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Original Research Paper

Study on Germination and Growth of Chromium Treated Green Gram, *Vigna radiata* (L.)

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ABSTRACT

The present study has revealed the effect of heavy metal chromium on germination and seedling growth of green gram, *Vigna radiata* (L.). The seed germination was recorded maximum for control, while germination percentage decreased with increasing concentrations of chromium. But still there is sign of germination at higher concentrations, 5ppm and 7.5ppm of chromium. The resultant seedlings were weak. Here we found that the lowest concentration of 0.05ppm promotes germination. Amount of protein, carbohydrates and chlorophyll gradually decreased with increasing concentration of chromium.

INTRODUCTION

Heavy metals are natural constituents of the lithosphere, whose geochemical cycles and biochemical balances have been drastically altered by human activity. It is responsible for environmental problems including the decrease of microbial activity, soil fertility and crop yields. At higher concentration it shows definite retarding effect. Chromium toxicity affects the length of primary roots and promotes changes in the architecture of the entire root system (Liu et al. 1992). The present study is an attempt to reveal the impacts of heavy metal chromium on leguminous plant, *Vigna radiata* (green gram). The effects on germination, morphological variation and biochemical composition are also analysed here.

MATERIALS AND METHODS

The parameters that have been used for the study are as below.

Germination Studies

1. Germination percentage, 2. Radicle and hypocotyl length, 3. Vigour index, 4. Phytotoxicity, 5. Growth index, 6. Phytomass and productivity.

Morphological Studies

1. Height of the plant, 2. Length of the roots, 3. Number of leaves, 4. Number of flowers and fruits, 5. Phytomass and productivity.

Biochemical Studies

1. Protein, 2. Carbohydrate 3. Chlorophyll pigments

Germination studies: The germination studies were conducted during the month of February 2013, based on the method prescribed by Chou & Muller (1972), Vilasini (1978) and Saran & Sharma (1992). The seeds of green gram kept in Petri dishes were treated with various concentrations of chromium (0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 ppm). The treated seeds were maintained for 1-5 days. The percentage of germination and the length of radicle as well as hypocotyl were also noted during these days.

Morphological studies: When the selected seeds of green gram sown in seed beds have started germination and reached 2 to 4 leaved condition, they were transplanted to pots filled with the soil. The pH of soil was 6.8. Triplicates were kept for each pot. Chromium in different concentrations such as 0.05 ppm , 0.5 ppm, 2.5 ppm, 5 ppm, 7.5 ppm were used for the treatments. After transplantation, one plant was taken out from each pot at every 5-day interval for morphological studies.

Biochemical analysis: Amount of protein was estimated by Lowry et al. (1951) method, carbohydrate by the method of Shirlaw & Gill Christ (1967) and chlorophyll by the quantitative estimation by the method of Arnon (1949).

RESULTS AND DISCUSSION

The results of the study are given in Tables 1-2. The seed germination was recorded maximum for control and germination percentage decreased with increasing concentrations of chromium. But still there was sign of germination at higher concentrations of 5 ppm and 7.5 ppm. However, the resultant seedlings were weak. It was found that the lowest concentration of 0.05 ppm promoted germination. The inhibi-

tory effect of chromium on seed germination may be due to ionic toxicity, because of an osmotic effect or due to decreased level of auxin. In the present study each plant radicle and hypocotyl length decreased with increasing concentration of Cr. The radicle length of different concentrations of chromium such as 0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 ppm were 3.46 cm, 2.84 cm, 0.76 cm, 0.37 cm and 0.34 cm respectively. The hypocotyl length was 8.95 cm, 8.27 cm, 4.69 cm, 4.48 cm and 0.53 cm for 0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 ppm respectively. Some heavy metals at low doses are essential micronutrients for plants, but in higher doses they may cause inhibition of germination and growth, and metabolic disorder etc. (Fernandes & Henriques 1991). The effect of heavy metal effluents on germination and seedling growth was dependant on changing concentration. An initial stimulation on germination at lower concentration was also explained by many researchers (Sharma 1982, 1983 Maury & Verma 1997, Vincent et al. 2001). Both seed germination and seedling growth were affected at high concentrations of chromium in green gram. Inhibitory effect of Cr, Cu, Zn on germination and growth of plants, especially at higher concentrations was reported (Aery & Sarkar 1991, Mishra et al. 1994). In this study the elevated concentration of chromium showed inhibition of germination, seedling growth and morphological variations in green gram.

The vigour index reduced from lower concentrations of chromium to higher concentrations. It is seen that phytotoxicity reaches maximum at higher concentration and displayed less toxicity in lower concentration treated plants.

At higher concentrations of chromium, green gram exhibited notable growth changes as seen to be 1 cm, 0.91 cm, 0.45 cm, 0.15 cm and 0.06 cm for different concentrations of chromium, 0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 ppm respectively. Growth index was very low in the higher concentrations.

The phytomass and productivity was seen to be decreased with increasing concentration. Phytomass was 0.20g, 0.17g, 0.15g, 0.13g and 0.10g for different concentrations of chromium, 0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 ppm respectively. Productivity in different concentrations of chromium, 0.05 ppm, 0.5 ppm, 2.5 ppm, 5 ppm and 7.5 was 0.07 g cm^{-2} day^{-5}, 0.05 g cm^{-2} day^{-5}, 0.04g cm^{-2} day^{-5}, 0.04g cm^{-2} day^{-5} and 0.03g cm^{-2} day^{-5} respectively.

