ALFALFA MANAGEMENT IN NORTH-EASTERN ROMANIA

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Abstract

In the last years, the alfalfa crop (*Medicago sativa* L.) area is increasing because of its high productivity and quality. Improving technologies for growing alfalfa helps to raise productivity and quality parameters as well. One of the most important factors that influences both quality and productivity of alfalfa is the growth stage in which the alfalfa plants are harvested. The research was conducted in NE region of Romania (47°05'-47°10' north latitude and 27°28'-27°33' east longitude). During experimentations we monitored the influence of alfalfa plant maturity at harvest on the dry matter yield (whole plant, leaves and stems) at the four cuts in the second year of vegetation. The results showed that delaying harvesting contributes to a higher total DM production but with a decrease in the quantity of leaves. It was observed that the first cut represented 45-48% from the total DM yield, second cut 20-27%, third cut 26-27% and fourth cut 0-9% from the total DM yield. The largest quantity of leaves were obtained when alfalfa was harvested at mid bud, late bud and early flowering. Regardless of the growth stage at harvest, at the first cut was obtained half (48-53%) of the stem production from the entire year.

Key words: harvesting growth stage, forage yield, alfalfa leaves, alfalfa stems, dry matter distribution

Alfalfa (*Medicago sativa* L.) is one of the most important forage crops because of its high productivity. Soil fertility, climatic conditions, cultivar, disease, weeds and pest control, plant growth stage at harvest, preservation and storage represents factors that influence both forage productivity and quality. Knowing how to control these factors will enhance forage quantity and quality.

Worldwide and Romanian agricultural ecosystems are subjected to climatic changes over the past years. Prolonged periods with high temperatures and drought occur more frequently in the past years, which, in the absence of precipitations put a high stress on the majority of crops. Alfalfa is one of the crops that adapts quite good to drought conditions.

For the efficiency of water usage, but also for obtaining high biomass yields, in the pedoclimatic conditions in the north-east of Romania, the factor that must be controlled with attention is the plant growth stage at harvest. Harvesting alfalfa at early growth stages can lead to low yields and plant energy depletion due to insufficient nutrients accumulation within the crown. On the other hand, delaying too much the harvesting of plants can result in lower quality of the forage and a high consumption of soil water. (Rimini F. et al., 2010; Chen J. et al., 2012; Vîntu V. et al., 2012).

This research proposes to analyze the effect of cutting date on biomass productivity of alflafa, in the conditions of NE Romania, as well to establish the correlation between biomass accumulation with temperature and precipitation.

MATERIAL AND METHOD

The research was conducted during March-October 2011, on the Ezăreni farm, Iasi (47°05'-47°10' North latitude and 27°28'-27°33' East longitude). The soil from the region is a cambic chernozem with a pH between 6.68 to 7.01, medium supplied with humus (2.40%), total nitrogen (1.78%) and phosphorus (26.00 ppm) in the 0-30 cm horizon. Geographical area, including the farm Ezăreni, is characterized by a temperate climate with annual average temperature of 9.7°C and average annual precipitation of 518 mm.

In the area where the research was conducted, monthly mean temperatures during the growing season (April to September), were 0.8 to 1.7°C higher than the multiannual average. Deficit rainfall was recorded in May, June and September (11.5 to 37.2 mm month^{-1}), as shown in *table 1*.

The influence of alfalfa growth stage at harvest and number of cut on the dry matter production (DM) was studied in the second year of vegetation.

The experiment was monofactorial, arranged in randomized plots in three replications. The studied factor had six graduations, represented by the growth

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stage at harvest: V_1- early bud, V_2 - mid bud, V_3 - late bud, V_4 - early bloom, V_5 - 10% bloom and V_6 - full bloom, growth stage described by (Skinner R. H. *and* Moore K., 2007; Mueller S. C. *and* Teuber L. R., 2007).

