

Physiological Growth of Sunflower with Treatment of Copper

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Abstract

The effects of different concentrations of copper sulfate on the growth of and the accumulation of Cu^{2+} by root, shoot and leaf growth of sunflower (*Helianthus annuus*) were examined in this study. The purpose of our experiments was to consider sensitivity of the chosen 2 sunflower cultivars (*Helianthus annuus* L.Cv.FH626 and FH674) to copper ions on the ground of physiological characteristics (content of leaf area, fresh matter, dry matter, amount of to show possible resistance mechanisms of this plant to copper ions. Afterwards they were poured with distilled water with the solution enriched with copper with concentration 20 mM $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and the last chosen combination was 40 mM $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$. Waterings in the next phases of the experiment did not contain metal. In spite of the fact that no significant visual symptoms of toxic effect of metal were markedly noticeable, we detected decrease in the content of dry basis in the roots (less than 25–39% in comparison with the control of two tested cultivars treated by Cu cv. FH626 & FH674 tends to be the most resistant or tolerant to Cu toxicity from the point of view of evaluation of physiological parameters of particular cultivars.

Keywords: *Helianthus annuus*, copper sulphate, shoot growth, root growth, leaf area.

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INTRODUCTION

Environmental pollution by heavy metals has received increasing attention over the last few decades. Heavy metals in soil may come from various anthropogenic sources, such as atmospheric deposition from industry, phosphate fertilizers and wastewater sludges. In spite of its physiological importance, an increase in Cu contents threatens plant health because it interacts with several enzymes, and disturbs membrane permeability and electron transport in chloroplasts. Its toxicity to plants is well documented [1].

Copper (Cu) loading of agricultural soils may originate from the application of sewage sludge or fungicidal sprays. Although Cu is an essential element for plant growth its accumulation in soils may be toxic to biota, such as plants and microorganisms, and at toxic concentrations it interferes with numerous physiological. It is also known to damage cell membranes by binding to sulphhydryl groups of membrane proteins and inducing lipid peroxidation. Cu is extremely toxic and can catalyze the formation of active oxygen species in the cell through Haber-Weiss reaction. Since oxidative stress is produced in plants exposed to high metal concentrations, the implication of

some antioxidant enzymes may complement the role of phytochelatin in the cellular response to metal toxicity [2].

Copper is an essential micronutrient for normal plant metabolism. Copper is involved in a number of physiological processes such as the photosynthetic and respiratory electron transport chains and as a cofactor or as a part of the prosthetic group of many key enzymes involved in different metabolic pathways, including ATP synthesis [3].

In spite of its physiological importance, an increase in Cu contents threatens plant health because it interacts with several enzymes, and disturbs membrane permeability and electron transport in chloroplasts. Its toxicity to plants is well documented. Cu is extremely toxic and can catalyze the formation of active oxygen species in the cell through Haber-Weiss reaction. Inhibition of photosynthesis is the consequence of interference of metal ions with photosynthetic enzymes and chloroplast membranes [4].

The effects of excess Cu with respect to sunflower (*Helianthus annuus*) growth, physiology, and metabolism were studied. Although sunflower is usually regarded as a highly tolerant crop, impairment of root growth at initial stages of plant development may result in poor crop establishment and higher susceptibility to pathogen attack [5].

In order to evaluate if Cu²⁺ may impact on sunflower germination and initial root development, a pot experiment under controlled conditions was carried out. Although Cd²⁺ and Cu²⁺ treatments affect neither seed germination nor radicle emergence, sunflower seedlings grown in the presence of these heavy metals showed significant inhibition of root growth [6].

MATERIALS AND METHODS

Plant Material and Sowing

Seeds of *Helianthus annuus* (Hybrids FH.626 and FH.674) were obtained from the Ayub Agriculture Research Institute, Faisalabad. 18 plastic pots for three treatments were got to sow the seeds and analyze the influence of copper stress on their growth, physiology and metabolism. These seeds were germinated in pots of plastic filled with soil. 8 seeds were sown per pot.

