Subterranean clover persistence in south-western Victoria

P.E. Quigley, J. Gittins and T. Morgan

Department of Agriculture, Pastoral Research Institute, Private Bag 105, Hamilton VIC 3300

Summary. Data were collected from 12 randomly selected paddock sites within a 1,500 km2 land corridor. Subterranean clover seed reserves were suboptimal in autumn 1989 (1760 seeds/ m^2) but increased substantially after spring (6,650 seeds/m^2, measured in autumn 1990). In 1990, few seeds contributed to the spring plant density of subterranean clover, as there was a 1:10 ratio between plant density and seed reserve. This was presumed to be caused by a high proportion of hard seed in autumn. The majority of the sites were grossly undergrazed, indicated by high proportions of dead matter present in the swards in mid-winter. The percentage of dead vegetation in the sward during mid-winter was negatively related to the plant density of clover, measured in spring.

Introduction

The success of subterranean clover, *Trifolium subterraneum,* depends on its ability to establish and maintain dense plant populations. Although this criterion may depend on a number of specific factors, the main one determining subterranean clover persistence, over many years, is its ability to maintain an adequate seed reserve in the soil. The plant must be able to initially produce large quantities of seed for regeneration in the following pasture year, even for moderate seedling densities. To achieve an adequate plant density, it has been suggested that a minimum subterranean clover seed reserve of approximately 200 kg/ha is desirable at the time of the first autumn rains (2). The influence of thermal insulation of annual legume seed through cover by soil and vegetation remaining from the previous growing season has been shown to be important for natural regeneration (5). The following study was undertaken to examine factors which may be limiting plant density and hence herbage production in pastoral districts of south-western Victoria.

Methods

The 12 pastoral sites used were located within a representative 'corridor' area of the region which extends in a band, 30 km wide, from 20 km north of Ararat, south to Mortlake, passing through Lake Bolac and Streatham. It was chosen because the major soil types found in the region were represented; it included typical rainfall patterns from 500 to 650 mm annual rainfall; and the important grazing industries including sheep and beef occur within the corridor. All sites were chosen at random and are likely to be a representative sample of pasture. Further information on the sites including rainfall, soil fertility, and botanical composition has been reported (6).

The subterranean clover seed reserves for autumn 1989 and 1990 were measured by taking 15 pairs of soil cores (76.7 cm^2 x 5 cm deep) from an area of 30x30 m in each paddock. The soil cores were air dried, crushed and hand sieved through a 1.18 mm mesh sieve to remove the finer soil particles and vegetable matter. Perchloroethylene was used to separate the seed from the remaining gravel and sand (1). The seed/burr samples were air dried and mechanically threshed then seeds were counted and weighed.

To compare the seed reserve between autumn 1990 and the following spring, additional cores were obtained from three sites. The sites were chosen on the basis of high, medium and low seed reserves determined from the autumn seed count. The subsequent soil cores were wet sieved through a 1.18 mm^2 mesh sieve then the remaining organic matter was air-dried and threshed. Seeds were counted and weighed.

The subterranean clover plant densities were determined by counts in randomly placed quadrats within an overall area of approx 2,000 m^2 at each site. Three different sized quadrats were used (32 cm^2, 21.2 cm^2 and 16.2 cm^2), with the chosen quadrat size dependent on a visual estimate of the subterranean clover plant density, i.e. if the plants were very sparse the large quadrat was used, and the converse. Acceptable error in the estimate of plant density was obtained through varying the number of quadrats at each site.

The proportion of dead vegetation, in each sward, was measured from hand-sorted samples over the July-August period in 1990. Randomly selected samples of herbage were harvested at ground-level from 40 areas, each approximately 30 cm^2 and hulked.

Results and discussion

Comparison of seed reserves between autumn 1989 and autumn 1990

The mean subterranean clover seed reserve in autumn 1990 (Table 1) was significantly greater than that in the previous year (1.s.d. (P=0.05) =590). There were significant increments at all sites with the exceptions of sites 6, 11 and 12. The l.s.d. (P=0.05) for comparison between years at each site was 2050.

Although there was about a four-fold increase in average seed reserve, the increase between sites varied considerably. For example, at site 2 there was nearly a six-fold increase in seed reserve, whereas at sites 4 and 10, which had similar seed reserves in autumn 1989, the seed reserves only doubled.

Table 1. Measurements of subterranean clover from 12 randomly selected sites.

Site no.	1989 Seed reserve (seeds/m²)	1990 Seed reserve (seeds/m²)	(kg/ha)	Plant density (plants/m²)	Seed Weight (mg)
1	2400	9070	398	1230 ± 172	4.4
2	2730	15200	654	1440 ± 299	4.3
3	4450	15820	1080	1150 ± 252	6.8
4	2590	5500	275	1080 ± 237	5.0
5	670	8900	463	621 ± 170	5.2
6	1340	3280	167	101 ± 37	5.1
7	1550	5040	252	189 ± 68	5.0
8	900	4290	202	643 ± 257	4.7
9	740	3480	192	600 ± 171	5.5
10	2250	5010	170	156 ± 54	3.4
11	470	2290	110	31 ± 6	4.8
12	990	1910	84	152 ± 41	4.4
Mean	1590	6650	337	616	4.9

? 95% confidence limit

Five of the sites had seed reserves of less than 200 kg/ha in autumn 1990 and only one site (site 3) had more than 200 kg/ha in autumn 1989. These low seed densities suggest that this problem may be common in the district. The above average rainfall in spring 1989, particularly in October, extended the growing season and permitted a large seed set of subterranean clover. Grazing management would have also affected these increases. For example, at site 2, where there was nearly a six-fold increase in seed reserve, the pasture had high stocking rates compared to other sites in the study (6). Defoliation increases the rate of flower inflorescence production and promotes burr burial (3). These differences would account for the large seed reserves found in autumn 1990.

