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SEED RESERVES OF BARREL MEDIC (*MEDICAGO TRUNCATULA*) AND SNAIL MEDIC (*M. SCUTELLATA*) IN THE TOPSOIL OF PASTURES ON A BRIGALOW SOIL IN SOUTHERN QUEENSLAND

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SUMMARY

Seed reserves of barrel medic (Medicago truncatula) *and snail medic* (Medicago scutellata) *in the topsoil of a fertile brigalow clay soil were measured in 1985 at Narayen in subcoastal south-east Queensland. Measurements were made on 2 grazed crop-pasture rotations where medic was sown every fourth year, on an ungrazed crop-pasture rotation sown to medic every year and on a 10-year-old permanent pasture. Seed reserves to a depth of 10 cm were highest under permanent pasture (14,200 seeds/m²) followed by the ungrazed ley (8600/m²), a 3-year pasture: 1 year-wheat rotation (6400/m²) and a 2-year pasture: 2 year-wheat rotation (2300/m²).*

In the surface 10 cm of soil under permanent pasture, 96% of medic seed was in the top 5 cm of soil compared with 77% in ley pastures. The percentage of seed recovered in pods was highest in the top 5 cm of soil (70–80%) and lowest at 15-20 cm (<5%). Seedling emergence after adequate germinating rain in early winter accounted for less than 10% of the reserves of medic seed. The possibility of low densities of medic seedlings limiting medic productivity is discussed.

INTRODUCTION

Annual medics are widely used in pastures in southern Australia (Carter 1983b) but have also shown promise in some areas of subcoastal south-east Queensland (Jones and Rees 1972; Clarkson 1977; Lloyd and Hilder 1985; Russell 1985). Medics have been used on a fertile clay brigalow soil at Narayen Research Station (25°41′S, 150°52′E) as 1 component of a ley pasture in a crop rotation experiment. After being sown in autumn (May) as a component of a ley pasture, the average percentage of medic in the presentation yield in the following spring had been 25%. However, this had declined to an average of 6-10% in the second and third spring periods of the ley (author's unpublished data). Carter (1982, 1983a, 1983b) has shown that poor yields of medic in pastures in southern Australia can be largely attributed to low soil reserves of soil seed. Hence we initiated this study of soil seed reserves of medic in ley pastures to ascertain if low seed numbers were a potential limitation to subtropical medic production. Similar measurements were made on an adjacent permanent pasture and on ungrazed ley pastures where medics were used as a green manure crop in rotation with grain sorghum.

METHODS

The environment

The annual average rainfall at Narayen Research Station is 716 mm, of which 210 mm falls in the cooler months (March-October) when medics grow. Cool season rainfall is very variable (Cook and Russell 1983). Rainfall and temperatures during the experimental period are presented in Table 1. All the medic sowings were on clay soils which in their virgin state were dominated by brigalow (*Acacia harpophylla*). The soils have high levels of nitrogen (*c.* 0.3%) and phosphorus (total P *c.* 0.1%), and a neutral to slightly alkaline reaction.

TABLE 1

Monthly rainfall and temperature during the experiment (Jan-June 1985) and long term average monthly rainfall

	Jan.	Feb.	Mar.	Apr.	May	June
Average rainfall (mm)	106	95	72	37	39	37
1985 rainfall (mm)	72	26	16	32	9	53
1985 max. temp. (°C)	33	33	31	28	25	20
1985 min. temp. (°C)	18	18	17	13	10	5

Seed recovery

Medic seed was recovered from soil samples using the method outlined by Jones and Bunch (1977) after overnight soaking in a Calgon solution (5 g/l) to aid dispersal of the clay. Seed was recovered both in and out of pods. Seed in pods was removed by hand and germination tests carried out over 21 days on both 'free' seed and 'pod' seed to measure both germination and hard seeded content.

