Persistence of Red Clover (*Trifolium pratense* L.): relationships between plant population and forage yield

Fernando Ortega [A], Andrés Quiroz [B], Leonardo Parra [B], Juan Levío [A] and Muriel Melo [A]

[A] INIA-Chile, Chile, www.inia.cl
[B] Universidad de La Frontera, Laboratorio de Ecología Química, Departamento de Ciencias Químicas y Recursos Naturales, Chile, www.ufro.cl
Contact email: fortega@inia.cl

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Introduction

Red clover (*Trifolium pratense* L.) is an important forage species in temperate regions of the world; in Chile, it is a valuable resource for animal production and for the seed industry. However, the main limitation of this species worldwide is the lack of persistence related to the high mortality of plants due to a complex of multiple biotic and abiotic factors (Ortega 1996; Taylor and Quesenberry 1996). Therefore, in 1989, a red clover breeding program was started at INIA Carillanca Research Center, Chile, with the main objectives of improving the survival of plants, forage yield and persistence. Since then, two cultivars have been released to replace the old cultivar Quiñequeli-INIA: first the cultivar Redqueli-INIA and recently Superqueli-INIA. The purpose of this paper is to review the relationship between plant populations of red clover and forage yield.

Methods

We analyzed five experiments conducted at Carillanca Research Center (38°41'S and 72°25'W) under irrigated (I) conditions (sowing years 2005, 2007 and 2008) and non-irrigated (NI) conditions (sowing years 2006 and 2008). Trials were evaluated under infrequent cutting (3 to 4 cuts/season); I trials were evaluated during four seasons and NI trials during three seasons. The five trials considered the same Chilean cultivars (Quiñequeli-INIA, Redqueli-INIA and Superqueli-INIA) and seven experimental synthetics. Sowing rate was 15 kg/ha in rows separated by 20 cm; the design was complete randomized blocks with three to four replicates and plots of 5 m^2 or 12.6 m^2 each, depending on the trial. For the purpose of this paper, we evaluated plant population (plants/m^2) by non-destructive counting and forage yield (DM kg/ha). Plant population was evaluated at the beginning and end of each season by counting one metre of three central rows of each plot; forage yield was evaluated by sampling 1.2 m^2 of the central part of each plot at 10% flowering or when clover was 40-60 cm high. The relationship between plant population and forage yield was studied by linear Pearson correlations for each trial and season.

Results and discussion

In all five trials plant population decreased considerably from establishment onwards. Average plant population for the I trials in the establishment season was above 200 plants/m^2, decreasing to 30 plants/m^2 in the fourth season; while for the NI trials the decrease was faster, being similar to the I trials at establishment but decreasing in the third season to an average of 22 plants/m^2 . In all trials the correlations between plant population and forage yield were highly significant from the third season onwards (Fig. 1, I trial sown in 2005; Fig. 2, NI trial sown in 2006). In the third season the average plant population in the I trials was between 44 and 54 plants/m^2 (ranging from 17 to 70 plants/m^2 depending on trial, cultivar and synthetic). On the other hand, the average in the NI trials was between 18 and 26 plants/m^2 (ranging from 6 to 41 plants/m^2 depending on

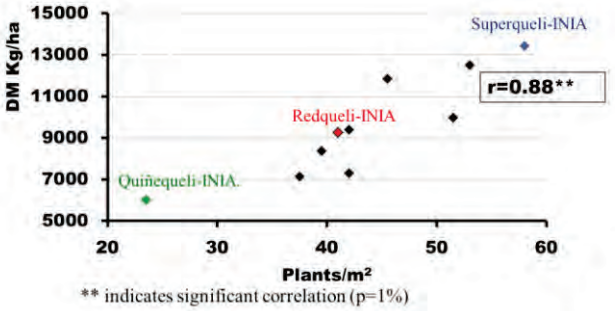

Figure 1. Relationship between plant population (plants/m^2) and forage yield (kg DM/ha) of Chilean red clover cultivars at the third season. INIA Carillance, Chile, irrigated trial sown in 2005.

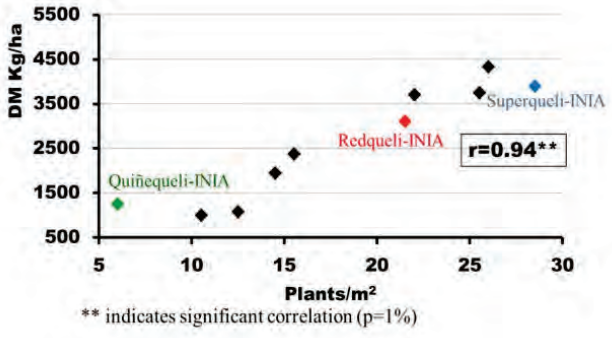

Figure 2. Relationship between plant population (plants/m^2) and forage yield (kg DM/ha) of Chilean red clover cultivars at the third season. INIA Carillance, Chile, non- irrigated trial sown in 2006.

trial, cultivar and synthetic). In all trials the new cultivar Superqueli-INIA was superior to the former cultivars Quiñequeli-INIA and Redqueli-INIA both in survival of plants, yield and persistence.

There are not enough studies of red clover plant densities and their relationships with forage yield. However, the relationship will depend on the environment, management and morpho-physiology of the genetic material. In pure stands, Jewis (1993) reported a minimum population of 30 plants/m^2 to sustain an economic production; while in mixtures with grasses, Frame *et al*. (1976) and Sheldrick *et al*. (1986) showed that a population density of around 100 plants/m^2 is low enough to affect yield. Our results are in agreement with the references since in monoculture, infrequent cutting and irrigation, an average population below 54 plants/m^2 already restricted significantly the forage yield. In the same environment but without irrigation, the critical population value was lower because forage yield potential is lower and probably fewer plants can withstand better the hydric limitation.

Conclusions

The decrease in plant population was faster with non-irrigated conditions; however, plant population that began to limit the forage yield potential was higher with irrigation. The positive and highly significant correlation between plant population and forage yield demonstrated the importance of selecting for survival of plants under field conditions with the dual aim of improving forage yield and persistence of red clover. The improved performance of the newest cultivar Superqueli-INIA is a demonstration of this successful breeding strategy.

Acknowledgments

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