University of Kentucky
UKnowledge

Defoliation and Water Deficit: Their Influence on Pasture Growth and Water Use of White Clover

F. H. Santiñaque
Universidad de la República, Uruguay

Follow this and additional works at: https://uknowledge.uky.edu/igc

Part of the Plant Sciences Commons, and the Soil Science Commons

This document is available at https://uknowledge.uky.edu/igc/19/1/15

This collection is currently under construction.

The XIX International Grassland Congress took place in São Pedro, São Paulo, Brazil from February 11 through February 21, 2001.

Proceedings published by Fundacao de Estudos Agrarios Luiz de Queiroz

This Event is brought to you for free and open access by the Plant and Soil Sciences at UKnowledge. It has been accepted for inclusion in International Grassland Congress Proceedings by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

ID # 01-17

DEFOLIATION AND WATER DEFICIT: THEIR INFLUENCE ON PASTURE GROWTH AND WATER USE OF WHITE CLOVER.

F.H.Santiñaque

Department of Animal Production and Pastures. Facultad de Agronomía.Universidad de la República. CP 60000, Paysandú, Uruguay.

Abstract

With the objective of understanding the physiological basis of defoliation and water use relationships of white clover (*Trifolium repens L.*) pastures during water deficits, an experiment in controlled conditions was carried out. Outdoors nine liters pots were filled whith a loam-clay soil with a water content at field capacity (FC), of 35%(w/w), at a bulk density of 1.1 g/cm ^{3}. Pre-germinated and inoculated clover seeds were transplanted, and the number of plants was adjusted to permit the development of full plant cover. The level of P in the soil did not limit plant establishment or growth. The factors studied were: defoliation frequencies (cut every 20 days and cut every 40 days), and soil water levels (watering to mantain soil water content at 80% of FC and watering delayed until soil water content fell to 40-50% of FC). There were two white clover cultivars: the medium leaved Zapican and the large leaved ladino type Regal. Treatments were set out in a factorial arrangement in a randomized blocks design with three replicates and data were analysed using ANOVA, correlation estimates and regression models. The results indicated a positive correlation between the amount of water lost by evapotranspiration (ET), and forage yield or root weight. Managements and cultivars which promoted less production of aerial biomass and less root growth thus resulted in better water conservation.

Keywords: drought, management, physiological responses, *Trifolium repens.*

Introduction

White clover (*Trifolium repens L.*), is the most important winter perennial forage legume sown in Uruguay. Its production and persistence is limited to 2 or 3 years, due to its high sensibility to water deficits. Defoliation management affects aerial and root plant growth, and, therefore, water use. There is evidence that more soil moisture is conserved with managements that mantain low leaf area index (LAI), due to less evapotranspiration (ET). This contradicts data showing the benefits of lax managements (higher LAI), in conserving soil moisture due to the plant cover avoiding soil water evaporation (Barker and Chu, 1985). Consequently, the objective of this study was to quantify the defoliation management, water levels and cultivars effects on summer forage yield, root growth and water use of white clover swards.

Material and methods

The experiment was carried out from July 4, 1994 to March 29, 1995, in 9L outdoors pots 18.8 cm depth. The experiment was carried out at the Agronomy Faculty, Paysandu (32 ^{o} S). The pots were filled with a loam – clay soil with a water content of 35% (w/w), at field capacity (FC), and arranged with a bulk density of 1.1 g/cm^3. Pregerminated and Rhizobium inoculated seeds were transplanted into pots on 04/07/94. The plant stand was adjusted to obtain a density that did not limit the potential of forage yield. The level of P in the soil was raised to a level that would not limit plant establishment and plant growth. The factors and levels studied were: - defoliation frequency (frequently defoliated: management F, cut every 20 days, infrequently defoliated: management I, cut every 40 days, the residual forage height was 2.5 – 3 cm); - soil water levels in summer (W: watered: rewatering every day to mantain the mean soil water content at 80% of FC;

