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The influence of meteorological conditions on the growth and yielding of leek cultivated in living mulches

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ABSTRACT

Five living mulch treatments were investigated: white clover, mulch of white clover desiccated in mid July by Roundup, black medic, rye, and the mixture of living mulches of rye and white clover which were compared to two controls: weeded permanently and twice time weeded. The experiment was conducted on brown soil developed on loess. Living mulches were sown in the middle of April in 50 cm wide strips. Leek 'Lancelot' was transplanted on 17 May in bare ground rows in the spacing of 62.5 × 20 cm. During vegetative period mean monthly air temperature and total precipitation were assessed at meteorological station situated next to the experimental plots. The amount of water available for plants was determined by soil moisture meter. The highest leek yielding was observed in the

year 2000, when neither the temperature nor the rainfall were unfavorably distributed during the vegetation. In the months with both high temperature and precipitation mulches were mown twice (in very warm and extremely humid June 1999 and July 2001). The differences in available water between the mulched object increased during the minimal or no rainfall times. Living mulches decreased leek height, the fact that was especially evident during the measurements done at harvest. In result of limiting leek's vegetative growth by mulching shaft, the weight and length decreased. Living mulches decreased leek yielding. Mulch of white clover decreased total and marketable leek yield the least, whereas mulches with rye the most. Desiccating white clover by Roundup decreased total and marketable leek yield by 11 and 18 percent respectively in comparison with objects were white clover was mowed. Mulch of white clover desiccated by Roundup and mulch of mixture of rye and white clover significantly lowered dry matter and total sugar content in shaft according to the control objects.

INTRODUCTION

An increased competition among combinations of certain crops results in reduced yield what may eliminate some species from living mulch system (Carruthers et al. 2000). Therefore the selection of proper main crop suitable for living mulches is particularly important. There are several factors that predispose leek for the mulching system. Species recommended for mulching are cultivated from transplants and are characterized with a long vegetative period (Masiunas 1998, Kołota and Adamczewska-Sowińska 1999). Secondly, leek favors organic nutrition and living mulches provide organic matter to soil. Moreover leek, unlike other vegetables, is not vulnerable to water deficiency at the beginning of the vegetation. In view of the slow growth 30% of field water capacity is sufficient for it (Kołota 1997). Low sensitivity on competition by first 3-5 weeks of vegetation favors leek cultivation in mulching systems (Kołota 1997). Leek critical sensitivity on weed infestation falls to 5-7 week since transplanting. In this time mulches should be mowed in order to minimize their competition. Kołota and Adamczewska-Sowińska (2002) suggest delayed sowing term of mulches. They found that delaying sowing term of living mulches to 7, 9 and 11 weeks after leek transplanting did not decrease leek yielding.

The influence of mulch on crop yield and its quality highly depends on climatic conditions. Temperature or rainfalls simultaneously affect the interaction and competitiveness between mulching components. Plants sown in inter-strips can store water, therefore improve soil water conditions but only when proper rainfall distribution is provided (Poniedziałek and Kunicki 1995). In the situation of insufficient rainfall, mulches compete for water, causing yield decrease. Therefore

Wortmann et al. (2000) recommend additional irrigation in mulched cultivations. On the other hand, mulches reduce water evaporation by increasing infiltration which results in higher soil humidity (Bottenberg et al. 1997).

Temperature characteristics processed by Ziernicka (2001) together with precipitation characteristics by Kaczorowska (1962) allow objective specification of the months in south-east part of Poland and may be helpful in explaining dependences in mulched cultivations.

The aim of the investigation was to estimate the influence of living mulches of white clover, black medic and rye on leek vegetation and yielding on the ground of meteorological factors.