SEED RESERVES IN GRAZED LEY PASTURES

Site details

The experiment commenced in 1968 and was based on a 4-year cycle. There were 2 rotations which included medics in the ley phase: 2 years of pasture followed by 2 years of wheat (2p:2w) and 3 years of pasture followed by 1 year of wheat (3p:1w). The first year of each ley phase was sown to *Sorghum almum* cv. Croodle (5.2 kg/ha), *Medicago sativa* cv. Hunter River (5.2 kg/ha), *Medicago truncatula* (barrel medic) cv. Jemalong (2.9 kg/ha) and cv. Cyprus (1.5 kg/ha), and *Medicago scutellata* (snail medic) cv. Robinson (1.5 kg/ha). Both annual medics germinate in autumn/winter (April-August), and set seed and die in spring (October-November). These sowing rates of medic are equivalent to approximately 110 barrel medic and 9 snail medic seeds/m^2, almost all of this being soft seed as supplied commercially.

Prior to 1982 the ley phase was grazed rotationally (1 week on:3 weeks off) at 1.25 weaner steers /ha but subsequently was grazed continuously at 1.65 head/ha. There were 4 replicates in a randomised block design and within each replicate there were paddocks in each of the 4 phases of the 2 rotations. Thus there were 32 (2 rotations x 4 phases x 4 replicates) paddocks, each of which was sown to medic every fourth year. To prepare paddocks for sowing to wheat, pastures were chisel ploughed to 10-15 cm, and followed by disc cultivation to 7 cm.

Measurements

Initially 2 paddocks, 1 currently under pasture and 1 under cultivation, were studied to document the profile of medic seed in the topsoil. Fifty cores of 4.5 cm diameter and 20 cm depth were taken from each 0.6 ha paddock in late January 1985, sliced into 5 cm sections, and medic seed was recovered. Subsequently the remaining 30 paddocks were sampled to 10 cm (0-5 and 5-10 cm) in February 1985.

Following good rains in June 1985, with 53 mm falling over 2 days, seedling density was counted in all 12 paddocks (3 treatments x 4 replicates) which were in an established pasture phase, using 50 quadrats of 20 x 20 cm per paddock. Approximately 200 newly emerged barrel medic seedlings and 50 snail medic seedlings were dug up. The depth from which they emerged was measured and a record kept of whether the seedling originated from 'free' seed or 'pod' seed.

Results

In the 2 paddocks sampled in detail, 67% of all seed reserves were in the 0-5 cm strata, 26% in 5-10 cm, 6% in 10-15 cm and 1% in 15-20 cm. The profile of seed density was similar for both medic species, and the proportion of seed in pods was greatest in the 0-5 cm strata (70-80%) and least below 10 cm (< 5%).

The mean seed reserve of all paddocks in both rotations is given in Table 2. In the surface 10 cm of soil, 77% of medic seed was in the top 5 cm. There were approximately 9 times more barrel medic than snail medic seeds, and 3 times more medic seeds in the 3p:1w rotation than in the 2p:2w rotation. Seed of both medic species was 98% viable, but the germination percentage of snail medic (21%) was higher than for barrel medic (11%). The remaining viable seed was hard.

TABLE 2

Barrel and snail medic seeds in the 2-years' pasture: 2-years' wheat (2p:2w) and 3-years' pasture: 1-year wheat (3p:1w) rotations

Depth	Seed type	Barrel			Snail			Total		
		2p:2w		3p:1w	2p:2w		3p:1w	2p:2w		3p:1w
		(seeds/m²)								
0-5cm										
	free seed	566		1142	35		49	601		1191
	pod seed	817	**	3372	195	**	480	1012	**	3852
	total seed	1383	**	4514	230	**	529	1613	**	5043
5-10 cm										
	free seed	449		859	27		42	476		901
	pod seed	199		419	32		63	231		482
	total seed	648		1278	59		105	707		1383
0-10 cm										
	total seed	2031	**	5792	289	**	634	2320	**	6426

** Differences significant at $P < 0.01$ following log transformation.

The average seedling density in June was 86/m² (range 6-675 over all paddocks) for barrel medic and 29/m² (4-72) for snail medic. There was a significant ($P < 0.01$) linear relationship between seedling density in June and seed reserves measured in January, with 3.5% of barrel medic seed reserves in the surface 0-5 cm emerging as seedlings ($r = 0.98$) and 7% of snail medic seeds as seedlings ($r = 0.75$). All the snail medic seedlings and 94% of the barrel medic seedlings which were examined originated from pods. Most seedlings (64% of barrel medic and 95% of snail medic seedlings) emerged from the top 0.5 cm of soil. No seedlings emerged from below 4.5 cm.

