Effect of planting date and daylength on establishment of *Dorycnium hirustum*

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Abstract

Successful integration of new species into farming systems depends largely on the ease of establishment. This study investigated seedling vigour issues of *Dorycnium hirsutum* (L.) Ser by measuring root length and weight, and shoot length and weight of plants established at different sowing dates from June to October, over a three month growing period. The effect of daylength on shoot and root growth was also examined. A significant correlation ($P<0.05$) was observed between shoot weight, shoot height and root weight, and daylength and daytime temperatures, but there was no correlation ($P<0.05$) between root length and the above variables. A positive relationship was observed, between daylength and shoot and root DM yield, which supports the observation of good seedling growth and development for plants that were sown in August. The onset of warmer weather (mean monthly temperature of 12.3^{o}C) and longer days (mean daylength 11.9 hr) were recorded for August. However, it is important that this be considered with the need to have well developed plants to ensure survival, over the first summer period.

Key Words

Canary clover, forage, perennial legume

Introduction

Pasture productivity in the wool growing areas of the Tasmanian Midlands and Derwent Valley has been severely affected by extended periods of below average rainfall, overgrazing and the lack of well adapted, persistent herbage species (Friend et al. 1997). As a result, enterprise and whole farm profitability has been reduced and the risk of environmental degradation has increased. The situation has been exacerbated in some areas by the additional grazing pressure exerted due to browsing by native herbivores.

Dorycnium hirsutum (L.) (hairy canary clover) is a productive, leguminous shrub (Douglas and Foote 1994) that maintains green leaf and provides grazing throughout summer and autumn (Wills et al. 1989; Lane et al. 2004). Provision of low cost, high quality forage during this period can increase carrying capacity and therefore profitability, as well as reducing the risk of overgrazing (Crawford and MacFarlane 1995).

Low seedling vigour during establishment (Bell et al. 2005) is a characteristic of *D. hirsutum* that will likely influence its adoption by farmers. In addition Sheppard and Douglas (1986) have recommended *D. hirsutum* swards should not be grazed for the first two summers. An unpublished study by Eric Hall (pers comm) suggested that early spring is the preferred time for establishment of *D. hirsutum* because of the relatively vigorous growth that occurs in response to increasing temperature and daylength. However, due to Tasmania's erratic rainfall, the risk of establishment failure from an early spring sowing is relatively high. In Western Australia, Bell et al. (2005) observed the lowest mortality was recorded from a July sowing and the highest mortality was recorded from a September sowing.

The aim of this study was to investigate the effects of daylength and temperature on the establishment and growth of *D. hirsutum* in two pot studies during the period from autumn to spring.

Methods

Experiment 1

The experiment was designed with sowing date as the main treatment with six replicates in a completely randomised design.

Six seeds were sown into 150 mm diameter pots containing a standard sand:peat potting mix. The first plants were established from a sowing date of March and this was repeated at monthly intervals until October. Plants were grown in the field under ambient conditions at the University of Tasmania in Hobart for three months with an automatic watering system, before being harvested for measurement of shoot and root length and shoot and root dry matter (DM) yield. Temperature and daylength data were obtained from the Bureau of Meteorology in Hobart.

Experiment 2

This experiment was designed to examine the effect of daylength on seedling vigour of *D. hirsutum*.

Thirty six, 150 mm diameter pots, each containing four seedlings of *D. hirsutum* were established under ambient glasshouse conditions at the University of Tasmania, Hobart for a period of one month. Twelve pots were then randomly allocated to one of three daylength treatments consisting of 8, 12 or 16 hours of daylight. The daylength treatments were applied using a growth tunnel facility in a glasshouse where day-time temperature of 20 – 24^{o}C and night-time temperatures of 15^{o}C were maintained for the duration of the experiment. After one month of growth, four randomly chosen pots from each daylength treatment were harvested and the same measurements taken as described for experiment 1. The treatments continued with the remaining pots, with two further series of measurements taken at monthly intervals.

Statistical analysis

All experiments were analysed using the PROC GLM in SAS, v. 9.1 program (SAS Institute, 2003) and Fishers LSD was used to test the differences ($P \leq 0.05$) among means. For experiment 1, Pearson's correlation coefficient (SAS Institute, 2003) was calculated to correlate daylength and daytime temperatures, with root and shoot measurements.

