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Response of Various inter-row Spacings and Levels of Plant Growth Regulators on Yield Attributes and Yield of Linseed (*Linum usitatissimum*)

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ABSTRACT: An experimental study was conducted to understand the response of various inter-row spacings and levels of plant growth regulators on yield attributes and yield of linseed during *rabi* season of 2021 which was laid out at crop research farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. The soil of the experimental field was sandy loam in texture having pH of 6.9, organic carbon of 0.91%, available nitrogen at 301.26 kg/ha, available phosphorus 37.23 kg/ha and available potassium at 271.47 kg/ha. It consisted of different levels of plant growth regulators such as Gibberellic acid (125 and 250 ppm) and Indole acetic acid (1 and 3 ppm) and two spacings (20 cm × 5 cm and 30 cm × 5 cm), respectively. Overall nine treatments were developed along with consideration of control plot as one of the treatments. Finally, the experimental study concluded that maximum number of capsules (49.93/plant), test weight (7.14 g), seed yield (1.48 t/ha), stover yield (3.19 t/ha) and harvest index (35.69%) were reported with incorporation of T_3: 20 cm × 5 cm + GA_3 at 250 ppm compared to all other treatments. Whereas, number of seeds (8.13/capsule) was recorded higher in T_4: 30 cm × 5 cm + GA_3 at 250 ppm, respectively.

Keywords: Inter-row spacing, Plant growth regulators, Seed yield, Stover yield.

INTRODUCTION

Linseed also called flax which is an important crop to break up disease and insect populations common with our cereal and other oilseed crops. In India, it is cultivated about 3.30 lakh hectares with contribution of 1.72 lakh tones to the annual production of oilseeds. The average productivity is about 523 kg/ha and it contributes 7 per cent to the worlds production (Anonymous, 2017). In India, linseed growing states are Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Bihar, Rajasthan, Orissa and Karnataka. Flax often seems to pencil out as one of the best crops for net returns. Linseed is valuable non-edible oil seed crop playing an important role in agriculture economy. Linseed oil has diversified uses and has great value of foreign trade. Linseed contains about 33 to 45% oil and 24% crude protein and is one of the oldest commercial oilseeds. Linseed oil is used in the manufacturing of high grade lubricants, paints, varnishes, textile dyeing, printing, per fumery, lubricating greases, polishing, plastic, transparent soaps, tooth paste, disinfectant and medicine. The stem fibre of flax is of considerable interest for the emerging bio-fibre industry. Flax fibre has good strength, light weight and is gaining momentum as key ingredient in the manufacturing industry i.e. used for the production of paper, coarse textiles, rope, fibre board, moulded panels and as insulation material. Despite the potential uses of linseed fibre especially for composites and bio-based industries, linseed fibre production is still economically marginal (Rennebaum *et al*., 2002). This may be due to the wide use of conventional linseed cultivars which produce high seed and oil yield but low stem and fibre yield. However, recently there has been increased interest in breeding and growing dual purpose linseed cultivars (Easson and Molloy, 2000) which can be harvested for both seed and fibre.

Growth regulators improve the physiological efficiency and photosynthetic ability which enhance the effective partitioning of accumulates from source and sink in crops. Foliar application of growth regulators during flowering stage may improve the physiological activity and may play a significant role in improving the productivity of the crop. Foliar application of either amino acids significantly increase the growth parameters in terms of plant height, fresh and dry biomass.

Gibberellins are essential endogenous hormones naturally found in plants and fungi for plant development by regulating various physiological mechanisms. It stimulates growth of stems, roots, leaves, flowering, fruit senescence, seed germination. They induce transcription of genes in cell division and cell elongation during plant growth (Miceli *et al*., 2019). Application of GA_3 had a positive impact on growth and yield of mustard because the yield loss had been reduced to 17.7% (Akter *et al*., 2007). When applied twice (double spray) (Sarkar *et al*., 2002), the GA_3 and IAA resulted in an improvement in the production, flowering, fruit setting and yield contributing soybean characters.

