17TH - 21ST JUNE 2018 | CORK, IRELAND

Sustainable meat and milk production from grasslands

Edited by

B. Horan
D. Hennessy
M. O'Donovan
E. Kennedy
B. McCarthy
J.A. Finn
B. O'Brien

Volume 23
Grassland Science in Europe

Sustainable meat and milk production from grasslands

Proceedings of the 27th General Meeting
of the European Grassland Federation
Cork, Ireland
17-21 June 2018

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teagasc
Agriculture and Food Development Authority

Published by

The Organising Committee of the 27th General Meeting of the European Grassland Federation, Teagasc, Animal and Grassland Research and Innovation Centre, Moorepark, Fermoy, Co. Cork, Ireland.

ISBN: 978-1-84170-643-6
eISBN: 978-1-84170-644-3

Abstract submission and evaluation by

OASES
Online Academic Submission and Evaluation System

Editing and production by

Wageningen Academic Publishers
P.O. Box 220
6700 AE Wageningen
The Netherlands
www.WageningenAcademic.com

Wageningen Academic Publishers

Distributed by

European Grassland Federation EGF
W. Kessler, Federation Secretary
c/o Agroscope
Reckenholzstrasse 191
CH-8046 Zürich, Switzerland
E-mail: fedsecretary@europeangrassland.org

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Dry matter yield and plant density of alfalfa as affected by cutting schedule and seeding rate

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Abstract

Alfalfa cutting schedule is a more significant factor in achieving high quality, high yields and stand persistence than numerous cultural practices such as irrigation, fertilisation, pest control, sowing management, variety selection, etc. The objective of this research was to determine dry matter (DM) yield and plant density of alfalfa stand as affected by the three different cutting schedules: C 1 - early (first flower, 5 cuts), C 2 - medium (late flower, 4 cuts), and C 3 - late (green pod, 3 cuts), and two seeding rates: S1-8 kg ha^{-1} and S2-16 kg ha^{-1}, during 2009 - 2011. The numbers of plants per square metre were determined six weeks after sowing, in the spring 2010 and in spring 2011. In each year and over a two year total, C 3 had significantly lower DM yield than other treatments. Alfalfa harvested at the C 1 stage produced higher total DM yield (45.0 t ha^{-1}) than harvesting at the C 3 stage (36.4 t ha^{-1}). Cutting schedule did not influence plant populations of alfalfa stand. The final plant densities were approximately the same in all cutting treatments (early - 90; medium - 85; late - 90 plants m^{-2}). The analysed agronomic traits were not significantly affected by seeding rate.

Keywords: alfalfa, cutting schedule, plant density, seeding rate, yield

Introduction

Alfalfa (*Medicago sativa* L.) is very highly regarded as a forage crop because of its high adaptability, great yield potential and high nutritional value. The forage yield of alfalfa depends on many factors, primarily on growing conditions, cultural practices and varieties. Moreover, harvest timing is the most powerful tool under the alfalfa grower's control to impact yield and quality. Alfalfa maturity at time of cutting strongly influences dry matter (DM) yield (Orloff and Putnam, 2010). Cutting at later stage (full flower) increased DM yield by 18% when compared with earlier cutting (first flower), whilst prolonging the productive life of the alfalfa field (Lloveras *et al*., 1998). Alfalfa cut at earlier stages (i.e. pre-bud or early bud) has high forage quality but DM yield reduces. Conversely, alfalfa cut in the later stages (flowering) is higher yielding but lower forage quality (Orloff and Putnam, 2006). According to Sheaffer *et al*. (1988), cutting at the first flower stage generally resulted in the best combination of seasonal herbage and nutrient yield and persistence. The successful establishment of an alfalfa stand depending on seeding rate has long been a focus of studies. According to Bradley *et al*. (2010), planting alfalfa at different seeding rates from 4.5 to 18 kg ha^{-1} do not produce higher DM yield. The objective of this research was to determine the DM yield and plant density of an alfalfa stand under three cutting schedules and two seeding rates.

Materials and methods

The trial was carried out at the Experimental Field of Institute of Field and Vegetable Crops in Novi Sad, Serbia. The soil was a chernozem with good physical properties (pH 7.5 in KCl, 6.4% $CaCO_3$, 23.5 mg P_2O_5 100g^{-1} and 40.0 mg K_2O 100g^{-1} of soil). The experiment, a randomised complete block design with three replications in a split-plot arrangement, was set up in the spring of 2009. The experimental treatments included i) two seeding rates: S1-8 and S2- 16 kg ha^{-1} and ii) three cutting schedules at different phenological stages, according to Kalu and Fick (1981): C 1 - early (first flower, 5 cuts), C 2 - medium (late flower, 4 cuts) and C 3 - late (green pod, 3 cuts). During the 2010 - 2011 influence of investigated factors on DM yield (t ha^{-1}) was tested. Plant density was determined by counting the

