ZESZYTY PROBLEMOWE POSTĘPÓW NAUK ROLNICZYCH 2002 z. 481: 269–273

DECOMPOSITION OF APPLE LEAVES AND ROOTS IN SOIL

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Introduction

Removal of an old orchard and replantation of young trees on the same site lead to the occurrence of the so-called replant disease manifesting itself in the delayed start of the vegetation of replanted fruit trees and in their slow growth and delayed bearing [TRAQUIAR 1984]. Among various causes of replant disease, the principial ones are reported to be: an excess development of pests in the soil, particularly parasitic nematodes and pathogenic fungi, bacteria and actinomycetes, as well as accumulation of phytotoxic substances [UTKHEDE, SMITH 1994]. However, if the role of nematodes and pathogens as causative agents of replant disease has become well-known, little is known in this respect about phytotoxic substances.

One of important groups of phytotoxic substances occurring in soils is a group of phenolic compounds liberated from decomposing plant residues [EINHELLIG 1995].

The purpose of this work was to trace changes in phenolic compounds released from apple residues at the initial stage of their decomposition in soil, depending on its type, pH and the rate apple leaves and roots are added to the soil.

Material and methods

Two experiments were carried out under laboratory conditions, in which apple (*Malus domestica* BORB.) leaves and roots of the Cortland cv. were subjected to decomposition in the soil at 20°C. Three soils were used in the experiment I: 1– light loamy sand of pH 5.4; 2 – light loamy sand of pH 7.1 and 3 – heavy loamy sand of pH 7.0. The soil was supplemented with 1% air-dried and crumbled apple leaves or roots. In experiment II, 1%, 2.5% and 5% leaves and roots were added to the soil (light loamy sand of pH 5.4). Soil without the addition of apple residues was used as a control. The content of phenolic compounds in the soil was analysed over a three-month period.

Extraction of phenolic compounds was carried out by the method of POLITYCKA AND WÓJCIK-WOJTKOWIAK [1984]. Phenolic content was determined spectrophotometrically using Folin & Ciocalteu's reagent, with phloridzin as a standard.

Results and discussion

The addition of apple leaves and roots to the soil caused an increase in the content of phenolic compounds proportionally to the rate of apple residues applied (Fig. 1 and 2). Differences in the effect of added leaves and roots became markedly evident – the phenol level increase in the soil was, on average, 2-fold higher after the addition of roots than after the addition of leaves. Comparatively high amounts of phenolic compounds occur in plants of the genus *Malus* [FULCHER et al. 1998], among which phloridzin as well as phloretin, naringenin, chlorogenic acid, and catechin were identified. Phloridzin content in leaves may even reach 6.75% of dry weight [HUNTER et al. 1994]. This compound and the products of its microbiological degradation are toxic to young apple plants [BORNER 1959].

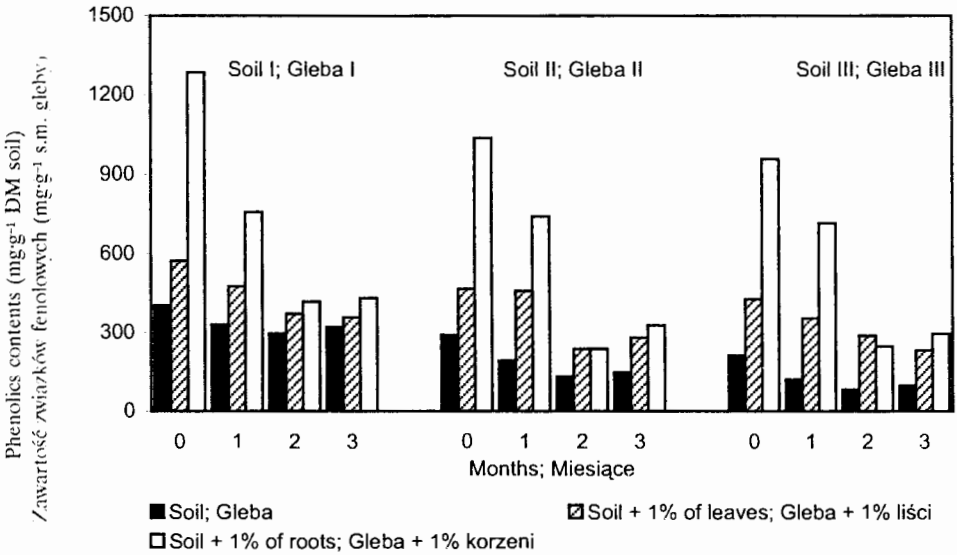

Fig. 1. Phenolics content in three soils of varying type and pH during decomposition of apple leaves and roots. $LSD_{0.05}$ = 87.95

Rys. 1. Zawartość związków fenolowych w trzech glebach różniących się typem i pH podczas rozkładu liści i korzeni jabłoni. $NIR_{0,05}$ = 87.95

The initially high phenolic content in the soil samples with the addition of apple residues gradually decreased with the time of degradation (Fig. 1 and 2). An exception was a combination of soil with the addition of 5% roots (Fig. 2), in which phenolic content maintained a high level throughout the duration of the experiment. However, no significant differences have been found in the content of phenolic compounds depending on the type and pH of the used soil (Fig. 1).

