Evaluating Cultivars of Subterranean Clover in Monoculture or with Perennial Ryegrass

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ABSTRACT
Over four years, sowing perennial ryegrass (*Lolium perenne*) with a range of subterranean clover ("sub clover", *Trifolium subterraneum*) cultivars was found to reduce the yield of clover per se by 31% and increase pasture yield by 11%. For one high-producing experimental variety, the presence of grass did not reduce clover yield (P<0.001). Clover yield in monoculture plots was poorly correlated with that measured in mixed swards (r = 0.44), but clover yield (± grass) was correlated with total herbage yield (r = 0.94). Clover seed yield was not reduced by the presence of grass. However, in year 2 - but not in the establishment year - grass reduced seed weight. Irrespective of grass treatment, the new late maturing cultivar, Leura outyielded the other commercial cultivars (P<0.05). Enfield and Enfield x Daliak crosses set the most seed and regenerated with a greater density than other cultivars (P<0.05) - apart from Leura. It was concluded that the winter-active, late maturing cultivar, Leura, will compete most successfully with perennial ryegrass.

KEYWORDS
Subterranean clover, perennial ryegrass, cultivars, seed yield, regeneration

INTRODUCTION
In south western Victoria rainfall is reliable; hard seed is not required and the long growing season requires late maturing cultivars to utilise soil moisture. Permanent pastures are common and farmers sow sub clover with perennial grass. With the release of Larisa and Leura, attention has focused on the potential of such late-maturing cultivars to extend the supply of quality pasture/hay. Early trials on monocultures (Reed et al., 1985) have been followed by more recent trials measuring clover production in perennial ryegrass pasture (Clark and Hirth, 1987). The present study examined both a range of cultivars, and experimental varieties (selected to replace Woogenellup and Enfield) competing with perennial ryegrass, and the usefulness of monocultures for predicting cultivar performance in grass clover mixtures.

METHODS
A field experiment was established on May 8th, 1989 on a hard-setting, clay loam at Hamilton, Victoria - mean annual rainfall, 700 mm, pH ($CaCl_2$) 4.5. The experiment had a split plot design with presence (+ grass) or absence (- grass) of perennial ryegrass as the main plots; there were three replicates. Main plots were split into 11 sub-plots of 5 x 1.4 m (cultivars, Table 1). Seed was scarified and inoculated. Woogenellup was sown at 16 kg/ha of pure live seed (PLS); other cultivars were sown on an equivalent PLS basis. Low endophyte perennial ryegrass seed (cv. Ellett) was sown at 5 kg/ha.

The 11 clover cultivars represented sub species *T.s. yanninicum* (Trikkala), T.s. *brachycalycinum* (Nuba) and a range of early-mid season to late maturing cultivars/experimental varieties of *T.s. subterraneum*. Plots were sprayed with MCPA amine and omethoate on 29th June to control weeds and mites. Plots were sown with 200 kg/ha of a 1:1 mix of lime-superphosphate, containing molybdenum (0.015%). Subsequent dressings provided 28 kg phosphorus and 70 kg potassium/ha/year.

The field experiment was rotationally grazed by sheep. Ten occasional harvests were taken over 4 years. Each time 10 random samples were cut at 2 cm to determine botanical composition (dry matter (DM) basis). Plots were harvested at 2 cm with a mower and the herbage weighed and sampled for DM. Seed numbers and yield were measured annually (for 7 cultivars) in early February by removing 10 soil cores (8 cm diameter; 6 cm deep; 6 cores only in 1991) per sub-plot. Regenerating seedlings were counted in random quadrats (5/sub plot; 10 x 10 cm) on 18th April 1991. Results were subjected to analysis of variance.

RESULTS AND DISCUSSION
Herbage yield. The yield of herbage (Table 1) depended on cultivar (P<0.001). Leura treatments produced more herbage than any others apart from Enfield and BD15AB7 (P<0.05). The presence of grass reduced the clover proportion in the herbage and increased yield by 11.7% (P = 0.05); there was no significant interaction.

Clover yield. The yield of clover per se depended on cultivar (P<0.05). Grass reduced the yield of clover by 31.5% (P<0.01). The interaction was significant; grass did not reduce the yield of clover for Woogenellup, Nuba or BD15AB7 (P<0.001). Of these three, only BD15AB7 had a relatively high yield of clover. Between cultivars, the clover yield was correlated with the yield of all herbage: r = 0.94 (- grass), r = 0.84 (+ grass), r = 0.94, (+ grass). Between grass treatments, clover yield (r = 0.44) and herbage yield (r = 0.67) were poorly correlated.

