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Enhancement of Production and Profitability of Flax by Foliar Application of Plant Growth Regulating Hormones

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Authors' contributions

This work was carried out in collaboration among all authors. Author BB designed the study, done statistical analysis. Author KP prepared of the manuscript. Authors JH and GK collected references. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: An agricultural experiment was carried out to study the effect of growth hormones on linseed. Linseed is commonly known as flax or Alsi or Tissi is an important rabi oilseed crop next to rapeseed-mustard in India. Linseed is a hardy crop which requires less amount of additional fertilization as compared to rapeseed-mustard. Proper use of nutrients along with foliar spray of growth regulating hormones can boost up the productivity of the crop as they help in biochemical processes of the plant and stimulates stem elongation, increases dry weight and yield.
Study Design: The experiment was laid out in randomized block design with eight different treatments in three replications.

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Place and Duration of Study: The experiment was carried out during rabi season of 2018-19, 2019-20 and 2020-21 at Experimental unit of Zonal Research Station, Shillongani, Assam.
Methodology: In our study we incorporated eight different treatment combinations of plant growth regulating hormones mainly auxin, gibberellic acid, salicylic acid, Tebuconazole and including control i.e. water spray. The different treatments were applied to linseed crop at vegetative stage and flower initiation stage by using flat fan nozzle sprayer.
Results and Conclusion: Foliar application of 1.0 ppm Auxin + 200 ppm Gibberellic acid resulted in better seed yield (985 kg/ha) and gave higher net monetary return (Rs. 35915.6/ha) and benefit cost ratio (2.9) in all the three consecutive years of experiment as well as in pooled result.

Keywords: Auxin; flax; foliar application; hormone.

1. INTRODUCTION

Linseed (*Linum usitatissimum*) is an erect annual herbaceous rabi oilseed crop next to rapeseed-mustard in India. It belongs to Linaceae botanical family. It has higher nutritional value because it contains fat (41%), protein (20%), dietary fibres (28%), linoleic and omega-3 fatty acids. Hence, consumption of flaxseed regulates blood flow, lower cholesterol, prevent coronary complications and provide the body with anti-carcinogenic properties. Linseed oil has a high percentage of unsaturated fatty acids and used in paints varnishes, printed inks, coating oils, and soaps due to quick-drying properties. Linseed fibre is used in making high quality writing paper, cigarette paper, currency paper. India's ranks 4th in terms of total area coverage and 3rd in total production followed by Canada and Russia [1]. The total area of linseed in Assam is around 5000 ha with a productivity of 628 kg/ha [2].

An increase in demand of flaxseed or oil and by-products was seen in last few years, which has increase in present times due to its importance in industrial uses and health benefits. It has been noticed that the productivity of the crop is not up to the mark. The main reason of low yield is may be non-availability of high yielding variety to different agro-climatic zones. It requires very less amount of fertilizer but to cope up the global demand of linseed approaches to be made to increase the production and productivity. To tackle such global issue so as to increase productivity of flax the principal direction is the study of plant growth regulators, which are an integral part of the complex chemistry of crop production [3].

Plant growth regulators (PGRs) are organic substance produced naturally by plant to regulate their growth and development at very low concentration. It is produced by plant itself but production of plant growth regulator is affected by biotic and abiotic factor, which cause constraint in the growth and development of plant through physiological process. Plant growth regulators can be successfully working to enhance the yield in the economically important oil seed crops [4]. Application of plant growth hormones to crop helps in metabolic processes and lead to visible changes in the course of development phases, shoot growth, the formation of an assimilation surface and the rhizosphere formation [5]. They activate the main life processes of plants like membrane processes, cell division, respiration and nutrition processes. Furthermore, they contribute to increasing the biological and economic efficiency of crop production [6,7]. The ultimate objective of our study was to set up a valid conclusion that by applying plant growth hormones there is a possibility of increasing productivity of linseed crop.

