# Changes of weed ecological groups under different organic mulches

*Änderungen innerhalb ökologischer Gruppen von Unkräutern unter verschiedenem organischen Mulch*

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## Summary

The aim of the investigation was to evaluate the influence of different organic mulches and different thickness of mulch layer on weed ecological groups. The field experiment was carried out in the Pomological Garden of the Aleksandras Stulginskis University (54°53'N, 23°50'E). The soil type was *Calc(ar)i-Endohypogleyic Luvisol* (*LVg-n-w-cc*). Treatments of the experiment: factor A – mulching: 1) without mulch, 2) straw, 3) peat, 4) sawdust, 5) grass; factor B – thickness of the mulch layer: 1) 5 cm, 2) 10 cm.

All investigated organic mulches decreased weed density by 2.7–10.3 times compared with non-mulched soil. The mulch layer of 10 cm thickness decreased the weed density better by 1.3–2.9 times compared with the 5-cm mulch layer. The highest amount of weeds belonged to species indifferent to soil pH, rich in nitrogen, moderately moist and moist soil. Organic mulches, not infected with weed seeds, decreased density of the mentioned weed ecological groups compared with no-mulching. On that score mulching with 10 cm thickness mulch layer was more effective than that with 5 cm thickness mulch layer. Qualitative distribution of weeds into ecological groups influenced by mulch and thickness of mulch layer was even, but the quantitative distribution was uneven.

**Key words:** Ecological group, organic mulch, thickness of mulch layer, weed

## Zusammenfassung

Ziel der Untersuchungen war die Bewertung des Einflusses von unterschiedlichem organischen Mulch bei unterschiedlicher Dicke der Auflagen auf die Verunkrautung. Die Untersuchungen wurden in den Jahren 2004 bis 2009 im Pomologischen Garten von der Aleksandras Stulginskis Universität (54°53'N, 23°50'E) durchgeführt. Die Bodenart war Calc(ar)i-Endohypogleyic Luvisol (LVg-n-w-cc). Die Versuchsvarianten waren: Faktor A – organischer Mulch: 1) ohne Mulch, 2) Winterweizenstroh, 3) Torf, 4) Sägemehl, 5) Gras; Faktor B – Mulchschichtdicke: 1) 5 cm, 2) 10 cm.

Alle angewandten Mulchverfahren reduzierten die Unkrautdichte um das 2,7- bis 10,3-Fache im Vergleich mit nicht mit Mulch bedeckten Flächen. Mulchauflagen von 10 cm reduzierten die Unkrautdichte um den Faktor 1,3-2,9 im Vergleich mit Auflagen von 5 cm Mulch. Die höchste Unkrautdichte fand sich bei Boden-pH-, Stickstoff- und Feuchte-toleranten Unkrautarten. Organischer Mulch, nachweislich frei von Unkrautsamen, reduzierte in allen Fällen die Dichte der in Frage stehenden ökologischen Unkrautgruppen im Vergleich mit Flächen ohne Mulchauflage. In dieser Hinsicht waren 10 cm Mulchauflage in allen Fällen besser als nur 5 cm Mulchauflage. Die qualitative Verteilung innerhalb der ökologischen Gruppen der Unkräuter war unabhängig von Mulchart oder Dicke der Auflage immer ausgeglichen. Nicht ausgeglichen hingegen war die quantitative Verteilung.

**Stichwörter**: Mulchschichtdicke, ökologische Gruppen, organischer Mulch, Unkraut

## Introduction

Weed control is one of the essential problems in organic farming system. Organic mulches can be used as alternative mean for weed control. Plant residues used for mulching affect soil properties: they increase the soil moisture (PAKDEL *et al.*, 2011); they change the soil-pH (BROSHAT, 2007); they increase the content of nitrogen, phosphorus and potassium in the soil (FANG *et al.*, 2008; PAKDEL *et al.*, 2013). Those changes can influence the weed diversity.

