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BIOLOGICAL GEOTEXTILES AGAINST SOIL DEGRADATION UNDER SUBHUMID CLIMATE – A CASE STUDY

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Abstract: The objective of this paper is to investigate the effect of biological geotextiles on soil erosion and on the main physical (porosity, texture), chemical (soil organic carbon (SOC), total nitrogen (TN)) and biological (cellulose decomposition activity) properties of the topsoil. 16 runoff plots were installed in Abaújszántó, NE Hungary, on a slope with 15% gradient. The plots are in orchard, traditional and espalier vineyards. The lower half of 8 plots were covered by Jute, Borassus and Buriti geotextiles respectively, the other 8 plots served as control plots (uncovered). All the used geotextiles reduce soil loss. Higher runoff volume provides a better water retention efficiency of the geotextile. In the measurement period of 30 month no significant ($p<0.05$) changes could be identified in porosity, SOC, TN content and microbiological activity of the topsoil. Regarding the texture of the eroded soil the filtering effect of runoff seems to be important as the eroded sediment is enriched in fine (clay) fraction. Borassus mats were the most effective geotextiles against soil erosion followed by Jute. The upscaling and the extrapolation of these results are rather difficult because of the high variability of environmental factors. Further research is needed on the effect of the environmental conditions to be able to give a reliable assessment on the protecting effect of geotextiles under the conditions of a sub-humid climate.

Keywords: Erosion, Biological geotextile; Runoff; Soil loss; Soil degradation; BORASSUS project

1. INTRODUCTION

The application of geotextiles rapidly increases, especially in engineering and architecture. The applications in soil conservation are subsidiary, mainly in connection with costal erosion (Recio & Oumeraci, 2007; Shina & Oh, 2007). Protection against soil erosion on hill slopes is also an important application possibility (Lekha, 2004; Lekha & Kavitha, 2006). Geotextiles are effective tools to reduce splash erosion (Bhattacharyya et al., 2010a). Geotextiles can successfully be applied for soil erosion control also under temperate climatic conditions (Davies et al., 2006).

Nonwoven, synthetic geotextiles provide the cover of the whole surface with different permeability parameters and hinder weed development. Biological geotextiles are woven mats covering the surface only partly so that they can be applied on slopes to be planted. Blended geotextiles ally the advantages of both types (Basu et al., 2009). Biological geotextiles are better tools for soil conservation purposes than synthetic geotextiles. Covering bare surfaces by biological geotextiles decreases considerably both runoff (Booth et al., 2007; Fullen et al., 2007) and the quantity of soil loss (Bhattacharyya et al., 2008, 2009), although Giménez-Morera et al., (2010) report data on higher runoff volumes under cotton geotextile cover. Reduced soil loss and runoff values are due to the inhibition of rill erosion (Smets et al., 2007), although in other cases biological geotextiles are less effective against concentrated flow erosion compared with sheet erosion (Smets et al., 2009). The efficiency of biological geotextiles in decreasing soil erosion widely varies depending on several parameters such as slope length and steepness, soil properties, geotextile types and precipitation (Bhattacharyya et al., 2010b, Smets et al., 2011b). Subaida et al., (2008) investigated the tensile and pullout behaviour of undegraded coir fibres and mats and found remarkable differences depending on gauge length. However, till the end of their short lifetime they totally degrade (Sarsby, 2007) and this way increase the organic matter content of the topsoil. Finally the higher OM content results better aggregate stability and bigger biological activity (Rickson, 2006). Bhattacharyya et al., (2010a) report data on no significant decrease in SOM after Buriti and Borassus mat degradation.

The construction of biological mats is considerably cheaper than the production of synthetic geotextiles. Mat weaving doesn't require any qualifications offering good possibilities for unemployed people in the third world. The EU-funded BORASSUS Project (Contract number INCO-CT-2005-510745) is evaluating long-term effectiveness of biological geotextiles (Booth et al., 2007; Fullen et al., 2006, 2007, 2011). The present study was carried out within the framework of the BORASSUS project.

In Hungary soil erosion threatens mainly agricultural areas (Szilassi et al., 2006, Centeri et al., 2009; Farsang et al., 2011). The application possibilities of geotextiles and surface coverage against soil erosion on arable land are strongly restricted because of the cultivation technologies (Kertész et al., 2007a). The same problem arises also in vineyards and orchards where bare soil surface is quite frequent on steep slopes. Grass cover between wine rows could be a solution against erosion but under subhumid climate precipitation amount and frequency do not always provide enough moisture for both the wine and the permanent grass cover. Another solution is mulch or geotextile cover. The role of artificial surface cover in crop production in order to decrease soil loss is not clarified adequately however it has primary importance in soil erosion modelling (Smets et al., 2011a).

