

Studies on evaluation of toxic effect of *Cajanus cajan* grown under the metal stress condition

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Abstract : The effects of metal chloride salt on seed germination, root, shoot length and dry biomass of *cajanus cajan* was evaluated under laboratory conditions. The seeds of *cajanus cajan* (Pigeon pea) were germinated in different concentrations of (0, 15, 10, 20, 50 mg/L) mercuric chloride and cadmium chloride. The germination parameters like germination percentage root and shoot length, fresh and dry weight of 12 days seedlings showed a decreasing trend with the increase in concentration of mercuric chloride and cadmium chloride. Hg and Cd showed significant inhibition of root elongation and the inhibition was more pronounced in the seedlings treated with cadmium.

(Keywords: Seedlings, Pigeon Pea, Mercury and Cadmium metals)

Introduction

Soil contains different heavy metals. Metals are continuously released to the soil by volcanoes, natural weathering of rocks and industrial activities such as mining and combustion of fossil fuel, urban waste disposal, surface run off. They present a risk for primary and secondary consumer and ultimately to human beings. Excess accumulation of heavy metals operate as stress factors causing physiological constraints leading to decreased vigour and plant growth. Heavy metals cause pollution after reaching certain concentration in soil. Mercury and cadmium has no essential function but cause toxicity above certain tolerance level. Recently, there was a great concern for mercury as an environmental pollutant. Mercury occurs in organic as well as in inorganic forms and both the forms is highly toxic. Extensive use of mercury containing

compounds, fungicides, algacide, paper pulp industries and in agriculture, create a problem of mercury concentration in soil and water.

Cadmium is considered to be one of the most toxic metals. Cadmium compounds are water soluble. It is used for dye and paint, pigment production batteries, ceramic industries, wooden industries and plastic production. The metal is also used in electroplating, semi conductor, rectifiers, solder for aluminum etc. Industries that are engaged in extraction, refining, electroplating and welding of Cadmium containing materials and also refining copper, lead and zinc etc. are the chief sources of cadmium. Cadmium is the chief constituents of Phosphatic fertilizers. Application of high levels of commercial fertilizers increases cadmium level in the soil. It would accumulate in the soil permanently and also in plant products. Plants uptake is one of the major pathways by which toxic metals enter to human food chain. Heavy metals presence in the atmosphere, soil and water even in trace concentration can cause serious problems to all living being¹. Accumulation and exclusion were two basic strategies by which plants respond to elevated concentration of heavy metals². Treatment of high concentration of some heavy metals to plants shows in reduction of seed germination and seedling growth³⁻¹⁵. Mercury pollution has become an important current issue of its environment¹⁶. Seed germination was significantly decreased with mercury treatment. The effect of mercury chloride was found to be highly toxic to seedling growth of *Archais hypogea*¹⁷. Plant grown under different levels of

cadmium showed a significant reduction in the length of shoots and roots, yellowing and ultra structural alterations of the leaves and a significant decrease in the essential oil composition¹⁸.

Cajanus cajan is a multiuse legume crop in the world, especially in Indian subcontinent. Due to its multiple use, pigeon pea is widely grown as inter crop in semi arid regions. It provides the main source of protein for many poorest populations and plays important role in reducing malnutrition for millions of people in the world. Pigeon pea is an ideal source of protein and vitamins in human diet, especially in the vegetarian population. The present study is to assess the effect of different concentrations of mercuric chloride and cadmium chloride on seed germination and seedling growth of *cajanus cajan*.

Materials and methods

Seeds of *cajanus cajan* was collected from Singrauli region.

Test Chemicals

Mercuric chloride (HgCl_2) and cadmium chloride (monohydrate) $\text{CdCl}_2 \cdot \text{H}_2\text{O}$ were used as test

chemicals. Different concentrations of the compounds were prepared using distilled water as solvent.

Five concentrations of the metals (1, 5, 10, 20, 50 mg/L) were prepared using distilled water and for control only distilled water was used. Healthy pigeon pea seeds of uniform size were selected and soaked in different concentrations of mercuric chloride and cadmium chloride solution for 24 h. Twenty seeds were placed at equidistant in each sterilized Petri dish lined with filter paper. The filter paper was moistened with 20 ml of each concentration regularly and for control 20 ml of distilled water was used. Three replicates of each concentration were taken for study.

The seeds were allowed to germinate in Seed Germinator (R-6C) with relative humidity 90% and 20°C temperature with 12 h. exposure to tube light which was set in auto mode. The percentage of germination was studied after 48 h. and growth of seedling was evaluated after 10 days treatment. Various growth parameters like root length, shoot length, fresh weight of root and shoot, dry weight of root and shoot were measured in triplicates and mean value was calculated. The 10 days old pigeon pea seedlings were taken for recording fresh weight of shoot and root.