Segetal weed species are associated with a particular range of conditions, for example pH, site moisture and soil fertility, and on this basis values can be given denoting the position along environmental gradients at which each species, on average, reaches its peak abundance (SMART,

2000). The indicator species system of ELLENBERG *et al.* (1992), which is one of the most widely used systems, describes the response of a species to edaphic and climatic parameters in comparison with other species. RIESINGER (2006) also reported that the level of weed infestation was clearly influenced by climate, edaphic factors and management. According to OTTE *et al.* (2006), the tendency of changing occurrence of arable weeds showed higher correlations with habitat traits (expressed as Ellenberg indicator values) than with seed and germination traits. BRAZIENĖ *et al.* (2010) established the influence of pH and nitrogen content value on botanical composition of plants in different soil ecotypes.

In our experiment (from 2004 to 2009) all examined organic mulches reduced weed germination (JODAUGIENĖ *et al.*, 2006; JODAUGIENĖ *et al.*, 2012). Straw, peat and wood chips mulches have the strongest influence on the decrease of weed germination. Mulch of chopped grass is quick to decompose so its effect on weed density is weaker. Changes of weed ecological groups under different organic mulches in horticultural crops in organic farming systems under Lithuanian climate conditions were not investigated.

The aim of investigation was to evaluate the influence of different organic mulches and different thickness of mulch layer on weed ecological groups.

**Material and methods**

The field experiment was carried out in the Pomological Garden of Aleksandras Stulginskis University (54º53'N, 23º50'E) in organic certified field in 2004-2009. The soil type *Calc(ar)i-Endohypogleyic Luvisol*. Soil texture: medium clay loams on heavy clay loams and clays. Soil $pH_{KCl}$: 6.4–6.7, the content of total nitrogen: 0.119–0.142%, organic C: 1.63–3.50%, available nutrients: phosphorus: 219.7–234.9 mg $kg^{-1}$, potassium: 134.3–180.5 mg $kg^{-1}$.

Treatments of the experiment: Factor A – mulch: 1) without mulch; 2) straw; 3) peat; 4) sawdust; 5) grass. Factor B – thickness of mulch layer: 1) 5 cm; 2) 10 cm. The influence of organic mulches on weed density was investigated in 2004–2009. The data of 2009 are presented in this paper. The data of 2009 are compared with unpublished data of 2007.

In 2007 in each plot were grown *Brassica oleracea* L. variety *Kamennaja golovka* in rows with spacing of 0.5 m, in 2009 *Phaseolus vulgaris* L. variety *Igoloneska* in rows with spacing of 0.5 m. These different organic materials were used for mulching: chopped wheat straw, medium decomposed fen peat, sawdust from different tree species, regularly cut grass from grass-plots. The mulch was spread manually in 5 cm and 10 cm thick layers shortly after sowing (planting). Remains of mulch were incorporated into the soil by ploughing after harvest in autumn. Crops were grown under organic farming requirements. No pesticides and fertilizers were used.

Weed shoots were countered and removed every 10 days from 10 June until 10 October on four 0.2 x 0.5 m squares in each plot. Summarized data of weed numbers during the period from 10 June until 10 October are given in this paper.

The classification into ecological groups was done according to ELLENBERG *et al.* (1992).

For different organic mulches and thickness of mulch layer the number of species and amount of weeds per $m^{-2}$ belonging to the different weed categories were counted and submitted to the independence test. Keeping organic mulches and thickness of mulch layer in turn constant, contingency tables were obtained to which the independence test was applied to detect any relationship between the size of each group and the organic mulches or between groups and thickness of mulch layer. The evaluation was done using the $\chi^2$ test.

Statistics estimates:

$$\chi^2 = \sum_{i=1} \sum_{j=1} (O_{ij} - ((n_{i.} * n_{.j}) * n^{-1})) * ((n_{i.} * n_{.j}) * n^{-1})^{-1}$$

where $\chi^2$ - Chi – Sauare; $O_{ij}$ – i population part, in which meaning of variable x passes to category j;

$\sum_{j=1}^{c} O_{ij}$ – number of initiate members, which indication x meaning is $x_i$; $\sum_{i=1}^{r} O_{ij}$ – number of initiate members, which meaning of indication y is $y_j$; n = $\sum_{i=1}^{r} \sum_{j=1}^{c} O_{ij}$ - size of initiate (ČEKANAVIČIUS and MURAUSKAS, 2001).