The aim of this paper is to present a study on the effect of biological geotextiles on runoff and on soil loss under sub-humid temperate climatic conditions. Various geotextiles (Borassus, Buriti and Jute) were tested in terms of runoff and soil loss amount as well as selected soil physical (moisture content, porosity, temperature) and biological properties in a period of two years. The experiments ran on plots with three typical land use types, i.e. traditional vineyard, espalier vineyard and orchard. The practical objective of this paper is to elaborate for the use of biological geotextiles in Hungary.

2. STUDY AREA

The study area is situated in NE Hungary where vineyards and orchard extend also on steep slopes. The wine is very famous here (Tokaj wine growing region) and fruit productions is also significant. Because of the high erosion risk in the plantations on hillslopes the protection against soil is extremely important. The experimental station was established in Abaújszántó (48° 16' 18"N; 21° 11' 23"E, Fig. 1).

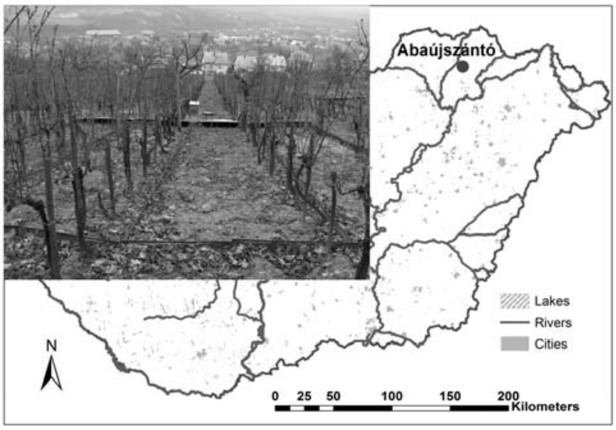

Figure 1 Location of the study site in Hungary

The soil type is haplic Luvisol (skeletic). The texture is silty loam (Table 1), the skeleton content varies between 14-23% m m^{-1}, the soil parent material is amphibole andesite (Kertész et al., 2007b). Investigations were carried out on a terraced slope. Mean annual precipitation is 597 mm, maximum rainfall intensity is 83 mm h^{-1} (1% probability) and the potential evaporation is 750 mm $year^{-1}$ (Kertész et al., 2007c). The climate is of subhumid temperate character.

3. MATERIALS AND METHODS

Three types of woven biological geotextiles were investigated. Main parameters of these mats are given in table 2.

Table 1. Soil properties of the experimental station (SOC=Soil Organic Carbon, SD=standard deviation particle size classes are in mm, C:N= Carbon – Nitrogen ratio)

n=8	Nitrogen ppm	SD	SOC ppm	SD	Clay % <0.002	Silt % 0.002-0.02	Sand % 0.02<	C:N
Orchard	1186	201	12579	5916	7.0	69.7	23.3	10.6
Espalier vineyard	986	109	9069	1270	7.0	69.7	23.3	9.2
Traditional vineyard	1906	272	25483	5035	7.9	69.7	22.5	13.4

Table 2. Main parameters of the applied geotextiles (*Borassus aethiopium* [Borassus], *Mauritia flexuosa* [Buriti], *Chorchorus sp.* [Jute])

	Borassus	Buriti	Jute
Material	Palm leaves		Jute yarn
Thickness (mm)	18	10	8
Surface cover (%)	76	44	46
Weight (g m^{-2})	950	520	470

While the palm leaf mats were untreated (Davies et al., 2006), the jute was bitumen treated (Chattopadhyay & Chakravarty, 2009) to inhibit the decomposition and to extend its lifetime. Runoff and soil loss measurements were performed on various land-use types, with and without the application of geotextiles. 4 measuring blocks were established (Fig. 2).

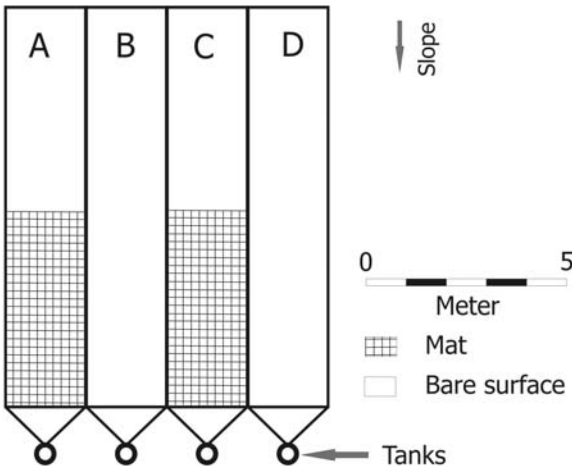

Figure 2. Sketch of one measuring block (4 plots)