Seed set. With seed numbers and yield, the grass by cultivar interaction was only significant in 1991 (P<0.01) when grass had no effect on Woogenellup. Consequently the data are presented as main effects (Table 2). Seed numbers were lowest in February, 1992 after a dry year in which October rain was 19 mm (cf. long term average of 66 mm). Grass did not reduce the weight or number of seeds set in the establishment year (P>0.05). Differences in seed yield between grass treatments were similar to those of Evans and Hall (1995) but were not significant. Amongst established grass in the second year, seed weight was reduced by 8.5% (P<0.05). All seed measurements were affected by cultivar (P<0.001). In each of three years either Enfield or ED3.19 produced the most seeds; Woogenellup the least. The seed yield of Trikkala was greater than any other cultivar in 1990 (P<0.05) but equal to Enfield and ED3.19 in 1991.

Most work on grass sub clover competition has been with Phalaris aquatica L. Perennial ryegrass has a longer growing season than Phalaris, and restricts sub clover more (Reed, 1974). The presence of endophyte in perennial ryegrass may further increase this effect (Snell and Quigley, 1993). Woogenellup is not productive in south western Victoria (Reed et al., 1985). The autumn regeneration by Enfield (and its derivatives) was almost double that of the other cultivars. These findings, together with results confirming the high yield potential of Leura (CPI 89822H), support those of Clark and Hirth (1987) and Evans et al. (1992). Individual harvests indicated Enfield was the most suitable cultivar for autumn - early winter production, and that Leura produced well in autumn-winter relative to Trikkala and other winter-active cultivars.

The unique ability of BD15AB7 to maintain a high yield of clover when sown with grass illustrates the risk of selecting varieties on monoculture performance. It was concluded that winter-active, late season cultivars are best suited to competing with perennial ryegrass.

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Table 1
Main effects of perennial ryegrass, and cultivar of clover, on herbage production and seedling density.

Main effect	Clover DM (t/ha)			Total herbage DM (t/ha)			Seedlings (no./m2)
	- grass	+ grass	mean	- grass	+ grass	mean	- grass
*Cultivar**							
Trikkala	6.64	4.20	5.42	10.84	11.92	11.38	827
Nuba	3.21	3.60	3.41	9.21	11.29	10.25	440
BD15AB7	5.57	5.69	5.63	10.73	12.68	11.70	600
BD15AB8	6.79	4.54	5.66	11.93	13.09	12.51	780
BD5.5	4.71	2.91	3.81	10.13	11.21	10.67	547
Woodenellup	3.84	4.04	3.94	9.53	11.98	10.75	687
Enfield	7.30	3.66	5.48	12.11	11.92	12.01	1527
ED3.17	6.52	3.95	5.24	10.99	12.52	11.75	1700
ED3.19	7.02	4.25	5.63	11.01	12.50	11.76	1433
Karridale	7.30	3.66	5.12	11.11	11.63	11.37	853
Leura	8.96	5.74	7.35	12.37	13.31	12.84	1193
Mean	6.12	4.19	5.15	10.90	12.18	11.54	962.5
LSD (P=0.05):							
Main effects: grass		0.901			1.318		-
cultivar		0.872			0.953		358.2
Grass x cv.: within cv.		1.233			1.347		-
between cv.		1.248			1.426		-

* BD = Burnley x Daliak cross; ED = Enfield x Daliak cross.

Table 2
Main effects of grass presence, and cultivar, on seed bank of sub clover in February.

Main effect	Mean weight of seed (mg)		Number of seeds (Square root no./m2)			Seed yield (t/ha)	
	1990	1991	1990	1991	1992#	1990	1991
Cultivar							
Trikkala	7.89	6.95	111.4	112.0	75.7	0.98	0.95
BD15AB8	6.64	6.50	82.4	77.4	45.2	0.48	0.46
Woogenellup	7.22	6.24	79.9	72.8	41.1	0.46	0.34
Enfield	4.48	4.06	123.4	136.8	80.9	0.70	0.88
ED3.19	4.95	4.26	119.5	147.9	72.0	0.71	1.03
Karridale	5.01	4.56	97.7	113.5	66.8	0.56	0.65
Leura	4.62	4.29	99.8	121.8	68.8	0.46	0.69
LSD(P=0.05) ±grass	0.65	0.67	17.13	19.15	17.45	0.165	0.239
-grass	5.86	5.50	103.7	138.2	74.7	0.64	1.06
+grass	5.81	5.03	100.3	85.3	54.0	0.59	0.37
LSD(P=0.05)	0.62	0.32	38.81	59.85	9.40	0.424	0.868

\# Two replicates.