, the seed and straw yield of linseed were influenced significantly by seed rates (Table 1). The highest seed yield (778 kg ha^{-1}) was recorded with the plant density of 35 kg seed rate ha^{-1} followed by 30 kg seed rate ha^{-1} (724 kg ha^{-1}) and the lowest was recorded with plant density of

Figure 1. Monthly precipitation and mean air temperature during the two growing seasons of the experimentation



25 kg seed rate ha^{-1} (633 kg ha^{-1}). The magnitude of increase in seed and straw yield was to the extent of 22.9 per cent with 35 kg seed rate ha^{-1} over 25 kg seed rate ha^{-1}. The most of the growth and yield attributing characters were favourably influenced by the lower seed rates but on the contrary but yield profile was more under relatively higher seed rates of 35 kg ha^{-1} (Kumar *et al*., 2009). Due to increasing plant density, biomass production was increased correspondingly with increasing seeding rates up to 35 kg ha^{-1}in mungbean (Kumar and Kumawat 2014).

Economics

Increasing levels of fertility from control to 80-60-60-40 kg NPKS ha^{-1} significantly increase the net return and benefit: cost ratio (Table 1). Due to increased cost of fertilizer and comparatively the lower seed yield decreased the benefit: cost ratio but net return significantly increases up to 80-60-60-40 kg NPKS ha^{-1} and this dose was the most optimum from net return point of view (Singh *et al.*, 2013). This could be attributed due to more production of seed and stover yield under the respective treatment. Similar results have also been reported by Meena *et al.,* (2011) and Singh *et al.,* (2010). Increasing of seed rate from 25 to 35 kg ha^{-1} significantly increased the net return and benefit: cost ratio (Table 1). The highest net return (Rs. 22,303 ha^{-1}) and B: C ratio (1.78) was recorded with the plant density of 35 kg ha^{-1} followed by 30 kg seed rate ha^{-1} and the lowest was in 25 kg seed rate ha^{-1}. This might be due to more yields of linseed with the respective treatments (Kumar *et al.,* 2009; Kumar and Kumawat 2014).

Moisture use efficiency and rainfall use efficiency

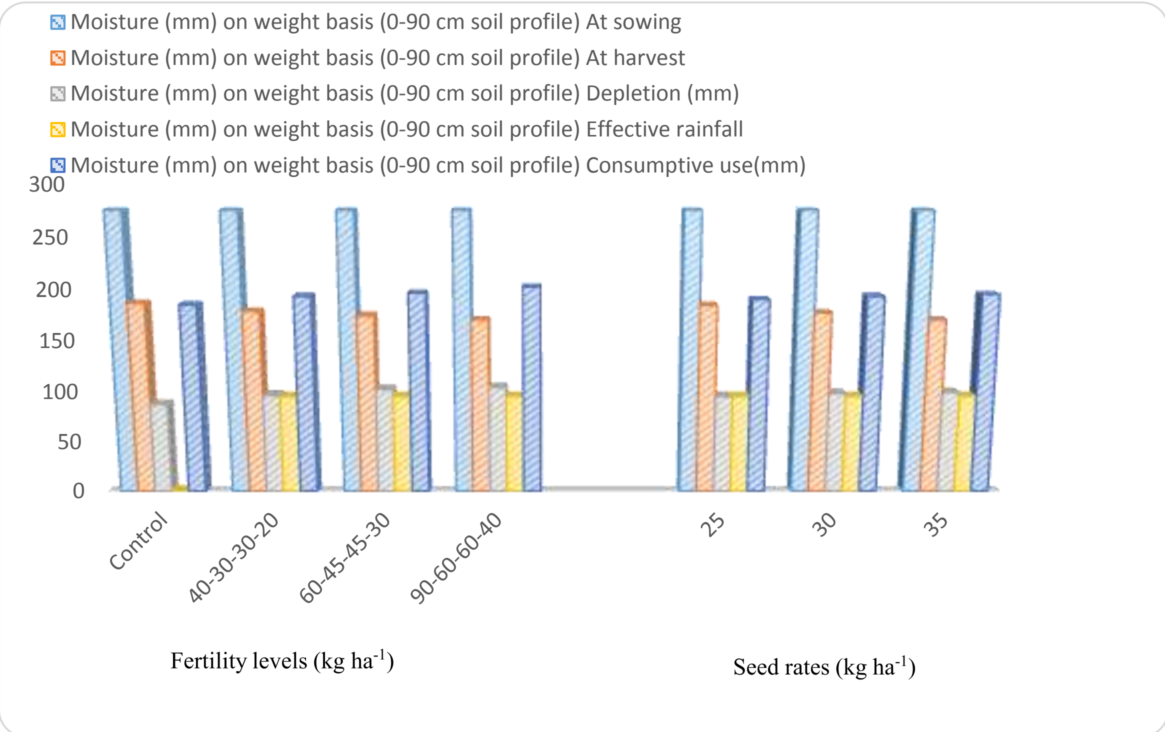
The moisture use efficiency increased with increasing in fertility levels and it was the maximum with application of 80-60-45-45 kg NPKS ha^{-1} followed by 60-45-45-30 kg NPKS ha^{-1} and the lowest yield with control (Fig. 1). Similarly, the higher total and effective rainfall use efficiency was observed with application of 80-60-45-45 kg NPKS ha^{-1} (Fig. 1). Higher total and effective rainfall use efficiency were also recorded with the application of 80-60-45-45 kg NPKS ha^{-1} (Fig. 3).

