Response of Roots of *Plumbago zeylanica* L. to the Different Growth Regulators

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ABSTRACT: The objective of this study was to know the response of root of *Plumbago zeylanica* to the different growth regulators. *Plumbago zeylanica* L. (Vernacular name: Chitrak) is very useful medicinal plant in terms of chemical constituents it contains. It is distributed throughout as a weed in the tropical and subtropical countries of the world. In this experiment the seeds were treated with three different concentrations of IAA, IBA and GA_3 before sowing and compared with the seeds directly sown in control or normal conditions. Results of the present study revealed variation in root length, circumference, basal area and biomass as an evidence of response to growth regulators.

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Key words: Growth regulator, *Plumbago zeylanica*, medicinal plant, Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA), Gibberelic acid (GA_3)

1. Introduction

Growth regulators play an integral role in rapid and better growth and development of plants. Effect of growth regulators is very important in life cycle of plants. Different concentrations of applied growth regulators enhance cell elongation and development of root, shoot, leaves, flowering and fruiting. The present investigation was undertaken to find out the effect of Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA) and Gibberelic acid (GA_3) on roots of *Plumbago zeylanica.*

The plant species *Plumbago zeylanica* (known vernacularly as Chitraka, *Chitramulamu*, *Tellachitramulamu*, *Agnichela*, *Agnimaala* or by its trade or popular names of "Lead wort-white flowered" and "Ceylon Lead wort") belonging to family Plumbaginaceae, is distributed as a weed throughout the tropical and subtropical countries of the world (Chetty *et al.,* 2006).

The roots and aerial parts of *Plumbago* spp. contain several alkaloids and alkaloid derivatives, such as plumbagin, chitrancne, zelanone etc. The root is the chief source of an acrid crystalline principle called plumbagin, a yellow naphtoquinon pigment, and also characteristic of plants in the tribe Plumbagineae including *Plumbago capsensis, P. europea*, *P. rosea* (Kubo *et al*., 1983; Aditi *et al*., 1999; Komaraiah *et al*., 2003).The roots of the plant are main source of an alkaloid, plumbagin (Modi, 1961) used as anticancer drug (Jayaraman, 1987; Krishnaswamy and Purushothaman, 1980). The root bark of *Plumbago zeylanica* contains a pigment, plumbagin (2- methyl- 5- hydroxyl-1, 4-naphthoquinone) which acts as a powerful irritant and has well marked antiseptic properties.

2. Materials and Methods

The study has been undertaken to evaluate the effect of growth regulators (IAA, IBA, and GA_3) in different concentrations on roots of *Plumbago zeylanica.*

2.1. Collection of plant material

The seeds of *Plumbago zeylanica* were procured from Sushila Tiwari Herbal Garden, Muni-ki-Reti, Tehri Garhwal , Uttarakhand for the experiment.

2.2. Effect of growth regulators

The seeds were treated with growth regulators (IAA, IBA and GA_3) in different concentrations (10 ppm, 25 ppm and 50 ppm) to determine their effect on root.

2.3. Experimental design

The seeds of plant were sown in three sets. The seeds of the set P0 were sown directly without pretreatment, whereas the seeds of control set were not given any treatment. The seeds of set P1 were treated with three different concentrations of IAA, IBA and GA_3 before sowing. Aqueous solutions of different concentrations of IAA (10, 25 and 50 ppm), IBA (10, 25 and 50 ppm) and GA_3 (10, 25 and 50 ppm) were sprayed after 30 days of germination, and afterwards at 30 days of intervals to plants of sets P0 and P1. Plants of Set third were treated simply with tap water and considered as control. Aqueous solutions of different concentration of IAA (10, 25 and 50 ppm), IBA (10, 25 and 50 ppm) and GA_3 (10, 25 and 50 ppm) were sprayed (foliar spray) after 30 days of germination, and afterwards at 30 days of intervals to plants of sets P0 and P1. Plants of Set third were treated simply with tap water and considered as control. Periodic observation of growth patterns were made at an interval of 60 days after first spray till 12 months. Three plants from each treatment were carefully uprooted and observations were made for root.

