BIOLOGICAL EFFECTS OF CYANIDES ON GROWTH DYNAMICS OF CORN AND WHEAT PLANTS

EFECTE BIOLOGICE ALE CIANURILOR ÎN DINAMICA CREŞTERERII PLANTELOR DE PORUMB ŞI DE GRAU

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***Abstract**. The aim of this paper is to evaluate the effects of cyanides on corn and wheat plant growth. Seeds of corn (Zea mais) and wheat (Triticum aestivum) were put into Petri dishes on double filter paper together with solutions of cyanides of different concentrations. The dynamics of germination and root growth have been monitored. After that, the germinated seeds were planted in soil where they continued to growth. Two weeks later the content of photosynthetic pigments has been obtained spectrophotometrically. The negative effect from point of view of plant germination has been established for these cyanides, these effects depending on concentration of cyanide solutions. However, the content of some photosynthetic pigments increased, as a response of plants to the chemical stress.*
Key words: cyanides, root growth, photosynthetic pigments

***Rezumat**. Scopul acestei lucrări este de a evalua efectul cianurilor în creşterea plantelor de porumb şi grâu. Semințele de porumb şi grâu au fost puse în sticle Petri cu hârtie de filtru şi soluții de cianuri cu diferite concentrații. Dinamica germinării şi creşterea rădăcinilor a fost monitorizată. Apoi semințele de porumb germinate au fost plantate în sol, unde acestea au continuat să crească. După circa 2 săptămâni a fost determinat conținutul de pigmenți fotosintetici din frunze printr-o metoda spectrofotometrică. Din punct de vedere al germinării plantelor a fost stabilit un efect negativ al cianurilor, depinzând de concentrație. Pe de alta parte, conținutul unor pigmenți fotosintetici a crescut, ca răspuns al plantelor la stresul chimic.*
Cuvinte cheie: cianuri, creşterea rădăcinilor, pigmenți fotosintetici

INTRODUCTION

The environmental pollution is the major problem of humanity today when we are surrounded by numerous physical and chemical sources with devastating effects on the environment. Many studies related to the chemical contamination revealed the mechanism of contaminant action on plant growth and the relationship between these effects on human health. Some of these studies show that the toxicity is not tied to chemical compound quantity. Among the studied chemical compounds, the heavy metals and cyanides have the most important effects. The cyanides are used in gold mining holding, especially in Roşia Montană (Ballhorn, 2005; Eisler, 2004; Craig, 2015). This is the reason for analyzing the impact of cyanides on plant growth. The aim of this

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paper is to evaluate the effects of cyanides on corn *(Zea Mays)* and wheat (*Triticum aestivum*) plant growth.

MATERIAL AND METHODS

To study the effect of cyanides on plant growth, the following variants were used: **1.** Control; **2.** Na(CN) 0.1%; **3.** Na(CN) 0.2%; **4.** K_4 [Fe(CN)$_6$] 0.2%; **5.** K_4[Fe(CN)$_6$] 5%.

50 seeds of corn and wheat were put into Petri dishes on double filter paper together with 5 mL treatment solution. Four days, the seeds have been kept in dark and at optimal temperature (20-23°C). Every day was poured bidistilled water for control and treatment solution for the other variants to determine seed germination. After that, the germinated seed were planted in soil where they developed in optimal conditions. The dynamics of germination and the growth has been monitored during the first phenophase of growth, in accordance with the specialty literature (Wang, 2001). The photosynthetic pigments have been extracted in acetone (Foca N. et al, 2004), (Oancea S. et al, 2005), measured spectrophotometrically using a spectrophotometer SPECORD 200 produced by Analytik Iena and calculated according to Lichtenthaler formula (Lichtenthaler H.K., Wellburn A.R., 1983).

To analyse the effects of cyanides on plant growth the following measurements were performed: 1. the dynamics of seed germination; 2. biometric measurements on plant roots and plantlets; 3. measurements of photosynthetic pigments.

RESULTS AND DISCUSSIONS

Figure 1 shows a picture of corn germination after five days. The dynamics of corn germination is given in figure 2. A comparable dynamics for seeds treated with small concentration can be seen, but for the variant with 5% concentration in K cyanide, the germination is absent.

