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RESEARCH PAPER

Response of linseed (*Linum usitatissimum* L.) to different plant growth regulators

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Abstract : The commercial importance of linseed (*Linum usitatissimum* L.) has attracted Agronomist to increase its seed yield using various agronomical and breeding approaches. Plant growth regulators (PGRs) have a significant role in enhancing yield and its related traits in linseed. Hence, to find out effect of different growth regulators on growth, yield attributes, yield and economics of linseed, the present experiment was conducted under AICRP on Linseed, College of Agriculture, Nagpur. Growth regulator shows significant effect on growth, yield attributes and yield of linseed. Plant height and number of capsules per plant was observed highest and significantly superior after application of 400 ppm Gibberellic acid (GA) and application of 0.1 % Tebuconazole which was at par with T_7 *i.e.* 1.0 ppm Auxin + 200 ppm GA and T_5 *i.e.* 75 ppm salicylic acid. Number of branches and number of capsules per plant were also observed at par in the treatment T_3 *i.e.* 200 ppm GA. The seed yield of linseed was recorded significantly higher in T_4 *i.e.* 400 ppm GA which was at par with T_7 *i.e.* 1.0 ppm Auxin + 200 ppm GA and treatment T_3 *i.e.* 200 ppm GA and treatment T_5 *i.e.* 75 ppm salicylic acid. The gross monetary return was found maximum in the treatment T_4 *i.e.* 400 ppm GA, this might be due the maximum seed yield after application of 400 ppm GA, but net monetary return and B:C ratio resulted minimum due to the high market cost of GA (Rs. 9000/- for 400 ppm). Net monetary return and B:C ratio was found maximum in treatment T_5 *i.e.* 75 ppm salicylic acid, this might be due to the low cost of Salicylic acid.

Key Words : Linseed, Growth regulator, Gibberellic acid, Salicylic acid, Tebuconazole, Growth, Seed yield

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INTRODUCTION

Linseed (*Linum usitatissimum* L.), or flax, is a crop of interest from prehistoric times, as it is used both for fiber and oil. Linum genus, belonging to the *Linaceae* botanical family, consists of approximately 300 species, most of which are wild, a few are grown as ornamental plants, some fibrous forms have become of local significance; however, only one species of flax *i.e. Linum usitatissimum* is commonly cultivated in India. Linseed occupies a greater importance among oilseeds, owing to its various uses and special qualities. In India, it is grown mainly for seeds, used for extracting oil. It is a source of complete protein, high-order linolenic acid (an essential polyunsaturated omega-3 fatty acid), complex carbohydrates, vitamins and minerals and lignans (Morris 2005). Therefore, it is becoming increasingly popular as

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a nutritional and functional food especially for vegetarians. Flax is commonly called as Linseed. Moreover, every part of the plant is potentially useful: the stem is the source of fibers, while the seed capsules provide seeds and chaffs. As far as the textile industry is concerned, flax is the only source of cellulosic fiber in the countries with temperate climate. Furthermore, it can be successfully applied in many branches of construction industry, and used as a fodder component in animal feed. Linseed, on the other hand, is a component used in the oil, pharmaceutical, cosmetic and food industry (Duguid, 2009; Cullis, 2011). Linseed is largely a crop of temperate climate confined mainly to low elevations, but it can be grown successfully up to 770 meters. Linseed has long been used as a cash crop and is mainly grown for its oil, which is continuously being utilized for various industrial purposes and also as a food supplement (Chauhan *et al.,* 2009).

Growth regulators are organic substances besides nutrients, synthesized in plants, causing alteration in their cellular metabolism. Synthesis of some plant hormones is adversely affected by environmental factors, which causes restriction on physiological processes of the plant and ultimately, limits their growth potential (Copur *et al.,* 2010). Also Plant growth regulators are indicator molecules that are produced by plants and control a wide range of plant growth and developmental processes at low concentrations. There is different plant growth–regulating hormones that show different effects on plant growth such as reproduction, stimulating defensive responses, development and cell division or seed germination, and inhibiting stem elongation. Linseed is rabbi oilseed crop responding to plant growth hormones. They promote cell division, cell enlargement, flowering, fruiting and seed formation. They play a key role in different physiological processes related to growth and development of crops. It is obvious that changes in the level of endogenous hormones due to biotic and abiotic stress alter the crop growth and any sort of manipulation including exogenous application of growth substances would help for yield improvement or at least sustenance of the crop.

