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EFFECT OF ORGANIC MULCHING ON THE QUANTITY OF MICROORGANISMS IN SOIL OF APPLE PLANTATION

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A B S T R A C T

The purpose of our experiments was to examine the effect of different soil covering matters (livestock manure, straw and crushed pine bark) on the quantity of some microbial groups (total bacteria, aerobic cellulolytic bacteria, microscopic fungi) occuring in soil. During two years samples were taken from a Cider apple plantation at the Fruit Production Research and Advisory Kht, Újfehértó four times a year.

We determined the moisture and nutrient content of the soil (Buzás, 1988), and its plasticity according to Arany (Filep, 1995). Total numbers of bacteria on bouillon agar and microscopic fungi on peptone-glucose agar (Ubrizsy and Vörös, 1968) were calculated by the plate dilution method. Number of cellulolytic bacteria was determined on a special liquid culture medium according to Pochon and Tardieux (1972).

Moisture content of the soil decreased in the following order: manure, crushed pine bark, straw and control.

Numbers of total bacteria, and microscopic fungi increased from the control, through crushed pine bark, straw, to manure. The number of cellulolytic bacteria decreased in order: manure, crushed pine bark, straw and control on average for the four samplings in both years. Based on the results of soil biological examinations, covering matters are suggested to put into practice in the following order: manure, crushed pine bark and straw.

Key words: organic mulches, soil water content, apple, total bacteria, cellulose decomposing bacteria, microscopic fungi

INTRODUCTION

Application of mulching systems has been known for many years (common before appearance of herbicides), but its advantageous effects have

not really been studied, therefore its adoption is limited. It is well-known that the use of soil cover has an important role mainly in the conservation of soil moisture and in weed control without herbicides (Szwedo and Maszczyk, 2001). We are also familiar with soil protection (from drying, erosion, deflation) and microclimate changing effect of mulching. So this solution in the case of integrated production, reduces the pesticide application, takes care of the environment and meets the demand of such production that has been applied in Hungary.

The applied soil covers can be of plant, animal or industrial origin, or by-products. A multifarious reaction exists between the vegetation and soil physicochemical properties and microorganisms (Kátai, 1992). In this interaction the characteristics of the soil have a definite effect on soil micro-organisms.

The effect of mulching on the quantity of soil microbes has till now been examined only in rather limited studies, almost exclusively conducted by Bubán et al. (1996ab; 1997) and Helmeczi et al. (1997). It seems to justify our examination which focused on the quantitative analysis of such micro-organisms under the experimental condition, with no reference to soil fertility. Data obtained, together with other parameters such as enzyme activity, CO_2 production, cellulose decomposing intensity, etc (Kátai et al., 1999; 2002; Varga, 2003ab) should be important to explore the soil life and to assess its possible changes under the influence of mulching.

MATERIAL AND METHODS

Research was conducted in 1996-1997 on the apple plantation of the Fruit Production Research and Advisory Kht, Újfehértó. Trees were replanted in the spring of 1994 after a liquidated apple plantation (‘Florina’) which had been cultivated for 22 years. The soil type was fine acid humus sand with a pH_{H2O} 5.71 and 1.02% humus content. Before planting, 70 t/ha livestock manure was incorporated to the soil. On the plantation a 2 m plant spacing was applied in the rows 5 m apart. Five trees were planted per plot (60 m^2 each). The soil in tree lines was covered at the width of 120 cm with the following matters: straw (11 kg/tree), crushed pine bark (80 kg/tree), livestock manure (35 kg/tree). Hoe-cultivated plots were established for the control.

Soil moisture was measured with a laboratory cabinet dryer at 105°C. Nutrient content (Buzás, 1988) and plasticity of the soil according to Arany (Filep, 1995) were also determined (Tab. 1).

Total numbers of bacteria on Bouillon agar and microscopic fungi on peptone-glucose agar (Ubrizsy and Vörös, 1968) were determined by the plate dilution method. The number of cellulolytic bacteria was established on a special liquid culture medium according to Pochon and Tardieux (1972).

Soil samples were obtained four times (May, July, September and November) in both experimental years. Each examination was carried out in three replications and the results were conversed into absolutely dry soil. Each sample was taken from the top 20 cm layer of soil. Results were estimated by an analysis of variance.

