Chapter 3

Weed Control by Organic Mulch in Organic Farming System

Rita Pupalienė, Aušra Sinkevičienė,
Darija Jodaugienė and Kristina Bajorienė

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/60120

1. Introduction

Weeds are one of the most significant agronomic problems in organic farming [1] and they are an important factor limiting the spreading of organic farming system in the world [2]. Mulching reduces weed incidence in crops [3–7] and is increasingly used as a weed control measure, which is of special relevance in an organic cropping system when growing high quality and safe plant raw materials for food production [8]. Mulching of plant residues is applied in agricultural crop production and exerts many-sided effects on the agroecosystem [9]. [4], [6], [10], estimated that mulches (straw, grass and others) provide weed control. Mulches can control weeds by several ways: as physical barrier and by associated changes in the microclimate, pH, C:N ratio of the soil, immobilization of nutrients, inhibition by allelopatic compounds, less amount of visible light reaching the soil surface. Organic mulches maintain a more stable soil temperature and optimal moisture content, which results in more favourable conditions for living organisms' activity in the soil [11]. Organic mulches enhance soil enzyme activity [12, 13], amount and diversity of soil biota [14–16]. Soil biological properties largely determine crop productivity in organic farming system. Mulching often is used for the influence on soil physical properties. Mulching helps to reduce moisture evaporation from the soil, diminish and maintain a more constant soil temperature [17–19], and this is also very important for the crop growth and yield. Natural organic mulch eventually breaks down and adds organic material back into the soil. Slow nutrient release during mulch decomposition process is more synchronized with plant needs [20, 21]. It was found that straw mulch [22] and grass mulch [23] tended to increase available phosphorus and potassium contents in the soil. Quickly decomposing organic mulch serves as an important source of nutrients for plants. Significantly higher crop yields were obtained in grass mulched plots not only due to weed

smothering but due to higher plant nutrient content in the soil and better soil physical properties [24]. Better growing plants have higher ability to suppress weeds.

Some research evidence suggests that mulching reduces the occurrence of annual weeds; however, it does not exert any effect on perennial weeds [25–27]. Plant residues (straw and others) used as mulch have been found to suppress weed emergence and growth due to the phytotoxins released during the breakdown process [28–30]. Many authors [25, 26, 31] observed a reduction in the number of annual weeds using crop residues for soil mulching. A reduction of weed density was established as the level of soil cover increased [3]. Mulching reduces soil bulk density and shear strength and increases air filled porosity [32–34]. The growth of some perennial weeds depends on those soil properties [35].

Some organic mulches are good for using in large scale farms –over-ground mass of catch crops, peat, sawdust, straw and other residues of agricultural crops. In small scale farms and gardens we can use still varied organic residues for mulching: grass regularly cut from grass-plots, hulls of sunflower seeds, nuts, coffee beans and others.

The aim of the investigation was to evaluate the influence and the residual effect of different organic mulches and different thickness of mulch layer on weed emergence.

2. The investigation of organic mulches for weed control

The two factor stationary field experiment was carried out at the Experimental Station of Aleksandras Stulginskis University (previously Lithuanian University of Agriculture) (54°53'N, 23°50'E). The soil type – *Calc(ar)i – Endohypogleyic Luvisol.* The influence of organic mulches and different thickness of mulch layer on weed density was investigated in 2004–2009, in 2010–2012 the residual effect of the mulches and mulch layer was studied. Treatments of the experiment: Factor A – mulch: 1) without mulch; 2) straw mulch (chopped wheat straw); 3) peat mulch (medium decomposed fen peat); 4) sawdust mulch (from various tree species); 5) grass mulch (regularly cut from grass-plots). Factor B – thickness of mulch layer: 1) 5 cm; 2) 10 cm.

Randomised design was used (Fig.1.). Individual plot size was 2 x 6 m. The experiment involved 4 replications.

In 2004 in each plot common bean *Phaseolus vulgaris* L. cultivar *Baltija,* 2005 – common onion *Allium cepa* L. cultivar *Stuttgarter Riesen*, 2006 – red beet *Beta vulgaries* subsp. *vulgaris* convar. *vulgaris* var. *vulgaris* L. cultivar *Cylindra*, 2007 – white cabbage *Brassica oleracea* var. *capitata* f. *alba* L. cultivar *Kamennaja golovka* in raws with interlinears 0.5 m, 2008 – potatoes *Solanum tuberosum* L. cultivar *Anabela* in raws with interlinears 0.7 m, in – 2009 – *Phaseolus vulgaris* L. cultivar *Igoloneska* in raws with interlinears 0.5 m were grown. In 2010, common onion *Allium cepa* L. cultivar *Stuttgarter Riesen*, in 2011 – red beet *Beta vulgaris* subsp. *vulgaris* convar. *vulgaris* var. *vulgaris* cultivar *Kamuoliai,* and in 2012 – white cabbage *Brassica oleracea* var. *capitata* f. *alba* L. cultivar *Kamennaja golovka* was grown.

http://dx.doi.org/10.5772/60120

Figure 1. Field experiment

In 2004–2009 mulch was spread manually in a 5 cm and 10 cm thick layer shortly after sowing (planting). Remains of mulch were inserted into the soil by ploughing. The soil was ploughed after crop harvest in the autumn. In 2010—2012 in all experimental plots crops were grown without mulch, the residual effect of organic mulches was investigated. During all period of experiment the crops were grown employing common organic crop production technologies. The plots without mulching were weeded 2–3 times per vegetation. No chemical plant protection products and fertilizers were used when investigating the influence and residual effects of mulches. The C:N ratio in the mulches used was as follows: in straw 51:1; in peat 40:1; in sawdust 133:1; in grass 11:1.

Weed emergence dynamics. Weed seedlings were counted in each plot in four permanent 0.2 × 0.5 m sites. Assessments were done every 10 days from May to October. During each assessment, the weeds were pulled out, counted and their species composition was determined. The number of weeds was re-calculated into weeds m^{-2}.

Number of weed seeds in the soil. Soil samples were taken by a sampling auger from the 0-25 cm layer after harvesting of agricultural crops. The number of weed seeds was determined by [36] method. The number of weed seeds found in the arable layer (0-25 cm) was re-calculated into thousand seeds m^{-2}.

The means were compared using Fisher's protected LSD test at $P_{(level)}$ <0.05 with ANOVA procedure with SYSTAT 10 [37]. Data transformations lg(x+1) were used as necessary to achieve statistical normality [38]. Pearson's correlation coefficient was used to evaluate the relationships between indices. Probability level: *– 95 %, ** – 99 %, *** – 99.9 %.

3. The dynamics of weed emergence in plots mulched with organic mulches and different thickness of mulch layer

The carried out investigations show that mulching of soil with various organic mulches is particularly important in the first part of summer. In the second part of summer and at the beginning of autumn weed emergence is weaker in comparison with that in the period of spring and early summer, therefore, lower influence of mulch is established.

In 2004 common bean crop was damaged by spring frost for two times, particularly in plots mulched with sawdust. As crop was thin, intensive weed emergence in plots without mulching was lengthen out. According to the data of 2004, sawdust had the longest impeding effect on weed germination (Table 1). Though crop in plots mulched with sawdust was weak, weed emergence was not intensive: at the beginning of summer weed density was established to be by 5.4-11.4 times lower than that in the plots without mulching. The allelopatic effect of sawdust could be a reason of such results.

Peat, straw and grass provide different reducing impact on weed germination. Straw mulch has the most obvious reducing impact (3.5-14.1 times) on weed emergence in June. Later, however, after abundant appearance of *Tripleurospermum perforatum* (Merat.) M. Lainz, which seeds have infected the mulch, the weediness is higher than that in the soil without mulch (July 20). After most of seeds of *Tripleurospermum perforatum* have germinated, the positive influence of mulch comes out again.

