A monitoring protocol for annual ley pastures

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ABSTRACT

After preliminary observations and discussions with a farmer focus group near Wagga Wagga, a range of experimental subterranean clover (*Trifolium subterraneum*) pastures were generated through the use of various agronomic treatments, among them seeding rate and grass management treatments. These pastures were monitored while they were grazed over two years (1995 and 1996), using several parameters applicable to grazed pastures (seed/seedling population, ground cover, botanical composition, growth and biomass). The biomass and pasture growth parameters measured in the two field experiments were used to calibrate the GrassGro model, which was then used to estimate production targets for growth, biomass and N fixation using historic climatic data for Wagga Wagga, Lockhart, Condobolin and Tamworth. A benchmarking protocol for monitoring the performance of annual ley pastures based on subterranean clover is proposed and discussed.

Key Words

Subterranean clover, pasture, ley, monitoring.

INTRODUCTION

In recent years, on-farm improvement in pasture production has languished behind improvements in crop production. Declines in medic and clover pastures in southern Australia have been widely reported (1, 5, 7) and attributed to ecological factors and poor management. Farmers have willingly embraced the concept of crop monitoring systems such as TOPCROP (12) and pasture management courses such as Prograze (8). However, the recognition and correction of problem pastures on farms is inhibited by the current absence of a common language for describing the status of pastures (3). Furthermore, there is a need for a standard set of descriptors or indicators of pasture production, and simple techniques for measuring pasture attributes, to provide managers with performance benchmarks.

Following discussions with a group of 5 farmers in the Wagga Wagga - Lockhart area of southern NSW a preliminary monitoring protocol was developed from the available literature and tested on-farm and in a set of experiments. Two field experiments at Wagga Wagga in southern NSW were conducted in order to produce and monitor subterranean clover pastures from which indicators and benchmarks of pasture productivity could be determined and/or refined. The use of the GrassGro model (10), for estimating the probability of achieving production targets and calculating the nitrogen added by ley pastures, is demonstrated and discussed.

METHOD

At a site on the Charles Sturt University farm, mini-swards of subterranean clover were sown in 1994 and grown in 1995 and 1996 in two experiments. Experiment 1 comprised three clover seeding rate treatments (0.7, 7 and 70 kg ha^{-1}) and three clover cultivar treatments (Dalkeith, Junee and Woogenellup), and this experiment was winter-cleaned to control broadleaf and grass weeds. From this experiment, the results reported here are from the intermediate density treatment, averaged over cultivars. Experiment 2 comprised two fertiliser treatments (100 or 300 kg ha^{-1} Mo superphosphate), three grass management treatments (control, a winter-cleaned treatment and a grass/clover treatment with ryegrass sown to give 100 plants m^{-2} in 1994) and two clover cultivar treatments (Dalkeith or Junee sown at 7 kg ha^{-1}). From Experiment 2, only the values from the grass/clover treatment, averaged over the fertiliser x clover cultivar treatments, are reported. Both experiments contained four replicates and were arranged in a randomised complete block design.

After the initial establishment period in 1994, the site was continually stocked with sheep. Throughout 1995 and 1996 the stocking rate was constant at 10 dry sheep equivalents (DSE) per ha. At four-weekly intervals, the pastures were assessed in terms of the following parameters: pasture cover (green and dead herbage as a % of total area), botanical composition (% of all green herbage), height (cm) and biomass (kg green DM ha^{-1}). Less frequently, the pastures were assessed for clover population (seed and seedling numbers), disease incidence, pasture growth (early spring), nitrogen fixation by the legume component and available soil nitrogen. Simulation modelling was carried out using GrassGro for Windows software, version 2.3.0a, set for a grazing wether enterprise.

RESULTS AND DISCUSSION

Rainfall in the 1994 growing season (April to November inclusive) was well below average (169 mm) and if not for some supplementary irrigation in September (30 mm) and October (60 mm) the clover may have failed to flower and set seed. In 1995 and 1996, rainfall during the growing season (531 mm and 461 mm, respectively) was favourable for growth, flowering and seed set.

Population dynamics

The number of clover seedlings present after the autumn break is an easily measured indicator of potential pasture productivity, particularly during the autumn and winter periods when growth is density dependent (2). The medium density treatment in Experiment 1 produced a clover population of 133, 550 and 837 plants m^{-2} in winter 1994, autumn 1995, and autumn 1996 respectively, demonstrating the potential of this population statistic to improve in clover swards given favourable years. In autumn 1996 in Experiment 2, the average clover population for the grass/clover and clover pastures was 338 and 608 plants m^{-2} respectively (l.s.d. $P<0.05$ = 125 plants m^{-2}). Whilst previous studies have proposed 1500 to 2000 plants m^{-2} as being an optimum benchmark for subterranean clover (2), the findings of this study and a companion early growth study (not reported) indicate that a practical target value on-farm is around 1000 plants m^{-2}.

