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PhD THESIS

CHANGES OF BIOLOGICAL ACTIVITY IN SOIL OF AN INTEGRATED APPLE PLANTATION

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1. Introduction and object

Application of mulching systems has been known for many years (spread before appearance of herbicides), but its advantageous effects are not really studied therefore its adoption is limited. It is well-known that the use of soil coverings has an important role mainly in the conservation of soil moisture content and realizes weed control without herbicides. We are also familiar with soil protecting (drying, erosion, deflation) and microclimate changing effect of mulching. So in case of integrated production this solution, which reduces the pesticide application, takes care of environment and meet the demand of the integrated production that has been applied in Hungary, too.

The applied soil coverings may have been plant, animal or industrial origin, or by-products. A multifarious reaction exists between the vegetation, physical and chemical properties and microorganisms of the soil (KÁTAI, 1992). In this interaction the characteristics of the soil has a definitive effect on the cropped plant and soil microorganisms. Majority of the soil microorganisms obtain energy from plant residues in a direct or indirect way. Decomposition degree of this residues shows a close connection with intensity of biological activity, composition microbe groups, bulk of their biomass, etc.

The effect of mulching on soil-life and soil microbes has been examined only by a few researchers till this time. Data regarding this could be found almost exclusively in papers of BUBÁN et al. (1996/a; 1996/b; 1997) and HELMECZI (1997). These circumstances gave us the reason to deal with the above mentioned examinations. Different methods are kept suitable to measure the biological activity of the soil by scientists. JAKAB (1991) used the cellulose decomposing activity and GAWRONSKA et al. (1991) used the quantity of CO_2 produced in the soil for this purpose. The

latest method was successfully applied by FEHÉR (1954) under desert conditions. In additional degree of protein decomposition was also considered fit for measure the soil fertility by MALISZEWSKA (1969).
Begining examinations of enzymes produced in the soil by plants, animals and mainly microorganisms are dated back to the first years of the previous century, but its development started in the 1950' years by HOFMANN (1952) and his followers. They had taken attempt to verify close connection between these parameters and soil fertility. The soil enzymology contributed to developing our soil biological knowledge with many data, but it had been discovered soon that their methods are not suitable to characterize the soil fertility (SZABÓ, 1955). In spite of this number of enzymes found out from soil doubled in the past few decades, their role and importance in judge of soil fertility are being very disputed. (KOZLOV, 1962; MALISZEWSKA, 1969; HE et al., 1991; WACHENDORF et al., 1992).

For this reason, our examinations did not aimed to estimate the soil fertility, we only wanted to get information about the activity of some soil enzymes under the applied experimental conditions. In our opinion the value of enzyme activity together with other parameters, such as number of total bacteria microscopic fungi falling under different physiological groups, CO_2 production, cellulose decomposing intensity, etc that we studied could be important to judge the effect of soil coverings on soil-life.

2. Materials and methods

2.1. Description of the experimental field

Our soil microbiological experiments were carried out within the scope of T-016471 OTKA project. The experimental field was two different apple plantation of Újfehértói Gyümölcstermesztési Kutató és Szaktanácsadó

Kht. Trials happened in two different interval (1996-1997 and 200-2001), too. Plantation used in the first period, was planted in the spring of 1994 into a liquidated apple plantation (species Florina) which was cultivated for 22 years. The soil type of the plots was fine acid humous sand with a pH_{H2O} of 6.0 (5.1 measured in KCl) and its humous content was less than 1 %. Before planting 70 t/ha livestock manure was corporated into the soil. In the whole plantation 5m row spacing and 2 m plant spacing was applied. Experimental plots (each was 60 m^2) contained 5 trees. Trials applied during the plantation are the followings. The soil of tree lines was covered with black polyethylene, crushed pine bark, livestock manure and straw in a width of 120 cm, and hoe-cultivated plots were established to compare the effect of soil covering matters.

The second test period started in 2000 and ended in 2001. It was located also in an apple plantation of Újfehértói Gyümölcstermesztési Kutató és Szaktanácsadó Kht. The soil type was the same as in the previous preiod, but had a higher humous contenet (1,08 %). The pH of this soil was similar to the first period measured are (5.77 in distilled water and 4.95 in KCl). 5x3 m growing area and 14 different Cyder apple species were applied in this experimental field. Plots, contained Brown's Apple and Dabinett species were drawn into our experiments. The applied soil covering matters were the followings: conventional black polyethylene and porous black polyethylene called 'agroszövet'. Certainly hoe cultivated control plot was also established.