**Results and Discussion**

Floristic analysis

Weeds belonging to 41 species were obtained in the *Brassica oleracea* crop in 2007: 25 annuals and 16 perennials (unpublished data). 37 weed species were obtained in 2009: 22 annuals and 15 perennials. During the experiment period not only the total weed amount, but amounts of annual and perennial weeds decreased. During the experiment in organically grown vegetable crops dominated these annual weed species: *Echinochloa crus-galli*, *Galinsoga parviflora*, *Poa annua*, and perennial species: *Cirsium arvense*, *Elytrigia repens*, *Mentha arvensis*, *Rorippa palustris*, *Sonchus arvensis* and *Taraxacum officinale*. Straw and sawdust mulches decreased the weed density in 2009 compared with 2007, peat and grass mulches increased it. All investigated organic mulches decreased weed density compared without mulching (in 2007 from 2.7 to 5.4, in 2009 from 2.8 to 10.3 times). Thicker (10 cm) mulch layers decreased weed density better compared with 5-cm mulch layers: in 2007 from 1.3 to 2.0, in 2009 from 1.9 to 2.9 times.

Ecological groups according to soil pH

According to soil pH, weeds distributed into 7 ecological groups in 2007, into 6 in 2009 (Tab. 1). During all experiment years indifferent weed species dominated quantitatively and qualitatively. Dominant weed species belong to the indifferent weed ecological group were: *Echinochloa crus-galli*, *Poa annua*, *Cirsium arvense*, *Elytrigia repens*, *Mentha arvensis*, *Rorippa palustris* and *Taraxacum officinale*. In plots covered with organic mulches compared with plots without mulches the number of indifferent weed species decreased. In 2009, compared to 2007, straw and sawdust mulches decreased the density of indifferent weed species, peat and grass mulches increased the density.

**Tab. 1** Qualitative (number of species) and quantitative (number of weeds per $m^{-2}$) distribution of weeds of ecological groups according to soil pH, 2009.

***Tab. 1** Qualitative (Zahl von Unkrautarten) und quantitative (Zahl von Unkräutern per $m^{-2}$) Verteilung von ökologischen Gruppen anhand des pH-Wertes, 2009.*

| Analysis | OM | ML | Ecological groups according to soil pH | | | | | | Within mulch layer | Within organic mulches |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rx | R4 | R5 | R6 | R7 | R8 | $\chi^2/\chi^2_{0.05}$ | $\chi^2/\chi^2_{0.05}$ |
| Qualitative | WM | 5 | 22 | 0 | 2 | 3 | 5 | 1 | - | 5.96/9.49 (5 cm mulch layer) |
| | | 10 | 21 | 1 | 2 | 2 | 5 | 2 | | |
| | ST | 5 | 12 | 0 | 1 | 1 | 4 | 0 | 1.46/7.82 | |
| | | 10 | 12 | 0 | 2 | 0 | 3 | 0 | | |
| | PT | 5 | 17 | 0 | 2 | 2 | 4 | 0 | 2.08/7.82 | 12.6/11.07 (10 cm mulch layer) |
| | | 10 | 14 | 0 | 1 | 0 | 3 | 0 | | |
| | SD | 5 | 15 | 0 | 1 | 0 | 2 | 0 | 0.93/5.99 | |
| | | 10 | 14 | 0 | 0 | 0 | 2 | 0 | | |
| | GR | 5 | 16 | 0 | 2 | 2 | 5 | 0 | 1.16/7.82 | |
| | | 10 | 9 | 0 | 1 | 0 | 2 | 0 | | |
| Quantitative | WM | 5 | 1120 | 0 | 237 | 9.00 | 99.0 | 1,00 | - | 192.3/9.49 (5 cm mulch layer) |
| | | 10 | 1210 | 1.00 | 241 | 13.0 | 163 | 1,00 | | |
| | ST | 5 | 159 | 0 | 8.00 | 1.00 | 29.0 | 0 | 21.1/7.82 | |
| | | 10 | 61,0 | 0 | 3.00 | 0 | 39.0 | 0 | | |
| | PT | 5 | 642 | 0 | 29.0 | 2.00 | 43.0 | 0 | 18.4/7.82 | 173.1/ 11.07 (10 cm mulch layer) |
| | | 10 | 271 | 0 | 1.00 | 0 | 34.0 | 0 | | |
| | SD | 5 | 300 | 0 | 5.00 | 0 | 66.0 | 0 | 2.36/7.82 | |
| | | 10 | 126 | 0 | 0 | 0 | 31.0 | 0 | | |
| | GR | 5 | 611 | 0 | 103 | 3.00 | 103 | 0 | 8.84/7.82 | |
| | | 10 | 230 | 0 | 19.0 | 0 | 34.0 | 0 | | |

