Preliminary investigations into the persistence of a vegetatively reproductive red clover cv. Astred in mixed swards

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Abstract

All red clover (*Trifolium pratense* L.) cultivars currently used in New Zealand grow from crowns and predominantly reproduce from seed. However they lack persistence in temperate pastures, particularly where grazing pressure is high. Vegetatively reproductive red clover selections that have prostrate stems that produce clonal replacement plants at nodes (plantlets) are available. A vegetatively reproductive red clover, cv. Astred was sown in mixed swards on three farm trials at Hastings, Dannevirke and Palmerston North in 1996. Each experiment had contrasting grazing pressure over time with all grazing management decisions made by each farmer. Cv. Astred parent plant persistence decreased from 30 plants/m^2 to 4 plants/m^2 at Palmerston North; however significantly more ($P<0.001$) survived at Dannevirke after two seasons than for cv. Grasslands Pawera, a crown type red clover, used as a comparison. Cv. Astred out yielded cv. Grasslands Pawera from September to November by 997 kg DM/ha (S.E.M ± 296) at the Dannevirke site and contributed 55% of pasture yield in the first summer at Palmerston North. The Hastings trial did not persist due to a dry winter after sowing, followed by a dry summer, which showed that the drought tolerance of cv. Astred and cv. Grasslands Pawera was similar. Vegetatively reproductive red clovers appear to have the potential in mixed swards to maintain a stable population through plant replacement by vegetative reproduction, but only under suitable environmental and management conditions.

Additional key words: *Astred, persistence, plantlet,* Trifolium pratense *L., vegetatively reproductive*

Introduction

Red clover (*Trifolium pratense* L.) can provide high quality summer feed in New Zealand's temperate grazing systems (Hay *et al.*, 1978; Cosgrove and Brougham, 1985; Ussher, 1986; Hay *et al.*, 1989). However, its use by farmers in pasture mixtures and for pure specialist swards has declined in recent years, due mainly to poor persistency.

Lancashire (1985) reported that red clover is one of the least persistent clovers in temperate pastures, particularly where grazing pressure is high (Cosgrove and Brougham, 1985). All red clover cultivars currently available in New Zealand grow from crowns and predominantly reproduce from seed. The crowns are susceptible to treading damage and fungal infection, particularly in winter, resulting in poor persistence (Hay *et al.*, 1989). Pure stands of red clover usually only persist three to four years, with no vegetative replacement.

Red clover selections that have prostrate stems producing clonal plants at stem nodes exist. The only cultivar with seed available in commercial quantities at the time of planting was cv. Astred which has shown improved persistency relative to crown type red clovers in grazed pastures in Tasmania (Smith, 1992). Astred red clover has a prostrate growth habit and has the ability to vegetatively reproduce(Smith, 1992; Hyslop *et al.*, 1996; Orr and Wedderburn, 1996). Cv. Astred produced both the largest and the most plantlets per parent plant when compared with other vegetatively reproductive selections in spaced plant trials (Hyslop *et al.*, 1996).

A three year sheep grazing trial in Tasmania which compared cultivars Astred, Grasslands Turoa, Grasslands Hamua and Redwest, showed cv. Astred retained 55% ground cover after three years compared to 5%, 2% and 0% for cvs. Grasslands Turoa, Grasslands Hamua and Redwest respectively(Smith and Bishop, 1993).

The perennation and productivity of vegetatively reproductive red clovers requires evaluation to determine their potential in New Zealand farming systems, and to develop appropriate management strategies to ensure clonal plantlets develop and establish.

The objective of this preliminary research was, therefore, to evaluate the plant survival and productivity of cv. Astred red clover when sown in pasture mixtures on farms with contrasting grazing management and environmental conditions.

