THE EFFECT OF AUTUMN HARVEST MANAGEMENT OF LUCERNE IN THE SEEDING YEAR ON THE YIELD IN THE FOLLOWING YEAR*

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The effect of autumn harvest management of two cultivars of lucerne (*Medicago sativa* L.) – Jarka and Europe in the seeding year on stand development before overwintering and dry matter yield (DMY) in the following year was studied in plot experiments in the years 2000 to 2002. The autumn cut in seeding year was done in three different terms of growing degree days from summer cut (in 630 GDD; 860 GDD and 980 GDD). The development of stands was evaluated by length of shoots before overwintering. The length of shoots in 630 GDD was significantly higher ($P < 0.05$) than in 860 and 980 GDD, respectively. The DMY of the first cut in the following production year was significantly higher in 630 GDD than in 980 GDD ($P < 0.01$). There were no affects of different terms of the second cut on dry mass yield (DMY). The total DMY (sum of the first and second cut) was significantly different in 630 GDD and 980 GDD ($P < 0.05$). In our results a year had a significant effect on both the cut and total DMY. The significant interaction "term vs. year" was showed in the second cut as well as in total DMY. The autumn cut management in the seeding year significantly influenced DMY in the following production year, mainly in the first cut. According to our opinion very long interval (18 weeks, 980 GDD) between summer and autumn cut in the seeding year is not suitable for significantly lower yield in the following year.

lucerne; autumn management; plant development; yield; growing degree day

INTRODUCTION

Many authors explain the influence of autumn harvest management of lucerne on stand development before overwintering and dry matter yield (DMY) in the following year. Frequently, these experiments are conducted in production years and under irrigation. Bagg (2003) mentioned that the subsequent second and third cuttings of lucerne may be in intervals of approximately 30 days (mid-bud) to 40 days (early flower) or more, depending on whether the goal is a high quality or maximum persistence and yield. The regrowth interval between the last summer harvest and the autumn harvest is for Dhont et al. (2004) the major determinant of lucerne persistence and spring regrowth. This minimum interval should be of seven weeks long (Petr et al., 1980; Edmisten et al., 1988). Bélanger et al. (1992) conclude that the autumn-harvesting management of lucerne should be based on the duration of the growth period between the last two harvests, instead of autumn rest period based on calendar dates. In Atlantic Canada, a minimum interval of 500 GDD between the two last harvests to maintain dry matter yield across several years was required (Bélanger et al., 1999).

Štráfelda and Velich (1987) recommended having stands with short stems before over wintering to achieve the persistence and yield in the following year. The term of autumn cutting is very important for optimal stem length. Hrušková (1988) mentioned that stems growing from crowns are the most important for lucerne regrowth after cutting particularly in the first year of vegetation. The stems from crowns represent almost 60–80% of dry matter yield of individual plants.

The interval between last summer and autumn cut has the influence on the yield in the following year. Very short interval can cause reduction of yield (Dhont et al., 2004). But the main factor on the yield in each year is the term of the first cut. Hrušková et al. (1987) and Dukić, Erić (1995) recommend the first harvest in the bud stage for good forage quality. The earlier cut causes a lower dry matter yield.

These principles of optimal autumn harvest management were not still full investigated in the seeding year, and remain to be determinant. Many authors recommended the minimal interval between the last summer and the autumn harvest approximately 6 or 7 weeks (Štráfelda, Velich, 1987; Bagg, 2003) but nothing has been published about the maximal interval. The aim of this work was to investigate the effect of different autumn harvest management with longer intervals between summer and autumn cut in the seeding year on stand development before overwintering and on dry matter yield (DMY) in the following year.

* This research was supported by Research Project MSM of Czech Republic No. 6046070901.