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
10 06	440.6	31.2***	62.6***	38.8***	24.7***
20 06	204.4	58.1***	44.1***	38.1***	26.2***
30 06	233.4	45.9***	46.6***	25.9***	25.9***
10 07	144.0	85.6***	34.1	20.9***	52.5***
20 07	54.7	113.1	38.1	30.0**	66.2
30 07	50.6	33.1	22.2*	11.6***	45.3
10 08	67.5	40.9**	30.9*	23.4**	44.4**
20 08	54.7	33.4*	20.6*	23.4**	38.4
30 08	34.4	20.3*	18.1*	16.9**	32.2
10 09	25.0	13.4	10.3	14.1	23.1
20 09	5.3	5.3	7.5	6.2	18.1
30 09	25.3	15.0	5.3***	15.0*	29.4
10 10	25.6	20.6	5.0***	16.6	31.6
20 10	13.4	6.6*	2.8***	8.1***	12.5

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 1. The influence of different organic mulches on weed emergence dynamics in common bean crop, 2004

http://dx.doi.org/10.5772/60120

At the beginning of summer peat has slightly weaker impeding effect on weed emergence (4.2-7.0 times), which, however, is uniform during the entire investigational period. Positive effect of grass mulch is manifested at the beginning of the investigations and reduces weed germination from 17.8 to 2.7 times. Later, after decomposition of grass has started, this mulch has no significant influence. Experiments conducted in Hungary indicated that mulching with straw, grass and other materials showed good results in weed control [4].

Even stronger positive influence of mulches on the decrease of weed emergence was determined in 2005. Weed control means in common onion crop are very important because common onion crop hasn't good smothering effect on weeds. In contrast to that in previous years, straw mulch was the best to reduce weed germination, as the mulch itself was not infected with weed seeds (Table 2). A number of studies have documented that straw mulch is a good mean decreasing weed emergence [5, 6]. Though [39] stated that there was no significant effect of straw mulch on number of weeds, but they explain it was mainly attributed to the low amounts of straw applied.

The number of weeds that germinated in the beginning of summer in mulched soils was by 30.9-50.6 times lower than that in the soils without mulch. Later this positive influence weakened but remained for the entire vegetation period. Peat had the influence similar to that in the previous years of investigations.

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
10 06	207.5	4.1***	65.6***	43.5***	6.3***
20 06	436.3	14.1***	65,9***	56.0***	23.4***
30 06	95.6	22.8***	36.6***	45.9***	16.6***
10 07	76.3	22.5***	18.1***	38.4**	8.8***
20 07	25.6	15.6	24.7	29.0	5.3**
30 07	41.3	13.4***	5.6***	18.4***	16.7***
10 08	30.0	10.1***	6.3***	11.6***	7.8***
20 08	43.8	6.6***	5.3***	7.5***	40.3
30 08	66.3	11.9***	14.0***	11.6***	56.3
10 09	31.0	6.6**	11.0**	4.7***	30.0
20 09	77.5	26.3**	17.8***	20.3***	84.7
30 09	126.3	19.1*	82.2	9.4**	209.4
10 10	95.6	22.8	31.3	7.5	158.1

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 2. The influence of different organic mulches on weed emergence dynamics in common onion crop, 2005

The effect of chopped grass remained until the first decade of August, the number of germinated weeds was significantly lower (by 2.0-32.9 times) than that in the plots without mulch. However, later the weed emergence became equal and even started increasing as rapid germination of *Poa annua* L., which might have got into together with the used mulch, started. During the entire vegetation period grass mulch decreased the germination of weeds by 2.0 times in comparison to that in the soil without mulch.

In 2006 mulches were spread late – after the red beet sprouting (Table 3). The first weed sampling time was before mulching. No significant differences in weed number between plots without mulching and plots mulched with different organic mulches were obtained. Though the highest number of weeds was estimated in plots where grass mulch in previous year was used, the grass mulch smothered weeds significantly till the end of September. Weed germination and re-growth decreased on July 30, and the influence of straw, peat and sawdust mulches on weed number at this sampling time was not significant. In 2006 al examined organic mulches suppressed weeds in red beet crop very well.

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
10 06●	457.7	496.9	525.9	438.5	592.1
30 06	286.6	49.4***	70.3***	54.1***	29.1***
10 07	62.2	31.3**	22.8***	37.8	12.8***
20 07	114.1	27.2***	21.3***	31.6**	10.0***
30 07	53.1	40.3	30.3	39.4	12.2***
10 08	58.4	16.6***	19.1***	21.6**	10.0***
20 08	234.7	36.6***	50.9***	53.1***	47.8***
30 08	104.4	35.3***	33.4***	20.9***	31.9***
10 09	93.4	34.7***	30.6***	30.0***	33.1***
20 09	56.9	21.9*	14.4*	18.8**	22.2*
30 09	38.1	22.2*	54.7	24.4	16.6***
10 10	38.4	15.9***	17.8*	19.4**	23.4

● – before mulching

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 3. The influence of different organic mulches on weed emergence dynamics in red beet crop, 2006

All examined organic mulches significantly suppressed weed emergence during the most intensive weed germination period in May 30 (by 11.7-32.6 times) and June 10 (by 7.5-19.4 times) in 2007 (Table 4). The suppressing effect of organic mulches weakened when weakened

http://dx.doi.org/10.5772/60120

weed germination (June 20). The significant suppressing grass mulch effect on weed emergence persisted till the August 10. In 2007 the grass mulch was the best means for weed control till the end of summer (August 30). During the first part of summer grass mulch effectively smothered weeds, and during the second part of summer white cabbage crop smothered weeds very well.

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
30 05	293.6	11.3***	25.0***	24.5***	9.0***
10 06	324.5	21.1***	31.5***	43.1***	16.7***
20 06	57.0	47.3	43.1	63.5	19.3**
30 06	93.1	35.6***	34.3***	46,7**	18.1***
10 07	60.0	43.3	28.5	44.6	23.8*
20 07	65.5	33.0*	32,5*	41.1	9.9***
30 07	32.5	36.8	17.3	34.8	17.3*
10 08	40.8	25.4	16.4	31.8	12.3*
20 08	28.1	31.8	13.5	24.1	7.4
30 08	25.9	25.1	12.4	22.0	11.8
10 09	45.3	46.9	13.1*	21.0	22.4
20 09	31.6	22.0	14.3	14.4	18.4
30 09	35.3	28.4	19.8	16.9	29.0

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 4. The influence of different organic mulches on weed emergence dynamics in white cabbage crop, 2007

In 2008, potatoes after planting were harrowed, were hilled after sprouting and then mulches were spread. Spring in 2008 was very dry, without rainfall till the second half of June. Because of lack of humidity we had no grass mulch at the beginning of June. The grass mulch was polluted with matured weed seeds. The lowest number of weeds emerged at the first sampling date in June 20. Late weed germination and re-growth was intensive: weed number in plots without mulch at different sampling times varied from 109.7 to 651.6 units m^{-2} (Table 5). All examined organic mulches significantly suppressed weed emergence till the end of July. From that date the effect of grass mulch weakened, and the number of weeds in grass mulched plots exceeded the number of weeds in plots without mulch.

In 2009 straw and sawdust mulch significantly decreased weed emergence during all experimental period (Table 6). The significant suppressing effect of grass mulch ended at the end of July.

