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IMPACT OF CADMIUM ON GERMINATION AND EARLY SEEDLING GROWTH OF *CAJANUS CAJAN* L.

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ABSTRACT

Cadmium is a highly toxic heavy metal that contaminates soil and adversely affects the plant growth which results in the decrease of crop production. The objective of this study was to find the effect of cadmium on germination and early seedling growth of *Cajanus cajan*. Seeds placed on sterilized filter papers were exposed to varying concentrations of cadmium solutions (20, 60, 100, 200 and 400 ppm) made using anhydrous Cadmium chloride under laboratory conditions. Increasing concentrations of cadmium chloride significantly reduced the germination percentage, root length, shoot length, fresh weight, dry weight when compared to control.

Key Words: Cadmium, germination, *Cajanus cajan*, Proline

INTRODUCTION

Heavy metals are the natural components of the earth crust and are present insoil, water and living matter. Elevated levels of heavy metals due to anthropogenic activities such as extended use of superphosphate fertilizers, sewage discharge, industrial effluents and smelters dust spreading cause heavy metal pollution. The uptake and accumulation of heavy metals by plants is hazardous, since plants are part of the food chain. Contamination of food supplies by heavy metals may lead to risk for human and animal health (1).

Cadmium, one of the toxic heavy metals has no essential function in plants. It has high mobility in the soil- plant system. Plants exhibit numerous toxic effects as a result of cadmium exposure. The impact of cadmium on various crop plants and their morphological, physiological and molecular responses during stress has been well elucidated by many authors. Genotypic differences in response to cadmium exposure have been reported in various species including wheat (2), cotton (3), pea (4) and rice (5). This is may be due to high mobility of cadmium and its hyperaccumulation leading to leaf chlorosis (6). Such symptoms determine the severity of stress, and therefore may be useful in detecting stress effects and developing appropriate strategies to increase stress tolerance (7, 8).

Pigeonpea (*Cajanus cajan* L.) is an important legume crop (Family-Fabaceae) in the semiarid tropics. It has high commercial and nutritive value. It is an ideal source of protein. The symptoms of cadmium toxicity and seedling survival have close association with each other and determine the final plant stand. Despite scattered information existing (1,9), the present study is carried out to explore the effect of cadmium on germination and early seedling growth of Pigeonpea (cvPushpa).

MATERIAL AND METHODS

Seeds of Pigeon pea (*Cajanus cajan* (L.) Millspaugh) cv. Pushpa obtained from commercial vendors in the local market were surface sterilized using 0.1% $HgCl_2$ and washed repeatedly with sterile distilled water to remove the remnants of adsorbed sterilants. The seeds were then transferred to the germination boxes lined with sterile filter papers for germination and subjected to varying concentrations of cadmium solutions (20, 60, 100, 200 and 400 ppm) made using anhydrous $CdCl_2$.

Distilled water was used in place of cadmium solution to maintain the control. The experiment was conducted with three replications of fifteen seeds each.

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For growth analysis, samples were collected on 7th day after sowing and growth parameters like % seed germination, root length, shoot length, fresh and dry weights were measured. Emergence of the radicle was taken as an index for the purpose of identifying seed germination. A cotton thread and cm ruler was used to measure the root length of the seedlings to the nearest mm. Fresh weight of the seedlings was recorded to the nearest mg using an electronic balance. The seedlings were oven dried at 80^0C in a hot air oven to a constant dry weight and the data was recorded to the nearest mg using sensitive electronic balance. All the observations are means of three replications.

Seed Germination Percentage (G %):

Percentage of seed germination (G %) was calculated by using the formula:

$G\% = 100 \times A / N$, where

A = Number of seeds found germinated

N = Total number of seeds used in the germination test.

Proline accumulation during seedling development

The accumulation of proline in the leaves was measured (10).