3. Results and Discussion

3.1. Average values under pretreatment and without pretreated plants

The difference in root length and root biomass between pretreated and without pretreatment plants was highly significant. In pretreatment, average root length (17.19 cm) and average root biomass (4.378 gm) was higher compared to without pretreatment, where average value of root length was 13.50 cm and root biomass was 3.525 gm (Table 1 and Table 2). The circumference and basal area of root did not differ significantly between pretreated and without pretreatment plants. But due to pretreatment average circumference (1.444 cm) and basal area (0.1350 cm^2) of roots was higher than that for without pretreatment plants, where circumference and basal area was 1.090 cm and 0.1252 cm^2 respectively (Table 1 and Table 2).

From the interaction of pretreatments and growth regulators, it was observed that pretreated values of root's length, circumference, basal area and biomass were always higher than that for without pretreatment values for all the growth regulators. It may be said that pretreatment boosted the effect of growth regulators. Under soaking treatment with growth regulators Shiva Prasad *et al.* (2001) also observed superior results compared to control.

3.2. Variations in different time periods

The growth rate of root increased up to 4^{th} month and then became constant, after that it declined and became stable in case of root length (Table 1). The comparison of periodic data of circumference of root i.e., bimonthly records revealed that circumference of root increased with time period or age initially during the period of experimentation. The growth rate of circumference of root was quite similar to the growth of root length. The circumference of root initially grew faster but in later stage i.e. after 6^{th} period of observation it steadily increased (Table 1). Basal area of root i.e., bimonthly records revealed that basal area of root increased at faster rate initially with time period or age. The rate of growth of circumference of root was highest in the beginning but it started falling after November leading to stable growth in basal area of root (Table 2). There was a marked similarity with the growth of root. Root biomass increased with time period. The rate of growth of root biomass up to 6 months of growth was very slow or nearly constant but it rapidly increased after 6^{th} month (Table 2).

The observed values showed that pretreated values were higher than those for without pretreatment plants during the total period of experimentation. The comparison between averages showed that root length, circumference of root, basal area and biomass of root increased with time period.

The comparison between averages showed that root length, circumference of root, basal area and biomass of root increased with time period. The interaction of months with pretreatment values also showed that pretreated values were higher than those for without pretreatment plants during total period of experimentation. Joint effect of months and growth regulators on root revealed that IBA gave best growth throughout the experimental period.

3.3. The variation among the growth regulators

3.3.1. IBA (Indole-3-butyric acid)

All concentrations of IBA responded favourably towards root parameters as compared to other growth regulators and control. Plants treated with IBA 25 ppm exhibited highest root length, circumference, basal area and biomass (25.41cm, 1.532cm, 0.2401 cm^2 and 7.602 gm respectively) followed by plants treated with IBA 10 ppm (19.14 cm, 1.323 cm, 0.2081 cm^2 and 4.653 gm) for root length, circumference, basal area and biomass. IBA with 50 ppm concentration had lower values of all root parameters (14.65 cm, 1.181 cm, 0.1291 cm^2 and 4.066 gm) (Tables 1 and 2; Fig. 1 to 4).

All concentrations of IBA responded favourably towards root parameters as compared to other growth regulators and control. In present study, IBA was found suitable for root, which might due to better root formation because of accumulation of metabolites at the site of application. It appears probable that the success of IBA is due to its slow degradation by auxin-destroying enzyme, which is quite strong and is not readily translocated (Shiva Prasad *et al.*, 2001). There are numerous reports in literature concerning the effects of IBA on roots. IBA is probably the best material for general use because it is generally non-toxic to plant over a wide concentration range and is effective in promoting rooting of a large number of plant species (Hartmann *et al*., 1990). Generally IBA treated plants have strong and fibrous root system (Weaver, 1972) and good root system facilitates plant to get better anchorage and improve nutrient absorption (Kono, 1995; Watanabe, 1997).

