Effect of Various Concentrations of Chromium Polluted Soil on Germination and Morphological Studies of Globe Amaranth (Gomphrena Globosa L.)

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Abstract- *The present investigation was carried out to the effect of different concentrations of chromium on germination, morphological specifications on response of Globe amaranth (Gomphrena globosa L.). The seeds were obtained from Private Agro centre, Villupuram District, Tamil Nadu, India. The healthy seeds of globe amaranth were chosen and used for both laboratory experiments. The various Cr concentrations were used (25, 50, 75 and 100 mg/l). Among the results 7 days plants increasing concentrations of Cr caused considerable reduction in germination percentage, vigour index, tolerance index, were also significantly decreased in all different concentration of Cr treated as compared to control. The Phytotoxicity level was increasing with increasing concentration of Cr treated plants as compared to control. On the other hand, morphological parameter such as root length, shoot length, fresh weight and dry weight were also significantly decreased in all different concentration of Cr treated as compared to control.*

Keywords- Chromium, Globe amaranth, Vigour index, Tolerance index and Phytotoxicity

I. INTRODUCTION

Heavy metals (HM) are innately present as trace elements in environment and their presence are marked in soil, water etc. The term “heavy metals” refers to any metallic element that has a relatively high density and is toxic or poisonous even at a low concentration. In general, the term applies to the group of metals and metalloids with atomic density greater than 4 g cm–3, five times or more greater than water [1]. However, chemical property of Heavy metal is regarded as a more influencing factor in comparison to its density [2]. Their presence in soils is in the form of free metal ions, soluble metal complexes, organically bound metals, exchangeable metal ions, precipitated or insoluble compounds, such as carbonates and oxides [3].

Chromium is a hard steel-gray metal that is highly resistant to oxidation, even at higher temperatures. Which is found in all phases of the environment, including air, water and soil. Chromium is essential in certain amounts, but it becomes toxic at higher doeses. Hexavalent chromium is highly soluble highly toxic, carcinogenic and mutagenic whereas trivalent chromium is relatively less toxic and less mobile [4,5]. Moreover the highest concentration of Cr was found to be harmful for plant life. It reduces the protein contents; inhibit the enzyme activity and causes chlorosis and necrosis [6].

In addition to the chromium is widespread heavy metal in the environment. The environment contaminated by the chromium in the way of both natural and anthropogenic sources. Chromium is released into the environment by a large number of industrial operations such as electroplating, chromate manufacturing, leather tanning and wood preservation resistant alloys, mining etc [7].The leather industry is the major cause of high efflux of Cr to the biosphere, accounting for 40% of the total industrial used [8]. Notably Trivalent chromium (III) and hexavalent chromium (VI) are the two species of chromium which are found naturally in the environment Cr(VI) appears to be more toxic than Cr (III).

The Amaranthaceae is a cosmopolian family which occurs at disturbed, arid or saline areas; one of the characteristics that ensure its survival in adverse environments is the operation of C4 pathway of photosynthesis [9]. It is erect or ascending herbs to 50cm. leaves spiral, deltoid to elliptic ovate. Inflorescence is axillary, slender, thyrsiform spike. Flowering mostly occurs in June to December. Globe amaranth Gomphrena globosa L. might be one of the plants that can use atmospheric sulphides for its growth [10, 11].

Globe amaranth (Gomphrena globosa L.) in tamil-Vadamalli, Family- Amaranthaceae commonly known as globe amaranth is an annual branched herb which is cultivated as ornamental flowering herb in garden [12]. It is native to North-America, South-America, Myanmar, and India and grows well over Bangladesh. Amaranthaceae is a large family comprising around 10 sub families, 176 genera and 2400 species available all over the world [13,14]. Moreover this

Plant is a medicinal herb with broad clinical significance in blood coagulation, jaundice, hypertension, diabetes, cancer, kidney and other urinary problems [15,16]. Hence, the present work has been carried out to find out the seed germination and morphological parameters like shoot length, root length, fresh weight and dry weight.

II. METERIALS AND METHODS

The present investigation was carried out to the effect of different concentrations of chromium on germination and growth of Globe amaranth (Gomphrena globosa L.). The research work comprises of the following aspects, Morphological parameters such as the germination percentage, shoot length, root length, fresh weight, dry weight, vigour index, tolerance index and per centage of phytotoxicity of Gomphrena globosa L. seeds grown under different concentrations of chromium

Seed materials

Globe amaranth (Gomphrena globosa L.) seeds were obtained from Private Agro centre, Villupuram District, Tamil Nadu, India. The healthy seeds of Globe amaranth were chosen and used for both laboratory and field experiments.