WS: water stress: before irrigation to replace soil water, these tratments did not received water until the soil water content fell to 40 - 50% of FC) ; - white clover cultivars (Z: cv. Zapicán, medium leaved; R: cv. Regal, large leaved ladino type). The factors were disposed in a factorial arrangament in a complete randomized blocks design with three replicates. Summer forage yield, root dry weight and ET data were analysed using ANOVA, regression models and correlation coeficients (SAS Institute, 1996). During summer there were realized 2 cuts whith management I and 4 cuts with management F. From the sowing to the beginning of the water treatments (12/01/95), the available soil water content was maintained at 80% of FC. Drying cycles length were variable, depending on water atmospheric demand, rainfalls occurrence and the quantity of forage biomass in the pots. The forage harvested in each cut was oven dried (60º C), for dry matter weight determination. At the end of the experiment, the plants were removed from pots and washed to separate roots from the soil. The roots was oven dried (60º C), for total root weight determination. The daily water loss per pot via ET (average of January and February), and the soil water content were measured by daily weighing of the pots.

Results and discussion

Summer forage yield, root weight and ET of white clover swards (Fig.1) were affected ($p<0.01$) by the defoliation management and by the soil water level ($p<0.01$). Without water deficit, management I yielded 54% more forage ($p<0.01$), 123% more roots ($p<0.01$), and lost 24% more water by ET ($p<0.01$), than the F management. In contrast, with water deficit, management I did not yielded more forage than management F (n.s), but yielded 143% more roots ($p<0.01$) and lost 11% more water via ET($p<0.01$). Cultivar affected forage yield ($p<0.01$), root weight ($p<0.05$) and ET ($p<0.01$), and these effects were independent of defoliation management and soil water level (interactions cultivar x management: n.s and cultivar x water level: n.s). Regal (ladino type), yielded 33% more forage (17.7 vs. 13.3 g DM/pot), more root (9.9 vs. 8.5 g DM/pot) and 6.3% more water lost via ET (6.7 vs. 6.3 mm/day) than cultivar Zapican (medium leaved). When all treatments were considered, ET had a higher correlation with forage yield than with the root weight (Table 1). Under unlimited water conditions, ET had a high correlation with both variables. In contrast, under water deficit pasture ET had a higher association with root weight (Table 1). The differences in ET between treatments are explained by the different soil water content during summer, and by differences in forage and root growth of the different managements and cultivars. So,whithout soil water stress, the higher ET of management I was due to the higher forage and root growth, mainly forage growth, which were capable to developed a high water absorption and transpiration rates, according with the high atmosferic evaporative demand. With management F, the lower forage and root yield limited pasture water lost by ET. In contrast, with soil water deficit, differences between managements in ET are explained by differences in their root growth (Fig.1). Therefore, it is important to emphasize that the frquent management was able to conserve more soil water than the lax cutting treatment under both water levels. The differences in ET between cultivars Regal and Zapican, was attributed to their morphophysiological traits. Thus, cultivar Regal with larger leaves and greater percentage of taproots than intermediate types (Caradus, 1977, Caradus et al. 1990), had a greater forage and root growth than cultivar Zapican, and so higher pasture ET. Therefore, the differences in water loss between managements and cultivars are explained by the effect of both factors on the summer forage yield and/or root growth. These findings agree with the results obtained by Barker et al. (1993) and Wang et al. (1996), who concluded that growth parameters of smaller leaved white clover cultivars were less affected than the large leaved cultivars in their response to water deficit, due to the faster exhaust of soil water content of the large-leaved cultivars, and, as a consequence plants developed water stress before than the others cultivars. Taking only the water relations into account, this study indicates that keeping white clover pastures under lax defoliation managements during the summer would be not recomendable. The advantage of reducing soil water loss with frequent managements will be studied in field experiments with a higher rank and more levels of defoliation managements in order to quantify its potential of reducing water losses and its importance for white clover production and persistence.

Acknowledgements

The author wishes to thank Ing.Agr. Fernando Ducamp for his contribution to improving this manuscript, and Ing.Agr. Oscar Bentancur for his assistance in statistic data analysis.