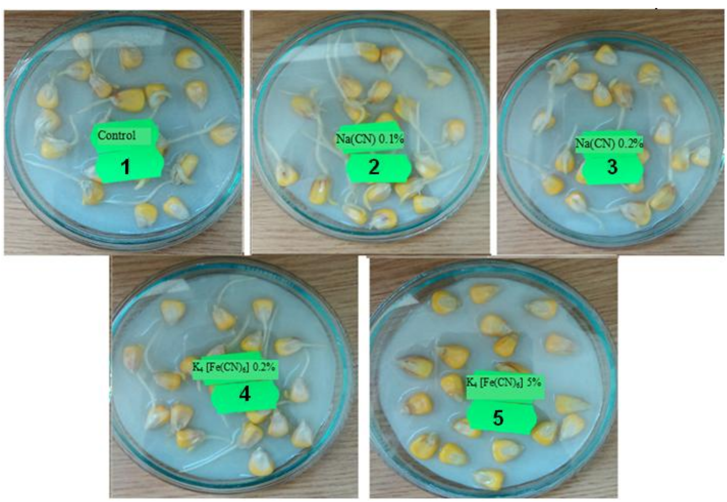

Fig.1. Corn seed germination after 5 days

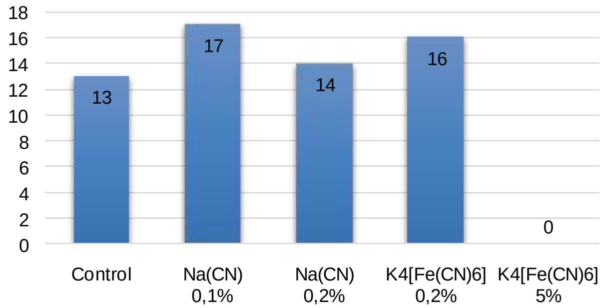

Fig. 2 Number of germinated corn seeds after 5 days

Control | Na(CN) 0.1% | Na(CN) 0.2% | K_4 [Fe(CN)6] 0.2% | K_4[Fe(CN)6] 5%

Fig. 3. Wheat seed germination after 8 days

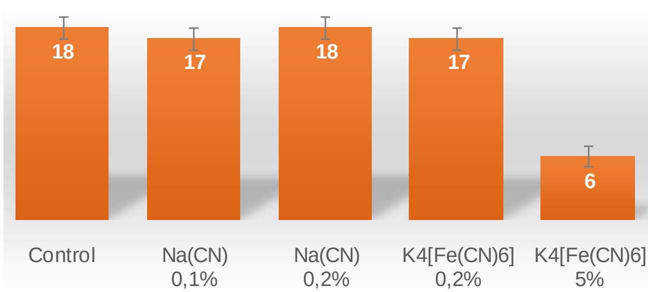

Fig. 4 Number of germinated wheat seeds after 5 days

Wheat germinated seeds can be seen in fig. 3 and germination dynamics in fig. 4.

Similar to the corn seeds, from figure 4 can be seen a comparable dynamics for seeds treated with small concentration of cyanides and control. In the variant case treated with 5% concentration in K cyanide, the germination is slowed down. After 8 days, all wheat seeds from the control variant germinated, but from the treated variants the strongest negative effect on germination was observed for K cyanide of 5% concentration.

The mean root length after five days for corn is given in fig. 5 and for wheat in fig. 6.

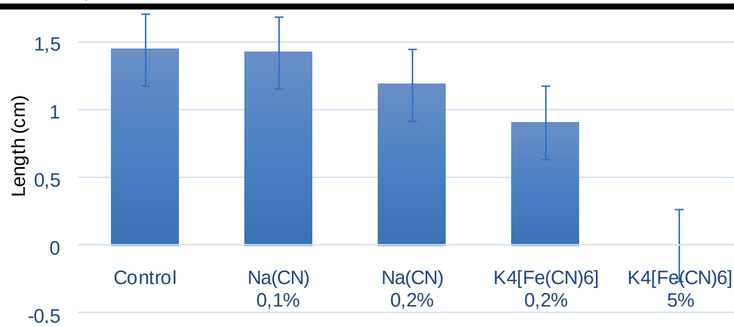

Fig. 5 Total corn root dimensions after 5 days of cyanide treatments. Error bars are confidence intervals as in (Oancea S., 2007), where n=20.

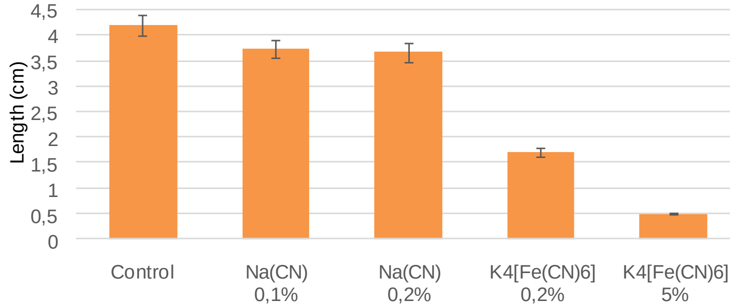

Fig. 6 Total wheat root dimensions after 5 days of cyanide treatments. Error bars are confidence intervals as in (Oancea S., 2007), where n=20.

From figure 5 and 6, a reduction of root dimension of the variants as compared with the control can be observed.

The content of photosynthetic pigments, chlorophyll a (Cha), chlorophyll b (Chb) and carotenoids (Car) from corn leaves is presented in figs. 7, 8 and 9.