Note: OM – organic mulches; ML – cm thickness of mulch layer; WM – without mulch; ST – straw; PT – peat; SD – sawdust; GR – grass; Ecological groups according to soil pH: R4 – weed species in-between R3 and R5; R5 – weed species of moderately acid soil; R6 – weed species in-between R5 and R7; R7 – weed species of weakly acid to weakly basic soil; R8 – weed species in-between R7 and R9; Rx – indifferent weed species (growing at wide pH range).

Ecological groups according to nitrogen

The analysis of weed ecological groups according to nitrogen showed that during the experiment period weed species of very N-rich soil (8th group (ELLENBERG *et al.*, 1992)) dominated in vegetable crops (Tab. 2). *Echinochloa crus-galli*, *Galinsoga parviflora*, *Poa annua*, *Rorippa palustris* and *Taraxacum officinale* belong to this group. The lowest density of weeds belonging to weed species of very N-rich soil was established in plots mulched with straw and sawdust mulches during the experiment period. Mulches decreased density of very N-rich soil weeds compared with no mulching (in 2007 from 5.2 to 9.6, in 2009 from 2.3 to 24.9 times). In plots mulched with a 10-cm mulch layer compared with the 5-cm layer, the emergence of weeds of the very N-rich soil weed ecological group decreased: in 2007 1.4–2.4, in 2009 2.6–16.5 times.

Higher density of indifferent weed species and weeds belonging to weed species of richly fertile places (7th group) was established. *Mentha arvensis* and S*onchus arvensis* belong to indifferent

weed species, and *Cirsium arvense* and *Elytrigia repens* belong to weed species frequent on N-rich soil (7th group). Straw and sawdust mulches decreased the density of indifferent weeds in subsequent years, and peat and grass mulches increased their density. All examined organic mulches decreased the emergence of indifferent weeds. The thicker grass mulch layer (10 cm) decreased the emergence of indifferent weeds compared with thinner (5 cm) mulch layer by 1.8–2.8 times. Organic mulches (except 5-cm layer of straw and peat mulches in 2007) decreased the density of weed species frequent on N-rich soil compared with not mulched soil. Emergence of weeds belonging to this group in plots covered with a 10-cm mulch layer decreased compared with plots covered with the 5-cm mulch layer: in 2007 for 1.4–2.6, in 2009 for 1.6–6.5 times.

**Tab. 2** Qualitative (number of species) and quantitative (number of weeds per $m^{-2}$) distribution of weeds of ecological groups according to nitrogen, 2009.

***Tab. 2** Qualitative (Zahl von Unkrautarten) und quantitative (Zahl von Unkräutern per m-2) Verteilung von ökologischen Gruppen anhand des Stickstoffs, 2009.*