2. MATERIALS AND METHODS

2.1 Experiment Details

The experiment was conducted at Research Farm of Zonal Research Station, Shillongani, Nagaon district of Assam during 2018-19, 2019-20 and 2020-21 under the affiliation of Assam Agricultural University, located in Jorhat, Assam. The experimental site was sandy loam in texture, lies within $26^0$21' N latitude and $90^0$45' E longitude with an elevation of 50.2 m mean sea level. The highest rainfall was received during the year 2018-19 and maximum temperature was attained in 2020-21 (Fig. 1).

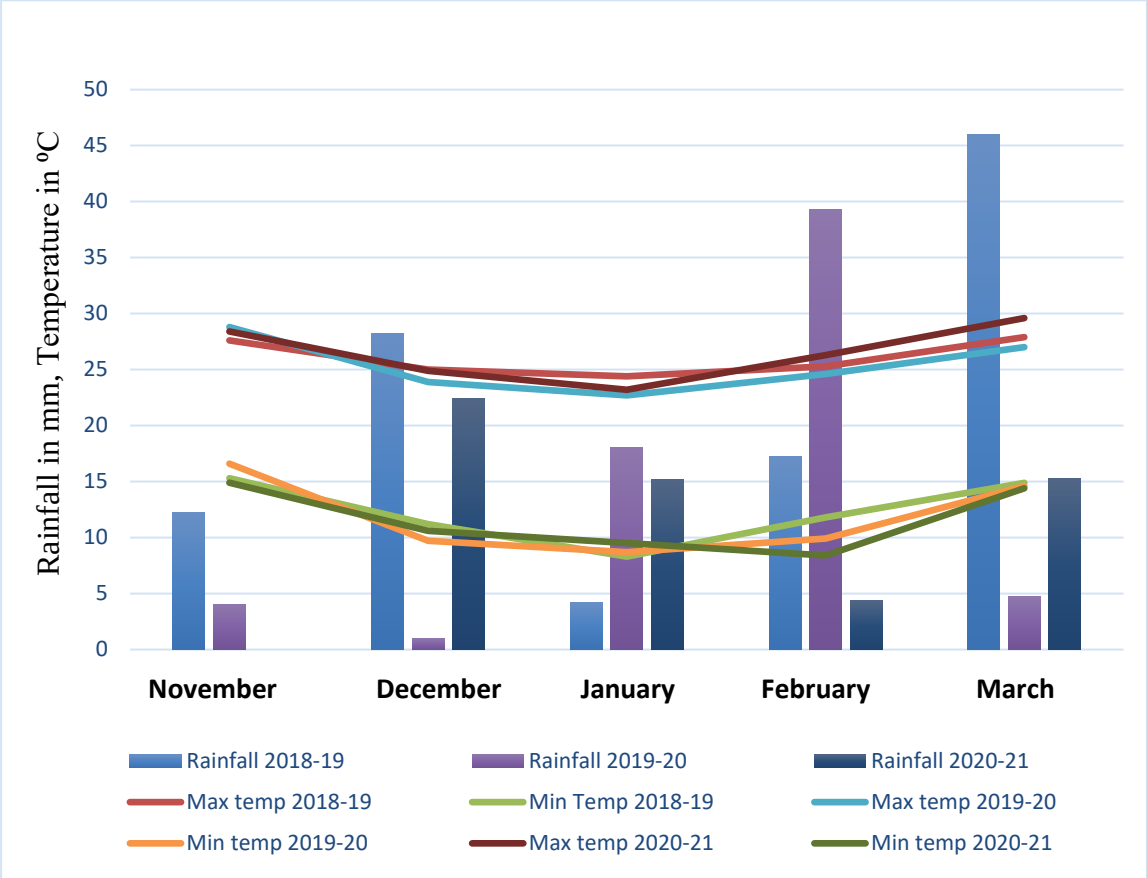

Fig. 1. Weather parameters of three consecutive years during the crop season

2.2 Cultivation Practice

The experiment was designed by choosing 'Shekhar' a high yielding variety of linseed suitable for Assam condition. The seeds were sown in three replications with randomized block design. The seed rate was of 20 kg/ha and spacing was 25 cm between rows and 10 cm between plants. Four growth hormones auxin (IBA), salicylic acid, Tebuconazole and Gibberellic acid (GA) were used individually and in combinations. The hormones were dissolved in water in different concentrations. The experiment consisted of eight treatments as follows; G_1: 1.0 ppm Auxin, G_2: 1.0 ppm Auxin + 200 ppm GA G_3: 200 ppm GA, G_4: 400 ppm GA, G_5: 75 ppm Salicylic acid, G_6: 0.1% Tebuconazole, G_7: 2.0 ppm Auxin and G_8: Control (water spray). Each experimental unit was size of 5.0 m x 3.0 m. Fertilizers 40:20:10 N-P_2O_5-K_2O kg/ha was applied as basal. Intercultural operations and plant protection measures were given as an when required. The hormonal treatments were sprayed to the crop at vegetative and at flower initiation stages.

2.3 Data Collection

The growth characters like plant height in cm were recorded in randomly selected five numbers of plants from each unit and plant height was measured from base of the plant to tip of the plant and average was taken out. Accordingly, number of branches per plant was measured in randomly selected five numbers of plant from each unit at maturity stage and average was taken out. The plant population was recorded in three randomly selected 1 m^2 size spots from each unit and average was taken out and finally converted it to hectare.

Yield attributing character number of capsules per plant was recorded from five randomly selected plants at maturity stage and average was taken out. Number of seeds per capsule was measured at harvesting stage in ten randomly selected capsules and average was recorded. The seed yield (kg/ha) were computed based on seed weight per plot and computed for hectare. Economics of foliar application of growth hormones were worked out by using the current market price of inputs and linseed. The net return

per hectare was worked out for all the treatments by subtracting the cost of cultivation from the gross return. B: C ratio was also calculated as ratio of gross return (Rs/ha) over cost of cultivation (Rs/ha).

