

## CULTIVATION OF ORGANIC POTATOES WITH THE USE OF MULCHING MATERIALS <sup>1</sup>

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### Introduction

Mulching has become more popular for the last 10 years and it is an important way of soil protection in plant production. Mulching significantly decreases soil erosion [DÖRING et al. 2005], virus vector in seed potatoes [DÖRING et al. 2006] and it may also act as a tool for the control of nitrogen losses by the immobilization of post-harvest nitrate [DÖRING et al. 2005].

Mulch especially reduces water evaporation from the soil and helps to maintain stable soil temperature [JI, UNGER 2001; KAR, KUMAR 2007]. For that reason, the cover of mulch influences the soil moisture as well [BRANT et al. 2006]. Next, mulching has a positive effect on the weed density, which was documented by the results of some authors [JOHNSON et al. 2004; DÖRING et al. 2005; SINKEVIČIENE et al. 2009].

The aim of this paper was to evaluate the effect of different mulch materials (organic and plastic mulch) on the yield and on some other factors which have an effect on potato production in the potato growing region of the Czech Republic. The studies were mainly focused on the effect of mulching on the growing temperature of plants, the level of soil moisture and the occurrence of the late blight.

### Materials and methods

Field experiments were conducted in Leškovice in the Czech-Moravian Highlands (potato growing region) in 2008 and 2009. Leškovice is situated at 498 m over sea level with the average annual temperature of 6.9°C and annual rainfall of about 630 mm. In this region the soil is of pseudogleyic acid cambisol (brown gleysol) type and mostly outbalances lighter, loam-sandy soils. Further information such as pre-crops, dates of planting, mulching and harvesting are described in Table 1.

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<sup>1</sup> This study was financed from the Research Proposal of the MŠMT ČR No. 6046070901 and from the project of the NAZV MZe No. QH 82149.

In the experimental field in Leškovice (LE) variants with chopped grass mulch (GM) and black textile mulch (TM) were compared with a non-mulched control variant with mechanical cultivation (C). In the plots with TM ridges were formed at the beginning which afterwards became covered with the black polypropylene non-woven textile. After potato tubers were manually planted into holes prepared in the textile at the required spacing (450 mm × 800 mm) GM was spread by hand in a 25 mm thick layer, on 14<sup>th</sup> day after planting (immediately after the second hoeing). All treatments were divided into four parallel determinations (plot trials 7.2 m<sup>2</sup>).

Table 1; Tabela 1

Pre-crop, dates and harvesting terms in the experimental years of 2008–2009  
Przedplon, daty i terminy zbiorów w latach 2008 i 2009

Factor; Czynn timer	2008	2009
Pre-crop; Przedplon	grass-clover; koniczyna	broad bean; bobik
Planting date; Data sadzenia	29.04.	14.04.
Mulching date; Data przyorania mulczu	28.4. MT; MW 12.5. GM; TM	14.4. MT; MW 27.4. GM; TM
Date of harvest; Data zbioru	12.09.	20.08.

In all treatments (MT, GM and C) the air temperature and the relative humidity were continuously measured from planting to the harvest at 15 min intervals with the use of Minikin TH (EMS, Brno). During the vegetation period (from April to September) an average temperature and total rainfall were of 13.3°C/ 351 mm and 15.7°C and 359 mm respectively in 2008 and 2009.

Manually harvested tubers with late blight, necrosis or grow green were removed, tubers infested by late blight were counted out and weighted. The remaining tubers were sorted out with the use of commercial potato sorters into four fractions (under 40 mm, 40–55 mm, 56–60 mm and over 60 mm), in which the number of tubers and their weight were determined.