| Analysis | OM | ML | Ecological groups according to nitrogen | | | | | | | Within mulch layer | Within organic mulches |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nx | N3 | N5 | N6 | N7 | N8 | N9 | $\chi^2/\chi^2_{0.05}$ | $\chi^2/\chi^2_{0.05}$ |
| Qualitative | WM | 5 | 6 | 1 | 3 | 7 | 4 | 11 | 1 | - | 6.75/ |
| | | 10 | 5 | 1 | 3 | 9 | 5 | 9 | 1 | | 12.59 |
| | ST | 5 | 4 | 1 | 1 | 1 | 4 | 6 | 1 | 2.89/ | (5 cm mulch layer) |
| | | 10 | 3 | 1 | 1 | 0 | 3 | 9 | 0 | 12.59 | |
| | PT | 5 | 4 | 1 | 1 | 4 | 4 | 10 | 1 | 1.36/ | |
| | | 10 | 4 | 1 | 1 | 1 | 3 | 7 | 1 | 12.59 | |
| | SD | 5 | 2 | 1 | 1 | 3 | 4 | 6 | 1 | 1.38/ | 16.7/ 12.59 |
| | | 10 | 3 | 1 | 1 | 2 | 4 | 5 | 0 | 12.59 | |
| | GR | 5 | 3 | 1 | 1 | 3 | 4 | 12 | 1 | 3.51/ | (10 cm mulch layer) |
| | | 10 | 2 | 1 | 1 | 0 | 2 | 6 | 0 | 12.59 | |
| Quantitative | WM | 5 | 167 | 46.0 | 47.0 | 35.0 | 172 | 972 | 27.0 | - | 390.0/ |
| | | 10 | 309 | 67.0 | 14.0 | 43.0 | 229 | 946 | 21.0 | | 12.59 |
| | ST | 5 | 44.0 | 4.0 | 9.0 | 1.00 | 71.0 | 65.0 | 3.0 | 26.5/ | (5 cm mulch layer) |
| | | 10 | 39.0 | 6.0 | 1.0 | 0 | 45.0 | 12.0 | 0.0 | | |
| | PT | 5 | 139 | 35.0 | 21.0 | 8.00 | 97.0 | 400 | 16.0 | 23.5/ | |
| | | 10 | 69.0 | 37.0 | 5.0 | 1.00 | 45.0 | 142 | 7.0 | | 482.9/ 12.59 |
| | SD | 5 | 81.0 | 38.0 | 27.0 | 3.00 | 101 | 115 | 6.0 | 83.9/ | |
| | | 10 | 79.0 | 35.0 | 4.00 | 1.00 | 31.0 | 7.00 | 0 | | |
| | GR | 5 | 98.0 | 11.0 | 19.0 | 6.00 | 72.0 | 606 | 8.00 | 18.6/ | (10 cm mulch layer) |
| | | 10 | 35.0 | 1.00 | 1.00 | 0 | 11.0 | 235 | 0 | | |

Note: OM – organic mulches; ML – cm thickness of mulch layer; WM – without mulch; ST – straw; PT – peat; SD – sawdust; GR – grass; Ecological groups according to nitrogen: N3 – weed species of more or less infertile sites; N5 – weed species of intermediate fertility; N6 – weed species in-between N5 and N7; N7 – weed species of richly fertile places; N8 – weed species in-between N7 and N9; N9 – weed species of extremely rich situations; Nx – indifferent weed species (growing at wide nitrogen range).

All organic mulches during all experiment periods compared with not mulched soil decreased the density of weed species frequent on N-poor soil (i. e. more or less infertile sites) (3rd group), weed species in-between N5 and N7 ecological groups (6th group) and weed species of N-surplus soil (9th group). The emergence of weed species of moderately N-rich soil (5th group) compared with not

mulched soil was promoted by the 5-cm layer of straw and sawdust mulch in 2007. Spreading of *Agrostis stolonifera,* belonging to the 5th group, could also result from this tendency.

According to nitrogen, weeds distributed depending on organic mulches and thickness of mulch layer qualitatively evenly, and quantitatively unevenly due to uneven spreading of indifferent weed species, weed species of moderately N-rich soil, weed species of moderately N-rich soil and frequent on N-rich soil and weed species frequent on N-rich soil.

Ecological groups according to soil moisture

According to soil moisture weeds distribute to 6 ecological groups during all experiment period (Tab. 3). Weed species of moderately moist soil (5th group) qualitatively and quantitatively dominated. Weed species dominated in vegetable crops in field experiment: *Echinochloa crus-galli*, *Galinsoga parviflora*, *Sonchus arvensis* and *Taraxacum officinale* belong to 5th group. Density of weed species of moderately moist soil in mulched plots decreased. In 2009 density of weed species of moderately moist soil in plots mulched with straw and sawdust mulches decreased compared with that in 2007, and peat and grass mulches – increased. All examined organic mulches decreased density of weed species of moderately moist soil: in 2007 – for 5.8–9.8, in 2009 – for 3.4–16.4 times. Thicker mulch layer better decreased density of those weeds compared with thinner mulch layer: in 2007 – for 1.1–3.4, except sawdust mulch, in 2008 – for 1.5–2.9 times, except straw mulch, in 2009 – for 2.0–4.7 times.

