

## The value of round-leafed cassia (*Cassia rotundifolia* cv. Wynn) in a native pasture grazed with steers in south-east Queensland

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### Abstract

Wynn cassia is a new forage legume which was untested with grazing animals prior to its release in 1984. Wynn cassia was sown into two 24 ha paddocks of black speargrass and, in an unreplicated trial lasting 5 years, steer growth was compared between Wynn cassia paddocks, with and without superphosphate (55 kg/ha/yr), and with a 75 ha native pasture paddock, all at a common stocking rate of 2.4 ha/steer.

Unfertilised Wynn cassia spread rapidly and, despite its reputation for low palatability, provided at least 16% of the steers' diet. Steers on Wynn cassia gained an average of 35 kg/hd/yr more (40%) than those on native pasture. Wynn cassia responded strongly to superphosphate but weight gains improved by only a further 10 kg/hd/yr.

Wynn cassia increased the N concentration of the associated spear grass by 20% when unfertilised, and by nearly 40% when fertilised. On the granodiorite soil at this site, P was generally adequate for plant and cattle but sulphur appeared deficient.

### Resumen

*La cassia Wynn es una leguminosa forrajera que no fue evaluada para pastoreo antes de ser liberada en 1984. Con el fin de evaluar su potencial en pastoreo, se sobre-sembró la cassia Wynn en potreros de speargrass de 24 ha y se comparó*

*el crecimiento de novillos en estos potreros, con y sin superfosfato (55 kg/ha/a), con el crecimiento de novillos en potreros de 75 ha de pasturas nativas; el ensayo no tuvo repeticiones, duró 5 años y se utilizó una carga general de 2.4 ha/novillo.*

*La cassia Wynn sin fertilizar se estableció rápidamente y, a pesar de tener la reputación de baja aceptación animal, contribuyó con 16%, cuando menos, en la dieta de los novillos. Los novillos en cassia Wynn tuvieron una ganancia promedio de peso de 35 kg/novillo/a (40%) por arriba de aquellos en pasturas nativas. A pesar que cassia Wynn respondió fuertemente a la aplicación de superfosfato, los novillos únicamente tuvieron una ganancia adicional de 10 kg/a.*

*La cassia Wynn sin fertilizar incrementó 20% la concentración de nitrógeno de la gramínea asociada speargrass, y cerca de 40% cuando fue fertilizada. En los suelos granodiorite de esta localidad, el nivel de fósforo fue por lo general adecuado para el crecimiento de las plantas y los animales, pero parece haber deficiencias de azufre.*

### Introduction

Round-leafed cassia (*Cassia rotundifolia*) is a native of savanna in tropical and subtropical South and North America, and of Africa. Dr D. Norris of CSIRO introduced a number of accessions to Australia in 1964 and one, CPI 34721 from Valinhos (23°S) in Brazil, was released in 1984 with the cultivar name Wynn (Anon 1984).

Because many species of *Cassia* are unpalatable or even toxic (Everist 1974), they are well known as weeds in many tropical countries. Selections of *Cassia* were tested in rat-feeding trials by Strickland *et al.* (1986) and round-leafed cassia was found to be palatable, of high quality, and free from deleterious compounds.

Round-leaved cassia had been planted in small evaluation plots at a number of sites before Wynn was released (Strickland 1985), but only by 1984 was sufficient seed available for a grazing trial. We report results of the first large-scale trial using pastures based on Wynn round-leaved cassia.

## Materials and methods

### Site

The trial site at Gaeta, near Gin Gin, in south-east Queensland (lat. 25°S, long. 154°E) was on undulating to slightly steep slopes supporting native pasture dominated by black speargrass (*Heteropogon contortus*). The original woodland community of narrowleaf ironbark (*Eucalyptus crebra*), spotted gum (*E. maculata*) and Moreton Bay ash (*E. tessellaris*) had been cleared with bulldozers, but the understorey shrubs, hickory wattle (*Acacia aulacocarpa*) and corkwood wattle (*A. bidwillii*) regrew during the trial. Mean annual rainfall at Gin Gin is 1070 mm of which 70% falls between October and March.

### Soils

Soils on the site are texture-contrast, or duplex, non-calcareous browns or solodics (Dy 3.2.2 and Dr) (Northcote 1971) derived from granodiorite. They have 30–60 cm of hard-setting loam or sandy clay loam overlying yellow or red moderately heavy clay. Chemical analyses of the soils in the paddocks before fertilising are given in Table 1.