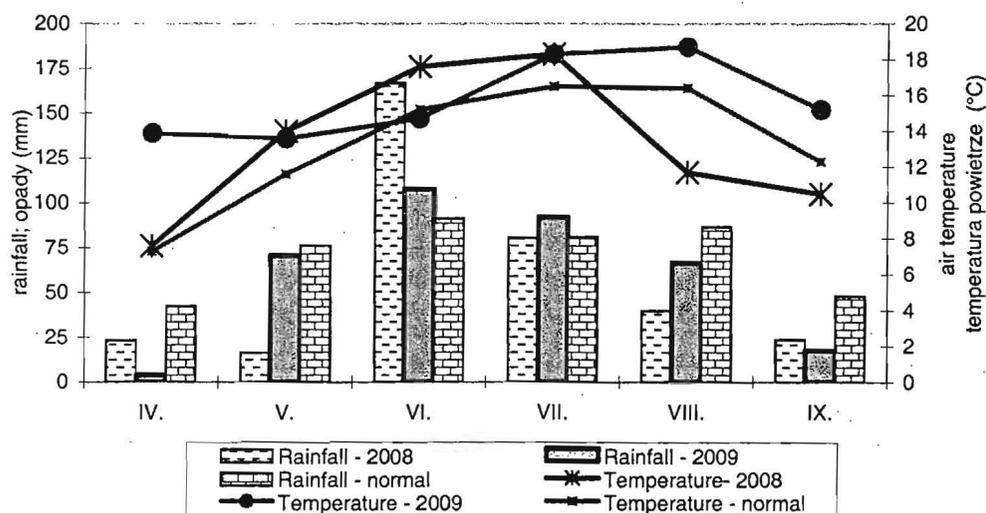


Fig. 1. The range of air temperature and the rainfall during the vegetation period in the Leškovice region (in 2008 and 2009)

Rys. 1. Przebieg temperatur powietrza i opadów w latach 2008 i 2009 w Leškovice

Statistical calculations were done with the SAS statistic program ver. 9.1.3. (SAS Institute Inc., 2003). The GLM procedure and Tukey test (P value 0.05) were used to determinate the effect of the two mulching materials (MT and GM) on the crop properties.

## Results and discussion

### The air temperature, relative humidity and *Phytophthora infestans*

It was observed that the use of mulch had slightly reduced the air temperature at the level of 250 mm above the soil surface. During the first experimental year (2008) the temperature of the air decreased by about 0.2°C in the mulch textile (MT) and by about 0.4°C in the grass mulch (GM) as compared to the non-mulched control variant (C). In 2009 similar trends were observed. The air temperature decreased by 0.3°C in MT and by 0.2°C in GM as compared to the control plot (C). Table 2 shows temperatures and humidity of air conditions during the period from the close of growth to the removal of potato haulm.

Table 2; Tabela 2.

The effect of mulching on the temperature and relative humidity of air  
(from the close of growth to the removal of potato haulm)

Wpływ rodzaju okrycia uprawy ziemniaka na temperaturę (°C)  
i wilgotność względną powietrza (%) (od zakrycia międzyrzędzi do usunięcia naci)

Mulching variant; Rodzaj okrycia (mulczu)	Temperature (°C) Temperatura (°C)		Relative humidity (%) Wilgotność względna (%)	
	2008	2009	2008	2009
Without mulch (C); Bez mulczu (K)	17.1	16.5	88.1	92.5
Textile mulch (MT); Okrycie włókniną (MW)	17.0	16.2	87.2	92.4
Grass mulch (GM); Mulcz z trawy (TM)	16.6	16.5	86.8	90.4

Table 3 gives further information about the possible utilization of mulch as a protection material from the infestation of haulm with *Phytophthora infestans*. This table evaluates the risk periods (from close of growth) for the expansion of *Phytophthora infestans* and its duration (risk period I. – 100% air humidity and air temperatures from 10 to 22°C, risk period II. – air humidity of over 90% and air temperatures from 17 to 22°C). The shortest period convenient for the expansion of *Phytophthora infestans* (as a sum of durations of risk period I. and risk period II.) was observed in GM (320 hours) on the average both in 2008 and 2009 (Tab. 3).