Preparation of chromium solution:

Potassium dichromate (K2Cr2O7) salt was used as Cr source for the present study. A known weight (2.9583 g) of potassium dichromate salt was dissolved in 1000 ml of distilled water to get a concentration of 1000 ppm as Cr. From this standard solution, the various concentrations (25, 50, 75 and 100 mg/l) of chromium solution were prepared and used both for laboratory and field experiments.

Germination Study

Germination study was conducted with the globe amaranth seed (Gomphrena globosa L.).The seeds were equispacially arranged in plastic container filled with garden soil and they were treated with different concentrations (10, 25, 50, 75 and 100mg/l) of potassium di chromate. The germination study parameters such as germination percentage, off seedlings were taken and recorded five replicates were maintained for this experiment. From these data, the following values of vigour index, tolerance index and percentage of phytotoxicity were calculated 7th day after treatment.

Germination per centage

Twenty seeds were equispacially arranged in germination experiment. The number of seeds germinated in each treatment was counted on each and every day up to 7th day after sowing. The total germination percentage was calculated by using the following formula

$$\text{Germination percentage} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Vigour index

Vigour index of the seedlings were calculated by using the formula

Vigour index = Germination percentage × seedling length

Tolerance index

Tolerance index of the seedlings were calculated by using the formula

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in treatment}}{\text{Mean length of longest root in control}}$$

Percentage of phytotoxicity

The percentage of phytotoxicity of potassium dichromate response to globe amaranth was calculated by using the following formula:

$$\text{Percentage of phytotoxicity} = \frac{\text{Radicle length of control} - \text{Radicle length of test}}{\text{Radicle length of control}} \times 100$$

Morphological studies

Shoot length and root length

The seedlings were randomly selected on 7th day from each treatment to record the seedling growth. The Shoot length and root length of the Globe amaranth seedlings were measured by using a centimeter scale and the values were recorded.

Fresh weight and dry weight (cm seedling-1)

Twenty seedlings were taken, air dried and their fresh weight was taken. The same seedlings were kept in a hot air oven at 800C for 24 hrs. Then, the samples were kept in desiccators and their dry weight was taken by using an electrical single pan balance.

III. RESULTS AND DISCUSSION

Germination per centage

The germination studies of Globe amaranth seeds grown under different concentrations of effect of chromium were carried out and the results were recorded in 7th day old seedlings. The effect of chromium on seed germination of Globe amaranth were shown fig-1. The highest value of seed germination per centage (98.0%) was observed in control. However, the seed germination per centage was gradually decreased with increasing concentration of chromium (10, 25, 50, 75 and 100 mg/l). The lowest value seed germination per centage (38%) was observed in higher concentration of chromium 100 mg/l. The germination percentage was decreased in chromium and cadmium treatment when compare control. The seed germination of Sesbania was affected up to 1 g kg-1 chromium and cadmium polluted soil [17]. In addition, chromium and cadmium affected soil relations not only by decreasing soil stress tolerance. Hence, the higher K2Cr2O4 and CdCl2 concentration treatment to Sesbania sesban seeds seemed to reduce the availability of water in the embryo axis, and this may be the reason for the low seedling establishment or retardation in overall seedling growth in the experiment. Moreover, seed germination under cadmium stress could be decreased owing to accelerated breakdown of food material present in seed embryo.

Vigour index, Tolerance index and Per centage of Phyotoxicity

The vigour index, tolerance index and phytotoxicity of Globe amaranth seeds grown under different concentrations of effect of chromium were carried out and the results were recorded in 7th day old seedlings. The effect of chromium on vigour index, tolerance index and phytotoxicity of Globe amaranth were shown fig- 2, 3 & 4. The vigour index, tolerance index increasing with increasing chromium concentration while percentage of phyotoxicity decreasing with increasing chromium concentration. The highest vigour index (3217.63), tolerance index (1.55) and also lowest phytotoxicity (0.29 %) levels were recorded in10mg/l concentration of chromium. The lowest vigour index (648.65), tolerance index (0.32) and also highest percentage of phyotoxicity (0.96 %) were recorded in the seedlings treated with 100mg/l concentration of chromium. This finding was in line with those reported earlier it was reported that heavy stress decreased seed germination, germination index and vigour index of different crops [18,19,20,21]. Since, seed germination is the first physiological process affected by Cr treatment, the ability of a seed to germinate in a medium containing Cr would be indicative of its level of tolerance to this metal [22].