MATERIAL AND METHODS

The experiment was conducted at the experimental field of AICRP on Linseed, College of Agriculture, Nagpur during the Rabi Season of 2019-20. The experimental soil was medium black soil. The experimental design was randomized block design three replications. Sowing was done with spaced 30 cm between rows and 10 cm between plants. Four growth hormones, IBA, Salicylic acid, Tebuconazole and GA, were used indi-vidually and in combinations. An experiment was designed by choosing "PKV NL 260", a high yielding variety of linseed. The hormones were dissolved in water in different concentrations. The eight treatments are being set as T_1 - 1.0 ppm Auxin, T_2 - 2.0 ppm Auxin, T_3- 200 ppm GA, T_4 - 400 ppm GA. T_5 - 75 ppm T_6 - 0.1 % Tebuconazole, T_7 - 1.0 ppm Auxin + 200 ppm GA, T_8 - Control (water spray). All the treatments were given through sprayer on the api-cal tip of stem. The first spray was applied at vegetative and second at reproductive stage. Final data on plant height, branches plant^{-1}, capsules plant^{-1}, seeds capsule^{-1}, dry weight plant^{-1}, seed yield plant^{-1} and vegetative (biomass) yield plant^{-1} were recorded at the time of maturity.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on growth and yield attributes:

Plant height, number of branches and number of capsules per plant was observed highest and significantly superior in treatment in T_4 *i.e.* 400 ppm GA which was at par with T_7 *i.e.* 1.0 ppm Auxin + 200 ppm GA and T_5 *i.e.* 75 ppm salicylic acid. Number of branches and number of capsules per plant were also observed at par in the treatment T_3 *i.e.* 200 ppm GA. The mean values for different observations showed that the variety PKV NL 260 responded positively to all four growth regulators. An apparent association appears to exist between growth hormones and growth parameters in linseed in the present study. These results are inconformity with the results of Quaderi, 2006. Ayala-Silva *et al.* (2005) revealed that application of GA3 increased plant height, while in the case of auxin, plant height decreased, probably due to the increase in stem diameter, which lowers down the shoot growth.

Seed yield:

It was observed that applica-tion of growth hormones increased seed yield. The seed yield of linseed was recorded significantly higher in T_4 *i.e.* 400 ppm GA which was at par with T_7 *i.e.* 1.0 ppm Auxin + 200 ppm

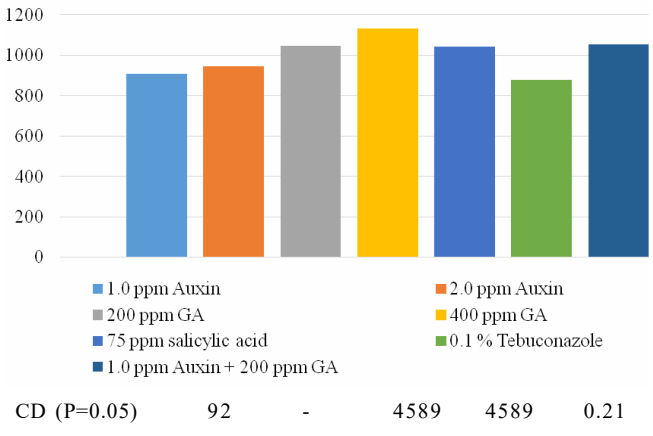
Table 1: Effect of growth regulators on growth and yield parameters of linseed