MATERIAL AND METHODS

The investigation was carried out in 1999 – 2001 in Garlica Murowana near Kraków, Poland on brown soil developed on loess. A randomized block design was used in four replications on 6.3 m^2 plots. The combinations of the experiment included five living mulch treatments which were compared to two controls: control weeded permanently, control twice time weeded, living mulch of white clover (*Trifolium repens* L.), mulch of white clover desiccated in mid July by Roundup 360 SL (4 l ha^{-1}), living mulch of black medic (*Medicago lupulina* L.), mixture of living mulches of rye and white clover, living mulch of rye (*Secale cereale* L.). Living mulches were sown in the middle of April in a rate of: white clover and black medic 10 kg ha^{-1}, rye 100 kg ha^{-1}, mixture consisted of 60 kg ha^{-1} rye and 10 kg ha^{-1} white clover. Mulches were sown in 50 cm wide strips. Leek 'Lancelot' was transplanted on 17 May in bare ground rows in spacing of 62.5 × 20 cm. The nutrients were supplemented to the level of 200 kg ha^{-1} N, 360 kg ha^{-1} P_2O_5, 290 kg ha^{-1} K_2O. During vegetative period mean monthly air temperature and total precipitation were assessed at meteorological station in Garlica Murowana. The amount of water available for plants was determined by soil moisture meter. In order to minimize competition, living mulches were four-times mown, leaving the crop on the plots. In 1999 mowing was executed on 10 June, 6 July, 22 July, 9 August, in 2000 on: 19 June, 30 June, 26 July, 21 August, and in 2001 on: 18 June, 5 July, 28 July, and 21 August. During vegetation period the height of leek plants was measured twice: in mid vegetation and at harvest time. Leek was harvested at the end of September, than the total and marketable yield was assessed and measurements of mean leek weight, shaft length and diameter were performed. The content of dry matter and total sugar (colorimetric method with antron) was assessed. The results were statistically verified using analysis of variance, the significant differences were evaluated using Student t test at $p = 0.05$.

RESULTS AND DISCUSSION

Low thermal demands of leek were completely alleviated in all three years of the experiment. Leek, a plant of moderate climate, requires 15-20°C during vegetation (Kołota 1997). Mean monthly temperatures during leek vegetation ranged within the required limits (Table 1). In 2001, according to earlier years, lower temperatures of May and June were observed, the fact that was manifested in braking of leek growth. Plants height, weight as well as shaft diameter in the control objects in this year were lower. As far as pulse plants are concerned, in all three years of investigation, temperatures of April favored quick emergence and initial plants growth. Temperature distribution is decisive for the length of development stages. Higher temperature shortness length because shoots growth quicker, whereas the lower one prolongs it (Jasińska and Kotecki 1999). In comparison with white clover black medic has higher temperature demands. Optimal temperature of May and June oscillate about 20°C (Jasińska and Kotecki 1999), that may explain its weaker growth. Especially June 2001 according to Ziernicka (2001), turned out to be very cold (14.3°C), that contributed to the limitation of mulches growth and delayed mowing. In July – extremely warm in 1999 (20.8°C) and very warm in 2001 (19.0°C), the number of mulches mowing increased to two. As far as rye is considered in all years of the investigation the temperatures favored its growth and development.

Table 1. Mean monthly temperature during leek vegetation (°C) in the years of the investigation and its characteristics according to Ziernicka (2001)

Month	1999	Characteristics	2000	Characteristics	2001	Characteristics
April	11.0	very warm	11.9	extremely warm	7.7	normal
May	14.2	warm	15.1	very warm	14.4	warm
June	17.9	very warm	16.7	normal	14.3	very cold
July	20.8	extremely warm	16.4	cold	19.0	very warm
August	18.1	warm	18.8	extremely warm	18.6	very warm
September	16.8	extremely warm	11.8	cold	11.3	cold

Water demands of leek are high, about 500 mm of rainfall, properly distributed during vegetation (Kołota and Adamczewska-Sowińska 2000). The most suitable conditions were in the year 2001, due to the fact that July and September were extremely humid and August humid (Table 2). The most unfavorable precipitation was observed in 1999, when July and September were moderate and August, the time when water demands of plants are the highest, was dry. In the year 2000, July was extremely humid, August moderate and September dry. Both in 1999 and 2000

the total sum of precipitation was lower than required 500 mm. When examining leek growth and yielding against the two factors: temperature and precipitation, mutual influences are visible. The year 1999 had best temperature distribution but precipitation was the worst. In the year 2001 inverse, the distribution of precipitation was the most favorable for leek but temperature distribution was the worst. Finally, the highest leek yielding (Table 5) was observed in 2000, when neither temperature nor rainfall were unfavorably distributed during vegetation.