3.3.2. IAA (Indole-3-acetic acid)

After IBA, IAA is second best growth regulator. Except root length all the root parameters were higher in plants treated with IAA 10 ppm over 25 ppm and 50 ppm concentration. Plants treated with IAA 10 ppm exhibited circumference of 1.212 cm, basal area of 0.1462 cm^2 and biomass of 4.726 gm. Circumference, basal area and biomass reflected second highest values in plants treated with IAA 25 ppm (1.169 cm, 0.1321 cm^2, 4.075 gm respectively), whereas root length was maximum (19.51 cm) among other concentrations. Among all concentrations of IAA, 50 ppm had minimum values for root length, circumference, basal area and biomass (15.36 cm, 0.990 cm, 0.0900 cm^2 and 3.766 gm respectively) (Table 1 and 2; Fig. 1 to 4).

In the present study for all the root parameters, IBA concentrations had been found to increase highest values over IAA. Report of many other workers also revealed that application of IBA stimulates the growth of root more than IAA. IBA and other synthetic auxins are preferably used over IAA, as the latter is rapidly metabolized or degraded, and therefore, inactivated when applied (Pluss *et al*., 1989). Weaver (1972) stated that IBA is usually used to promote root initiation, root formation and early development of root. It was discovered that Indole-3-butyric acid (IBA) promoted rooting and was even more effective than IAA (Zimmerman and Wilcoxon, 1935). Similar results in present study were observed as IBA responded favorably towards root's growth as compare to IAA. Root length was maximum in IBA for 25 ppm concentration similar to the findings of Khali and Sharma (2003), who also observed that IBA was the most suitable hormone for inducing length of roots.

3.3.3. GA_3 (Gibberellic acid)

Values of root parameters were highest in plants treated with GA_3 25 ppm (12.22 cm, 1.052 cm, 0.1053 cm^2 and 3.126 gm) for root length, circumference, basal area and biomass respectively. Plants treated with GA_3 10 ppm followed next (11.80 cm, 1.025 cm, 0.1014 cm^2 and 2.789 gm). Plants treated with GA_3 50 ppm had lower values of root parameters (10.14 cm, 0.933 cm, 0.799 cm^2 and 2.719 gm respectively) compared to other concentrations (Table 1 and 2; Fig. 1 to 4).

So, the variation among the treatments (growth regulators) for all parameters was also highly significant. It was observed that IBA 25 ppm concentration with 25.41 cm was found best for root length (Fig. 1, Table 1). For circumference IBA 25 ppm concentration with 1.532 cm was most effective which was followed by IBA 10 ppm (1.323 cm) (Fig. 2; Table 1). Root basal area was also maximum (0.2401 cm^2) with IBA 25 ppm concentration followed by IBA 10 ppm (0.2081 cm^2) (Fig.3; Table 2). It was noted that in later period of age when basal area of root took steady growth showed highest growth under the influence of IBA 25 ppm (Fig. 3; Table 2). Root biomass reflected highest value (7.602 gm) in plants treated with IBA 25 ppm followed by IAA 10 ppm (4.726 gm) (Fig. 4, Table 2). Thus IBA responded favourably towards all root parameters as compared to IAA and GA_3 and least values of all the above parameters were found in GA_3 treatment.

Table 1: Root Length, and Circumference of Root in *Plumbago zeylanica*

Parameters		**Root Length (cm)**	**Circumference of root (cm)**
Without pretreatment (P0) / with pretreatment (P1)	**P0**	13.50	1.090
	P1	17.19	1.144
	CD	**0.569*****	**NS**
Age in Month	**02**	6.10	0.343
	04	8.69	0.588
	06	13.65	1.163
	08	17.21	1.402
	10	21.97	1.551
	12	24.45	1.655
	CD	**0.986*****	**0.0868*****
Control /Growth Regulators (ppm)	**Control**	7.23	0.753
	IAA 10	17.98	1.212
	IAA 25	19.51	1.169

