

Effect of indole-3-acetic acid on the stem and root growth pattern of *Phaseolus vulgaris* (Rajma)

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Abstract

The aim of present study was to evaluate the appropriate concentration of plant growth regulator i.e. (10^{-3} M) of the IAA on the stem growth of *Phaseolus vulgaris* (Rajma) over the control. Seeds of *Phaseolus vulgaris* (Rajma) were sown in sandy loam soil in field plots (A & B). Plot-A of legume crop was treated as control and not sprayed with growth regulator. Plot-B was sprayed with IAA solution of (10^{-3} M) concentration daily. It was observed that IAA was found most effective in (10^{-3} M) concentration for the stem & root growth patterns of *Phaseolus vulgaris* (Rajma).

Keywords: IAA, *Phaseolus vulgaris*, Stem & root growth

Introduction

Healthy dietary patterns comprising of fruit, vegetables, legumes and nuts has a positive effect on physical and mental health. The 2015 US dietary guidelines committee found that the vegetables and fruits were the only dietary elements that proved beneficial in preventing or treating an array of different diseases. These plant species declined to a great extent due to the change in environmental conditions and less adaptability, lack of nutrients in soil, less growth and productivity of plants and lastly the stress. These all problems can be solved by using a small quantity of plant growth regulators (PGRs). It has been well established that the plant growth regulators influence the growth and development of plants. These chemical substances are able to coordinate growth among different plant parts or different physiological & biochemical processes.

Thimann *et al.*, (1948) ^[1] defined a phytohormone as an organic compounds, produced naturally in higher plants, controlling growth or other physiological functions and active in minute amount and regulates plant physiological processes and these compounds are naturally occurring/or synthetic, stimulating/or inhibitory substances. An auxin is defined as an organic substance, which promotes growth (increase in growth) along the longitudinal axis, when applied in low concentrations to shoots of the plants.

The importance of synthetic plant growth regulators in achieving higher yield and better quality of horticultural crop has been well recognized in recent time. Plant growth regulators have given encouraging results in case of pomegranate fruit and other crops. However, practically, there has been very little work done on the use of plant growth regulators in different crops and other crops as it was observed by Anwal *et al.*, (2015) ^[2].

The term plant growth regulators (PGRs) cover the broad category of organic compounds other than nutrients. A large number of synthetic compounds exhibit PGRs like activity and marketed for commercial use, particularly naphthalene acetic acid (NAA), Auxin and GA₃ etc. The impact of PGRs in physiological processes in crop production include

germination, vigour, nutrient uptake from soil, photosynthesis, respiration, partitioning of assimilate, growth suppression, defoliation and post-harvest ripening as was observed by Kathiresan and Balasubramanian (1995) ^[3]. Poor germination and subsequent establishment of different pulse seed is a general problem in pulse production. Improvement in germination, capability and increasing seed vigour might be one option to make the growing pulse seedling more competitive with those of weeds. There are evidences that different natural and synthetic growth regulators improve seed germination and seedling growth of many crops as observed by Devi and Vijayageetha (2009) ^[4]. Different experiments have been conducted in many field and horticultural crops with plant growth hormones to evaluate germination and seedlings growth. It was found that the plant growth hormone increased the growth and yield of various economically important crop plants including cereals, legumes, vegetables, fibres, oilseeds, medicinal plants, beverages and narcotics as noted by Hussain *et al.*, (1980) ^[5]. Plant growth regulator were found to increase the growth and yield of many field and horticultural crops (Karim, 2005) ^[6]. Plant growth hormones improve the crop resistance to lodging and can improve harvest ability and grain quality. In some instances PGRs have been linked to an increase in stem strength as noted by Tripathi *et al.*, (2004) ^[7], number of roots observed by Emam *et al.*, (2009) ^[8] and some improvement in yield has been reported in response to PGRs on wheat crops.

Auxins and gibberellins play very important role in regulating the developmental processes within plant bodies noted by Gou *et al.*, (2010) ^[9]. Auxin promotes cell elongation, especially of shoots and induces apical dominance and rooting, while gibberellins helps in cell growth of stem, leaves and other aerial parts by causing cell elongation and increase in internodal length. Thus, only low doses of auxins are effective in growth promotion as noted by Vwioko and Longe (2009) ^[10].

