The Effects of Living Mulches on Yield, Overwintering and Biological Value of Leek

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Abstract

In field study conducted in 1998-2001 leek cv. Arkansas was grown from seedlings planted on 10 June. Perennial ryegrass, white clover and hairy vetch used as the living mulches were sown between plant rows after 3, 5, 7, 9 and 11 weeks from the date of transplanting. Harvest of leek was conducted in October or in early April, after overwintering the plants in the field. In both terms samples of edible parts were collected for chemical analysis.

During autumn harvest the first two sowings of living mulches considerably reduced the leek biomass and marketable yield by 59.7 % and 31.0 %, respectively. Sowings delayed to 7, 9 and 11 weeks after transplanting did not adversely affect plant growth and yield of leek. The most competitive species for leek growth appeared to be hairy vetch, which sown 3 or 5 weeks after planting overtopped leek plants and caused heavy reduction of the yield. White clover and hairy vetch in treatments with first two sowings were the most preferable for leek overwintering.

Living mulches did not influence the content of dry matter, vitamin C, total and reducing sugars in edible parts of leeks. Plants harvested in spring season contained lower amounts of dry matter and total sugars, while higher level of reducing sugars.

INTRODUCTION

In many countries there is observed a growing interest in living mulches used in field vegetable crops production. They are recommended as an important part of an environmentally-sustainable system of crop production, which can reduce runoff and leaching of nutrients from the soil, cause considerable suppression of weeds and pest population and as a result of these provide smaller need for mineral fertilizers as well as herbicides and pesticides (Müller-Schärrer and Potter, 1991; Hormes, 1995; Masiunas, 1998). The other advantages of living mulches are the enrichment of the soil in organic matter (Koch, 1990) and improvement of some physical properties such as soil structure, moisture retention and reduction of soil compaction (Nicholson and Wien, 1983; Wiles et al., 1989; Poniedziaek and Stokowska, 1999). On the other hand they compete with vegetable crops for light, moisture and nutrients and for this reason often reduce the yield of vegetables (Shennan, 1992; Bottenberg et al., 1997; Brandsaeter et al., 1998; Henning, 1998). However, in some of the studies high yields and good quality crop in growing such species as cabbage, broccoli, pepper and sweet corn was obtained (Finch, 1993; Guldan et al., 1996; Infante and Morse, 1996; Starck et al., 1996), especially if white clover as a living mulch was used. According to research conducted by Müller-Schärrer et al. (1992) a satisfactory yield of leek may be received in growing together with perennial ryegrass sown not earlier then 5 weeks after transplanting. Till now there are not indications in the literature upon the impact of cover crops on composition of leek crop and plant overwintering in the open field conditions.

The aim of the present study was to evaluate the effect of living mulches on yield of leek in autumn and spring harvest as well as composition of plants in both terms of harvest.

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MATERIAL AND METHODS

A field study was arranged in 1998-2001 at Piastów Horticultural Experimental Station on a sandy clay soil with 1,8 % organic matter and pH in H_2O 7.2.

Leek cv. Arkansas was grown from bare-root transplants produced in high plastic tunnel. Seed sowing was done on 26-27 March by using 5 g seeds per 1 m^2 of the seed-bed. Well developed seedlings with 3-4 true leaves were planted in the field on 10 of June in spacing 50 x 50 cm. Preplant phosphorus and potassium fertilization was applied in the amounts required to assure the recommended standard level of these nutrients in the soil equal to 100 mg available P and 200 mg K per 1 dm^3 of the soil. Nitrogen fertilization was split: 100 kg N ha^{-1} was supplied before planting and similar dose used as top dressing at the end of July.

Species used as the living mulches: perennial ryegrass (*Lolium perenne*), white clover (*Trifolim repens*) and hairy vetch (*Vicia villosa*) were sown between leek rows after 3, 5, 7, 9 and 11 weeks from the date of planting. White clover and ryegrass were sown in the amounts of 5 g seeds per 1 m^2, while hairy vetch - 10 g m^{-2}. The experiment was arranged in two factorial design in four replications and plot area 15 m^2.

All treatments were kept weed free till sowing the living mulches by hoeing the inter-row stripes and hand weeding the leek rows, while thereafter plants were grown without any weed control. The other crop management operations were carried out following the commonly accepted recommendations for this species.