Tr. No.	Treatments	Plant height (cm)	No. of branches plant^{-1}	No. of capsules plant^{-1}	Seed per capsule
1.	1.0 ppm Auxin	51.00	3.68	64.87	7.87
2.	2.0 ppm Auxin	52.17	3.78	66.43	7.90
3.	200 ppm GA	54.67	4.01	77.00	8.09
4.	400 ppm GA	60.00	4.30	81.33	8.60
5.	75 ppm salicylic acid	57.33	4.13	77.33	8.30
6.	0.1 % Tebuconazole	54.80	3.70	69.13	7.91
7.	1.0 ppm Auxin + 200 ppm GA	58.33	4.01	80.00	8.43
8.	Control (water spray)	45.73	3.28	56.43	7.17
	S.E. ±	1.69	0.16	2.19	0.24
	C.D. (P=0.05)	5.09	0.48	6.60	0.73

Table 2 : Effect of growth regulators on seed yield (kg ha^{-1}) and economics of linseed

Tr. No.	Treatments	Seed yield (kg ha^{-1})	Cost of cultivation (Rs. ha^{-1})	GMR (Rs. ha^{-1})	NMR (Rs. ha^{-1})	B:C ratio
1.	1.0 ppm Auxin	909	18172	45445	27273	2.50
2.	2.0 ppm Auxin	943	18257	47149	28892	2.58
3.	200 ppm GA	1044	22587	52182	29595	2.31
4.	400 ppm GA	1132	27087	56577	29490	2.09
5.	75 ppm salicylic acid	1042	18237	52117	33880	2.86
6.	0.1 % Tebuconazole	876	19387	43817	24430	2.26
7.	1.0 ppm Auxin + 200 ppm GA	1053	22672	52667	29995	2.32
8.	Control (water spray)	800	18087	40017	21930	2.21
	S.E. ±	30	-	1520	1520	0.07

GA and treatment T_3 *i.e.* 200 ppm GA and treatment T_5 *i.e.* 75 ppm salicylic acid. The doses of growth hormone which enhanced the number of secondary branches plant^{-1}, capsules plant^{-1}, and seeds per capsule ultimately enhanced seed yield. The present study clearly indicated that growth hormones have the potentiality to increase seed yield, as also reported by Faizanullah *et al.* (2010). Rahimi *et al.* (2011) reported that seed yield was strongly influenced by various growth components, *i.e.*, plant height, seeds capsule^{-1}, capsules plant^{-1} and branches plant^{-1}. It was noticed that plant height was strongly associated with seed yield in linseed.



CD (P=0.05) 92 - 4589 4589 0.21

Fig. 1 : Effect of growth regulators on Seed yield kg ha^{-1}

Economics:

The gross monetary return was found maximum in the treatment T_4 *i.e.* 400 ppm GA, this might be due the maximum seed yield after application of 400 ppm GA, but net monetary return and B:C ratio resulted minimum due to the high market cost of GA (Rs. 9000/- for 400 ppm). Net monetary return and B:C ratio was found

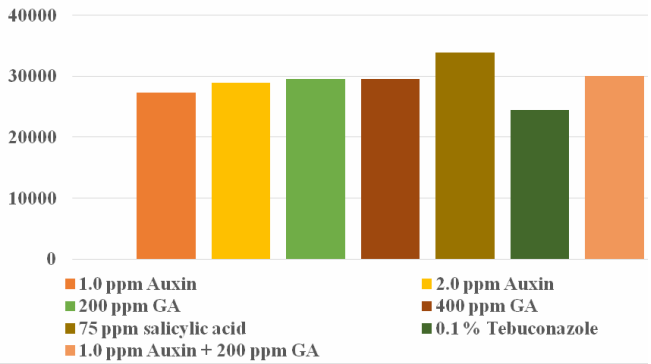


Fig. 2 : Effect of growth regulators on net monetary returns Rs. ha^{-1}

maximum in treatment T_5 *i.e.* 75 ppm salicylic acid, this might be due to the low cost of Salicylic acid.

Conclusion:

The present investigation clearly indicated that growth hormones, whether alone or in combination, have a major impact in the stimulation of various growth parameters in linseed. It was concluded that plant growth hormones could be successfully employed for enhancement of seed yield, directly or indirectly, through its components. Based on the findings, it is concluded that Foliar application of 75 ppm Salicylic acid as growth regulator resulted in significantly maximum in yield and economic returns for enhancing productivity and profitability of Linseed.

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