Each block consists of 2x2 runoff plots, one partly covered by geotextiles and one uncovered plot with a repetition of each, each with an extent of 2x10 m. The blocks are on a slope of 15% slope gradient with eastern slope aspect (Booth et al., 2007). The four blocks represent different treatments, i.e. different land uses and/or cover types. They are as follows:

- Young orchard (plum trees planted in a 2*2m grid, 0.4 canopy cover) – Jute
- Espalier vineyard (2m between the rows, 0.5 canopy cover) – Jute, Buriti, Borassus
- Traditional vineyard (planted in a 1.2*1.2m grid, 0.6 canopy cover) – Jute

On the treated plots mats covered the lower half of the soil surface, because Bhattacharyya et al. (2009) proved that the partly covered plot is more effective in water retention than the totally covered.

Runoff and sediment measurements and collection were carried out by a system developed by the authors (Fullen et al., 2006, 2007). Measurements started on June 22 2006 and ended on December 8 2008.

For soil moisture measurements Eijkelkamp soil moisture blocks were installed at each plot (measurements at the soil surface and in 20 cm depth). In addition to this gravimetrical soil moisture content measurements were carried out (Kertész et al. 2011). For the measurement of soil temperature changes and the effect of geotextile on this, soil thermometers were put into the soil at 20 cm depth on each block. The values were measured every minute.

For soil porosity measurements samples were taken from all the three plot blocks and investigated by the following method. In each case three undisturbed samples were taken by a 100 cm^3 cylinder from the upper 0-7 cm layer to determine porosity volume and distribution. Saturated hydraulic conductivity was determined by infiltration measurements (Vér, 1982).

The biological activity of the topsoil was investigated by the Unger (1968) method. Early spring 3 cotton packages were put into the soil at 5 cm depth on each plot. At the end of the growing season (9 month later) the packages were taken out. The biological activity was estimated on the basis of cellulose decomposition (weight difference between the input and output samples).

For soil organic carbon (SOC) and total nitrogen (TN) content measurements 5 soil samples were taken from each plot covered by jute before (2006) and after (2008) the measurement period. SOC and TN content were measured using Tekmar Dohrmann Apollo 9000 NDIR spectrometer. Soil particle size distribution was determined using Fritsch Analysette Microtech 22 (FAM 22) laser diffractometer.

The normally distributed data were analysed using one way ANOVA with post hoc Tukey test and linear regression.

4. RESULTS AND DISCUSSION

4.1. Runoff and soil loss

Altogether 277 precipitation events were recorded during the measurement period. Surface runoff and soil loss were observed only in 44 and 39 cases, resp. (Table 3). Soil loss was recorded in 90% of all runoff events.

In the first year 23 precipitation events out of 141 generated runoff accompanied by soil loss in 21 cases. No thresholds and relationships between the investigated parameters (rainfall amount and intensity, maximum intensity etc.) and surface runoff were found. In accordance with the results of Bhattacharyya et al., (2010b) probably all of these parameters and other ones (e.g. actual soil moisture content) control the dynamics of infiltration and runoff together.

Table 3. Statistical parameters of precipitation events
I_{30}=maximal 30 min intensity

Measurement period	06/2006 – 12/2008	
Rainfall	277 events	
Runoff	44 events	
Soil loss	39 events	
	Maximum	Median
Duration (min)	2811	22.3
Intensity (mm h^{-1})	38.7	0.7
I_{30} (mm h^{-1})	38.7	1.6

As it is well known surface runoff and soil loss are controlled by the cultivation methods, too (Szilassi et al. 2010). According to previous research results the use of geotextiles decreases surface runoff (Ahn et al., 2002; Bhattacharyya et al., 2008; Lekha, 2004; Smets et al., 2007). The effect of geotextiles in preventing erosion and runoff depends on the rate of runoff which can be measured also on the bare soil surface. The geotextiles used in this study did not decrease the amount of runoff water in areas characterized by low runoff (traditional vineyard) (Table 4).

These results agree with those published by Bhattacharyya et al. (2008). In contrast to the case of low runoff the geotextile cover decreases the amount of runoff water if the amount of runoff is higher. At the study site higher runoff was measured in the orchard, here runoff was reduced by 25% when geotextiles were applied. The highest runoff decrease was measured in the espalier vineyard where the highest runoff values were registered.

Comparing runoff values of covered and uncovered plots only a very weak correlation could be detected between them independently from land-use. Runoff volume increased by 5-7 % in the orchard and in the traditional vineyard covered by jute. In the espalier vineyard a decrease of 250 % was registered (Fig. 3).