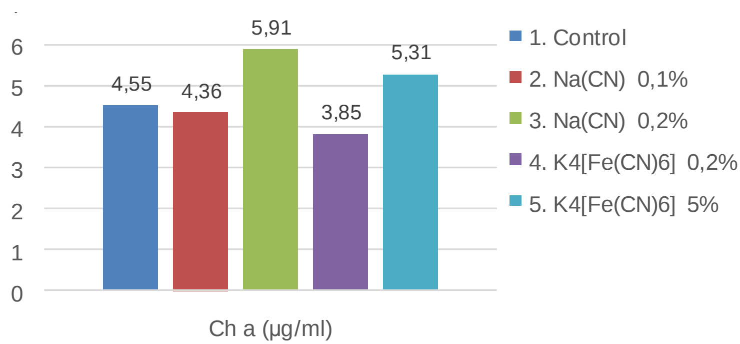

Fig. 7. The content of chlorophyll a from corn leaves (Cha)

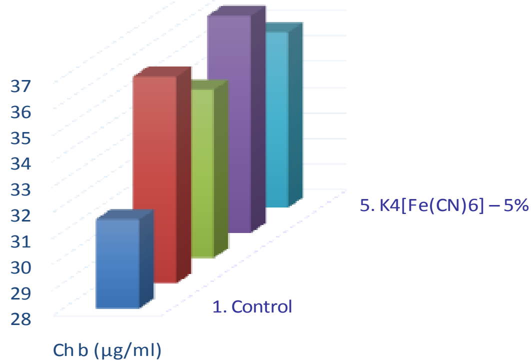

Fig. 8 The content of chlorophyll b from corn leaves (Chb)

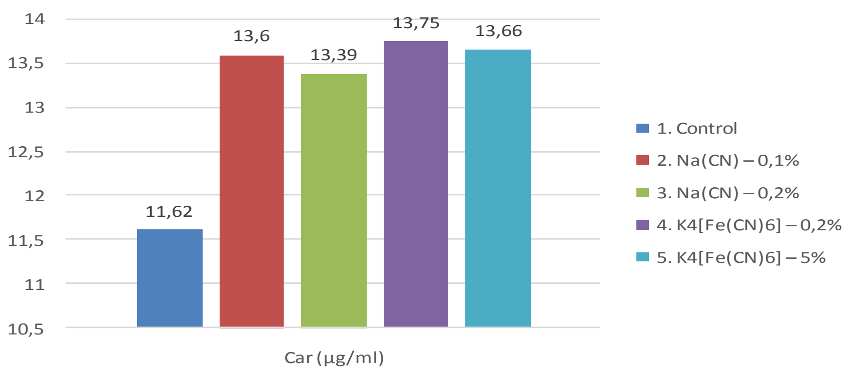

Fig. 9 The content of carotenoids from corn leaves (Car)

The ratio between (Cha+Chb)/Car is given in figure 10.

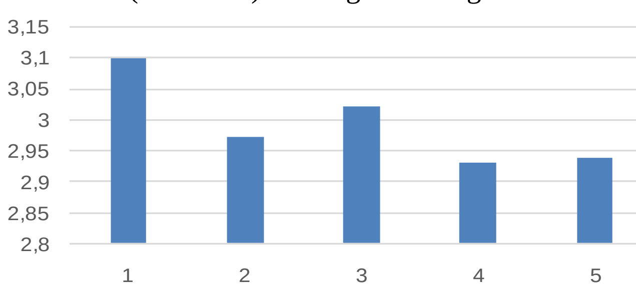

Fig. 10 The ration between (Cha+Chb)/Car

From fig. 10, can be noticed that the ratio (Cha + Chb)/Car is lower for treatment variants than for control and lower than 4, which is the optimal value for plant growth. These values are justified by the increase of carotenoid content, the carotenoids being involved in the resistance of plants to the chemical stress (Demming-Adams, 1996).

CONCLUSIONS

The effects of cyanides on plant growth for *Zea Mays* and *Triticum aestivum* are as follows.

For *Zea Mays* and *Triticum aestivum* species, an inhibition of germination can be observed and the highest negative effect was for K cyanide of 5% concentration. The same effect is registered on root dimension of plantlets.

Regarding the content of photosynthetic pigments, the response to the chemical stress is highlighted by increase of the Cha content and the decrease of Chb content.

The content of carotenoids is higher for treated plants than for the control plants, which means that the carotenoids assure the resistance of plants to the chemical stress. The carotenoids protect the plants against photo-oxidation produced in secondary reactions.

The ratio (Cha + Chb)/Car is lower for treatment variants than for control variant and lower than 4 (the optimal value for plant growth). These values are justified by the increase of carotenoid content, the carotenoids being involved in resistance of plants to the chemical stress.

These results shows that, beside the fact that $K_4[Fe(CN)_6]$ is considered to be non-toxic, at high concentration (5%) it has a strong negative effect on germination in root growth.

Because of these effects of cyanides on plant growth, these chemical compounds that show a great interest, require new tests in this domain. Concerning the cyanide effect on human health, it is very important to know the content of cyanide found in the fruits of these plants that are consumed.

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