PRELIMINARY TEST RESULTS CONCERNING THE EFFECTS OF ANIONIC CLAYS ON PLANT GROWTH

REZULTATE PRELIMINARE PRIVIND EFECTELE ARGILELOR ANIONICE ÎN CREŞTEREA PLANTELOR

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Abstract. *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). The anionic clays exhibit anion sorption, anion diffusion and exchange properties together with surface basicity making them materials of importance for many modern applications. These anionic clays are useful in agriculture due their physical and chemical properties, which decrease the pollution effects, in order to obtain organic products. In this work, a preliminary test concerning the effects of some anionic class on tomato plant growth is presented. Seeds of tomato (Lycopersicon esculentum) were put into Petri dishes on double filter paper together with suspensions from some anionic clay and they were kept here for 6 days. The dynamic of germination and the growth has been monitorized during the first phenophase of growth. Our results showed that the anionic clays could modify the plant growth.*

Rezumat. *Argilele anionice (LDH) sunt analogii unei familii intens studiate de argile minerale cationice, smectitele, un grup de argile minerale care tind să se umfle când sunt introduse în apă (bentonita include minerale din grupul smectite). Argilele anionice prezintă proprietăți de sorbție a anionilor, de difuzie a anionilor şi de schimb şi datorită bazicității superficiale sunt materiale cu importanță şi aplicații în domenii moderne. Aceste argile anionice sunt materiale care pot fi folosite in agricultură datorită proprietăților fizice şi chimice, care permit micşorarea efectelor poluarii, cu scopul obținerii unor produse agricole ecologice. In această lucrare este prezentat un test preliminat privind efectele unor argile anionice în creşterea plantelor de tomate. Semințele de tomate (Lycopersicon esculentum) au fost puse în sticle Petri cu hârtie de filtru şi suspensia de argilă şi au fost ținute aici timp de 6 zile. A fost monitorizată dinamica germinației şi creşterea plantelor în timpul primelor fenofaze. Rezultatele noastre arată că argilele anionice pot modifica dezvoltarea plantelor.*

INTRODUCTION

Mesoporous synthetic clays (MSCs) are derived from layered structures (heterostructures of porous clays). A series of mesoporous synthetic organo-clay complexes has been prepared by hydrothermal crystalization of gels containing silica, magnesium hydroxide, lithium fluoride, and an organic of choice, followed by calcination to remove the organics. 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). 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), (3), (10). 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 (7). 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 (9). M. Lakraimi and coworkers (4) 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 (5). 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 *Lycopersicum esculentum* 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 (8).

MATERIAL AND METHODS

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

1. control
2. MgFeLDH (Mg Fe Layer Double Hydroxide) (301);
3. MgAlLDH+Fe_3O_4 (303);
4. ZnAlLDH (401);
5. MgAl LDH (405);

50 seeds of tomatoes were put into Petri dishes on double filter paper together with 5 mL treatment solution (a suspension that contains 0.4g of clay and 40mL bidistilled water). Here the seeds were kept in dark and at optimal temperature (20-23^{0}C) for a week. 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 the greenhause 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. After 12 days the tomato plants were pricked out in pots and here they continue to growth.

RESULTS AND DISCUSSIONS

In figure 1 the seed germination is presented.

