BIOLOGICAL EVALUATION OF LAYERED DOUBLE HYDROXIDES EFFECT ON THE GROWTH OF CORN PLANTS

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Abstract

The Layered Double Hydroxides are useful in many domains due their physical and chemical properties; in agriculture they are useful in order to obtain organic products. In this work, a study concerning the plant growth dynamics of corn plant during the LDH action is presented. To study the effect of LDHs on plant growth, we prepared MgAlLDH (Mg Al Layer Double Hydroxide), MgAlLDH+sodium paranitrophenolate and MgAlLDH+ sodium paranitrophenolate +Fe_3O_4. Seeds of corn (Zea mais) were put into Petri dishes on double filter paper together with suspensions from these anionic clay and they were kept here for 5 days. The dynamic of germination and the growth has been monitorized during the first phenophase of growth. After that the germinated seed were planted in soil where they continued to growth. The content of photosynthetic pigments has been obtained spectrophotometrically. Despite the fact that the germination was faster for the control than the other variants, the content of the photosynthetic pigment was very closed for control and treated plants. The effect of magnetite introduced in structure of LDH was positive, it moderated the toxicity of sodium paranitrophenolate. Because are not toxic LDHs can be materials of great interest especially in organic agriculture. Therefore they can substitute some fertilizers or plant growth stimulators, (especially toxic chemical compounds) in order to obtain organic products.

Key words: LDH, magnetite, sodium paranitrophenolate, photosynthetic pigments.

Layered double hydroxides (LDHs) or the so-called anionic clays are described with formula $[M^{2+}_{1-x}M^{3+}_{x} (OH)_2][A^{n-}_{x/n} .zH_2O]$, where M is a metal cation and A is the anion (Chiriac H. and collab., 2008). The LDHs are now widely studied materials due to their aplication in various researchs and industrial purposis sucjh as catalists, anion exchangers, medicine and nanometer sized materials (Lee, J.H. and collab., 2005). Due their capacity of ion exchangers, anionic clays have been used to remove the toxic compounds from water as arsenite (You, Y.W. and collab., or chromate (Houri, B. and collab., 1999) or ion exchange from paraquat by the anionic clay [Zn-Al-Cl] (Lakraimi, M. and collab., 1999. Some authors reported about the advantages of mesoporous materials as drug delivery vehicles (Ajat, M.M.Md. and collab., 2008), Salonen, J. and collab., 2005, Xu, Z.P. and collab., 2006). There is also an increasing amount of research on the effects of nanomaterials on plant growth (Chiriac, H and collab., 2008, Frunza, M. and collab., 2007). Limited studies reported both positive and negative effects of nanoparticles on higher plants. It was pointed out that some nanoparticles enhance the abilities of absorbing and utilizing water and fertilizer and apparently hasten its germination and growth. However, there are still many unresolved issues and challenges concerning the biological effects of nanoparticles. In this paper, the comparative effects of two anionic clay on germination rate, root elongation, growth of *Zea mais* were analyzed. Germination rate and root elongation, as a rapid phytotoxicity test method, possess several advantages, such as sensitivity, simplicity, low cost and suitability for unstable chemicals or samples. These advantages made them suitable for developing a large-scale phytotoxicity database and to study mechanisms of phytotoxicity (Wang, X. and collab., 2001).

MATERIAL AND METHOD

To study the effect of anionic clays on plant growth, two kinds of clays have been prepared and we sorted the following variants:

1. control;
2. MgAlLDH + sodium paranitrophenolate;
3. MgAl LDH + sodium paranitrophenolate +Fe_3O_4.

The experiments were conducted in the Biophysics Department Laboratory of the University of Agronomy from Iasi. As a biological material we used corn (*Zea mays*), the most widely used cereal in our country. 50 seeds of corn were put into Petri dishes on double filter paper together with 5 mL treatment solution (a suspension that contains 0.5g of clay and 50mL bidistilled water). Here the seeds were kept in dark at the optimal temperature (23^0C) for 5 days. After that the germinated seed were planted in soil in the our laboratory where they developed for two months. The dynamic of germination and the growth has been monitorized during the first phenophase of growth. Photosynthetic pigments were extracted in acetone (Foca, N. and collab., 2004, Oancea, Servilia, 2007, Oancea, Servilia and collab., 2005 measured spectrophotometrically using a spectrophotometer SPECORD 200 produced by Analytik Iena and calculated according to Lichtenthaler formula (Lichtenthaler, H.K and collab., 1983).

RESULTS AND DISCUSSIONS

Figure 1 shows the corn seed germination after LDH treatment.

Germination dynamics of corn seeds is given in *figure 2* and the root dimensions in *fig. 3*.

Figure 2 shows that the control seeds germinated faster that the treated seeds but after 95 hours the number of germinated seeds remains unchanged.