Table 2. Monthly precipitation during leek vegetation (mm) in the years of the investigation and its characteristics according to Kaczorowska (1962)

Month	1999	Characteristics	2000	Characteristics	2001	Characteristics
April	45.9	intermediate	10.3	extremely dry	100.4	extremely humid
May	32.0	very dry	77.9	intermediate	60.1	intermediate
June	167.1	extremely humid	80.1	intermediate	83.6	intermediate
July	70.1	intermediate	198.7	extremely humid	199.6	extremely humid
August	43.6	dry	67.8	intermediate	123.2	humid
September	50.9	intermediate	30.4	dry	111.6	extremely humid

The highest water demands of white clover and black medic are observed in the stage of quick growth of plant biomass (Jasińska and Kotecki 1999). In each of the three years of the investigation precipitation distribution was favorable for pulse plants. Except extremely humid April 2000 and very dry May 1999, according to Kaczorowska (1962) the remaining months are classified as intermediate or humid. Water deficiencies at the beginning of the vegetation period probably equalized considerable amounts of water cumulated during winter. According to Jasińska and Kotecki (1999) white clover and black medic regrow rapidly and their biomass in succeeding swaths depend on water availability. In the months with high sum of rainfall mulches were twice mown (in extremely humid June 1999 and July 2001). Rye ratio transpiration is low, therefore it has economical water management. Optimal rainfall, before sowing and straight afterwards, equals to 16-18 mm in ten days what guarantees quick and uniform germination (Jasińska and Kotecki 1999). Such demands have been satisfied only in 2001. In 1999 and 2000 the sum of precipitation in April was low. During May and June rye water demands increased to 140 mm (Jasińska and Kotecki 1999). In every year of the investigation sum the of precipitation was higher than minimum.

Meteorological conditions, especially precipitation and mulch species may modify soil water availability (Morse 1993, Abdin et al. 2000, Wortmann et al.

2000). In 2000 at the beginning of the vegetation when all mulches were weakly spread (from the second decade of May till the first decade of June) the differences in soil moisture were small (Figs 1 and 2). While mulches started to expand the contrast in soil moisture in the objects increased. This confirms the results of Drost and Price (1991). In their experiment, the differences between mulched objects appeared 30 days after planting in result of reduced evaporation and improved infiltration by mulches.

Wortman et al. (2000) stated that soil humidity depends on mulches biomass and rooting habits. That was confirmed in the present investigation. Mulches with rye with strong root system, decreased soil moisture to the third decade of June 2000 and the second decade of June 2001 the most.

According to Wortmann et al. (2000) differences between mulched objects increase during minimal or no rainfall times, what was confirmed in the present experiment.

Drost and Price (1991) suggest early desiccation of the growing mulch in the years of low rainfall, to minimize soil moisture depletion.

Living mulches limit leek vegetative growth (Table 3). According to Kołota (1997) leek critical vulnerability period on other plants (i.e. mulch or weeds) falls between the fifth and seventh week after transplanting. In the present experiment, first mowing was executed in the fifth week after transplanting so before critical vulnerability period. That explained why differences between mulched and not mulched objects were slight untill mid vegetation. Measurement done at harvest time showed much bigger differences in the height of leeks from mulched and control objects. The present investigation confirmed that crop vegetative growth depends on the type of mulch what had been observed by numerous authors (Weston 1996, Masiunas et al. 1997, Winiarska and Kołota 2003). White clover and black medic living mulch decreased leek height lower (by 10-16% respectively) than mulch of rye (by 23%).