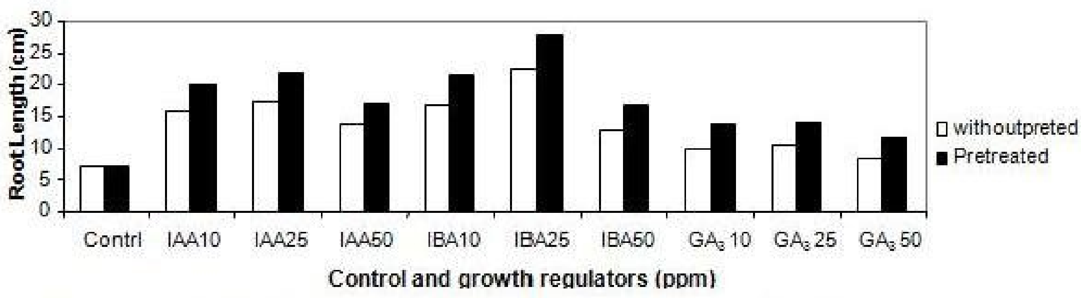
	IAA 50	15.36	0.990
	IBA 10	19.14	1.323
	IBA 25	25.41	1.532
	IBA 50	14.65	1.181
	GA_3 10	11.80	1.025
	GA_3 25	12.22	1.052
	GA_3 50	10.14	0.933
	CD	**1.273*****	**0.1120*****

*** Significant at 0.1% Probability level

Table 2: Basal area of Root and Biomass of Root in *Plumbago zeylanica*

Parameters		**Basal area of root (cm^2)**	**Biomass of Root (gm)**
Without pretreatment (P0) / with pretreatment (P1)	**P0**	0.1252	3.525
	P1	0.1350	4.378
	CD	**NS**	**0.1837*****
Age in Month	**02**	0.0097	0.473
	04	0.0288	1.062
	06	0.1374	3.055
	08	0.1664	4.674
	10	0.2102	7.200
	12	0.2282	7.245
	CD	**0.03422**	**0.3182*****
Control /Growth Regulators (ppm)	**Control**	0.0688	1.993
	IAA 10	0.1462	4.726
	IAA 25	0.1321	4.075
	IAA 50	0.0900	3.766
	IBA 10	0.2081	4.653
	IBA 25	0.2401	7.602
	IBA 50	0.1291	4.066
	GA_3 10	0.1014	2.789
	GA_3 25	0.1053	3.126
	GA_3 50	0.0799	2.719
	CD	**0.04418**	**0.4108*****

*** Significant at 0.1% Probability level



Variation in Root Length of *Plumbago zeylanica* under control and different growth regulators