Materials and Methods

Three field experiments were conducted using the red clover cultivars, Astred and Grasslands Pawera within pasture mixtures at three distinct meteorological sites. Cv. Grasslands Pawera was used as a comparison because it is widely considered the most persistent red clover available at present within New Zealand. At each site, the cultivars were sown in 0.2 ha strips at a rate of 5.4 kg/ha for cv. Astred and 13.3 kg/ha for cv. Grasslands Pawera which was coated. These sowing rates ensured that for both cultivars, 250 viable seeds were planted per square metre. Red clover seed was sown in addition to the other herbage species used at each site (see individual experiments). Each 0.2 ha strip was divided into 4 strata for non biased sampling and measurement. Parent plants within a 0.5 m^2 quadrat were counted every three months over all experiments. Plantlets were only counted in autumn when they were identifiable within the sward. Herbage samples were oven-dried at 80°C. All grazing management decisions were made by each farmer with grazing time and the number and type of animal recorded. Experiment 1 was grazed with young replacement dairy stock, Experiment 2 with a milking herd and Experiment 3 with beef steers, lambs, hoggets and ewes.

Experiment 1

Experiment 1 was conducted at Kiritaki Road, Dannevirke, New Zealand (latitude 40° 15' S) from September 1996 to June 1998. Annual rainfall is 1329 mm (10 year mean).

The soil type was a Kopua silt loam, with pH 5.5 and Olsen P 21 µg/g soil. The paddock was ploughed, harrowed and rolled after being in winter green feed oats, then sown on 27 September using a V ring roller drill. The red clovers were each mixed with 12 kg/ha perennial ryegrass (*Lolium perenne* L.), cv. Yatsyn 1, 4 kg/ha white clover (*Trifolium repens* L.), cv. Aran and 4 kg/ha cocksfoot (*Dactylis glomerata* L.), cv. Sarborto. Potassic 15% superphosphate 320 kg/ha was applied in spring and 75 kg/ha of urea was applied in autumn of both years. Establishment counts were taken on 4 November 1996 and 3 December 1996 using a 0.5 m^2 quadrat, and one set of plantlet counts was taken on the 27 May 1998 using a 0.25 m^2 quadrat with 12 replicates.

Experiment 2

Experiment 2 was conducted on No. 1 dairy farm, Massey University, Palmerston North, New Zealand (latitude 40° 23' S) from February 1995 to June 1998. Annual rainfall is 1031 mm (10 year mean). The soil type was a Manawatu silt loam, with pH 6.2 and Olsen P 50 ug/g soil. The paddock was sprayed with 6 l/ha Roundup (36% glyphosate) and 200 gm/ha Lorsban (9.9% chloropicrin) in 300 l of water per ha eight days before drilling on 28 February 1995. Cv. Astred was sown in a 0.2 ha strip with 12 kg/ha perennial ryegrass cv. Embassy, 3 kg/ha white clover cv. Grasslands Kopu and 2 kg/ha of white clover cv. Grasslands Tahora. Cv. Grasslands Pawera was not sown at this site. Diammonium phosphate (D.A.P, 150 kg/ha) was drilled with the seed, and 300 kg/ha of 50% potassic superphosphate, 200 kg/ha D.A.P + selenium and 120 kg/ha urea were applied within the years of 1996 and 1997. In 1996 establishment counts were taken on 5 March, 11 March, 18 March, 26 March and 4 April by measuring 20 randomly selected, one metre row sections. Herbage accumulation was measured from 8 pre- and post-grazing dry matter cuts using 0.1 m^2 quadrats, and botanical composition was determined from eight subsamples dissected into red clover and other species at each grazing. Plantlets were counted on 6 June 1997 using a 0.5 m^2 quadrat and 12 replicates.

Experiment 3

Experiment 3 was sited at "Turamoe", Hawkes Bay, New Zealand (latitude 39° 42' S) from May 1996 to June 1998. Annual rainfall is 710 mm (10 year mean). The soil type was a Noi II sandy loam on clay pan, with pH 5.4 and Olsen P 15 ug/g soil. The paddock was sprayed with 6 l/ha Roundup (36% glyphosate) in 300 l water per ha, two weeks before sowing, then grazed down to 400 kg DM/ha residual at drilling. The red clovers were sown on 5 May 1996 in a mixture of 25 kg/ha grazing brome (*Bromus inermis* cv. Grasslands Gala) and 5 kg/ha white clover cv. Grasslands Prop using a Bioblade cross slot direct drill with 120 kg/ha of Cropmaster 20 (20N - 10P - 0K) drilled with the seed. Establishment counts were made on 12 June 1996 and 20 July 1996 by measuring 20, one metre row sections. Cropmaster 20 (125 kg/ha) was applied in late autumn of 1997 and 1998.

