Research Paper

Influencing of phytohormones on root development and some biochemical parameters of Coriandrum sativum L.

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ABSTRACT
Coriander is an aromatic herb of the family apiaceae that is generally grown for its leaves and seeds as flavouring materials. Effect of phytohormones (GA₃ and 2,4-D) at different concentration (10, 50 and 100 µM) on root development, biomass production, proline content and carbohydrate content of Coriandrum sativum was studied in the present investigation. The application of these two hormones with various concentrations enhanced all the parameters except the proline content which decreased significantly by the increasing concentration of both the hormones. Secondary roots were found maximum at 10 µm concentration of 2,4-D whereas tertiary root at 100 µm concentration of 2,4-D. Biomass production was maximum at 100 µM concentration of GA₃ and carbohydrate were observed maximum at 50 µM concentration of GA₃. Under control conditions, Proline was 1.22 mg g⁻¹ FW but it was decreased from 0.71 mg g⁻¹ FW by 50 µM concentration of 2,4-D.

Key words: Biomass, coriander, proline, phytohormones, root development.

INTRODUCTION
Coriander (Coriandrum sativum L.) is an annual herb of the family apiaceae and is extensively grown in Bangladesh, India, Russia, Central Europe and Morocco and has been cultivated since human antiquity (Small, 1997). The fruits and leaves of Coriander are aromatic and are used as flavouring materials. It is widely used as a folk medicine as carminative, spasmodic, digestive and galactagogue; seed extract is antimicrobial, used in lotions and shampoos, with castor oil useful in rheumatism (Ghani, 2003). It has been suggested for long time that plant growth regulators play a vital role in germination growth and overall development of plants. Many observations have revealed that the pre-sowing treatment of growth regulators may lead to increase in tissue hydration, redistribution of nutrient reserves, increase respiratory activities, enhancement of seedling growth, dry-matter production, early flowering and yield in many agricultural crops (Abraham and Atanga, 1981; Shen et al., 1988). PGR's are generally a group of organic substances that effect various physiological processes in plants especially their growth, differentiation and development (Kucera et al., 2005). They are the chemical messengers produced in one part of the plant and translocated to other parts where they play critical roles in regulating plant responses to stress at extremely low concentrations (Sharma et al., 2005). Gibberellins constitute a group of tetracyclic diterpenes generally known for their influence on seed germination, leaf expansion, stem elongation, flower and fruit development (Yamaguchi, 2008). GA₃ acts synergistically with other hormones like auxins, cytokinins etc and might be called a system approach or synergism. 2,4-D is a chlorophenoxy herbicide and is said to have been initiated on agricultural revolution when it was first marketed in 1940’s. According to EPA, 2,4-D kills plants by increasing the three characteristics of the plants – the plasticity of the cell wall, the amount of proteins being made in the plant and the amount of ethylene being produced by the plant. The end result is that the tissues of the plant are damaged and
death occurs (Anonymous, 2005).

MATERIALS AND METHODS

An experiment was carried out under laboratory conditions having a temperature range of 30 ± 2°C and humidity 60 ± 2 in the Department of Botany, School of Life Sciences, Dr. B.R. Ambedkar University, Agra, during the month of February – March, 2012. The seeds of *C. sativum* were obtained from the National Seeds Corporations, Sikandra, Agra. In this study the chemicals (2,4-D, GA₃) used were obtained from Sigma chemical company, USA and Qualigens India Pvt. Ltd. Distilled water was used for preparation of all the solutions. The Petri dishes were sterilized by keeping them in hot air oven at 60°C for 48 h. Sterilized Petri dishes were lined with filter paper Whatman N0. 1, to this 5 ml solution of 10, 50 and 100 µM concentration of various hormones namely; 2-4-D and GA₃ were used surface sterilized seeds were kept in each Petri dish distilled water was used as control. The seeds were allowed to in all the parameters studied germinated for 15-20 days in dark growth chamber having temperature of 30 ± 2°C. Seeds were considered germinated when radical emerged by about 2 mm in length (Mohammadi, 2009). Three replicates of each treatment were maintained. After the germination, root and shoot length were measured with the help of scale at the intervals of 24 h for seven days. The seeds were surface sterilized with 0.1% solution of mercuric chloride to prevent the fungal contamination of seeds. Two types of experiments – (1) Petri dish experiment and (2) pot and sand culture experiment were conducted in triplicate form. Root development was determined by taking out the roots from the pots and by counting the number of primary, secondary and tertiary roots. An average of three plants was taken per treatment in triplicate for this purpose (Agnihotri, 2009). After twenty four days of growth, fresh weight of root and shoot was weighed and then they were dried at 70°C in oven for three days and weighed until the constant values were observed. Proline estimation was carried out by Bates et al. (1973) method, transmittance was read at 520 nm by using double beam UV-visible spectrophotometer (Systronics) and the standard curve was prepared by using pure proline (BDH). Carbohydrates were estimated with the help of Dubois et al. (1956) method and the absorbance was read at 485 nm by double beam UV-visible spectrophotometer (Systronics).