MATERIALS AND METHODS

The plot experiment was established in the field of the Research Station of the Faculty of Agrobiology, Food and Natural Resources (CUAP) in Červený Újezd on 10th April 2000 (Experiment I) and 15th April 2001 (Experiment II). Those experiments were established in split plot design with four replications and the harvest area of 10 m^{-2} per plots. Used cultivars were Jarka and Europe (quantity of seed sown 15 $kg.ha^{-1}$). The site characteristics are: 405 m above sea level (latitude: 50°04´ N, longitude: 14°10´ E). Prevailing soil type is clay loam orthic luvisol, kind of soil is medium with the neutral or slightly alkalic soil reaction. According to the agro-meteorological characteristics this place belongs from moderate to warm and mostly dry climatic area. The vegetation period is from 150 to 160 days, with mean annual temperature 7.7 °C throughout (30 years) long term normal and during the warm half-year 13.8 °C. The long-term total annual precipitation is 493 mm and 333 mm during the warm half-year.

There were two cuts in the seeding year. The second cut (autumn) was taken in three different terms (Table 1). The interval between summer and autumn harvest was based on cumulative growing degree-days (GDD). This parameter was calculated for each day using the maximum daily temperature (T_{max}), the minimum daily temperature (T_{min}), and the base temperature (T_{base}) as: GDD = (T_{max} + T_{min}) / 2 – T_{base}. The base temperature (T_{base}) is the temperature, below which development is zero, for lucerne is used T_{base} 5 °C (Bélanger et al., 1992; Dhont et al., 2004). The length of stems before overwintering was measured in the first week in December in both years. There were three cuts in the production year. The comparative dry matter yields (DMY) are from the first and second harvest because of three different terms of autumn cut in the production year. Results were statistically evaluated by multiple analyses of variance with interactions.

RESULTS AND DISCUSSION

Seeding year

Individual plants of lucerne have only short shoot before overwintering in all different terms of autumn cutting, as it was recommended by Štráfelda and Velich (1987). Plants in the first autumn cutting term (630 GDD) have significantly longer shoot over against 860 and 980 GDD (Fig. 1). The significant shortest shoots were evaluated in the third term (980 GDD). There were no significant differences by year and cultivar. The significant interaction was "term vs. year"

Table 1. Field operation by two experiments during the establishment year and the first production year. The autumn harvest in the establishment year was taken in 630, 860, 980 growing degree days (GDD) after the summer harvest

Establishment year			
		Experiment I	Experiment II
Establishment	Date	10 April 2000	15 April 2001
First harvest		26 July 2000	24 July 2001
Second harvest			
630 GDD		13 September 200 (620 GDD)*	11 September 2001 (641 GDD)
860 GDD		11 October 2000 (831 GDD)	17 October 2001 (892 GDD)
980 GDD		30 November 2000 (974 GDD)	30 November 2001 (985 GDD)
Production years			
First harvest	Date	31 May 2001	4 June 2002
Second harvest		19 July 2001	16 July 2002

* The intervals between summer and autumn harvest expressed in GDD

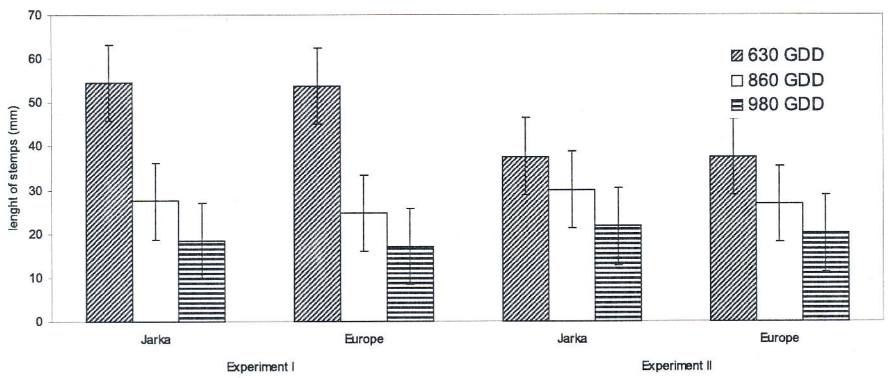

Figure 1. Length of stemps of two alfalfa cultivars, Jarka and Europe. Autumn harvest treatments were: 630, 860 or 980 GDD after the summer harvest, on 13 September, 11 October, 30 November 2000 by the Experiment I, 11 September, 17 October, 30 November 2001 by the Experiment II. Samples were taken after the 980 GDD harvest. Vertical bars indicate ± least significant difference (Tukey; $P < 0.05$)