number of live plants in randomly placed quadrat (1 m^2) in each plot. The initial counting of plants was performed at the five trifoliate leaf stage, then in the spring of 2010 and 2011. Green forage yield was determined by cutting the plot area and the fresh weight was determined immediately. The plots were cut at a stubble height of 7 cm, using the forage harvester Cibus. Subsamples of 300 g from each plot were weighed fresh and again after drying for 96 h in a forced-air oven at 50 °C to determine DM content. The annual and two year total DM yield was calculated by summing the individual cuts annually for the two year period. The four alfalfa cultivars used in the experiment (Banat VS, Nijagara, NS Alfa i NS Mediana ZMS V) did not show statistically significant differences in tested variables so the data are not reported. Results were analysed by the analysis of variance and tested by the LSD test.

Results and discussion

Of the two factors used in this experiment, seeding rate and cutting schedule, the latter had a significant effect ($P < 0.01$) on DM yield of alfalfa. Early cutting (C 1) had the greater DM yield (20.7 t ha^{-1}) in 2010, while in 2011 the greater DM yield was obtained with the medium (C 2) cutting schedule (24.6 t ha^{-1}). In 2010 and 2011 and over a two year total, there is no DM yield difference between cutting at C 1 and C 2 stage, while the cutting at C 3 stage had significantly lower DM yield than other treatments (Table 1). These results are in line with Scheaffer *et al*. (2000), who found that cutting frequency, or more accurately, the maturity of the alfalfa at the time of harvest, determines forage yield. Seeding rate did not affect DM yield. In both production years, increasing seeding rate did not result in significant increases in the DM yield of alfalfa, which is in agreement with Heerden (2012), who found no DM yield increase with increasing alfalfa seeding rate from 6 to 12 kg ha^{-1}. The DM yields and plant density obtained under three cutting schedules over two seasons are presented in Table 1.

In this study, both higher seeding rate and more frequent cutting of stand did not increase density of alfalfa plants (Table 2). Plant density, six weeks after sowing, was 9% higher for S1 (290 plants m^{-2}) than S2 (263 plants m^{-2}). The difference was not statistically significant. In spring 2010, both seeding rates had similar densities (210 and 213 plants m^{-2}) and in 2011 (year 3), plant density was 88 plants m^{-2} for both seeding rates.

Results obtained in our study support the findings of Hall *et al*. (2010), who claimed that there is no significant impact of higher seeding rates on density of alfalfa plants. Plant density, with all cutting schedules, decreased over the three years of investigation. In the spring of 2010, plant density averaged 201, 203 and 230 plants m^{-2}, for C 1, C 2 and C 3. There were no differences among the cutting schedules. In 2011, plant densities were approximately the same in all cutting treatments (C 1 - 90; C 2 - 85; C 3 - 90 plants m^{-2}), so taking three, four or five cuts per year did not affect plant density.

Table 1. Effect of cutting schedule (C) on dry matter yield (t DM ha^{-1}) and plant density (number of plants m^{-2}) of alfalfa stand during 2009 - 2011.

Cutting schedule (C)	DM yield (t ha^{-1})			Plants m^{-2}		
	2010	2011	2-year total	Initial plant density (29 June 2009)	29 March 2010	Final plant density (15 March 2011)
C 1	20.7**	24.3**	45.0**	281^{NS}	201^{NS}	90^{NS}
C 2	19.8**	24.6**	44.4**	274^{NS}	203^{NS}	85^{NS}
C 3	17.9	18.5	36.4	275^{NS}	230^{NS}	90^{NS}
lsd	1.6	1.4	1.9	52	34	7

NS - non significant; * significant $P < 0.05$; ** significant $P < 0.01$.

Table 2. Effect of seeding rate (S) on dry matter yield (t DM ha^{-1}) and plant density (number of plants m^{-2}) of alfalfa stand during 2009 - 2011.

Seeding rate (S)	DM yield (t ha^{-1})			Plants m^{-2}		
	2010	2011	2-year total	Initial plant density (29 June 2009)	29 March 2010	Final plant density (15 March 2011)
S1	19.1^{NS}	22.7^{NS}	41.8^{NS}	290^{NS}	210^{NS}	88^{NS}
S2	19.9^{NS}	22.3^{NS}	42.2^{NS}	296^{NS}	213^{NS}	88^{NS}
lsd	0.9	0.8	1.2	42	28	6

NS - non significant; * significant $P < 0.05$; ** significant $P < 0.01$.

Conclusion

Cutting schedule or seeding rate did not influence alfalfa plant density. Results of these investigations showed that cutting schedule had a significant effect on DM yield of alfalfa. This factor did not influence plant density. The more frequent cutting did not cause thinning of alfalfa stand. In both production years, alfalfa harvested at the early flower stage produced higher DM yield than harvesting at the green pod stage.

Acknowledgements

This study is a part of the project TR31024 of the Ministry of Education and Science of the Republic of Serbia.

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