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
20 06	22.2	0.6**	5.3*	10.3	1.9*
30 06	651.6	28.4***	145.9***	43.1***	183.8***
10 07	133.8	37.2*	59.1	36.9*	81.9*
20 07	157.8	37.8***	61.3**	38.4***	796.3**
30 07	181.9	19.4***	28.1***	26.6***	65.0***
10 08	241.9	100.0	40.3***	60.0**	156.3
20 08	214.7	25.9***	21.9***	34.4***	320.6
30 08	118.4	49.1	98.4	71.3	1947.2***
10 09	109.7	60.6*	27.8***	19.4***	438.8**

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 5. The influence of different organic mulches on weed emergence dynamics in potatoes crop, 2008

Sampling time	Weeds units m^{-2}				
	Without mulching	Straw	Peat	Sawdust	Grass
10 06	313.4	27.8***	199.4	20.9***	46.9***
20 06	293.4	14.1***	106.9***	36.3***	20.9***
30 06	205.4	14.4***	50.9***	20.6***	47.7***
10 07	150.0	17.1***	22.3***	17.2***	25.7***
20 07	82.2	5.2***	14.5***	11.1***	10.4***
30 07	66.1	5.6***	9.1***	13.3***	15.6**
10 08	45.6	8.4*	12.5	23.4	48.1
20 08	47.8	14.4**	9.1***	14.7**	50.6
30 08	37.9	8.8**	4.4***	10.3*	72.2
10 09	22.5	11.6**	9.2***	12.8*	104.5

*- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

Table 6. The influence of different organic mulches on weed emergence dynamics in common bean crop, 2009

Perennial weeds. The results of the experiments carried out in Lithuania showed that straw mulch suppressed emergence of annual weeds but not perennial [27]. By the data of our experiments, the effect of organic mulches on the germination and re-growth of perennial weeds is weaker than the effect of organic mulches on germination of annual weeds [7]. In 2007 at the end of spring (May 30) and at the beginning of summer (June 10) the higher amount

http://dx.doi.org/10.5772/60120

of perennial weeds was established in experimental plots without mulching. Grass mulch well suppressed perennial weeds during all vegetation period (Fig. 2).

Contrary results were obtained in 2008: the germination and re-growth of perennial weeds was more intensive in unmulched plots during all sampling time. The lowest amount of perennial weeds was obtained in plots mulched with straw and grass mulches.

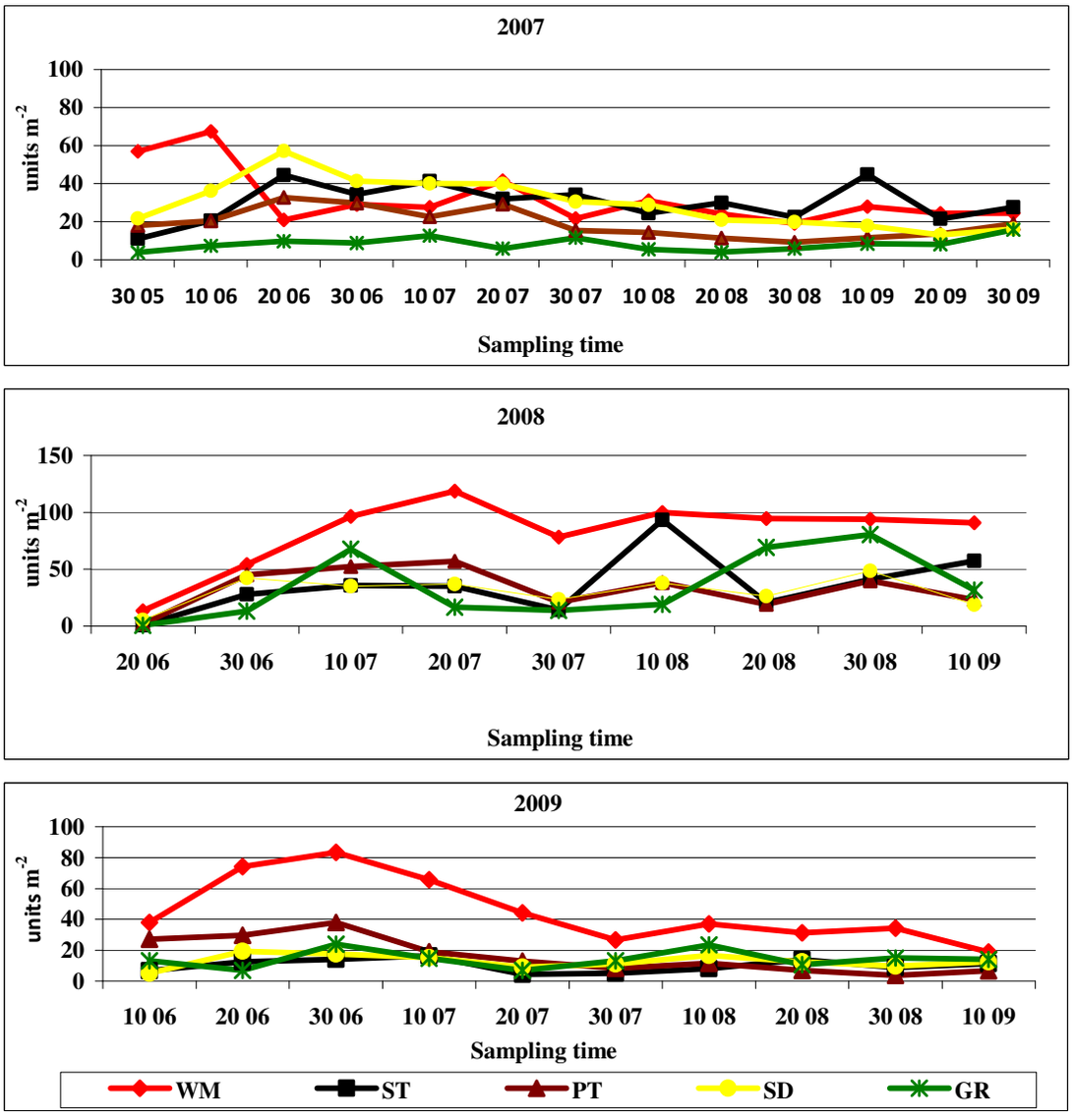

Figure 2. The influence of organic mulches on perennial weed emergence dynamics, 2007–2009. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass.

In 2009 the highest number of perennial weeds germinated and re-grew in plots without mulching during all vegetation period. Significant differences between the number of perennial weeds in unmulched plots and plots mulched with different organic mulches were established at many sampling dates.

Annual weeds. The period of more intensive germination of annual weeds is from the middle of May to the middle of June [40]. In 2007 all examined organic mulches well suppressed annual weed germination. The mulching as annual weed control means was particularly important at the first part of summer (Fig.3).

The contrary results were obtained in 2008 when *Poa annua* L. germination in plots mulched with grass mulch prolonged during all vegetation period. Grass mulch has been infected with seeds of *Poa annua*. The number of germinated annual weeds in grass mulched plots exceeded the number of annual weeds in unmulched plots during almost sampling dates from the 20 of July.