Results

Plant population

Established plant populations varied substantially between sites (from 7-37 plants/m^2), even though sowing rates of viable seed did not differ (Fig. 1). Significant differences ($P<0.05$) between cv. Astred and cv. Grasslands Pawera populations did not start to become apparent until the spring of 1997 for experiment 1. The last measurement of plant population in Experiment 1 on

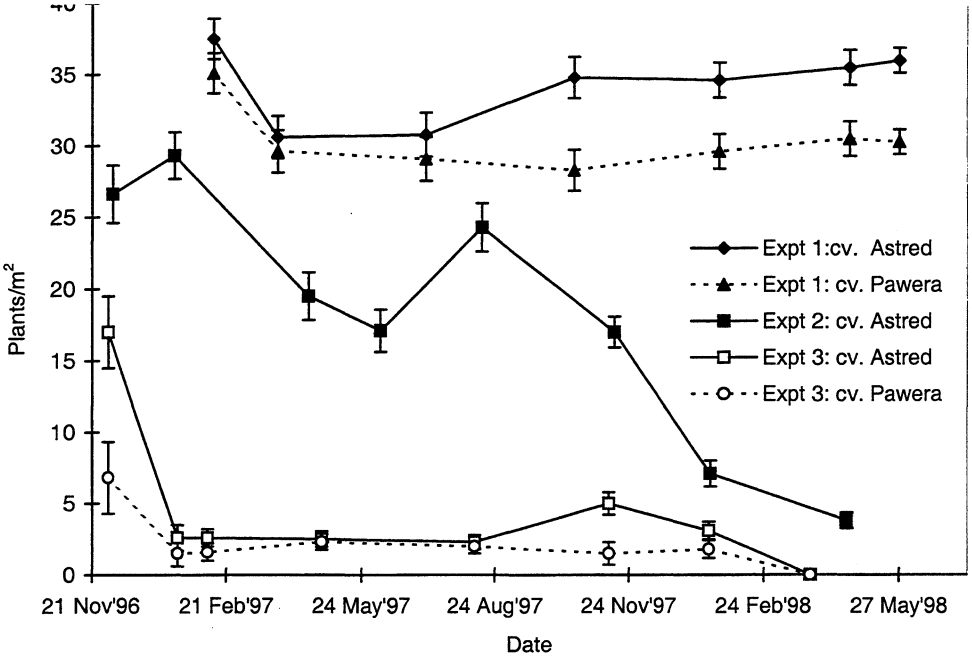

Figure 1. Parent plant populations of cv. Astred and cv. Grasslands Pawera in mixed swards over time. Vertical lines represent ± SEM.

27/5/98 showed a significant ($P<0.001$) difference between cultivars with Astred and Grasslands Pawera having 36 and 30 plants/m^2 (S.E.M ± 0.87), respectively. Plantlet density in cv. Astred on 27/5/98 was 64 plantlets/m^2 (S.E.M ± 1.7). Cv. Grasslands Pawera did not produce plantlets.

In experiment 2, parent plant numbers of cv. Astred steadily declined from 30 plants/m^2 (1996) to 4 plants/m^2 (1998), except for an increase in winter/spring 1997 when plantlets that were formed in autumn (14 plantlets/m^2; S.E.M ± 2.4) were counted as independent parent plants (Fig. 1).

Late sowing in autumn (May) led to a poor establishment (7-17 plants/m^2) in Experiment 3 (Fig. 1) and a very dry spring in 1996 meant that plant numbers did not recover. Rainfalls of 54(92), 27(83) and 19 mm (79) were recorded for August, September and October respectively at this site(normal monthly average in brackets). Complete parent plant population death occurred in the summer of 1998 due to lack of soil moisture (Fig. 1).