In the espalier vineyard covered by Borassus and Buriti runoff volume was also reduced although the coefficients of determination are very low (Fig. 4). The effect of geotextiles on runoff rate is primly influenced by the precipitation properties, however, there was no connection between total intensity and 30 minutes maximal intensity and runoff rate.

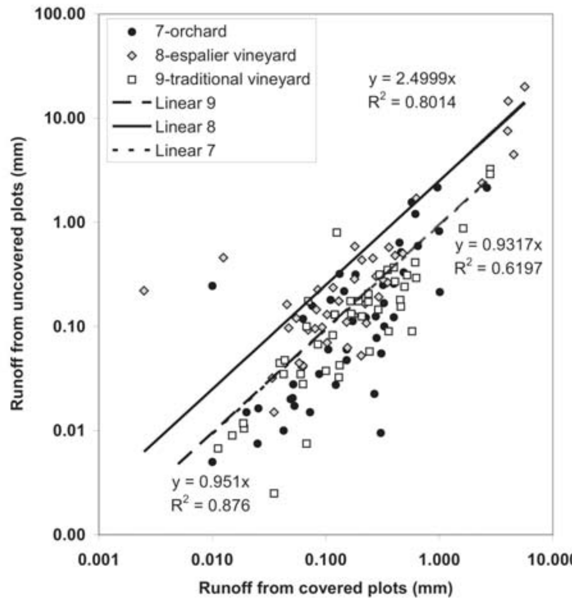

Figure 3. The effect of jute cover on runoff volume under different land uses based on 44 runoff events

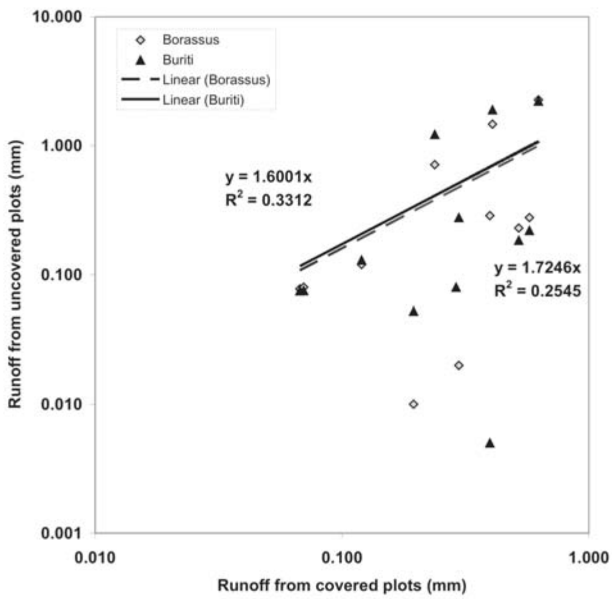

Figure 4. The effect of Borassus and Buriti cover on runoff volume in the espalier vineyard (15 runoff events).

The decrease in runoff depends also on the quality of geotextile materials. As Mitchell et al., (2003) proved Jute net cover decreased both runoff and soil loss. Runoff volume was 50 % lower on soils covered by jute than on the uncovered soil and 25% lower on Buriti covered soils.

Table 4. Average runoff values of each two plots under various treatments

	Orchard		Espalier vineyard				Traditional vineyard	
	Jute	Uncovered	Jute	Borassus	Buriti	Uncovered	Jute	Uncovered
Runoff mm $year^{-1}$	7.1	9.5	13.7	17.2	11.2	29.0	7.5	6.3
Runoff coefficient	1.3	1.7	2.5	3.6	2.3	5.3	1.4	1.1

Similar results were obtained on the Borassus covered soil. Soil erosion took place if precipitation amount was more than 9 mm pro event except in one case when a 2 mm rainfall caused erosion. Table 5 summarizes the amounts of eroded soil according to the observed precipitation events.

It is conspicuous, that the difference in the amount of eroded soil between orchard and espalier vineyard is as high as 900% in spite of the similar soil physical properties both on bare soil and under jute cover. This difference can be explained by the different surface cover, i.e. in the espalier vineyard a unit area is characterized by higher canopy cover.

The highest soil cover is in the traditional vineyard ensured by the canopy of wine and by the large proportion of rock fragments. Probably the high proportion of rock fragment content on the surface explains the weakest effect of geotextiles in preventing soil erosion. Soil loss is reduced considerably on the plot covered by jute. Comparing the uncovered and the covered plot the reduction owing to the jute cover is 80%. It is interesting that there is no reduction in runoff volume which is higher on the covered plots.

