Original Research Article

Response of Plant Growth Regulators on Morphology, Flowering & Maturity, Yield Attributes & Yield of Lentil (*Lens culinaris* L. Medik.) Variety: DPL-62

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ABSTRACT

Comprehensively, nutrient deficiencies in humans and animals are a quiet epidemic in many underdeveloped nations. Lentil is one of the most important and nutritious *Rabi* pulse and ~~also it~~ is a leguminous crop, ~~to~~ which can improve ~~the fertility of soil through biological nitrogen fixation~~soil fertility. Hence, a field experiment was conducted at the Students' Instructional Farm of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Utter Pradesh, India to study the Enhancement of Plant Growth, Chlorophyll Content, Flowers, Yield and Seed Protein Content by Plant Growth Regulators in Lentil (*Lens culinaris* L. Medik) Variety: DPL-62 during the *Rabi* season of 2019-20 and 2020-21. The field experiment wa~~y~~s laid out in Randomized Block Design (RBD) with three replications and comprising eleven treatments i.e., T1: Control, T2: TIBA@25ppm, T3: TIBA@50ppm, T4: GA3@25ppm, T5: GA3@50ppm, T6: Cytokinin@5ppm, T6: Cytokinin@10ppm, T8: IAA@25ppm, T9: IAA@50ppm, T10: NAA@25 ppm, T11: NAA@50 ppm. The results revealed that the maximum ($P < 0.05$) plant height was obtained by the GA3 @ 50 ppm (38.12, 38.15cm at harvest) followed by IAA @ 50 ppm (37.00. 38.10cm at harvest) spray at all stages. The TIBA @ 50 ppm show better results viz., number of branches plant^{-1} (15.00, 15.33 at 110DAS), leaf area planrt^{-1} (86.50, 86.32 at 110DAS), number of pods plant^{-1} (160.20, 160.37), pod setting (65.45, 65.50%), seed weight plant^{-1} (2.02, 2.10g), test weight (27.32, 27.39g) and seed yield (1500.00, 1510.00 kg ha^{-1}) of lentil as compared to all other treatments. The maximum ($P < 0.05$) days of flowering (67.50, 67.85) and days of maturity (136.30, 136.40) were recorded with the application of IAA @ 50 ppm during both the year 2019-20 and 2020-21, respectively. On the basis of observed results, farmers were instructed to ~~farmers~~ grow ~~the L~~lentil variety DPL-60 with foliar applications of TIBA @ 50ppm for greater production and profitability.

Comment [SC2]: This info is less important. Rather include the PGR and its importance. It is also important to state the background of the work and problem statement for undertaking this experiment.

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Key Words:- *Lentil; PGR; GA$_3$; TIBA; IAA; NAA; Yield; Morphology; Flowering; Maturity*

INTRODUCTION

One of the most important and healthiest Rabi pulses is lentil. It could make up for the risk of farming in the rain. It can also be used as a cover crop to stop soil erosion in places where it is a problem. As green manure, the plants are also tilled back into the ground (Meena *et al.*, 2018). Most people consume it as "dal", the grain is split into two orange-red or orange-yellow cotyledons, which are used to make Dal. Some of the dishes also use the whole grain. Since it is a leguminous crop, it makes the soil more fertile by fixing nitrogen in a natural way. The starch in lentil seeds is also used to make textiles and ink. Feed for animals are made from lentil waste. Soups can be thickened with lentil flour. It is added to wheat flour to make bread and cakes. Lentil is usually grown as a rain-fed crop after rice, maize, and pearl millet during the Rabi season (Singh *et al*., 2016). Lentils have always been a part of the human diet, and after soybeans and hemp, they have the third-highest amount of protein. Methionine and cysteine are two essential amino acids that lentil doesn't have enough of lentils also have minerals, fibre, and vitamin B1 in them. Lentils are a good source of iron, one cup of lentils has more than half of a person's daily iron needs (Singh & Singh, 2014). Lentils can handle drought pretty well and are grown all over the world. Lentil is one of the 30 most important economically important plant groups that many people use as their main source of nutrition and it has a lot of carbs, protein, and amino acids (Khawar and Ozcan 2002). Per 100 grams of lentil have 24–26% protein, 57–60% carbohydrates, 1.3% fat, 3.2% fibre, 300mg phosphorus, 7 mg iron, 10-15 mg vitamin C, 69 mg calcium, 343 Kcal per 100 grammes, and 450 IU of vitamin A.