Table 1
Seed germination and seedling growth of *cajanus cajan* in different concentrations of mercuric chloride.

Treatment	Germination percentage	Root Length (in cm)	Shoot Length (in cm)	Root/Shoot Ratio	Fresh weight of Root (in gm)	Dry weight of Root (in gm)	Fresh weight of Shoot (in gm)	Dry weight of Shoot (in gm)
Control	100	6.35	9.25	0.686	0.565	0.053	1.061	0.179
1 mg/l	100	6.30 (-0.78)	9.20 (-0.54)	0.684 (-0.29)	0.272 (-51.85)	0.043 (-18.86)	1.064 (+6.28)	0.194 (+8.37)
5 mg/l	90	5.02 (-20.94)	8.10 (-12.43)	0.619 (-9.76)	0.200 (-64.60)	0.040 (-24.52)	1.065 (+0.37)	0.192 (+7.26)
10 mg/l	80	4.70 (-28.98)	7.60 (-17.84)	0.61 (-9.91)	0.165 (-70.79)	0.029 (-45.28)	0.768 (-25.91)	0.163 (-8.93)
20 mg/l	73	3.00 (-52.76)	7.30 (-21.08)	0.410 (-40.23)	0.10 (-76.99)	0.027 (-49.05)	0.772 (-27.23)	0.158 (-11.73)
50 mg/l	70	2.30 (-63.78)	6.50 (-29.73)	0.353 (-48.54)	0.120 (-78.76)	0.023 (-56.60)	0.641 (-39.58)	0.124 (-30.72)

Table 2

Percent of germination and seedling growth of *cajanus cajan* treated with different concentrations of CdCl_2 . The data were recorded in 7-days old seedlings. Figures in parenthesis indicate % increase/decrease from control value.

Treatment	Germination percentage	Root Length (in cm)	Shoot Length (in cm)	Root/Shoot Ratio	Fresh weight of Root (in gm)	Dry weight of Root (in gm)	Fresh weight of Shoot (in gm)	Dry weight of Shoot (in gm)
Control	96	6.35	9.25	0.686	0.565	0.053	1.061	0.179
1 mg/l	90	3.40 (-46.45)	7.55 (-18.37)	0.450 (-34.40)	0.203 (-64.07)	0.037 (-30.18)	0.868 (-18.19)	0.165 (-7.82)
5 mg/l	80	2.85 (-55.11)	6.50 (-29.72)	0.438 (-36.15)	0.152 (-73.09)	0.024 (-54.71)	0.563 (-46.93)	0.098 (-45.25)
10 mg/l	70	1.42 (-77.63)	4.45 (-51.89)	0.319 (-53.49)	0.083 (-85.30)	0.010 (-81.13)	0.400 (-62.29)	0.090 (-49.72)
20 mg/l	68	0.55 (-91.33)	2.0 (-69.72)	0.196 (-71.42)	0.022 (-96.10)	0.002 (-96.22)	0.225 (-78.79)	0.037 (-79.32)
50 mg/l	63	0.50 (-92.12)	2.65 (-7.35)	0.188 (-72.59)	Not developed	Not developed	Not developed	Not developed

Results and Discussion

The results of germination percentage, root length, shoot length, fresh weight and dry weight of root and shoot with heavy metal treatment to pigeon pea seeds of different concentrations are presented in Table 1 and 2. The germination percentage was maximum (100%, 96%) in control and it declined with the increase in concentration of mercuric chloride and cadmium chloride respectively. The seeds treated with 50mg/L concentration of mercuric chloride the % of germination was 70% whereas, it was 60% in case of cadmium chloride treatment. Similarly, the maximum root length and shoot length was 6.35 cm and 9.25 cm respectively in the controlled seedlings which was gradually decreased with the increase in concentration of test chemicals. The maximum fresh weight and dry weight recorded in control plants. There is a gradual decrease in the fresh weight and dry weight with the increase in the concentration of mercuric chloride and cadmium chloride treatment.

The visible symptoms of toxicity of mercuric chloride and cadmium chloride treatment was stunting and chlorosis, browning of leaf tip, reduction in growth, stunting of seedlings and root were the morphological symptoms of mercury toxicity. Brown margin of leaves chlorosis, necrosis, brown stunted roots, reddish veins and petioles, purple stems are the visible symptoms of cadmium toxicity.

Conclusion

The effect of mercury chloride and cadmium chloride on *cajanas cajan* was carried out in the present investigation to find out the toxic effect of Hg and Cd on seedling and germination parameters. In comparison, the toxicity of Cd is more severe than Hg. Further work is required to biochemistry and enzymatic level to evaluate the toxic effect of the heavy metals on the physiology of the test plant.

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