Table 1. Chemical soil parameters in the experimental area before planting

Parameter		Value (depth 0-60 cm)
pH(H_2O)		5.71
pH(KCl)		4.88
K_A		28
$CaCO_3$	%	0
Humus	%	1.02
NO_3+NO_2-N	mg/100 g	0.53
NH_4-N	mg/100 g	0.12
P_2O_5	ppm	52
K_2O	ppm	139
Mg	ppm	129
0Na	ppm	16
Zn	ppm	163
Cu	ppm	4.1
Mn	ppm	192

RESULTS

Moisture content of covered and uncovered soil

At all sampling times the soil moisture content measured under manure mulch was higher by 0.27-4.22% than that in the control, and only in July was this difference not significant (Tab. 2). Excluding May, straw mulching and crushed pine bark significantly increased soil moisture by 0.9-1.1% and 1.05-1.46 respectively, in relation to the control. To conclude, the highest soil moisture was measured under manure in May, September and November and under crushed pine bark in July.

Table 2. Changes in soil moisture content (m/m%) due to mulching – means for 1996-1997

Sampling time	Mulch				$LSD_{0.05}$
	control	straw	manure	crushed pine bark	
May	12.23 a*	13.24 a	16.45 b	13.53 a	1.44
July	11.28 a	12.37 bc	11.55 ab	12.46 c	0.86
September	11.60 a	12.50 b	13.60 b	13.06 b	1.15
November	12.00 a	13.10 b	13.50 b	13.05 b	0.84

*The means followed by the same letters do not differ significantly. Mean separation within columns by Student t-test at P = 0.05

Quantitative determination of microorganisms

The number of total bacteria was the highest under manure, followed by crushed pine bark, control and straw in every sampling time for both years (Fig. 1). Microscopic fungi were also most numerous under manure, than under straw (except November 1996), crushed pine bark and in the control (Fig. 2). Similarly, the number of cellulose decomposing bacteria was always the highest under manure, followed by crushed pine bark (except July 1996), straw and control (Fig. 3).

On average for 1996-1997, total bacteria increased in the following order: straw, control, crushed pine bark, manure. Only the effect of manure differed significantly from the control and other trials (Tab. 3). The number of microscopic fungi increased from the control through crushed pine bark, straw to manure; all differences were significant. Cellulose decomposing bacteria were also most numerous under manure covering, followed by crushed pine bark. There was no significant difference between the effect of crushed pine bark and straw, and between straw and control, but the effect of crushed pine bark significantly prevailed over the control.

Table 3. Changes in numbers of microorganisms due to mulching – maeans for 1996-1997

Mulch	Number of		
	microscopic fungi [10^3]	total bacteria [10^6]	aerobic cellulolytic bacteria [10^2]
Control	34.363 a*	15.850 a	1.415 a
Straw	49.350 b	14.688 a	3.955 ac
Manure	73.750 c	24.050 b	22.815 b
Crushed pine bark	41.488 d	17.475 a	11.948 c
$LSD_{0.05}$	5.924	3.209	8.614