In 2009 the affection of the potato haulm by *Phytophthora infestans* was significantly lower in the GM than in C treatment (Tab. 3) as a result of optimization of unfavourable conditions by the grass mulch. The duration of risk period, with the threat of the expansion of *Phytophthora infestans*, was shorter by 12.6% in the GM than in C treatment (Tab. 3). Thus the vegetation period as well as the tuber growth period were longer in GM.

Table 3; Tabela 3

The duration of risk periods for the occurrence of late blight  
(period I. – 100 % of air humidity and the temperature from 10 to 22°C;  
period II: air humidity of over 90% and the temperature from 17 to 22°C)

Długość okresu ryzyka pojawienia się zarazy ziemniaczanej (okres I: 100% wilgotności względnej i temperatury powietrza od 10 do 22°C; okres II: wilgotność powietrza ponad 90%, a temperatura od 17 do 22°C)

Mulching variant; Rodzaj okrycia (mulczu)		2008	2009	<i>Phytophthora infestans</i> on potato haulm in 2009 (without infection: 9 points); Porażenie naci zarazą ziemniaczaną w roku 2009 (bez porażenia: 9 punktów)
C; K	duration of risk periods (in hours) długość okresów ryzyka (godzina)	272	411	6.6 a*
	period I.; etap I.	218	327	
	period II.; etap II.	54	84	
MT; MW	duration of risk periods (in hours) długość okresów ryzyka (godzina)	310	427	6.7 ab
	period I.; etap I.	269	360	
	period II.; etap II.	41	67	
GM; TM	duration of risk periods (in hours) długość okresów ryzyka (godzina)	275	365	7.3 b
	period I.; etap I.	228	293	
	period II.; etap II.	47	72	

Note:

*Phytophthora infestans* on potato haulm  $LSD_{0,05}$ ;  $NIR_{0,05} = 0.7003$

\* Means indicated by the same letter do not differ significantly at  $P \leq 0.05$ ; Statistical analysis was made separately for each characteristics; Średnie oznaczone tą samą literą nie różnią się istotnie przy  $P \leq 0,05$ . Analiza statystyczna została wykonana oddzielnie dla każdej cechy

It was planned to verify the hypothesis that mulch could behave as a barrier (a filter) for the interception of spores of *Phytophthora infestans*, thereby reduce the expansion of late blight into potato tubers. In the year of 2008 the conditions for the expansion of *Phytophthora infestans* were unsuitable, thus none of potato tubers in any of the experimental treatments were affected by late blight and the hypothesis could not be verified. However, in 2009 the effect of mulch as tuber protection from late blight could be evaluated because of the favorable conditions for the expansion of *Phytophthora infestans* (Tab. 4).

In 2009 a greater susceptibility to the attack of potato tubers with late blight in the case of the used grass mulch or mulch textile was observed. The use of mulch reduced a number and weight of tubers attacked by late blight. By far the best results were reached in the MT treatment, where the weight of attacked tubers was lower by 2.6% than it was found in the control (C) treatment (Tab. 4).

Table 4; Tabela 4

The effect of mulching on the late blight (*Phytophthora infestans*) attacking tubers in 2008 and 2009

Wpływ mulczowania na porażenie zarzą ziemniaka (*Phytophthora infestans*) bulw w latach 2008 i 2009

Mulching variant Rodzaj mulczu	Number of attacked tubers Liczba porażonych bulw (%)		Weight of attacked tubers Ilość (masa) porażonych bulw (%)	
	2008	2009	2008	2009
C; K	0.0	3.21	0.0	3.35
MT; MW	0.0	0.59	0.0	0.71
GM; TM	0.0	1.92	0.0	1.81