The content of phenolics in soil may be reduced as a result of their abiotic oxidation, sorbtion by soil minerals and metabolizing by microflora [MAKINO et al. 1998; BLUM 1998]. It is most probable that a high phenolics content in the soil with the addition of 5% roots inhibited microflora activity, and for that reason no decrease occurred in the level of phenolic compounds, although a decrease in their content was observed in other combinations.

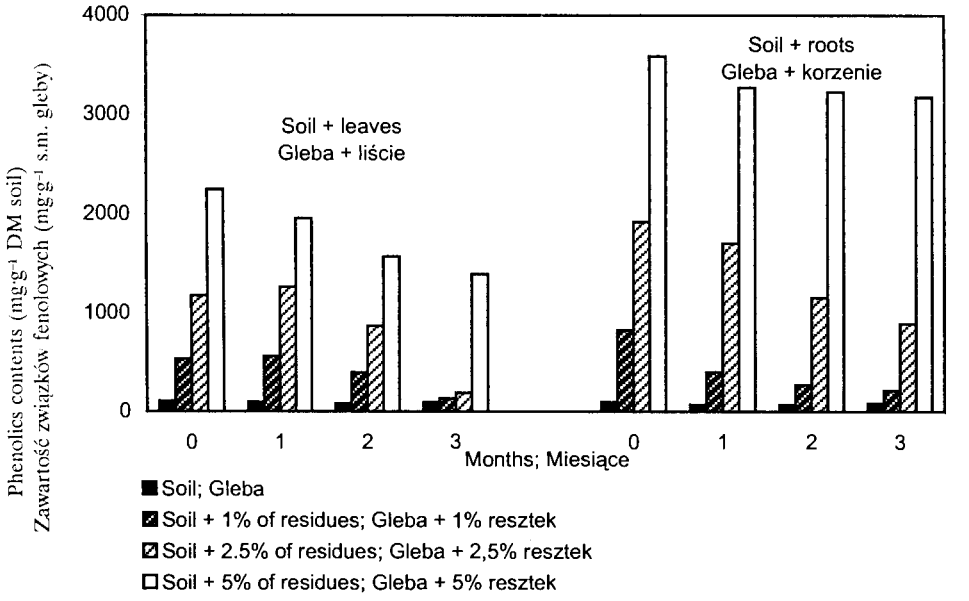

Fig. 2. Phenolic content in soil during decomposition of apple leaves and roots depending on the rate of the added apple residues. $LSD_{0.05}$ = 121.87

Rys. 2. Zawartość związków fenolowych w glebie podczas rozkładu liści i korzeni jabłoni w zależności od dawki dodanych resztek. $NIR_{0,05}$ = 121,87

Conclusions

Apple leaves and roots decomposing in the soil present a rich source of phenolic compounds. In the course of time the level of phenolics gradually decreases. However, an excess accumulation of apple residues may lead to accumulation of phenolic compounds in the soil. The question whether these compounds are toxic to young apple plants requires further investigations.

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Key words: apple replant disease, apple residues, phenolic compounds

Summary

The studies have been performed to trace changes in the soil content of phenolic compounds entering from decomposing apple leaves and roots, depending on the type and pH of soil and the rate of added apple residues.

In has been found that roots added to soil were a richer source of phenolic compounds than leaves. Amount of phenols entering to soil from apple leaves and roots was in proportion with the applied rates of apple residues. A gradual fall in the content of phenolic compounds was found to occur in three successive months. But root residues added to the soil at a relatively high rate delayed this process. Neither liberation of phenolic compounds from the added apple residues nor the later fall of their content depended on the type and pH of the applied soil.

ROZKŁAD LIŚCI I KORZENI JABŁONI W GLEBIE

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Słowa kluczowe: choroba replantacyjna jabłoni, resztki jabłoni, związki fenolowe

Streszczenie

Celem pracy było prześledzenie zmian zawartości związków fenolowych, pochodzących z rozkładających się w glebie liści i korzeni jabłoni, w zależności od typu i pH gleby oraz od ilości wprowadzonych resztek.

Stwierdzono, że korzenie dodane do gleby były bogatszym źródłem związków fenolowych niż liście. Ilość fenoli uwalniających się z liści i korzeni była pro-

porcjonalna do ich dawki wprowadzonej do gleby. Podczas trzech kolejnych miesięcy obserwowano stopniowy spadek zawartości fenoli. Resztki korzeni wprowadzone do gleby w stosunkowo wysokiej dawce hamowały ten proces. Zarówno uwalnianie fenoli z resztek jabłoni, jak i późniejszy spadek ich zawartości nie zależały od typu i pH gleby.

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