Estimating plant density using a modified Carter ring method

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Abstract

The 'Carter ring' method assesses potential legume plant density in regenerating annual pastures. Steel rings are forced into the ground, watered and germination counts recorded in the field. The requirement to water sites regularly until emergence can be restrictive. A modified method was used to overcome the difficulty of widely distributed sites, and to estimate potential density of non-legume pasture species.

Paddocks throughout the Victorian Mallee were sampled during late February 2001. In each of nine paddocks, ten PVC rings were driven 5 cm into the soil. A spade was inserted underneath and the ring and intact soil cores secured into a plastic bag. These 'pots' were placed in a glasshouse, and watered. Plant counts were recorded after four weeks. In late June plant counts were made in the field from 30 quadrats each 0.1m2, and botanical composition assessed in July, for each of the paddocks previously sampled.

The density of legumes, grasses and broadleaf plants in pots was closely related to field counts (r2 = 0.82 to 0.95; P<0.001). The percentage of grass and broadleaf plants in pots were related (P<0.10) to field composition, but legume content was not (P=0.24). The modified method reported here adequately assesses potential germination of grasses and broadleaf species as well as legumes. It is a more efficient method than watering sites at multiple distant locations.

Key Words

legume, pasture, density, composition, measurement

Introduction

Plant density is a key determinant of the productivity of annual pastures. Estimation of potential plant density prior to the seasonal break is useful for both researchers and farmers who may want to re-sow pastures that have a poor legume content. The potential density of regenerating annual legume pastures can be predicted by measuring either soil seed reserves (Carter 1982) or plants artificially germinating prior to the seasonal break (Carter *et al.* 1989). The Carter ring method (Carter *et al.* 1989) involves watering of soil *in situ*. The time involved in maintaining these field sites can preclude the use of the technique in situations where labour is scarce or large distances between sites are involved. This paper describes a modification to the Carter ring method that was hypothesised could overcome the difficulties associated with distant field sites or could be used to estimate several pasture parameters.

Methods

During late February 2001, nine paddocks throughout the Victorian Mallee were sampled. Soil types ranged from predominantly sand to predominantly clay. In each paddock (area 1 to 196 ha), ten PVC rings, 21.3 cm in diameter, were driven into the soil to a depth of 5 cm. A block of wood was placed on top of the rings to prevent splitting when hit with a sledgehammer. A spade was inserted underneath and the ring and intact soil cores tightly secured into a plastic bag to minimise soil movement. These 'pots' were placed on a solid surface in a glasshouse, a large rubber band secured towards the base of each ring and the top of the bag rolled down. The pots were watered as required to maintain damp soil. Holes were cut in the bottom of the bags if drainage of excess water was required. Plants were counted after four weeks, and classified into winter or summer-growing grasses, broadleaf weeds, and legumes.

Numbers of plants per class were expressed as percentages of total winter-growing plant counts to convert to botanical composition. In late June, following the seasonal break, plant counts were made in the field from 30 quadrats each $0.1m^2$, for each of the paddocks previously sampled. Botanical composition of paddocks was estimated in late July from 200 records per paddock using the rod-point method (Little and Frensham 1993). Composition was calculated as percentages of legume, grass or broadleaf of total green winter-growing plant records. Regression analyses were conducted using Excel.

Results

A good seasonal break occurred in autumn 2001, such that water is unlikely to have restricted field germinations. Plant density measured in pots was closely related to field counts ($P<0.001$) for legumes (medics and clovers), grasses and broadleaf weeds (Table1). The density of legumes ranged from very poor to good, using the scale of Carter (1982). The regression equations, where x is plant density in pots and y is field counts, were:

Annual legumes: $y = 0.9x + 3.6$ $r^2 = 0.82$; Root mean square error (RMSE) = 89

Winter grasses: $y = 0.8x - 28.9$ $r^2 = 0.95$; RMSE = 77

Winter broadleafs: $y = 0.4x + 2.0$ $r^2 = 0.89$; RMSE = 20

Table 1: Mean plant density (plants/m^2) of legumes, grasses and broadleafs in pots or field

	Legumes				Grasses				Broadleafs			
Paddock	Pot	*(s.e.)*	Field	*(s.e.)*	Pot	*(s.e.)*	Field	*(s.e.)*	Pot	*(s.e.)*	Field	*(s.e.)*
1	96	*(20)*	50	*(10)*	303	*(167)*	98	*(40)*	37	*(33)*	4	*(2)*
2	357	*(48)*	404	*(51)*	11	*(6)*	34	*(21)*	124	*(60)*	70	*(32)*
3	50	*(12)*	136	*(19)*	166	*(129)*	20	*(8)*	8	*(6)*	1	*(1)*
4	110	*(24)*	80	*(19)*	6	*(4)*	2	*(1)*	84	*(44)*	9	*(4)*
5	739	*(124)*	552	*(84)*	1307	*(441)*	1135	*(192)*	472	*(103)*	164	*(33)*
6	256	*(118)*	93	*(23)*	98	*(24)*	80	*(26)*	264	*(105)*	87	*(14)*
7	587	*(77)*	661	*(45)*	843	*(146)*	555	*(62)*	11	*(6)*	0	*(0)*
8	298	*(47)*	305	*(31)*	20	*(9)*	59	*(17)*	14	*(9)*	2	*(1)*
9	233	*(47)*	150	*(17)*	126	*(38)*	104	*(24)*	113	*(60)*	81	*(30)*

The grass and broadleaf, but not legume, composition of pastures in July could be predicted from the percentage of each pasture type in pots. Regression equations, where x is the percentage of each pasture class in pots, calculated from plant numbers, and y is the percent composition in field observations, calculated from number of records, were:

Annual legumes: $y = 0.6x + 25.3$ $r^2 = 0.19$; $P = 0.24$; RMSE = 25

Winter grasses: $y = 0.5x + 16.6$ $r^2 = 0.39$; $P = 0.07$; RMSE = 17

Winter broadleafs: $y = 0.8x - 0.6$ $r^2 = 0.46$; $P = 0.04$; RMSE = 13

Conclusion

Carter reported regression co-efficients of $r^2 = 0.73$ and $r^2 = 0.69$ between emergence of medic plants in watered field rings and growth room emergence with natural emergence, respectively. The modified method reported here appears at least as accurate for determining potential density of annual legumes, and extends the prediction to grasses and broadleaf species. It also has some ability to predict percentage botanical composition early in the growing season. The accuracy of predicting composition would probably be improved if pot harvests of dry matter rather than plant density was used.

The modified method potentially has a number of other uses. Soft-seed reserves could be calculated from plant numbers, and a pot harvest might be a useful way of predicting botanical composition and perhaps potential biomass. This prediction could be a useful comparator in marginal rainfall environments where complete loss of pasture data in experiments may otherwise result. Retention of plants in pots for species identification may be of use. The timing of collection of soil samples and commencement of watering will influence the species (summer or winter growing) and percentage or number of each species (through seed softening and removal or consumption of seed by stock or other means) which germinate. Work is continuing to evaluate some of these options.

References

(1) Carter, E.D. (1982) Proc. Aust. Agron. Conf., Wagga Wagga, N.S.W. p. 180.

(2) Carter, E.D., Le Lau, K.M. and Baldwin, G.B. (1989) Proc. Aust. Agron. Conf., Perth, W.A. p. 438.

(3) Little, D.L. and Frensham, A.B. (1993) Aust. J. Exp Agric., 33: 871-875.