Plant growth regulators like promoters, inhibitors or retardants play a key role in controlling internal mechanisms

of plant growth by interacting with key metabolic processes such as nucleic acid metabolism and protein synthesis. Use of plant growth regulators (PGR's) might be a useful alternative to increase crop production. Recently, there has been global realization of the important role of PGR's in increasing crop yield. GA_3 is a group of plant hormones that control developmental processes such as germination, shoot elongation, tuber formation, flowering, fruit set and it also promotes growth of diverse plant species. IAA exerts influence on plant growth by enlarging leaves and increasing photosynthetic activities in plants observed by Naeem *et al.*, (2004) [11]. IAA also activates the translocation of carbohydrates during their synthesis. It has been observed that IAA in combination with kinetin caused a decrease in length and number of internodes, expansion of main stem diameter and increases the number and area of leaves (Naeem *et al.*, 2004) [11].

Therefore, this study was aimed at comparing and characterizing the effects of IAA on the stem growth of *Phaseolus vulgaris*. This study provides the information to enhance the potential for successful production of *Phaseolus vulgaris* by applying (10^{-3} M) concentration of IAA with respect to the control field.

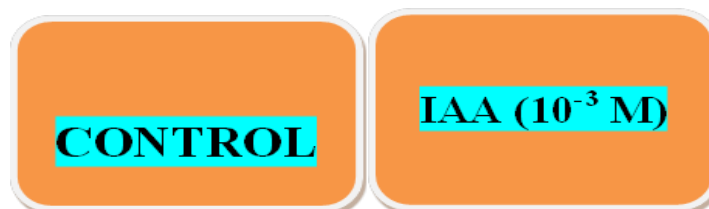


Fig 1: Experimental design in the field plots

Observation and Results

In the control plot (A) as shown in Fig. 2(a), the values of stem length (cm/pl), were recorded at the tenth (10^{th}) day stage of the growth as 9.6(cm/pl) and observed continuously up to 50 days and noticed as 35.5(cm/pl). When the plot (B) as shown in Fig. 2(b), was sprayed by IAA (10^{-3} M) concentration daily, the enhancement was observed in the stem length as compared to the control. The maximum promotion of length was noticed at the 10^{th} day stage of growth and recorded as ca.70.8%, at the 20^{th} day as ca.165%, at the 30^{th} day as ca. 21.7%; at the 40^{th} as ca.18.5% up to the 50 days as ca. 25.3% as compared to control [Table

Materials and Methods

Study Area

Present work was carried out in the field of agriculture department of Uttaranchal college of Science & Technology (P.G.) Dehradun, Uttarakhand (India). Dehradun is the gateway of Mussoorie and Garhwal region of Uttarakhand. Dehradun is the capital city of the state of Uttarakhand; it is located in the Doon Valley on the foothills of the Garhwal Himalayas between two of India's greatest rivers-the Ganges and the Yamuna. For the investigation the seeds of *Phaseolus vulgaris* (Rajma) were procured from Seed Centre of Forest Research Institute (F.R.I), Dehradun (Uttarakhand).

General Experimental Design in the Field Plots:

During field study, seeds of *Phaseolus vulgaris* were grown in field plots and the plots were divided by black paper sheets into two blocks. Each field block was given treatments as follows:

1. In plot-A, plant species (*Phaseolus vulgaris*) was taken as control. No treatment was given to the crop of this plot.
2. Plot-B was sprayed with IAA (10^{-3} M) solution daily.

and Fig. 3]. The root growth analysis was also carried out from the 10^{th} day stage up to 50 days. Root length & data was depicted in the [Table 2 and Fig 4]. In the control plot-(A), the value of length of root was found at the 10^{th} day stages of growth and observed continuously up to 50 days and amounted as ca. 2.5, 6.14, 12.5, 13.2, & 14.5(cm/pl). While the plants of plot-(B) were sprayed by IAA (10^{-3} M) concentration, the maximum promotion was observed on length of roots were noted at the 10^{th} , 20^{th} , 30^{th} , 40^{th} and up to the 50^{th} days stage of growth and an increased by ca.52%, 20.5%, 8%, 62.8% and up to 50 days as 62% with respective to the control plot.