(P 0.0069) where the significantly longer stems were at 630 GDD in the first year in comparison with 630 GDD in the second year. It can be caused by various developments of stands in individual years. Table 2 shows the number of days and GDD from each autumn cut to end of vegetation.

Production year

The terms of cuts in the first production year are shown in Table 1. The dry matter yields in the first cut were significantly influenced by term of autumn cut in the seeding year. There were no significant differences between cultivars (Table 3). Dhont et al. (2004) presented the similar results in production years. The significantly highest yield was observed on the plots in 630 GDD in comparison with 980 GDD. The period between summer harvest and first term of autumn cut was 7 weeks in both experiments. It is the minimal recommended interval between two last cuts (Petr et al., 1980). The second term of autumn cut (860 GDD, after 10 weeks) was not significantly different from other terms. The autumn cut in the third term (980 GDD) significantly reduced the yield of the first cut in the following year in the both experiments.

There are no significant differences of yields in the second cut among terms and cultivars used. Year had a significant influence on the yield in the both cuts. It could be caused by various developments of stands in individual years. We also recorded a significant interaction "term vs. year". The interaction showed effect of the year 2001 where in 980 GDD reached lower yield than in

Table 2. Date of the autumn harvest in the establishment year, days and GDD to end of vegetation

	Autumn harvest treatments	Date of autumn cut	Days to end of vegetation	GDD to end of vegetation
Experiment I	630 GDD	13 September	70	353
	860 GDD	11 October	42	143
	980 GDD	30 November	0	0
Experiment II	630 GDD	11 September	63	345
	860 GDD	17 October	27	93
	980 GDD	30 November	0	0

Table 3. Dry matter yields (DMY) from first and second harvest in the production year of two cultivars (Jarka and Europe) in Experiment I and II. The autumn harvest in the establishment year was taken 630, 860 or 980 growing degree days (GDD) after the second summer harvest

Cultivar	Autumn harvest treatments	DMY in the production year ($t.ha^{-1}$)					
		First cut		Second cut		First + second cut	
Jarka	630 GDD	6.69	6.67	4.31	5.13	11.00	11.80
	860 GDD	6.22	7.02	4.3	4.57	10.52	11.59
	980 GDD	6.12	6.77	4.55	4.91	10.67	11.68
Europe	630 GDD	6.68	7.68	4.33	4.51	11.01	12.19
	860 GDD	5.94	6.97	4.18	5.76	10.12	12.73
	980 GDD	5.8	6.12	4.7	3.77	10.50	9.89
		Significance probability					
Cultivar		ns		ns		ns	
Autumn harvest treatments		0.0066		ns		0.0416	
Year		0.0009		0.0254		0.0004	
Interactions							
Cultivar x autumn harvest treatments		ns		ns		ns	
Cultivar x year		ns		ns		ns	
Autumn harvest treatments x year		ns		0.0157		0.0486	
Range test							
630 GDD > 860 GDD		ns		ns		ns	
630 GDD > 980 GDD		0.01		ns		0.05	
860 GDD > 980 GDD		ns		ns		ns	
2001 < 2002		0.001		0.05		0.001	

Autumn harvest treatments were: 630, 860 or 980 GDD after the summer harvest, on 13 September, 11 October, 30 November 2000 by the Experiment I, 11 September, 17 October, 30 November 2001 by the Experiment II
ns – not significant at $P < 0.05$ (Tukey)

860 GDD. Jefferson and Gossen (1992) confirmed the significant interactions among different winter hardiness cultivars and terms of autumn cut as well as the effect of sites. Dhont et al. (2004) presented the significant influence of autumn cutting management in the second cut only at one site from two. There were no significant interactions "terms vs. cultivars" in our experiment. It seems that the autumn cut management negatively affects the first cut of the following year and in the second cut is in interaction of year condition, site, and level of stand development.

