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Living grass mulches in strawberry cultivation

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Abstract. Strawberries grow best on soils with high organic matter content and high fertility levels. Green manure crops were used successfully as a substitute for farm manure. Another opportunity to increase organic matter content of soil is to grow groundcover crops, for example grass species, between strawberry rows. Proper management can reduce weeds, erosion on slopes, soil compaction, dust and mud. Potential disadvantages of using cover crops between rows include the consumption of nitrogen and other nutrients as well as water. The aim of this research was to elucidate the impact of various living mulches on plant vegetative growth and yield of cv. 'Bounty'. Different living mulches were evaluated at the Polli Horticultural Research Centre during 2001–2003. The following living mulches were compared: natural grass cover, red fescue, Kentucky bluegrass, perennial ryegrass, timothy, orchardgrass, and white clover.

Key words: *Fragaria ananassa*, grasses, cover crop, yield

INTRODUCTION

Strawberries grow best on soils with high organic matter content and high fertility levels. Therefore, the use of cattle manure or other organic fertilizer is essential. The concentration of animal husbandry onto big farms has made cattle manure quite expensive for berry growers due to high transportation costs. Green manure crops were used successfully as a substitute for farm manure. Cover crops enhance soil organic matter, carbon dynamics and microbiological function compared with traditional tillage systems (Pritts & Kelly, 1993; Steenwerth & Belina, 2008). Another opportunity to increase soil organic matter content is to grow groundcover crops, for example grass species, between strawberry rows. An established cover crop that is interplanted and grown with an annual row crop is known as a living mulch. Living mulches can provide many benefits to a cropping habitat, including weed control, reduced erosion, enhanced fertility, improved soil quality (Lanini et al., 1989), and protection of strawberry crowns from cold temperatures in winter (Newenhouse & Dana, 1989). The aim of the present research was to study the influence of different living mulches on plant vegetative growth and yield of strawberries.

MATERIALS AND METHODS

The experiment was conducted at the Polli Horticultural Research Centre in 2001–2003. The field trial was carried out on sod podzolic sandy loam soil, with pH

5.3, 1.9% organic matter, 143 mg kg^{-1} P_2O_5, 134 mg $kg^{-1}K_2O$. The site was mechanically clean cultivated before the establishment of the plantation, and 90 kg ha^{-1} of PK fertilizers were applied in pre-planting ploughing. The plants of strawberry cultivar 'Bounty' were planted with 3 replications in 2001, planting scheme was 35 × 95 cm. The size of the plot was 10.2 m^2, of which 6.3 m^2 was covered with grasses and 3.85 m^2 with strawberries. In each plot there were 16 plants, which were planted in double rows; the beds were covered with plastic mulch. No chemical treatments, mineral fertilization and irrigation were used on the plantation. The living mulches were as follows: (1) red fescue (*Festuca rubra* L.) 'Kauni', (2) 'Jõgeva 70' and (3) 'Waldorf'; (4) Kentucky bluegrass (*Poa pratensis* L.) 'Esto'; (5) perennial ryegrass (*Lolium perenne* L.) 'Raidi'; (6) timothy (*Phleum pratense* L.) 'Jõgeva 54' and (7) 'Tika'; (8) orchard grass (*Dactylis glomerata* L.); (9) white clover (*Trifolium repens* L.) 'Jõgeva 4' and (10) natural grass cover. Natural grass cover consisted mostly of grass species and included weeds like dandelion, quackgrass, sagebrush and Canada thistle. The grass sward was mown 4–6 times during the summer. In this study mulch biomass production per plot was weighed (kg), inflorescences and leaves per plant unit were counted and total yield (including all the rotted berries) per plot was recorded. Results were statistically evaluated by the analyses of variance using Duncan's test.

RESULTS

In 2001, the average strawberry yield was 4.87 kg per plot, ranging from 3.9 to 5.7 kg per plot (Table 1). The yield level was similar in most living mulches compared to natural grass cover. Higher yield was recorded only in variants of timothy 'Tika' and Kentucky bluegrass. In 2002 crop failure occurred due to adverse weather conditions. Late spring frost occurred during the flowering time of strawberries and the weather was extremely dry during the ripening of berries. Yield was only 0.51 to 0.90 kg per plot. Higher yields were obtained from timothy and white clover mulch. In 2003, the average yield was 1.3 kg per plot, ranging from 1.12 to 1.90 kg per plot. Comparing different mulch variants, the variant of red fescue 'Jõgeva 70' was significantly different from others.

Table 1. The effect of living mulches on the number of leaves and inflorescences per plant and the yield of strawberries 'Bounty' in 2001–2003.

Living mulch	Number of leaves, 2003	Number of inflorescences		Total yield, kg per plot (3.85 m^2)		
		2002	2003	2001	2002	2003
Natural grass cover	22 a	3.5 ab	4.5 a	4.20 ab	0.61 a	1.72 ab
Red fescue 'Kauni'	19 a	3.7 ab	4.2 a	4.30 ab	0.61 a	1.41 ab
Red fescue 'Jõgeva 70'	21 a	3.0 a	4.1 a	4.90 ab	0.65 a	1.90 c
Perennial ryegrass 'Raidi'	21 a	3.4 ab	4.2 a	4.10 a	0.63 a	1.12 a
Red fescue 'Waldorf'	19 a	3.5 ab	4.0 a	4.30 ab	0.68 a	1.18 a
Orchard grass 'Jõgeva 220'	22 a	3.1 a	3.7 a	4.00 a	0.51 a	1.29 ab
Kentucky bluegrass 'Esto'	21 a	3.5 ab	4.1 a	5.40 bc	0.65 a	1.57 ab
Timothy 'Tika'	22 a	4.5 c	4.5 a	5.70 c	0.72 b	1.53 ab
Timothy 'Jõgeva 54'	18 a	3.0 a	3.4 a	3.90 a	0.70 b	1.17 a
White clover 'Jõgeva 4'	19 a	3.5 ab	3.5 a	5.00 abc	0.90 c	1.19 a