Harvest of leeks was conducted in the last week of October from half of the plots area and in early April, after overwintering in the field from the other part of the plots. In both terms samples of edible parts of leeks were collected for evaluation the contents of dry matter, vitamin C, total and reducing sugars (Drzazga, 1974).

Data of the study concerning marketable yield, included plants with stem diameter >1.5 cm were analyzed by standard statistical procedure of two factorial design and least significant differences calculated by Tukey's test for $\alpha = 0.05$.

RESULTS AND DISCUSSION

Results of the field study shown as the means for three years (Table 1) indicated that during autumn harvest the marketable yield was greatly dependent on the time of sowing the living mulches, but not significant differences were observed among plant species used for this purpose. The first two sowings conducted after 3 and 5 weeks from the date of transplanting highly restricted plant growth and as a consequence of this there was a drop of final leek yield by 59.7 % and 31.0 %, respectively. Sowing delayed to 7, 9 and 11 weeks after planting did not adversely affect plant growth and leek yield. This statement is in agreement with our previous work (Kolota and Biesiada, 1991) devoted to disadvantageous effects of weed competition for leeks, in which we found that the critical period of weed infestation lasted up to 7 weeks from transplanting. Weeds emerging in the later stages of plants growth did not have a harmful effect on leek yield and quality of the crop.

Significant interaction was observed between plant species used as the living mulches and time of their sowing in the field. Long period of competition lasted since 3 or 5 weeks after transplanting was a little more disadvantageous for leek growth in the case of using the perennial ryegrass in comparison to white clover. According to the data from the literature (Müller-Schärrer et al., 1992; M.K., 1993) sowing both this species in leek production should not be done earlier than 5 weeks after planting. The most competitive species for leek growth appeared to be hairy vetch, which sown 3 and 5 weeks after planting overtopped leek plants and caused heavy yield reduction by 91.3 % and 41.3 %. It means that this species can be used as cover crop for leeks only in the case if sowing will take place 7 weeks or later after transplanting.

The adverse effect of early sowing the living mulches on leek yield maintained also during harvest in spring season in 1999-2001. The presence of white clover created better conditions for leek overwintering than other mulches. On the average for all terms of sowing the participation of spring yield in that received in autumn on plots with white

clover amounted 83.4 % (Table 2), while for other species ranged within 70.5 - 72.0 %. As the most preferable for leek overwintering conditions, it appeared to be treatments with hairy vetch and white clover sown 3 or 5 weeks after planting date.

Chemical plant analysis showed (Table 3-4) that living mulches did not influence the contents of dry matter, vitamin C, total and reducing sugars in edible part of leeks. The only exception was a considerable lower content of dry matter and vitamin C in plants grown together with hairy vetch sown 3 and 5 weeks after leek transplanting, in both terms of harvest.

The major factor influencing plant composition appeared to be the period of leek harvest. Irrespective of the kind of living mulch and date of sowing, plants harvested in autumn season contained 18.95 % of dry matter, while after overwintering this level dropped to 13.20 %. The amount of total sugars decreased from 7.94 % to 6.58 %, while reducing sugars increased during that period of time from 2.54 % to 4.58 %. Vitamin C content changed very little in plants left in the field throughout the winter season. This finding is generally in agreement with our previous studies (Kolota and Adamczewska-Sowińska, 1996; Adamczewska-Sowińska and Kolota, 2001), which proved that some frost resistant cultivars like Arkansas contained similar or even higher level of this compound in early spring harvest. However, a considerable drop of its amounts in overwintering plants can be expected in frost susceptible cultivars.

As a conclusion, results of this study show that high yield of a good quality leeks crop may be obtained if living mulches will be sown not earlier than 7 weeks after transplanting. White clover and perennial ryegrass as less completive species are being recognized as more suitable for this purpose than hairy vetch. Presence of hairy vetch and white clover reduced frost damage of leek plants left for the winter season in the open field.

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Tables

Table 1. The effects of cover crops on marketable yield of leek harvested in autumn and spring season (mean for 1998-2001 in t ha^{-1}).