Yield was determined by weighing the yield harvested from an area of 10 m^{-2}. Dry matter was determined by drying samples at 105°C for 3 hours.

The variety sown represented by Sandra (F 660-94) registered in 2003 to I.N.C.D.A. Fundulea (Schitea Maria and Martura T., 2004).

The results were interpreted statistically by analysis of variance and calculation of least square difference (LSD). Also, were established correlation equations (quadratic regression and significance) between: the accumulated rainfall (mm) or the amount of heat accumulated (ºC) and dry matter production during the growing season (April - September).

Tabele 1

Air temperatures and rainfall amount in growing season 2011

Monthly air temperatures (ºC)							
	Month						Average (IV-IX)
	IV	V	VI	VII	VIII	IX	
First decade	9.4	12.0	22.6	20.7	21.9	19.1	
Second decade	8.5	17.6	20.9	25.8	21.6	21.0	
Third decade	14.8	21.3	19.1	22.6	22.6	16.3	
Monthly average	***10.9***	***17.1***	***20.9***	***23.0***	***22.0***	***18.8***	**18.8**
Multiannual average	***10.1***	***16.1***	***19.4***	***21.3***	***20.6***	***16.3***	**17.3**
Deviation	***0.8***	***1.0***	***1.5***	***1.7***	***1.4***	***2.5***	**1.5**
Monthly rainfall amount (mm)							
	Month						Total (IV-IX)
	IV	V	VI	VII	VIII	IX	
First decade	13.0	27.0	17.8	8.0	19.4	13.2	
Second decade	55.4	12.4	8.8	9.2	1.0	0.0	
Third decade	4.6	1.6	61.6	32.6	0.0	9.6	
Monthly amount	***73.0***	***41.0***	***88.2***	***49.8***	***20.4***	***22.8***	**295.2**
Multiannual average	***40.3***	***52.5***	***75.1***	***69.2***	***57.6***	***40.8***	**337.5**
Deviation	***32.7***	***-11.5***	***13.1***	***-19.4***	***-37.2***	***-18.0***	**-42.3**

RESULTS AND DISCUSSIONS

Results have shown that with advancing maturity total DM production and stems DM production was increasing. Leaves DM production was also increasing until late bud - early flowering and then decreased. More specifically, once the first flowers appear, the leaves on the lower floors of stems fade, dried and then felt down. Thus, as the plants were harvested later than in the beginning of flowering, leaf production will be lower and hay quality will be inferior.

Analyzing the influence of growth stage at harvest on the distribution of dry matter production per cut in the second year of vegetation, it was clear that late harvest time contributed to increased total DM production (*table 2*). It was observed that the first cut represented 45-48% from the total DM yield, second cut 20-27%, third cut 26-27% and fourth cut 0-9% from the total DM yield. Although dry matter yields varied depending on the time of harvest, percentage distribution did not differ very much from one cut to another.

In mid bud, late bud and early flowering stages the highest leaf production was obtained. The situation was similar to that of the total DM production, but with a lower rate: of 4.9% compared to the first cut, and an additional 2-6% and 2-3% at third and fourth cut.

Stems DM production was greatly increased with delayed harvest, from the beginning of bud stage to complete flowering it almost doubled. Regardless of the time of harvest, in the first cut was obtained half (48-53%) of the stems DM throughout the year. In the next cuts stems DM productions were almost identical.

The most intense rate of daily dry matter accumulation was recorded at the first cut (86.8 to 103.9 $kg \cdot ha^{-1} \cdot day^{-1}$) and lowest at the fourth scythe due to lack of rainfall (*table 3*).

The largest increase of daily dry matter per mm of rainfall was obtained at the third cut (27.5 to 60.7 $kg \cdot ha^{-1} \cdot mm^{-1}$). Results show that the precipitation water is better used by alfalfa plants under sufficient heat conditions.