Note: means within columns followed by the same letter do not differ at $P = 0.05$

The number of inflorescences per plant ranged from 3.0 to 4.5 in 2002 and from 3.4 to 4.5 in 2003. In both years, no significant differences were observed. In the last experimental year the leaves per plant were counted. Different living mulches had no effect on number of leaves per plant.

The growth of herbaceous plants lasts from early spring to late autumn. Biomass production is low in the sowing year. In the second growing year (2002), biomass production varied from 0.62 to 8.09 kg (Table 2). The crop biomass of white clover was over 6 times higher than other living mulches. In 2003, the average biomass production of different mulches was 3.6 kg per plot. Highest biomass production was recorded on variant of white clover again, as in the previous year.

Table 2. Mulch biomass production per plot (6.3 m^2) in 2002–2003.

Living mulch	Biomass production, kg		Distribution of biomass production in 2003, kg		
	2002	2003	Before harvest	During harvest	After harvest
Natural grass cover	1.27 ab	1.95 a	1.06 a	0.36 a	0.53 a
Red fescue 'Kauni'	0.93 a	2.59 bc	1.37 ab	0.47 ab	0.67 ab
Red fescue 'Jõgeva 70'	1.32 ab	2.33 ab	1.28 ab	0.46 ab	0.69 ab
Perennial ryegrass 'Raidi'	1.30 ab	2.18 ab	1.24 ab	0.32 a	0.62 ab
Red fescue 'Waldorf'	0.62 a	2.87 c	1.47 b	0.51 ab	0.87 b
Orchardgrass 'Jõgeva 220'	1.81 b	2.65 bc	1.47 b	0.53 ab	0.63 ab
Kentucky bluegrass 'Esto'	1.22 ab	2.50 bc	1.43 b	0.49 ab	0.54 a
Timothy 'Tika'	1.04 ab	2.78 c	1.45 b	0.55 ab	0.68 ab
Timothy 'Jõgeva 54'	1.44 ab	2.67 bc	1.32 ab	0.57 b	0.69 ab
White clover 'Jõgeva 4'	8.09 c	5.40 d	2.30 c	1.28 c	1.47 c

Note: means within columns followed by the same letter do not differ at $P = 0.05$

50 to 60% of the biomass of different living mulches was mown before strawberry harvest. Comparing different mulches, it can be said that red fescue 'Waldorf', orchard grass, Kentucky bluegrass, timothy 'Tika' and white clover could be characterized by early and quick growth. The grass sward was mown once during strawberry harvesting and the differences of biomass production were smaller. Compared to natural grass cover, the biomass production was significantly higher in the following mulches: timothy 'Jõgeva 54' and white clover. After berry harvest the biomass of mown sward varied between 0.53 and 1.47 kg per plot. Compared to natural ground cover significantly higher biomass production was recorded on variants of white clover and red fescue 'Waldorf'. Compared to other grasses, white clover continued its intensive growth during and after the strawberry harvesting.

DISCUSSION AND CONCLUSIONS

The most basic types of limiting factors for plants are sunlight, water, temperature and soil. Long-term field experiments showed that in soddy-podzolic soils long-term application of fertilizers decreased humus content by 10–14%. This is caused because the organic matter accretion is lower than organic C dissolution and CO_2 efflux (Shevtsova & Volodarskaya, 1998). Growing grasses for several years may increase soil organic matter and accumulate mineralized soil nitrogen. Perennial grasses

produce biomass and add 40–120 kg N, 15–18 kg K and 8–15 kg P ha^{-1} into biological circulation in one year (Fokin, 1999). In the present trial, biomass production varied from 5–21 t ha^{-1} per covered sod during two growing years. White clover had the highest mulch biomass production compared to other living mulches. Organic matter which is accumulated by grasses is relatively quickly decomposed by soil biota. The decomposition of plant residues depends on the chemical composition of crop biomass. A general trend exists that high lignin content retards decomposition (Trofimov, 1997). Visual examination showed that crop residues of white clover decomposed faster and residues of orchard grass slower than other living mulches. The reason why white clover did not reduce strawberry yield might be related to its quick decomposition of above-ground biomass and ability to release symbiotically fixed nitrogen. Neuweiler et al. (2003) found that white clover living mulch decreased fruit yield significantly compared to bare ground, straw, black and white plastic mulch.

Living grass mulches influenced strawberry yield in our experiment. Higher yields were obtained from variants of timothy 'Tika', Kentucky bluegrass 'Esto' and red fescue 'Jõgeva 70'. Orchard grass, perennial ryegrass and timothy 'Tika' showed a negative influence on strawberry yield. Several contradictory reports can be found concerning the influence of perennial ryegrass living mulch on berry yield. For example, Newenhouse & Dana (1989) found that perennial ryegrass was best for strawberries. At the same time perennial ryegrass reduced berry yield on raspberries (Freyman, 1989).

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