Indifferent weed species dominated compared with other weed ecological groups. *Cirsium arvense* and *Elytrigia repens* belong to indifferent weed group. In 2009, the emergence of indifferent weeds decreased. Mulching (except the 5-cm straw and peat mulch layer in 2007) decreased the emergence of indifferent weeds.

Mulching with thicker (10 cm) mulch layer resulted in lower density of indifferent weeds compared with mulching with the 5-cm mulch layer: in 2007 for 1.2– 2.5, in 2009 for 1.5–6.4 times. Organic mulches, except grass mulch in 2009, compared with not mulched soil, decreased the emergence of weed species of moderately moist and moist soil (in-between F5 and F7 ecological groups) (6th group). Straw, peat and sawdust mulches, spread by of 5 cm and 10 cm layer, decreased the emergence of weed species of moist soil (7th group) compared with unmulched soil. Spreading of *Agrostis stolonifera* and *Mentha arvensis*, weeds from 7th group, could represent this process. Emergence of weed species of moist soil decreased in plots covered with 10-cm thickness mulch layer compared with plots covered with 5-cm thickness mulch layer. In 2007 was plenty emergence of weed species of moist and wet soil (8th group), especially *Rorippa palustris*. In 2009 the density of weed species of moist and wet soil decreased. Organic mulches, except sawdust mulch in 2007, decreased emergence of weed species of moist and wet soil compared with not mulched soil in 2007 for 1.6–5.9, in 2009 for 4.1–8.3 times. The emergence of weed species of moist and wet soil in plots covered with 10-cm thickness mulch layer decreased compared with that in plots covered with 5-cm thickness mulch layer.

Under the influence of mulches and thickness of mulch layers the weed qualitative distribution according to soil moisture was even, but the quantitative distribution was uneven due to uneven distribution of indifferent weed species and weed species of moderately moist and moist soil.

**Tab. 3** Qualitative (number of species) and quantitative (number of weeds per $m^{-2}$) distribution of weeds of ecological groups according to soil moisture, 2009.

***Tab. 3*** *Qualitative (Zahl von Unkrautarten) und quantitative (Zahl von Unkräutern per $m^{-2}$) Verteilung von ökologischen Gruppen anhand der Bodenfeuchte, 2009.*

Note: OM – organic mulches; ML – cm thickness of mulch layer; WM – without mulch; ST – straw; PT – peat; SD