In the orchard and in the espalier vineyard the total amount of soil loss was only 20% compared to uncovered soils. The preventing effect of jute can be primarily explained by the decrease of the effect of splash erosion processes as mentioned by Bhattacharyya et al., (2010a, 2011a,b) as the result of their research carried out under palm leaf cover. Similarly to the runoff values, total soil loss on Buriti and Borassus covered plots was only 10% and 5% of the values measured on the control plots. In espalier vineyards two times and four times higher soil volume was retained by Buriti and Borassus geotextiles, respectively, compared to jute.

When soil loss due to individual rainfall events is studied the covered and uncovered plots show various relationships. Good correlation can be found when the two extreme values are left out of the 36 events data sets under orchard (Fig. 5), although these two events account for half of the total soil loss during the observation period. According to the results jute coverage reduce soil erosion 7.7 times.

This relationship is quite close for the espalier vineyard (Fig. 5) and it corresponds to the relationships between the average values for the whole studied time range. It means that soil loss on the uncovered plot is 4.5 times higher than that on the covered one. Very small differences were found in soil loss between the covered and uncovered plots in the traditional vineyard (Fig. 5).

The relationships mentioned above are only relevant under a certain soil loss threshold value. Presumably above this threshold other processes, like rill erosion become dominant. To determine this value long term plot measurements or rainfall simulation studies are needed.

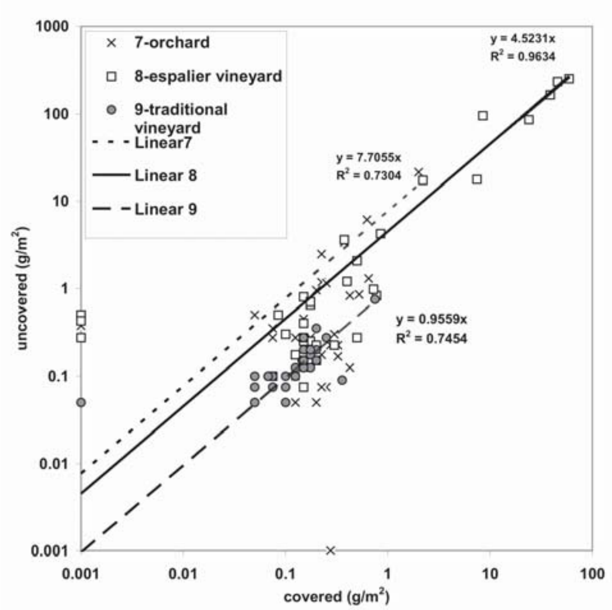

Figure 5 Soil loss in orchard, espalier and traditional vineyards (jute and uncovered) based on 34 rainfall events

The protective effect of geotextiles can be calculated as the P factor of the USLE (Wischmeier & Smith 1978, Bilaşco et al., 2009, Ştefănescu et al., 2011). Summing up the erosivity values of the measured precipitations (01/01/2007 – 08/31/2008) R=257.3 arose. As the soil loss values (A), the factors of topography (LS=0.6715) and plant cover (C=0.55) of each block are known, the erodibilty (K) factor can be calculated (Centeri, 2002, Arghius & Arghius 2011). The ratio of the covered and uncovered plots under a given land use can be interpreted as the factor of the protecting effect (P) of the geotextiles calculated by the USLE (Table 5).

4.2. The effect of geotextiles on the texture of eroded soil

The texture of the eroded soil was different because of the geotextile coverage. Average soil loss from the covered plots can be characterized by the lack of the sand fraction, which is about 20% in the original soils. The filtering effect of geotextiles prevailed on the coarse soil fractions irrespectively of the amount and intensity of precipitation and of the amount of sediment. Bhattacharyya et al 2010a reported data on the relative increase of the sand content in topsoil due to Borassus mat cover during two years. In this case splash erosion dominated the soil loss processes while the results of this paper refer mainly to splash and interrill erosion.

