GROWTH DYNAMICS OF CORN PLANTS DURING ANIONIC CLAYS ACTION

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Layered double hydroxides (LDHs) known as anionic clays are an important class of ionic lamellar solids. The anionic clays exhibit anion sorption, anion diffusion and exchange properties together with surface basicity making them materials of importance for many modern applications. The LDHs clays are useful in agriculture due their physical and chemical properties, in order to obtain organic products. This work is a study concerning the plant growth dynamics of corn plant during the LDHs action. To study the effect of anionic clays on plant growth, we prepared MgAlLDH (Mg Al Layer Double Hydroxide)+ sal and Mg Al LDH + sal +Fe_3O_4.

Seeds of corn (Zea mays) were put into Petri dishes on double filter paper together with suspensions from these anionic clays and they were kept here for 3 days. The dynamics of germination and the growth has been monitorized during the first phenophase of growth. After that the germinated seeds were planted in soil where they continued to growth. The content of photosynthetic pigments has been obtained spectrophotometrically. The best anionic clay from point of view of plant growth was the clay containing Mg, salicylic acid and magnetite. Despite the fact that the germination was faster for the control than the other variants, the content of the photosynthetic pigments was greater for the treated plants. A slow release of the active substance from nanocomposite material can be exploited for control release formulation of some pesticides or plant growth stimulators; this means the intercalation of pesticides or plant growth stimulators 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.

***Key words**: LDH, magnetite, salicilic acid, photosynthetic pigments.*

Layered double hydroxides (LDHs) or the so-called anionic clays are the analogue of the extensively studied family of cationic smectite clay minerals, a group of minerals which tend to fill out when they are inserted into water (bentonite includes minerals from smectite group). LDH structure is 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.

The anionic clays exhibit anion sorption, anion diffusion and exchange properties together with surface basicity making them materials of importance for many modern applications (1), (2), (5), (12), (15). Recent reports on the advantages of mesoporous materials as drug delivery vehicles have imposed research in novel applications and several materials with this purpose have been reported (11). The potential of mesoporous materials to improve the permeability of large hydrophilic drug substances has also been explored. Due their capacity of ion exchangers, anionic clays have been used to remove the toxic compounds from water as arsenite (14) or chromate (4). M. Lakraimi and coworkers (6) studied the ion exchange from the molecule of pesticide 2.4-dichlorophe- noxyacetate (2.4D), the paraquat by the anionic clay [Zn-Al-Cl] using X rays and IR spectroscopy.

There is also an increasing amount of research on the effects of nanomaterials on plant growth. 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. On the other hand, the toxicity of nanoparticles may be attributed to two different actions a) a chemical toxicity based on the chemical composition, e.g., release of (toxic) ions; and (b) stress or stimuli caused by the surface, size and/or shape of the particles (8). However, there are still many unresolved issues and challenges concerning the biological effects of nanoparticles.

In this paper, the comparative effects of some 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 (13).

MATERIAL AND METHOD

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

1. control
2. MgAlLDH+Fe_3O_4
3. MgAl LDH +sal +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^{0}C) for 3 days. After that the germinated seed were planted in soil in the greenhouse where they developed in optimal conditions. The soil was prepared from celery soil in proportion of ¾ and red peat (produced by Kekkilä Ozi from Tuusula, Finland) in proportion of ¼. The peat contains 40% organic compounds 23% carbon of biological origin and 0,4% organic nitrate.

The dynamic of germination and the growth has been monitorized during the first phenophase of growth. Photosynthetic pigments were extracted in acetone (3), (10) measured spectrophotometrically using a spectrophotometer SPECORD 200 produced by Analytik Iena and calculated according to Lichtenthaler formula (7).

RESULTS AND DISCUSSIONS

Figure 1 shows the corn seed germination dynamics after 3 days and figure 3 the root dimension after 3 days.

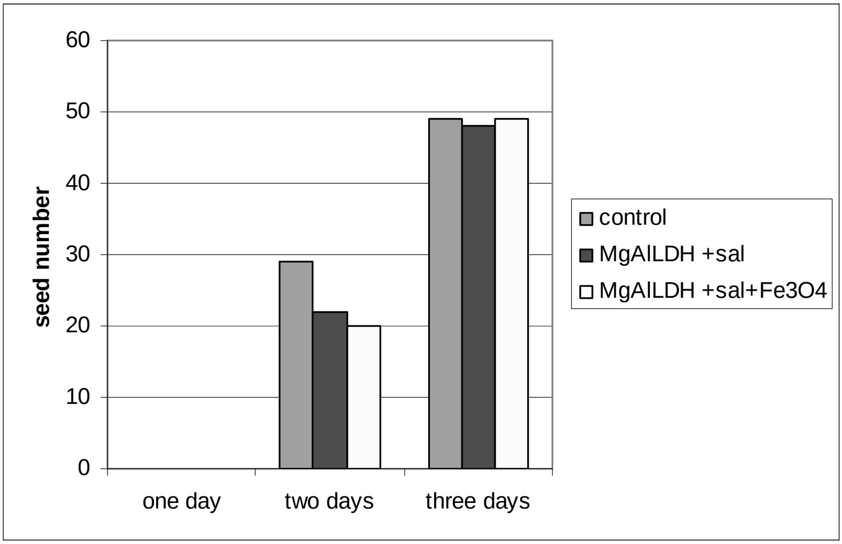

Figure 1 **Corn seed germination dynamics after anionic clay treatments**

Figure 1 shows that the control seeds germinated faster that the treated seeds but after three days the number of germinated seeds is the same.