Sowing term of cover crops (in weeks from the date of leek transplanting)	Autumn harvest				Spring harvest			
	perennial ryegrass	white clover	hairy vetch	mean	perennial ryegrass	white clover	hairy vetch	mean
3	11.96	13.57	1.98	9.17	8.21	11.91	2.53	7.55
5	15.81	17.98	13.38	15.72	11.04	16.66	12.43	13.38
7	20.29	22.16	21.87	21.44	14.09	16.90	15.51	15.50
9	19.68	21.97	23.84	21.83	14.24	18.29	15.28	15.94
11	22.15	23.10	25.94	23.73	15.83	18.60	16.90	17.11
Mean	17.98	19.76	17.40	18.38	12.69	16.47	12.53	13.90
Control without cover crop				22.78				17.10
LSD α = 0.05 for: kind of cover crop				n.s				
sowing term of cover crop				2.58				1.44
interaction I x II				4.54				2.02
								2.50

Table 2. The effects of cover crops on overwintering of leeks (mean for 1998-2001).

Sowing term of cover crops (in weeks from the date of leeks transplanting)	Percentage of spring yield in autumn harvested yield			
	perennial ryegrass	white clover	hairy vetch	mean
3	68.6	87.8	127.7	82.3
5	69.8	92.7	92.9	85.1
7	69.4	76.3	70.9	72.3
9	72.4	83.2	64.1	73.0
11	71.5	80.5	65.2	72.1
Mean	70.5	83.4	72.0	75.6
Control without cover crop				75.1

Table 3. The effect of living mulches on dry matter and vitamin C contents on leeks harvested in autumn and spring season.

Sowing term of living mulches (in weeks from the date of leek planting)	Autumn harvest				Spring harvest			
	perennial ryegrass	white clover	hairy vetch	mean	perennial ryegrass	white clover	hairy vetch	mean
				Dry matter (%)				
3	19.77	20.07	16.82	18.89	14.13	12.05	10.37	12.18
5	19.44	19.56	16.93	18.64	14.97	14.93	11.42	13.77
7	19.83	19.84	19.29	19.65	13.00	12.06	14.24	13.10
9	20.63	19.40	17.94	19.32	14.33	12.97	12.98	13.43
11	18.38	17.83	18.61	18.27	13.27	13.62	13.69	13.53
Mean	19.60	19.34	17.92	18.95	13.94	13.12	12.54	13.20
Control without living mulch				18.59				12.36
				Vitamin C (mg %)				
3	22.10	27.21	21.47	23.59	34.27	24.75	23.25	27.42
5	26.74	29.34	22.65	26.24	27.39	23.92	24.71	25.34
7	27.16	27.78	24.21	26.38	27.08	27.03	29.52	27.88
9	29.69	31.33	32.77	31.26	28.62	24.04	27.86	26.84
11	27.04	30.75	29.92	29.24	32.42	27.93	30.47	30.27
Mean	26.55	29.28	26.20	27.34	29.95	25.53	27.16	27.55
Control without living mulch				27.46				28.09

Table 4. The effect of living mulches on total and reducing sugar contents in leeks harvested in autumn and spring season (% d.m.).

Sowing term of living mulches (in weeks from the date of leek planting)	Autumn harvest				Spring harvest			
	perennial ryegrass	white clover	hairy vetch	mean	perennial ryegrass	white clover	hairy vetch	mean
				Total sugars				
3	8.61	8.25	7.00	7.95	7.05	6.12	6.19	6.45
5	8.11	7.42	6.55	7.36	6.64	6.87	6.65	6.72
7	8.65	7.28	7.15	7.69	6.62	6.59	6.44	6.55
9	8.56	8.53	7.79	8.29	6.47	6.45	6.67	6.53
11	8.82	8.33	8.10	8.42	6.83	6.49	6.62	6.65
Mean	8.55	7.96	7.32	7.94	6.72	6.50	6.51	6.58
Control without living mulch				8.13				6.01
				Reducing sugars				
3	2.55	2.73	2.42	2.57	4.69	4.66	4.42	4.59
5	2.48	2.46	2.62	2.52	4.60	4.64	5.04	4.76
7	2.41	2.51	2.63	2.52	4.38	4.58	4.60	4.52
9	2.40	2.72	2.47	2.53	4.36	4.78	4.38	4.51
11	2.40	2.63	2.64	2.56	4.57	4.60	4.45	4.54
Mean	2.45	2.61	2.56	2.54	4.52	4.65	4.58	4.58
Control without living mulch				2.61				4.54