### Treatments

The site had 2 main paddocks, a native pasture control of 75 ha and a Wynn cassia area of 48

ha which was divided into 2 equal paddocks. The treatments were:

- i) native pasture,
  - ii) native pasture with Wynn cassia, and
  - iii) native pasture with Wynn cassia and fertiliser.
- Wynn cassia seed was oversown, at 1.2 kg/ha, into the native pasture in the relevant paddocks after a single chisel ploughing in October 1984. The fertilised paddock received 110 kg/ha of single superphosphate (9% P) at establishment and every second year thereafter.

Weaner steers of mixed Brahman and Africander breed were introduced in December 1984 at a stocking rate of 1.6 ha per animal and stayed in the trial for 2 years. In subsequent years, yearling steers were grazed, at 2.4 ha per animal, and changed annually.

At the beginning of March 1988, following months of drought (see rainfall in Table 2), the water supply became unreliable and the trial steers were removed. The whole trial area was then grazed by commercial cattle with access to water elsewhere. Although good rain fell immediately after the steers were taken out and the subsequent growth of Wynn cassia was excellent, we were unable to alter our contingency plans. Trial steers were reintroduced in August 1988.

The native pasture treatment was stopped in December 1989, but trial steers remained on the 2 Wynn cassia paddocks until June 1990.

### Measurements

Steers were weighed every 3 months, after an overnight fast. Because of the unreplicated design of the trial, the annual responses of the steers were compared using an analysis of variance, with protected l.s.d.; error was estimated from within-paddock variation.

Samples of green shoot of grass or tips (first 5 open leaves) of Wynn cassia were plucked every

Table 1. Chemical analyses of soils (to 10 cm depth) in the treatment paddocks.

| Paddock                          | pH<br>(1:5 H <sub>2</sub> O) | Nitrate N<br>( $\mu\text{g/g}$ ) | Extract. P<br>(bicarbonate)<br>( $\mu\text{g/g}$ ) | Extract.<br>K<br>( $\mu\text{g/g}$ ) | Extract.<br>SO <sub>4</sub> -S <sup>1</sup><br>( $\mu\text{g/g}$ ) |
|----------------------------------|------------------------------|----------------------------------|--|--------------------------------------|--|
| Native pasture                   | 5.9                          | 1                                | 4  | 160                                  | 3  |
| NP + Wynn cassia                 | 6.1                          | 1                                | 4  | 133                                  | 3  |
| NP + Wynn cassia<br>+ fertiliser | 6.1                          | 1                                | 4  | 94                                   | 2  |

<sup>1</sup> Method of Barrow (1967).

**Table 2.** Seasonal rainfalls recorded at trial site, and long-term averages for Gin Gin.

| Season           | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | Gin Gin average |
|------------------|------|------|------|------|------|------|------|-----------------|
|                  | (mm) |      |      |      |      |      |      |                 |
| Summer (Dec–Feb) |      | 152  | 503  | 169  | 83   | 165  | 111  | 469             |
| Autumn (Mar–May) |      | 130  | 74   | 138  | 254  | 420  |      | 263             |
| Winter (Jun–Aug) |      | 234  | 99   | 65   | 309  | 125  |      | 141             |
| Spring (Sep–Nov) | 177  | 214  | 239  | 166  | 39   | 92   |      | 192             |
| Annual total     | 739  | 757  | 855  | 474  | 904  | 1041 |      | 1068            |

3 months and analysed for N, P, K and S. These herbage samples, and dung samples taken from the individual trial steers were bulked and analysed to determine faecal carbon isotope ratios ( $\Delta^{13}\text{C}:^{12}\text{C}$ ) (Jones *et al.* 1979) as a means of estimating the legume content of the diet.

The legume population was counted in spring of 1985 and 1986. Yield, botanical composition and species frequency were measured in 125–150 quadrats of 0.25 m<sup>2</sup> in each of the Wynn cassia paddocks in most years, and analysed using a modified Botanal technique (O'Rourke *et al.* 1984). The native pasture control was surveyed only in 1988.

Seed reserves of Wynn cassia were measured in the faeces (from rectal samples and dung pats), and in the soil in 7 quadrats of 300 cm<sup>2</sup> of soil to a depth of 2 cm. The soil was sieved with water, and the organic material floated off with perchlorethylene (Jones and Bunch 1977) before being separated in an ascending column of air.

