THE EFFECTS OF MAGNETITE ON GROWTH DYNAMICS OF CORN PLANTS

EFECTUL MAGNETITEI ÎN CREŞTEREA PLANTELOR DE PORUMB

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Abstract. *The aim of this paper is to evaluate the effects of magnetite on corn plant growth. Seeds of corn (Zea mays) were put into Petri dishes on double filter paper together with suspensions from anionic clay with Mg, anionic clay containing Fe and magnetite. In addition, we performed a treatment with pure magnetite on corn seeds. The seeds were kept here for 4 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. The best stimulator treatment from point of view of plant growth was the clay containing magnetite. Therefore, a slow release of the active substance from nanocomposite material can be exploited for control release formulation of some plant growth stimulator.*
Keywords: LDH, magnetite, photosynthetic pigments

Rezumat. *Obiectivul acestei lucrari este de a evalua efectele magnetitei in cresterea plantelor de porumb. Semințele de porumb (Zea mays) au fost puse în sticle Petri cu hârtie de filtru şi suspensia de argilă cu Mg, argilă continand Fe si argila continand magnetita. In plus am realizat si un tratament asupra semintelor cu magnetita pura. Semintele fost ținute aici timp de 3 zile. A fost monitorizată dinamica germinației şi creşterea plantelor în timpul primar fenofaza de crestere. Dupa acea semintele germinate au fost plantate in sol unde au continuat sa creasca. Continutul de pigmenti fotosintetici a fost obtinut spectrofotometric. Cel mai stimulator tratament din punct de vedere al cresterii plantelor a fost cel cu argila ce continea magnetita. Astfel o eliberare inceata a unei substante active din nanocompozita poate fi folosita pentru controlul stimulatorilor de crestere.*
Cuvinte cheie: argile anionice, magnetită, pigmenți fotosintetici

INTRODUCTION

Layered double hydroxides (LDHs) known as anionic clays are an important class of ionic lamellar solids. LDH structure is described with formula $[M^{2+}{}_{1-x}M^{3+}{}_{x}(OH)_{2}][A^{n-}{}_{x/n}.zH_2O]$, where M^2 is a divalent metal ion such as Mg^{2+}, Ca^{2+}, Zn^{2+}, etc, M^3 is a trivalent ion such as Al^{3+}, Cr^{3+}, Fe^{3+}, Co^{3+} and A is an anion such as Cl^-, $CO_3{}^{2-}$,$NO_3{}^-$ etc.The anionic clays exhibit anion sorption, anion diffusion and exchange properties together with surface basicity making them materials of importance for many modern applications

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(Chiriac et al., 2008; Dorante, 2007; Houri et al., 1999; Salonen et al., 2005; Tsai et al., 2002; You et al., 2001).

Anionic clays, have attracted increasing interest as nanovehicles for delivering genes, drugs, and bio-active molecules into cells. The LDHs clays can be useful in agriculture due their physical and chemical properties, in order to obtain organic products (Chiriac et al., 2008).

Comparative effects of some composites containing anionic clays, Fe_3O_4 on germination rate, root elongation, stem dimension, and photosynthetic activity have been reported in this paper. 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 (Lin, 2007; Wang et al., 2001).

MATERIAL AND METHOD

To study the effect of anionic clays on plant growth, many types of clay have been prepared, but here we sorted the following variants:

1. control;
2. Fe_3O_4;
3. MgAl LDH+ Fe_3O_4;
4. MgFe LDH;
5. MgAlLHD

30 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).

Four days the seeds have been kept in dark and at optimal temperature (20-23^{0}C). Every day we 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 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 dynamic of germination and the growth has been monitorized during the first phenophase of growth.

Photosynthetic pigments have been extracted in acetone (Foca et al., 2004; Oancea et al., 2005), measured spectrophotometrically using a spectrophotometer SPECORD 200 produced by Analytik Jena and calculated according to Lichtenthaler formula (Lichtenthaler, 1983).

RESULTS AND DISCUSSIONS

Figure 1 shows the corn seed germination dynamics after 48hours, 72 hours and 86 hours of treatment and figure 2 the root dimension after 4 days.