2.2. The applied treatments and sampling times

Test period: 1996-1997

Trials	Treatment	Examinations
1.	*Control*	*Soil moisture content, cellulose decomposition activity (potential and actual), Number of total bacteria, microscopic fungi and aerob cellulose decomposing bacteria.*
2.	*Straw 11kg/tree*	
3.	*Black polyethylene 2.4m^2/tree*	
4.	*Livestock manure 35kg/tree*	
5.	*Crushed pine bark 80kg/tree*	

Test period: 2000-2001

Trials	Treatment	Species	Examinations
1.	*Control*	*Brown's Apple*	*Soil moisture content, cellulose decomposition activity (potential and actual), CO_2 production, enzyme activity, number of total bacteria, microscopic fungi, aerob cellulose and protein decomposing bacteria, and nitrogen fixing bacteria.*
2.	*Agroszövet*		
3.	*Black polyethylene*		
4.	*Control*	*Dabinett*	
5.	*Agroszövet*		
6.	*Black polyethylene*		

Parameters	Sampling time				
	1996	1997	2000	2001	Repetition
Soil moisture content	May 25. July 27. Sept. 25. Nov. 22.	May 15. July 16. Sept. 18. Nov. 20.	March 22 May 11. July 13. Sept. 12. Nov. 14.	March 19 May 15. July 12. Sept. 11. Nov.14.	3
Actual cellulose decomposition activity*	May 25. July 27. Sept. 25. Nov. 22	May 15. July 16. Sept. 18. Nov. 20.	May 11. July 13. Sept. 12. Nov. 14.	May 15. July 12. Sept. 11. Nov.14.	9
Potential cellulose decomposition activity	May 25. Sept. 25.	May 15. Sept. 18.	May 11. Sept. 12.	May 15. Sept. 11.	3
CO_2 production	Non examined		March 22 May 11. July 13. Sept. 12.	March 19 May 15. July 12. Sept. 11.	3
Enzyme activities	Non examined		March 22 May 11. July 13. Sept. 12. Nov. 14.	March 19 May 15. July 12. Sept. 11. Nov.14.	3
Microbe counts	May 25. July 27. Sept. 25. Nov. 22	May 15. July 16. Sept. 18. Nov. 20.	March 22 May 11. July 13. Sept. 12.	March 19 May 15. July 12. Sept. 11.	3

* tests were placed into soil in 20 March 1996, 17 March 1997, 22 March 2000, 19 March 2001

2.3. Methods of physical, chemical and microbiological examinations

2.3.1. Examination of some physical and chemical parameters important from microbiological aspect.

Physical and chemical parameters of the soil was examined according to BUZÁS (1988). Moisture content of the soil was measured with a portable electronic soil detector and with laboratory drying cabinet at 105 ^oC as usual. The former instrument measure the soil resistance and moisture content in each 10 cm of the 80 cm deep soil layer. Plasticity of the soil according to Arany (FILEP, 1990) and nutrient content of the soil (ICP-OES) was also determined.

2.3.2. Measurement of cellulose decomposition activity under field (natural) conditions.

Apart from smaller modification, The examinations was carried out according to cellulose test method of Unger (UNGER, 1968). Bags of 8x16 cm size were stitched by nylon fibre from loosen-woven synthetic cloth. Cotton wool of 5g was taken into every bag. The cotton wool was previously dried, till constant weight at 105 ^oC, and kept in a desiccator until it was used. The cotton was uniformly distributed in the bag and then the bag was completely stitched. The complete test bags were marked with tiny aluminium plates with a number on them.

The test bags were placed into the soil in a way that the spade was stabbed into the soil surface, and following this, the soil surface was widened by moving the handle of the spade, in the way, that the bag could be placed into the soil downward by its longer side. After this the spade was stabbed into the soil again in a distance of a few cm next to the former hole, and this containing the bag was closed by moving the handle of the spade laterally. As the intensity of the decomposition is greatly influenced by the soil depth, it was extremely taken care of placing the bags into the same depth. According to the original description of this method 8-12 test bags should be used in each experimental variants. In our experiments 9-9 bags were placed into each treatment consequently. The number of each bag was registered and the point of the placing was marked with small sticks. Taking into consideration that the growing season of apple trees is longer, the test bags were lifted up after 8 months. The method was modified in a way that bags were lifted up after every 2 months to study the dynamic of cellulose decomposition activity. Bags lifted up were brought to an air-dried state as soon as possible. For the sake of this the soil stuck to the surface of the bags was carefully eliminated after the laboratory delivery. After it the bags were placed in a tray to dry them.