Results and Discussion

Effect of time of sowing on the seedling vigour of D. hirsutum

There was a significant correlation ($P<0.05$) of daylength and daytime temperatures with all measurements except root length (Table 1). More vigorous shoot growth occurred, as indicated by the lower root/shoot length ratio, from August to October sowings (Figure 1). This shoot growth occurred at a time of increasing temperature and daylength (Table 2), and confirms Hall's unpublished observations, that the species is most vigorous from a spring sowing.

There was a highly significant negative correlation, between root/shoot length and both daylength and day time temperatures (Table 1). Root extension dominated growth until June, which corresponded with decreasing temperatures and daylength (Figure 1). Root/shoot length then decreased in response to increasing temperatures and daylength. Henkin (1998) and Benayas et al. (2005) observed that competition for water, rather than light, is the primary determinant of successful establishment of perennial plants in semi-arid areas. As seedling root length is independent of daylength and temperature (Table 1) and root/shoot length ratio decreased after June (Figure 1) then it is likely that the rate of root extension decreases as a response to the plant allocating a higher proportion of growth resources to shoot growth. Nicotra et al. (2002) observed that rapid root extension is a strategy of seedling establishment in dry areas where soil moisture can recede at a high rate, and seedlings allocate more resources to the main root axis, during the winter establishment period.

Table 1. Pearson correlation coefficients between daylength and daytime temperatures from March to October and *D. hirsutum* shoot and root lengths, shoot and root weights, root/shoot length and root/shoot weight.

	Shoot weight	Root weight	Shoot length	Root length	Root/shoot weight	Root/shoot length
Daylength	0.69***	0.60***	0.69***	0.11ns	0.63***	-0.73***
Day time temperature	0.40***	0.30*	0.44**	-0.24ns	-0.65***	-0.80***

*** P < 0.001;** P < 0.01; * P < 0.05; ns – not significant.

Table 2. Average day time temperatures and day length hours, for the three month growing period, per sowing month (Calculated from the Bureau of Meteorology data, Hobart).

Sowing Month	March	April	May	June	July	August	September	October
Average daytime temperatures (°C)	15.0	12.8	10.8	9.9	10.3	12.3	13.6	14.4
Average daylight hours	11.0	9.9	9.5	9.7	10.6	11.9	13.3	14.4

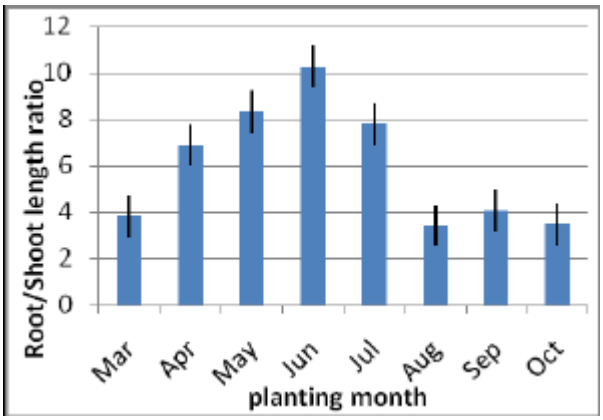

Figure 1. Effect of sowing date on root/shoot length ratio of *D. hirsutum*. Bars represent ? 0.5 Fisher's LSD. Bars that do not overlap are significantly different at p<0.05.

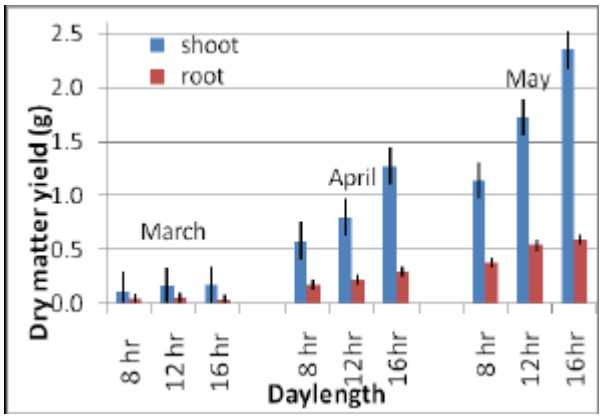

Figure 2. The effect of daylength on shoot and root DM yield (g) of *D. hirsutum* measured over three harvest dates. Separate bars for mean shoot weight and mean root weight represent ? 0.5 Fisher's LSD. Bars that do not overlap are significantly different at p<0.05.