The morphological studies revealed that in the comparison with the control, the plants growing in different concentrations of Cr show gradual reduction in shoot length. It was found to be 32.4 cm, 46.5 cm, 27.3 cm, 25.3 cm, 22.2 cm and 18.2 cm for 0.05ppm, 0.5ppm, 2.5ppm, 5ppm and 7.5ppm respectively. But the very low concentration of 0.05ppm has promoted the growth than the control.

The control plants of one month old growth showed flowering followed by setting of fruits. The lowest concentration treated plants also showed signs of flowering. It was 4, 8, 3, 2,1 and 0 for control, 0.05ppm, 0.5ppm, 2.5ppm, 5ppm and 7.5ppm respectively. Fruit setting showed 2, 4, 2, 1 in the initial concentration and no fruit in the higher concentration due to wilting. It was found that the very low concentration of 0.05ppm promoted the growth of plant and flowering. But proceeding to the higher concentration inhibition of growth and destruction of plant by damage was also noticed. Here, again phytomass and productivity was seen to decrease with increasing concentration.

In the well dried leaves of green gram, a decrease in the amount of protein was measured in the higher concentrations. Amount of protein showed 0.535 mg/mL, 0.358 mg/mL, 0.297 mg/mL, 0.288 mg/mL and 0.135 mg/mL for 0.05ppm, 0.5ppm, 2.5ppm, 5ppm and 7.5ppm respectively. The estimation of carbohydrate showed positive value in the control of about 0.197 mg/mL. Amount of carbohydrate was found to be 0.165 mg/mL, 0.201 mg/mL, 0.194 mg/mL, 0.242 mg/mL and 0.243 mg/mL for 0.05, 0.5, 2.5, 5 and 7.5ppm concentrations of chromium respectively. Chlorophyll-*a* at different concentrations of chromium, 0.05, 0.5, 2.5, 5 and 7.5ppm showed 1.63 mg/g, 0.91 mg/g, 0.82 mg/g, 0.61 mg/g and 0.52 mg/g respectively. Chlorophyll-*b* showed 2.8 mg/g, 2 mg/g, 1.8 mg/g, 1.3 mg/g and 1 mg/g for these concentrations. Amount of protein, carbohydrate, and chlorophyll showed gradual decrease in correspondence with increasing concentrations. Chromium was found to induce metabolic modifications in plants and degradation of photosynthetic pigments (Abdul Ghani 2011).

CONCLUSION

The heavy metals have an adverse effect on plant growth of *Vigna radiata* with respect to germination percentage, radicle length, hypocotyl length, etc. At higher concentrations germination percentage was found to be less. It can be ascertained from the study that phytotoxicity increased in increasing concentrations of chromium. The morphological studies of shoot length and root length have shown reduction in accordance with increasing concentrations of chromium. The higher concentration could lead to burning of leaves and stem thus giving it a wilted appearance and also die off without attaining flowering and fruiting. The biochemical analysis revealed that the amount of protein, carbohydrate, and chlorophyll have shown reduction in the higher concentrations of chromium and an increase in very low concentration.

REFERENCES

Abdul Ghani 2011. Effect of chromium toxicity on growth, chlorophyll

Table 1: Effect of chromium on seed germination of *Vigna radiata*.

Parameters	Concentration					
	Control	0.05 ppm	0.5 ppm	2.5 ppm	5 ppm	7.5 ppm
Germination percentage (%)	100 ± 4.43	96.6 ± 4.38	93.3 ± 4.30	93.3 ± 4.32	86 ± 4.27	83.3 ± 4.35
RadicleLength (cm)	3.39 ± 0.81	3.46 ± 0.72	2.84 ± 0.08	0.76 ± 0.77	0.37 ± 0.65	0.34 ± 0.73
Hypocotyl Length (cm)	8.82 ± 0.29	8.95 ± 0.33	8.27 ± 0.22	4.69 ± 0.14	4.48 ± 0.18	0.53 ± 0.21
Seedling length (cm)	12.11 ± 0.37	12.19 ± 0.48	11.10 ± 0.39	5.47 ± 0.21	1.87 ± 0.33	0.74 ± 0.25
Growth Index (cm)	-	1.0	0.91	0.45	0.15	0.06
Vigour Index (%)	-	11.77	10.35	5.10	1.60	0.61
Phytotoxicity (%)	-	0.02	16.22	77.5	89	89.9
Fresh weight (g)	0.20	0.23	0.21	0.18	0.16	0.13
Dry weight (g)	0.018	0.021	0.019	0.017	0.016	0.011
Phytomass (g)	0.18	0.20	0.19	0.16	0.14	0.11
Productivity (g cm^{-2} day^{-5})	0.045	0. 05	0.04	0.04	0.03	0.02

Table 2: Effect of chromium on yield and yield attributing parameters of *Vigna radiata*.

Parameters	Concentration					
	Control	0.05 ppm	0.5 ppm	2.5 ppm	5 ppm	7.5 ppm
Height of the plant (cm)	32.4	46.5	27.3	25.3	22.2	18.2
Root length (cm)	6.4	8.4	7.9	6	5.4	4.7
Number of leaves	7	10	6	6	5	4
Number of flowers	4	8	3	2	1	-
Number of fruits	2	4	2	1	-	-
Fresh weight (g)	2.84	3.25	2.97	1.87	0.40	0.25
Dry weight (g)	0.9	1.15	0.94	0.72	0.26	0.14
Phytomass (g)	1.94	2.82	2.03	1.15	0.12	0.11
Productivity (g cm^{-2} day^{-5})	0.04	0.06	0.04	0.02	0.003	0.002

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