In both experiments, Dalkeith and Junee were persistent in terms of seed reserves and seedling numbers but the soft-seededness of the Woogenellup variety predisposed it to seed bank decline under the conditions experienced. Our findings agreed broadly with those of Dear (4), indicating that for persistence in the Wagga Wagga environment subterranean clover seed pools of at least 700 kg ha^{-1} (summer) and 350 kg ha^{-1} (winter) are required.

Cover and composition

The monitoring of cover and botanical composition is perhaps the simplest and easiest way to assess pasture status. Throughout this study, the rod-point method (9) proved to be a simple, useful tool for assessing these parameters.

In 1995, the removal of non-legumes by winter cleaning in Experiment 1 created areas with no green plants and caused the level of ground cover to dip (Figure 1) below the threshold of 70% which is considered necessary to minimise erosion (6). In 1996, large quantities of dead material covered the ground (remnants of a favourable 1995 season), maintaining cover levels.

A measurement of clover cover or botanical composition (Figure 2) prior to herbicide application is important to indicate if winter cleaning is worthwhile. In these experiments, to maintain cover and ensure a productive legume-dominant pasture in spring, it was necessary prior to winter cleaning to have a clover content of about 30%, or a clover cover (% of total ground area) value of 20%.

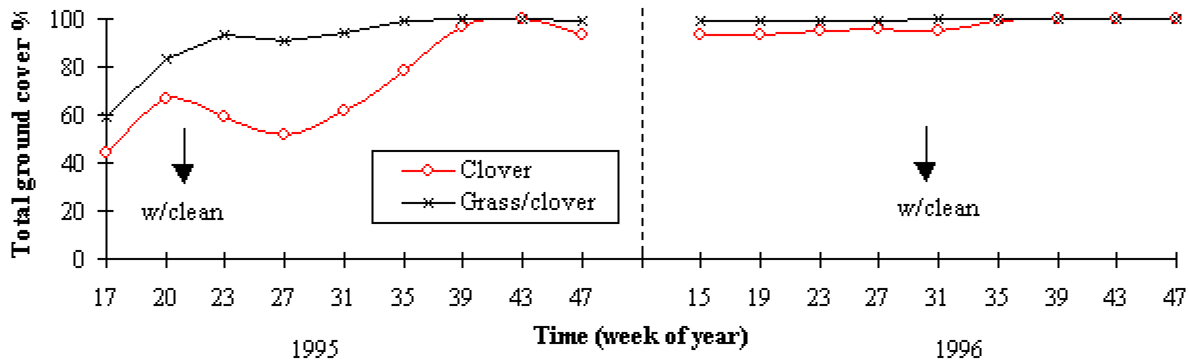

Figure 1. Total ground cover for the medium density treatment of Experiment 1 (clover – winter-cleaned on the dates indicated) and the grass/clover treatment of Experiment 2 (grass/clover).

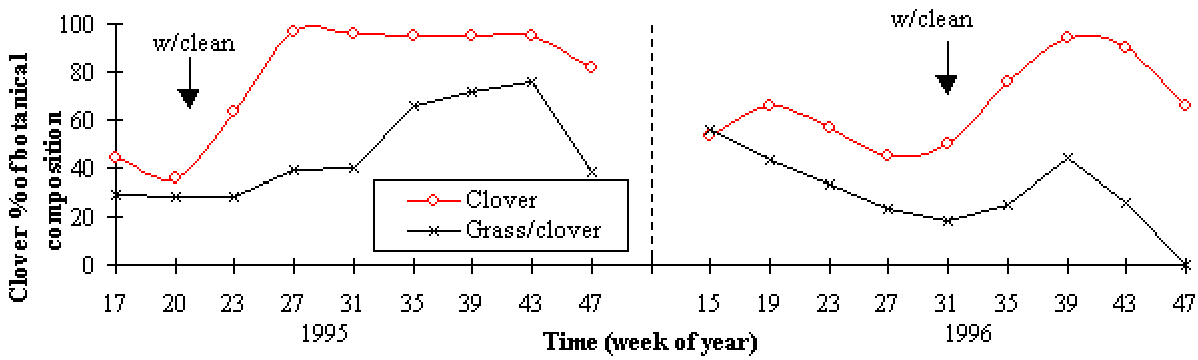

Figure 2. The clover content of the medium density treatment of Experiment 1 (clover – winter-cleaned on the dates indicated) and of the grass/clover treatment of Experiment 2 (grass/clover).