Effect of daylength on the seedling vigour of D. hirsutum

There was a positive relationship between increasing daylength and DM production for plants harvested in April and May, two and three months after allocation to daylength treatments (Figure 2). This is suggestive of a requirement for a certain threshold of light units before *D. hirsutum* will commence vigorous growth in the early spring and confirms the strongly significant relationship between daylength and shoot growth that was observed in the first experiment. Root length data (results not shown) also confirmed the conclusion that daylength has no effect on root length. These results are in agreement with

Phillipott et al. (1991), who studied the effect of changing daylength on lucerne. Phillipott et al. (1991) proposed that shoot growth is dependent on a threshold of daily irradiance.

Conclusion

D. hirsutum seedlings were most vigorous, in terms of shoot length and DM yield, from an August sowing, a period represented by higher temperatures and longer daylength. However, as *D. hirsutum* is a perennial it is important that the plant develops an adequate root system to access soil moisture to survive the crucial first summer. These results suggest that seedling development in *D. hirsutum* is biased towards establishment of a deep root system, at the expense of root weight and shoot growth. Thus it should establish more reliably from a late winter sowing, when soil moisture levels are most dependable. As temperature and daylength increase, it is concluded that the plants allocate more resources towards shoot and root growth, with no relationship to root length.

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References

Bell LW, Moore GA, Ewing MA and Bennett SJ (2005). Establishment and summer survival of the perennial legumes *Dorycnium hirsutum* and *D. rectum* in Mediterranean environments. Australian Journal of Experimental Agriculture 45, 1245 – 1254.

Benayas JMR, Lopez-Pintor A, Garcia C, de la Camara N, Strasser R and Sal AG (2002). Early establishment of *Retama sphaerocarpa* seedlings under different levels of light, water and weed competition. Plant Ecology 159, 201 – 209.

Crawford MC and MacFarlane DJ (1995). Lucerne reduces soil moisture and increases livestock productivity in an area of high ground water recharge potential. Australian Journal of Experimental Agriculture. 35, 171 – 180.

Douglas GB and Foote AG (1994). Establishment of perennial species useful for soil conservation and as forages. New Zealand Journal of Agricultural Research 37, 1 - 9.

Friend DA, Thompson RP, Ball PD Corkrey SR and Graham BRF (1997). Pastures of the Midlands and Derwent Valley in Tasmania – Relationships to environmental and management factors. International Wool Secretariat.

Henkin Z, Seligman NG, Kafkafi V and Prinz D (1998). End of season soil water depletion in relation to growth of herbaceous vegetation in subhumid Mediterranean dwarf shrub communities on two contrasting soils. Plant and Soil 202, 317 – 326.

Lane PA, Davies SR, Hall EJ and Moore G A (2004). Dorycnium species as alternative forage plants. *R I R D C. Report* 04/159

Nicotra AB, Babicka N and Westoby M (2002). Seedling Root Anatomy and Morphology: An examination of ecological differentiation with rainfall using phylogenetically independent contrasts. Oecologia 130, 136 – 145.

Phillippot S, Allirand AM, Chartier M and Gosse G (1991). The role of different irradiations on shoot growth and root/shoot ratio in lucerne (*Medicago sativa* L.). Annals of Botany 68, 329 – 335.

SAS Institute 2003. The SAS system.v.9.1 SAS Institute, Cary, NC.

Sheppard JS and Douglas GB (1986). Management and uses of *Dorycnium sp.* Water and Soil Miscellaneous Publication 94, 260 – 262.

Wills BJ, Begg JSC and Foote AG (1989). Dorycnium species – two new legumes with potential for pasture rejuvenation and resource conservation in New Zealand. Proceedings of the New Zealand Grassland Association 50, 169 – 174.