Fig 2: (a) Control Plot (A)



(b) IAA (10^{-3} M) Treated Plot (B)

Table 1: Stem growth patterns of field grown *Phaseolus vulgaris* (Rajma) increased by plant growth regulator IAA (10^{-3} M) concentration as compared to control

Treatments	Parameters	Length of stem growth in days				
		10 th	20 th	30 th	40 th	50 th
Control	Length (Cm)	9.6±3.20	7.8±1.64	20.2±3.34	30.2±2.58	35.5±2.70
Iaa (10^{-3} M)	Length (Cm)	16.4±0.89	20.7±4.60	24.6±12.1	35.8±3.19	44.5±3.04

Table 2: Root growth patterns of field grown *Phaseolus vulgaris* (Rajma) increased by plant growth regulator IAA (10^{-3} M) concentration as compared to control

Treatments	Parameters	Length of stem growth in days				
		10 th	20 th	30 th	40 th	50 th
CONTROL	Length (cm)	2.5 ±1.17	6.14±2.50	12.5±2.55	13.2±1.77	14.5±1.14
IAA (10^{-3} M)	Length (cm)	3.8±1.92	7.4 ± 3.28	13.5±1.77	21.5±1.88	23.5 ± 2.38

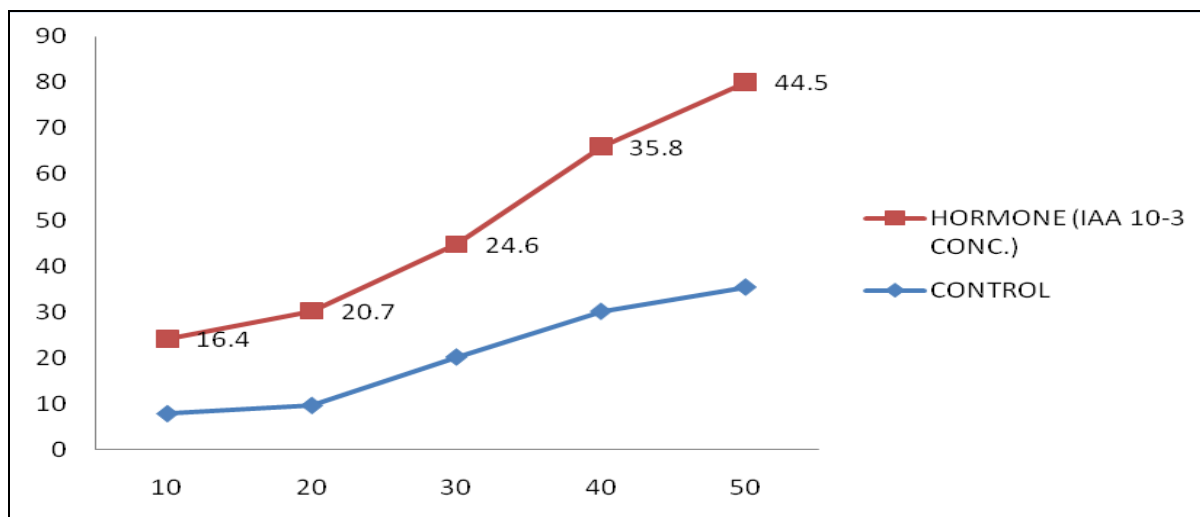


Fig 3: Stem growth patterns of field grown *Phaseolus vulgaris* (Rajma) increased by plant growth regulator such as IAA (10^{-3} M) concentration as compared to control.