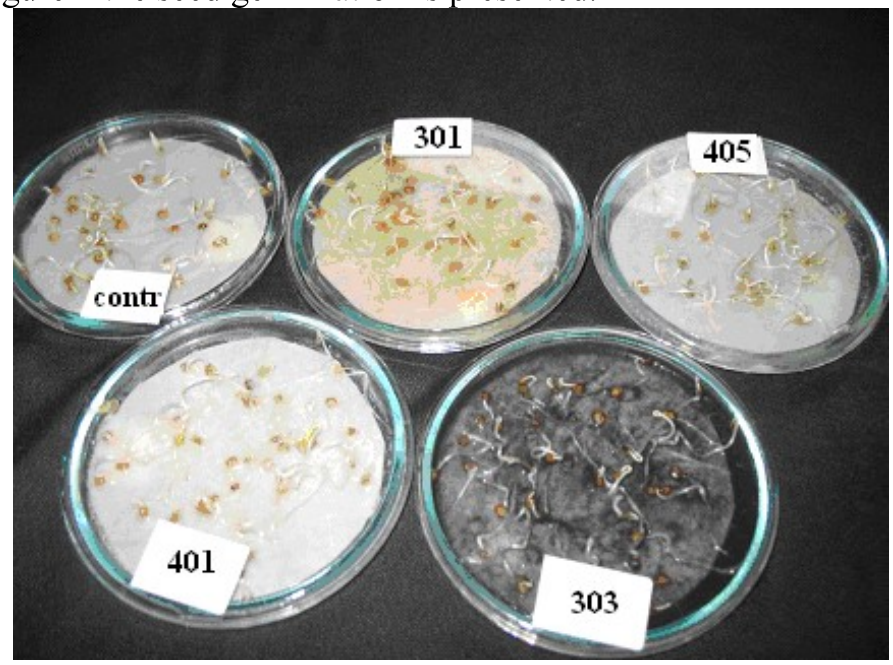

Fig.1 – Tomato seed germination after 6 days after mesoporous clay treatments

Figure 2 shows the tomato seed germination dynamics after 7 days and figure 3 the root dimension after 7 days

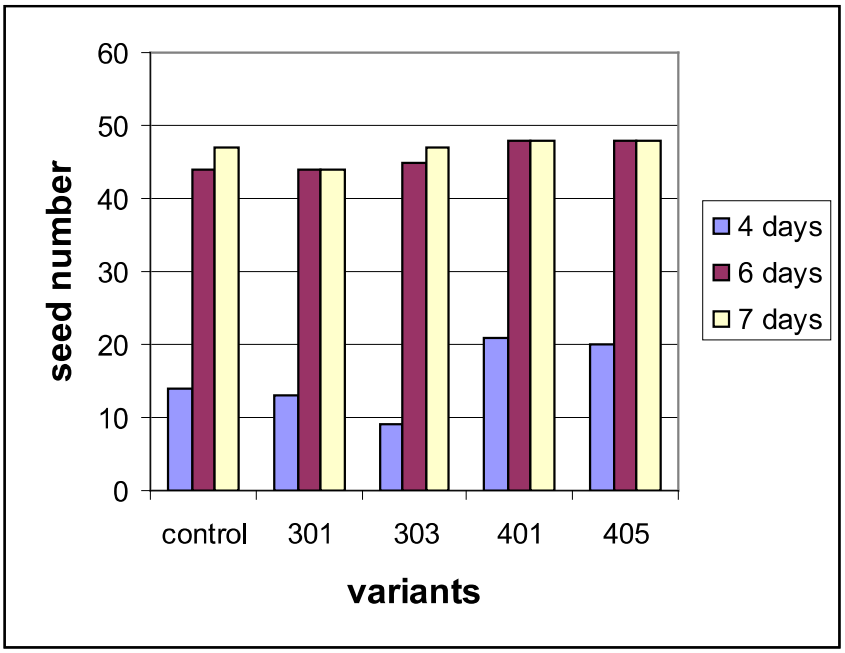

Fig.2 – Tomato seed germination dynamics after mesoporous clay treatments

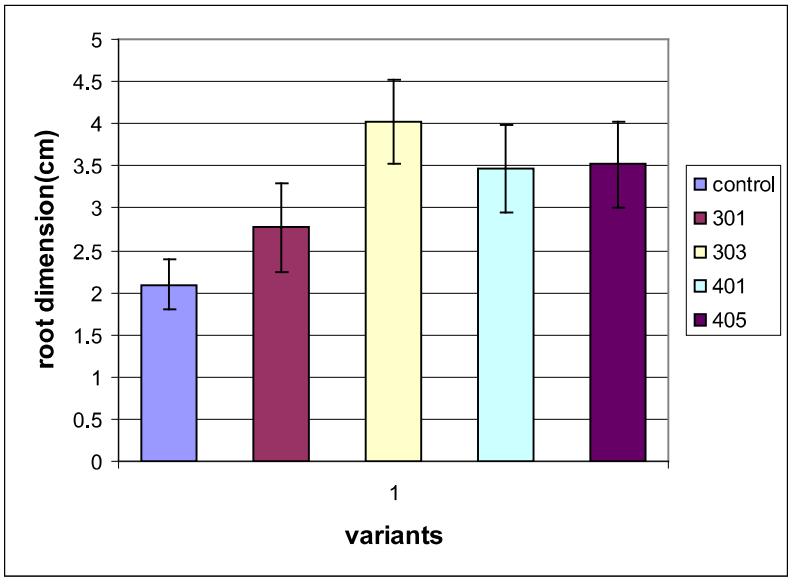

Fig.4 – Tomato root dimension e after 7 days of mesoporous clay treatments. Error bars are confidence intervals (n=50)

From figure 4 we can see that the errors bars don't overlap for 303, 401 and 405 variants; this means a highly significant difference exist between these variants (6). The strongest increase of the plant roots has been observed for the seeds treated with clay from variant 303 (almost twice as much as control).