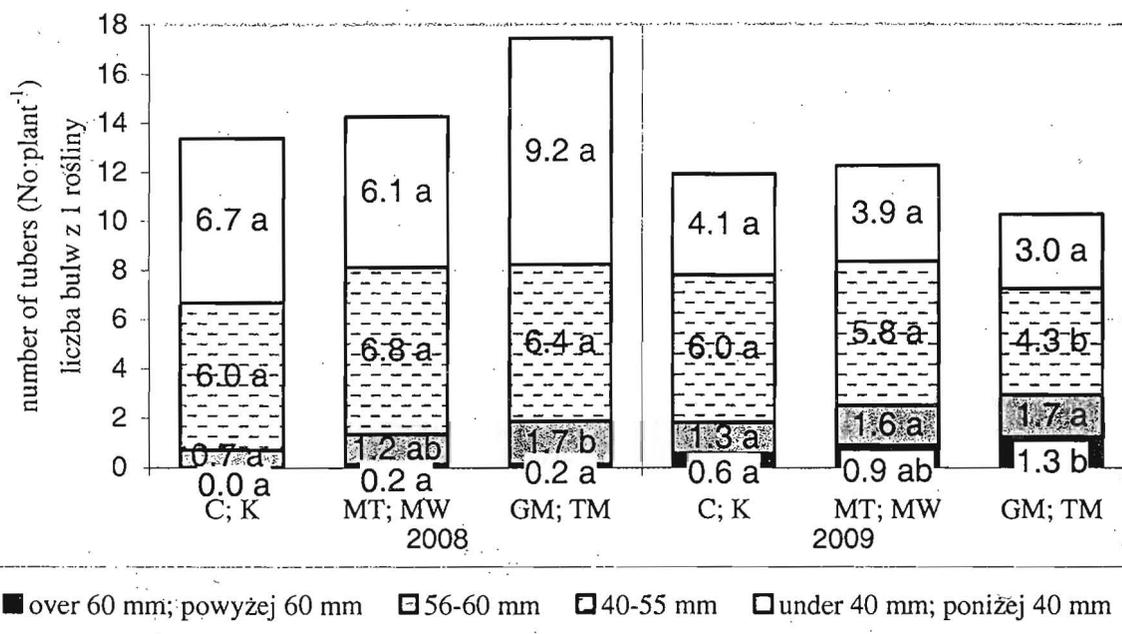


Fig. 2. The effect of mulching on the number of tubers  
Rys. 2. Wpływ mulczu na liczbę bulw

### Tuber fractions and yields

A two-year experiment (2008–2009) confirmed the effect of GM on the structure of potato yield in LE. The application of GM (Fig. 2, 3) resulted in the increase of the number and the weight of tubers of over 56 mm (tuber fraction 56–60 mm and over 60 mm) as compared to the C treatment. On the other hand the weight of tubers under 40 mm (non ware potatoes) was lower in GM than in C.

Similar trial conducted in Uhříněves showed that the highest weight proportion of tuber size fractions of over 60 mm and 55–60 mm were also found in the variants with GM [DVOŘÁK et al. 2010]. Positive effect of the organic mulch (air-dry material from natural meadows *Festucetum falax rubrae*) on the structure of potato seed crop (*Solanum tuberosum* L.) cv. Desiree was also mentioned by MOMIROVIC et al. [1997].

The results showed statistically significant differences in the yield of ware potatoes (Fig. 4) between the GM (30 t·ha<sup>-1</sup>) and the control (C) treatment

(24 t·ha<sup>-1</sup>) on the average in the years 2008–2009. It resulted of the different distribution of tuber size fraction mentioned above. The significant differences in the yield of ware potatoes between MT (29.7 t·ha<sup>-1</sup>) and the control (C) were also observed (Fig. 4) as well as with yield of tubers which strongly differed between the experimental years, with generally lower yields in 2008 (by 8.6 t·ha<sup>-1</sup>) than it was in 2009.