In consequence of leek vegetative growth limitation shaft weight decreased (Table 4). Shaft weight depends not only on the species of mulch but also on the year of investigation. The greatest differences in shaft weight of mulched leeks in comparison with the control weeded permanently were observed in 1999, when the weight lowered by 183.5 g for all mulched objects. In 2000 the weight was lower by 149.5 g and in 2001 the difference was the smallest (40.7 g).

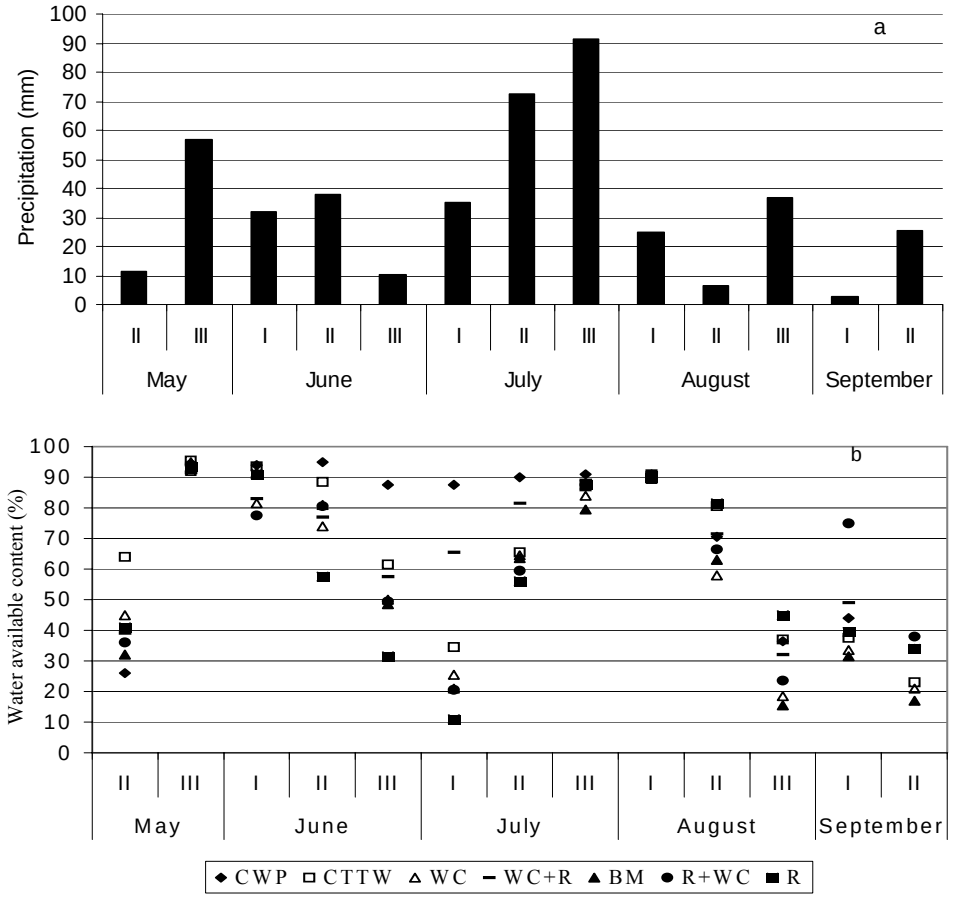

Fig. 1. The 10-days precipitation in 2000 (a) and the influence of living mulches on the content of available water (b)

CWP – Control weeded permanently; CTTW – Control twice time weeded; WC – White clover; WC+R – White clover desiccated with Roundup; BM – Black medic; R+WC – Rye with White clover; R – rye