Growth, biomass and nitrogen fixation

On one occasion in 1995 and several in 1996, grazing exclusion cages were used in both experiments and on a mixed pasture area bordering the two field experiments to assess pasture growth. Then, using the GrassGro model set for the site parameters (a wether stocking rate of 10 sheep ha^{-1}, a wether liveweight of 56 kg at the start of simulation, a loam topsoil on a clay loam subsoil, and a fertility scalar of 0.83), the biomass of grazed clover and grass/clover pastures was simulated and compared with the values recorded over 1995 and 1996 in Experiment 1 (clover) and Experiment 2 (grass/clover) (Figure 3).

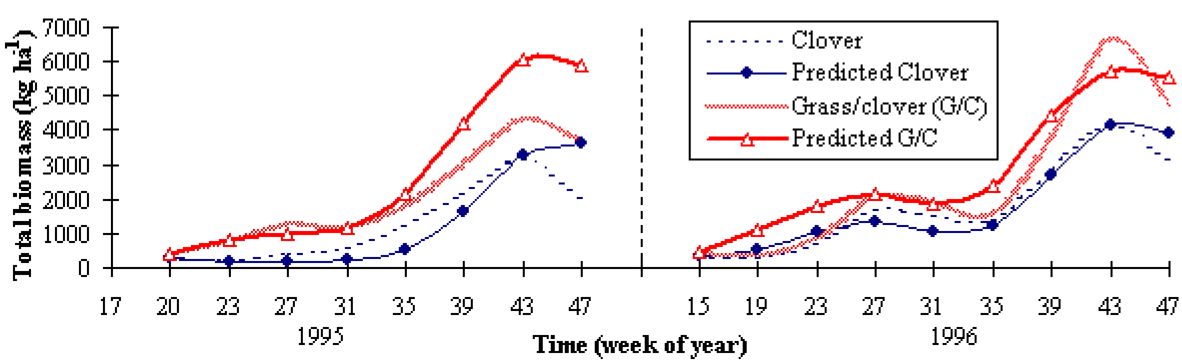

Figure 3. Actual and predicted (GrassGro) total biomass (kg green DM ha^{-1}) for a clover sward (medium treatment, Experiment 1) and a mixed sward (grass/clover treatment, Experiment 2).

The actual and simulated growth and biomass values were considered sufficiently close to warrant the use of the GrassGro model to predict the median growth rates of pure (or nearly so) subterranean clover pastures at four locations in the NSW wheat belt. For these predictions, the real climatic records (over at least 40 years) for Wagga (southern NSW, eastern wheatbelt), Lockhart (southern NSW, central wheatbelt), Condobolin (central NSW, western wheatbelt) and Tamworth (northern NSW, eastern wheatbelt) were extracted from MetAccess, a companion program to GrassGro. The potential for legume production was greatest at Lockhart and least at Condobolin (Figure 4).

In these and related field experiments, legume biomass production was the principal determinant of the nitrogen fixation input to the system, rather than the efficiency of the legume-*Rhizobium* symbiosis which was between 20 to 25 kg N ha^{-1} per 1000 kg ha^{-1} of legume biomass (11). Hence, at Wagga, there is an expectation of a production of 7 t ha^{-1} of legume DM (mid break, 50% of years, Figure 4) and at least 140 kg of fixed N ha^{-1} compared with only 4.5 t DM ha^{-1} and 90 kg N ha^{-1} at Condobolin.

Monitoring protocol

A major outcome of this work was the development of an objective monitoring protocol (and associated benchmarks) for annual ley pastures. A detailed protocol involving 12 annual checkpoints is available, but a subset of 4 critical parameters (5 checkpoints) may be sufficient for most managers. This subset is summarised in Table 1.

CONCLUSIONS

There is currently a need for Australian cropping and grazing industries to adopt benchmarking and best practice strategies. A good start that has been made on pasture monitoring with TOPCROP (12) and Prograze (8).

The pasture monitoring tools presently available are simple and efficient enough for the on-farm assessment of seedling populations, cover and botanical composition of annual ley pastures. However, the present methods of biomass assessment are less satisfactory, being labour intensive (cuts), subjective with training or experience requirements (visual methods), and / or requiring expensive equipment. This may present an impediment to the adoption of a grower focussed pasture monitoring system for use on-farm.

The development of the GrassGro decision support system (10) has provided pasture managers with a powerful tool for the development of pasture benchmarks and for assessing the risk associated with current and future production systems. Using the model, the nitrogen value of a ley can be estimated and included in gross margin analyses. This may be useful in switching the viewpoint of some growers to seeing pastures as a crop, and as a more valuable component in the paddock rotation.

