EFFECT OF MULCHING MATERIALS ON THE SOIL TEMPERATURE, SOIL WATER POTENTIAL, NUMBER AND WEIGHT TUBERS OF ORGANIC POTATOES

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Key words: grass mulch, textile mulch, yield, organic agriculture

Abstract

The mulching with chopped grass (GM) and black textile mulch (BTM) were compared to non-mulching control variant (C) with mechanical cultivation in two regions of the Czech Republic. Especially in plots with BTM were first formed ridges and covered by the black polypropylene non-woven textile and then they were planting. The surface mulching of potatoes affected the soil temperature (higher about 0.2 – 1.6 °C than in C) and water potential of the soil (higher only by 8 kPa than in C). GM had a significant effect on the yield of ware potatoes. The final tuber yield was higher by 22.9 % on plots with GM in comparison with C. GM resulted in a significant increase of the number and weight of tuber fraction 56–60 mm and over 60 mm.

Introduction

Mulching which has become more popular lately is an important way of soil protection in the plant production. Surface mulching is one of the most cost effective means (Shelton et al., 1995), because of a range of positive effects on the soil fertility and other factors important for plant production. Moreover mulch improves soil conditions, especially reduces water evaporation from soil and helps to maintain stable soil temperature (Ji and Unger, 2001; Kar and Kumar, 2007). The cover of mulch influences soil moisture as well (Ramakrishna et al., 2006). Mulch maintains stable soil moisture, especially in surface soil layer. In warmer areas the Colorado potato beetle (CPB) is considered as the most important pest species. The CPB is a great problem especially in organic growing potatoes, because the CPB has relatively few natural enemies (Rifai et al., 2004). The aim of this paper was to evaluate the effect of different mulch materials (of vegetable origin and plastic mulch) on the yield of tubers and on some factors influencing potatoes production in two regions of the Czech Republic. The research was mainly focused on the effect of mulching on soil temperature, soil water potential (SWP).

Materials and methods

Field experiments were conducted over two years on two sites – Leškovice (LE) in the Czech-Moravian Highlands (potato growing region) and Uhříněves (UH) – sugar beet region. Leškovice is 498 m a.s.l., the average of annual temperature is 6.9 °C and annual precipitation is 630 mm.

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On the site the type of soil is pseudogleyic acid cambisol (brown gleysol), mostly prevail lighter, loam-sandy soils. Uhříněves is 295 m a.s.l., the average of annual temperature is 8.4 °C and annual precipitation is 575 mm. The soil used in the experiment was Luvisol.

Soil temperature was measured in all treatments (BTM, GM and C) in the depth of 100 mm in 15-min intervals during period from planting to harvest by MicroLog SP (EMS, Brno). Soil water potential (SWP) was measured in all treatments (BTM, GM and C) in the depth of 240 mm in 30-min intervals during period from planting to harvest with sensor Watermark 200SS-X cooperates with MicroLog SP (EMS, Brno). **Mulching.** GM (material from natural meadows *Dactylis glomerata* – 40 %, *Festuca pratensis* – 20 %, *Lolium perenne* – 20 %, *Poa pratensis* – 10 %, *Alopecurus pratensis* – 10 %) was spread manually in a 25-mm thick layer 14th day after planting (immediately after second hoeing). In plots with BTM ridges were formed firstly and then covered by the black polypropylene non-woven textile. During hand-planting potato tubers in demanded spacing (450 mm x 800 mm) were set to prepared holes in the textile. The fertilizers, fungicides, and other formulation against CPB or slugs were not applied in this experiment. The area of the trial plot was 7.9 m^2. There were 4 replicates of each variant. Tubers were harvested by hand. Harvested tubers were sorted out with commercial potato sorters (tubers with potato blight, necrosis or grow green were previously removed) into four fractions (under 40 mm, 40–55 mm, 56–60 mm and over 60 mm). Statistical calculations were done with SAS ver. 9.1.3. (SAS Institute Inc., 2003).

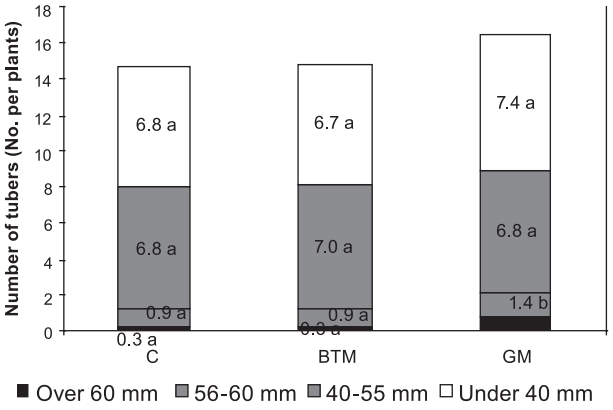
Results

Soil temperature was generally about 0.2–1.6 °C higher in treatments with BTM (at both sites) than in control variant (without mulch). Comparing treatments with BTM at both sites in 2009, soil temperature was about 2.1°C higher in UH than in LE.