SEED RESERVES IN SORGHUM/MEDIC ROTATIONS

Site history and sampling

This experiment, commenced in 1978, compared a number of cropping systems in the absence of grazing. There were 2 treatments, each with 4 replicates, where medic was used as an ungrazed winter green manure crop alternating with grain sorghum as the summer crop. In 1 treatment the sorghum was inter-row cultivated after emergence while the other treatment was not cultivated. There was a brief cultivation phase between the alternating crops. Medic (3.3 kg/ha each of Jemalong and Cyprus barrel medic and Robinson snail medic, equivalent to some 165 barrel medic and 20 snail medic seeds/m^2) was sown in autumn of every year until 1983, but, in view of the large numbers of seedlings regularly emerging from the soil seed reserve, medic seed was not sown in Autumn 1984. Twenty-five cores per plot were sampled to 10 cm in March 1985 for measurements of seed reserves, but the cultivated soil could not be separated into the 0-5 and 5-10 cm strata. Emerging seedlings were counted in June 1985.

Results

Reserves of barrel medic seed (6221/m^2) and snail medic seed (3150/m^2 were higher ($P < 0.01$) where there was no inter-row cultivation than with cultivation (5209 and 2600/m^2 respectively). Seedling emergence in June was similar in both treatments with 112 barrel medic seedlings/m^2 and 180 snail medic seedlings/m^2, equivalent to 6% of snail medic seed reserves (0-10 cm) and 2% of barrel medic seed reserves. The percentage of hard seed (80%) was similar for both species.

SEED RESERVES IN PERMANENT PASTURE

Site history and sampling

In autumn 1976, a 5 ha paddock was sown to oats and Jemalong barrel medic. Summer growing grasses, mainly Rhodes grass (*Chloris gayana*) invaded and the paddock was grazed as a farm pasture. In August 1985, 50 cores of 4.5 cm diameter were taken to 10 cm and split into 0-5 and 5-10 cm sections for measurement of seed reserves.

Results

There were 14,800 (±1600) medic seeds/m^2. Ninety-six percent of seed was in the 0-5 cm layer and 81% of seed was still in pods. Ninety percent of recovered seed was hard seeded.

DISCUSSION

The seed reserves measured in our experiment tend to be at the higher end of the ranges measured in farm pastures in South Australia (Carter 1982, 1983a, 1983b). However, these measurements of seed reserves give no indication of the rates of input and loss of seed in the 2 areas. Patterns of seed set, hard seed breakdown and seed loss could be quite different. It is also likely that more medic pods would be eaten by sheep in southern Australia than would be eaten by cattle in brigalow pastures. Furthermore, sheep would probably digest more of the ingested seed than cattle and return fewer seeds to the soil seed reserves in excreta (Simao Neto *et al.* 1987).

The permanent pasture had higher seed reserves than the 3p:1w rotation which in turn had higher reserves than the 2p:2w rotation. This would be anticipated as an increase in the length of the cropping phase and number of cultivations would result in less seed being set and in greater loss of seed. The higher reserves of medic seed when medic was grown as a green manure crop can be attributed to the very heavy seeding, in the absence of grazing, offsetting seed loss through frequent cultivation. This effect of cultivation is highlighted by the fact that medic seed reserves were lower with the more frequent cultivations under inter-row cultivation of sorghum.

As no medic sample emerged from below 5 cm it is reasonable to take 5 cm as the sampling depth when relating seedling emergence to seed reserves. In the ley pasture experiment, 77% of the medic seed was in the top 5 cm of the soil profile, contrasting with 96% under permanent pasture. This difference is attributed to the periodic cultivation of the ley pastures. Seed below 5 cm, however, could be redistributed to the surface at a later date by further cultivation. The increasing proportion of free seed with increasing depth suggests that seed in deeper layers is generally older than surface seed. The distribution of medic seed in 5 cm layers down the soil profile was similar to that found in South Australia under a ley pasture recently disc ploughed (Quigley *et al.* 1987).