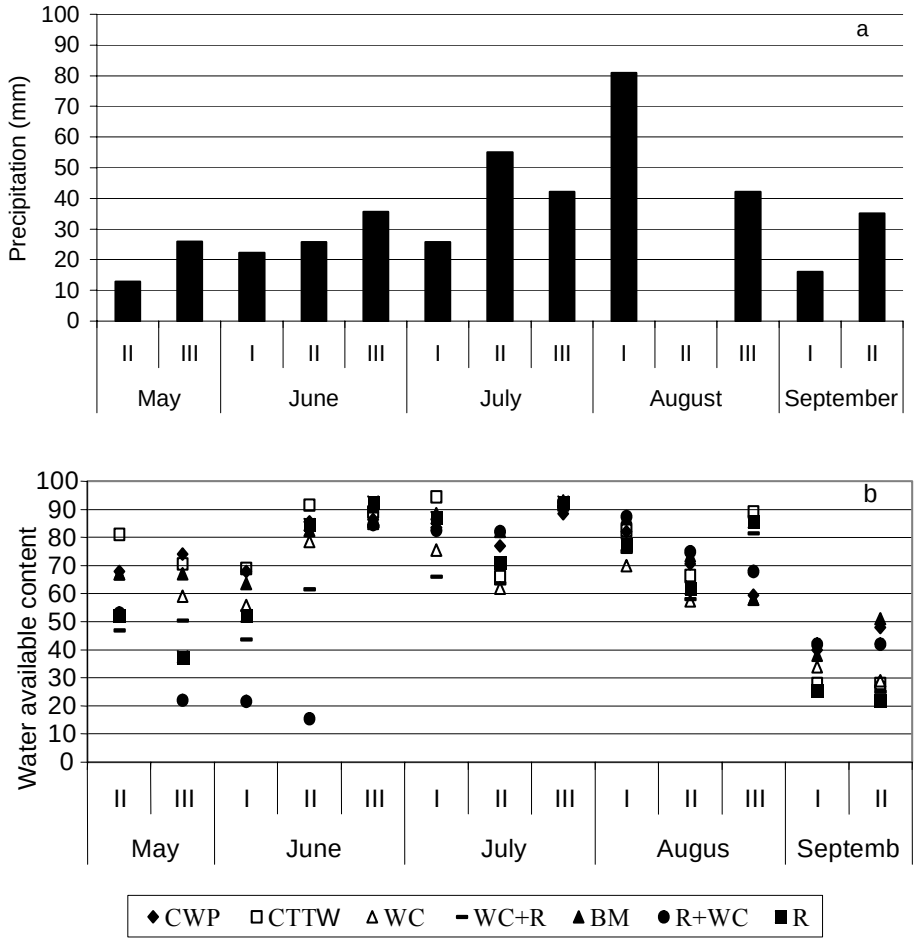

Fig. 2. The 10-days precipitation in 2001 (a) and the influence of living mulches on the content of available water (b)
Explanation: see fig. 1.

Table 3. The influence of living mulches on leek height (cm)

Objects	1999	2000	2001	Mean for years
	Intensive vegetative growth			
Control weeded permanently	65 c	66 b	52 bc	61 b
Control twice time weeded	60 bc	67 b	54 c	60 b
White clover	62 bc	64 b	52 bc	59 b
White clover with Roundup	57 b	57 a	41 a	52 a
Black medic	57 b	66 b	56 c	60 b
Rye+White clover	50 a	62 ab	41 a	51 a
Rye	46 a	60 ab	48 b	51 a
	Harvest time			
Control weeded permanently	103 d	104 c	79 c	95 d
Control twice time weeded	96 c	94 b	83 c	91 cd
White clover	91 bc	91 ab	60 a	80 ab
White clover with Roundup	86 b	87 a	63 ab	79 ab
Black medic	89 b	90 ab	77 c	85 bc
Rye+White clover	78 a	88 ab	68 b	78 ab
Rye	72 a	87 ab	60 a	73 a

The assumption that mulches may lengthen white part of shaft has not been confirmed at least in strip tillage system. Positive influence on shaft length was observed in neither year, on the contrary, leeks mulched with rye created shorter white part of shaft (14.4 cm) than leeks from control weeded objects. In the objects mulched with white clover, black medic and the mixture of rye and white clover the length of shaft was at the same significance level as in the plants of weeded control (16.0-16.8 cm).