## Results

### *Liveweight gains*

The yearling steers on the native pasture augmented with Wynn cassia gained, on average, an extra 34 kg/head (40% improvement), or an extra 45 kg/head with fertiliser, over those on native pasture alone (Table 3). These figures are the average over the last 4 years of the trial with all treatments at a stocking rate of 2.4 ha/steer. Only between September 1989 and June 1990 was there a significant advantage in liveweight gain from fertilising.

In the first year (1984–85) the weaner steers, at stocking rate of 1.6 ha/steer, grew poorly on all pastures, causing concern about the feeding value of Wynn cassia. These steers continued to grow poorly through autumn and winter of their second year but, in the last quarter of that year,

the stocking rate was reduced to 2.4 ha/steer and the final gains for 1985–86 were good, probably due, in part, to some compensatory growth.

### *Botanical composition*

The sown Wynn cassia seed germinated well in October 1984 but, as many seedlings failed to survive a subsequent heat wave in November, establishment was mediocre. After one year, there were less than 2 mature plants of Wynn cassia per square metre (Table 4). Steers from the other groups accidentally grazed the fertilised treatment for over a month in February and March 1985 and the higher grazing pressure reduced seed production. Hence, there were fewer seedlings in November 1985 and fewer mature plants in the next year. However Wynn cassia populations in both paddocks were sufficient to set large amounts of seed during 1985, resulting in about 165 seedlings per square metre by November 1986.

The population of black spear grass plants in the oversown paddocks remained high even though Wynn cassia spread throughout them; spear grass contribution declined from 65% in 1985 to 55% in 1989, but it still had a 90% frequency. Speargrass dominated the control paddock, contributing 73% of total herbage yield in 1988, although Wynn cassia started to invade from the fence line and access track to the weighing yards in later years.

Wynn cassia responded strongly to maintenance fertiliser in September 1986 and October 1988; uneven spread produced dark green strips of Wynn cassia-dominant pasture but the overall yield was not affected until 1989 (Table 4).

After four years, Wynn cassia provided over 30% of the overall herbage dry matter. Although it provided over 60% in the fertilised strips, the associated speargrass plants were vigorous. By the end of the trial period, the grass was recovering

**Table 3.** Liveweight gains of steers grazing native pasture with and without Wynn cassia.

| Period                        | Initial steer weight | Stocking rate | Liveweight gain  |                         |                                 |
|-------------------------------|----------------------|---------------|------------------|-------------------------|---------------------------------|
|                               |                      |               | Native pasture   | Native pasture + cassia | Native pasture + cassia + super |
|                               | (kg)                 | (ha/steer)    |                  | (kg)                    |                                 |
| Dec 84–Dec 85                 | 200                  | 1.6           | 24 <sup>a1</sup> | 46 <sup>b</sup>         | 31 <sup>a</sup>                 |
| Dec 85–Dec 86                 |                      | 1.6/2.4       | 106 <sup>a</sup> | 142 <sup>b</sup>        | 153 <sup>b</sup>                |
| Mar 87–Mar 88                 | 310                  | 2.4           | 75 <sup>a</sup>  | 93 <sup>a</sup>         | 103 <sup>a</sup>                |
| Aug 88–Sep 89                 | 290                  | 2.4           | 81 <sup>a</sup>  | 131 <sup>b</sup>        | 141 <sup>b</sup>                |
| Sep 89–Jun 90                 |                      | 2.4           |                  | 149 <sup>a</sup>        | 160 <sup>b</sup>                |
| Av. lwg/yr<br>(Dec 85–Sep 89) |                      |               | 87               | 121                     | 132                             |

<sup>1</sup> Values followed by the same letter are not significantly different ( $P > 0.05$ ).

strongly, especially in spring after the Wynn cassia had been reduced by frost.

#### Herbage mineral concentrations

Potassium levels of around 1.2% in the grass and 1.2–1.9% in the legumes were well above published critical levels for legume growth, except in winter (0.6% K).