Growth stage at harvest is the factor with great influence on the daily rate of biomass accumulation. Thus, during the mid bud - early bloom was recorded the highest daily rate of biomass accumulation, of 53.1 to 103.9 $kg \cdot ha^{-1} \cdot day^{-1}$ (except fourth cut). With the delay of harvest, daily rate values of dry matter accumulation are smaller (*table 3*).

Table 2

Distribution of the dry matter production of alfalfa

Whole plant dry matter production (Mg·ha^{-1})							
Cut number		I[a]	II	III	IV	Total	%
Experimental plot	V_1	4.33[C]	1.94[C]	2.47[C]	0.91[C]	9.65[C]	100
	V_2	5.41	2.55*	3.03*	0.48°	11.47*	119
	V_3	5.72*	3.03*	3.40*	0.41°	12.55*	130
	V_4	6.05*	3.20*	3.43*	-	12.68*	131
	V_5	6.19*	3.49*	3.52*	-	13.20*	137
	V_6	6.25*	3.57*	3.53*	-	13.36*	138
	$LSD_{0.05}$	*0.09*	*0.14*	*0.11*	*0.09*	*0.30*	
Leaves dry matter production (Mg·ha^{-1})							
Cut number		I[a]	II	III	IV	Total	%
Experimental plot	V_1	1.49[C]	0.97[C]	1.13[C]	0.52[C]	4.10[C]	100
	V_2	1.77*	1.25*	1.28*	0.27°	4.58*	112
	V_3	1.92*	1.37*	1.27*	0.21°	4.76*	116
	V_4	1.92*	1.38*	1.16	-	4.46*	109
	V_5	1.74*	1.43*	1.13	-	4.30*	105
	V_6	1.67*	1.27*	0.86°	-	3.80°	93
	$LSD_{0.05}$	*0.07*	*0.10*	*0.06*	*0.06*	*0.15*	
Stems dry matter production (Mg·ha^{-1})							
Cut number		I[a]	II	III	IV	Total	%
Experimental plot	V_1	2.84[C]	0.97[C]	1.34[C]	0.40[C]	5.55[C]	100
	V_2	3.63*	1.29*	1.75*	0.22°	6.89*	124
	V_3	3.80*	1.67*	2.12*	0.20°	7.80*	141
	V_4	4.13*	1.82*	2.27*	-	8.22*	148
	V_5	4.44*	2.06*	2.39*	-	8.89*	160
	V_6	4.58*	2.30*	2.68*	-	9.56*	172
	$LSD_{0.05}$	*0.06*	*0.07*	*0.09*	*0.03*	*0.17*	

[C] - Control; * - Significant at the 0.05 probability level; [a] - Stavarache M. et al., 2012