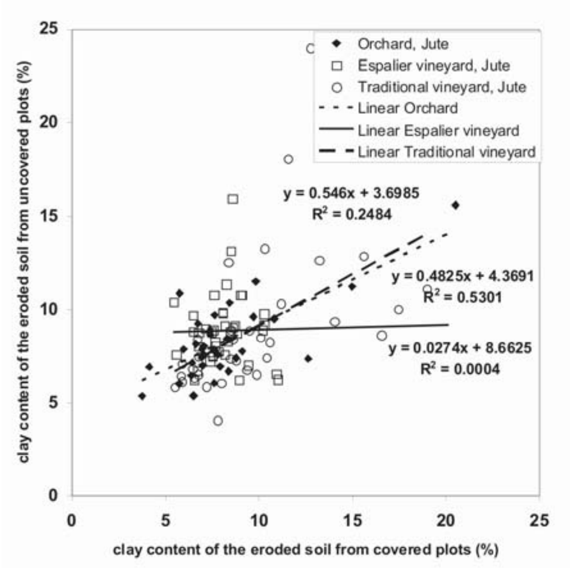

Figure 6 The effects of jute geotextile surface cover on the clay content of the eroded soil. (n= 42, 43, 42)

As the particle size distribution of an amount of eroded soil coming form one event depends on additional factors like land use, rainfall amount, intensity etc., the results should be interpreted separately, i.e. by pairs (Fig. 6). Under espalier vineyard the clay content of the eroded soil does not seem to be influenced by the geotextile coverage. In the orchard and in the traditional vineyard Jute cover halved the clay content, in the eroded sediments, however, the relationships are very feeble.

4.3. The effect of mats on porosity

The lack of relationship between specific weight and porosity can probably be explained by the high proportion of rock fragments in the topsoil. Initial parameters of the samples taken from orchard, espalier and traditional vineyard show big differences (Table 6).

The lowest bulk density is in traditional vineyard block referring to a different soil parent material. The other two blocks have higher bulk densities with similar values. With respect to infiltration (water content) orchard and espalier vineyard form a unit in spite of the differences in their soil mineralogy. Their total porosity values are almost equal.

The soil of the espalier vineyard has the lowest total pore volume whereas the values of gravitational and capillary pores are lower than those of the other two blocks. These differences, however, are not as significant as to explain the strong decrease of leakage. The explanation for this may be the disadvantageous distribution of gravitational pores and the effect of cultivation on them.

Our results show that the effect of geotextiles on soil physical parameters is not remarkable. We did not observe any significant differences in the soil physical parameters during the two years of this study. Bhattacharyya et al (2011a) reported that after two years without geotextile cover resulted significant increase in bulk density and decrease in aggregate stability while no significant difference under geotextile cover were observed. In addition to this no changes in soil organic carbon, pH and total soil nitrogen were found both under Borassus and Buriti.

According to the results of this study 30 month Jute coverage was not enough to change significantly ($p<0.05$) the soil organic carbon and total soil nitrogen content of the topsoil (Figure 7-8). It can be assumed therefore that geotextiles did not affect the structure of topsoil during 30 month. The differences of the measurement values of 2008 reflect presumably the differing environmental conditions of the study areas and the effects of geotextiles can not really be followed and shown.

Table 6 Porosity values of the topsoil (0-8 cm). The data in the table represent the average of three analyses. Data in bold are from 2006, all other data are from 2008

Land use	Coverage	Bulk density g cm^{-3}	Water content cm^3 cm^{-3}	Gra-vitational pores cm^3 cm^{-3}	Capillary and adsorption pores cm^3 cm^{-3}	Total pore volume cm^3 cm^{-3}	Specific weight g cm^{-3}	Saturated hydraulic conductivity mm h^{-1}
Orchard	initial state	1.25	0.291	0.166	0.365	0.532	2.7	2.5
	covered	1.32	0.300	0.151	0.359	0.510	2.7	-
	uncovered	1.23	0.263	0.226	0.335	0.561	2.8	-
Espalier vineyard	initial state	1.41	0.264	0.154	0.310	0.464	2.6	0.4
	covered	1.25	0.254	0.188	0.339	0.527	2.6	-
	uncovered	1.33	0.264	0.117	0.375	0.493	2.6	-
Traditional vineyard	initial state	1.13	0.300	0.176	0.356	0.532	2.4	3.0
	covered	1.13	0.281	0.209	0.330	0.540	2.5	-
	uncovered	1.05	0.286	0.225	0.329	0.554	2.3	-

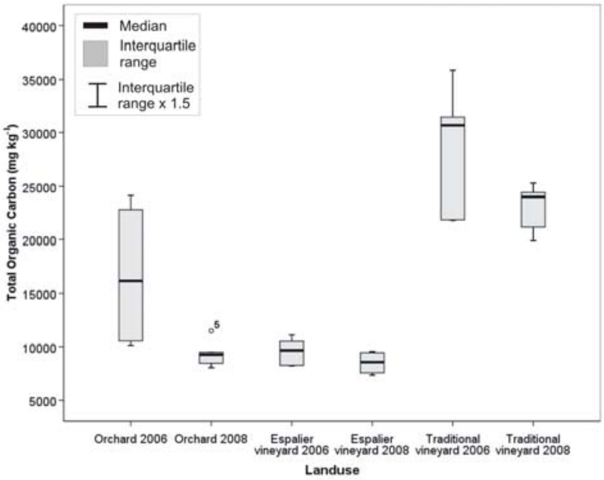

Figure 7 Changes in soil organic carbon content due to 2 years jute geotextile coverage under different land use conditions (o:1.5–3 x interquartile range)

