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Original Research Paper

Observations on the Effect of Copper on Growth Performance, Dry Matter Production and Photosynthetic Pigments of *Ludwigia Perennis* L.

Sushma Jangid and S. K. Shringi
P.G. Department of Botany, Govt. College, Kota-324 001, Rajasthan, India

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ABSTRACT

Effects of various concentrations of copper were studied on growth performance, dry matter production and photosynthetic pigments of *Ludwigia perennis* L. The growth of the plant showed significant negative correlation with increase in concentration of copper. Higher concentrations of copper caused maximum reduction of shoot and root dry weight over the control plants. The reduction in dry weight of root was higher than the shoot. The photosynthetic pigments also showed reduction with increasing concentration of copper.

INTRODUCTION

The effect of heavy metals on living organisms are attracting widespread attention. In earlier times, there was little concern about the role of metals in environmental contamination. However, salts of the metals began to find their way into various uses in industries. It is evident that metallic salts posses certain biocidal properties. Though, many metals play a vital role in the physiological processes of plants, animals and humans, but excess concentration of heavy metals is harmful.

Some heavy metals (Fe, Cu, Zn) are essential for plants and animals (Wintz et al. 2002). Heavy metals such as Cu, Zn, Fe, Mn, Mo, Ni and Co are called micronutrients (Reeves & Baker 2000) and are toxic only when taken in excess of quantity (Monni et al. 2000, Blaylock & Huang 2000). Metals like mercury, copper, cadmium, lead, chromium and nickel are much toxic for all living organisms.

MATERIALS AND METHODS

Ludwigia perennis L. belonging to Family Onagraceae is a creeping herb, found abundantly at clean and polluted water bodies along Alaniya river near Kota (Rajasthan). The plant grows luxuriantly at contaminated sites. Higher copper concentrations were recorded in water and soil samples during year 2005-2006 (Table 1). Hence, it was interesting to know about tolerance levels of this plant species with respect to copper, a common contaminant of the study area.

In the present investigation an attempt has been made to observe the behaviour of *Ludwigia perennis* L. with respect to stress conditions by treating with different concentrations of copper in laboratory. The plants were collected from clean site of the study area immediately after rains.

Preparation of standard and culture solutions: For preparation of standard solution of copper, copper sulphate ($CuSO_4$) was dissolved in distilled water as per method of Welcher (1963). Solutions of four different concentrations, 10ppm, 1ppm, 0.1ppm and 0.01 ppm of the salt were prepared. Five plants of about same size were planted at equal distance in each earthen pot. Five replicates were used for each treatment and a control with only distilled water was also maintained. The plants were watered regularly with 500 mL water of different concentrations of the metal.

After ninety days of growth, growth performance of treated plants such as length of shoots, length of roots, and oven dry weight of shoots and roots were measured for the treated and control plants.

The estimation of photosynthetic pigments like total chlorophyll and carotenoids was carried out in control and treated plants (Arnon 1949).

RESULTS AND DISCUSSION

At different concentrations of copper the reduction in shoot length was observed (Table 2). As the concentration of copper increases, the shoot length of plants shows declining trend. In copper treated plants length of shoot decreases with increasing concentration of copper up to 0.10 ppm but after this concentration, the length of shoot slightly increases. The highest decrease (34.73%) in length was observed at

Table 1: Copper concentrations observed at clean and contaminated sites along Alaniya river system near Kota (Rajasthan).

Site	Water (mg/L)	Soil (µg/g)
Clean	Traces - 0.019	0.18 - 0.688
Contaminated water	0.09 - 0.121	3.40 - 6.14

0.10ppm, and the lowest decrease (7.82%) in length was observed at 0.01ppm concentration of copper over control plants (Fig. 1). Chaffai et al. (2005) in their studies on maize seedlings reported that the exposure of maize seedlings to 100µg $CuSO_4$ resulted in inhibition of shoot growth.