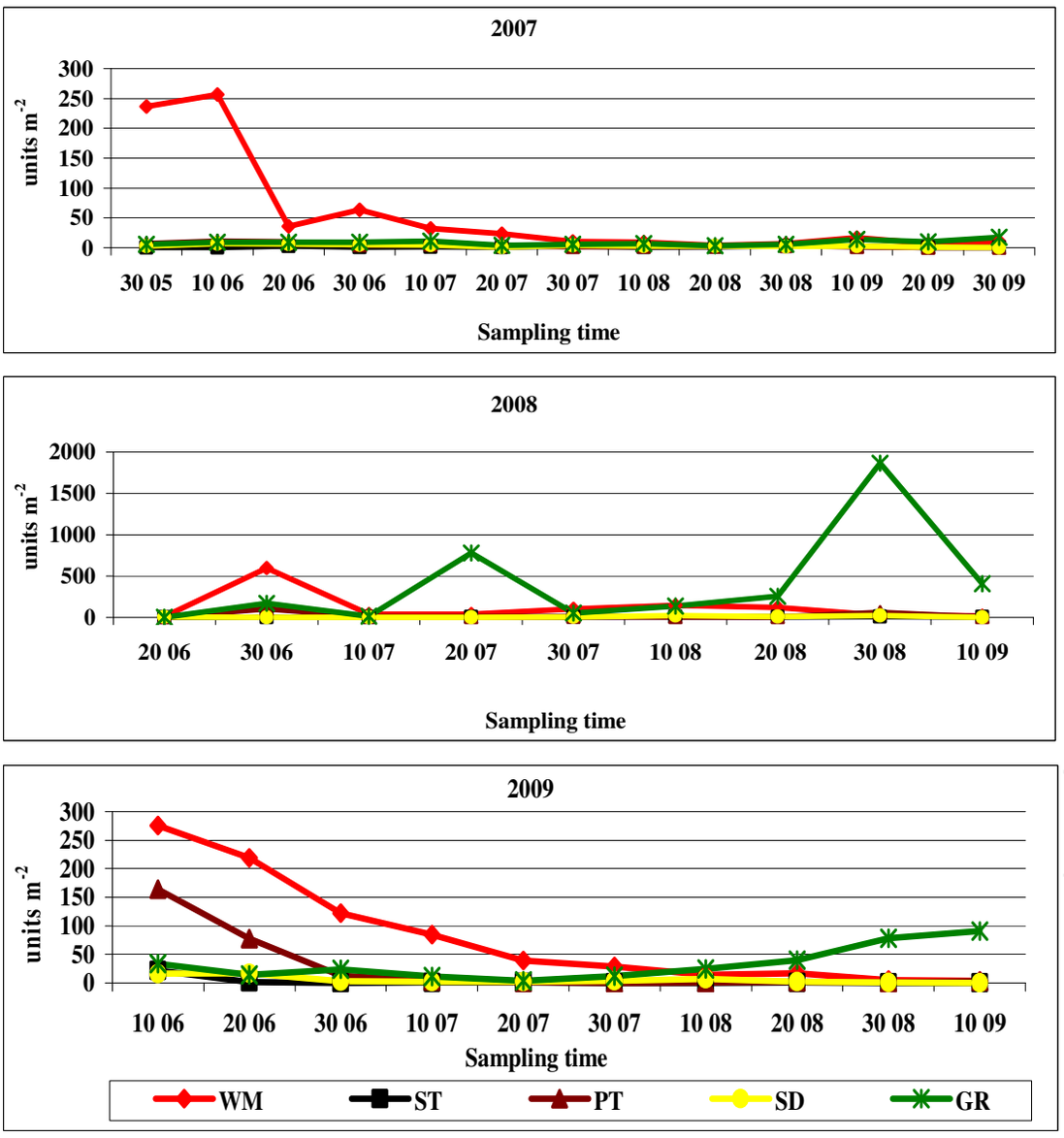

Figure 3. The influence of organic mulches on annual weed emergence dynamics, 2007–2009. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass.

http://dx.doi.org/10.5772/60120

In 2009 the germination of annual weeds in unmulched plots was significantly more intensive till July 30 compared with germination of annual weeds in plots mulched with all examined organic mulches (Fig. 3). From the beginning of August the suppressive effect of grass mulch on annual weed germination disappeared. During this period the suppressive effect on annual weeds of straw, peat and sawdust mulches persisted.

4. The total weed amount influenced by mulching

Mulching decreased weed density (Fig. 4). By the data of our experiments, the best for weed control is straw mulch. In plots with straw mulch weed density was established for 2.6-10.0 times lower compared with weed density in plots without mulch. Significant differences between weed density in plots mulched with peat and sawdust compared to weed density in plots without mulch were estimated.

The influence of grass mulch on weed emergence is not equal. In 2004-2009 (except 2008) grass mulch significantly decreased weed number – by 2.6-5.4 times compared with weed number in unmulched plots. In 2008 weed density in plots mulched with grass was established higher that is in plots mulched with straw, peat and sawdust due to rapid emergence of *Poa annua* at the second part of summer. In 2008 number *of Poa annua* formed a big part – 79.5% of total weed number, as in 2005 – 11.3%, 2006 – 4.9%, and 2007 – 5.1%.

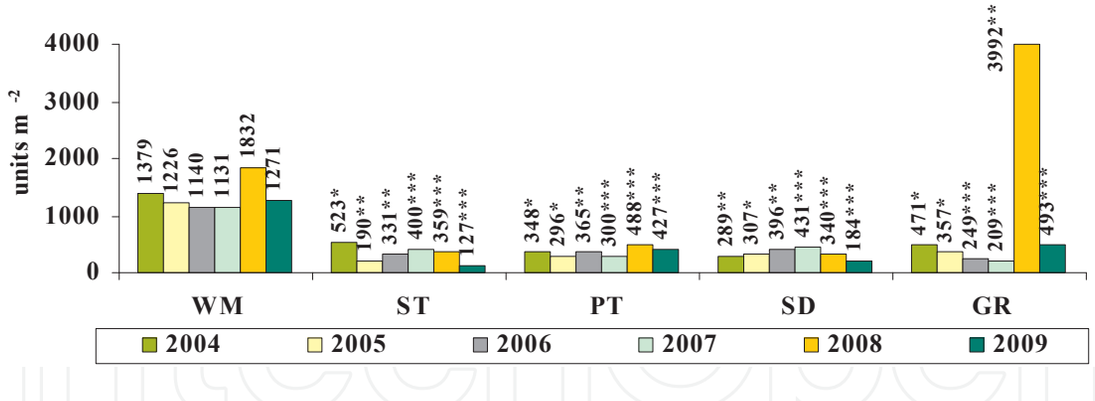

Figure 4. The influence of organic mulches on weed density, 2004-2009. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass. *- 95 % probability level, ** - 99 % probability level, *** - 99.9 % probability level

The influence of peat and sawdust mulch on weed density was significant during all experiment period in 2004–2009. Weed density in peat mulched plots was lower by 3.0-5.4 times compared with this in plots without mulch and weed density in sawdust mulched plots was lower (by 2.6-6.9 times) compared with this in plots without mulch. The growth of agricultural crops in plots with sawdust mulch was poor and the yield obtained was the lowest (Fig.5.).

Weed density in plots mulched with 10 cm mulch layer was lower compared with plots mulched with 5 cm mulch layer (Fig. 6). Differences were significant in 2004, 2006, 2008 and

2009. The thickness of mulch layer is important for weed control. Thick enough layer of organic mulch can serve as physical barrier for weeds.

