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EFFECT OF CADMIUM ON CERTAIN GROWTH PARAMETERS OF *VINCA ROSEA* (*CATHARANTHUS ROSEUS*)

Jaisheel Das

Department of Botany, Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allagabad

ABSTRACT

The present investigation was undertaken to study the effect of heavy metal, Cadmium on various growth factors viz plant height, number of leaves, no. of branches of *Vinca rosea* (*Catharanthus roseus*) a valued medicinal plant. The plant was exposed to different concentration of heavy metal salts of Cadmium Chloride ($CdCl_2$) with a view to observe the growth parameters (plant height,number of leaves and branches). Two months old plants , grown in normal soil were administered with different concentration of Cdcl2 through irrigation, senescence of lower leaves and extensive chlorosis was noticed after one week of irrigation. However, plants gradually acclimatized. After twenty days samples receiving $CdCl_2$treatment (400µM/l and less) became acclimatized and started normal growth. However stunted growth with reduced leaf area and reduced biomass was recorded after two months.

Keywords: *Vinca rosea*, cadmium, growth parameters

INTRODUCTION

Among heavy metals, Cadmium (Cd) is one of the most toxic heavy metals present in the environment (Wagner, 1993). Cd ions are easily taken up by roots and translocated to different plant parts (Baker *et al*., 1994).High accumulation generally causes growth inhibition and even plant death (Khan and Khan, 1983). However, uptake and accumulation of Cd^{+2} by plants reduces qualitative and quantitative productivity of species and causes a serious health hazard, through the food chain, to other life forms. Cadmium enters first the roots, and consequently they are likely to experience the Cadmium damage first. In root tip cells of *Allium cepa*, Cadmium damaged nucleoli (Lui *et al*., 1995) and in rice, it altered the synthesis of RNA and inhibited ribonuclease activity (Shah and Dubey, 1995). Cadmium also

reduces the absorption of nitrate and its transport from roots to shoots by inhibiting the nitrate reductase activity in shoots (Hernandez *et al*., 1996). The inhibition of root Fe (III) reductase induced by Cadmium leads to Fe (II) deficiency, and it seriously affects photosynthesis (Alcantara *et al*., 1994)

` In very general way, Cadmium in plants causes leaf roll and chlorosis and reduces growth, both in roots and in stems (Aidid and Okamoto, 1992, 1993). Cadmium interacts with water balance (Barcelo and Poschenrieder, 1990; Costa and Morel, 1994) and damages the photosynthetic apparatus, in particular the light harvesting complex II (Krupa, 1988) and the photosystem I and II (Siedlecka and Baszynsky, 1993; Siedlecka and Krupa, 1996). In *Brassica napus* plants Cadmium lowers total chlorophyll content, carotenoid content and increases the non-photochemical quenching (Larsson *et al*., 1998). Furthermore, Cadmium inhibits the oxidative mitochondrial phosphorylation (Kessler and Brand, 1995).

Cadmium also actively inhibits the stomatal opening, the stomatal movement are not directly affected by Cadmium, but rather are due to the strong interference of Cadmium with movement of K^+, Ca^{2+} and Abscisic acid in the guard cells (Barcelo *et al*., 1986; Barcelo and Poschenrieder, 1990). Cadmium significantly reduces the normal H^+/K^+ exchange and the activity of plasma membrane ATPase (Obata *et al*., 1996) and strongly affects the activity of several enzymes such as glucose-6-phosphate dehyrogenase (Van Assche and Clijsters, 1990), Rubisco and Carbonic anhydrase (Siedlecka *et al*.,1997). *Vinca rosea*(*Catharanthus roseus*) is a perennial herb belonging to the family Apocynaceae. It is pantropical in distribution and found throughout India on waste lands and sandy tracts especially in the coastal areas with pink and white flowers that bloom throughout the year. The genus *Catharanthus* has now gained considerable reputation in the therapeutic world for its wide assemblage of over 100 alkaloids including vincristine,vinblastine, ajmaline,ajmalicine and serpentine which are extremely important. In the present investigation, it has been tried to analyze the growth of the plant including height, number of leaves and number of branches.

MATERIAL AND METHOD

The plant samples were exposed to known concentration of heavy metal salts of cadmium chloride, $CdCl_2$ viz 0,100, 200, 300, 400, 600, 700 and 800µM, through irrigation.The heights of the plants were measured in cm, using a standard scale, from the ground level up to the tip of plant at 40 DAT. The average height was then calculated for each treatment.The number of branches was counted at 40 DAT and expressed as average number of branches per treatment level.The number of leaves were counted at 40 DAT and

represented in data as average number of leaves per treatment level.