Statistical Analysis

Data represents mean± standard error. Dunnet's test was performed to compare control and treatments. Values were considered significant if $p< 0.05$

RESULTS

The percentage of germination decreased in the stress induced plants when compared to control (Fig 1). There was no germination found at 400ppm cadmium concentration. Hence, data on morphological parameters has not been recorded at 400ppm cadmium concentration. Emergence of radicle started on 3rd day after sowing(3DAS).Brown, stunted roots and leaf chlorosis are the visualsymptoms observed in the cadmium treated plants. Elevation in the concentrations of cadmium resulted in significant decrease in root length (Table 1).Shoots did not arise at 200ppm cadmium concentration. Shoot length, fresh weight, dry weight of *Cajanus cajan* seedlings decreased with increase of cadmium chloride concentrations (Table 1).The osmolyte proline content increased with high concentration of cadmium (Table 2).

DISCUSSION

This study showed increasing levels of cadmium exposure is detrimental to *Cajanus cajan* which is evident from gradual decrease in germination percentage and early seedling growth. Concentration dependent decrease in germination percentage might be attributed to physiological disturbance in mobilization of the reserve food materials(11). Reduction in root and shoot length may be due to alteration in water relations, nutrient uptake (12). Similar observations of reduction in root length, shoot length, fresh weight and dry weight with $Cdcl_2$ treatment to *Cajanus cajan* L. (Upas-120) seeds were noticed (9). Reduction in root and shoot length indicated that Cd concentration produced toxic effects within 7 days.

Proline is an aminoacid known to accumulate in plants on exposure to abiotic stress. Accumulation of proline may contribute to osmotic adjustment at the cellular level and enzyme protection stabilizes the structure of macromolecules and organelles. Increase in proline content may be either due to de novo synthesis or decreased degradation or both (7). Similar result has been reported in *Brassicajuncea, Triticumaestivum* and *Vignaradiata* in response to cadmium toxicity (13).

CONCLUSION

Results of this study show that cadmium reduced seed germination and early seedling growth significantly in *Cajanus cajan* (L.) (Pushpa).

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Table 1: Effect of cadmium on morphological parameters of *Cajanus cajan*

Treatment	Root length(cm)	Shoot length(cm)	Fresh weight (g/10seedlings)	Dry weight (g/10seedlings)
Control	3.4±0.15	5.5±0.17	2.91±0.02	1.14±0.02
20ppm	1.36±0.21	2.6±0.2	2.39±0.01	1.06±0.03
60ppm	0.83±0.12	1.5±0.15	2.30±0.03	1.01±0.03
100ppm	0.8±0.05	0.66±0.12	2.26±0.02	0.92±0.01
200ppm	0.53±0.03	-	2.19±0.01	0.82±0.03

Table 2: Effect of cadmium on Proline content of *Cajanus cajan*

Treatment	Proline content
control	3.58±0.03
20ppm	4.32±0.02
60ppm	5.61±0.04
100ppm	5.93±0.04
200ppm	8.2±0.02

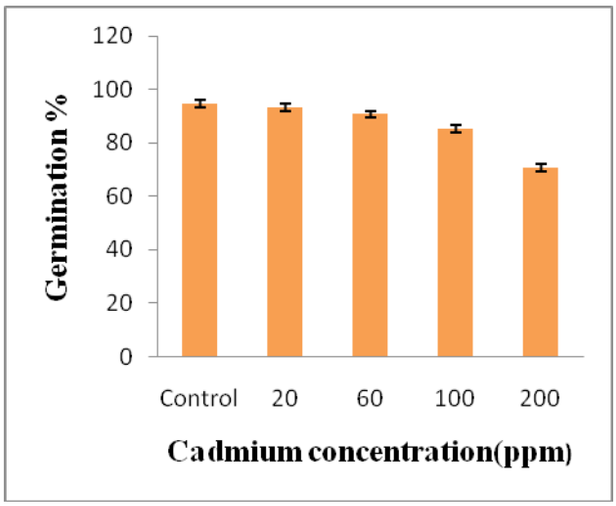

Figure 1: Effect of cadmium on Germination Percentage of *Cajanus cajan*