Since the determination of decayed cellulose quantity is a very roundabout procedure, the whole process is described schematically.

- Boiling the test bags in 1% HCL solution for an hour to eliminate the depolymerised cellulose.
- After it the test bags were rinsed and washed by distilled water.

The measurement of the remained cellulose happened in many steps.

- The content of the washed and dried bags were cleaned from root residues, dried, cooled in exsiccator and weighed again.
- Then it was heated in an electric furnace of 600 ^{o}C for 2 and a half hours.
- After heating the ash was treated with $(NH_4)_2CO_3$ solution, then put into a drying cabinet at 105 ^{o}C and dried until constant weight, cooled in an exsiccator, measured again.

- The quantity of non-decomposed cellulose come from the difference of the weight of the dried, remaining cellulose and the weight of the heated residue.

2.3.3. Examination of cellulose decomposition activity under laboratory (artificial) conditions

Examinations were carried out to compare the results of the laboratory measures with the field ones. For this reason, cellulose decomposition activity was examined under laboratory conditions according to SZEGI (1979).

The spring samples originated from May of 1996, 1997, 2000, 2001, the autumn ones from September of the same years. They were taken from the top 20 cm layer of the soil from 5-5 place in each treatment and repetition. Samples were mixed, delivered to laboratory, dried till constant weight and cleaned from plant residues. Air-dried samples were grinded in order to the most effective homogenisation (SCHUMMACHER et al., 1990).

Three pieces of dried, measured, same-sized filter paper stripe were stitched into the loosen-woven synthetic bag. 100 g prepared soil sample was taken into china pot and damped until 60 % of maximum water capacity. Then the half quantity of the soil was measured into Petri pot under the bag containing filter paper, and it was covered with the other half of the soil. The original method prescribes 2-4 weeks incubation period on 28 ^{o}C. Seeing that there was only a little difference detected between the activities after 3 weeks' incubation, in the further 8-week incubation period was applied.

After the incubation period the quantity of the remained cellulose was measured according to the chapter of 2.3.2.

2.3.4. Detecting the CO_2 production of the soil

The CO_2 production was measured in laboratory after 5-day incubation period according to WITKAMP (1966 cit. SZEGI, 1979). 100 g field moisture soil, free from plant residues, was weighted into air tightly closed glass bottle and 10 ml 0,1n NaOH was put into the a and placed also into the glass bottle. After the incubation period the NaOH was titrated with HCl in presence of fenolftalein and after it of metilorange indicator. The difference of the lost HCl quantity during the two titration was multiplying with the factor of NaOH and of HCl and 2,2. It gives the quantity of CO_2 production.

2.3.5. Examination of soil enzymes activity

The phosphatase activity (KRÁMER-ERDEI, 1959) based on the quantity of phenol got free from disodium-phenyl-phosphate, urease activity (KUPREVICS-SCSERBAKOVA, 1966 modified by KREMPERS cit. FILEP, 1995) based on the spectopfotometric measure of ammonia got free from urea was detected. Catalase activity was determined by gas voloumetric methods (KUPREVICS-SCSERBAKOVA, 1966) with Scheibler calcimeter, saccharase activity was measured according to FRANKENBERGER-JOHANSON (1983/a) based on glucose determination after Bertrand. Dehydrogenase activity of the soil was determined according to MERSI-SCWIMMER (1991) based on the spectrophotometric measure of remaining iodo-nitro-tetrazolium-formazane. The measurement was carried out in three repetatioin from each treatments.

2.3.6. Quantitative determination of micro organisms falling under different physiological groups

The total number of bacteria on Bouillon agar and of microscopic fungi on peptone-glucose agar (UBRIZSY-VÖRÖS, 1968) was determined by plate dilution method. The number of nitrogen fixing, cellulose-, and protein decomposing bacteria was determined on special liquid culture medium according to POCHON-TARDIEUX (1972). Each examination was carried out in three repetition and the results was conversed into absolutely dry soil.

2.3.7. Statistical evaluation of results

The effect of mulching experiments were statistically evaluated by variation analysis. Kolmogorov probe was apploed to determine the homogeneity of variations. We have also determined correlation and regression analysis between the examined parameters. Calculations were carried out with MICROSOFT EXCEL and SPSS.