The length of roots also showed reduction with different concentrations of copper over control plants. The value of root length decreases with increasing concentrations of copper (Table 2). The root length of plants decreases at 0.01ppm and higher concentrations of copper compared to control plants, except at 0.1ppm of copper concentration the length of root slightly increases. The highest decline in root length was observed at 10 ppm (36.85%) and lowest at 1ppm (5.57%) over control plants (Fig. 2). The decline in the length of roots due to copper toxicity was also observed by Martins et al. (2006) in tomato plants.

The dry weight of shoots decreased significantly due to toxicity of copper in the plants. With the increasing concentration of copper, dry weight of shoots of plants decreased (Table 2). At higher concentration there was more decrease in the weight of shoots. The highest reduction (63.66%) in dry weight was observed at highest concentration (10ppm) of copper and lowest decline (48%) was observed at lowest concentration (0.01ppm) of copper over control plants (Fig. 3). Chaffai et al. (2005) also recorded reduction in the dry matter of maize seedlings exposed to copper toxicity.

The decline in dry weight of roots was observed at different concentrations of copper. The dry weight of roots also decreases with increasing concentrations of copper. The highest decline (67.30%) in the weight of dry matter of roots was recorded at higher concentration (10ppm) of copper and at low concentration (0.01ppm) of copper showed lowest decline (58.99%) over control plants (Fig. 4). The decrease in dry matter of roots of plants treated with copper was also recorded in tomato plants by Martins et al. (2006).

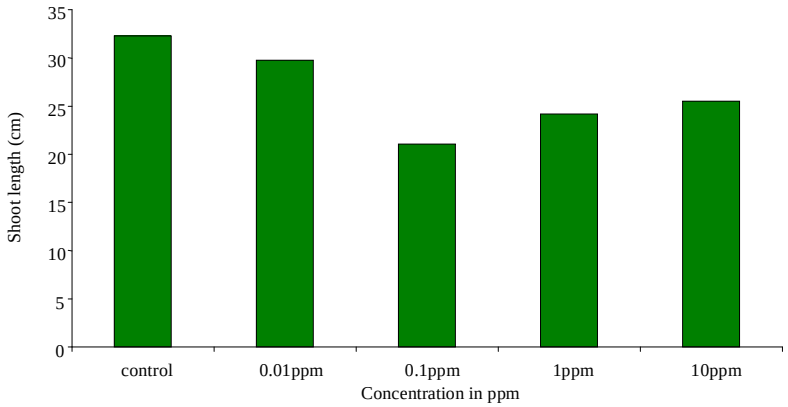

Fig. 1: Effect of different concentrations of copper on shoot length of *Ludwigia perennis* L.

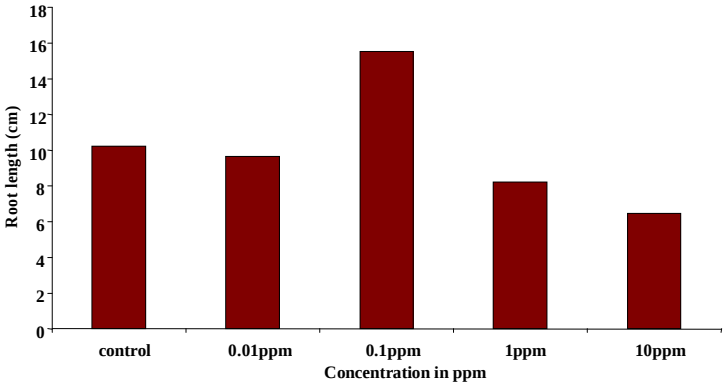

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Fig. 2: Effect of different concentrations of copper on root length of *Ludwigia perennis* L.

