ASPECTS CONCERNING THE INFLUENCE OF SOME POLYMERIC COMPOSITE STRUCTURES SUSCEPTIBLE AT BIODEGRADATION ON THE PROCESS OF PLANT DEVELOPMENT

ASPECTE PRIVIND INFLUENȚA UNOR STRUCTURI COMPOZITE POLIMERICE SUSCEPTIBILE BIODEGRADĂRII ASUPRA PROCESULUI DE DEZVOLTARE A PLANTELOR

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Abstract. *This paper presents some results referring to the influence of some composite structures based on lignin (L), wood powder (PL), and low density polyethylene (LDPE) (Arpechim Pitesti), incorporated into the soil, on the process of growth and development plant. The experiment took place in laboratory conditions at 23-25°C. As biological material one used tomato seeds (Lypercosium esculentum, variety San Marzano) offered by USV Iasi. The evolution of plants was monitored for 35 day and during this period one realized some analyses as: the capacity of germination, the quantity of green and dry biomass, which offer indices upon the possible stimulative effect of the products used. For biodegraded composite materials, the surface aspects were analyzed visually and with the help of SEM microscopy. According to this research one has established that composite products used are susceptible to biodegradation and positively influence the growth and development of plants, except for polyethylene, so they can contribute to soil bioremediation.*

Key words: composite structures, biodegradation, bioremediation, soil, tomato plants, biomass

Rezumat. *În lucrare sunt prezentate rezultatele unui studiu privind influența unor structuri compozite pe bază de lignină (L), praf de lemn (PL) şi polietilenă de joasă densitate (PE) oferite de Arpechim Piteşti, incorporate în sol, asupra procesului de creştere şi dezvoltare a plantelor de tomate. Experimentul s-a desfăşurat în condiții de laborator la 23-25°C. Ca material biologic, s-au folosit semințe de tomate (Lypercosium esculentum, soiul San Marzano) oferite de USV Iaşi. Evoluția plantelor s-a urmărit timp de 35 de zile, perioadă în care s-au efectuat analize de determinare a capacității de germinare şi a cantității de biomasă verde şi uscată, care oferă indicii asupra posibilului efect stimulativ al produselor luate în lucru. Pentru materialele compozite supuse biodegradării s-au analizat aspectele de suprafață vizual şi cu ajutorul microscopiei SEM. În urma studiilor efectuate s-a*

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constatat că produsele compozite folosite sunt susceptibile biodegradării şi influențează pozitiv creşterea şi dezvoltarea plantelor, cu excepția celui pe bază de polietilenă, astfel încât pot contribui la bioremedierea solului.

Cuvinte cheie: structuri compozite, biodegradare, bioremediere, sol, plante de tomate, biomasă

INTRODUCTION

Composite materials, more and more frequently called "materials of the future", belonging to the "new materials" category, constitute a primary field of interest intensely studied worldwide. Composite structures have prevailed, as due to their functioning characteristics that are superior to those of individual materials and also to the possibility of modeling their properties according to the field in which they are applied. (Ungureanu E., 2008).

The interference of the aromatic composite structures in the physiology of plants occupies a relatively reduced area of research, through the specialized literature presents a series of their important functions in the cellular metabolism. Due to their hydrophilicity, natural polymers are biodegradable whereas synthetic polymers are hardly biodegradable because of their hydrophobicity. Join them together, it results composite materials which are biodegradable. Microorganisms growing in rhizosphere have a significant role in composite materials biodegradation. The composite structures undergo different changes being decomposed into simple organic compounds which modify the metabolism of the plant, this leading to the modification of the plant structure. The quantity of nitrogen from the roots and stalks of the plant varies both according to the type of used product and its addition. (Ungureanu, 2008; Iftime *et al*, 2019).

At the present moment, the notion of „ growth regulator" is becoming more and more familiar, this representing an endogenous are synthetic substance which regulates most of the processes of growth, development and metabolism at plants. Therefore, the composite structures, either natural, for example the wood, or realised by main through different methods, in the presence of some chemical agents, can stimulate, inhibit or modify the physiological processes in plants. Through the intervention of bioregulators, an effort is made to change the hormonic equilibrium and thus a whole chain of physiological phenomena is changed (Căpraru *et al*, 2010).

The fertility of the soil and the mineral nutrition of the plants are conditioned in the first place by the nutritional elements produced during the biological cycle through the process of mineralization of organic waste. (Căpraru *et al*, 2010).

The fact that the composite structures undergo changes at the level of the cultivated soil can also be emphasized through the analysis of plants resulted on such soil. In the agricultural soil, the chemical substances respond to the cultivated plants in the rhizosphere zone which is characterized by a larger biomass and microbial activity, a higher level of oxygen and organic carbon than non-rhysospheric soil. (Mansouri *et al*, 2006; Ungureanu, 2008).