Figure 5. Red beet crop in plots mulched with sawdust (a) and mulched with grass (b)

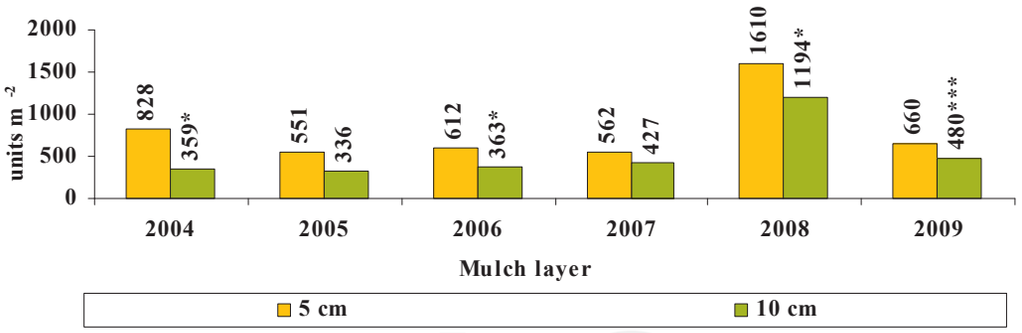

Figure 6. The influence of different thickness of mulch layer on weed density, 2004-2009 yers. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass. * – 95% probability level, *** – 99,9% probability level

5. Mulching effect on weed seed bank

The formation of weed seed bank is multiplex process, belonging on various factors. Weed seed bank in the soil in unmulched plots and plots mulched with different layer of organic mulches was studied in 2007-2009, after three years from the beginning of the experiment. There was no significant influence of mulching on weed seed bank during all experimental period.

http://dx.doi.org/10.5772/60120

The tendency of lower amount of weed seeds in the soil in plots mulched with straw, peat and sawdust was investigated. Only grass mulch increased the total amount of weed seeds in the soil. We used the grass regularly cut from grass-plots for mulching, but sometimes it could be polluted with weed seeds. Moreover, the grass mulch quickly decomposes and its effect on weed control is shorter compared with other studied mulches. Some matured weeds seeds in grass mulched plots can supplement weed seed bank in the soil. It is very important to use the grass for mulching from plots which are cut every few days (4–7) if we are concerning about weed seed bank.

Seeds of *Chenopodium album* L., *Echinochloa crus-galli* L. (Beuv.) and *Stelaria media* L. dominated in the weed seed bank of all experimental plots (Fig.7). It is known that seeds of *Chenopodium album* amount about 90% of weed seed bank [41].

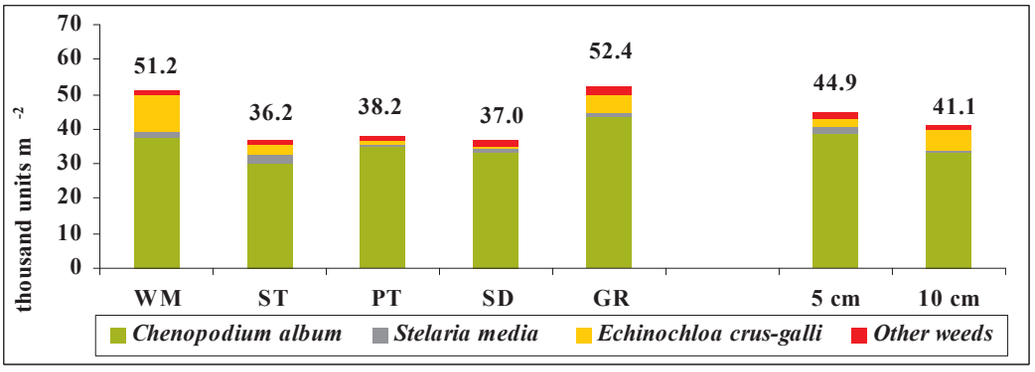

Figure 7. The influence of organic mulches and different thickness of mulch layer on weed seedbank, 2007. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass. $P > 0.05$

The tendency of higher number of *Chenopodium album* seeds in the soil of grass mulched plots was observed in 2007 and 2008. The part of *Echinochloa crus-galli* seeds increased in 2008, especially in plots without mulch and plots mulched with peat (Fig.8).

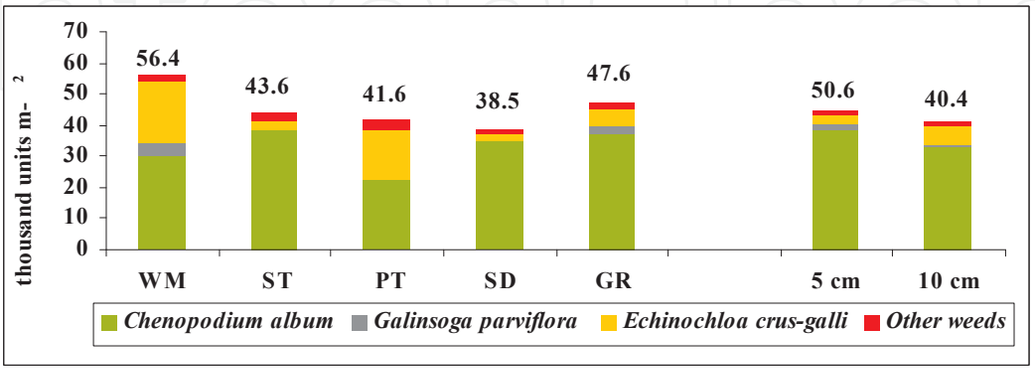

Figure 8. The influence of organic mulches and different thickness of mulch layer on weed seedbank, 2008. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass. $P > 0.05$

In 2009 the lower total amount of weed seeds in the soil was evaluated in mulched and unmulched plots (Fig. 9). The number of seeds of *Echinochloa crus-galli* in unmulched plots and plots mulched with peat decreased, but in plots mulched with straw, sawdust and grass increased.

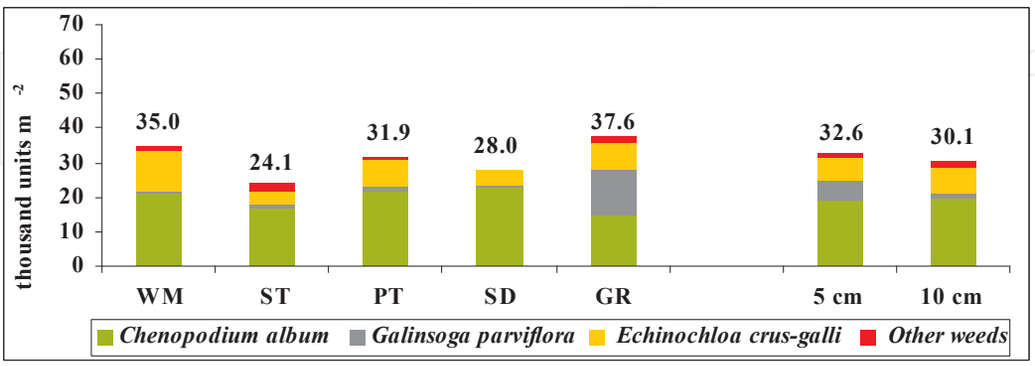

Figure 9. The influence of organic mulches and different thickness of mulch layer on weed seedbank, 2009. WM – without mulch, ST – straw, PT – peat, SD – sawdust, GR – grass. $P > 0.05$

The tendency of the lower amount of weed seeds in the soil was established in plots mulched with thicker (10 cm) mulch layer compared with this in plots mulched with thinner (5 cm) mulch layer during all experiment period 2007–2009.

No significant correlation between the amount of sprouted weeds and weed seeds in the soil was established in 2007. Very strong or strong significant correlation between the amount of sprouted weeds and weed seeds in the soil was established in 2008 ($r = 0.96$; $P < 0.05$) and in 2009 ($r = 0.92$; $P < 0.05$). *Chenopodium album* L. was the dominant weed in crops and *Chenopodium album* seeds dominated in weed seed bank and influenced correlations.

6. The residual effect of organic mulches on weed incidence in crop stands

Soil coverage with any organic mulch inhibits weed emergence at first due to the shortage of light and changed moisture and warmth regime [25]. The previously six year used and incorporated organic mulches did not significantly decreased total weed amount in 2010–2012 because they do not mechanically suppress weed emergence (Fig. 10). Total weed number in experimental plots during 2010–2012 was influenced by weed smothering ability of crops. The lowest total weed number was evaluated in 2012 when white cabbage was grown, and the highest – in 2010, when the common onion was grown.

