A COMPARISON OF LUCERNE GROWTH AND DEVELOPMENT UNDER FIELD AND CONTROLLED ENVIRONMENT CONDITIONS

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ABSTRACT

Herbage growth and development of irrigated lucerne was monitored in a field study in the Manawatu through the November/December/January period. Lucerne was then grown under simulated sward conditions in the controlled environment rooms of the DSIR Climate Laboratory using a similar day/night temperature regime and photo-period to the field conditions.

In both the field and the controlled environment rooms the lucerne took 36-37 days to flower. Detailed herbage characteristics measured at the 1% flower stage were very similar in both the field and the simulated conditions of the controlled environment rooms. The relative growth rates of the herbage during regrowth to the flowering stage were identical in both situations.

The results give confidence for further work with sward plants in the Climate Laboratory.

INTRODUCTION

In 1975 a project commenced at Massey University to examine certain aspects of the grazing management of lucerne. One of the objectives of the project was to examine the influence that climatic factors may have on lucerne's response to cutting or grazing management. In view of the considerable expense involved in conducting grazing trials in different parts of the country (i.e. under different climates) it was decided to attempt to establish the principles governing the interaction of climatic factors and lucerne grazing management by growing the lucerne under different 'climates' in controlled environment (c.e.) conditions. It was felt that if the principles could be established in c.e. conditions considerable costs could be saved at the next stage of the project (field testing) by using the principles from the c.e. conditions to select only the most relevant and therefore a minimum number of treatments. One grazing trial was conducted under actual field conditions at one site in the Manawatu prior to the start of the studies in the c.e. conditions.

The purpose of this paper is to compare the growth and development of lucerne growing under actual field conditions with that of lucerne growing in c.e. conditions set to a similar daylength and day/night temperature regime as prevailed in the field.

MATERIALS AND METHODS

The field trial was conducted through the 1975/76 spring/summer period on a field of Wairau lucerne sown one year previously on a Manawatu fine sandy loam 2 km from Palmerston North. The trial was sprinkler irrigated to return the soil to field capacity whenever the evapotranspiration model developed by Clothier *et al.* (1975) on this soil indicated that 40% of the available water in the root zone had been lost by evapotranspiration. The lucerne was vigorous, free of weeds, adequately supplied with major and trace elements and had an established plant density of 90 per square metre.

The Wairau lucerne for study in the c.e. conditions was sown into a mixture of Manawatu fine sandy loam and Opiki peat loam in 5 litre plastic pots (18 x 18 x 18 cm) 4 plants per pot, eight months before entry to the c.e. conditions. During this eight month establishment period (October-May) the plants were grown outside and watered to maintain rapid growth. The lucerne was given a conditioning period of 40 days following its entry to the c.e. rooms. Three c.e. rooms were used in the DSIR Climate Laboratory at Palmerston North but this paper is concerned with the growth of lucerne in only one of the rooms.

For this project, because it was important that sward conditions be simulated as closely as possible the pots of lucerne were grouped closely on the trolleys and the trolleys tied together in pairs. This created a 'sward' 130 x 100 cm comprising 30 pots of four lucerne plants each to give a lucerne plant density of $92/m^2$ (c.f. the lucerne plant denisity in the field of $90/m^2$). To reduce light penetration into the simulated 'sward' from the side and improve its relevance to a field sward where, of course, all light filters down from the top, a screen of black material was erected around each 'sward' of 30 pots. The top of the screen was lifted as the 'sward' increased in height but was always kept about 5-6 cm below the top of the stems.

At the outset of the project it was decided that the environmental conditions imposed in the c.e. rooms should be relevant to areas in N.Z. where lucerne is, or could be, used extensively. The 40 year averages of the mean daily maximum and minimum temperatures for the 3 summer months at Wairakei, Hastings, Dannevirke, Blenheim and Winchmore were 22.5°C average maximum temperature and 11.2°C average minimum temperature. On the basis of this information the day/night temperature regime for the c.e. room that forms the basis of this paper was set at 22°/12°C. Soil moisture in the pots was maintained close to field capacity by regular automatic additions of water 3-5 times daily.

A 14 hour photoperiod was used with a light intensity or irradiance throughout of 140-150 watts/meter^2 (photosynthetically active range: 400-700 nanometers) with an abrupt light-dark change.