Statistical analysis

The experiment was carried out in completely randomized design with three replications. For statistical analysis of data windows 7 was used and graphs were plotted using Microsoft excel. The root length and biomass were statistically analyzed by analysis of variance (ANOVA) (Steel and Torie, 1984) to determine the level of significance at p<0.05%.

RESULTS AND DISCUSSION

Roots are positively geotropic and negatively phototropic. It is evident from the Table 1 and Figure 1 that PGRs (GA₃ and 2,4-D) have a marked affect on root development in *C. sativum*. Primary root, however, was not influenced by the hormonal treatments. The number of primary root was one in all the treatments, that is, in control as well as in the hormonal treatment. The secondary and tertiary roots however, showed a marked increase in number with hormonal treatments, when compared with the roots of control plants. Similar results with increase in the number of roots by the application of growth regulations have been observed by Agnihotri et al. (2006, 2009), Vamil et al. (2011). Biomass refers to the fresh weight or the dry weight of tissue, organ or plant (Figure 2). Both fresh and dry weight increased significantly by the application of hormonal treatment. Plants grown under control conditions exhibited 1.18 g/plant fresh weight. Application of PGRs (GA₃ and 2,4-D) increased the fresh weight of *C. sativum* L. Fresh weight increased over control up to 1.49 and 1.28 g/plant by 10 µM concentration of GA₃ and 2,4-D; upto 2.01 and 1.70 g/plant by 50 µM concentration of GA₃ and 2,4-D and 2.06 and 1.62 g/plant by 100 µM concentration of GA₃ and 2,4-D. Under control conditions dry weight observed was 0.40 g/plant. Dry weight increased over control up to 0.78 and 0.64 g/plant by 10 µM concentration of GA₃ and 2,4-D; up to 0.98 and 0.91 g/plant by 50 µM concentration of GA₃ and 2,4-D and up to 1.08 and 0.86 g/plant by 100 µM concentration of GA₃ and 2,4-D. Our results were similar with various workers Abraham and Ataga (1981), Shen et al.(1988), Radakrishnan et al. (2008), Cavusoglu et al. (2007), Vamil et al. (2011) while working on various plants. Application of PGRs decreased the proline synthesis as compared to the control. It is evident from the Table 1 and Figure 3 that the proline content of *C. sativum* decreased with the application of PGRs (that is, GA₃ and 2,4-D). Under control conditions, it was 1.22 mg g⁻¹ FW and was decreased from control up to 0.83 and 0.73 mg g⁻¹ FW by 10 µM concentration of GA₃ and 2,4-D and up to 0.81 and 0.71 mg g⁻¹ FW by 50 µM concentration of GA₃ and 2,4-D respectively. Under 100 µM concentration of GA₃ and 2,4-D proline content decreased up to 0.75 and 0.70 mg g⁻¹ FW respectively. The proline content decreased by 47 and 67% under 10 µM concentration of GA₃ and 2,4-D; by 51 and 72% under 50 µM concentration of GA₃ and 2,4-D; and by 63 and 74% under 100 µM concentration of GA₃ and 2,4-D. Similar reports have been observed by different workers (Kavikishore et al., 2005; Vamil et al., 2011). The carbohydrate content of *C. sativum* was also enhanced significantly when compared with the control (Figure 4). Under control conditions carbohydrate content observed
Table 1. Effect of plant growth regulators - GA3 and 2,4-D on root development, biomass production, proline content and carbohydrate content Coriandrum sativum L.