Shaft diameter turned out to be an established feature, not dependent on mulching (Table 4). With exception of 1999, all mulches led to the lowering of shaft diameter, in other years there were no differences between the objects observed.

The limitation of leek vegetative growth decreased yielding (Table 5). According to Kołota and Adamczewska-Sowińska (2000) leek harvested in autumn yields 35 t ha^{-1}. In the present investigation total leek yield from weeded control equaled to 38.2 t ha^{-1} and in mulched objects significantly decreased and varied from 20.9 t ha^{-1} in the objects mulched with rye to 26.5 t ha^{-1} in objects mulched with white clover. Living mulches reduced marketable yield of leek, what was especially evident in 1999. The first class of marketable yield of leek from the objects without mulching equals to 35.7 t ha^{-1}. Living mulch of white clover decreased first class marketable leek yield the least (20.8 t ha^{-1}), whereas mulches with rye the most (15.4 t ha^{-1}).

The decrease of 11% of the total yield and 18% of the marketable yield was observed when mulch of white clover was desiccated by Roundup in comparison with the mowed objects.

Living mulch of white clover decreased leek yielding the least. This corresponds with the observations of Winiarska and Kołota (2003). Authors comparing living mulches of white clover, common seradella and winter rape demonstrated highest suitability of the first one as the living mulch in leek production. In the investigation of Kołota and Adamczewska-Sowińska (1999) no influence of mulch species on leek growth and yielding was observed, whereas the term of mulch sowing was significant. The highest leek yield was observed when sowing of mulch was performed 11 weeks after transplanting.

According to Masiunas (1998), mixtures of *Fabaceae* and cereal plants used as mulches have greater influence than every mulch alone. In the present investigation the mulch of the mixture of white clover and rye did not influence the marketable yield, which was equal to the one obtained from objects of mulched rye alone but lowered the yield obtained from the objects mulched with white clover alone.

Table 4. The influence of living mulches on selected morphological leek features

Objects	1999	2000	2001	Mean for years
		Weight (g)		
Control weeded permanently	404.8 c	512.5 c	316.1 b	411.1 b
Control twice time weeded	401.6 c	432.0 b	296.2 ab	376.6 b
White clover	250.3 b	357.5 a	268.6 ab	292.1 a
White clover with Roundup	232.8 ab	382.5 ab	298.0 ab	304.5 a
Black medic	247.4 ab	369.5 a	249.4 a	288.8 a
Rye+White clover	209.0 ab	361.6 a	252.7 a	274.4 a
Rye	192.4 a	343.8 a	256.2 a	264.1 a
		Shaft length (cm)		
Control weeded permanently	16.6 a	17.1 ab	16.5 d	16.7 d
Control twice time weeded	16.5 a	16.6 ab	12.2 ab	15.1 abc
White clover	17.0 a	17.7 ab	15.3 cd	16.7 d
White clover with Roundup	15.7 a	15.3 a	13.6 abc	14.9 ab
Black medic	15.9 a	18.6 b	14.4 bcd	16.3 cd
Rye+White clover	15.4 a	17.0 ab	15.6 cd	16.0 bcd
Rye	15.1 a	16.3 ab	11.7 a	14.4 a
		Shaft diametter (cm)		
Control weeded permanently	5.4 b	4.5 a	3.5 a	4.5 b
Control twice time weeded	3.7 a	3.9 a	3.3 a	3.6 a
White clover	3.1 a	4.0 a	3.3 a	3.5 a
White clover with Roundup	3.0 a	3.9 a	3.4 a	3.4 a
Black medic	3.0 a	3.8 a	2.9 a	3.2 a
Rye+White clover	2.9 a	3.9 a	2.7 a	3.2 a
Rye	2.9 a	3.7 a	3.0 a	3.2 a

Table 5. The influence of living mulches on leek yielding (t ha^{-1})