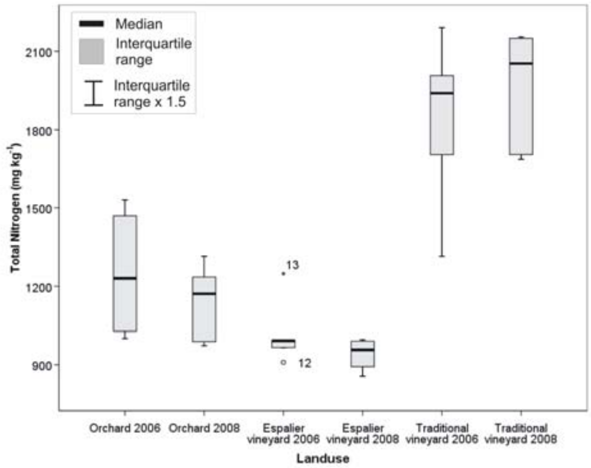

Figure 8 Changes in soil total nitrogen content due to 2 years jute geotextile coverage under different land use conditions (o:1.5–3 x interquartile range; *: >3 x interquartile range).

4.4. Soil moisture

We found often high (saturated) moisture content in covered soils even in case of low annual precipitation and high temperature fluctuations. The actual soil moisture contents of soils covered by jute, Borassus and Buriti do not show significant differences. The uncovered soils are characterized by strongly fluctuating moisture content values, while soils on the covered plots were often saturated with water, but statistical relationships could not be proved. Detailed results of soil moisture content changes due to biological geotextile cover under subhumid climate (Hungary) are summarized in the paper of Kertész et al., (2011).

The daily oscillation of soil temperature reached 9-10°C in the orchard and we did not find any differences between the geotextile covered and the bare surface. The biological geotextiles served as a soil temperature buffer in shade (espalier vineyard) where this geotextile cover reduced the 6-7 °C oscillation range to 3-4 °C. In this case the minimum values of covered and uncovered soils are the same, but the covered soils heated up less at noon. The mitigation effect disappeared in overcast weather during summertime (Fig. 9).

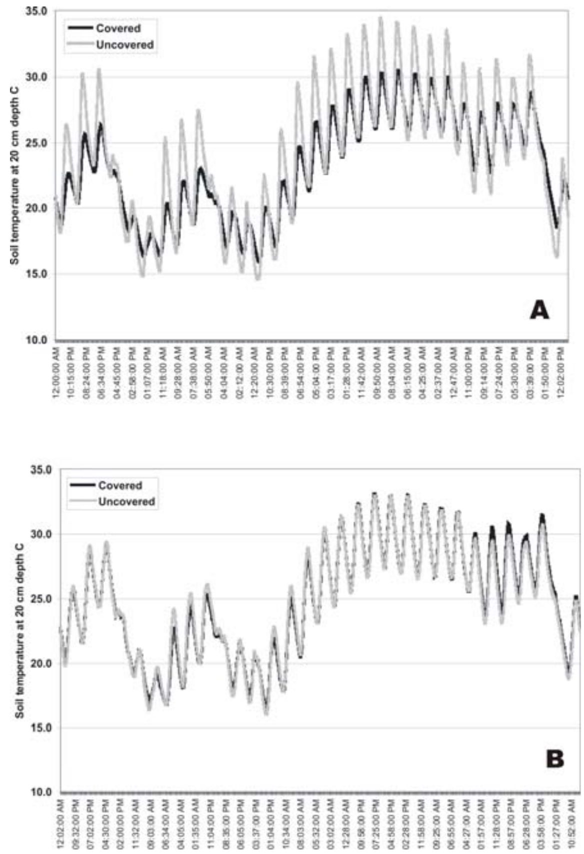

Figure 9 Daily soil temperature oscillations at 20 cm depth (July 2007) A – Espalier vineyard; B – Traditional vineyard

4.5. The effect of geotextiles on soil temperature

According to the measurements, geotextiles decrease the daily fluctuation of soil temperature in bright, anticyclonic weather. In summer on bright days the daily oscillation of soil temperature depends on the incident solar radiation at the soil surface. The highest incident radiation values were measured at the soil surface of young orchard, while the lowest ones in the espalier vineyard.