3.Results

3.1. Soil physical and chemical parameters of the test field

At the same time P_2O_5, K_2O and humus content showed a negligent downward tendency in the above mentioned order. The pH of the soil decreased under each soil covering matters, but the humus content increased in case of straw and black polyethylene, and decreased in case of livestock manure and crushed pine bark.

Examinations carried out in 2001 showed an increase in soil pH and zinc constant, but the humus, nitrogen and potassium content decreased for the value measured before the plantation. The quantity of other examined nutrients was not changed essentially.

Between 1996 and 1997 the moisture content of the soil was higher in the covered tree lines either in dry period or after an abundant precipitation than in the control one. During the drought period the moisture content was higher with 5-30 % in the top 50 cm layer of soil, covered by crushed pine bark, straw, black polyethylene, livestock manure than in the control soil. This difference was bigger after an abundant precipitation. For example under the livestock manure the soil moisture content was higher with 38 % than in the control soil.

There was essentially difference in the precipitation of 2000-2001 fell in the same months. The total rainfall during the examined 5 months was 218,9 mm in 2000, but 349,3 mm in 2001; which means a rainfall surplus of 159,57 %. Based on the annual precipitation, 2000 could be considered a dry, but 2001 an average year. The fell and infiltrated precipitation was kept for a longer time in the covered soil than in the control.

3.2. Results for microbiological examinations

3.2.1. Results for cellulose decomposition activity under field (natural) conditions

Tests were placed into the soil in March, and lifted up four times two-monthly in each year.

Almost 100 % of the cellulose, contained by bags, decomposed in the soil covered by livestock manure, straw and crushed pine bark lifted up at the fourth date, after 8 months. The cellulose decomposition rate was 80% in the soil covered by black polyethylene and 65% in the control soil. The effect of treatments (covering matters) on cellulose decomposition activity decreased in order livestock manure, straw, crushed pine bark, black polyethylene and control.

The effect of livestock manure was significantly better in May, September, November of 1996 and non-significantly in July than the effect of straw, which gave the second best value. The third best results was given by the crushed pine bark in each month. The differences were significant. In May and July there was higher, in September and November lower activity measured in case of control than in case of black polyethylene, however the difference occurred in July was not significant.

Seeing the dynamic of the cellulose decomposition we can say that the evenest decomposition was measured under the crushed pine bark followed by livestock manure, straw, black polyethylene and control.

From the results of variation analysis, it was discovered that differences occurred in the dynamic of cellulose decomposition were significant in each sampling time. The livestock manure showed the highest figure in May and September, the straw in July and the black polyethylene in November.

The cellulose decomposition activity was higher under crushed pine bark, manure and straw than under black polyethylene or control in May, July and September of 1997. The activity measured under crushed pine bark and manure was almost the same to the last. The cellulose decomposition was the least in control (80%) while 100% of the cellulose was decomposed in the other treatment by the end of the experiment. However, the activity measured under the black polyethylene was higher than in the control only at the last sampling time. Differences measured in May and July were significant.

There were not significant differences between the effect of manure and crushed pine bark, similar to the effect of straw and control in September. The lowest value in

November was showed by the control soil, the other treatments showed the same figures. In spite of the previous year, in 1997 the dynamic of the decomposition was the evenest in case of the control. The dynamic in soil covered by crushed pine bark, manure and straw was similar to each other; there was a peak in May and a minimum in September. In case of the black polyethylene the most cellulose decomposed in September and the less in July. All of the differences measured in May and September were significant. There was non-significant difference between the effect of the control, crushed pine bark and manure in July, and between straw, crushed pine bark and manure in November.

In 2000 the highest cellulose decomposition activity was measured under black polyethylene at the first sampling time (May), and under the agroszövet in the other cases. The control showed always the lowest value. The dynamic of decomposition was the highest under black polyethylene at the first but under agroszövet at the second, third and fourth sampling time. These differences were generally significant.

In 2001 significantly the most cellulose decomposed under the agroszövet covering. The cellulose decomposition activity was higher under black polyethylene than in control soil. The dynamic of the decomposition was the highest in May, September and November in case of agroszövet, but in July in case of black polyethylene. The less value was measured under black polyethylene in May, and in control soil in July, September and November. The less and the more values significantly differed from the other values.

In our experiments a medium strong correlation was observed between the soil moisture content and the actual cellulose decomposition activity.

3.2.2. Results for cellulose decomposition activity measured under laboratory (artificial) conditions

The first examination happened right after the samples were delivered into the laboratory in case of spring and autumn samples. The second examination in case of spring samples happened three, in case of autumn samples six months after the first examination. For the second examination the samples were stored in laboratory under regulated conditions.