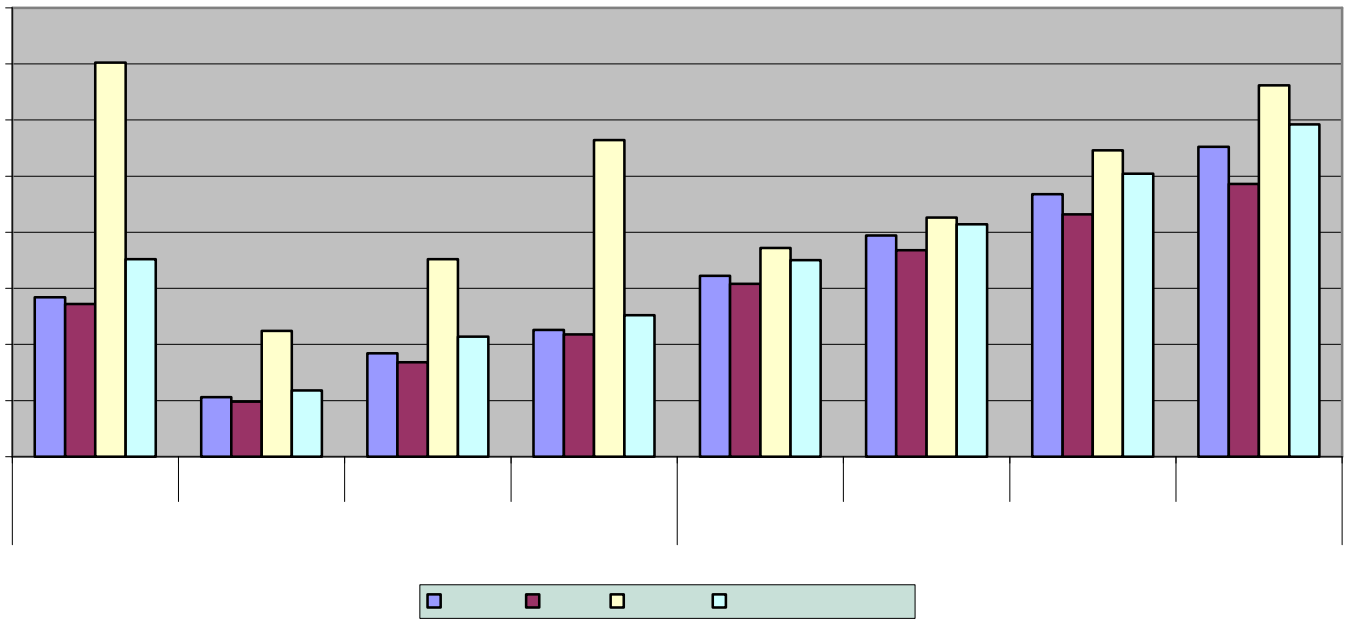
*For explanation, see Table 2

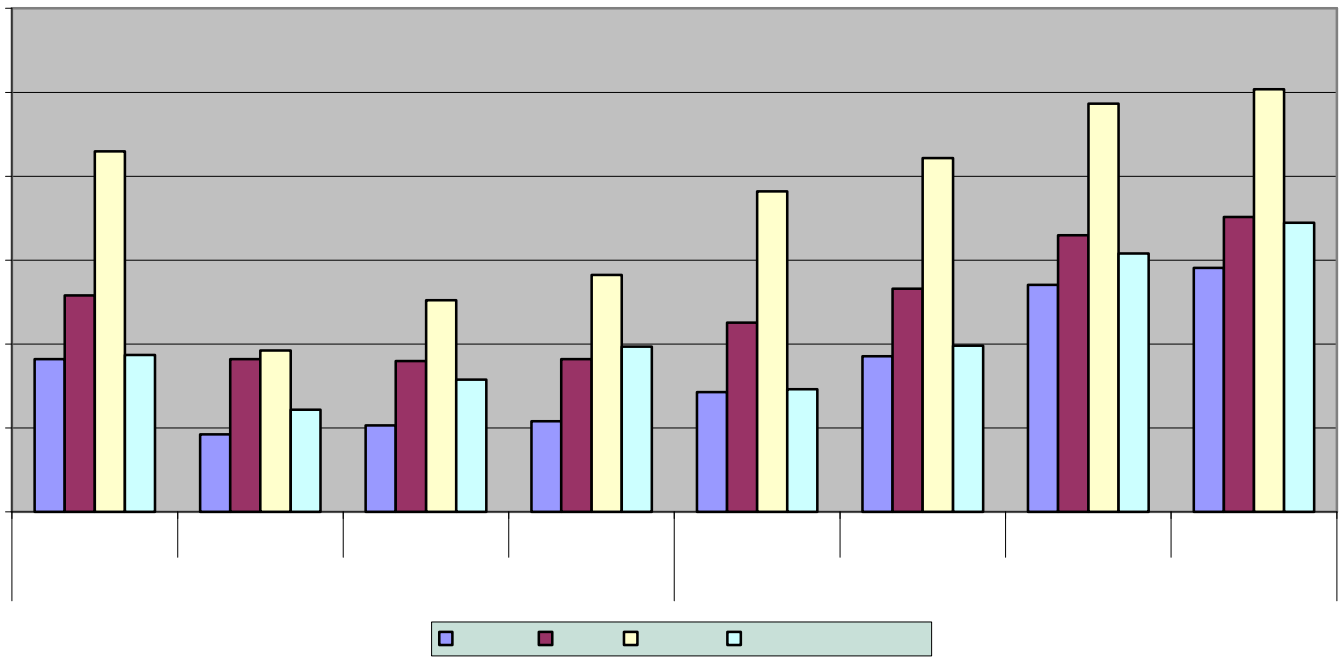
DISCUSSION

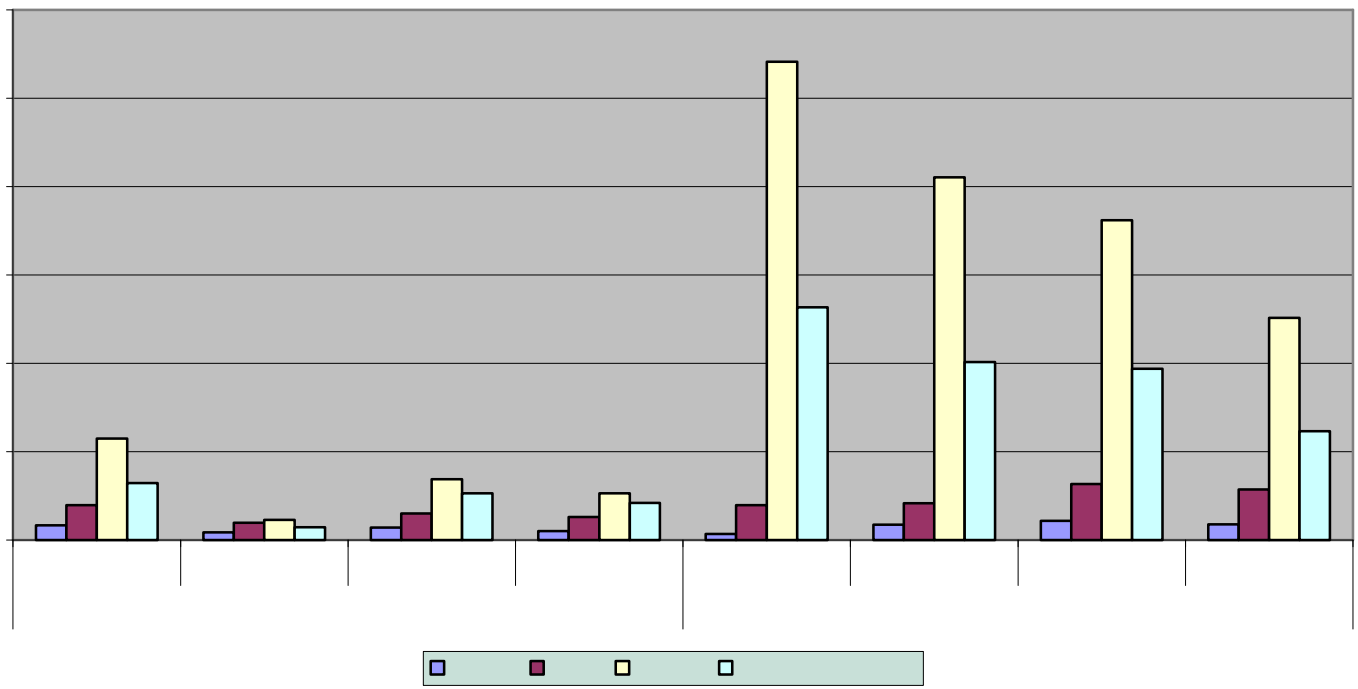
Mulching assisted to conserve the moisture content of soil but the degree of such effect depended on the covering matter and was the highest under manure, followed by crushed pine bark and straw.

Numbers of total bacteria, aerob cellulose decomposing bacteria and microscopic fungi enhanced either significantly or only slightly due to soil covering depending on its kind.

According to our experiments, herbicides could be replaced by different mulching to the benefit of saving money and environmental protection. Among the tested covering matters, soil biological parameters exposed manure followed by crush pine bark, as the most recommendable mulch to put into practice.







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WPŁYW EKOLOGICZNYCH ŚCIÓŁEK NA LICZEBNOŚĆ GLEBOWYCH MICROORGANIZMÓW W UPRAWIE JABŁONI

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S T R E S Z C Z E N I E

Celem badań było poznanie wpływu różnych rodzajów okrywy gleby (obornik, słoma, rozdrobniona kora sosnowa) na liczebność trzech grup mikroorganizmów glebowych: bakterie ogółem, tlenowe bakterie rozkładające celulozę i grzyby mikroskopijne. W ciągu dwóch lat czterokrotnie w roku pobierano próby gleby z plantacji jabłoni cydrowej na stacji doświadczalnej w Újfehértó.