Objects	1999	2000	2001	Mean for years
		Total yield		
Control weeded permanently	33.34 c	42.94 d	38.35 c	38.21 e
Control twice time weeded	31.44 c	35.94 c	34.07 c	33.82 d
White clover	20.30 b	33.02 bc	26.25 b	26.52 c
White clover with Roundup	18.10 ab	27.75 a	24.63 ab	23.49 ab
Black medic	19.11 ab	29.86 a	24.64 ab	24.54 bc
Rye+White clover	15.62 a	30.37 ab	21.98 ab	22.66 ab
Rye	14.74 a	27.59 a	20.35 a	20.89 a
		Marketable yield I class		
Control weeded permanently	29.15 c	40.72 d	37.23 c	35.70 c
Control twice time weeded	25.78 c	33.32 c	32.18 c	30.43 c
White clover	12.24 b	28.82 bc	21.42 b	20.83 b
White clover with Roundup	8.82 ab	22.68 a	19.69 b	17.07 ab
Black medic	11.73 b	26.54 ab	19.26 b	19.18 ab
Rye+White clover	6.15 a	26.57 ab	12.74 a	15.15 a
Rye	3.92 a	25.52 ab	17.69 ab	15.71 ab
		Marketable yield II class		
Control weeded permanently	2.62 b	0.59 a	0.63 a	1.28 ab
Control twice time weeded	1.16 a	0.42 a	0.84 a	0.81 a
White clover	2.72 b	0.62 a	1.48 a	1.61 b
White clover with Roundup	2.99 b	0.93 a	1.18 a	1.70 b
Black medic	3.03 b	0.61 a	0.84 a	1.50 ab
Rye+White clover	3.73 b	0.90 a	1.21 a	1.95 b
Rye	3.83 b	0.32 a	0.83 a	1.67 b

The mean dry matter content in leeks shaft ranged from 12.34% to 14.28% (Table 6). The highest one, comparable to the content from the control objects, was found in the leeks mulched with black medic and rye (13.97% and 13.33% respectively). Mulch of white clover desiccated with herbicide and mulch of the mixture of rye and white clover significantly lowered dry matter content in shaft as compared to the control objects (12.34% and 12.41%). Winiarska and Kołota (2003) stressed the influence of mulch species and the date of its sowing on dry matter content in shaft. The authors found out highest dry matter content in leeks mulched with common seradella in comparison the ones mulched with white clover and winter rape. They observed that delaying living mulch sowing time to 7 and 9 weeks after leek transplanting boost dry matter in shaft.

Table 6. The influence of living mulches on dry matter and total sugar content in shaft (% f.w.)

Objects	1999	2000	2001	Mean for years
		Dry matter		
Control weeded permanently	14.26 cd	15.08 a	11.74 b	13.69 bc
Control twice time weeded	15.04 d	16.57 a	11.23 ab	14.28 c
White clover	12.67 abc	15.29 a	10.87 ab	12.94 ab
White clover with Roundup	11.11 a	15.71 a	10.19 ab	12.34 a
Black medic	14.51 d	15.90 a	11.49 b	13.97 bc
Rye+White clover	12.11 ab	15.44 a	9.67 a	12.41 a
Rye	13.24 bcd	15.79 a	10.96 ab	13.33 abc
		Total sugar		
Control weeded permanently	7.42 cd	8.28 ab	5.76 b	7.15 c
Control twice time weeded	8.52 d	9.33 b	5.36 b	7.74 c
White clover	6.55 abc	9.27 ab	5.27 ab	7.03 bc
White clover with Roundup	5.47 a	8.10 a	4.70 ab	6.09 a
Black medic	7.46 cd	9.34 b	5.40 b	7.40 c
Rye+White clover	6.12 ab	8.95 ab	4.07 a	6.38 ab
Rye	7.06 bc	9.30 ab	4.90 ab	7.09 c

The total sugar content in the objects mulched with black medic (7.40%), white clover (7.03%) and rye (7.09%) maintained at the level of the control objects (7.15%). Desiccating mulch of white clover by Roundup 360 SL influenced total sugar decrease by 13% in comparison with the objects where white clover was mowed. The positive effect of green manures with *Fabaceae* plants on total sugar content was observed by Jabłońska-Ceglarek et al. (2003). The authors found significantly more total sugars in cabbage cultivated after the vetch catch crop than after farmyard manure. In the investigations of Winiarska and Kołota (2003) total sugar content in leek depended on the species of living mulch, the least sugar was found in leek mulched with white clover (9.61%) and the highest – with common seradella (9.98%).