Apart from the crushed pine bark, the cellulose decomposition activity was less in the covered soil than in the control one in 1996 during the first examination of spring samples. The cellulose decomposition activity measured under crushed pine bark was higher with 20% than measured in the control soil. The difference between the effect of black polyethylene and the control was non-significant.

During the second examination of spring samples the cellulose decomposition activity measured under crushed pine bark (159%), manure (133%), straw (110%) and black polyethylene (108%) was higher than in the control soil (100%). In case of straw and black polyethylene the differences were non-significant.

There are not essentially differences between the results of the first and the second examination in case of autumn samples. The cellulose decomposition activity was higher in case of all treatment than in the control. This difference was only 1% in case of manure but 100% in case of crushed pine bark.

The effect of straw and crushed pine bark differed significantly from the effect of control and of each other. During the second examination of the autumn samples, the cellulose decomposition activity measured under manure (135%), black polyethylene (150%), crushed pine bark (210 %) and straw (220%) was significantly higher than in the control soil. Between the effect of crushed pine bark and straw was not found significant difference.

Apart from the crushed pine bark, the cellulose decomposition activity was less in the covered soil than in the control one in 1997 during the first examination of spring samples. The cellulose decomposition activity measured under crushed pine bark was higher with 17% than measured in the control soil. During the second examination of spring samples the cellulose decomposition activity measured under crushed pine bark (+65%) and manure (+25%) was significantly higher than in the control soil. Straw and black polyethylene covering did not show significant difference from the control. During the first examination of spring samples only the effect of manure was lower than of control with few percent, and it was non-significant. The cellulose decomposition activity measured under straw (162%) and crushed pine bark (210%) was significantly higher than in the control soil. At the second examination the cellulose decomposition activity was significantly higher under every cover matter than in the control soil. The activity measured under crushed pine bark and straw was more than doubled than in the control soil.

In 2000, the cellulose decomposition activity measured under the black polyethylene was equal or lower (-8%) than in the control. The effect of agroszövet was not significant but higher than the effect of control treatment. During the second examination of spring samples the cellulose decomposition activity was higher under agroszövet and black polyethylene than in the control soil. Both cover matter had a more favourable effect on cellulose decomposition activity than the control in autumn during the first and the second examination, too. At the first examination the cellulose decomposition activity was higher under black polyethylene with 4-11 % and with 22-30% in case of agroszövet. These differences were 30-41 and 70-80% at the second examination of autumn samples.

In spring of 2001 the cellulose decomposition activity was significantly higher in the control soil than in the covered ones. Moreover, the cellulose decomposition activity in the control soil was significantly lower than in the covered soil only at the second examination of autumn samples.

3.2.3. Results for CO_2 production of soil measured under laboratory conditions

Under agroszövet covering the CO_2 production was significantly higher in March, July and September, and non-significantly higher in May than in the control soil. From two soil cover matter the most CO_2 was produced under the black polyethylene but the difference in July was not significant.

In both experimental years and the average of 2000-2001 the significantly most CO_2 was produced in May and the less in March in average of the treatments. There was a peak in 2001 September but this did not differ significantly from the value measured in May.

The black polyethylene covering significantly enhanced the CO_2 production of the soil as compared with other treatments.

Weak correlation was observed between the soil moisture content and the soil CO_2 production.

3.2.4. Results for soil enzyme activity

Phosphatase activity decreased in order of agroszövet, control, black polyethylene in 2000 and in order of agroszövet, black polyethylene, control in 2001. Only the agroszövet showed significant difference from the control.

Saccharase, urease, catalase and dehydrogenase activity decreased in order of agroszövet, black polyethylene, control in both experimental years. Only significant difference was pointed out between the agroszövet and control.

Activity of the all examined enzymes was higher in the second, more wet year, and there was a seasonality observed in both the years.

During the examinations of the connection between soil moisture content and enzyme activity, a weak correlation was found between the phosphatase, saccharase, urease activity and soil moisture content, and a medium one between the catalase, dehydrogenase activity and soil moisture content. Also a relatively close correlation was observed between catalase and dehydrogenase activity, saccharase and dehydrogenase activity. A close connection was found between urease and catalase, saccharase and catalase, urease and dehydrogenase activity.

3.2.5. Results for quantitative determination of micro organisms falling under different physiological groups

In 1996, the number of microbes was the highest in the soil covered by manure in every sampling time. The effect of manure is followed by crushed pine bark, straw, black polyethylene and control.