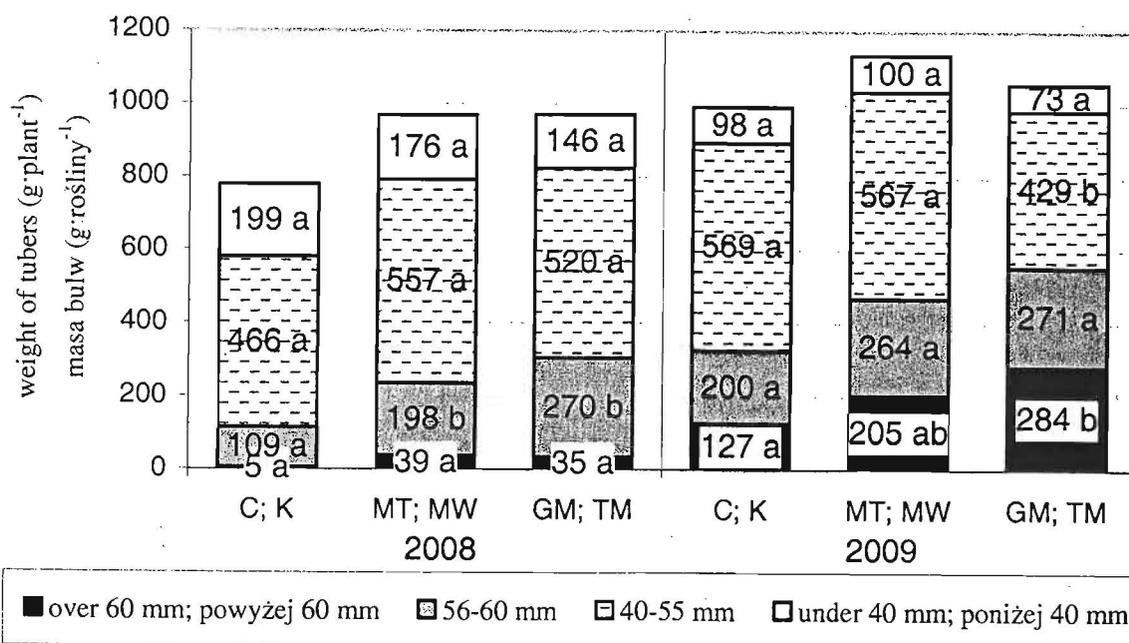


Fig. 3. The effect of mulch on the weight of tubers  
Rys. 3. Wpływ mulczu na masę bulw

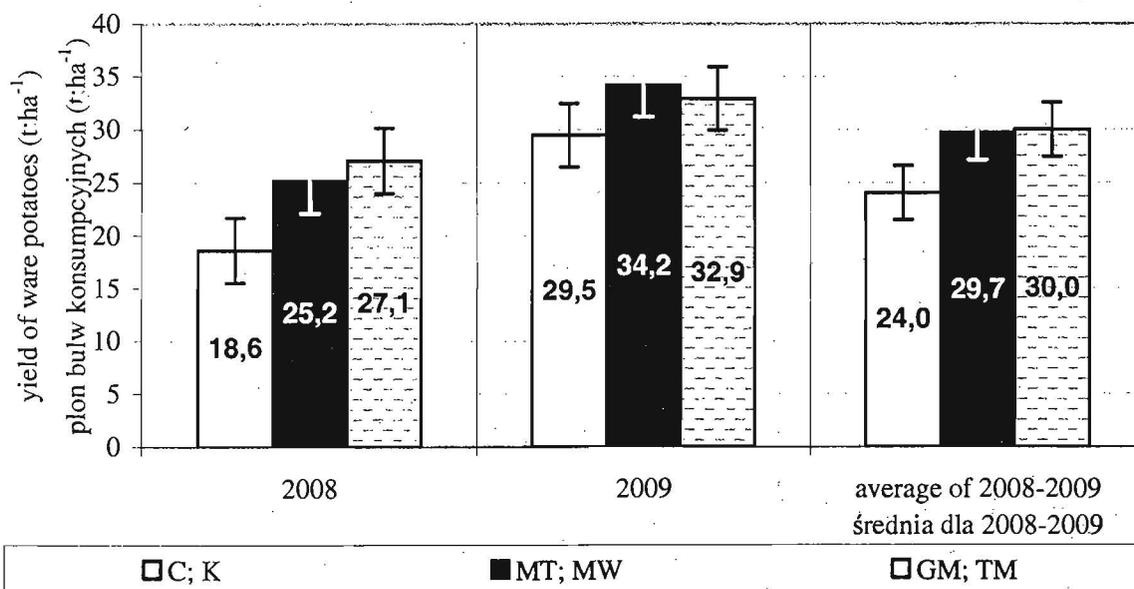


Fig. 4. The effect of mulching on the yields (t·ha<sup>-1</sup>) of ware potatoes  
Rys. 4. Wpływ mulczu na plon bulw konsumpcyjnych (t·ha<sup>-1</sup>)