The tendency of lower amount of weeds in plots previously mulched with sawdust was established in 2011–2012. Due to allelophatic effect the decrease of growth and yield of agricultural crops in plots mulched with sawdust was evaluated in 2004-2012. Decreased weed density in plots mulched with sawdust was significantly lower in 2004-2009. Weeds could be

http://dx.doi.org/10.5772/60120

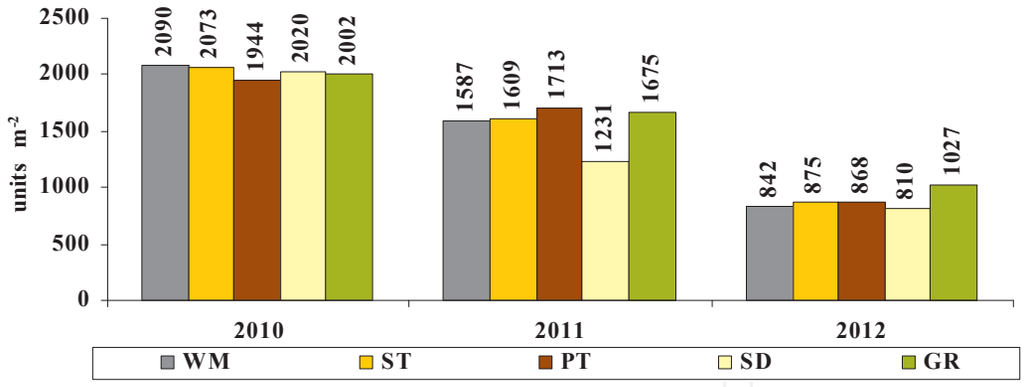

Figure 10. The residual effect of organic mulches on the weed emergence, 2010–2012; $P > 0.050$

affected by the allelophaty too. But the strongest effect on weed emergence and re-growth was the effect of organic mulches as physical barrier.

In 2010 and 2012 the higher weed emergence was established in plots previously mulched with thicker (10 cm) mulch layer (Fig. 11). But in 2011 significantly lower amount of emerged weeds was evaluated in mentioned plots.

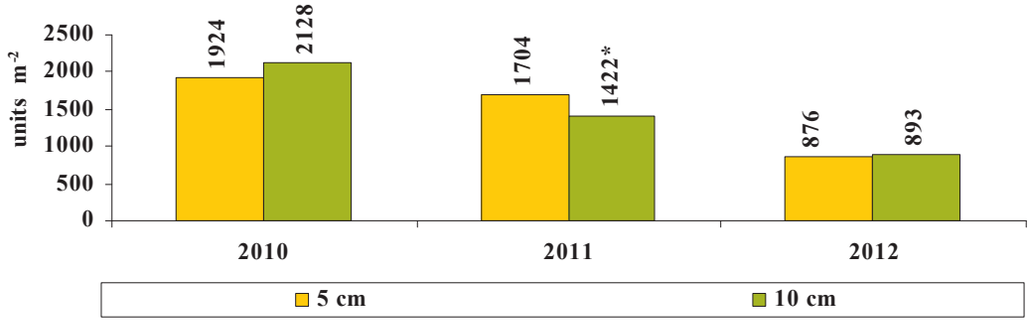

Figure 11. The residual effect of the thickness of mulch layer on the weed emergence, 2010–2012; $P > 0.050$

The residual effect of organic mulches on the emergence of annual weeds was not significant (except plots with peat mulch in 2011), but not the same that on perennial weeds. In 2010, the first year after the use of organic mulches all of the previously used and incorporated organic mulches reduced the abundance of annual weeds during the entire vegetation period (Fig. 12). The residual effect of straw, peat and grass was weaker and tended to reduce (by 6.2–11.4 %) the abundance of annual weeds during vegetation. In 2011, when studying grass and peat residual effect a trend towards increasing (by 4.8–11.2 %) of abundance of annual weeds during the whole vegetation was established.

In 2012, the previously used and incorporated grass mulch significantly (by 1.3 times) increased emergence of annual weeds. The previously incorporated sawdust mulch reduced the abundance of annual weeds most markedly in all experimental years.

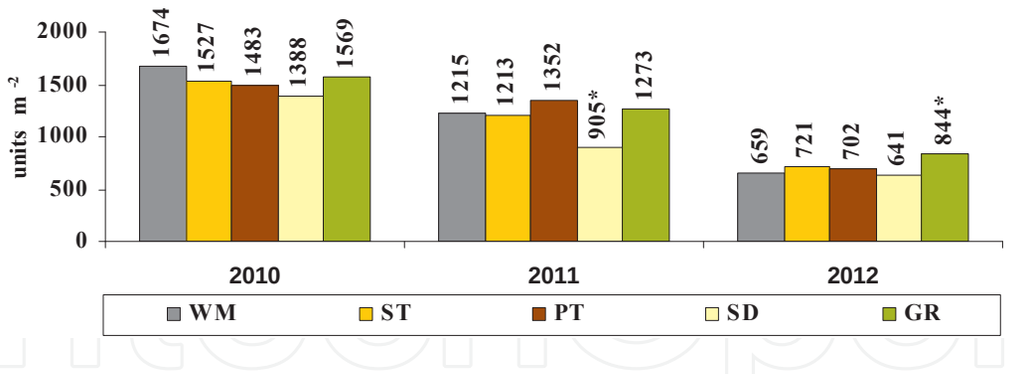

Figure 12. Residual effect of organic mulches on the emergence of annual weeds in 2010-2012; * - 95.0% probability level

Species composition of annual weeds was determined during the 2010–2012. Out of annual weeds the most abundant emergence was exhibited by *Echinochloa crus–galli* (L.), *Galinsoga parviflora* and *Poa annua* L. The residual effect of organic mulches on the emergence of annual weeds was irregular. The previously incorporated thicker mulch layer tended to diminish *Galinsoga parviflora* and *Poa annua* L. emergence, and exhibited uneven effect on *Echinochloa crus–galli* (L.) emergence, compared with the thinner mulch layer.

Perennial weeds. In 2010, the previously used and incorporated straw, peat and sawdust mulches tended to increase (by 11.3–31.5 %) the abundance of perennial weeds during vegetation period; however, the increase was insignificant (Fig. 13). When investigating residual effect of grass mulch, we established a trend towards reduction (by 12.4 %) of re-growth of perennial weeds. In 2011, the previously used and incorporated straw and grass mulches tended to increase (by 7.9–30.1 %) re-growth of perennial weeds, while peat and sawdust mulches tended to reduce it (by 8.3–12.4 %); however, insignificantly. In 2012, no significant differences in the abundance of perennial weeds were established.

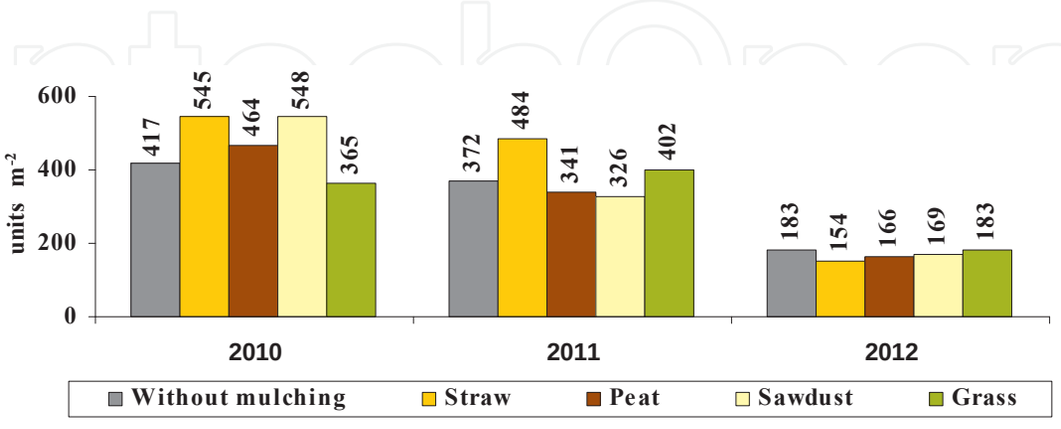

Figure 13. Residual effect of organic mulches on the emergence of perennial weeds in 2010-2012; there are no significant differences: $P > 0.050$

http://dx.doi.org/10.5772/60120

In 2010 and 2012, the previously incorporated thicker (10 cm) mulch layer tended to increase (by 5.8 %) the abundance of annual weeds, and in 2011 it significantly (by 13.8 %) reduced annual weed abundance, compared with the incorporated thinner mulch layer (Fig. 14).