Indole-3-acetic acid (IAA), is a commonly occurring natural auxin which is a hormone produced by plants, fungi and bacteria. It plays a major role in plant growth and development (Woodward *et al*., 2005; Teale *et al*., 2006). In addition as it is produced by plants, IAA is produced in the rhizosphere zone by some beneficial bacteria, which acts as a signalling molecule that has significant benefits on the interaction among plants and microorganisms and leads to the plant growth.

Considering the above facts, a research study was conducted to find out the response of various inter-row spacings and levels of plant growth regulators on linseed crop.

MATERIAL AND METHODS

The experiment was carriedout to find the inter-row spacings and plant growth regulators interaction on yield attributes and yield of linseed grown in *rabi* season, 2021 which was located in Prayagraj, Uttar Pradesh. It was located at 25.57°N latitude, 87.19°E longitude and at an altitude of 98 m above mean sea level. Soil condition was sandy loam in texture. The research was done with two inter-row spacings (20 cm × 5 cm and 30 cm × 5 cm) and plant growth regulators (gibberellic acid at 125 ppm and 250 ppm; Indole acetic acid at 1 ppm and 3 ppm). Finally, nine treatments were madeup along with control plot and were replicated thrice in a randomized block design. The treatment combinations which are T_1: 20 cm × 5 cm + GA_3 at 125 ppm, T_2: 30 cm × 5 cm + GA_3 at 125 ppm, T_3: 20 cm × 5 cm + GA_3 at 250 ppm, T_4:30 cm × 5 cm + GA_3 at 250 ppm, T_5: 20 cm x 5 cm + IAA at 1 ppm, T_6: 30 cm × 5 cm + IAA at 1 ppm, T_7: 20 cm × 5 cm + IAA at 3 ppm, T_8: 30 cm × 5 cm + IAA at 3 ppm and T_9: Control plot. Yield attributes such as capsules/plant, seeds/capsule, test weight, seed yield, stover yield and harvest index were recorded just before and after harvest of the crop. The data was analysed statistically by analysis of variance.

RESULTS AND DISCUSSION

A. Effect of inter-row spacing and levels of plant growth regulators on yield attributes of linseed

(i) Capsules/plant: The resultant of capsules per pant which was depicted in Table 1, showed significantly higher in the treatment combination of 20 cm × 5 cm + GA_3 at 250 ppm (49.93/plant), while treatments 30 cm × 5 cm + GA_3 at 250 ppm and 20 cm × 5 cm + IAA at 3 ppm (48.87 and 48.13/plant) were found statistically at par. These findings are also confirmed by the results of the present study which shows that plants grown at narrow row spacing were more branched and produced significantly more seed capsules (Andruszczak *et al*., 2015). Same results were also found by Jakusko *et al*., (2013) observed positive response on capsules/plant of sesame in different row spacings.

Table 1: Performance of inter-row spacing and levels of plant growth regulators on yield attributes of linseed.

Sr.No.	Treatments	Capsules/plant	Seeds/capsule	Test weight (g)
1.	20 cm × 5 cm + GA_3 at 125 ppm	44.73	7.20	6.25
2.	30 cm × 5 cm + GA_3 at 125 ppm	41.47	6.60	6.59
3.	20 cm × 5 cm + GA_3 at 250 ppm	49.93	7.80	7.14
4.	30 cm × 5 cm + GA_3 at 250 ppm	48.87	8.13	7.02
5.	20 cm × 5 cm + IAA at 1 ppm	43.60	6.93	6.69
6.	30 cm × 5 cm + IAA at 1 ppm	42.07	6.87	6.30
7.	20 cm × 5 cm + IAA at 3 ppm	48.13	7.60	6.91
8.	30 cm × 5 cm + IAA at 3 ppm	45.20	7.53	6.76
9.	Control	40.20	6.47	6.11
	SEm ±	1.55	0.48	0.08
	CD (P = 0.05)	4.64	—	—

(ii) Seeds/capsule: Data in Table 2, indicated that number of seeds/capsule of linseed which was increasing with the advancement of experimentation but found non-significant. From the observations, it was revealed that 30 cm × 5 cm + GA_3 at 250 ppm obtained highest number of seeds (8.13/capsule) and control plot obtained lowest number of seeds (6.47/capsule), respectively. This could be due to there is relatively enough nutrient, water and aeration enhanced the conversion of solar energy to chemical energy, which might have stored on the seeds. On the other hand, the main effect of row spacing on this parameter showed non-significant Teshome *et al*., (2020).