Grazing pressure

Grazing pressure was calculated as average stock units per hectare (SU/ha) with grazing days for each season recorded for each experimental paddock. Average SU/ha were used because of the variety of stock across experiments and the different frequencies of grazing events. Total stock unit grazing-days per hectare (SUgd/ha) indicated the overall total grazing pressure received by each experiment from sowing (Table 1). Experiment 2 had three times more grazing pressure than experiment 3 and three and a half times the grazing pressure of experiment 1, after allowing for the different sowing dates.

Herbage accumulation

In Experiment 2 the cv. Astred red clover component produced 1483(S.E.M ± 46.4) and 2410(S.E.M ± 25.0) kg DM/ha in spring and summer of 1996/1997, compared to 4446 (S.E.M ± 239.1) and 1995 (S.E.M ± 159.1) kg DM/ha for the rest of the sward components (Fig. 2). This equated to 55% of the production coming from the

Table 1. Grazing pressure and grazing duration for the three experiments[1].

				1996/97				1997/98		total
	autumn	winter	spring	summer	autumn	winter	spring	summer	autumn	SUgd/ha
Eexpt 1	-	-	-	110(13)	110(6)	78(25)	cut	78(25)	78(15)	7160
Expt 2	904(2)	904(1)	904(4)	904(2)	904(3)	294(4)	cut	294(8)	294(6)	16735
Expt 3	-	53(2)	113(5)	14(22)	57(18)	61(17)	135(9)	132(10)	-	5577

[1] Units: stock units/ha and, in parentheses, days grazed. Stock units based on; ewe 1.0, hogget 0.8, lamb 0.6, beef steer 4.7, cow 7.5, dairy yearling 3.5, dairy weaner 2.5

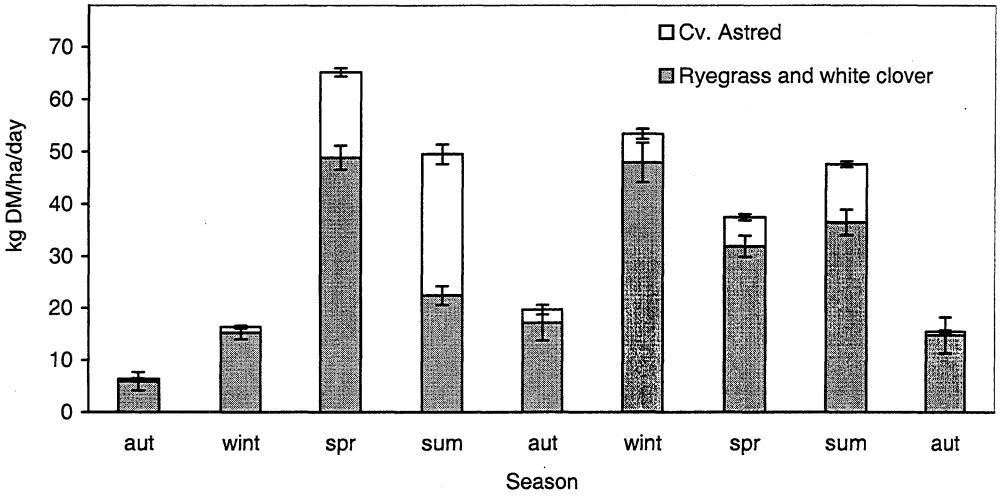

Figure 2. Herbage dry matter accumulation of cv. Astred in a mixed sward at Palmerston North. Vertical lines represent ± SEM.

red clover for that summer period. Total production over the experimental period of 26 months comprised 21,917 kg DM/ha ryegrass/white clover (S.E.M ± 2232.4) and 6338 kg DM/ha of red clover (S.E.M ± 607.5), with 4038 kg DM/ha of red clover being produced in the first year.