RESULTS AND DISCUSSION

There were three replications per treatment with five plants per replication.

Cu Treatments

The sow seeds were irrigated for two weeks until they germinated. Two-weeks old plants were treated with three concentrations:

Control Series (T₀) = distilled water

Treatment 1 (T₁) = 20mM Cu₂SO₄ solution

Treatment 2 (T₂) = 40mM Cu₂SO₄

The plants were harvested after two months of the germination date. Root and shoot fresh weights were taken at electrical balance in grams. Similarly, the root and shoot lengths were measured in cm with the help of scale. The Plants were placed in oven for 4 days at 75°C for observing the dry weight. The dry weight of roots and shoots separately calculated [7].

STATISTICS ANALYSIS

Values in the text and tables indicate mean values ± SE. Differences among treatments were analyzed by one-way ANOVA, taking P<0.05 as significant according to Tukey's multiple Range test.

Table-1: Effect of Copper on Shoot Length (cm) of Sunflower

Treatment	Variety FH 626	Variety FH 674
Distilled water (T ₀)	98.83	126
20 mM CuSO ₄ (T ₁)	79.5	105.5
40 mM CuSO ₄ (T ₂)	107.66	103.83

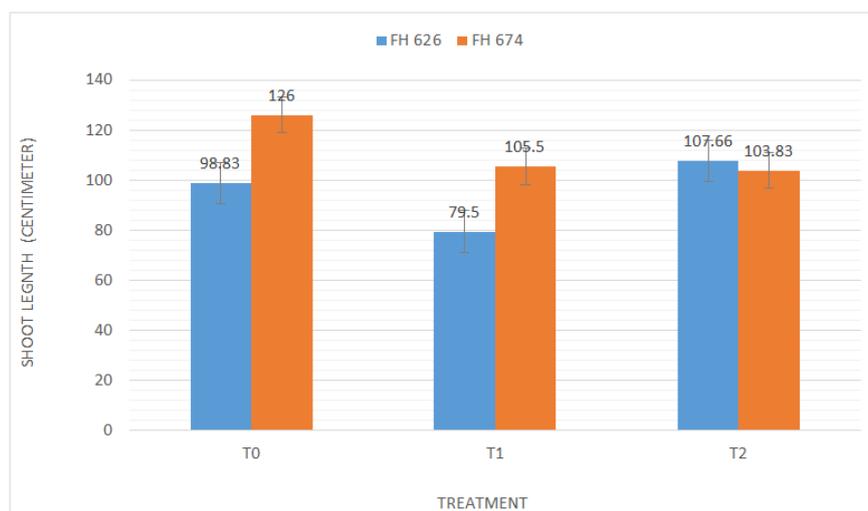


Fig-1: Effect of Copper on Shoot Length (cm) of Sunflower

Table-2: Effect of Copper on Root Length (cm) of Sunflower

Treatment	Variety FH 626	Variety FH 674
Distilled water (T ₀)	9.86	8.86
20 mM CuSO ₄ (T ₁)	6.75	7.73
40 mM CuSO ₄ (T ₂)	7.35	7.36

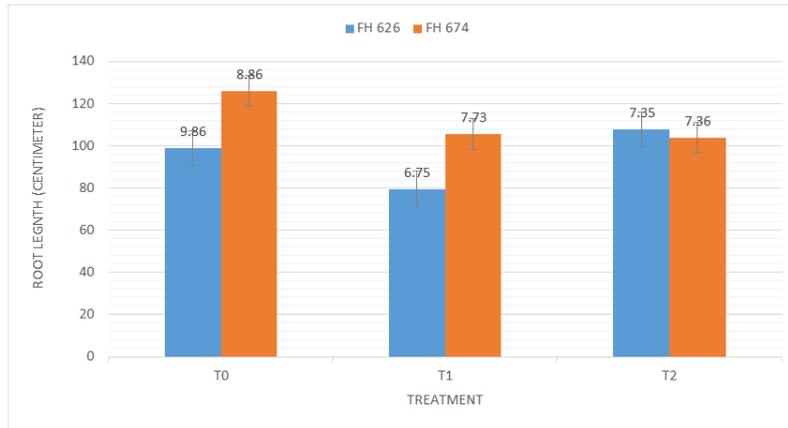


Fig-2: Effect of Copper on Root Length (cm) of Sunflower.