MATERIAL AND METHOD

The following materials have been used:

- composite structures offered by Arpechip Pitesti, based on: lignin (L), wood powder (PL) and low density polyethylene (PE) of composition: 1 - 20 % PL + L, 2 - 20 % L + PL, 3 - 20 % PL + 20 % L + PE, with the following characteristics presented in table 1;

Table 1

The characteristics for lignin (L), wood powder (PL) and low density polyethylene (PE)

Characteristics	***L***	**PL**	**PE**
Relative humidity, %	5.0		
Lignin solubility in acids	1		
Uronic acid, %	0		
COOH groups, %	3.8		
p-OH	1.7		
pH in water suspension	2.7		
Mn, %	0.7		
Ash, %	2.30		
N, %	1	0.77	
C, %;	50.15	44.96	
H, %;	5.97	8.15	
Cl, %;	0.21		
O, %	42.02	46.12	
OCH_3 groups, %		7.65	
OH groups, %		32.78	
Cellulose, %		43.8	
Hemicellulose, %		29.2	
Lignin, %		26.9	
Polydispersity	10.5		
Density, g/cm^3			0.92
Melting temperature, ^{0}C			125
Traction resistant, kgf/cm^2			114.2
Elongation at break, %			142
Relative humidity, %	5.0	5.8	

- tomato seeds *(Lypercosium esculentum*, variety *San Marzano*) offered by USV Iasi
- soil: equilibrium relative humidity: U = 14.4 %, pH = 7.96, organic carbon: $C_{\circ}$ = 0.15 %, total nitrogen: Nt = 0.2 %.

Work procedure*:* We preparated five pots with black peat (soil) as reference (M) and five pots for each type of composite. In each pot we sowed the 3 seed of the plants (tomato) chosen for testing; they were periodically watered for 35 days, establishing the degree of germination and in the end the quantity of biomass (green and dry). The germination experiment was conducted under laboratory conditions at 23-25^{o}C. A seed was considered to be germinated when 1-2 mm radicle appeared. Germination percentage was recovered each day until 35 days when the seedling emergence percentage was recorded and the seedlings were harvests. The degree of biodegradation of the composites used was determined by weighing them at analytical balance before and after incorporation into the soil, but also with the help of SEM microscopy.

RESULTS AND DISCUSSIONS

To analyze the biodegradation of composite materials, they were weighed before incorporation into the soil and after an interval of 35 days, during the culture, following the mass losses (fig. 1).

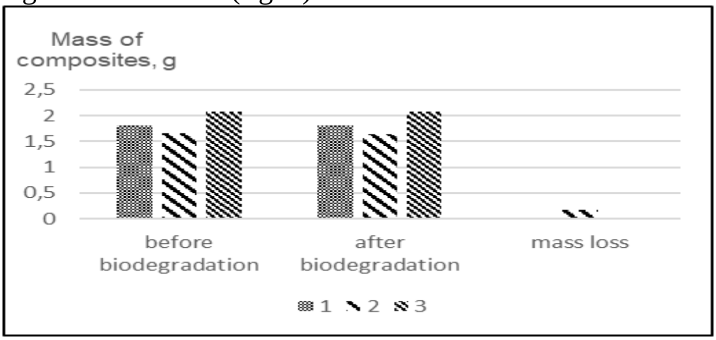


Fig. 1 Mass of composite materials before and after biodegradation
1 - 20 % PL + L, 2 - 20 % L + PL, 3 - 20 % PL +20 % L+ PE

Comparing the mass of composites after degradation with the mass of composites before degradation, there is a slight decrease in it, which means the initiation of this process. As expected, the lowest degradation of the composite is based on PE (fig.1). Also, for biodegraded composite materials, the surface aspects were analyzed visually and with the help of SEM microscopy (fig. 2.). It is observed that the composite materials have a different aspect from the initial one, related first of all to the color change as well as to the appearance of some asperities on their surface, which confirms the initiation of the biodegradation process.

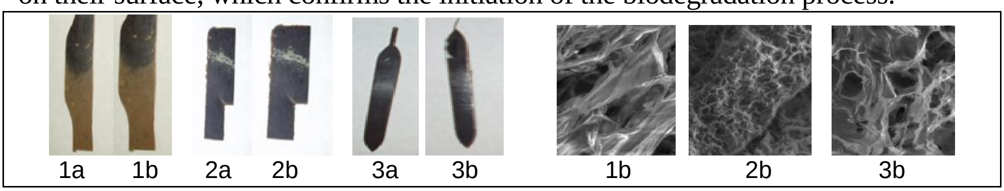
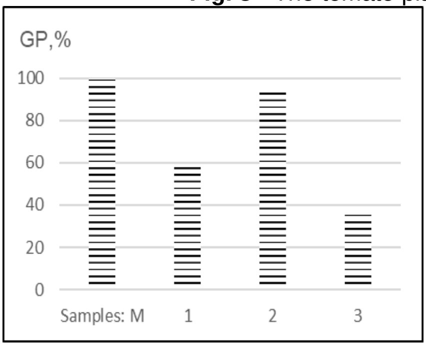


Fig. 2 Composite structures before/after incorporation into the soil
a. macroscopic images - before: 1a, 2a, 3a and after: 1b, 2b, 3b incorporation into the soil
b. SEM images of biodegraded composites

The capacity of germination represents one of the most sensitive parameters of evaluation both of the toxicity and of the degree of degradation of the composite. The germmination of the seeds is influenced by temperature each plant having a lowest level, an optimum level and a highest level of the thermic values between which this process takes place. The plants were uprooted after 35 (fig.3.) days to measure the growth indexes which included germination rate (GP%), root length (RL), green biomass (GB) and dry biomass (DB) and length of plants (PL). As we can observe in figure 4, the highest capacity of germinatin corresponds to soil without composite. By initiating the biodegradation process, toxic products are formed, which influence the germination capacity of tomato seeds.