The main effect was observed in the first cut and consequently in the total DMY ($P = 0.0486$) because of the first cut 60% of total yield. These results corresponded by Dhont et al. (2004) about significantly reduced seasonal yield under different autumn cut management in the first and second production years. On the other hand, Scheaffer and Marten (1990) presented that a delayed cut had no effect on stand persistence or yield for 3 years following the seeding year. A second or third cut in the third autumn on 15th September or 15th October reduced the yields (68% of average reduction) and stands (57% of average reduction) in the spring following a severe winter compared with a final cut on 1st September. They determined differences among cultivars related with cultivar's dormancy. There were no significant differences between cultivars as well as "cultivar vs. term" interactions in our experiment. The significant effect of year was observed in both cuts and total DMY because of one of the most important factors. The significant interaction "term vs. year" was showed in the second cut as well as for total DMY. It seems that term of autumn last cut is in interaction with year conditions, particularly in the second cut and total DMY.

CONCLUSIONS

We concluded that the autumn cut management in the seeding year had significant effect on yield in the following production year. The main effect was observed in the first cut and in the total DMY. The significant interaction "year vs. term" was observed for the second cut and total DMY. According to our opinion very long interval between summer and autumn cut (18 weeks, 980 GDD) in the seeding year exhibit significantly lower yield in the following year. New short stems in 980 GDD before autumn harvest can have the negative influence on root organic reserves.

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Received for publication on August 17, 2005
Accepted for publication on September 21, 2005

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Vliv termínu podzimní seče vojtěšky v prvním roce vegetace na výnos píce v následujícím roce.

Scientia Agric. Bohem., *37*, 2006: 9–13.

V období 2000–2002 byl v polních parcelových pokusech sledován vliv termínu podzimní seče vojtěšky seté (*Medicago sativa* L., odrůdy Jarka a Europe) na délku lodyh před přezimováním a výnos píce v následujícím roce. Podzimní seč v roce založení byla provedena ve třech různých termínech (tab. 1), kdy odstup mezi letní a podzimní sečí byl stanoven na základě sumy efektivních teplot (630 SET, 860 SET a 980 SET). U porostů sklízených v období SET 630 byly průkazně delší lodyhy ($P < 0,05$) v porovnání se SET 860 a 980, které se od sebe vzájemně nelišily. Výnos píce v první seči následujícího roku byl průkazně nižší u SET 980, v průměru o 0,78 $t.ha^{-1}$ v porovnání se SET 630. Na výnosy píce v druhé seči neměl termín podzimní sklizně v předcházejícím roce průkazný vliv, byla však zjištěna průkazná interakce mezi termínem seče a ročníkem. V celkovém výnosu (první + druhá seč) se průkazně lišily varianty s podzimní sečí SET 630 od SET 980, v průměru o 0,82 $t.ha^{-1}$. Ze statistického vyhodnocení výsledků vyplývá, že termín podzimní seče vojtěšky seté v prvním roce vegetace má průkazný vliv na výnos píce v následujícím roce. Nebyl zjištěn průkazný vliv odrůdy ani vzájemných interakcí. Ročník průkazně ovlivňoval celkový výnos i výnos v jednotlivých sečích.

Interval mezi předposlední a poslední sečí v roce založení delší než 11 týdnů (860 SET) může mít za následek snížení výnosů píce v následujícím roce.

vojtěška setá; termín podzimní seče; interval mezi letní a podzimní sečí; délka lodyh; výnos píce; SET

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