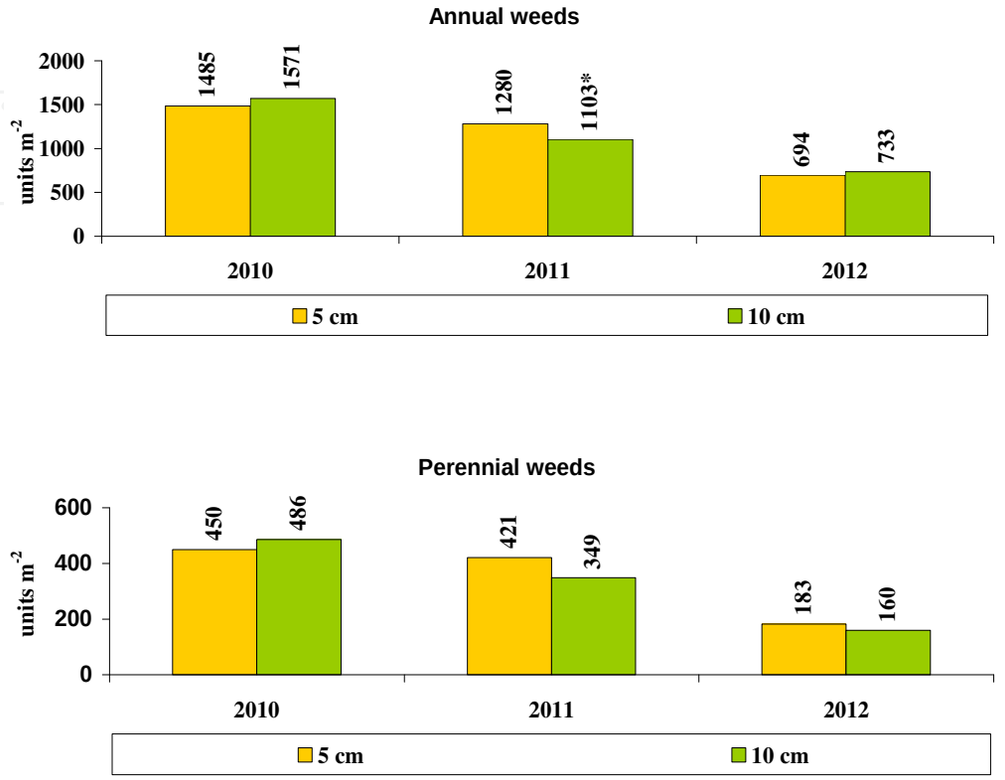

Figure 14. Residual effect of the thickness of organic mulch layer on the emergence of annual and perennial weeds in 2010–2012; there are no significant differences: $P > 0.050$

In 2010, the previously used and incorporated thicker 10 cm mulch layer tended to increase (by 8.0 %) re-growth of perennial weeds, and in 2011–2012 to decrease it (by 12.5–17.1 %), compared with the thinner 5 cm mulch layer; however, insignificantly.

Species composition of perennial weeds was determined. Of the perennial weeds the most prevalent were: *Sonchus arvensis* L., *Rorippa palustris* (L.) Besser., *Mentha arvensis* L., *Cirsium arvense* (L.) Scop., *Elytrigia repens* (L.) Nevski and *Taraxacum officinale* F. H. Wigg.). The residual effect of organic mulches on the re-growth of perennial weeds was unequal. The six year used and incorporated thicker mulch layer tended to reduce the re-growth of *Mentha arvensis*, *Rorippa palustris*, *Elytrigia repens* and *Taraxacum officinale* and tended to increase the re-growth of *Cirsium arvense*. The better re-growth of *Cirsium arvense* in plots mulched with straw, peat and sawdust was investigated in 2004–2007 [35]. The reasons for better *Cirsium arvense* emergence in mentioned plots can be various. As remains of mulch after harvesting were inserted into the soil by ploughing, soil shear strength decreased. Regression analysis of experiment data confirmed relationship between number of *Cirsium arvense* sprouts and soil shear strength.

7. Conclusions

1. All investigated organic mulches reduced weed emergence. Positive effect of mulches was particularly obvious in the period of intensive germination of weeds. Straw, peat and sawdust had the strongest influence on the decrease of weed germination and re-growth. Grass mulch quickly decomposed and its effect on weed density was shorter.
2. Germination of annual weeds was significantly reduced by all organic mulches applied. Re-growth of perennial weeds was significantly reduced by straw (up to 4.5 times), peat (up to 3.0 times), sawdust (up to 3.5 times) and grass (up to 3.9 times) mulches, however, they had a diverse effect on species composition of perennial weeds.
3. The residual effect of organic mulches on weed emergence was not significant. When the physical barrier – organic mulches – disappeared, the amount of weeds in the crop increased. The tendency of lower annual weed density in plots previously mulched with sawdust was established during 2010-2012. The re-growth of perennial weeds changed differently: *Rorippa palustris*, *Elytrigia repens* was significantly reduced by straw and peat mulches (by up to 1.9 times), while the re-growth of *Sonchus arvensis* was significantly increased by straw and sawdust mulches (by up to 2.9 times) and that of *Cirsium arvense* by sawdust mulch (by up to 16.8 times).
4. The influence of organic mulches and thickness of mulch layer on weed seedbank was not significant. The tendency of reduction of weed seedbank density was established in plots mulched with straw, peat and sawdust compared with plots without mulch and in plots with 10 cm mulch layer compared with plots with 5 cm mulch layer. Declining weed density in mulched plots decreased amount of weed seeds in the soil. But the amount of weed seeds in the soil may even increase when organic mulches are used. It is very important to make sure that mulches are not polluted with weed seeds. Dominant weed species in weed seedbank were: *Chenopodium album*, *Stellaria media* and *Echinochloa crus-galli*.
5. Organic mulches have different effects on agrocenosis, they suppress weeds by different ways, therefore a good knowledge of the characteristics of mulching materials and their proper choice are essential.

Author details

Rita Pupalienė*, Aušra Sinkevičienė, Darija Jodaugienė and Kristina Bajorienė

*Address all correspondence to: rita.pupaliene@asu.lt

Aleksandras Stulginskis University, Institute of Agroecosystems and Soil Science, Akademija, Kaunas distr., Lithuania

References

[1] Rasmussen J., Ascard J. W., Weed control in organic farming systems. In: Ecology and Integrated Farming Systems. London: Wiley Publishers; 1995. p. 49-67.

[2] Bond W., Grundy A. C. Non – chemical weed management in organic farming systems. Weed Research 2001;41(5) 383–405.

[3] Bilalis D., Sidiras N., Economou G., Vakali C. Effect of different levels of wheat straw soil surface coverage on weed flora in Vicia faba crops. Journal of Agronomy and Crop 2003;189 233–241.