The course of soil moisture during the year is strongly influenced by annual precipitation and its distribution during the year. Nevertheless **SWP** was generally higher in the GM and BTM treatments (only by 8 kPa and 1kPa) than in the C variants in UH. Those trends were measured as well in LE.

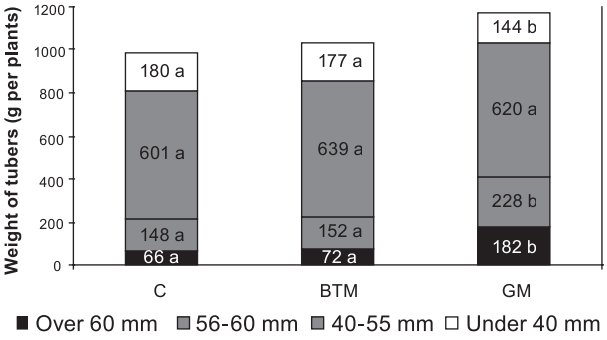
Tuber fractions and yields. An application of GM (Fig. 1, 2) resulted in a significant increase of the number and weight of tubers (tuber fraction 56–60 mm and over 60 mm), on the other hand GM decreased weight of tubers under 40 mm.

For that reason a very significant differences of yield of ware potatoes (Table 1) were found between GM (34.04 $t.ha^{-1}$) and C variant without mulch (26.23 $t.ha^{-1}$). No significant difference of yield of ware potatoes between BTM (28.33 $t.ha^{-1}$) and C was observed. Tuber yield also strongly differed between years, with generally lower yields in 2008 (by 5.5 $t.ha^{-1}$) than in 2009. Yield was not significantly influenced by site (for all that trend higher yields by 1.3 $t.ha^{-1}$ were at LE than at UH).



Note: $HSD_{0.05}$ (under 40 mm) = 3.985, $HSD_{0.05}$ (40–55 mm) = 0.819, $HSD_{0.05}$ (56–60 mm) = 0.316, $HSD_{0.05}$ (over 60 mm) = 0.207

Fig. 1: The effect of different types of mulching on the number of tubers (on average of the sites and years)



Note: $HSD_{0.05}$ (under 40 mm) = 26.74, $HSD_{0.05}$ (40–55 mm) = 79.99, $HSD_{0.05}$ (56–60 mm) = 51.65, $HSD_{0.05}$ (over 60 mm) = 50.90

Fig. 2: The effect of different types of mulching on weight of tubers (on average of the sites and years

Tab. 1: The effect of different types of mulching on larvae of CPB (number per 10 plants) and tuber yields (t.ha^{-1}) of ware potatoes (on average 2008–2009)

Site/Variant of mulching	Leškovice		Uhříněves		Average of sites
	larvae of CPB	yield	larvae of CPB	yield	yield
C	0.1 a	24.9 a	26.9 a	27.6 a	26.2 a
BTM	0.7 a	31.7 b	42.2 b	24.9 a	28.3 a
GM	0.7 a	33.9 b	13.3 a	34.2 b	34.0 b
$HSD_{0.05}$	1.451	4.564	16.82	3.340	3.327

Discussion

According to Brust (1994) potato is sensitive to higher soil temperature and low soil moisture and will not grow properly under these conditions. Brust (1994) mentioned that increase of tuber yields in mulching plots may have been result of lower soil temperature and higher soil water content. The higher soil temperatures was reported also in the plastic mulch by Ramakrishna et al. (2006) by 4 °C at 100 mm depth and by Wang et al. (2009) by 2 – 9 °C. The lowest yield of tubers in treatment with BTM in UH (Table 1) was related to higher occurrence of larvae of CPB and thereby with higher defoliation. In this experiment higher number of CPB egg clusters was found at on plots with BTM compared to C treatments. Potatoes can usually tolerate substantial defoliation without decrease of tuber yield, up to 30 % (when they are in vegetative stages). But they are more sensitive to the effects of defoliation (and bring decrease of tuber yield) when tuber are beginning to bulk and can only tolerate about 10 % defoliation (Hare, 1990). Zehnder and Hough-Golstein (1990) found out significantly lower number of overwintered adult beetles and first generation larvae on plots with straw mulch compared to those without mulch.

Conclusions

The mulching treatment systems affected the soil temperature and water potential of the soil on dependence of the physical and chemical properties of soil as well as organisms that live there.

This study indicated higher incidence of larvae and higher defoliation in BTM than in non-mulched potato plots.

In the experiment the mulching of chopped grass significantly decreased the small size tuber fraction (under 40 mm), while the large size fractions (56–60 mm and over 60 mm) were significantly increased.

The mulching had a positive effect on tuber yield (on average of sites and years). Tuber yields were significantly higher by 22.9 % on plots with GM and higher by 7.4 % in BTM (in comparison with C treatment without mulch).

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