A low percentage of medic seed (< 10%) emerged as seedlings, as was also recorded in South Australia (Carter 1982, 1983a, 1983b). The percentage of hard seed in the recovered seed samples (*c.* 80%) may have been slightly lowered by the seed recovery procedure (Jones and Bunch 1977) and so the true hard seededness of seed in the soil could be even higher. Thus the high percentage of hard seed is an important reason for the low percentage emergence of viable seed.

Carter (1982) considered a good barrel medic pasture as one with more than 200 kg/ha of medic seed; this is equivalent to approximately 7000 seeds/m^2 or 500 seedlings/m^2 (assuming 8% emergence). On this basis, seed reserves in our brigalow pastures were adequate in the permanent pasture, the sorghum/medic rotation and the 3p:1w rotation, although seedling numbers were below optimum in both the 3p:1w and 2p:2w rotations. Hence the low percentage of medic in the presentation yield of the second and third years of the pasture rotations could be attributed in part to insufficient seedling numbers. However, other factors would be involved. The unreliability of winter rainfall would be more of a limitation in subsequent years than in the year of sowing when usually more soil moisture, resulting from summer rains, is stored through cultivation prior to sowing. Also there would be more competition exerted by the companion perennial species, lucerne and *Sorghum almum*, in the second and third years of a pasture ley than in the year of sowing. The relative importance of these factors in reducing the medic yields in the second and third years of the ley pastures can only be determined by further research.

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LEUCAENA LEUCOCEPHALA PRODUCTION IN SUBCOASTAL, SOUTH-EAST QUEENSLAND

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ABSTRACT

The productivity of leucaena, grown as a winter supplement to native pastures, was assessed over 6 growing seasons on a range of adjacent soil and topographic sites in subcoastal, south-east Queensland.

Mean edible leucaena yield measured at the end of autumn reached a maximum of 800 kg dm/ha after 3 growing seasons and did not change substantially over the following 3 seasons. Leucaena plant height increased progressively each year to a mean of 190 cm after 6 seasons.

Highest yields were obtained on the alluvial and colluvial soils with potential rooting depths of 110-120 cm. Frosting was severe on these soils, but the leucaena still produced twice the edible yield of the leucaena on shallow basaltic and andesitic soils where frosts were absent or infrequent.

Leaf fall of leucaena during the summer/autumn growing seasons was equivalent to 30 to 40% of the annual production. Most of the remaining leaf was lost during winter if frosts occurred, or if winter rainfall was below average in the absence of frosting.

These results indicate that rooting depth, incidence of frost and winter rainfall strongly influence the productivity of leucaena grown as a winter grazing supplement in south-east Queensland. It is recommended that, where possible, leucaena should be planted on deep, fertile soils in frost free locations.

INTRODUCTION

Leucaena leucocephala (leucaena) is a legume adapted to and widely distributed throughout the tropics and sub-tropics (Oakes 1968; Hill 1971). It is a valuable protein supplement for beef cattle grazing native pasture (Addison 1970; Addison *et al.* 1984) and as a pasture forage (Jones and Jones 1982) in the subcoastal regions of south-east Queensland. Ambient temperature, annual rainfall, and soil characteristics are the major factors influencing leucaena production (Hutton and Gray 1959; Maclaurin 1981).

An extensive system for beef cattle production, using leucaena as a protein supplement to native pastures and which is applicable to large areas of grazing land in south-east Queensland (Cooksley 1984), has been developed in Gayndah. This paper reports the effect of some climatic and edaphic variables on the development of leucaena during the 6 years following planting, particularly in relation to the amount of edible material available for cattle grazing in south-east Queensland.

MATERIALS AND METHODS

Location

Leucaena growth was monitored at Brian Pastures Research Station, Gayndah (25°39′S, 151°45′E; altitude 130 m) which has an average annual rainfall of 733 mm (Table 1) and a mean monthly temperature range of 32°C (January maximum) to 6°C