Figure 1 **Corn seed germination after LDH treatment**

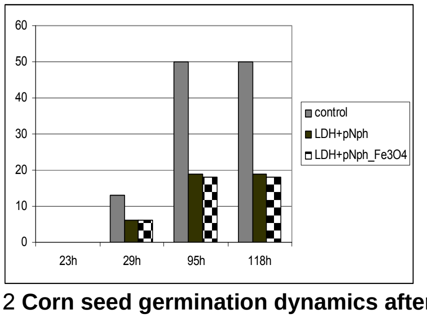

Figure 2 **Corn seed germination dynamics after LDH treatments**

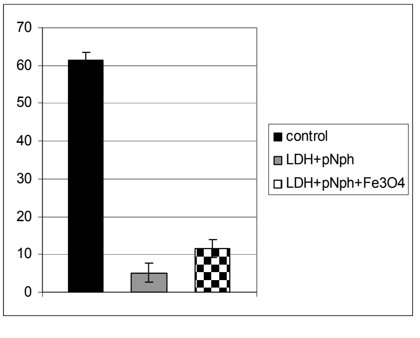

Figure 3 **Corn root dimensions (mm) after 5 days of LDH treatments. Error bars are 95% confidence intervals (n=10) (5)**

From *figure 3* we can see that the corn root dimensions of the control plants are much better developed than the treated plants.

By comparison with root dimensions, the difference between the stem dimensions of the treated plants and the control one is decreased, as the *figure 4* shows.

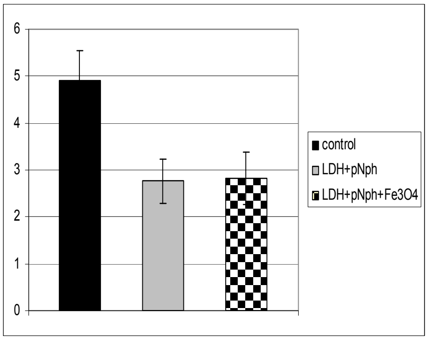

Figure 4 **Corn stem dimension e after 5 days of LDH treatments. Error bars are 95% confidence intervals (n=10)**

After two week these differences are smaller than before such as *figure 5*.

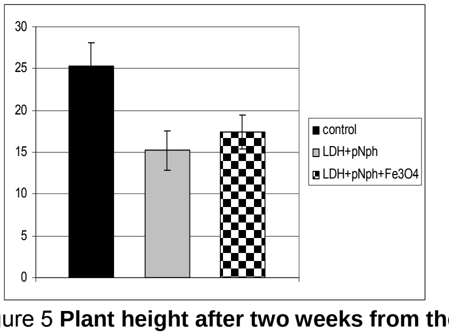

Figure 5 **Plant height after two weeks from the treatment**

Content of photosynthetic pigments, chlorophyll a (Chla), clorophyls b (Chlb) and carotenoids (Car) from corn leaves are given in *figure 6*.

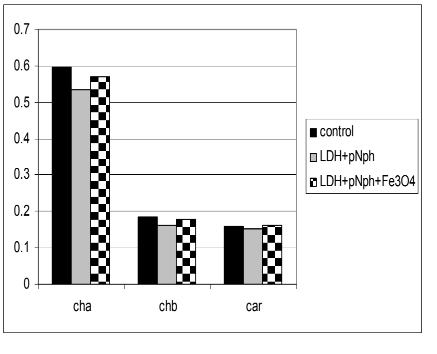

Figure 6 **The content of photosynthetic pigments (mg/g fresh tissue) from plant leaves**

Figure 6 shows that the content of pigments for treated plant is very close with the control plant; this means that, despite the fact that the control plants germinated faster and they have been grown better than the other plants, the plants have the capacity to revert for this dose of treatment.

CONCLUSIONS

Our results prove that there are differences between control plants and those treated with LDH suspensions. Despite the fact that the germination was faster for the control than the other variants, the content of the photosynthetic pigment for the treated plants was very close with the control plants.

Although the sodium paranitrophenolate is a chemical compound of Atonik, a growth stimulator, the dose used in this research (0.5g LDH for 50ml H_2O) have a negative effect on germination and plant growth.

The effect of magnetite introduced in structure of LDH was positive, it moderated the toxicity of sodium paranitrophenolate (the root dimension, the stem dimension and the height of plant for treated plants with LDH containing sodium paranitrophenolate and magnetite are higher than the plants treated with LDH containing only sodium paranitrophenolate).

Our results show that the action of this treatment is visible especially for germination and on the plant roots because the treatment is applied on plant seeds. A slow release of the active substance from nanocomposite material can be exploited for control release formulation of some pesticide or plant growth stimulator; this means the intercalation of pesticides or plant growth stimulator into layers of LDH is a feasible solution. Because are not toxic they can be materials of great interest especially in organic agriculture. Therefore they can substitute some fertilizers or plant growth stimulators, (especially toxic chemical compounds) in order to obtain organic products.

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