Morphological studies

Shoot length and root length

The shoot length and root length of Globe amaranth seeds grown under different concentrations of effect of chromium were carried out and the results were recorded in 7th day old seedlings. The effect of chromium on Shoot length and root length of Globe amaranth were shown fig- 5 & 6. The highest value (11.2 cm/seedling) was observed in control. However, the Shoot length and root length was gradually decreased with increasing concentration of chromium (10, 25, 50, 75 and 100 mg/l). The lowest value (2.2 cm/seedling) was observed in higher concentration of chromium 100 mg/l. The Sesbania sesban root and shoot length decreased in higher concentration of chromium and cadmium treatment when compared to control [20]. The inhibition of shoot and root length metal treatment supported by the following authors. Considering the effects of mercuric chloride on the growth of Clitoria ternatia, the growth was retarded more when compared to control and the effect on growth of plant was different depending on heavy metal [23].

Fresh weight and dry weight

The fresh weight and dry weight of Globe amaranth seeds grown under different concentrations of effect of chromium were carried out and the results were recorded in 7th day old seedlings. The effect of chromium on fresh weight and dry weight of Globe amaranth were shown fig- 7 & 8. The highest value (1.29 mg/fr.wt) and dry weight (0.48 mg/fr.wt) was observed in control. However, the fresh weight and dry weight was gradually decreased with increasing concentration of chromium (10, 25, 50, 75 and 100 mg/l). The lowest value (0.42 mg/fr.wt) and dry weight (0.05 mg/fr.wt) was observed in higher concentration of chromium 100 mg/l. [24, 25] reported that root length of Vigna radiata was decreased in presence of cadmium. Increasing of heavy metal concentration in most environment resulted in reduction of absorption of water and nutrients, reduction of water transpiration and disturbance in water balance, inhibition of enzymes activities, reduction of cell metabolism, reduction of photosynthesis, evaporation and transpiration, nitrogen and phosphorus shortage and stopping of growth, accelerating of maturity and even death of plant. Reduction in plant fresh weight under cadmium treatment was also noted in Vigna radiata [26]. The seedlings of L. leucocephala showed a gradual decrease in dry weight with increase in concentration of cadmium, which was evident in the poor growth of roots and aerial parts [27].

IV. CONCLUSION

From this experiment, it can be concluded that the heavy metal contaminated soil is toxic to crop. The increasing chromium concentrations (10, 25, 50, 75 and 100 mg/l) with the germination percentage, vigour index, tolerance index, were also significantly decreased in all different concentration of Cr treated as compared to control. The Phytotoxicity level was increasing with increasing concentration of Cr treated plants as compared to control. On the other hand, morphological parameter such as root length, shoot length, fresh weight and dry weight were also significantly decreased in all different concentration of Cr treated as compared to control. Further study is needed for the remediation of chromium polluted soil. Thus, future study directed towards by studying the phytoremediation of theses contaminated site with the plant of Globe amaranth (Gomphrena globosa L.).

V. ACKNOWLEDGEMENT

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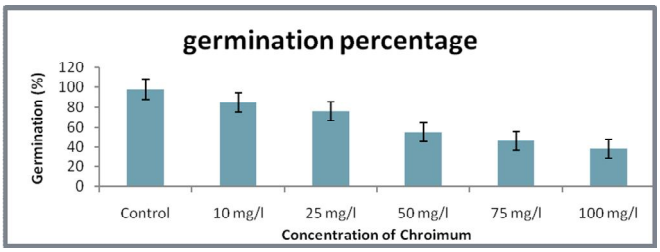
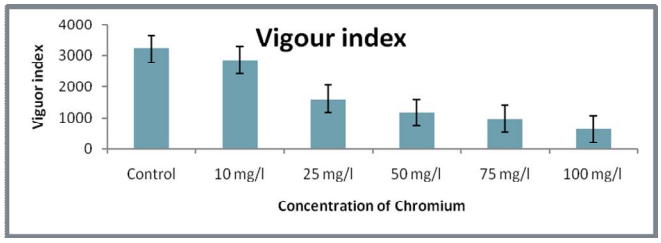
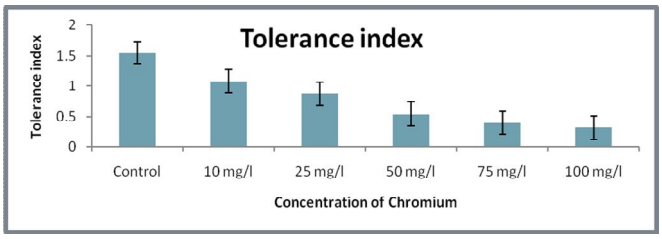