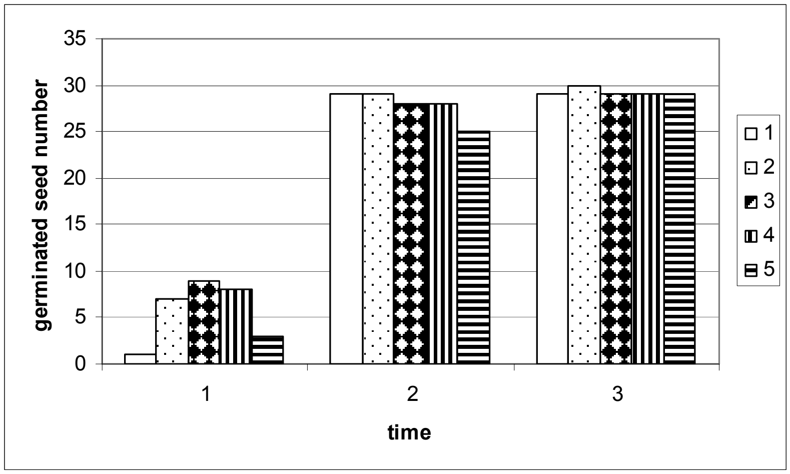

Fig. 1 – Corn seed germination after 4 days

Figure 1 show that the treated seeds with magnetite or anionic clay germinated faster than the control seeds but after fours days the number of germinated seeds is the same.

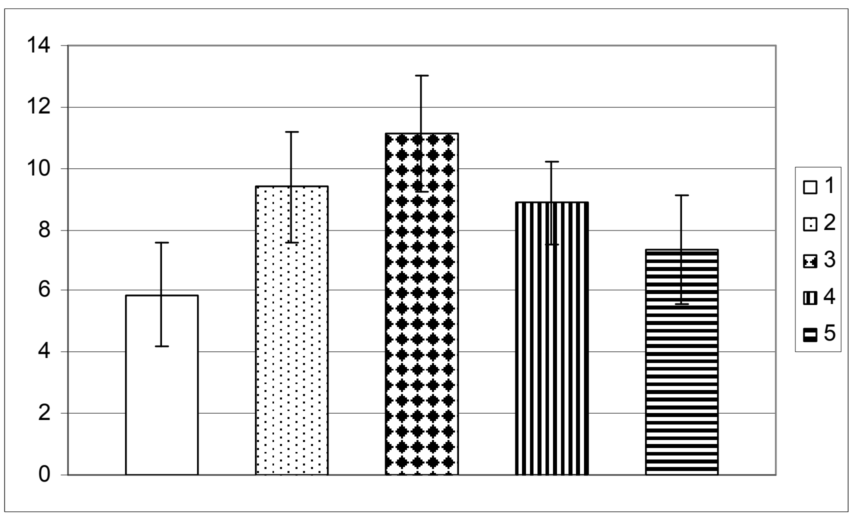

Fig. 2 – Total corn root dimensions after 4 days of anionic clay treatments. Error bars are confidence intervals as in [9] and n=10

From figure 2 we can see that the corn root of treated plants with magnetite or anionic clay are better developed than the control seeds. Comparing the error bars from treated plants with composite containing magnetite and the control plant, we can see that a significant statistic difference exists between them.

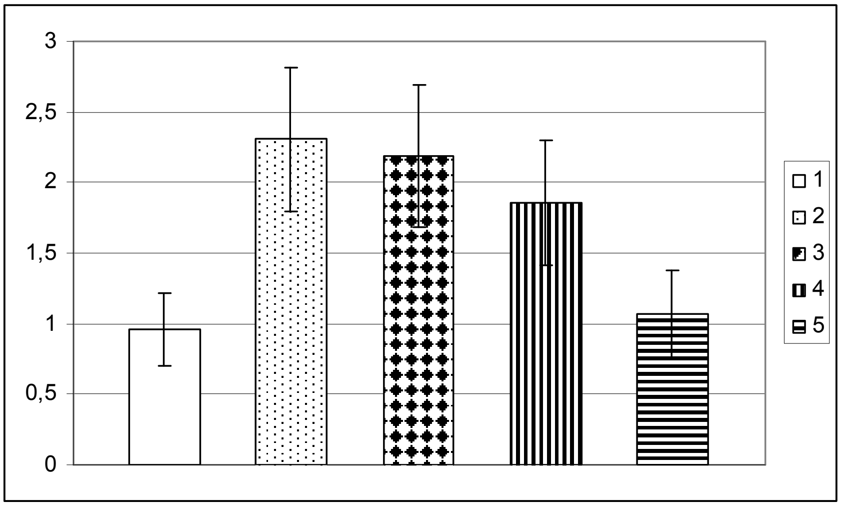

Fig. 3 – The stem dimensions, after 4 days of treatment with anionic clays

As the figure 3 shows, the corn stems of the treated plants were better developed than the control plants. A significant statistic difference can be put in evidence for treated plant with magnetite and anionic clay containing magnetite and Fe and the control plants.