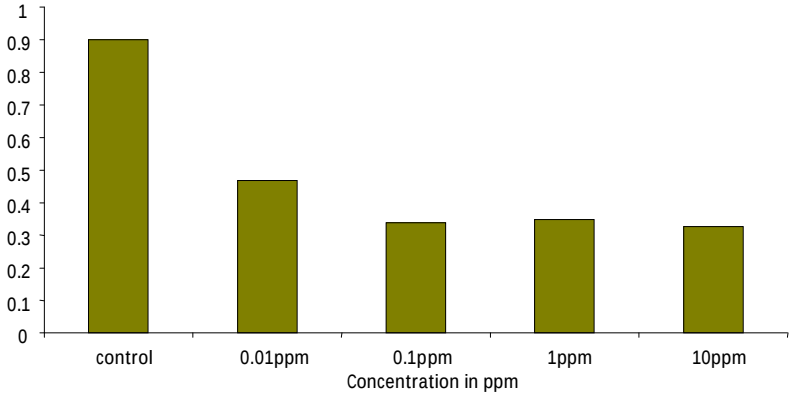

Fig. 3: Effect of different concentrations of copper on ODW of shoots of *Ludwigia perennis* L.

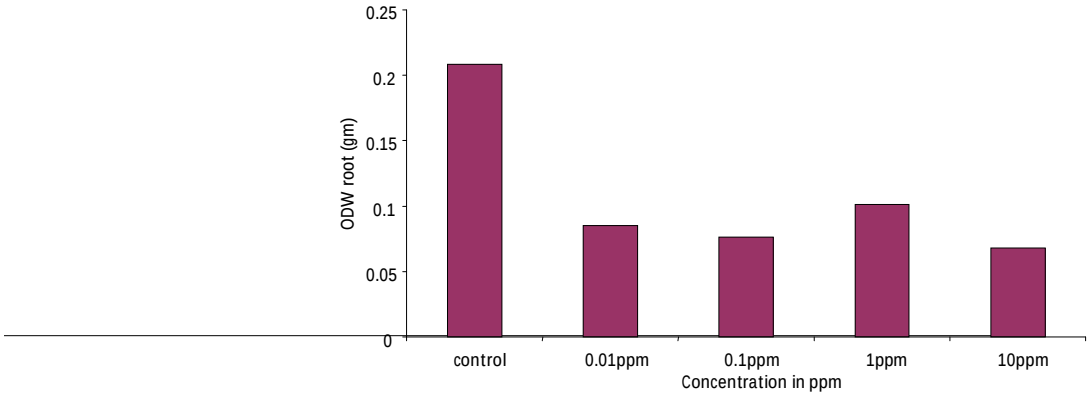

Fig. 4: Effect of different concentrations of copper on ODW of roots of *Ludwigia perennis* L.

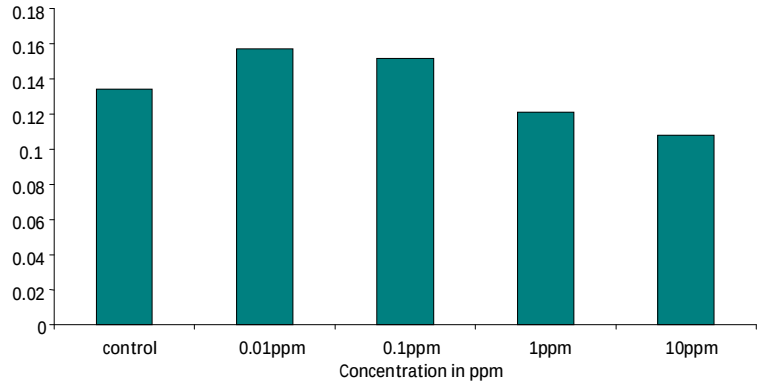

Fig. 5: Effect of different concentrations of copper on total chlorophylls of *Ludwigia perennis* L.

Copper toxicity has been shown to interfere with several aspects of plant biochemistry including pigment synthesis and photosynthesis (Fernandes & Hendriques 1991).