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India ranked first in the area and second in the production with 43% and 37% of world area and production respectively. The highest productivity is recorded in New Zealand (2667 kg/ha) followed by China (2239kg/ha). The Canada ranks first in production (38%) due to very high level of productivity 1971 kg/ha as compared to India 600 kg/ha **(FAO, 2017).** During 2019-20 the country's area under Lentil was 13.90 lakh hectares with a production of 12.30 lakh tonnes. In India Madhya Pradesh ranks I^{st} in acreage i.e., 35.54% (4.94 lakh ha) followed by UP 32.30% (4.49 lakh ha) and Bihar 10.43% (1.45 lakh ha). While in terms of production Madhya Pradesh ranks I^{st} at 34.79% (4.28 lakh tonnes) followed by UP 33.25% (4.09 lakh tonnes) and Bihar 10.89% (1.34 lakh tonnes). The highest productivity was recorded by the state of Meghalaya (1107 kg/ha) followed by Rajasthan (1007 kg/ha) and Manipur (929 kg/ha). The National yield average was (855 kg/ha).

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Plant growth regulaters (PGRs) are non-nutrient organic molecules. NAA, TIBA, IAA, GA3, Cytokinin, and other synthetic PGR-like substances are sold commercially (Pai & Desai, 2018). Plant Growth regulators have been used for a wide range of purposes, including overcoming dormancy problems in seeds, accelerating seedling growth, hastening and increasing rooting of cuttings in several vegetative propagated plants, and altering plant growth in areas where genetic or other manipulation is not possible. PGRS affects germination, vigour, soil nutrient uptake, photosynthesis, respiration, assimilate partitioning, growth inhibition, defoliation, and postharvest ripening (Thorat *et al.*, 2017). Plant growth regulators (PGRs) increase agricultural yields by improving plants' physiological efficiency and photosynthetic capabilities (Giannakoula *et al.*, 2012). PGRs improve source-sink relationships and photo-assimilates translocation, boosting productivity. PGRs have significant promise, but their application, accrual assessment, and ideal concentration, stage, species specificity, and seasons must be carefully managed (Srinivasan, 2016). Even a small increase of 10-15% in their effectiveness on every element of plant growth could enhance gross annual productivity by 10-15 m tonnes.

These PGRs promote floral production when administered during flowering. Spraying foliage with growth regulators reduces flower and pod drop. PGR and urea foliar spray dramatically boosted seed output per plant (Patil and Suryawanshi, 2005).

TIBA (2, 3, 5-triiodobenzoic acid), an auxin polar transport inhibitor, embryogenesis from embryogenic cells. Cell division is unaffected. TIBA suppresses stage-specific axial and bilateral polarity in globular embryos. TIBA-induced malformed embryos decrease shoot and root apical meristem and vascular differentiation (Márquez-López *et al.*, 2018). Thus, triodobenzoic acid inhibition causes aberrant embryo development and plantlets without branches and roots. Growth enhancers like gibberellins. In crop improvement projects, retardants stimulate cell division, growth, wall flexibility, and amylase gene transcription. These cause Brioche plants to grow slower, root faster, and resist environmental stress. Growth regulators promote crop physiological efficiency, photosynthetic ability, and assimilate partitioning from source to sink in field crops (Kumar *et al.*, 2015). Foliar use of growth regulators and chemicals during blooming can boost crop output and physiological efficiency. GA3 foliar spray boosted black gramme plant height by increasing internodes and vegetative and reproductive growth. GA3 boosted groundnut plant height by lengthening the main axis (Ikiba, 2017).