The high stored soil moisture at sowing and winter rains at capsule formation stage to maturity increase consumptive use of water due to increased availability of soil moisture to the plant in respect of higher levels of fertilization (Meena *et al*., 2011). The reverse trend was true in case of water use efficiency. The fertility levels increased moisture use efficiency due to their ability to supply the adequate nutrients to plant. Similarly, increase in seed rate resulted increase in water use efficiency due to competition among plants for space and sunlight and it was found that maximum at 30 kg ha^{-1} seed rate which then started to decreased (Fig. 2). Similar findings were also observed in linseed by Meena *et al*., (2011).

Table 1. Effect of fertility levels and seed rates on yield and economics linseed (Pooled data of 2 years)

Treatment	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Net return	B:C ratio
Fertility levels (NPKS kg ha^{-1})				
Control	521	1693	13720	1.40
40-30-30-20	683	2177	19282	1.68
60-45-45-30	795	2538	22696	1.75
80-60-60-40	848	2615	23722	1.66
SEM±	19	39	822	0.05
LSD (P=0.05)	56	113	2410	0.16
Seed rates (kg ha^{-1})				
25	633	2044	17042	1.44
30	724	2275	20220	1.65
35	778	2448	22303	1.78
SEM±	16	33	712	0.04
LSD (P=0.05)	48	98	2087	0.12

Figure 2. Effect of fertility levels and seed rates on consumptive use and moisture use efficiency of linseed (Pooled data of 2years)



Possible impact

Linseed is an energy (oil ranging between 48-55%) rich crop and can be cultivated in vast areas of rice fallow land during *rabi* season under moisture stress condition. Such practice would not only provide nutritional security and also increase the cropping intensity, employment generation, land use efficiency of the farming community. Inclusion of oilseed crop in rice based system would also make rice cultivation sustainable and enhance the productivity and profitability of the tribal farmers in the region. Realizing this potential, large-scale demonstration on linseed cultivation technologies are being undertaken by KVK, State Agriculture Department and NGO *etc*.

Conclusion

From the above study, It may concluded that linseed cv. Parvati fertilized with 80-60-60-40 kg NPKS ha^{-1} and seed rates of 35 kg ha^{-1} used to achieve the higher productivity and profitability with better resources utilization under rainfed condition of Nagaland.

Acknowledgement

Author is grateful to the Tribal Sub Plan (TSP) project for providing the financial support and all the other facilities to carry out the research.

References

Devasenapathy P, Senthikumar G, Shanmugam PM. 2009. Energy management in crop production. *Indian Journal of Agronomy* 54:80-80.

Meena R.L, Singh T, Kumar R, Singh A.K, Om H. 2011. Production performance of linseed (*Linum usitatissimum* L.) to fertility levels and seed rates in dryland conditions of Eastern Uttar Pradesh. *Indian Journal of Soil Conservation* 39 (3):230-235.

Singh D.N, Bohra J.S, Singh J.K. 2013.Influence of NPKS and variety on growth, yield and quality of irrigated linseed (*Linum usitatissimum*). *Indian Journal of Agricultural Sciences* 83 (4):456-458.

Gomez K.A, Gomez A.A. 1984. Statistical Procedure for Agricultural Research, 2nd Edn. John Wiley & Sons, New York.

Singh T, Singh V.K, Singh Y, Singh M.K. 2007. Effect of sowing dates, seed rates and sulfur levels on growth, yield, quality and moisture use of rainfed linseed. *Environment and Ecology* 25 S: 978-982.

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

Kumar Rakesh, Kumawat N. 2014.Effect of sowing date, seed rates and integrated nutrient management on production potential and profitability of summer mungbean in Eastern Himalaya. Archives of *Agronomy and Soil Science* 60(9):1207-1227.

Kumar Rakesh, Nandan R, Kumar V, Prasad S, Singh D. 2009. Response of summer mungbean cultivars to sowing time and seed rate. *Indian Journal of Agricultural Sciences* 79 (4): 309-312.

Singh R.K, Singh Y, Singh A.K, Kumar R, Singh V.K 2010. Productivity and economics of mustard (*Brassica juncea*) varieties as influenced by different fertility levels under late sown condition. *Indian Journal of Soil Conservation* 38 (2): 121-124.