This smoothing function of organic geotextiles can be observed during springtime as well. The differences between temperature oscillation of covered and bare soils increased in line with increasing incident solar radiation (Fig. 10A). In contrast to summertime daily minimum and maximum temperature values of the covered soils remained between the minimum and maximum temperature values of the uncovered soils in the first half of springtime. At the beginning of permanent temperature fall geotextiles can delay the cooling down of the soil for several days.

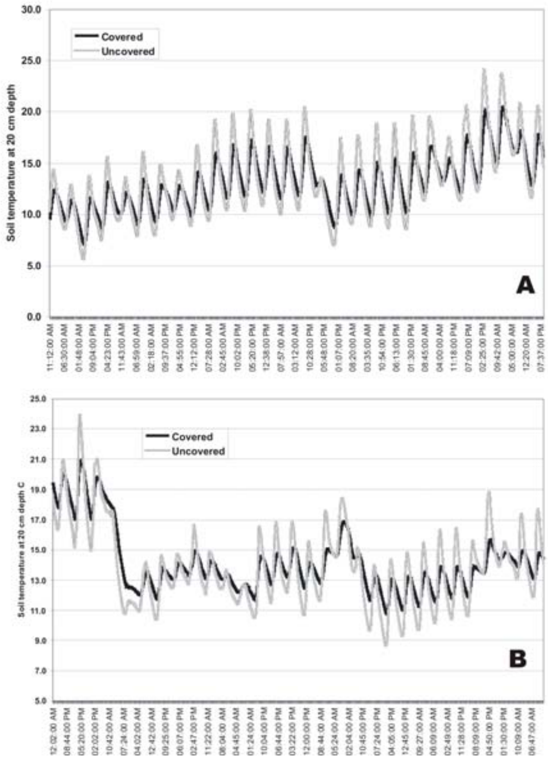

Figure 10 Daily soil temperature oscillations at 20 cm depth. A – April 2007; B – September 2007

In line with decreasing incident solar radiation during cloudless weather and during overcast and rainy days the mitigation of the oscillations was not so spectacular as in the summer and the minimum and maximum values of the covered soils remained between the minimum and maximum temperature values of the uncovered soils again (Fig. 10B). The key factor of the efficiency of geotextiles concerning temperature oscillations is the value of incident solar radiation at the surface. However, there is no a sharp threshold. The buffering of soil temperature oscillations is less effective above ~950-980 μmol cm^{-2} s^{-1}. We did not observe this buffering function under shaded conditions, where the maximum value of SR is not more than 200 μmol cm^{-2} s^{-1}.

4.6. The effect of geotextiles on soil biological activity

Geotextiles may influence soil biological activity through affecting temperature and soil moisture conditions. Results obtained in the project are contradictory. Palm leaf geotextiles seem to decrease soil biological activity in each case although the differences are not significant ($p<0.05$). Jute cover did not influence the decomposition activity of cellulose in the vineyards, while an increase of it could be observed in the orchard (Table 7) however it is not significant ($p<0.05$).

6. CONCLUSIONS

Geotextiles have a significant protecting effect against soil erosion in vineyards both on eroded and on non eroded surfaces. Highest soil erosion rates were found in the espalier vineyard. Geotextiles were most effective in retaining soil in case of the coarse soil fraction (sand). Among the three geotextiles studied Jute coverage proved to be the best in diminishing runoff, while Borassus was the most effective against soil loss under sub-humid climatic conditions. The effectiveness of Buriti was the lowest in decreasing both soil loss and runoff. The conclusion is that the degree of prevention is not related directly to the covering effect of different geotextiles. The runoff retaining and soil protecting effect of geotextile cover increases due to the increasing runoff volume.

As a consequence of the above statements Jute geotextiles are most suitable on the steep slopes of NE Hungary, where the water retention effect has primary importance. Although the soil protection effect of the Borassus mat is better, the much lower decomposition means a longer protection effect. The applicability of geotextiles depends also on the production and transportation costs. They should also be analysed in case of large scale applications. The spatial applicability of these results is limited because of the high variability of the environmental factors. Additional investigations are needed to clarify the role of the environmental factors.

As some of the soil properties (SOC, porosity, biological activity) do not change during 3 years very much a longer study period is necessary to obtain reliable results on their role.

Table 7 The percentage of decomposed cellulose % (n=6)

	Orchard		Espalier vineyard				Traditional vineyard	
	Jute	Uncovered	Jute	Borassus	Buriti	Uncovered	Jute	Uncovered
Average	69.5	59.7	57.8	47.1	55.5	59.8	66.4	65.1
Standard deviation	2.1	15.5	14.3	18.0	13.7	15.5	2.1	9.7

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