Cytokinins boosted soybean cell growth and stem thickness while kinetine reduced shoot length but improved fresh weight by increasing stem diameter in morning glory and okra (Chaudhry & Khan, 2000). Cytokinins regulate bud initiation, flowering, abscission, and yield. IAA exerts influence on plant growth by enlarging leaves and increasing photosynthetic activities in plants. It also activates the translocation of carbohydrates during their synthesis Indole-3 acetic Acid (IAA) is a well-known natural auxin generated in the apical meristem of the shoot ((Kasim *et al.*, 2017). IAA is produced by the developing seed and stimulates the formation of a succulent fruit. The removal of seeds from a strawberry, for example, inhibits the fruit from expanding. After removing the seeds, IAA is applied to the fruit, which causes it to grow naturally. IAA is involved in elongation and is produced in actively growing shoot tips and developing fruit. Before a cell can elongate, its cell wall must become less rigid in order to grow. IAA causes an increase in the cell wall's plasticity, or ability to withstand stress (Liu *et al.*, 2013). NAA is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products. It is a rooting agent and used for the vegetative propagation of plants from stem and leaf cuttings (Kachru *et al.*, 2017). It is also used for culture. The hormone NAA does not occur naturally, and, like all auxins, is toxic to plants at high concentrations. The objectives of the experiments were to evaluate the effect of growth regulators on growth parameters yield attributes of lentil and to identify the suitable growth regulators for enhancing yield and quality of Lentil.

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2. Materials and Methods

2.1 Experimental site: The field experiment was conducted on Student's Instructional Farm (SIF) at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. This is situated in the alluvial tract of Indo - Gangetic plains in central part of Uttar Pradesh between 25º 26' to 26º 58' North latitude to 79º 31' to 80º 34' East longitude at an elevation of 125.9 m above mean sea level. This region falls under agro-climatic zone V (Central Plain Zone) of Uttar Pradesh. The location of the experimental field was same for both the years of investigation.

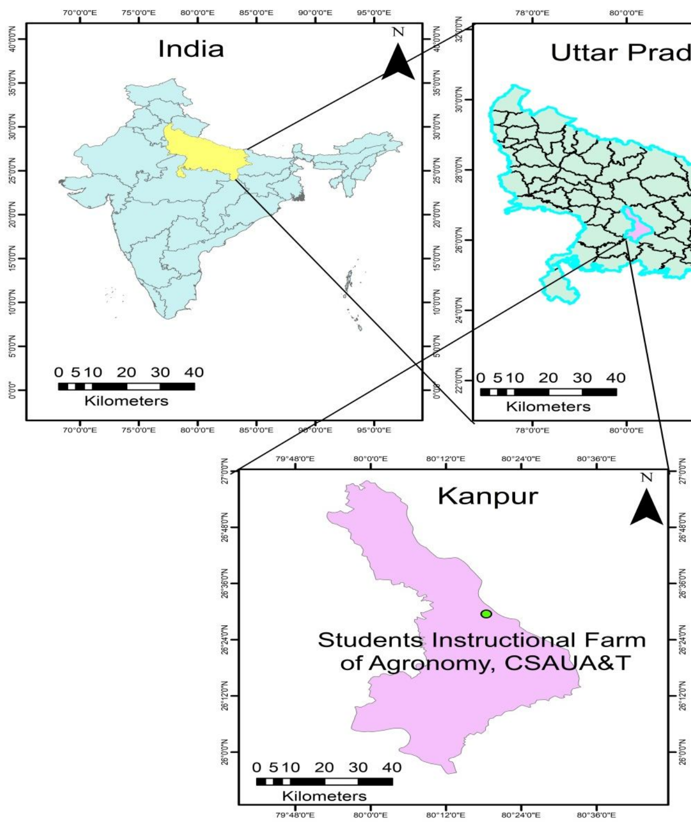

Fig 1: LOCATION MAP OF THE STUDY AREA

2.2 Climate and weather conditions: This zone has semi-arid climatic conditions, having alluvial fertile soil. The normal rainfall of the area is about 890 mm per annum. Most of the rains are received from mid-July to end of September. The winter months are cooler with occasional rains as well as frost during last week of December to mid-January. The temperature in the month of May and June may goes up to 44-47^{o}C or beyond and during winter it may goes down up to a certain degree. Mean relative humidity (7:00 A.M.) remains nearly constant at about 80-90% from July to end of March and after March slowly declines to about 40-50% by the end of April and remains constant at 80% up to May.