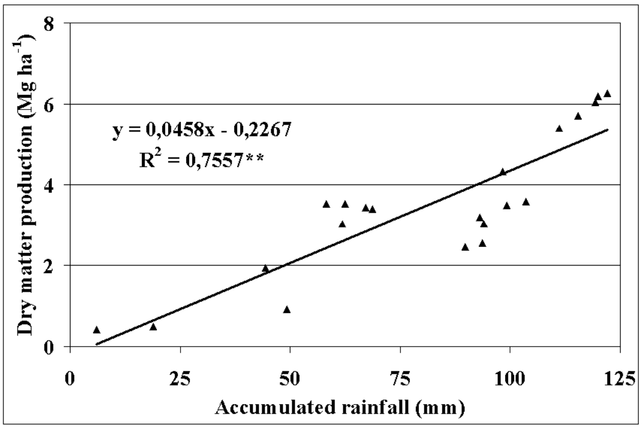
Table **3**

Alfalfa dry matter accumulation

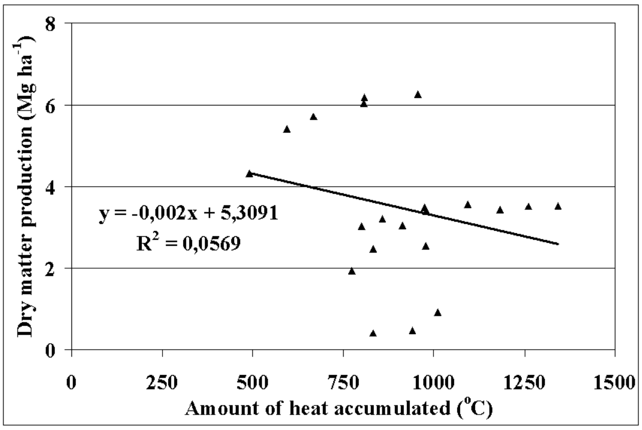
Experimental plot	**First cut**			**Second cut**		
	Dry matter production (Mg·ha^{-1})	Dry matter accumulation* (kg·ha^{-1}·day^{-1})	Dry matter accumulation* (kg·ha^{-1}·mm^{-1})	Dry matter production (Mg·ha^{-1})	Dry matter accumulation* (kg·ha^{-1}·day^{-1})	Dry matter accumulation* (kg·ha^{-1}·mm^{-1})
V_1	4328[C]	92.1[C]	44.0[C]	1942[C]	49.8[C]	43.8[C]
V_2	5405*	103.9*	48.6*	2547*	53.1*	27.2°
V_3	5719*	98.6*	49.6*	3031*	68.9*	32.3°
V_4	6047*	93.0	50.6*	3202*	78.1*	34.4°
V_5	6187*	91.0	51.6*	3487*	75.8*	35.2°
V_6	6253*	86.8°	51.2*	3571*	71.4*	34.5°
$LSD_{0.05}$	*85*	*1.6*	*0.8*	*141*	*3.1*	*1.5*
Experimental plot	**Third cut**			**Fourth cut**		
	Dry matter production (Mg·ha^{-1})	Dry matter accumulation* (kg·ha^{-1}·day^{-1})	Dry matter accumulation* (kg·ha^{-1}·mm^{-1})	Dry matter production (Mg·ha^{-1})	Dry matter accumulation* (kg·ha^{-1}·day^{-1})	Dry matter accumulation* (kg·ha^{-1}·mm^{-1})
V_1	2467[C]	64.9[C]	27.5[C]	913[C]	19.9[C]	18.6[C]
V_2	3030*	86.6*	49.0*	484°	11.0°	25.8
V_3	3395*	79.0*	49.4*	408°	10.2°	68.8°
V_4	3427*	65.9	51.0*	-	-	-
V_5	3521*	62.9	56.4*	-	-	-
V_6	3535*	56.1°	60.7*	-	-	-
$LSD_{0.05}$	*147*	*3.1*	*2.2*	*87*	*2.3*	*11.0*

* - growth rate calculated according to number of days and amount of precipitation for each cut; [C] - Control;

There is a positive, highly significant correlation between accumulated rainfall and DM production regardless of the number of cut or alfalfa growth stage at harvest (*figure 1, a*). Between the amount of heat accumulated and DM production, there is no correlation (*figure 1, b*). This result shows that in the study area, precipitation represents one of the limitative factors.



a



b

** - Significant at the 0.01 probability level

Figure 1 **Correlations between the accumulated rainfall (mm) and alfalfa dry matter production (a) and correlations between the amount of heat accumulated (ºC) and alfalfa dry matter production (b)**

CONCLUSION

Regardless of the growth stage at harvest, half of the stem production from the entire year was harvested in the first cut.

Along with the advancing maturity DM yield of entire plants and stems was increasing but leaf production increased until the end of bud - early flowering. This growth stage represent the optimal timing for harvesting alfalfa crops.

ACKNOWLEGMENTS

This work was co financed from the Social Fund through Sectoral Operational Programme Human Resource Development 2009-2012, number POSDRU/88/1.5/S/52176 „Supporting the participation of doctoral students in doctoral programs”.

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