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Effects of hexavalent chromium on growth, phytotoxicity, tolerance index of *Cosmos bipinnatus* Cav. and *Celosia cristata* L. – Phytoremediation

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ABSTRACT

Genetically modified (GM) foods are derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally. The introduction of a gene from a different organism or the term GM plants and foods are most commonly used to refer to crop plants created for human and animal consumption using the latest molecular biology techniques. However, not all GM plants are grown as crops. There are many GM ornamental plants are used for flowering purpose. The latest molecular technology alters the plant quality and used for many purposes. This present study is to investigate the phytoremediation based on GM ornamental plants *Cosmos bipinnatus* Cav. and *Celosia cristata* L. belongs to Asteraceae and Amaranthaceae family. The main aim of the study is remedy for heavy metal pollution and relation to human health, ecosystem and economical disasters of wealthy and poor farmers.

KEY WORDS: Carcinogenicity, economical disasters, genetically change, genetically modified plants, phytoremediation, suicide gene technology

INTRODUCTION

The plants play an important role in ecosystem. A biotic organism completely depends upon plants for the source of foods. Ecosystems are the network of interactions among organisms and between organisms and their environment (Chowdhury *et al.,* 2004). By feeding on plants and on one another, animal play an important role in the movements of matter and energy through the system. The ecosystem revealed plants and animals are part of human life. Phytoremediation is the process of heavy metal removal technology for conserving ecosystem (Wagner, 1995). The current molecular biological techniques are involved to discover the lots of genetically engineered plants (genetically modified [GM]) created for human and animal consumptions. These (GM) plants have been modified in the laboratory to enhance desired traits and used for phytoremediation in heavy metal polluted areas.

Heavy Metal

Heavy metals are containing high density and atomic number discharged from steal, leather, chemical, and textile manufacturing industries and increases the concentrations of heavy metal in the soil causing ecosystem damages in biotic life form. Hexavalent chromium is one of the heavy metals causes carcinogenicity, and they are toxic to biotic organisms (Walker *et al*., 2003). It alters the genetic materials and cause cancer. In this point of view, *Cosmos bipinnatus* Cav. and *Celosia cristata* L. (ornamental plants) were used for phytoremediation to remediate the Hexavalent chromium polluted soil by using genetically engineered ornamental plants (Petruzzelli and Pezzarossa, 2003).

Genetic Engineering

The genetic engineering can create plants with the exact desired trait very rapidly and with great accuracy. E.g., plant geneticists can isolate a gene for drought tolerance and insert that gene into different plants. The new GM plants will gain drought tolerance as well (Phipps *et al*., 2003). Not only can genes be transferred from one plant to another, but also genes from non-plant organisms also can be used. The best known example of this is the use of *Bacillus thuringiensis* (Bt) in cotton (Van Larebeke *et al*., 2000). Bt is naturally occurring bacterium that produces crystal proteins that are lethal to insect larvae. Genetically modified plants such as crops, pulses and ornamental plant seeds contains

Table 1: Effect of various treatment of *Arbuscular mycorrhiza* at hexavalent chromium polluted soil on germination studies of *Cosmos bipinnatus* Cav. - 15 DAS plant

Treatment (g/kg soil)	Germination (%)	Vigor index	Tolerance index	Toxicity level in soil	Percentage of phytotoxicity
Control	31.1	267.46	0.254	79.41	76.79
5	46.6 (+49.83)	591.82 (+121.2)	0.400	71.02	69.18
10	57.7 (+85.53)	750.1 (+180.4)	0.938	66.34	61.86
15	62.3 (+100.3)	920.56 (+244.1)	0.947	62.48	57.62
20	68.8 (+121.2)	1087.0 (+306.4)	0.958	55.92	43.18
25	64.1 (+106.1)	1023.3 (+282.5)	0.878	57.08	46.92

*Percent over control values are given in the parentheses

ANOVA

Source of variation	SS	Df	MS	*F*	*P* value	F crit
Rows	10.32384	5	2.064768	1.114662	0.384113	2.71089
Columns	2.608138	4	6.520346	36.69693	8.6409	2.866081
Error	3.704742	20	1.852371			
Total	12.93197	29				

different resistant capacities such as, pest resistance, herbicide tolerance, diseases resistance and drought tolerance.

Pest Resistance

The farmers typically use many tons of chemical pesticides annually. Chemical pesticides are potential health hazards, run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the water supply, and cause harm to environment. GM plants are grown and contain pest resistance, no need for chemical pesticides.

Disease Resistance

There are many viruses, fungi, and bacteria that cause plant diseases. Plant biologists are working to create plants with genetically engineered resistance to these diseases in plant life cycle from seedling to fruiting (Van Assche and Clijsters, 1983).