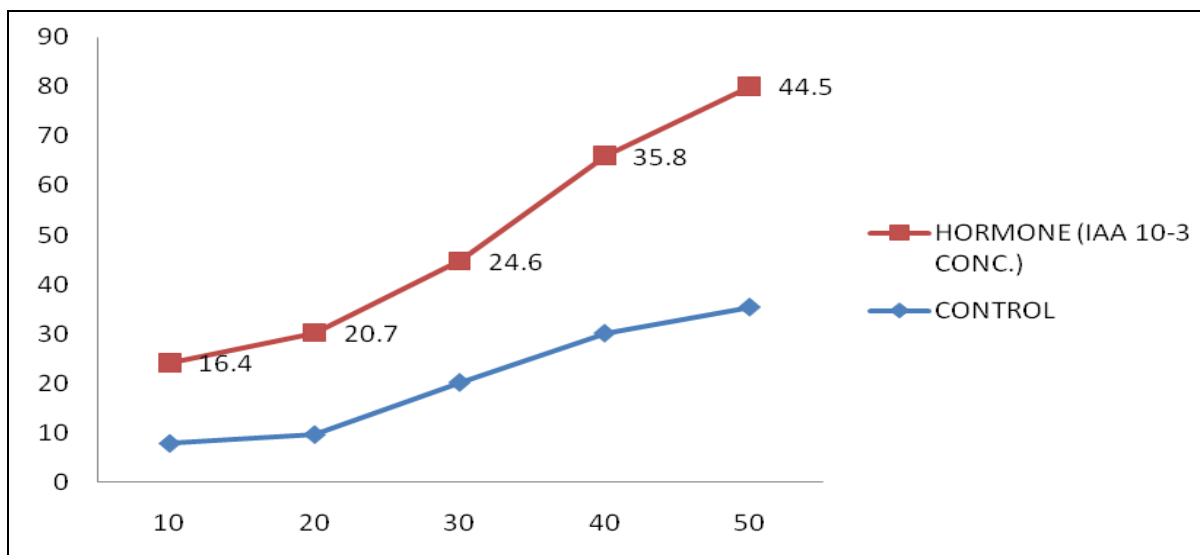


Fig 4: Root growth patterns of field grown *Phaseolus vulgaris* (Rajma) increased by plant growth regulator IAA (10^{-3} M) concentration as compared to control.

Discussion

The present investigation has been carried out to study the effects of plant growth hormone (IAA), on some of the morphological characters of *Phaseolus vulgaris*. It has been observed that, when PGR was applied to germinating seeds, it enhanced the stem & root growth of *Phaseolus vulgaris* as

compared to control. Similar results of promotory effects of IAA on plant were seen by Graeber *et al.*, (2012)^[12] and Bialek *et al.*, (1992)^[13]. In the control plot (A), the value of stem length (cm/pl), was recorded at the tenth (10th) day stage of the growth as 9.6 (cm/pl) and observed continuously up to 50 days and noticed as 35.5 (cm/pl). When the plot (B)

was sprayed by IAA (10^{-3} M) concentration daily, the enhancement was observed in the stem length as compared to the control. The maximum promotion of length was noticed at the 10th day stage of growth and recorded as ca.70.8%, at the 20th day as ca 165%, at the 30th day as ca. 21.7%; at the 40th as ca.18.5% up to 50 days as ca. 25.3% as compared to control. Similar observations were recorded by Bora and sarma (2006)^[14], Vwiako and Longe *et al.*, (2009)^[10]. Root growth analysis was also carried out from the 10th day stage up to 50 days, in terms of root length. In the control plot-(A), the value of length of root was found at the 10th day stages of growth and observed continuously up to 50 days and amounted as ca 2.5, 6.14, 12.5, 13.2, & 14.5 (cm/pl). While the plants of plot-(B) were sprayed to IAA (10^{-3} M) concentration, the maximum promotion was observed on the length of roots were noted at the 10th, 20th, 30th, 40th up to the 50th days stage of growth and an increased by ca. 52%, 20.5%, 8%, 62.8% up to the 50 days 62% as compared to control plot. The same results were also recorded by Syros *et al.*, (2004)^[15]. The above findings supports promotory effects of Indole-3-acetic acid on the stem and root growth pattern of the *Phaseolus vulgaris*.

Conclusion

Present study was investigated to study the promotory effects of Indole-3-acetic acid on the stem and root growth with appropriate concentrations of IAA (10^{-3} M) was studied on the *Phaseolus vulgaris* in the field study.

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