| Analysis | OM | ML | Ecological groups according to soil moisture | | | | | | Within mulch layer | Within organic mulches |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Fx | F4 | F5 | F6 | F7 | F8 | $\chi^2/\chi^2_{0.05}$ | $\chi^2/\chi^2_{0.05}$ |
| Qualitative | WM | 5 | 8 | 2 | 12 | 5 | 3 | 3 | - | 3.40/ 11.07 (5 cm mulch layer) |
| | | 10 | 8 | 1 | 12 | 6 | 3 | 3 | | |
| | ST | 5 | 5 | 1 | 6 | 2 | 2 | 2 | 1.58/11.07 | |
| | | 10 | 4 | 0 | 5 | 3 | 2 | 3 | | |
| | PT | 5 | 6 | 1 | 8 | 4 | 3 | 3 | 0.80/11.07 | |
| | | 10 | 5 | 0 | 6 | 3 | 2 | 2 | | |
| | SD | 5 | 3 | 0 | 7 | 3 | 3 | 2 | 0.70/9.49 | 6.13/ 11.07 (10 cm mulch layer) |
| | | 10 | 3 | 0 | 5 | 4 | 3 | 1 | | |
| | GR | 5 | 6 | 1 | 8 | 5 | 2 | 3 | 2.08/11.07 | |
| | | 10 | 4 | 0 | 4 | 1 | 2 | 1 | | |
| Quantitative | WM | 5 | 222 | 2,00 | 973 | 80.0 | 128 | 61,0 | - | 734.0/ 11.07 (5 cm mulch layer) |
| | | 10 | 336 | 1.00 | 1008 | 72.0 | 182 | 30,0 | | |
| | ST | 5 | 76.0 | 1.00 | 81.0 | 4.00 | 29.0 | 6,00 | 6.98/11.07 | |
| | | 10 | 46.0 | 0 | 40.0 | 4.00 | 7.00 | 6,00 | | |
| | PT | 5 | 129 | 1.00 | 431 | 22.0 | 122 | 11,0 | 17.9/11.07 | |
| | | 10 | 84.0 | 0 | 160 | 10.0 | 41.0 | 11,0 | | |
| | SD | 5 | 120 | 0 | 163 | 28.0 | 50.0 | 10,0 | 44.7/9.49 | 1046.0/ 11.07 (10 cm mulch layer) |
| | | 10 | 63.0 | 0 | 35.0 | 5.00 | 53.0 | 1,00 | | |
| | GR | 5 | 116 | 1.00 | 357 | 285 | 48.0 | 13,0 | 64.9/11.07 | |
| | | 10 | 18.0 | 0 | 83.0 | 174 | 7.00 | 1,00 | | |

– sawdust; GR – grass; Ecological groups according to soil moisture: F4 – weed species in-between F3 and F5; F5 – weed species of moderately moist soil; F6 – weed species in-between F5 and F7; F7 – weed species of moist soil; F8 – weed species in-between F7 and F9; Fx – indifferent weed species (growing at wide moisture range).

## Discussion

The investigation of BECKER and HURLE (1998) showed that organic farming had not significant influence on the number of weed species. However, soil coverage by weeds increased from 20 to 30%. In our experiment the number of weed species decreased: weeds belonging to 37 species were obtained in crops in 2009, and weeds belonging to 41 species in 2007. Organic mulches decreased the number of weed species in vegetable crops. All investigated organic mulches decreased the weed density (for 2.7–10.3 times) compared with not mulched soil. Results of our experiment showed that organic mulches such as straw, regularly cut grass from grass-plots and others can be used in organic farming for weed control (JODAUGIENĖ *et al.*, 2012). Weed diversity and density can be influenced by agricultural crop: different crops were grown in different years in the field experiment. According to LOSOSOVA *et al.* (2004) the type of crop affects weed species composition: nutrient-demanding weeds were more frequent in vegetables crops. Results of our experiment confirm this affirmation. Annual weed species: *Echinochloa crus-galli*, *Galinsoga parviflora*, *Poa annua*, and perennial: *Cirsium arvense*, *Elytrigia repens, Mentha arvensis*, *Rorippa*

*palustris*, *Sonchus arvensis* and *Taraxacum officinale* dominated in the experiment plots. According to MOHAMAD and PALLUTT (2006), in the organic farming system an increase in the occurrence of *Cirsium arvense* was observed. LOSOSOVA *et al.* (2004) established that in vegetable crops perennial weeds with parts of vegetative propagation over-winter in soil (geophytes) dominated.

A tendency of decreased soil pH in plots mulched with straw, peat and sawdust mulches was established (unpublished data). The highest density of weed species indifferent to soil pH, N-rich and moderately moist and moist soil was established. Organic mulches decreased the density of the mentioned weed species. BOGUŽAS and MARCINKEVIČIENĖ (2008) found that in organic farming the highest abundance of weeds belonged to weed species indifferent to soil pH.

The influence of the thickness of mulch layer on weed emergence was investigated. BILALIS *et al.* (2003) found a reduction of weed density as the level of soil cover increased. Mulching with 10-cm layer was more effective compared with mulching with 5-cm layer: the thicker mulch layer decreased weed density better compared with 5-cm mulch layer for 1.3–2.9 times.

Mulches affected the qualitative and quantitative distribution of weed species by changing soil properties and growth conditions. Under the influence of the investigated organic mulches and thickness of mulch layer even qualitative and uneven quantitative distribution of weed species was established.

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