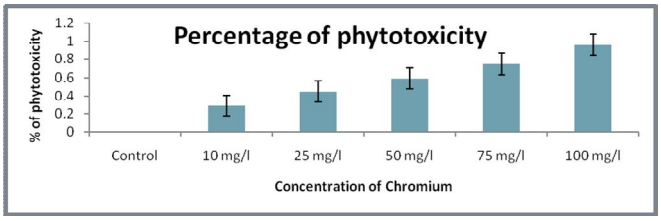
Figuer-1. Effect of various concentrations of chromium on seed Germination per centage of Globe amaranth (Gomphrena globosa L.)



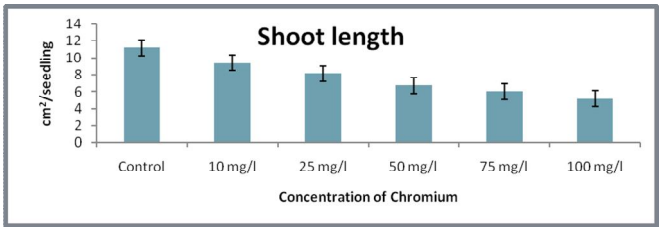
Figuer-2. Effect of various concentrations of chromium on vigour index of Globe amaranth (Gomphrena globosa L.)



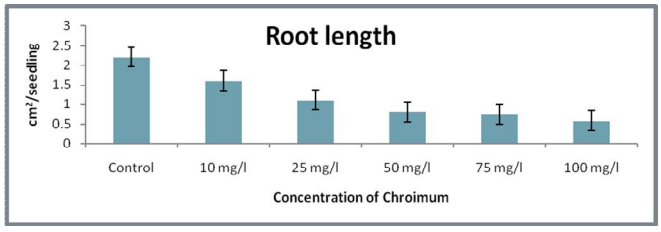
Figuer-3. Effect of various concentrations of chromium on tolerance index of Globe amaranth (Gomphrena globosa L.)



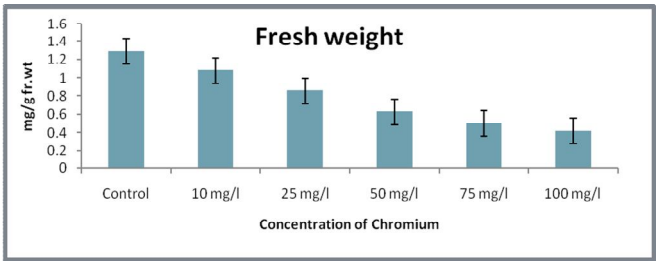
Figuer-4. Effect of various concentrations of chromium on tolerance index of Globe amaranth (Gomphrena globosa L.)



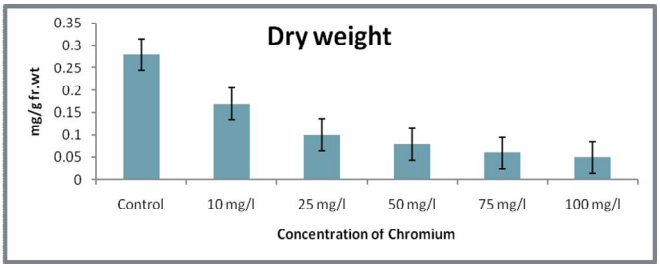
Figuer-5. Effect of various concentrations of chromium on shoot length of Globe amaranth (Gomphrena globosa L.)



Figuer-6. Effect of various concentrations of chromium on root length of Globe amaranth (Gomphrena globosa L.)



Figuer-7. Effect of various concentrations of chromium on fresh weight of Globe amaranth (Gomphrena globosa L.)



Figuer-8. Effect of various concentrations of chromium on dry weight of Globe amaranth (Gomphrena globosa L.)