In 1997, the results of our experiments showed similarity to the results found in 1996. The number of total bacteria and microscopic fungi was the highest under manure covering, but in case of black polyethylene these were sometimes lower than in case of control.

The number of cellulose decomposing bacteria decreased in order of manure, crushed pine bark, straw, black polyethylene and control in average of the four sampling time both in 1996 and 1997. In average of 1996-1997 the number of total bacteria increased in the following order: black polyethylene, straw, control, crushed pine bark, manure.

The number of microscopic fungi increased in order of control, black polyethylene, crushed pine bark, straw, manure. Differences found between crushed pine bark, straw, manure and control were significant.

In 2000-2001 the number of total bacteria was the highest under agroszövet blanket and the lower in the control soil. The number of microscopic fungi, cellulose decomposing, nitrogen fixing and proteolytic bacteria was the highest also under agroszövet covering, followed by black polyethylene and control.

The variation analysis showed that there is significant difference only between the effect of agroszövet and control. Medium correlation (r=0,504) was observed between the number of proteolytic and nitrogen fixing bacteria, and a close one (r=0,91) between the number of proteolytic bacteria and urease activity. A close connection was also detected between the number of cellulose decomposing bacteria and actual cellulose decomposition activity of soil in every experimental year (r=0,899; r=0,904; r=0,951; r=0,968).

3.2.6. Growth and progress of trees planted in the test area

Different soil cover matters had an advantageous effect on cellulose decomposition activity, number of bacteria falling under different physiological groups, number of microscopic fungi, CO_2 production and the enzyme activity of the soil. Therefore it could not be indifferent how soil cover matters influence the growth and progress of trees.

The more powerful growth was demonstrated by the fact that trunk diameter (+5,7-22,8%), average sprout length (up to 28,2%) was higher in case of mulched plots.

Throughout, it could be concluded from their differences that parameters demonstrated the growth and progress of trees did not show any connection with the examined soil biological parameters (cellulose decomposition activity, number of bacteria falling under different physiological groups, number of microscopic fungi, CO_2 production and enzyme activity of the soil.)

4. New scientific results

- The soil covering assisted to conserve the moisture content of the soil but the degree of the conservation depended on the soil cover matter and the irrigation.

- The cellulose decomposition activity measured under different cover matters increased to the control. The scale of the increasing was significant in case of some cover matters. A medium strong positive correlation was found between the soil moisture content and the cellulose decomposition activity.

- The CO_2 production of the soil showed the significantly highest figures under the black polyethylene blanket either monthly or yearly. Favourable or unfavourable effect of agroszövet compared to control was also significant. Between the soil moisture content and soil CO_2 production only a weak correlation was detected.

- In case of every enzyme activity the agroszövet blanket resulted the significantly highest value. Only the sacharase, catalase and dehydrogenase activity of the soil covered by black polyethylene was higher than of the control soil, but significance was not found in all cases. During the examinations of the connection between soil moisture content and enzyme activity, a weak correlation was found between the phosphatase, saccharase, urease activity and soil moisture content, and a medium one between the catalase, dehydrogenase activity and soil moisture content. Also a relatively strong correlation was observed between catalase and dehydrogenase activity, saccharase and dehydrogenase activity. Strong correlation was found between urease and catalase, saccharase and catalase, urease and dehydrogenase activity.

- The number of total bacteria, microscopic fungi, aerob cellulose decomposing, proteolytic and nitrogen fixing bacteria was higher in covered soil significant or significantly than in the control soil depending on the cover matter. There was a positive relatively strong correlation observed between the number of proteolytic and nitrogen fixing bacteria, and a strong one between the number of proteolytic bacteria and urease activity as well as between the actual cellulose decomposition activity and number of cellulose decomposing bacteria.

- The apply of mulching system had a favourable effect on the growth and progress of trees (sprout growing, trunk diameter) but there was not found significant connection between these parameters and application of soil coverings.

5. Recommendations for using the new scientific results

Application of soil cover matters assisted to conserve the moisture content of the soil which is important for young trees.

Biological activity of the soil was stimulated by using soil cover matters, and the soil cover matters generally had favourable effect on the development of apple trees.

According to our experiments, herbicides could be replaced with different mulches which means not only saving money, but also environmental protection.

The applied soil cover matters according to our soil biological examinations, could be suggested to put into practice in order manure, crushed pine bark, straw, black polyethylene, but if only the use of artificial origin matter is possible it is worth preferring agroszövet to black polyethylene.

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