Drought Tolerance

As the world population grows and more land is utilized for housing instead of food production, farmers will need to grow crops in locations previously unsuited for plant cultivation. GM plants are containing more drought tolerance because drought resistance gene transferred into another organism of gene. Hence, GM plants can with stand long periods of drought tolerance (Wong *et al.*, 1984).

MATERIALS AND METHODS

Seed Collection

Plant material and VAM (Arbuscular mycorrhiza) treatment

The seeds of *C. bipinnatus* Cav. and *C. cristata* L. were collected from Tamil Nadu Agricultural University, Coimbatore. Moreover, seeds were sowed in field area of hexavalent chromium polluted soil, Walajapet, Vellore district at 26°C with treatment of *A. mycorrhiza* (VAM) on control to 5, 10, 15, 20, and 25 g at 15-90 days interval. About 25 seeds were sowed in each row for all treatment, and fields were irrigated twice a day. Each treatment contained three replications. Furthermore, without *A. mycorrhiza* (VAM) treated soil was used as control and removed deleterious substances from the substrate as well as from the root surface (Zhang *et al.*, 2001). And plants were authenticated from Botanical Survey of India, Southern region, Tamil Nadu Agricultural University, Coimbatore (BSI/SRC/5/23/2013-14/2003).

Cosmos bipinnatus Cav. *Celosia cristata L.*

Plate 1: Effect of various treatment of *Arbuscular mycorrhiza* in hexavalent chromium polluted soil on morphological changes of *Cosmos bipinnatus Cav.* and *Celosia cristata* L.

Growth Analysis

At each time of the experiment, plants were collected and determined root length, shoot length, number of leaves per plant, number of flowers per plant, and fresh weight of the plants. The plants were divided into shoot, root, and leaves. These were oven dried at 85°C until they reached a constant mass to measure the respective dry weights. Three plants per replications were collected (Sharma and Dietz, 2009).

Table 2: Effect of various treatment of *Arbuscular mycorrhiza* at hexavalent chromium polluted soil on germination studies of *Celosia cristata* L. ‑ 15 DAS plant

Treatment (g/kg soil)	Germination (%)	Vigor index	Tolerance index	Toxicity level	Percentage of phytotoxicity
Control	33.3	289.71	0.282	77.31	75.09
5	51.1 (+53.45)	485.45 (+67.56)	0.522	69.12	64.28
10	53.3 (+60.06)	634.27 (+118.9)	0.761	62.64	59.76
15	57.7 (+73.27)	715.48 (+146.9)	0.914	59.48	51.92
20	64.4 (+93.39)	850.08 (+193.4)	0.926	51.92	43.08
25	63.3 (+90.09)	711.5 (+145.5)	0.853	57.08	49.92

*Percent over control values are given in the parentheses. DAS: Days after showing

ANOVA						
Source of variation	SS	Df	MS	*F*	*P* value	F crit
Rows	35.95705	5	7191.411	0.880246	0.512158	2.71089
Columns	1.578440	4	394610	48.30124	5.3110	2.866081
Error	1.633954	20	8169.771			
Total	39.16944	29				

RESULTS AND DISCUSSION

The ornamental plants of *C. bipinnatus* Cav. and *C. cristata* L. revealed morphological growth nature in hexavalent chromium polluted soil. *C. bipinnatus* Cav. expressed superior growth nature and tolerate chromium stress in soil compare than *C. cristata L*. Tables 1 and 2 showed growth, phytotoxicity, and tolerance index of *C. bipinnatus* Cav. and *C. cristata L*. Plate no: 1 shown morphological changes of C. bipinnatus Cav. and C. cristata L. grown under hexavalent chromium polluted soil. The *C. bipinnatus* Cav. data revealed for withstands the heavy metal of hexavalent chromium (Cr^{6+}) polluted soil, it has completely adopting edaphic factors of hexavalent chromium polluted soil.

CONCLUSION

Present investigation of phytoremediation was carried out with the effect of hexavalent chromium and different treatment of VAM (*A. mycorrhiza*) (Control, 5, 10, 15, 20, and 25 g/kg soil) for the functional role of soil amendments to reclamation of heavy metal in contaminated soil. The processes of phytoremediation were carried out in experimental plot study to decline the percentage of hexavalent chromium by using VAM on germination, growth, percentage of phytotoxicity, and vigor index, on *C. bipinnatus* Cav. and *C. cristata* L. From the present study of phytoremediation of hexavalent chromium polluted soil with treatment of *A. mycorrhiza* on *Tagetes erecta* can be concluded that the with out treatment of VAM in control plant was seriously influenced and reduction in germination, growth, percentage of phytotoxicity on *C. bipinnatus* Cav. and *C. cristata* L. at hexavalent chromium contaminated soil, when compare to various concentration of (5, 10, 15, 20, and 25 g/kg) VAM treatment rise the plant development, growth, germination, vigor index, and rehabilitation for impurity of hexavant chromium polluted soil.

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