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Impact of Cadmium Phytotoxicity on Photosynthetic Rate and Chlorophyll Content in *Triticum aestivum* L. DWR 225 Variety

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Abstract: Higher plants take up nutrients present in the form of minerals. Many heavy metals like Cu, Zn, Ni and Co are essential for plants. Cadmium is a heavy metal constituting a nonliving component of the biosphere and occurs naturally in soils and plants. It is a nonessential element ranked as one of the most hazardous heavy metal. *Triticum aestivum* L. DWR 225 variety is widely cultivated as irrigated crop plant in North Karnataka. Present research work was aimed to evaluate the impact of Cd^{+2} toxicity levels on Photosynthetic rate and total chlorophyll content of DWR 225 variety at 50mg/kg and 100mg/kg soil. Cd^{+2} phytotoxicity harmfully affects both photosynthetic rate and chlorophyll content. Photosynthesis is Harmfully affected by Cd^{+2} phytotoxicity at lowest concentrations. It is well evident from the results that, Cd^{+2} was found to be more lethal at 100mg/kg concentration to *Triticum aestivum* L. DWR 225 variety. Cd^{+2} phytotoxicity not only reduce total chlorophyll content but also the photosynthetic rate.

Key words: Cadmium · Phytotoxicity · *Triticum aestivum* L. Chlorophyll content and Photosynthetic rate

INTRODUCTION

Plants come across various kinds of environmental stresses. Currently heavy metal (HM) pollution is a serious environmental concern. Heavy metal pollution has increased due to mining activities [1], industries, automobile exhausts and increased use of agrochemicals. Cadmium, Zinc, Nickel and Mercury are the heavy metals released in to enviornment. The presence of heavy metals (HM) in excess amounts is a global problem, Cadmium is a heavy metal (specific density exceeding 5 g/cm3 and relative atomic mass above 40; [2]) constituting a nonliving component of the biosphere and occurs naturally in soils and plants [3]. Cadmium (Cd^{+2}) is non essential metal present in the soil. It accumulates in soil due to various anthropogenic activities like industrial emissions, sewage pollution and use of Cd^{+2} containing Phosphate fertilizers. Cadmium is also an environmental hazard, human exposures to environmental cadmium are primarily the result of fossil fuel combustion, cement production and related activities. It is a non essential element ranked as one of the most hazardous heavy metal [4].

Plants are able to absorb and accumulate nutrients including those with unknown metabolic functions. Higher plants take up nutrients present in the form of minerals. Many heavy metals like Cu, Zn, Ni and Co are essential for plants. Cadmium present in soil is absorbed by the roots along with other minerals. It affects normal functioning in plants and known to induce many physiological changes such as leaf chlorosis, growth inhibition, disturbance of respiration, nitrogen metabolism and reduction of photosynthesis.

Bread wheat (*Triticum aestivum* L) is a global food crop and it is one of the important crops in India. It is grown in different agro climatic regions. In Karnataka *Triticum aestivum* L. DWR 225 variety is widely cultivated. Phytotoxicity effect of cadmium at different concentrations is not yet studied in *Triticum aestivum* L. DWR 225 variety. The aim of present research work is to evaluate the impact of Cd^{+2} toxicity on Photosynthetic rate and total chlorophyll content in *Triticum aestivum* L. DWR 225 variety at 50mg/kg and 100mg/kg soil.

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MATERIALS AND METHODS

Plant Cultivation: Grains of DWR 225 variety were collected from wheat research station, University of Agricultural sciences Dharwad, India. Experiments were conducted in poly house using 30cm diameter earthen pots. About four Kg soil was taken in each pot. Six grains were sown in each pot. Plants were regularly watered on alternate days till the harvest. Hoagland's solution was applied at every fifteen days till the time of harvest.

Treatments: Experimental plants were subjected to following treatments.

Treatment 1. Plants were cultivated in sterile soil taken in pots without Cadmium

Treatment 2. Plants were cultivated in sterile soil taken in pots containing Cadmium in the form of Cadmium Chloride($Cdcl_2$) at the concentration of 50 mg/kg soil.

Treatment 3. Plants were cultivated in sterile soil taken in pots containing Cadmium in the form of Cadmium Chloride($Cdcl_2$) at the concentration of 100 mg/kg soil.

Plants of the above treatments are maintained in triplicates and arranged in randomized design.

Photosynthetic Rate: Photosynthetic rate was studied by using IRGA (Infra Red Gas Analyzer, LICOR 6400, USA) in flag leaf at 90 DAS (Days After Sowing) at 1500 PAR (Photo synthetically Activated Radiation). Flag leaf is inserted in to the leaf cuvette of IRGA. Measurements were taken between 9 AM to 11 AM inside the laboratory at 27°C - 29°C room temperature. Infra red gas analyzer was installed with reference (incoming) and sample (Outgoing) CO_2 and water (H_2O) concentrations. Before measuring a fast check up was performed according to check list to confirm good condition of the instrument. An attached LED (Light Emitting Diode) light Source was used to ensure stable light source during measurements.

Total Chlorophyll Content: Total leaf chlorophyll content was determined with SPAD-502 Portable Chlorophyll meter (Minolta Camera Co.Ltd. Japan). First leaf (from the top) was used for the measurement of total chlorophyll content. The leaf was inserted into sample slot of the measuring head. Press and hold it until a beep sounds and the measurement value appeared in the displays.