(iii) Test weight: Data regarding test weight depicted in Table 1, attained an increase in application of plant growth regulators but found non-significant difference. However, test weight was obtained maximum in treatment combination of 20 cm × 5 cm + GA_3 at 250 ppm (7.14 g) and least test weight (6.11 g) was recorded in control plot. Teshome *et al*., (2020) reported that spacing had no significant effects on 1000-seed weight but variation occurs with adaption in row spacing.

This was due to foliar application of plant growth regulators and providing adequate spacing got an advantage for developing more number in yield parameters. The results lend support to those reported by El-Mohsen *et al*., (2013); Maurya *et al*., (2017); Rastogi *et al*., (2014).

B. Effect of inter-row spacing and levels of plant growth regulators on yield attributes of linseed

(i) Seed yield (t/ha): Significantly higher seed yield (1.48 t/ha) was noticed in 20 cm × 5 cm + GA_3 at 250 ppm which was followed by the treatment combination of 30 cm × 5 cm + GA_3 at 250 ppm (1.39 t/ha) (Table 1). Application of GA_3 (150 ppm) significantly reported the highest seed yield in the genotype followed by GA_3 (100 ppm) and GA_3 (200 ppm), respectively reported by Khan and Khan (2016).

(ii) Stover yield (t/ha): In case of stover yield, almost the same trend was observed as it was noted in seed yield. Application of 20 cm × 5 cm + GA_3 at 250 ppm recorded significantly higher stover yield (3.19 t/ha) which was followed by 30 cm × 5 cm + GA_3 at 250 ppm and 20 cm × 5 cm + IAA at 3 ppm (2.97 and 2.94 t/ha), respectively. Nizamani *et al.,* (2018); Saini *et al.,* (2017) who were experimented on mustard reported similar results.

(iii) Harvest index (%): In case of harvest index, the treatment combination of 20 cm × 5 cm + GA_3 at 250 ppm recorded highest values of harvest index (35.69%) where lowest was noticed in the control plot (33.94%).

Table 2: Performance of inter-row spacing and levels of plant growth regulators on yield of linseed.

Sr.No.	Treatments	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	20 cm × 5 cm + GA_3 at 125 ppm	1.30	2.81	34.50
2.	30 cm × 5 cm + GA_3 at 125 ppm	1.24	2.76	34.00
3.	20 cm × 5 cm + GA_3 at 250 ppm	1.48	3.19	35.69
4.	30 cm × 5 cm + GA_3 at 250 ppm	1.39	2.97	34.93
5.	20 cm × 5 cm + IAA at 1 ppm	1.30	2.79	34.40
6.	30 cm × 5 cm + IAA at 1 ppm	1.27	2.79	34.23
7.	20 cm × 5 cm + IAA at 3 ppm	1.36	2.94	35.17
8.	30 cm × 5 cm + IAA at 3 ppm	1.35	2.91	34.86
9.	Control	1.19	2.67	33.94
	SEm $\pm$	0.03	0.08	0.91
	CD (P = 0.05)	0.10	0.25	—

Fig. 1. Spraying of plant growth regulatorsin the test crop at crop research farm.

Fig. 2. Field inspection at the time of harvest of linseed by advisor.

CONCLUSION

On the basis of the research work conducted in one season, it is concluded that treatment combination of 20 cm × 5 cm + GA_3 at 250 ppm was found to be beneficial for obtaining higher seed yield.

FUTURE SCOPE

However as the recommendation is based on findings of experiment in one season a year, it needs further verification at various locations before final documentation.

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Conflict of Interest. None.

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