All the sites, except for site 3, predominantly contained blackseeded, *T. subterraneum* cultivars, likely to be Mt Barker. Site 3 had about 50% of white seed which was probably *T. yanninicum* c v. Trikkala.

Comparison of seed reserves and seed weights between autumn and spring 1990

For the comparative analysis of seed reserves between autumn and spring 1990, the three sites sampled in spring were 2, 9 and 12, that is, they had high, medium and low seed reserves respectively. At all three sites there was no significant difference between the seed reserves in autumn and spring (Table 2). There would have been a decrease in seed reserve between autumn and spring to account for the seedlings established, however, this was only a small proportion of the seed reserve and the quantity was smaller than the errors associated with the estimates of the seed reserve in both seasons.

For the three sites, there were no significant differences between autumn and spring seed weights (Table 2). However, there was a significant difference in mean seed weight between the three sites ($P<0.01$), with the site containing the medium seed reserve recording the highest seed weight.

Table 2. Comparison of seed reserves and seed weights between autumn and spring 1990.

Site no.	Seed reserve		Mean seed weight	
	Autumn (seeds/m^2)	Spring	Autumn (mg)	Spring
2	15200	16560	4.3	4.1
9	3480	3430	5.5	5.4
12	1910	2280	4.4	4.6
l.s.d. (P=0.05) between sites	1580		0.6	

Relationship between subterranean clover seed reserve and plant density

The autumn seed reserve and spring plant density (SPD) measured from each site is shown in Table 1. The mean seed reserve for all sites in autumn was 6,650 seeds/m^2, and the mean plant density was 616 plants/m^2. However, there was a high degree of variation, so the average measurements are not a useful representation of the pasture status in this region. Regression analysis showed that the relationship between these two factors was linear (Equation 1) and there was approximately a 1:10 ratio between SPD and seed reserve(?standard error of constant and coefficient in parentheses) .

SPD = 30(?166) + 0.09(?0.022)SRr^2 = 0.64, RSD = 315 Equation 1.
where: SPD = spring plant density (plants/m^2); SR = soil seed reserve (seeds/m2).

Use of a curvilinear model of the general form $Y = a + bX + c/X$ did not improve the fit to the data.

Increased levels of hard-seededness at the end of spring and reduced rate of breakdown of hardseed over summer, due to the good growing conditions during seed set in 1989, are consistent with the earlier results of Collins (4).

Relationship between dead herbage and subterranean clover plant density

The proportion of dead herbage in the sward (data not presented), which ranged between 2-76%, was negatively related to the subterranean clover spring plant density. The linear equation describing this is given below (Equation 2) including the s.e. of the constant and coefficient in parentheses:

SPD = 1137(?153) - 14.7(?3.5)D *r2* = 0.64, RSD = 315 Equation 2.
where: SPD = spring plant density (plants/m^2); D = dead matter (% total dry matter)

The high proportion of dead matter on many of the sites (6) was an example of how the pastures were grossly undergrazed. During the 1990 winter period, 8 of the 12 pastures had a dead matter fraction which exceeded 20% of total dry matter; of these, six6sites had a dead matter fraction exceeding 57% of total dry matter. In addition, correlation analysis indicated that the level of dead matter in 1990 was positively related to the level of dead matter in the previous year. This indicates that the dead matter has been a consistent component in the pasture sward, hence the pastures have been undergrazed for at least three years. The considerable quantities of dry vegetation covering the soil over summer would have reduced the rate of softening of seed of subterranean clover.

As a consequence of the excessive dead matter, and the additional problem of sub-optimal seed reserves, many of the pastures had poor subterranean clover densities and concomitant growth. With inadequate densities of both subterranean clover and improved grasses, the pastures were dominated by low quality grasses such as barley grass, *Hordeum murinum,* silver grass, *Vulpia bromoides,* and Yorkshire fog grass, *Holcus lanatus (6).* The last species, in particular, is generally associated with low stocking rate regimes (J. Cayley, pers. comm., 1990).

References

1. Carter, E.D., Challis, S. and Ridgeway, I.A. 1977. Proc. XIII Int. Grassld Cong., Leipzig. pp. 735-738.

2. Carter, E.D. and Cochrane, M.J. 1985. Proc. 3rd Aust. Agron. Conf., Hobart. p. 217.

3. Collins, W.J. 1978. Aust. J. Agric. Res. 29, 789-801.

4. Collins, W.J. 1981. Aust. J. Agric. Res. 32, 783-792.

5. Quigley, P.E. and Carter, E.D. 1989. Proc. XVI Int. Grassld Cong., Nice. pp. 15471548.

6. Quigley, P.E., Morgan, T. and Ward, G.N. 1990. In: Research Review 1989-90,

7. Pastoral Research Institute, Hamilton. (Eds J. Cayley, N. Draffen and J. Graham) pp. 133-136.