Fig. 3 - The tomato plants 35 days after sowing



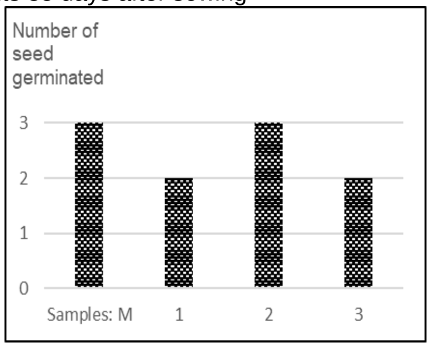
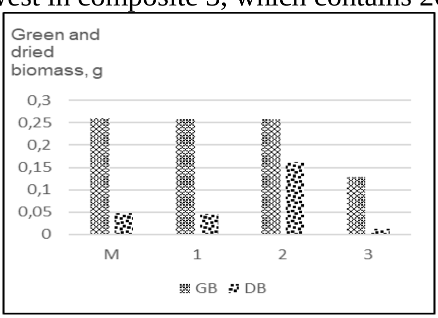


Fig. 4 Tomato plants: Germination percentage (GP) and number of seeds germinated (No)

a. germination percentage b. number of seeds germinated

Plant cultivation involves the manifestation of the rhizosphere by stimulating the development of microorganisms that may be involved in the biodegradation process. By initiating the biodegradation process, toxic products are formed, which influence the development of plants. It is noteworthy that in the pot without composite material, the plants developed better than if they were introduced into the soil along with composites. It could be said that these composite materials by their content of PE, PL and L disturb in some way the growth and development of plants. Therefore, the composite materials made are susceptible to the biodegradation process. The most pronounced effect on plant development is recorded in composite 2, which contains: 20% L + PL, and the lowest in composite 3, which contains 20% PL + 20% L + PE (fig. 5).



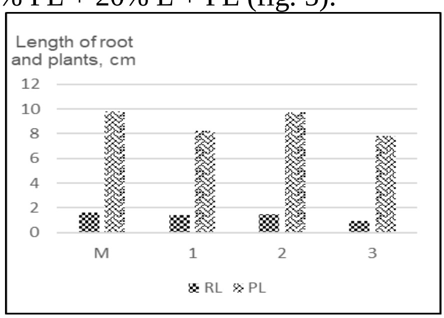


Fig. 5 Tomato plants: Green biomass (GB), dry biomass (DB), length of root (RL) and length of plants (PL)

a. green and dry biomass b. length of root and length of plants

Concerning the dynamics of total nitrogen in the soil, the differences between the different experimental variants are small, not statistically significant. Visual analysis during the vegetation period for experimental variants, biometric measurements, but also the amounts of green and dry biomass lead to the result, that the plants had enough nitrogen for growth and development (fig. 6).

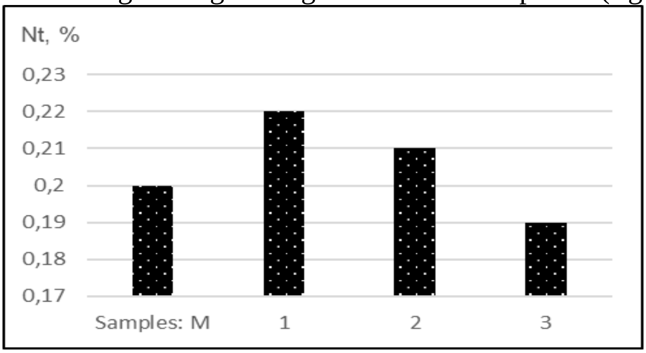


Fig. 6 Tomato plants: total nitrogen (N_t)
M - soil without composite, 1 - soil with composite: 20 % PL + L, 2 - soil with composite: 20 % L + PL, 3 -soil with composite: 20 % PL +20 % L+ PE

According to this research one has established that composite products used are susceptible to biodegradation and positively influence the growth and development of plants, except for polyethylene, so they can contribute to soil bioremediation.

CONCLUSIONS

1. Tomato plants grow better in the absence of composite materials, which are probably toxic due to their composition. What is interesting is that they degrade due to microorganisms that grow in the rhizosphere and can be recycled.

2. Although the treatment was applied for a relatively short time, the initiation of the biodegradation process was found, appreciated by mass losses and macro-/microscopic images.

3. The data obtained lead to the conclusion that the materials used to make composites allow the action of microorganisms in natural environments that can lead to the biodegradation of these structures.

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