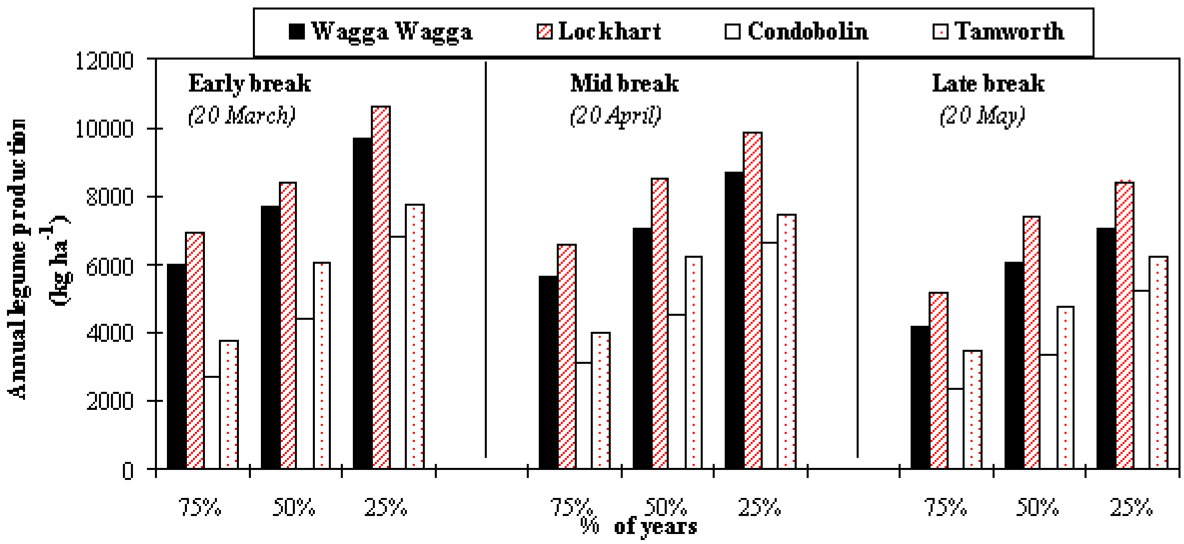

Figure 4. Predicted total annual legume production (kg green DM ha^{-1}) at three percentiles (75%, 50%, 25%) for pure clover swards (grazed at 10 DSE) grown at Wagga Wagga, Lockhart, Condobolin and Tamworth experiencing early, mid and late season breaks.

Table 1. Summary of critical pasture parameters for monitoring the performance of annual ley pastures.

Time	Attribute	Parameter	Method of assessment
Late May - early June	legume seedling density	plants m^{-2}	quadrat (10cm X 10cm)
Mid June AND early October	ground cover / botanical composition	% grass, clover, weeds, dead herbage, bare	rod-point (9)
Mid June AND October or November	biomass at the winter trough and spring peak	kg green DM ha^{-1}	visual estimates and cut quadrats (50cm X 50 cm)
All months	animal performance	records of stock numbers and weights	

REFERENCES

1. Carter E.D., Wolfe E.C. and Francis C.M. (1982). *Proc.2nd Aust. Agron.Conf.* pp. 68-82.

2. Cocks P.S. 1973. *Aust. J. Agric. Res.* **24**, 479-495.

3. Crosby J.R., Bellotti W.D., Kerkby J.S. and Harrison R. 1993. *Proc. 7th Aust. Agron. Conf.* pp. 321.

4. Dear B.S., Cregan P.S. and Murray G.M. 1993. *Aust. J. Exp. Agric.* **33**, 581-590.

5. Denton M.D. and Bellotti W.D. 1996. *Proceedings 8th Australian Agronomy Conference*, pp. 192-195.

6. Freebairn D.M., Loch R.J. and Cogle A.L. 1993. *Soil and Tillage Res.* **27**, 303-325.

7. Hochman Z., Osborne G.J., Taylor P.A. and Cullis B. 1990. *Aust. J. Agric. Res.* **41**, 669-682.

8. Latham S. and Murray G. 1996. Prograze, profitable sustainable grazing. Agdex 400/16. NSW Agriculture.

9. Little D.L. and Frensham A.B. 1993. *Aust J. Exp. Agric.* **33**, 871-875.

10. Moore A.D., Donnelly J. R. and Freer M. 1997. *Agric Systems* **55**, 535-582

11. Peoples M.B., Gault R.R., Scammell G.J., Dear B.S., Virgona J., Sandral G.A., Paul J., Wolfe E.C. and Angus J.F. 1998. *Aust. J. Agric. Res.* **49**, 459-474.

12. Wurst M., Cummins J. and Stanley S. 1997. TOPCROP crop monitoring guide. ISBN 0 7308 4306 8.