2.3 Soil Characteristics: The soil as a medium of plant growth is bound to affect profoundly the rate of growth of plants and ultimately the final yield through its properties. The general character of the field were soil texture is sandy loam soil with pH (7.83, 7.87), Electrical conductivity (0.26, 0.27 dSm^{-1} at 25ºC), Bulk density (1.39, 1.40 g cm^{-3}), Particle density (2.64, 2.63 g cm^{-3}), Organic Carbon (0.33, 0.35 %), Available nitrogen (156.22, 161.32 kg ha^{-1}), Available P_2O_5 (17.24, 18.15 kg ha^{-1}), Available K_2O (175.35, 181.49 kg ha^{-1}), Available Zn (0.56, 0.58 mg kg^{-1}), Available Fe (8.02, 8.07 mg kg^{-1}) and Available B (0.28, 0.38 mg kg^{-1}), Moisture content in air dried soil (5.3, 5.5), Water holding capacity (42.1, 40.8 %), Permanent wilting point (4.4, 4.6), Field capacity (19.5, 20.0 %) in both year 2018-19 and 2019-20, respectively.

2.4 Experimental Details: The experimental design was Randomized Block Design (RBD) with three replications. The experiment consisting of eleven treatments with lentil variety DPL-62 i.e., T1: Control, T2: TIBA@25 ppm, T3: TIBA@50ppm, T4: GA3@25ppm, T5: GA3@50ppm, T6: Cytokinin @ 5ppm, T7: Cytokinin@10ppm, T8: IAA@25ppm, T9: IAA@50ppm, T10: NAA@25 ppm, T11: NAA@50 ppm. The size of each plot was (13.5 m^2), 4.5m long and 3.0 m width.

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2.5 Crop Varieties:

DPL 62 (Sheri): it is also known as Sheri variety of lentil developed by ICAR-Indian Institute of Pulse Research, Kanpur for cultivation in north western plain zones (Punjab, Haryana, Delhi, North Rajasthan and Western Uttar Pradesh) of India. It is medium in plant height, Resistant to rust and wilt, large seeds. Important features are Yield: 22-25 q ha^{-1}.

2.6 Agronomical Practices Adopted: During the experimental period, the land was first ploughed using a tractor drawn cultivator and then harrowed. Weeds and stubbles were removed and the field was leveled using a leveler and later laid out into plots as per the design. The big clods were broken into fine soil particles and the surface was leveled until the desired tilth obtained. Uniform doses of nitrogen, and phosphorus calculated at the rate of 10 kg nitrogen and 40 kg. Phosphorus per hectare was applied at the time of sowing as basal application. Seeds were sown in the field behind the plough, keeping the rows 30 cm apart and maintaining a depth of 5 cm, as for as possible. The open furrows were planked immediately after sowing. Plant to plant spacing within the rows was maintained at 10 cm. The crop was irrigated and weeded as per seasonal requirements.

2.7 Preparation of growth regulators, solutions and spraying: The desired quantities of each growth regulator *i.e.* TIBA, GA_3, Cytokinin, IAA and NAA were weighed on a single pan automatic electric balance. IAA and NAA were firstly dissolved in a few drops of ethyl alcohol and there after the alcoholic solution were made up to 1000 ml with distilled water with stirring and were kept in stopper flasks. GA_3 was first dissolved in boiling distilled water and the volume was made up to 1000 ml with it. Cytokinin and TIBA were directly dissolved in distilled water and volume was made up to 1000 ml. A few drops of 'Teepol' were added as a wetting agent to each solution, followed by vigorous shaking. Thus, the solution was prepared carefully and sprayed on the plants with the help of one litre hand sprayer (automizer) and 1 litre of each solutions was sprayed in each plot (4.5X 3 m^2) at 30 days after sowing. Control plants were unsprayed. Caution was always taken to clean the sprayer by rinsing it several times with the solution intended for the next spray in order to avoid any residual effect of the previous hormone.

