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VARIABILITY IN HERBAGE MASS AND CHEMICAL COMPOSITION WITHIN A TIMOTHY SWARD

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Abstract

Variability in herbage mass (HM) and chemical composition of timothy (*Phleum pratense* L.) sward was studied in a three-hectare field. The field, which was flat, was divided into twelve sections and a sampling site was randomly selected in each. The study was carried out in Sotkamo (64^o 01'N, 28^{o}22'E) research station in Finland. Snow depth and frost conditions were measured in winter and soil water content was monitored in the growing season at each sampling site. Observations on the crop included assessment of herbage ground cover and winter damage percentage, stand height and HM and analysis of neutral detergent fibre (NDF) and nitrogen concentration. Forage was harvested twice during the experiment and the first cut was made at ear emergence. Winter damage varied from 0 to 68% and herbage ground cover in spring from 30 to 100%. Variability in HM was higher at the first cut (from 1767 to 4390 kg DM ha^{-1}) than at the second cut (from 3890 to 4348 kg DM ha^{-1}). NDF content varied from 601 to 688 g kg^{-1} at the first cut and from 582 to 632 g kg^{-1} from at the second cut. The 95% confidence limits for NDF at the first cut were from 635 to 663 g kg^{-1} and at the second cut from 589 to 604 g kg^{-1}.

Keywords: Overwintering, winter damage, frost, yield maps, NDF

Introduction

Dairy production in Finland is based on silage feeding and reliable forage yield is vital to dairy farms. Under Nordic conditions winter damage can cause substantial losses in forage yield and to the quality of grass which decreases very rapidly during spring growth. Delay in harvest leads to low feeding value of the silage but too early a harvest would lead to reduced yield. Fick *et al* . (1994) indicated that in working with methods developed to model forage quality, changes in the growing crop need further study particularly, in grass crops. Recent studies of Rinne *et al.* (2000) showed that under Finnish conditions the growing degree days (GDD) predict very well the development of organic matter digestibility of timothy and meadow fescue (*Festuca pratensis* Huds.) mixed swards. This recommendation based on GDD will be tested during the summer of 2000 on a nation-wide scale. The objective of this study was to assess the extent of variation in the quality of yield within a single timothy field, and attempt to specify the factors causing variation. In addition, the study aimed at providing information on how to utilize yield map data in identifying factors causing winter damage and variation in yield in a perennial forage crop.

Material and Methods

The timothy stand was established by undersowing spring barley in June 1998 at the Sotkamo (64^{o} 01' N, 28^{o}22' E) research station in Finland. The field was topographically even, exhibiting only minor variation possibly related to the ploughing pattern of the field. Two soil samples taken from two sites of the field prior to establishment indicated that the soil was a mineral loam soil (organic matter content (OMC) in category from 12 to 20 %) with some areas of organic soil (OMC between 20 and 40%). Soil pH ranged from 5.3 to 5.6.

The field was divided into twelve sections and one sampling site was randomly selected in each. Duration of frost in winter was recorded and soil water content during the growing season was monitored using tensiometers. Live herbage ground cover and winter damage were assessed visually. The stand was harvested first time on 27th of June when ears were fully emerged from leaf sheats and the second cut was taken on 12th of August. The stand height was measured at cutting, and a 10 m by 1.5 m sample plot was harvested using a Haldrup plot harvester at each site. Herbage mass was measured and Neutral Detergent Fibre (NDF) and nitrogen concetration were assessed from a sample at each site. NDF was measured by Fibertec System M and nitrogen concentration by Kjeltec Auto 1030 Analyzer. In this paper mean values and variation in stand characteristics are presented, as well as Pearson correlation coefficients between some stand characteristics and environmental parameters.

Results and Discussion

The summer of 1998 was exceptionally rainy. Wet conditions induced lodging in the spring barley cover crop and lodging caused unevenness in the establishment of the timothy stand. Live herbage ground cover of the timothy stand in fall 1998 ranged from 75 to 100 % (Table 1). Winter damage ranged from 0 to 68 % resulting in live ground cover percentage in spring 1999 ranging from 30 to 100 with a mean value of 76. The field was flat but small differences were evident. Winter damage was restricted to the low spots of the field. Snow melted completely in December and water from melted snow stayed on these spots, particularly because the soil was frozen, and this induced winter damage. The mean maximum snow cover in the field was 54 cm on 25th of March. Variation in the HM was higher (from 1767 to 4390 kg ha^{-1}; SD 880 kg ha^{-1}) at the first cut than at the second (from 3890 to 4348 kg ha^{-1}; SD 300 kg ha^{-1}). HM at the first cut was correlated with winter damage percent (r=-0.71) and percent live herbage ground cover in spring (r=0.66) but not with HM of the second cut (Table 2). Stand height was positively correlated with NDF and negatively correlated with the nitrogen content in both cuts (Table 2). 95% confidence limits for NDF concentration at the first cut were from 635 to 663 g $kg^{1}$and from 589 to 604 g kg^{-1} at the second cut. Soil water content (mean tensiometer value from weekly measurements) was not correlated with yield characteristics at the first cut. However, the DM yield at the second cut was correlated (0.63) with the mean tensiometer value between the cuts indicating that timothy grew better in the drier areas of the field. The data indicates substantial variation in yield within a relatively small and uniform field. However, the data are too limited in time to make general conclusions. Lark and Wheeler (2000) suggested that yield map data over the seasons, with use of cluster analysis, represent an analytical tool for identifying regions of similar limiting factors. Our study continues with a larger number of sampling sites and over seasons, which will possibly facilitate establishing factors that cause winter damage to perennial forage stands.

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Table 1 - Yield and chemical composition, and stand condition characteristics of timothy from 12 samples within a timothy sward.

Characteristics	Mean	Min	Max	Std Dev
Ground cover in previous fall (%)	92	75	100	7
Ground cover in spring (%)	76	30	100	20
Winter damage (%)	17	0	68	22
Data of the first cut:				
DM yield (kg ha^{-1})	3347	1767	4390	880
Stand height (cm)	66	58	71	4.5
Leaf / stem ration (DM basis)	0.57	0.38	0.96	0.16
NDF (g kg^{-1} DM)	649	601	688	22
N-concentration(g kg^{-1} DM)	22	17	27	3.0
N yield (kg N ha^{-1})	71	45	87	15
Data of the second cut:				
DM yield (kg ha^{-1})	4313	3890	4848	300
Stand height (cm)	63	57	73	4.3
NDF (g kg $^{-1}$ DM)	597	582	631	127
N-concentration (g kg^{-1} DM)	19	15	21	2.2
N yield (kg N ha^{-1})	82	65	95	9
Total yield per season:				
Total DM yield (kg ha^{-1})	7660	5966	8936	981
Total N-yield (kg N ha^{-1})	153	112	182	23

Table 2 - Correlation coefficients for some timothy stand and yield characteristics. (n=12)

Stand charaterictics / Yield characteristics	Ground Cover In spring	Winter damage %	Stand height at cut
First cut:			
DM yield	0.66 *	-0.71 *	0.91 ***
NDF	0.64 *	-0.70 *	0.72 **
N-content	-0.78 **	0.79 **	-0.64 *
N-yield	0.42 NS	-0.46 NS	0.84 ***
Second cut:			
DM yield	-0.32 NS	0.29 NS	0.45 NS
NDF	-0.73 **	-0.18 NS	0.73 **
N-content	0.39 NS	-0.41 NS	-0.73 **
N-yield	0.24 NS	-0.27 NS	-
Total yield:			
DM yield	0.49 NS	-0.54 NS	
N-yield	0.36 NS	-0.40 NS	