Silage production

In Experiment 1 with a conservation period of 102 days, cv. Astred produced 997 kg DM/ha more than cv. Grasslands Pawera and contributed 43% of the total yield compared to 34% for cv. Grasslands Pawera (Table 2). This cut was taken on 7/11/97, one year from sowing

Table 2. Silage produced (kg DM/ha) over 102 days to 7 Nov '97 in Experiment 1 and over 53 days to 21 Nov '97 in Experiment 2.

Expt	Cultivar	Plants/m^2	Ryegrass/ whiteclover	Red clover	Total	SEM
1.	Astred	35	4477	3425	7902	296
1.	Grasslands Pawera	30	4525	2380	6905	296
2.	Astred	15	5192	435	5627	240

and with respective parent plant densities of 35 plants/m^2 and 30 plants/m^2 for cv. Astred and cv. Grasslands Pawera. In contrast, cv. Astred produced only 7.7% of the silage yield in Experiment 2 when cut 1.75 years from sowing with a conservation period of 53 days (Table 2). Parent plant density had declined to 15 plants/m^2. The mean dry matter production per plant per day for cv. Astred was 0.96 kg in Experiment 1 and 0.55 kg in Experiment 2.

Discussion and Conclusions

Cv. Astred red clover appears to have similar susceptibility to drought (Experiment 3) and intensive grazing pressure (Experiment 2) as cv. Grasslands Pawera. However, the increase in plant density in cv. Astred in its second growing season in Experiment 1 where the grazing pressure was less than in Experiment 2, and the increase in plant density during spring in Experiment 2, suggested that cv. Astred has the potential for greater persistence than cv. Grasslands Pawera when conditions are suitable for plantlet production and survival.

Similar results were reported by Smith and Bishop, (1993) in Tasmania. Therefore, like cv. Grasslands Pawera the persistency of cv. Astred will be dependent on the intensity, frequency and timing of grazing (Cosgrove and Brougham, 1985).

When grazing pressure was high, and sometimes very high in the case of winter break grazing, parent plant density of cv. Astred declined over time, despite evidence that some plantlets were produced in autumn and survived into spring (Experiment 2). This decline in plant density demonstrated that management based on what a mixed pasture can withstand, but not taking into account the requirements of red clover, is as detrimental to cv. Astred as it is to crown type red clovers (Cosgrove and Brougham, 1985; Hay *et al.*, 1989). Although both cv. Astred and cv. Grasslands Pawera maintained an effective plant population of greater than 30 plants/m^2 (Hay *et al.*, 1989) under the grazing management in Experiment 1, the increase in plant density of cv. Astred in the second growing season showed that this cultivar can produce new vegetative plants in a grazed pasture. Further monitoring of the experiment will be required before the capacity of cv. Astred to maintain an effective plant density in a pasture beyond the two to three years usually achieved by cv. Grasslands Pawera can be determined. Grazing management that ensures cv. Astred produces plantlets which persist will need to be developed.

When grown as spaced plants, cv. Astred has produced up to 150 plantlets per plant, so it has the potential to develop a self-sustaining plant population (Hyslop *et al.*, 1996). The dynamics of plantlet initiation and development are poorly understood at present, but plantlets mainly develop in autumn on branches of old stems (Hyslop, unpublished data).

Cv. Astred is an early season, early flowering type of red clover (Hyslop unpublished data) of Mediterranean origins, and has a comparable growth pattern to cv. Grasslands Colenso and cv. Grasslands Hamua, whereas cv. Grasslands Pawera peaks and flowers later in the growing season (Rumball, 1983).

The higher winter activity of cv. Astred could be useful in a mixed forage for calving cows or for adding quality and bulk to the first silage cut of the season. The making of silage had no serious adverse effect on the number of plantlets produced.

Further research is underway to develop practical grazing management recommendations for the maintenance of vegetatively reproductive red clover in swards.

Acknowledgements

The authors are grateful to P.R and J. MacIntyre, E. Ross and Massey University for the use of land to conduct these experiments. The authors also thank M. Osborne and the late T.J. Lynch for their technical assistance, Wrightsons Seeds Ltd. for the provision of Seed and the David Johnstone Memorial Trust for stipend support for M.G. Hyslop.

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