2.4 Statistical Analysis

Statistical analysis of the recorded data was done by using OPSTAT. It is a free online statistical software developed by department of statistics, Chaudhary Charan Singh Haryana Agricultural University. The critical difference (CD) at the 0.05 level of probability was determined after two-way analysis of variance (ANOVA) in each case to compare the treatment means.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

The data in Table 1 revealed that the maximum plant height of 68.2 cm was attained under foliar application of 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage, in all three seasons. The minimum was recorded under control i.e. 60.9 cm. An observation of number of branches per plant under foliar application of 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage were recorded the highest number (4.1 branches/plant) and lowest branches were showed under control i.e. 3.1 branches/plant. Plant growth regulators, foliar application of auxin 1 ppm and gibberellic acid 200 ppm at vegetative and flower initiation stage were recorded maximum number of plant population of 688.6 thousand/ha. However, the morphological characters did not exhibit any significant variation. Plant growth regulator play a role in several physiological processes within plant including stem elongation, shoot development. Hence, our research results testify to the fact that application of auxin and gibberellic acid helps in increasing plant morphological characters, which is in close proximity with research findings of Sajjad et. al. [8], they also found that gibberellic acid helps in increasing plant morphological characters.

3.2 Yield Attributes, Yield and Economics of the Study

Improved yield attributes were achieved through integrated use of auxin and gibberellic acid, resulting in better seed yield of linseed. The highest number of capsules per plant (97.3), number of seeds per capsule (9.2) and seed yield of 985.9 kg/ha were recorded in treatment receiving foliar application of 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage in all three seasons as well as in pooled estimation as shown in the Table 2. The minimum average was recorded in control. The results are compatible with the research work of Harshit et. el. [4]. They also reported that during flower initiation stage one spray of 1.0 ppm Auxin + 200 ppm GA resulted in maximum yield attributes which ultimately increases the seed yield. The variation found in yield might be due to the fact that it was strongly influenced by various growth components, i.e., plant height, seeds/capsule, capsules/plant and branches/ plant. Combined doses of auxin and gibberellins were effective for the enhancement of tillers, secondary branches and capsules per plant, while auxin alone was effective for seeds per capsule [9,10].