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Observations: The observations were recorded at successive stages of growth. All the precautionary measures were adopted to eliminate sampling error. The following observation were recorded during both the years of investigation of plant height, number of branching, leaf area plant^{-1}, days of flowering, days of maturity, number of pods plant^{-1}, seed weight plant^{-1} , test weight and seed yield of lentil had to be determined. Data obtained was exposed to the proper method for statistical analysis of variance difference among mean of different treatments as described by (Gomez and Gomez, 1984). The treatments means were compared using the Least Significant Differences (LSD) test at 5% level of probability by using the Factorial Randomized Block Design (RBD) model as obtained by SPSS (Statistical Product and Service Solutions) Version 10.0, SPSS, Chicago and IL software.

3. RESULTS AND DISCUSSION

Plant height: The data regarding plant height was considerably ($P < 0.05$) influenced by the application of plant growth regulator at all the successive stages of growth during both the years. The maximum increase in plant height was recorded by the application of GA_3 @ 50 ppm followed by IAA @ 50 ppm, NAA (50ppm), respectively over the control during both the years. On the other hand, TIBA @ 50 ppm acted in a reverse direction means reduced the plant height. Maximum retardation effect was seen in the treatment of TIBA @ 50 ppm treatment. The effect once initiated during the early stage of branching continued at successive stage of growth viz., flowering, Pod formation, seed development and maturity. Increase in plant height occurring from sprays of GA well documented by (**Verma *et al*., 2016)** in chickpea. (**Kumar *et al*., 2017)** reported the reduction in plant height of pea plant due to TIBA application. The reduction in plant height may be attributed to restriction in cell division activity and elongation of sub-apical meristem resulting in shortening of inter-nodal length.

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Numbers of branches plant^{-1}: The perusal of data numbers of branches plant^{-1} was significantly ($P < 0.05$) increased by application of plant growth regulator during both the years. The Maximum number of branches was recorded under TIBA @ 50 ppm followed by IAA @ 50 ppm. Application of Cytokinin @ 5 ppm on the other hand led to the reduction in number of branches during both the years of experiment. (Singh and Singh, 2017), (Yadav *et al*., 2008), (Adam and Jahan, 2014), Kumar *et al*., 2017) (Suryawanshi *et al*., 2017) reported the increase in number of branches by TIBA application.

Leaf area plant^{-1}: The data pertaining leaf area plant^{-1} was significantly ($P < 0.05$) influenced by the application of plant growth regulator during both the years. The maximum leaf area plant^{-1} was noticed under the application of TIBA @ 50ppm closely followed by IAA @ 50 ppm during both years. While, the minimum leaf area plant^{-1} was recorded under the control. TIBA (50ppm) produced maximum leaf area meaning there by it improves the transport mechanism and utilization process for stimulation of leaf growth. (**Ganiger *et al*., 2001)**, and (**Kumar *et al.* 2017)** recorded an increase in leaf area due to application of these plant growth regulators on different crops.

Days to Flowering: A perusal of data clearly indicates that application of IAA @ 50ppm delayed the flowering by 5 days which varied from (70.10 and 70.25) over the control (65.00 and 65.30) days during 2019-20 and 2020-21, respectively. This is statistically significant ($P < 0.05$) during both the years of experiment. The application GA_3 @ 50 ppm and GA_3 @ 25ppm induced early flowering which ranged from 4 to 5 days. On the other hand, IAA @ 5 ppm and IAA @ 25ppm also delayed the flowering from 3 to 5 days in comparison to control during both the years

Days of maturity: The data pertaining days of maturity of lentil variety was affected by plant growth regulator days during 2019-20 and 2020-21. It was noted that IAA @ 50 ppm and IAA @ 25 ppm delayed maturity by 4 to 6 days in plants as compared to control. While the application of GA_3 @ 25 ppm and GA_3 @ 50 ppm caused an early maturity by about 5 to 6 days, which being statistically significant ($P < 0.05$) during both the years.