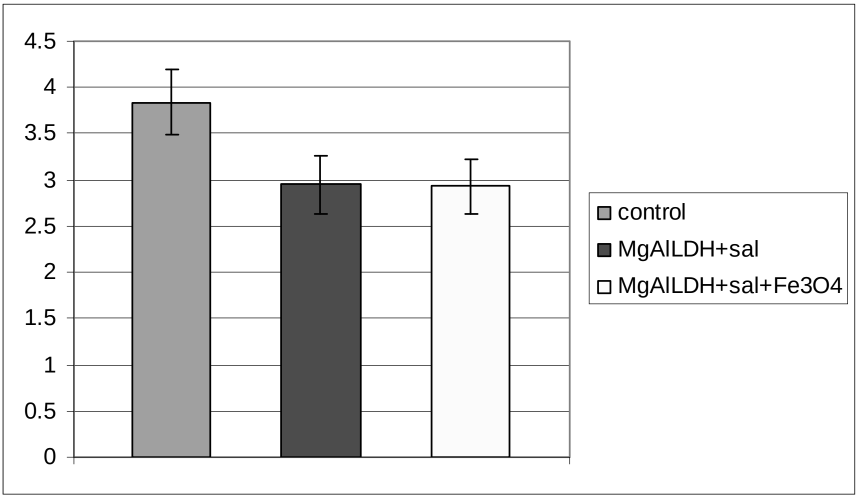

Figure 2 **Corn root dimensions after 3 days of mesoporous clay treatments. Error bars are 95% confidence intervals (n=50) (9)**

From *figure 2* we can see that the corn root dimensions of the control plants are better developed than the treated plants.

By comparison with root dimensions, the stem dimensions of the treated plants are higher that the control, as the *figure 3* shows.

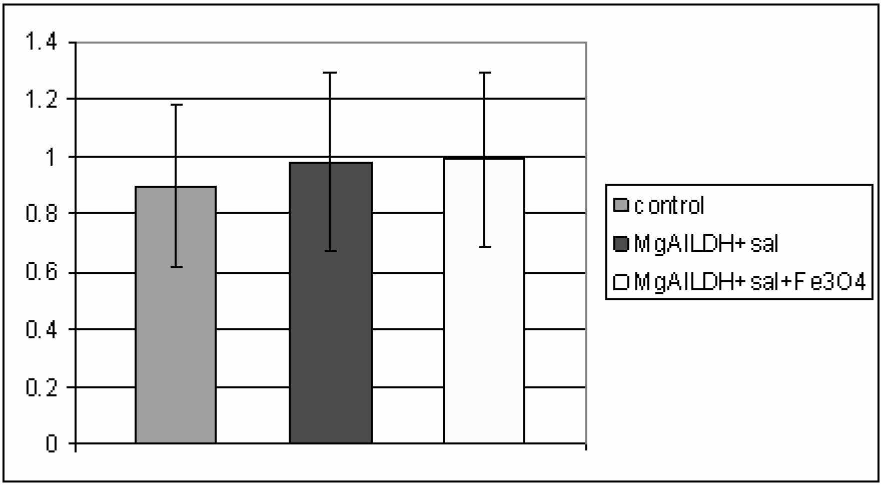

Figure 3 **Corn stem dimension e after 3 days of mesoporous clay treatments. Error bars are 95% confidence intervals (n=50)**

Content of photosynthetic pigments, chlorophyll a (Chla), clorophyls b (Chlb) and carotenoids (Car) from corn leaves are given in *figure 4*.

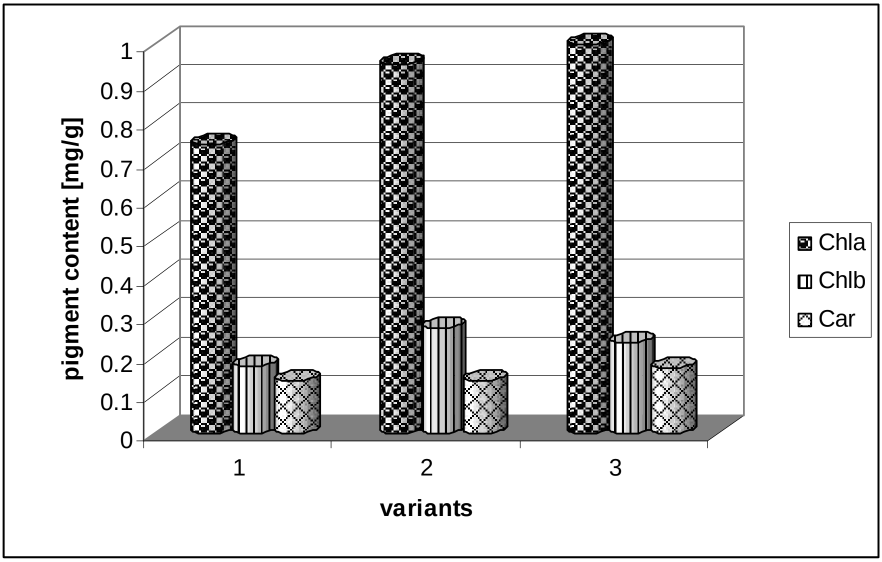

Figure 4 **The content of photosynthetic pigments (mg/g fresh tissue) from plant leaves**

From *figure 4* we can see that the content of chlorophyl a (the most important photosynthetic pigment), for treated plant is meaningful higher than the control plant leaves but the content of the other photosynthetic pigment only slightly increases.

CONCLUSIONS

Our results prove that there are differences between control plants and those treated with anionic clay suspensions. The best anionic clay from point of view of plant growth was the variant containing Mg, salicylic acid and magnetite; all these compounds contribute to improve the plant growth.

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 higher than the control plants.

The structure of LDH offers a good and controlled release of some active substances from nanocomposites to the plant cell. 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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