Table 1. Effect of growth regulating hormones in vegetative growth of linseed at Assam condition (3 years pooled)

Treatment	Plant height (cm)			Pooled	No. of branches/ plant			Pooled	Plant population' 000/ha			Pooled
	2018-19	2019-20	2020-21		2018-19	2019-20	2020-21		2018-19	2019-20	2020-21	
G_1	70.7	53.5	70.0	64.7	3.3	2.1	5.8	3.7	766.0	607.0	515.0	629.3
G_2	73.7	59.9	71.0	68.2	3.7	2.6	5.9	4.1	823.0	689.0	554.0	688.6
G_3	70.8	55.3	68.0	64.6	3.2	2.6	5.8	3.9	722.0	624.0	491.0	612.3
G_4	67.9	58.3	70.0	65.9	2.9	2.5	5.6	3.7	793.0	630.0	508.0	643.6
G_5	69.7	49.1	68.0	62.3	2.9	2.2	4.8	3.3	700.0	654.0	522.0	625.3
G_6	69.7	54.2	70.0	64.6	3.6	2.4	4.8	3.6	772.0	597.0	537.0	635.3
G_7	71.1	52.7	68.0	63.6	3.4	2.3	5.5	3.7	730.0	669.0	520.0	639.6
G_8	68.9	48.9	65.0	60.9	2.3	2.0	5.1	3.1	682.0	576.0	454.0	570.6
SEm+	2.7	3.7	1.4	1.5	0.5	0.2	0.8	0.3	41.4	33.3	37.8	21.5
CD 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV	6.7	11.8	3.6	7.0	15.7	15.9	14.7	15.1	9.6	9.2	12.7	10.2

Table 2. Yield attributes and yield of linseed influenced by growth regulating hormones (3 years pooled)

Treatment	No. of capsule/ plant			Pooled	No. of seed/ capsule			Pooled	Seed yield (kg/ha)			Pooled
	2018-19	2019-20	2020-21		2018-19	2019-20	2020-21		2018-19	2019-20	2020-21	
G1	95.3	55.3	102.7	84.4	9.4	7.8	9.5	8.9	878.0	774.0	679.0	776.8
G2	100.0	64.5	127.3	97.3	9.4	8.5	9.6	9.2	1178.0	876.0	924.0	985.9
G3	97.5	49.3	101.0	82.6	9.4	7.9	9.5	8.9	850.0	609.0	617.0	692.0
G4	75.5	41.6	124.4	80.5	9.3	7.6	9.4	8.8	945.0	649.0	667.0	753.8
G5	86.7	44.3	112.7	81.2	9.3	7.8	9.5	8.9	889.0	679.0	732.0	766.7
G6	82.8	50.2	107.9	80.3	9.4	7.6	9.4	8.8	1023.0	749.0	711.0	828.0
G7	98.0	45.8	102.8	82.2	9.3	8.0	9.6	8.9	874.0	717.0	753.0	781.1
G8	64.3	38.3	88.7	63.7	9.2	7.4	9.4	8.6	639.0	567.0	513.0	573.0
SEm+	14.5	5.4	7.4	5.1	0.1	0.3	0.1	0.1	38.2	28.7	36.8	19.5
CD5%	NS	NS	22.4	14.0	NS	NS	NS	NS	115.8	86.8	111.6	54.1
CV%	28.7	19.2	11.7	18.9	1.5	6.2	2.0	3.5	7.1	7.1	9.1	7.5

Table 3. Effect of growth regulating hormones on NMR and B:C of linseed (3 years pooled)