Number of pods plant^{-1} and seeds pod^{-1}: The data regarding number of pods plant^{-1} and seed pod^{-1} was significantly ($P < 0.05$) increased over the control, by sprays of TIBA @ 50ppm, IAA @ 50ppm and NAA @ 50ppm. The application of TIBA @ 25 ppm gave highest number of pods per plant during both the years of experiment. On the other hand, Cytokinin @ 5ppm gave the lowest number of pods per plant during both the years. Similar findings were reported by (**Verma *et al*., 2016),(Kumar *et al*., 2017)**.

Pod setting percentage (%): The perusal of the data pod setting percentage (%) application plant growth regulator significantly ($P < 0.05$) increased the extent of pod setting percentage per plant from the total number of flowers formed in comparison to the value of these attributes in the control. The maximum pod setting percentage was recorded by the application of TIBA @ 50ppm. A similar effect was also exerted under the treatment of IAA @ 50ppm followed by NAA @ 50 ppm. Minimum pod setting was recorded with the treatment of cytokinin @ 5ppm.

Seed Yield plant^{-1}: The weight of seeds produced per plant was significantly ($P < 0.05$) increased by the applications of different plant growth regulator during both the years. The maximum seed weight per plant recorded with the application of TIBA @ 50ppm than all other treatments and were followed by treatments of IAA @ 50 ppm and NAA @ 50ppm and the application of Cytokinin @ 5ppm and IAA @ 25ppm observed the lowest seed yield plant^{-1}.

Test weight: The Plant growth regulators exerted significant ($P < 0.05$) influence on test weight over the control during both the years. Among the plant growth regulators, the TIBA @ 50ppm produced highest test weight, IAA @ 50ppm proved next in effectiveness, which is followed by NAA @ 50ppm and TIBA @ 25ppm, respectively. While in control treatment recorded significantly lower test weight of grain than all other treatments.

Seed yield: The overall production of seed yield (kg ha^{-1}) was significantly ($P < 0.05$) influenced by the application of plant growth regulator during both the years. The maximum seed yield was found with application of TIBA @ 50 ppm (1500 and 1510 Kg ha^{-1}) and over the control (1200 and 1220 Kg ha^{-1}) during 2019-20 and 2020-21, respectively. IAA @ 50ppm recorded next highest seed yield (1450 kg ha^{-1} and 1465 kg ha^{-1}) during the years 2019-20 and 2020-21, respectively. Application of cytokinin (5ppm) also gave superior effects over control during both the years of experiment. Influence of GA_3 in increasing seed yield, has been observed in the present study, and has been described in Chick Pea. **(Verma *et al*., 2016), (Kumar *et al*., 2017)** reported increase in seed yield by TIBA application and NAA.

Table 1: Effect of Plant Growth Regulators on plant height (cm) at different stages of Lentil

Treatments	Plant height (cm) at 35 DAS		Plant height (cm) at 60 DAS		Plant height (cm) at 85 DAS		Plant height (cm) at 110 DAS		Plant height (cm) at harvest	
	2019-20	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**
Control	7.35	7.37	18.23	18.26	29.12	29.18	33.30	33.40	32.85	32.86
TIBA @ 25 ppm	6.35	6.40	16.65	16.50	27.70	27.25	30.75	30.70	30.15	30.20
TIBA @ 50 ppm	5.10	5.12	15.12	15.16	26.15	26.12	29.30	29.35	29.10	29.25
GA_3 @ 25 ppm	8.75	8.85	24.45	25.50	34.20	34.26	38.20	38.45	37.40	37.28
GA_3 @ 50 ppm	8.85	8.95	25.56	25.62	34.65	34.68	38.90	38.96	38.12	38.15
Cytokinin @ 5 ppm	7.50	7.60	22.18	22.25	30.20	31.35	34.85	33.78	34.48	33.60
Cytokinin @ 10 ppm	7.90	7.85	22.76	22.84	32.40	31.53	35.30	33.90	35.20	33.75
IAA @ 25 ppm	7.50	8.63	23.68	23.85	33.10	33.65	37.40	37.75	36.72	37.50
IAA @ 50 ppm	8.51	8.66	24.10	24.21	33.60	34.12	37.85	38.25	37.00	38.10
NAA @ 25 ppm	7.95	8.10	22.42	20.56	31.40	32.25	35.80	34.56	35.45	34.48
NAA @ 50 ppm	8.35	8.45	23.26	22.34	32.45	32.45	36.60	35.65	36.50	35.55
SE (d) ±	**0.33**	**0.54**	**0.54**	**0.62**	**0.76**	**1.02**	**0.98**	**0.99**	**0.94**	**1.25**
C.D at 5 %	**0.69**	**1.13**	**1.14**	**1.28**	**1.60**	**2.14**	**2.04**	**2.66**	**1.96**	**2.62**