Figure 5 shows the results of the measurements for the height of tomato plants after 9 weeks

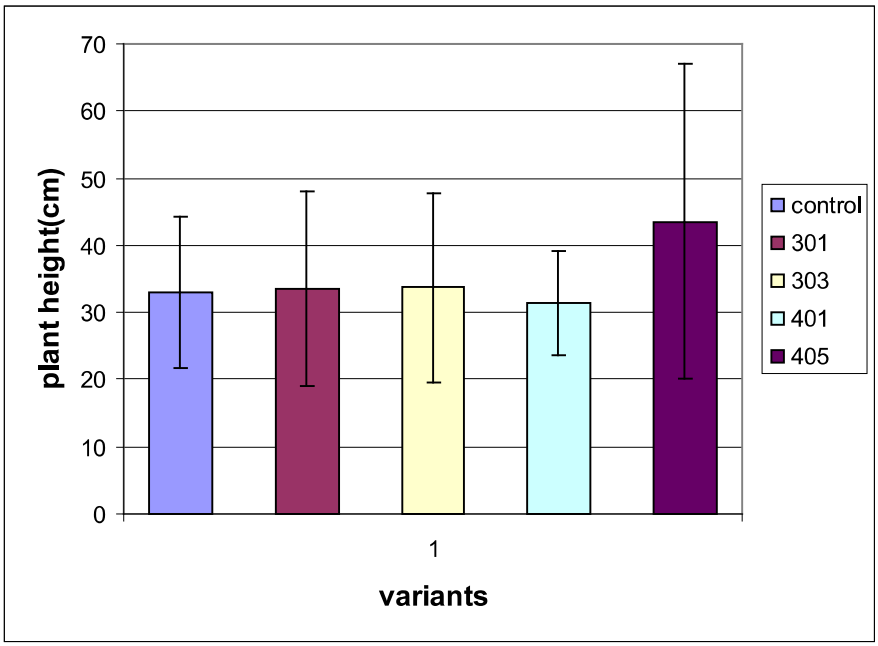

Fig.5 – The height of tomato plant s, 9 weeks after planting

Figure 5 shows that the highest plants are whose treated with MgAl LDH (variant 405), but there are no highly significant difference between variants.

We also monitorized the tomato growth as a function of quantity of clay used in treatments. In this case, 100 seeds of tomatoes were putted into Petri

dishes on double filter paper together with 10 mL treatment solutions containing MgAlLDH (suspensions that contains 0.5g of clay and 50mL bidistilled water (C1) and 1g of clay and 20ml bidistilled water (C2)). After 6 days, the seed germination is presented in figure 6 and the germination rate in figure 7.