Table-3: Effect of Copper on Shoot Fresh Weight (cm) of Sunflower

Treatment	Variety FH 626	Variety FH 674
Distilled water (T0)	48.81	20.013
20 mM CuSO ₄ (T1)	11.3	36.26
40 mM CuSO ₄ (T2)	57.033	51.49

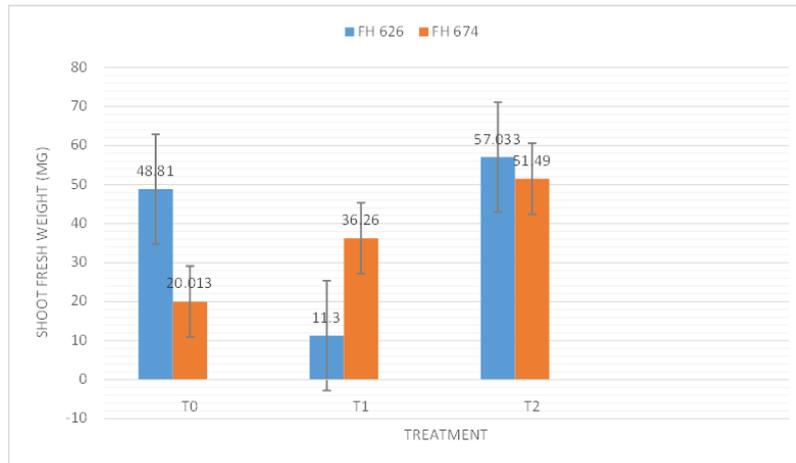


Fig-3: Effect of Copper on Shoot Fresh Weight (mg) of Sunflower

Table-4: Effect of Copper on Root Fresh Weight (mg) of Sunflower

Treatment	Variety FH 626	Variety FH 674
Distilled water (T0)	4.2	6.83
20 mM CuSO ₄ (T1)	1.51	2.84
40 mM CuSO ₄ (T2)	8.78	6.98

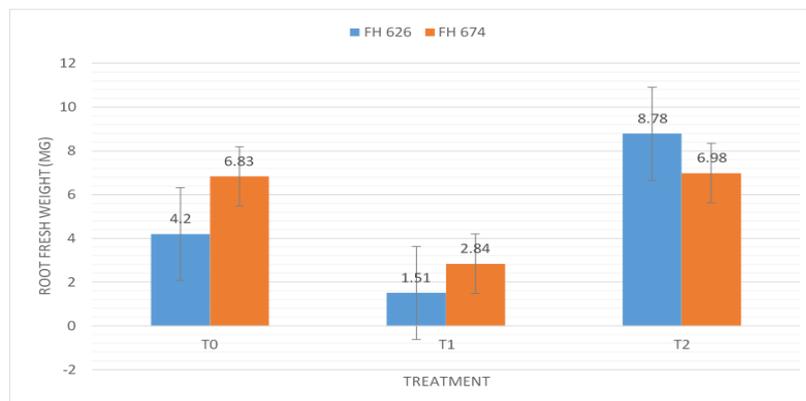


Fig-4: Effect of Copper on Root Fresh Weight (mg) of Sunflower

In higher plants, heavy metal toxicity is generally associated with growth inhibition and reduction in biomass production. Inhibition of both cell elongation and division by heavy metals results in a decline in biomass production [8].

CONCLUSION

Many aspects of the copper toxic efficiency on the plants are clarified, however results of several physiological and biochemical analysis are controversial. At the same time, high variability of plant reaction to the heavy metal ions depending up the genotypes complicates unambiguity of the conclusions. Deeper biochemical and molecular-biological analysis can contribute to revealing of other possible mechanisms of sunflower resistance to copper ions or other heavy metals.

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