Określano wilgotność i zawartość składników pokarmowych gleby (Buzás, 1988) oraz jej plastyczność według Arany`ego (Filep, 1995). Liczbę bakterii ogółem na agarze bulionowym i grzybów mikroskopijnych na agarze peptonowo-glukozowym (Ubrizsy and Vörös, 1968) uzyskano metodą szczepienia na płytki w rozcieńczeniach. Liczbę bakterii celulolitycznych określano na specjalnej pożywce płynnej według Pochon i Tardieux (1972).

Wilgotność gleby pod pokrywą zmniejszała się według następującej kolejności zastosowania ściółek: obornik, rozdrobniona kora sosnowa, słoma i kontrola. Liczebność bakterii ogółem oraz grzybów mikroskopijnych zwiększała się od kontroli, przez korę sosnową, słomę, kończąc na oborniku. Natomiast liczebność bakterii celulolitycznych zmniejszała się w kolejności: obornik, kora sosnowa, słoma i kontrola, licząc średnio dla dwuletniego okresu pobierania prób.

Uzyskane wyniki analizy biologicznej gleby wskazują, że najkorzystniejszą okrywą w praktyce będzie obornik, następnie rozdrobniona kora sosnowa i na końcu słoma.

Słowa kluczowe: ściółki organiczne, zawartość wody w glebie, jabłoń, bakterie ogółem, grzyby mikroskopijne, bakterie tlenowe rozkładające celulozę