This value will automatically stored in the memory. The values measured by the SPAD-5O2 correspond to the amount of Chlorophyll present in the leaf. The values are calculated based on the amount of light transmitted by the leaf in two wave length regions in which absorbance of chlorophyll is different.

RESULTS AND DISCUSSION

Results obtained from the experiments revealed that Cd^{+2} phytotoxicity harmfully affects both photosynthetic rate and chlorophyll content. Total chlorophyll content was reduced with increase of Cd^{+2} concentration. Reduction of 20 % chlorophyll content was observed in plants treated with 50mg Cd^{+2} /Kg soil treatment. Drastic decrease of chlorophyll content was observed in plants treated with 100 mg Cd^{+2} /Kg soil treatment. Almost 50% reduction in the total chlorophyll content was observed in plants treated with 100 mg Cd^{+2} /Kg soil treatment compared to those grown under control conditions.

Photosynthesis is also affected by Cd^{+2} phytotoxicity at different concentrations. There was reduction in photosynthetic rate with increase of Cd^{+2} concentration. At 50mg Cd^{+2} /Kg soil, about 10% decrease in the photosynthetic rate was observed. There was 40% decrease in the photosynthetic rate at 100 mg Cd^{+2} /K g soil concentration. It is well evident from the results that Cd^{+2} was found to be lethal to *Triticum aestivum* L. DWR 225 variety at 100mg/kg concentration.

Chlorophyll content was reduced due to toxicity of Cd^{+2}, authors [5] investigated the inhibition of chlorophyll biosynthesis. Earliar workers [6] explained the reduction in chlorophyll content with increase in the concentration of Cd+2. The research [7] reported the inhibitory effect of Cd^{+2} on chlorophyll biosynthesis. Another group of scientists [8] reported the effect of Cd^{+2} on biosynthesis in wheat seedlings. These findings strongly supports the present findings.

Cd^{+2} altered the photosynthetic rate by inhibiting different reaction steps of Calvin cycle. Earliar studies [9] reported that, at low concentrations Cd^{+2} acts as photophosphorylation inhibitor. Further research done by the scientists [10] explained that Cd^{+2} was very effective inhibitor of photosynthetic electron transport. Some workers [11] reported Cd^{+2} affect membrane bound protein complex of PS I, which is necessary for the oxidation of ferrodoxin under light reactions. Furter research [12] investigated the role of Cd^{+2} in reducing the rate of photosynthesis. Cd^{+2} inhibits the PS II at the level of water splitting system resulting in the decrease of photosynthetic rate.

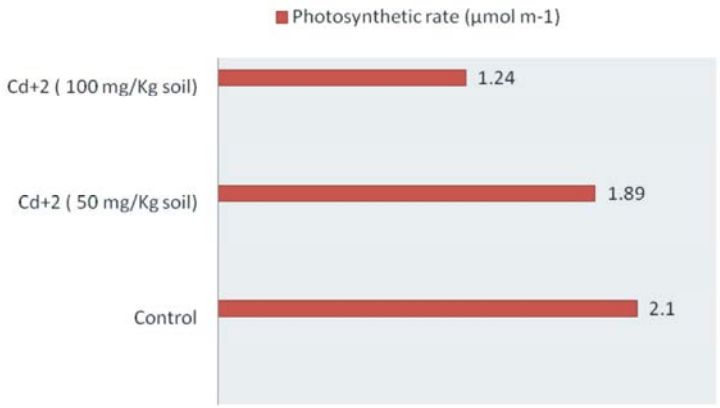

Fig. 1: Effect of Cd^{+2} phytotoxicity on photosynthetic rate

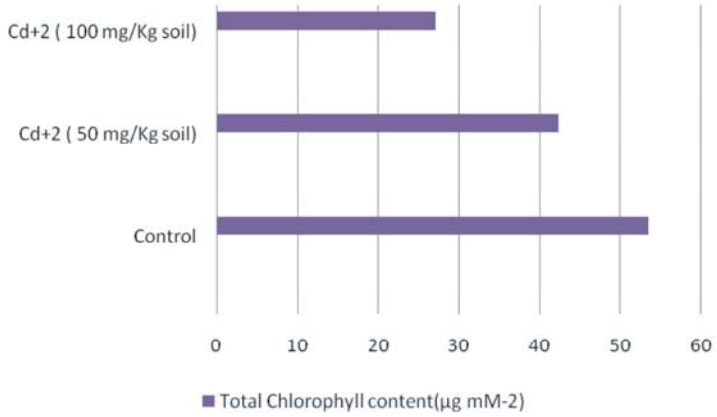

Fig. 2: Effect of Cd^{+2} phytotoxicity on total chlorophyll content

Authors [13] reported that Cd^{+2} inhibits the activity of RuBp carboxylase, further role Cd^{+2} in the inactivation of sulfohydryl proteins participating in photosynthesis. Present findings supports the research findings of earlier workers.

CONCLUSION

Cd^{+2} phytotoxicity not only reduce total chlorophyll content but also the photosynthetic rate. At 100mg/Kg soil concentration Cd^{+2} was found to be more lethal to *Triticum aestivum* L. DWR 225 variety.

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