## Conclusion

1. The use of grass mulch decreased the infestation of potato haulm by *Phytophthora infestans* by 8.2% as compared to the control (C) treatment (without

- mulch). Also the duration of the period convenient for the expansion of *Phytophthora infestans* was shorter in the case of GM than it was stated for C the treatment.
2. The use of mulching textile decreased the affection of potato tubers by late blight by 2.6% as compared to the C treatment.
  3. Grass mulch influenced the distribution of tuber size fractions by the increased number and the weight of tubers of over 56mm and on the other hand by the decreased weight of tubers of under 40 mm (non ware potatoes) as comparison in the C treatment.
  4. On the average in the experimental years (2008–2009) the use of mulch had a positive effect on the yield of ware potatoes (the yield was higher by 6.0t·ha<sup>-1</sup> in grass mulch and by 5.7 t·ha<sup>-1</sup> in mulch textile than it was stated for the C treatment).

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**Key words:** mulch, air temperature, air relative humidity, *Phytophthora infestans*, yield

### Summary

The experiment was conducted during two years (2008–2009) in Leškovice (the Czech Republic) on potato cv. 'Finka and Katka' at  $0.45 \times 0.80$  m spacing. In the experiment 2 types of mulch were used: textile mulch and grass mulch. The use of grass mulch decreased the attack of potato haulm by *Phytophthora infestans* by 8.2% as compared to the control variant (without mulch) and textile mulch decreased the late blight attack on tubers by 2.6% (as compared to the control variant). Grass mulch influenced the number and size of tubers, increasing the number and the weight of tubers of over 56 mm and on the other hand decreasing the weight of tubers of under 40 mm as compared to the control variant. The yield of ware potatoes was higher in the plots with mulches on the average in 2008–2009 (as compared to non-mulched control variant where the yield was higher by  $6.0 \text{ t}\cdot\text{ha}^{-1}$  in grass mulch and by  $5.7 \text{ t}\cdot\text{ha}^{-1}$  in textile mulch).

### UPRAWA ZIEMNIAKÓW W SYSTEMIE EKOLOGICZNYM Z ZASTOSOWANIEM MULCZU

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Słowa kluczowe: mulcz, temperatura powietrza, wilgotność względna powietrza, *Phytophthora infestans*, zbiór

### Streszczenie

Badania przeprowadzono w latach 2008–2009 w Leškovice (Republika Czeska). Przedmiotem badań były ziemniaki odmian 'Finka i Katka' uprawiane w rozstawie  $0,45 \times 0,80$  m. W badaniach uwzględniono 2 rodzaje mulczu: włókninę i skoszoną trawę. Użycie trawy jako mulczu zmniejszyło porażenie naci zarazą ziemniaczaną o 8,2%, a użycie włókniny o 2,6% w porównaniu z kontrolą (uprawa bez użycia mulczu). Trawa zastosowana jako okrycie wpłynęła na liczbę i wielkość bulw (zwiększyła liczbę i masę bulw o wymiarach ponad 56 mm i odwrotnie zmniejszyła masę bulw o średnicy mniejszej niż 40 mm). Plon bulw konsumpcyjnych był średnio w latach 2008–2009 wyższy o  $6,0 \text{ t}\cdot\text{ha}^{-1}$  gdy użyto trawy jako mulczu i o  $5,7 \text{ t}\cdot\text{ha}^{-1}$  po zastosowaniu włókniny.

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ISSN 0084-5477