Response of Wheat (*Triticum aestivum*) to Exogenously Applied Chromium: Effect on Growth, Chlorophyll and Mineral Composition

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Abstract

Heavy metals are very dangerous to environment and harm to all living organisms e.g. plants and animals etc. They enter the plant through soil and damage the internal mechanisms of plants. Chromium is very toxic to plants as well as animals. It has negative influences on plant growth, mineral nutrients and chlorophyll content.

Increasing its concentration causes reduction in plant growth, Chlorophyll contents and mineral nutrients in Wheat (*Triticum aestivum* L.). All the parameters were found to be reduced if increase in the concentration of chromium.

Keywords: Plant growth; Chlorophyll; Mineral nutrients; Wheat (*Triticum aestivum* L.) mechanism.

Introduction

Chromium is very toxic Heavy metal to living bodies and dangerous to human health and plant vegetation’s. Pollution of the environment is increasing with increase in the world population. Plant material consumes the chromium and it enters the food chain in this way. High concentrations of chromium were found to be very toxic to vegetation. Sometime excess concentration of chromium cause barren land but on the other hand in different countries, chromium is used on large scale including chemical Production, paper and pulp production, tanning, wood preservation, electroplating, production of pigments and in metallurgy [1]. These industries [2] have a major role in the spreading of Cr pollution which create serious threats to living creature both animals and plants. Chromium phytotoxicity has adverse effects on the growth parameters of plants such as stoppage of early seedling development, decrease in biomass, reduction in root growth and chlorosis (1995). There were many studies were concluded on chromium toxicity in crop plants. All the mechanisms of plants such as photosynthesis, respiration and defensive mechanisms etc were significantly affected by Chromium [3].

There are two sources through which chromium becomes available to the environment, natural and anthropogenic, burning of oil and coal, fertilizers, oxidants, metal plating tanneries, chromium steel and oil well drilling [4]. It is highly toxic metal to plants and microorganisms [5]. Different types of enzymes such as catalases, peroxidases, reductases are affected by chromium.

Lose of chlorophyll and accidental death of plant tissues and organs occur by chromium toxicity [5]. When there is direct contact of metal with cellular components then variety of metabolic responses leading to shift in the growth of plants [6]. Soil quality decreases due to accumulation of chromium in the soil and soil unable to produce yielding in normal quantity. Most of the soil nutrients are not easily available to plants for the development of new organs and production of yield. Toxic material transfer from one place to other through discharging from factories into water streaming and damage the water life including algae, fungi, phytoplankton’s and other microorganisms [7].

Material and Method

The seeds of Wheat (*Triticum aestivum* L.) were sown in earthen pots which were filled with loamy soil. Eight (08) seeds were sown in each pot and five plants were kept after germination in each pot for thinning process. Soil water applied to the plants when required. Completely randomizing designs were made for the experiment with three replicates. To eliminate the experimental bias the treatments were randomized. Eight levels of chromium 3, 6, 9, 12, 15, 18, 21, 24 ppm per kg soil with distilled water and applied to wheat 15 days old seedlings which were grown in the soil with pH 8. No plant survived beyond 24 ppm because chromium level selected for this study were 0 (control) 6, 12, 18 and 24 ppm. Normal growth conditions were provided to plants for their germination. These levels of chromium were applied to Wheat (*Triticum aestivum* L.) seedlings and plants were grown for 15 days after treatment application before harvest. The composition of nutrients follows: as Ca (NO3)3.4 mM; KNO3 5 mM; MgSO4 2 mM, KH2PO4 1.02 mM; as ppm–H3BO3 92.2 µM; MnSO4 2.19 µM, ZnCl2 1.62 µM CuSO4 0.69 µM, Na2MoO4; 0.29 µM Na-Fe-EDTA 0.15 µM each. All the salts were dissolved and mixed after autoclaving separately. Final pH of the solution was adjusted as 6.7.