<table>
<thead>
<tr>
<th>Hormones</th>
<th>Concentration</th>
<th>Root Development</th>
<th>Biomass Production</th>
<th>Proline Content (mg g⁻¹ FW)</th>
<th>Carbohydrate content (mg g⁻¹ FW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Primary roots</td>
<td>Secondary roots</td>
<td>Tertiary roots</td>
<td>Fresh wt. (g/plant)</td>
</tr>
<tr>
<td>Control</td>
<td>-</td>
<td>1</td>
<td>3.66 ± 0.32</td>
<td>8.00 ± 0.57</td>
<td>1.18 ± 0.011</td>
</tr>
<tr>
<td></td>
<td>10 µM</td>
<td>1</td>
<td>5.66 ± 0.87</td>
<td>9.33 ± 0.87</td>
<td>1.49 ± 0.132</td>
</tr>
<tr>
<td>GA3</td>
<td>50 µM</td>
<td>1</td>
<td>6.00 ± 0.57</td>
<td>9.66 ± 0.87</td>
<td>2.01 ± 0.144**</td>
</tr>
<tr>
<td></td>
<td>100 µM</td>
<td>1</td>
<td>7.33 ± 0.32</td>
<td>10.66 ± 1.20</td>
<td>2.06 ± 0.023*</td>
</tr>
<tr>
<td></td>
<td>10 µM</td>
<td>1</td>
<td>8.66 ± 0.87</td>
<td>10.33 ± 0.87</td>
<td>1.28 ± 0.063</td>
</tr>
<tr>
<td>2,4-D</td>
<td>50 µM</td>
<td>1</td>
<td>7.00 ± 0.57*</td>
<td>11.33 ± 0.87*</td>
<td>1.70 ± 0.052*</td>
</tr>
<tr>
<td></td>
<td>100 µM</td>
<td>1</td>
<td>6.33 ± 0.87</td>
<td>11.66 ± 0.66*</td>
<td>1.62 ± 0.023*</td>
</tr>
</tbody>
</table>

Data represent average percentage values of 3 replicates. Values represent mean ± standard error. ** Highly significant, * Significant, NS – Non significant at 5% level of significance.

Figure 1. Effect of plant growth regulators on the development of root of Coriandrum sativum L.

The carbohydrate content was 1.00 mg g⁻¹ FW. It is evident from the table that carbohydrate content increased up to 1.30 in 1.10 mg g⁻¹ FW under 10 µM concentration of GA3 and 2,4-D; up to 2.03 and 1.86 mg g⁻¹ FW by 50 µM concentration of GA3 and 2,4-D, and by 103 and 86% by 50 µM concentration of GA3 and 2,4-D. Under 100 µM concentration of GA3 and 2,4-D, carbohydrate content increased by 66 and 60%. Same increments in carbohydrate content by 30 and 10% by 10 µM concentration of GA3 and 2,4-D respectively. Carbohydrate content increased by 30 and 10% by 10 µM concentration of GA3 and 2,4-D, and by 103 and 86% by 50 µM concentration of GA3 and 2,4-D. Under 100 µM concentration of GA3 and 2,4-D, carbohydrate content increased by 66 and 60%. Same increments in carbohydrate content by 30 and 10% by 10 µM concentration of GA3 and 2,4-D, and by 103 and 86% by 50 µM concentration of GA3 and 2,4-D.
content by the application of phytohormones have been observed by various workers working on different plants (Geng et al., 2007; Khandaker et al., 2012).

**Conclusion**

Coriander is generally a rain fed crop and hence is grown mainly during the rainy or winter season. High temperature and soil salinity are the major threats to its germination and cultivation. Use of growth regulators may enhance its cultivation during the off season. The demand of Coriander leaves and seeds in flavoring is increasing day by day in every season, but under off season its cultivation is a major challenge to the farmers. However, the use of PGR’s may overcome the off season and enhance the germination,
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Figure 4. Effect of plant growth regulators on carbohydrate content (mg g⁻¹ FW) of Coriandrum sativum.

CARBOHYDRATE CONTENT

REFERENCES


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development and the nutritional status of coriander.