Table 2: Effect of Plant Growth Regulators on Number of branches plant^{-1} at different stages of Lentil

Treatments	Number of branches plant^{-1} at 35 DAS		Number of branches plant^{-1} at 60 DAS		Number of branches plant^{-1} at 85 DAS		Number of branches plant^{-1} at 110 DAS	
	2019-20	20120-21	2019-20	20120-21	2019-20	20120-21	2019-20	20120-21
Control	2.66	3.00	4.33	5.00	7.66	8.00	9.33	9.66
TIBA @ 25 ppm	5.66	5.66	7.66	8.00	11.33	11.66	13.66	13.66
TIBA @ 50 ppm	7.00	7.33	9.00	9.33	13.00	13.33	15.00	15.33
GA_3 @ 25 ppm	4.33	4.66	6.00	6.33	9.33	9.66	11.33	11.66
GA_3 @ 50 ppm	5.00	5.33	6.66	7.00	10.33	10.66	12.66	12.66
Cytokinin @ 5 ppm	3.33	3.66	4.67	5.66	8.33	8.33	10.00	10.33
Cytokinin @ 10 ppm	4.66	5.00	6.33	6.66	10.00	10.33	12.00	13.33
IAA @ 25 ppm	5.33	5.66	7.00	7.33	10.66	10.66	13.00	13.33
IAA @ 50 ppm	6.66	7.00	8.66	9.00	12.66	12.66	14.66	14.66
NAA @ 25 ppm	3.66	4.00	5.33	5.66	8.66	8.66	10.66	10.66
NAA @ 50 ppm	6.00	6.66	8.00	8.33	12.00	12.33	14.33	14.66
SE (d) ±	**0.18**	**0.19**	**0.25**	**0.26**	**0.38**	**0.39**	**0.45**	**0.46**
C.D at 5 %	**0.39**	**0.41**	**0.52**	**0.55**	**0.80**	**0.82**	**0.96**	**0.97**

Table 3: Effect of Plant Growth Regulators on Leaf area plant^{-1} at different stages of Lentil

Treatments	Leaf area plant^{-1} at 35 DAS		Leaf area plant^{-1} at 60 DAS		Leaf area plant^{-1} at 85 DAS		Leaf area plant^{-1} at 110 DAS	
	2019-20	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**
Control	34.95	35.10	55.65	55.64	60.20	60.23	70.85	71.56
TIBA @ 25 ppm	43.20	43.26	69.00	69.10	75.26	75.30	84.12	84.25
TIBA @ 50 ppm	44.12	44.23	70.85	70.78	77.84	77.86	86.50	86.32
GA_3 @ 25 ppm	36.00	36.20	61.25	61.21	70.12	70.23	80.10	80.20
GA_3 @ 50 ppm	41.16	41.21	63.12	63.14	70.95	70.98	82.24	82.26
Cytokinin @ 5 ppm	35.24	35.26	61.00	61.13	69.32	69.36	79.25	79.32
Cytokinin @ 10 ppm	36.14	36.23	61.56	61.57	70.24	70.28	81.32	81.42
IAA @ 25 ppm	42.22	42.32	67.95	67.97	74.60	74.65	83.75	83.87
IAA @ 50 ppm	43.91	43.95	70.25	70.28	77.20	77.28	86.10	86.20
NAA @ 25 ppm	35.85	35.86	61.10	61.15	71.30	71.60	80.00	80.13
NAA @ 50 ppm	43.50	43.52	69.85	69.88	76.50	76.54	84.65	84.68
SE (d) ±	**1.02**	**1.32**	**1.50**	**2.2**	**1.81**	**2.51**	**2.03**	**2.83**
C.D at 5 %	**2.14**	**2.76**	**3.15**	**4.68**	**3.79**	**5.25**	**4.25**	**5.92**