CONCLUSIONS

- The highest leek yielding was observed in 2000, where both temperature and rainfall were favorably distributed during vegetation.
- Differences in available water between mulched object increased during minimal or no rainfall times.
- Living mulches decreased leek height what was especially evident during measurements done at harvest time.
- In result of limitation of leek vegetative growth by mulching shaft weight and length decreased.

– Living mulches decreased leek yielding. Mulch of white clover decreased total and marketable leek yield the least, whereas mulches with rye the most.
– Desiccating white clover with Roundup decreased by 11% total and by 18% marketable leek yield in comparison with the objects from mowed white clover.
– Mulch of white clover desiccated with Roundup and mulch of mixture of rye and white clover significantly lowered dry matter and total sugars content in shaft according to the control objects.

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WPŁYW WARUNKÓW METEOROLOGICZNYCH NA WZROST I PLONOWANIE PORA UPRAWIANEGO W ŻYWYCH ŚCIÓŁKACH

Streszczenie: Obiekty doświadczenia stanowiły: kontrola odchwaszczana regularnie oraz kontrola z opóźnionym pieleniem, odchwaszczana dwukrotnie, a także pięć kombinacji różniących się rodzajem żywej ściółki: koniczyna biała, koniczyna zniszczona w połowie lipca herbicydem, lucerna chmielowa, mieszanka żyta z koniczyną oraz żyto zwyczajne. Badania prowadzono na glebie brunatnej, wytworzonej na lessie. Nasiona roślin ściółkujących glebę wysiano w połowie kwietnia, w pasach szerokości 50 cm. Por odmiany 'Lancelot' wysadzano 17 maja w rzędach bez ściółki, w rozstawie 62,5 × 20 cm. W sezonie wegetacyjnym, w stacji meteorologicznej w Garlicy Murowanej rejestrowano średnią temperaturę powietrza i sumę opadów. Wodę w glebie, dostępną dla roślin, oszacowano przy użyciu wilgotnościomierza cyfrowego. Najwyższy plon pora obserwowano w 2000 roku, w którym zarówno temperatura i opady były korzystnie rozłożone w sezonie wegetacyjnym. W miesiącach, w których zarówno temperatura i opady były wysokie dokonywano dwóch pokosów ściółek (w bardzo ciepłym i skrajnie

wilgotnym lipcu 1999 i czerwcu 2000). Różnice w ilości wody dostępnej dla roślin pomiędzy obiektami ściółkowanymi wzrastały w okresach bezdeszczowych lub z minimalnym opadem. Ściółki ograniczyły wzrost wegetatywny pora, co szczególnie było widoczne podczas pomiaru wykonanego w czasie zbioru. W efekcie ograniczenia wzrostu wegetatywnego pora przez żywe ściółki masa i długość części bielonej łodygi rzekomej były mniejsze niż w obiektach bez ściółkowania. Żywe ściółki ograniczyły plon ogółem i handlowy pora, najmniej ściółka z koniczyny białej, najbardziej ściółki z udziałem żyta. Niszczenie koniczyny herbicydem Roundup obniżyło o 11% plon ogółem, a o 18% plon handlowy w porównaniu z plonem z obiektów, gdzie koniczynę koszono. Ściółka z koniczyny białej desykowana Roundupem oraz mieszanka żyta z koniczyną istotnie obniżyły zawartość suchej masy i cukrów w łodydze rzekomej pora w porównaniu z obiektami kontrolnymi.

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