Figure 1

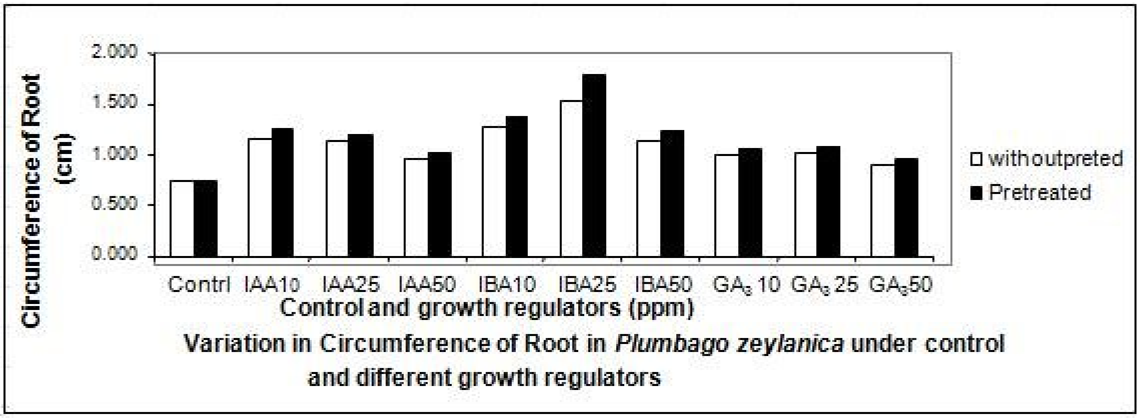


Figure 2

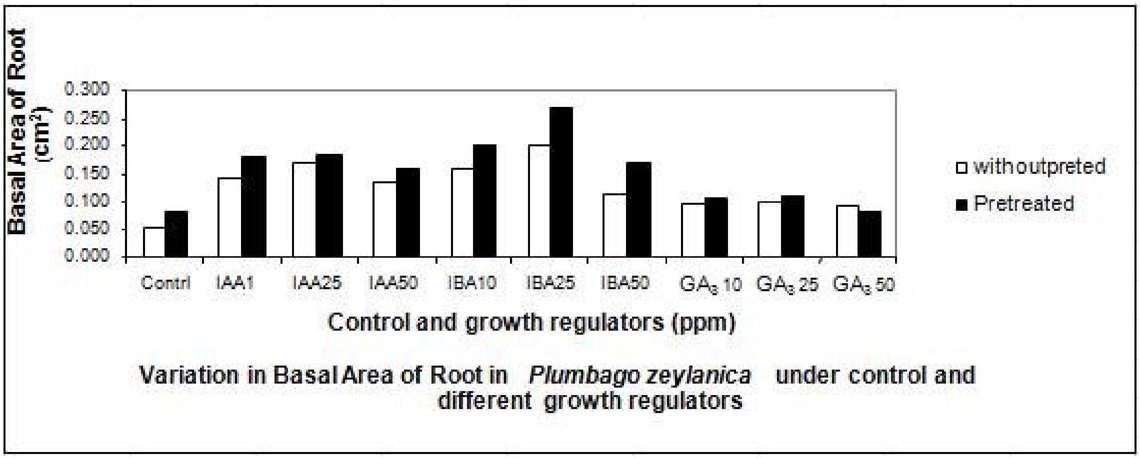


Figure 3

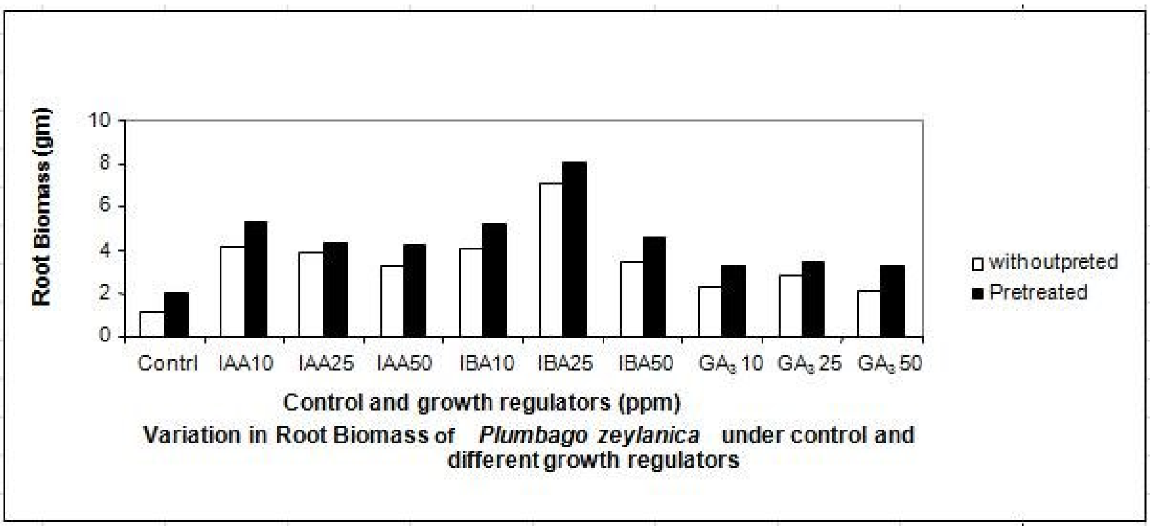


Figure 4

Least values of root length were found in GA_3 treatment. The effect of GA_3 on rooting was negative probably due to the diversion of food to the developing auxiliary buds (Nanda *et al*., 1968). GA_3 showed inhibitory effect on rooting also in vegetative propagation of *Vitex negundo* L. (Tewary *et al*., 2004). Thus, IBA responded favourably towards all root parameters as compared to IAA and GA_3 and least values of all the above parameters were found in GA_3 treatment and joint effect of months and growth regulators on root revealed that IBA gave best growth throughout the experimental period.

4. Conclusion

On the basis of present study it may be concluded that pretreatment is good for root and out of various growth regulators IBA has shown stimulatory effect on root. This finding would be useful for faster propagation of the plant in various social and agro-forestry applications.

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