Caucasian Clover is More Productive Than White Clover in Temperate Pastures

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Introduction White clover (wc) (*Trifolium repens)* is present and is often the dominant legume in the >11 m ha of grassland in New Zealand (NZ). However, wc has limitations and normally contributes less than 20% of total annual pasture dry matter (DM) production. The use of a wider range of legume species is one way to increase legume percentage in wc/grass pastures. Caucasian (Cc) or Kura clover (*Trifolium ambiguum)* is a persistent legume which is slower to establish than wc but can increase total legume production (Cc plus volunteer wc) and hence N_2 fixation and animal productivity. This paper compares the productivity of Cc and wc in irrigated and dryland environments, and relates their relative establishment success to differences in seedling development.

Materials and methods Three experiments were conducted at Lincoln University. 1) *Irrigated:* ewe hoggets were rotationally grazed on irrigated Cc/perennial ryegrass (rg) or wc/rg pastures; liveweight gain (LWG), total clover % of DM and N_2 fixation were measured in years 3 to 5 after seeding (Black *et al.*, 2000; Widdup *et al.*, 2001). 2) *Dryland:* Cc and wc monocultures were grown in dryland conditions (mean rainfall of 648mm/yr); DM production and net leaf photosynthesis rate (Pn), when light was non-limiting, were measured in years 2 to 4 (Black *et al.*, 2003). 3) *Establishment:* In growth chambers, Cc, wc and rg were grown at four mean temperatures (6.5, 10, 15 and 20ºC); seedling development was recorded until 1400ºC-days (Black *et al.*, 2002).

Results *Irrigated:* Cc/rg pastures produced more annual total clover (18 v. 11%, SED 0.6%) and greater hogget LWG (1140 v. 1040 kg/ha per year, SED 13kg) than wc/rg pastures over years 3 to 5. Both legume species had similar nutritive values (DOMD 78%, crude protein 29%). The proportion of N_2 fixed by the clovers was similar (0.56 of herbage N%) but N_2 fixation/ha was proportional to clover herbage production/ha.
Dryland: Cc produced less DM than wc in year 2 (3.6 v. 7.0 t/ha, SED 0.28 t) but more in years 3 (9.4 v. 7.0 t/ha, SED 0.84 t) and 4 (7.9 v. 4.6t/ha, SED 0.39 t). Photosynthesis rate for Cc was 6 µmol CO_2/m^2 per s higher than wc irrespective of temperature or soil moisture. Both clovers had similar temperature and soil moisture optima for Pn (21–25ºC, 1.00–0.86 of soil water-holding capacity). Thus, for any given leaf area index, the canopy Pn rate of Cc can be expected to exceed that for wc and give more assimilate/unit leaf area. This may explain the productive advantage of Cc once established. Caucasian clover was less productive than wc in autumn which suggests that photosynthates were directed to roots and rhizomes in this season. Rotational grazing to encourage a build up in root reserves in late summer/autumn may therefore be beneficial for Cc.
Establishment: Reasons for poor competitive ability of Cc seedlings were quantified. Germination, emergence and initial rates of leaf production for Cc, wc and rg were similar but secondary development in rg (375ºC-days to first tiller) and wc (532ºC-days to first stolon) were much faster than Cc which did not produce a secondary crown shoot until >1000ºC-days and the first rhizome was not initiated until >1400ºC-days.

Conclusions Once established, Cc is a persistent productive clover which is complementary to wc in temperate perennial pastures. This results in greater N_2 fixation and animal productivity/ha. The best strategy for Cc establishment is to sow in spring with minimal competition. Fast establishing species such as rg should be avoided. Low seeding rates of slow establishing grasses (e.g. timothy, tall fescue, cocksfoot) or summer brassicas (e.g. rape) are recommendations acceptable to farmers.

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