Figure 4 shows the height of corn plants after 7 days from the treatment.

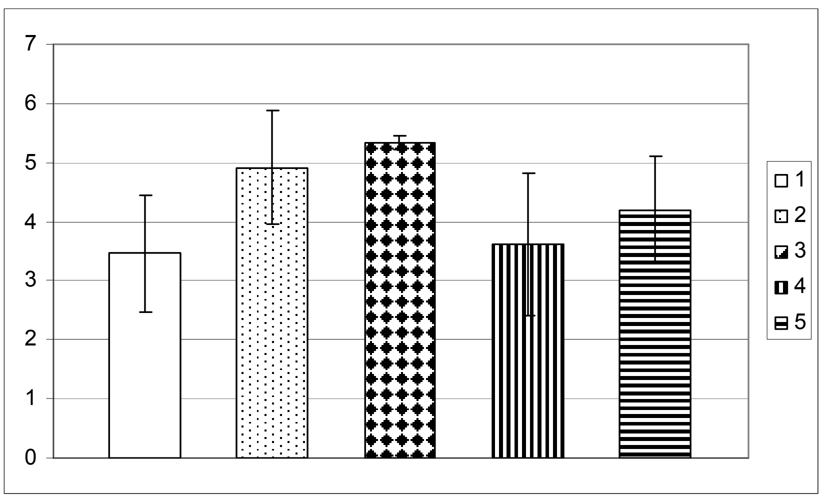

Fig. 4 – The height of corn plants after 7 days from the treatment

From figure 4 we can see that the errors bars don't overlap only for control plant and the plants treated with the clay containing magnetite; this means a significant difference between these plants. However the ANOVA test, single factor gives a value of p=0.003067, i.e. a statistical difference between variants.

In addition, the smallest value of the confidence interval for that treated plants with the clay containing magnetite shows that these plants grow uniformly.

Content of photosynthetic pigments, chlorophyll a (Chla), clorophyls b (Chlb) and carotenoids (Car) from corn leaves is presented in figure 5.

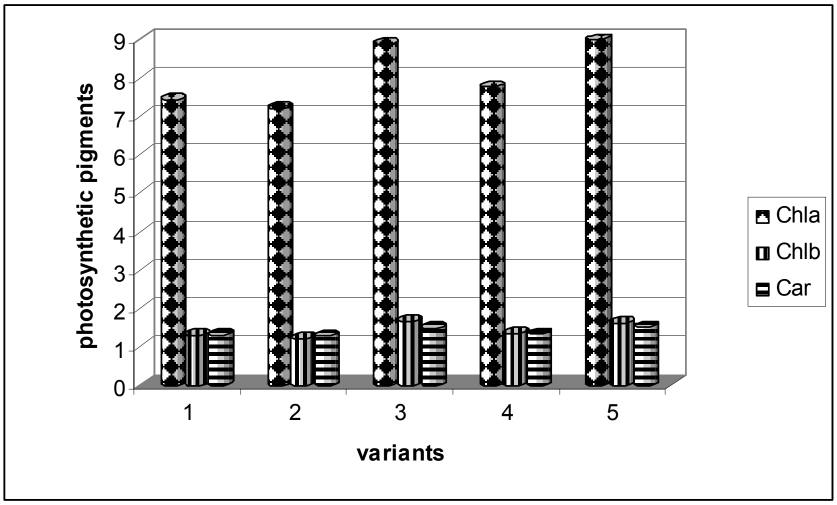

Fig. 5 – The content of photosynthetic pigments (mg/g fresh tissue) from corn leaves

From figure 5 we can see that the content of chlorophyl a (the most important photosynthetic pigment), for treated plant with anionic clays (especially for anionic clay containing magnetite) is higher than for the control plant leaves. In terms of content of chlorophyl b and carotenoid, these quantities slightly increase for the same treatments.

CONCLUSIONS

The anionic clays are useful in agriculture due their physical and chemical properties. 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 composite containing magnetite. This means the magnetite has a beneficial effect on plant growth. In addition, the structure of LDH offers a good and controlled release of some active substances from nanocomposites to the plant cell.

Our results are in concordance with C. Jiao et al. (2009) work, which recently reported the synergistic effects of Fe_2O_3 with layered double hydroxides.

Because are not toxic these composites 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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