Chlorophyll (a, b, and total) analysis

By using the formula of the pigment contents of 15 days old plants were extracted. The leaves were cut into small pieces that were extracted with 70% acetone. The absorbance was measured at 643 nm and 665 nm for chlorophyll a, b and total chlorophyll respectively by using spectrophotometer.

Chlorophyll a, b and total chlorophyll were calculated according to the Lichtenthaler and Wellburn (1983) formulae.

\[
\text{Chl a (mg g}^{-1}\text{ leaf fresh weight)} = \left[12.7(O663) - 2.69 (O645)\right] \times \frac{V}{1000}\times W. \\
\text{Chl b (mg g}^{-1}\text{ leaf fresh weight)} = \left[22.9(O645) - 4.68 (O663)\right] \times \frac{V}{1000}\times W.
\]
Table 1: Effect of different concentrations of chromium on growth and chlorophyll contents of Wheat (Triticum aestivum L.).

| Elements          | Control | 6 ppm | 12 ppm | 18 ppm | 24 ppm | C.D at 5% |
|-------------------|---------|-------|--------|--------|--------|-----------|
| N                 | 0       | 2.09 ± 3 | 2.26 ± 0.6 | 2.89 ± 1** | 1.86 ± 2*** | 3.32 ± 3 | 465 ± 5 | 244 ± 3 | 239 ± 3 |
| P                 | 0       | 2.32 ± 0.05 | 2.09 ± 0.05 | 1.46 ± 0.06 | 5.6 ± 0.3 | 524 ± 5 | 239 ± 3 |
| K                 | 0       | 4.98 ± 0.3 | 2.89 ± 1** | 1.86 ± 2*** | 3.32 ± 3 | 465 ± 5 | 244 ± 3 | 239 ± 3 |
| Na                | 0       | 1.46 ± 0.06 | 5.6 ± 0.3 | 524 ± 5 | 239 ± 3 | 244 ± 3 | 239 ± 3 |
| Ca                | 0       | 5.6 ± 0.3 | 524 ± 5 | 239 ± 3 | 244 ± 3 | 239 ± 3 | 244 ± 3 | 239 ± 3 |
| Fe                | 0       | 5.6 ± 0.3 | 524 ± 5 | 239 ± 3 | 244 ± 3 | 239 ± 3 | 244 ± 3 | 239 ± 3 |
| Zn                | 0       | 5.6 ± 0.3 | 524 ± 5 | 239 ± 3 | 244 ± 3 | 239 ± 3 | 244 ± 3 | 239 ± 3 |

Statistical significant: *= P ≤ 0.1 **= P ≤ 0.05 ***= P ≤ 0.01

Table 2: Effect of different chromium concentrations on mineral contents of Wheat (Triticum aestivum L.).

| Treatments Chromium Concentrations | Control | 6 ppm | 12 ppm | 18 ppm | 24 ppm |
|-----------------------------------|---------|-------|--------|--------|--------|
| shoot Length(cm)                  | 11.50 ± 0.286 | 10.370 ± 0.366 | 9.750 ± 0.07 | 9.350 ± 0.215 | 8.390 ± 0.212 | 1.14 |
| Root length (cm)                  | 10.745 ± 0.024 | 8.92 ± 0.082 | 7.950 ± 0.022 | 6.190 ± 0.089 | 5.980 ± 0.078 | 0.21 |
| Root dry weight (g)               | 2.90 ± 0.023 | 2.20 ± 0.025 | 2.11 ± 0.022 | 1.13 ± 0.027 | 1.09 ± 0.024 | 0.11 |
| Shoot dry weight (g)              | 4.80 ± 0.024 | 4.01 ± 0.022 | 4.01 ± 0.024 | 2.97 ± 0.025 | 2.01 ± 0.028 | 0.13 |
| Chlorophyll concentration (mg/g F.W) | 2.950 ± 0.000 | 2.650 ± 0.000 | 2.660 ± 0.000 | 2.520 ± 0.000 | 2.470 ± 0.000 | 0.03 |

Value represented in mean ± SD with three replicates.

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