Treatment	Net monetary return (Rs/Ha)			Pooled	B:C			Pooled
	2018-19	2019-20	2020-21		2018-19	2019-20	2020-21	
G1	29730.0	24010.0	18785.0	24175.0	2.6	2.3	2.0	2.3
G2	46109.0	29499.0	32139.0	35915.6	3.5	2.6	2.7	2.9
G3	27650.0	14395.0	14835.0	18960.0	2.4	1.7	1.8	1.9
G4	32545.0	16265.0	17255.0	22021.6	2.6	1.8	1.9	2.1
G5	29015.0	17465.0	20380.0	22286.6	2.4	1.8	2.0	2.1
G6	36595.0	21525.0	19435.0	25851.6	2.8	2.0	1.9	2.2
G7	28080.0	19445.0	21425.0	22983.3	2.4	1.9	2.1	2.1
G8	17325.0	13365.0	10395.0	13695.0	1.9	1.7	1.5	1.7
SEm+	1912.0	1283.0	1806.0	984.0	0.2	0.1	0.1	0.05
CD5%	5792.0	1857.6	5472.0	4720.0	0.5	0.2	0.3	0.16
CV%	15.1	22.5	31.3	21.3	12.5	6.8	9.6	8.3

Maximum net monetary return of Rs. 35915.6/ha and benefit cost ratio of 2.9 were recorded in treatment receiving foliar application of 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage in all three seasons as well as in pooled estimation as shown in the Table 3. Moreover, the lowest value was recorded in control. This is due the seed yield was minimum in this treatment combination.

4. CONCLUSION

The present research work clearly distinguished that growth regulating hormones alone or in combination have a positive effect on increasing seed yield as well as overall plant growth of linseed. It was concluded that plant growth hormones could be successfully employed for enhancement of seed yield, directly or indirectly, through its components. It was noticed that 72 % more seed yield were recorded in treatment receiving 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage as compared to water spray. Based on the three years of experimentation it can be concluded that foliar application of 1.0 ppm Auxin + 200 ppm GA at vegetative and flower initiation stage is recommended for increasing productivity and profitability of linseed in Assam condition.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Annual Report, AICRP on linseed; 2019-20
2. Agricultural Statistics of Assam, Directorate of Statistics; 2015-16.
3. Ahmad I, Kamran M, Meng X, Ali Bilegjargal, Cai B, Liu T, Han Q. Effects of plant growth regulators on seed filling, endogenous hormone contents and maize production in semiarid regions. Journal of Plant Growth Regulation. 2019;38(4):1467–1480.
4. Harshit K, Dhananjai S, Verma VK, Pyare R, Singh AK, Mandeep K, Singh J. Effect of foliar application of plant growth regulators on growth and yield attributes of linseed. Frontiers in Crop Improvement. 2021;9:1199-1201.
5. Rohach VV, Kiriziy DA, Stasik OO, Rohach TI. Morphogenesis, photosynthesis and productivity of eggplants under the influence of growth regulators with different mechanisms of action. Plant Physiology and Genetics. 2020;2(52):152–168. Available:https://doi.org/10.15407/frg2020.02.152
6. Koutroubas, Damalas. Morphophysiological responses of sunflower to foliar applications of chlormequatchloride (CCC). Bioscience Journal. 2016;32(6):1493–1501. Available:https://doi. org/10.14393/ BJ-v32n6a2016–33007
7. Zhou Q, Gao B, Li WF, Mao J, Yang SJ, Li W, Ma ZH, Zhao X, Chen BH. Effects of exogenous growth regulators and bud picking on grafting of grapevine hard branches. Scientia Horticulturae. 2020; 264:109-186.
8. Sajjad Y, Jaskani MJ, Ashraf MY, Qasim M, Ahmed R. Response of morphological and physiological growth attributes to foliar application of plant growth regulators in gladiolus 'white prosperity'. Pakistan Journal of Agricultural Science. 2014; 51(1):123-129.
9. Faizanullah, Nosheen. Role of plant growth regulators on oil yield and biodiesel production of linseed. Journal of Chemical Society of Pakistan. 2010;32:668-671.
10. Rahimi MM, Zarei MA, Arminian A. Selection criteria of flax for seed yield and yield components and biochemical composition under various planting dates and nitrogen. African Journal of Agriculture Research. 2011;6:3167-3175.

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