In the present study photosynthetic pigments were affected significantly due to copper toxicity (Table 3). The chlorophyll-*a* content decreases with the increasing concentrations of copper. At higher concentrations (10 ppm) 36.47 % reduction in the chlorophyll-contents was recorded over control plants. The chlorophyll-*b* content increases at low concentration (0.01ppm) but after this concentration, it started to decrease with increasing copper concentration. At higher concentration (10ppm) 8.88 % reduction in chlorophyll-b was recorded over control plants. The total chlorophyll contents increase at low concentrations of copper over

Table 2: Effect of different concentrations of copper on growth performance and primary production of 90-day old plants of *Ludwigia perennis* L. (Mean ± SEM).

Concentration of copper	Shoot length (cm)	Root length (cm)	SL/RL ratio	ODW Shoot (g)	ODW Root (g)
Control	32.33 ± 1.86	10.23 ± 0.32	3.17 ± 0.20	0.87 ± 0.017	0.21 ± 0.0025
0.01 ppm	29.80 ± 5	9.66 ± 1.49	3.23 ± 0 .53	0.46 ± 0.12	0.085 ± 0.0214
0.10 ppm	21.10 ± 1.39	15.53 ± 1.00	1.39 ± 0.18	0.33 ± 0.07	0.076 ± 0.00876
1.00 ppm	24.16 ± 2.28	8.23 ± 0.81	2.96 ± 0.03	0.35 ± 0.05	0.101 ± 0.0083
10.0 ppm	25.56 ± 1.010	6.46 ± 0.77	3.63 ± 0.99	0.28 ± 0.017	0.068 ± 0.014

Table 3: Effect of different concentrations of copper on photosynthetic pigments of 90-day old plants of *Ludwigia perennis* L. (Mean ± SEM).

Concentration of copper	Chlorophyll-*a* mg/g fr.wt.	Chlorophyll-*b* mg/g fr.wt.	Total chlorophyll mg/g fr.wt.	Carotenoides mg/g fr.wt.
Control	0.085±0.0005	0.045±0.0003	0.13±0.003	0.056±0.0005
0.01ppm	0.080±0.0005	0.072±0.0005	0.16±0.0007	0.050±0.0007
0.10ppm	0.080±0.0005	0.070±0.0005	0.15±0.0007	0.041±0.0003
1.00ppm	0.067±0.007	0.054±0.0005	0.12±0.0005	0.039±0.0003
10.0ppm	0.054±0.0003	0.041±0.0007	0.11±0.0005	0.031±0.0005

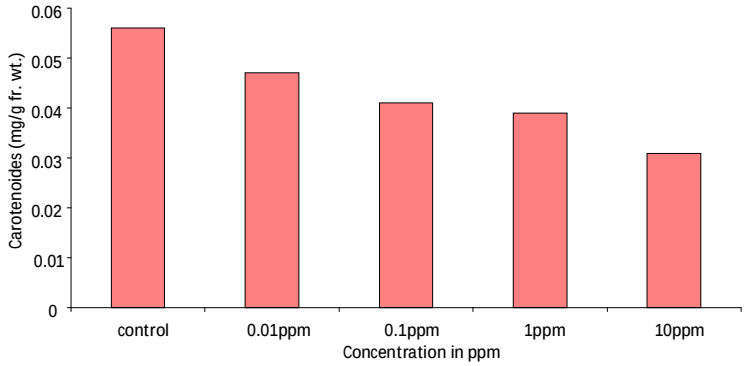

Fig. 6: Effect of different concentrations of copper on total carotenoids of *Ludwigia perennis* L.

control plants but at higher concentration declining trend in the total chlorophyll contents was observed over control plants. At highest concentration 15.38% reduction in total chlorophyll content was recorded (Fig. 5).

With the increasing concentration of copper, carotenoid content also decreases. The highest decline (44.64%) was recorded at higher concentration (10ppm) of copper (Fig. 6). The findings of Shakya et al. (2008) also supports our observations. They also recorded reduction in chlorophyll-*a*, chlorophyll-*b* and total chlorophyll in some moss and leafy liverworts like *Thuidium delicatulum*, *T. sparsifolium* and *Ptychanthus striatus* due to copper toxicity.

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