References

Barker, D.J., Caradus, J.R. and McManus, M.T. (1993). Physiological responses of white clover genotypes to water deficit. Proc. 17th. Int. Grass. Cong., p. 67.

Barker, D.J. and Chu, A.C.P. (1985). Strategies for dryland pasture management – a review. Proc. Agr. Soc. of New Zealand. **15:**115-119.

Caradus, J.R. (1977). Structural variation of white clover root systems. N. Z. Journal of Agr. Res. **20:**213-219.

Caradus, J.R., Mackay, A.C., Charlton, J.F.L. and Chapman, D.F. (1990). Genecology of white clover (Trifolium repens L.) from wet and dry hill country pastures. N. Z. Journal of Agr. Res. **33:**377-384.

SAS Institute. (1996). SAS/STAT. Guide for personal Computers. Ed. SAS Inst., Cary, N.C.

Wang, X., Caradus, J.R. and Chu, A.C.P. (1996). Effect of summer moisture deficit on growth of five white clover cultivars. Porc. of the N. Z. Grass. Assoc. **57:**73-76.

Table 1 - Correlation coefficients of forage yield and root weigth regressions with ET.

	Forage yield (gDM/pot)	Root weigth (gDM/pot)
All the data (W and WS)	r = 0.96	r = 0.84
n = 24	p < 0.01	p < 0.01
Watered (W)	r = 0.95	r = 0.95
n = 12	p < 0.01	p < 0.01
Water stress (WS)	r = 0.69	r = 0.80
n = 12	p < 0.01	p < 0.01

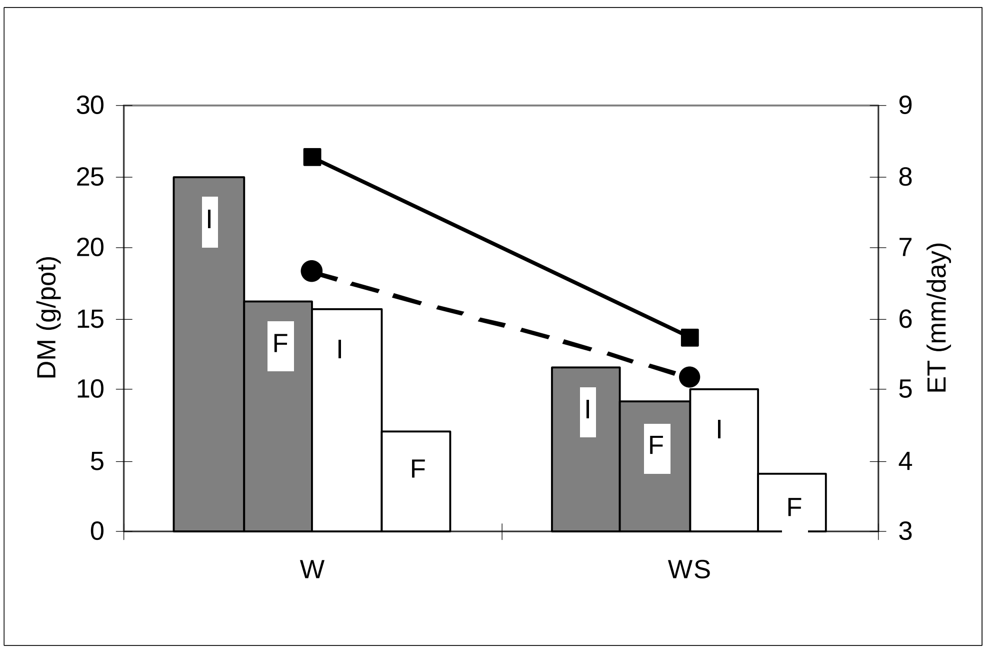

Figure 1- Effect of defoliation and water level (W: watered; WS: water stress) on forage yield (■), root weight (□), and ET of white clover; I: cut every 40 days; F: cut every 20 days; ET A (——), ET F (- - -).