Table 4: Effect of Plant Growth Regulators on Days of Flowering & maturity, Number of pods plant^{-1} and Pod setting at different stages of Lentil

Treatments	Days of 50% Flowering		Days of Maturity		Number of pods plant^{-1}		Pod setting percentage	
	2019-20	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**	**2019-20**	**20120-21**
Control	65.00	65.30	130.00	131.22	104.83	105.35	52.70	52.82
TIBA @ 25 ppm	66.20	66.40	130.80	130.90	146.72	148.00	62.65	62.76
TIBA @ 50 ppm	67.50	67.85	131.10	131.30	160.20	160.37	65.45	65.50
GA_3 @ 25 ppm	60.10	60.25	125.00	125.50	127.55	128.00	56.40	56.52
GA_3 @ 50 ppm	59.18	59.38	124.60	124.72	134.75	135.00	58.80	58.85
Cytokinin @ 5 ppm	63.20	63.30	133.20	134.33	116.40	117.00	54.25	54.36
Cytokinin @ 10 ppm	64.60	64.82	133.50	133.68	130.65	130.80	57.35	57.40
IAA @ 25 ppm	68.50	68.60	134.80	135.20	139.24	140.00	60.15	60.30
IAA @ 50 ppm	70.10	70.25	136.30	136.40	154.25	154.45	64.42	64.45
NAA @ 25 ppm	61.80	62.00	133.34	134.00	122.45	122.70	55.28	55.38
NAA @ 50 ppm	62.30	62.50	132.34	133.10	150.42	150.53	63.60	63.50
SE (d) ±	**2.32**	**2.33**	**0.53**	**0.73**	**2.55**	**3.08**	**2.15**	**2.15**
C.D at 5 %	**4.87**	**4.89**	**1.10**	**1.53**	**5.33**	**6.43**	**4.52**	**4.52**

Table 5: Effect of Plant Growth Regulators on Seed Yield plant^{-1}, 1000 seeds weight and Seed Yield of Lentil

Treatments	Seed Yield plant^{-1} (g)		Test weight (g)		Seed Yield (Kg ha^{-1})	
	2019-20	20120-21	2019-20	20120-21	2019-20	20120-21
Control	1.40	1.48	22.86	23.40	1200.00	1220.00
TIBA @ 25 ppm	1.57	1.89	25.60	26.90	1398.00	1418.00
TIBA @ 50 ppm	2.02	2.10	27.32	27.39	1500.00	1510.00
GA_3 @ 25 ppm	1.08	1.53	23.58	25.20	1267.00	1270.00
GA_3 @ 50 ppm	1.53	1.68	23.84	26.50	1284.00	1340.00
Cytokinin @ 5 ppm	1.47	1.51	23.29	24.80	1240.00	1260.00
Cytokinin @ 10 ppm	1.27	1.60	23.60	26.10	1268.00	1310.00
IAA @ 25 ppm	1.56	1.75	25.17	26.75	1370.00	1385.00
IAA @ 50 ppm	1.90	2.00	26.40	27.20	1450.00	1465.00
NAA @ 25 ppm	1.70	1.55	23.35	25.80	1250.00	1283.00
NAA @ 50 ppm	1.84	1.95	26.16	27.10	1435.00	1453.00
SE (d) ±	**0.07**	**0.06**	**0.89**	**0.94**	**49.14**	**54.04**
C.D at 5 %	**0.16**	**0.13**	**1.88**	**1.98**	**102.54**	**112.76**

4. CONCLUSION

Hence, based upon the findings of the present investigation it can be concluded that the use of TIBA would be rewarding to enhance the yield of Lentil. Of all the plant growth regulators, TIBA @ 50ppm is the optimum concentration for foliar application to significantly ($P < 0.05$) maximize the growth, yield attributes and seed yield of lentil. On the basis of observed results, farmers were instructed to grow the Lentil variety DPL-60 with foliar applications of TIBA @ 50ppm for greater production and profitability.

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