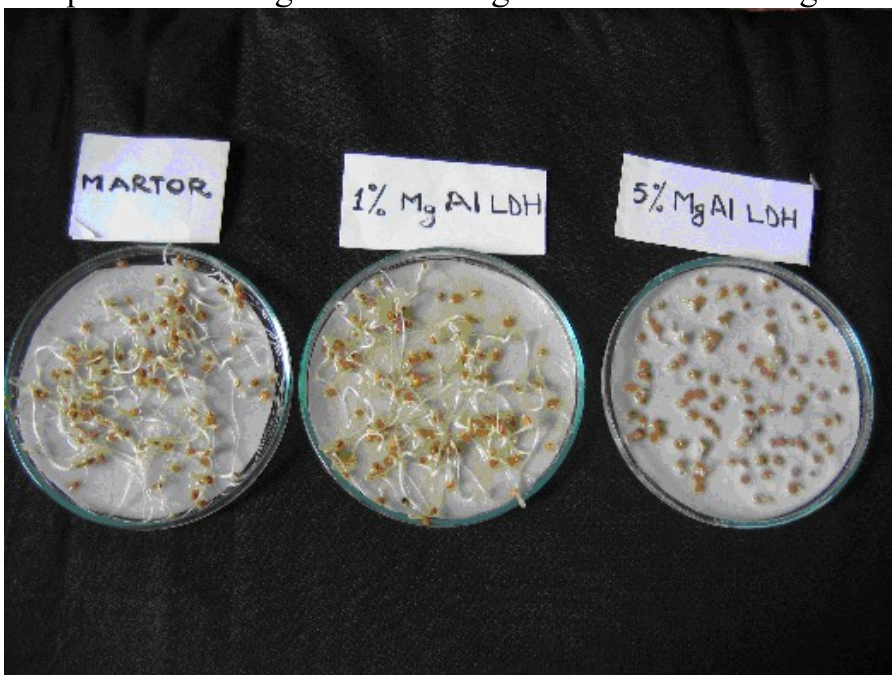

Fig.6 – Tomato seed germination dynamics after clay treatment

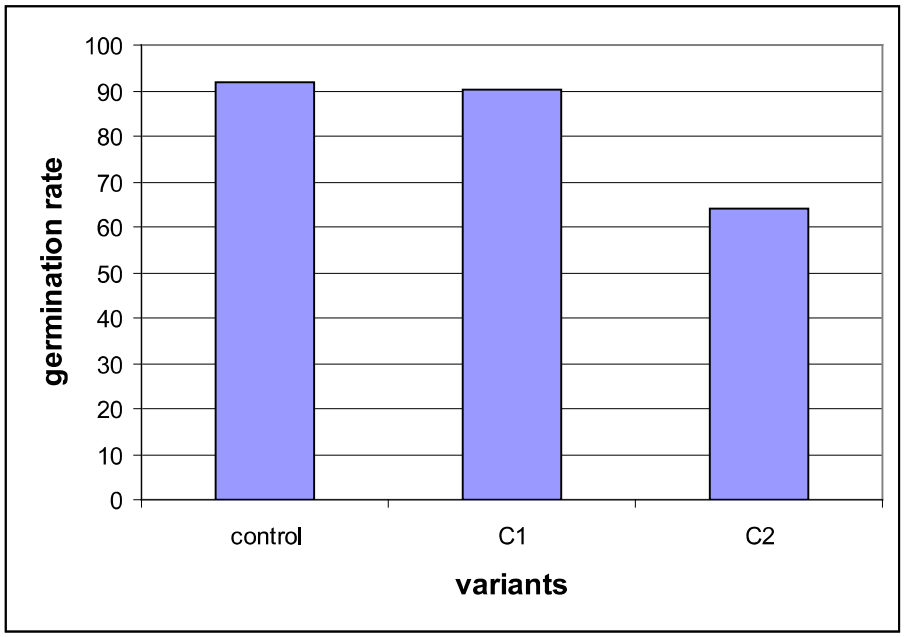

Fig.7 –Germination rate after clay treatment

Figures 6 and 7 show that anionic clays could produce an inhibition of growth and this inhibition depends on quantity of clay used in treatment.

CONCLUSIONS

The mesoporous clays are useful in agriculture due their physical and chemical properties, which could decrease the pollution effects, in order to obtain organic products.

The best anionic clay from point of view of root growth was the variant 303, variant containing Mg and magnetite; the variant 405, containing Mg, contributes to improve the plant growth, Mg being an essential element in plant nutrition.

The inhibition of germination and growth, when a greater quantity of clay has been used in the treatment, is probably due to the stress caused by the size and the number of the particles from suspension.

REFERENCES

1. **Auerbach S. M., Carrado K. A., Dutta P. K., 2004** - Handbook of Layered Materials, 261-311, New York
2. **Carrado K.A.; Marshall C.L.; Brenner J.R.; Song K., 1998 -** Materials with controlled mesoporosity derived from synthetic polyvinylpyrrolidone-clay composites, Microporous and Mesoporous Materials, 20(1-3), 17-26
3. **Kloprogge J. T., Komarneni S., Amonette J. E., 1999** - Synthesis of smectite clay minerals: a critical review, Clays and Clay Minerals, 47(5), 529-55
4. **Lakraimi M., Legrouri A., Barroug A., De Roy A., Besse J-P., 1999** - Removal of Pesticides from Water by Anionic Clays, J. Chim. Phys., 96 (3), 470-478
5. **Lin D., B., 2007** - Phytotoxicity of nanoparticles: Inhibition of seed germination and root growth, Environmental Pollution, 150(2), 243-250
6. **Oancea** S., 2007 - Ghid de prelucrare rapidă a datelor experimentale, Editura Performantica, Iasi
7. **Salonen J., Laitinen L., Kaukonen A.M., Tuura J., Björkqvist M., Heikkilä T., Vähä-Heikkilä K, Hirvonen J. , Lehto V.-P., 2005** - Mesoporous silicon microparticles for oral drug delivery:Loading and release of five model drugs, Journal of Controlled Release 108, 362– 374
8. **Wang X., Sun C., Gao S., Wang L., Shuokui H., 2001** - Validation of germination rate and root elongation as indicator to assess phytotoxicity with *Cucumis sativus,* Chemosphere, 44(8), 1711-1721
9. **You Y.W., Zhao H.T., Vance G.F., 2001 -** Removal of arsenite from aqueous solutions by anionic clays. Environ Technol, 22(12), 1447-1457
10. **Zhang J., Zhang F., Ren L., Evans D.G., Duan X., 2004** - Synthesis of layered double hydroxide anionic clays intercalated by carboxylate anions, Materials Chemistry and Physics, 85, 207-214