RESULT AND DISCUSSION

1. Plant Height

The plant height of *Vinca rosea* (Table 1) as subjected to Cadmium supplementation shows clear results. The statistical analysis showed significant effect in plant height due to application of Cadmium. Reduction in the plant height was seen with the increase in the concentration of Cadmium treatment administered, the maximum plant height was observed at T_0 (34.4 cm) followed by 31.03 cm in T_1 and 29.1 cm in T_3 and the minimum plant height (17.8 cm) was found at T_8.

Table 1. Effect of Cadmium on Height of *Vinca rosea* plants

Treatments	Height (cm)	% decrease
T0	32.46	
T1	31.03	4.41
T2	29.1	10.36
T3	28.46	12.32
T4	25.13	22.58
T5	21.66	33.26
T6	19	41.47
T7	18.1	44.25
T8	17.8	45.17

SE± = 0.57166

CD = 1.201012

2. Number of branches

The data presented in Table2 showed significant adverse effect on number of branches due to application of Cadmium. A drastic reduction in the number of branches was found due to application of Cadmium. The maximum number of branches recorded in treatment T_0 (control) was 16.33 followed by 12.66 and 11.66 in treatments T_1 and T_2 respectively and the minimum number of branches recorded was 5.33 in the treatment T_8

3. Number of leaves

Clear impacts of Cadmium toxicity (table 3) were seen as a reduction in the number of leaves. The maximum number of leaves recorded was 97.66 in the treatment combination T_0 followed by 87.33 and 83 in the treatment combination T_1 and T_2 respectively thereby a decrease in the number of leaves were observed with the increase in the concentration of Cadmium. The minimum number of leaves recorded was 48.66 in the treatment T_8.

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Table 2: Effect of Cadmium on number of branches of *Vinca rosea* plants

Treatments	No. of Branches	% decrease
T0	16.33	
T1	12.66	22.44
T2	11.66	28.57
T3	9.66	40.81
T4	8.66	46.93
T5	7.66	53.06
T6	7.33	55.10
T7	6.66	59.18
T8	5.33	67.34

SE± = 0.494136
CD = 1.038141

Table 3: Effect of Cadmium on number of leaves of *Vinca rosea* plants

Treatments	**No. of leaves**	**% decrease**
T0	97.66	
T1	87.33	10.58
T2	83	15.01
T3	77	21.16
T4	72.33	25.93
T5	63	35.49
T6	60	38.56
T7	54.66	44.02
T8	48.66	50.17

SE± = 1.538412
CD = 3.232084

CONCLUSION

The reduction in the plant height as affected by Cadmium toxicity is clearly visible. The heavy metal induced a drastic reduction in plant height of the treated plants as compared to the control plants. Stunted

growth and thin shoots were seen due to Cadmium stress on plant. The reduction in plant height may be attributed to the interference of Cadmium with auxin regulated cell elongation and suppression of the elongation and growth rate of cells, especially in the stem, because of an irreversible inhibition exerted by Cd on the proton pump responsible for the process (Aidid and Okamoto, 1992, 1993). The reduction in the number of branches is attributed to the translocation of Cd from roots into the shoot system (Baker, *et al.* 1994) and thus due to Cd stress, the branches were weak and also decreased in number. Accumulation of Cd in stem affects the water balance by reducing root growth, limiting water uptake via a reduction in the vessel size causing partial stomatal closure (Barcelo and Poschenrieder, 1990; Prasad, 1995). Due to water stress, reduction in plant growth and development as well as plant productivity and crop yields are affected (Boyer, 1992;Akinci, 1997) The above findings were supported by (Dhindsa, 1998) who observed the reduction in number of leaves, number of branches etc.

A decrement in number of leaves was recorded in T_8 followed by T_7 and T_6 showing a reduction of 50.1%, 44% and 38.5 % respectively as compared to control. The reduction in the number of leaves is attributed to the fact that the heavy metal impact on the plants increase with the increase in the concentration of heavy metal. (Page, *et al.* 1972; Turner, 1973; John, 1976; Jayaprakash, *et al.* 1994). Cadmium affects the water absorbtion level, leading to stomatal closure and significant decrease in stomatal opening with increased Cd concentration.

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