[4] Radics L., Bognar E. S. Comparison of different methods of weed control in organic green bean and tomato. Acta Horticultura 2004;638 189-196.

[5] Ramakrishna A., Hoang Minh Tam, Wani S. P., Tranh Ding Long. 2005.Effect of mulch on soil temperature, moisture, weed infestation, and yield of groundnut in northern Vietnam. Field Crops Research 2006;95 115–125.

[6] Petersen J., Röver A. Comparison of sugar beet cropping systems with dead and living mulch using a glyphosate – resistant hybrid. Journal of Agronomy and Crop Science 2005;191 1-80.

[7] Jodaugienė D., Pupalienė R., Urbonienė M. The influence of different organic mulches annual and perennial weed germination. Vagos. AUL Research papers 2006;71(24) 27-32.

[8] Neuweiler, R., Bertschinger, L., Stamp, P and Feil, B. The impact of ground cover management on soil nitrogen levels, parameters of vegetative crop development, yield and fruit quality of strawberries. European Journal of Horticulture Science 2003;68 183–191.

[9] Blanco-Canqui H., Lal R. Soil structure and organic carbon relationships following 10 years of wheat straw management in no-till. Soil and Tillage Research 2007;95 240-254.

[10] Dillard H. R., Bellinder R. R., Shah D. A. Integrated management of weeds and diseases in a cabbage cropping system. Crop Protection 2004;23 163–168.

[11] Lenka N. K., Dass A., Sudhishri S. Patnaik U. S. Soil carbon sequestration and erosion control potential of hedgerows and grass filter strips in sloping agricultural lands of eastern India. Agriculture, Ecosystems and Environment 2012;158 31–40.

[12] Yang Y. J., Dungan R.S., IbekweA.M., Valenzuela-Solano C., Crohn D.M., Crowley D.E. Effect of organic mulches on soil bacterial communities one year after aplication. Biol Fertil Soils 2003;38(5) 273–281.

[13] Jodaugienė D., Pupalienė R., Sinkevičienė A., Marcinkevičienė A., Žebrauskaitė K.; Baltaduonytė M., Čepulienė R. The influence of organic mulches on soil biological properties. Žemdirbystė – Agriculture 2010;97(2) 33–40.

[14] Kladivko E. J. Tillage systems and soil ecology. Soil and Tillage Research 2001;61 61–76.

[15] Razifimbelo T., Barthes B., Larre–Larrouy M. C., De Luca E. F., Larent J. Y., Cerri C. C., Feller C., 2006.Effect of sugarcane residue management (mulching versus burning) on organic matter in clayey Oxisol from southern Brazil. Agricultural Ecosystems Environment 115; 285–289.

[16] Brevault T., et al. Impact of a no–till with mulch soil management strategy on soil macrofauna communities in a cotton cropping system. Soil and Tillage Research 2007;97(2) 140–149.

[17] Lal R. Soil temperature, soil moisture and maize yield from mulched and unmulched tropical soils. Plant & Soil 1974;40(1) 129–143.

[18] Ji S.; Unger P. W. Soil water accumulation under different precipitation, potential evaporation, and straw mulch conditions. Soil Science Society of America Journal 2001;65(2) 442–448.

[19] Kar G., Kumar A. Effects of irrigation and straw mulch on water use and tuber yield of potato in eastern India. Journal Agricultural Water Management 2007;94 109–116.

[20] Cline G. R., Silveranail A. F. Residual nitrogen and kill date effects on winter cover crop growth and nitrogen content in a vegetable production system. Horticultural Technology 2001;11 219–225.

[21] Cherr C. M., Scholber J. M. S., Mcsorley R. Green manure approaches to crop production: a synthesis. Agronomy Journal 2006;98 302–319.

[22] Sønsteby A., Nes A., Mage F. Effects of bark mulch and NPK fertilizer on yield, leaf nutrien status and soil mineral nitrogen during three years of strawberry production. Acta Agriculturae Scandinavica Section B, Soil and Plant 2004;54 128–134.

[23] Cadavid L. F., et al. Long-term effects of mulch, fertilization and tillage on cassava grown in sandy soils in northern Colombia. Field Crops Research 1998;57 45.

[24] Sinkevičienė A., Jodaugienė D., Pupalienė R., Urbonienė M. The influence of organic mulches on soil properties and crop yield. Agronomy Research 2009; 7(1) 485–491.

[25] Teasdale J.R., Mohler C.L. Light transmittance, soil temperature, and soil moisture under residue of hairy vetch and rye. Agronomy Journal 1993;85 68–673.

[26] Cassini P., Vecchio V., Pasten W. Green manuring and mulching in the Bolivian Amazon. In: Proceedings of the 3rd Congress of European Congress of Agronomy. Abano-Padova (Italy), 1994; 662–663.

[27] Jucius D., Šniauka, P. Morkų mulčiavimas / Carrots mulching. Žemės ūkis / Agriculture, 2002; 5 24 (in Lithuanian)

[28] Putnam A. R., Defrank J., Barnes J. P.. Exploitation of allelophaty for weed control in annual and perennial cropping systems. Journal of Chemistry and Ecology 1983;(9) 1001–1010.

[29] Schillng G. R., Lieb R., Worsham A.D. Rye and wheat mulch: the suppression of certain broad – leaved weeds and the isolation and identification of phytotoxins. In: The Chemistry of Allelophaty. Washington: American Chemical Society, 1985. p. 243-271.

[30] Blum U. L., et al. Effects of clover and small grain cover crops and tillage techniques on seedling emergence of some dicotyledonous weed species. American Journal of Alternative Agriculture 1997; (12) 146–161.

[31] Singh R., S., Sharma R.R., Goyal R.K. Interacting effects of planting time and mulching on "Chandeler" strawberry (*Fragaria* x *ananassa* Duch.). Science Horticulture 2007;(111) 344-351.

[32] Unger P. W., Jones O. R. Long-term tillage and cropping systems affect bulk density and penetration resistance of soil cropped to dryland wheat and grain sorghum. Soil and Tillage Research 1998; 45(1-2) 39–57.

[33] Oliveira M. T., Merwin, I. A. Soil physical conditions in a New York orchard after eight years under different groundcover management systems. Plant&Soil 2001;234 233–237.

[34] Mulumba L. N., Lal R. Mulching effects on selected soil physical properties. Soil and Tillage Research 2008;98(1) 106–111.

[35] Jodaugienė D., Pupalienė R., Sinkevičienė A. The impact of different types of organic mulches on *Cirsium arvense* emergence. 24 th German Conference on Weed Biology and Weed Control, March 4-6, Journal of plant diseases and protection 2008;special issue XXI 401-405.

[36] Stancevičius, A., Špokienė, N. Weed seed germination dynamics in the vegetation period. LZUA research papers. 1972;18 15–24.

[37] SPSS Inc. Systat 10. Statistics I. USA; 2000

[38] Tarakanovas P. Data transformation of biological experiments using a computer program ANOVA. Žemdirbyste=Agriculture 2002;77 170-180.

[39] Döring T., Brandt M., Heβ J., Finckh M, Saucke H. Effect of straw mulch on soil nitrate dynamics, weeds, yield and soil erosion in organically grown potatoes. Field Crops Research. 2005;94: 238-249.

[40] Špokienė N. Annual weed prevailing in the soil germination. Weed problems in the current farming conditions in the Baltic region, Kaunas-Academy; 1995. 267-275.

[41] Grigas A. Land-tenure and soil pollution with weed seeds. Zemdirbyste=Agriculture. 1995;49. 90–111 (In Lithuanian).

IntechOpen