The day/night vapour pressure deficit (in millibars) was 10/2 (i.e. relative humidity percentage 62/85). Day/night humidity and temperature changes occurred over two hours, the photoperiod beginning or ending halfway through the changeover. Carbon dioxide concentration was ambient at 320-340 ppm.

The period of the field trial for which results are presented in this paper was from the end November to the middle of January. During this period mean daily maximum and minimum temperatures at the site (20.4°/12.8°C) closely approached the 22°/12°C day/night regime of the c.e. room.

The following herbage characteristics are for lucerne growing to the 1% flower stage following defoliation at the 1% flower stage by either a quick (2-3 day) grazing with sheep (field trial) or a cut to 3cm with hand shears (c.e. room).

In the field, the sampling procedure involved harvesting two randomly selected 0.2 m^2 quadrats from each of the 4 mini-paddocks or plots. This was done by severing with hand shears the tap root of each lucerne plant in the quadrat 2-3 cm below the crown. A 100g subsample was taken from each quadrat cut for full herbage analysis and drying. In the c.e. rooms two pots were removed at random from the 'sward' and the eight plants separated by root washing for full herbage analysis and drying.

TABLE 1: Herbage characteristics at 1% flower stage

	Field	Controlled Environment
Time to reach 1% flower stage (days	37	36
Height at 1% flower stage (cm)	50	54
Percentage of total stem wt in:		
top half of herbage	35%	41%
bottom half of herbage	65%	59%
Percentage of total leaf wt in:		
top half	88%	92%
bottom half	12%	8%
Percentage of total leaf area in:		
top half	84%	88%
bottom half	16%	12%
Leaf: stem ratio:		
top half	1.39	1.26
bottom half	0.10	0.07
total herbage	0.56	0.56
Specific leaf area (cm^2/mg):		
top half	0.26	0.26
bottom half	0.35	0.43
total herbage	0.27	0.27
New basal shoot numbers per plant*	1.4	3.4
Light penetration to base of sward	2.2%	0.8%

* Average shoot numbers after 10-15 days regrowth reach 50 per plant.

RESULTS

Table 1 presents the flowering time, shading effect and full herbage characteristics of lucerne grown either under field or c.e. conditions. Flowering time, stem height, leaf and stem distribution through the herbage profile, new basal shoot numbers, and light penetration are all very similar in both situations. Clearly the simulation of field conditions in the c.e. rooms was able to generate a comparable type of herbage morphology to field grown lucerne.

Table 2 presents the relative growth rates of the herbage in both the field and c.e. conditions during regrowth from cutting or grazing at the 1% flower stage to attainment of the same growth stage 36-37 days later. Herbage growth rates throughout the regrowth period are identical in both growth environments.

TABLE 2: Herbage relative growth rates (g/g/day) during regrowth under field and controlled environment conditions.

	Field	Controlled Environment
Week 1	0.17	0.17
Weeks 2 & 3	0.05	0.05
Weeks 4 & 5	0.02	0.02

DISCUSSION

The results indicate that the growth conditions in the c.e. room, coupled with the measures taken to reproduce sward conditions in the c.e. room, were successful in generating a type of herbage profile very similar to that produced in the field. The degree of success in the simulation of sward conditions in the c.e. room is indicated by the close similarity between the field and the c.e. grown herbage firstly in the distribution of leaf and stem through the herbage profile and secondly in the numbers of new basal shoots.

Both of these parameters are influenced by light distribution in the herbage profile (Keoghan 1970) and it is therefore interesting to note that shading levels at the bse of the sward were very similar in both the field and the c.e. conditions.

Langer and Keoghan (1970) drew attention to the difference in herbage morphology and new shoot production between lucerne grown under spaced plant and sward conditions. These differences have caused confusion in lucerne morphology studies in the past. However the work of Langer and Keoghan (1970) and the results of this study indicate that successful sward simulation in controlled environments can be achieved. The identical herbage growth rates of the lucerne in the field and the c.e. room was further evidence of the relevance of the growth conditions in the c.e. room to the field situation.

These results should give confidence for further work with sward plants in the c.e. rooms of the DSIR Climate Laboratory.

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