The overall mean concentrations of N, P and sulphur (S) in the grass and legume are given in Table 5. Average N concentrations in speargrass in the control paddock were low (1.14% N) but those in the unfertilised Wynn cassia paddock were raised by 20% (to 1.39% N) by the associated legume, and by nearly 40% (to 1.57% N) when the sward was fertilised with P and S. In general, P concentrations (over 0.12% P) appeared adequate for growth of plants

(Andrew and Robins 1969) and for grazing steers, but they were increased by superphosphate. The S levels, on the other hand, were well below critical levels for other legumes (Andrew *et al.* 1974) and probably marginal for steers. Applying superphosphate raised the S levels of both grass and legume. N:S ratios were around 15 for grass, 22 for legume and 12 for faeces but, with fertilising, the ratios were reduced to 15, 13 and 9 respectively in later years. Dry frosted leaf taken in July from standing Wynn cassia plants, with and without fertiliser, showed concentrations of N at 1.74% and 1.36%, and of P at 0.09% and 0.07% respectively.

#### Dietary legume content

The steers never appeared to relish or select Wynn cassia — but would have had difficulty avoiding

**Table 4.** Attributes of Wynn cassia when grazed in fertilised and unfertilised paddocks.

| Survey date  | Populations              |          |           | Presentation yield |      |
|--------------|--------------------------|----------|-----------|--------------------|------|
|              | Mature                   | Seedling | Frequency | Total              | Wynn |
|              | (Plants/m <sup>2</sup> ) |          | (%)       | (t/ha)             | (%)  |
| November 85  |                          |          |           |                    |      |
| unfertilised | 1.7                      | 2.8      | 30        | 2.5                | 4    |
| fertilised   | 1.6                      | 0.6      | 25        | 1.7                | 3    |
| November 86  |                          |          |           |                    |      |
| unfertilised | 13.2                     | 164      |           | 0.9                | 15   |
| fertilised   | 7.4                      | 174      |           | 1.0                | 13   |
| March 88     |                          |          |           |                    |      |
| unfertilised |                          |          | 82        | 1.0                | 32   |
| fertilised   |                          |          | 83        | 1.1                | 33   |
| April 89     |                          |          |           |                    |      |
| unfertilised |                          |          | 93        | 3.6                | 33   |
| fertilised   |                          |          | 95        | 5.9                | 39   |

**Table 5.** Concentrations of nitrogen, phosphorus and sulphur in grass and legume, averaged over all seasons and years.

| Treatment                                     | N     |        | P     |        | S     |        |
|---|-------|--------|-------|--------|-------|--------|
|   | grass | legume | grass | legume | grass | legume |
|   | (‰)   |        | (‰)   |        | (‰)   |        |
| Native pasture                                | 1.14  |        | 0.16  |        | 0.09  |        |
| Native pasture + Wynn cassia                  | 1.39  | 2.26   | 0.16  | 0.17   | 0.08  | 0.11   |
| Native pasture + Wynn cassia + superphosphate | 1.57  | 2.71   | 0.19  | 0.22   | 0.11  | 0.14   |

it — and there was no difference in the proportion of C<sub>3</sub> plant material (legumes and other broad-leaved plants) in the diet between the fertilised and unfertilised Wynn cassia treatments (Figure 1).

There was, on average, an extra 16 percentage units of C<sub>3</sub> material in the diets of the steers grazing paddocks oversown with Wynn cassia than in the diets of those on native pasture alone. This can be assumed to be the minimum extra legume (Wynn cassia) in the diet. The difference was greatest in early winter (June) but the proportion of C<sub>3</sub> material in the diet of the native pasture steers was highest in early summer (December).

#### *Wynn cassia seed reserves*

The seed reserves in the soil under stands of vigorous fertilised Wynn cassia were 300 kg/ha. Germination of Wynn cassia seed was high after fires and rainfall, and bare ground was soon covered densely with seedlings.

Dung samples, taken from the rectum of steers after a 16-hour fast at the weighing in May 1989, showed little mature Wynn cassia seed, but fresh pats from the field at the same time of the year contained 800 mature seeds per kg of dry faeces.

#### Discussion

The value of Wynn cassia to augment native pasture is shown by the large increase in live-weight gain of the steers, even though this was an unreplicated trial. Good responses have also been shown in other recently conducted unreplicated grazing trials at Kabra near Gracemere (C. Middleton, personal communication) and at Gayndah (M. Quirk and R. Tyler, personal communication).

Wynn cassia showed nearly all the characteristics needed for a forage legume to naturalise —

rapid germination and growth, early and extended flowering, high seed set, little or no disease, promiscuous rhizobial nodulation and only moderate palatability. Its population increased rapidly during the first 2 years because of these features, and this was aided by spread of seed through the dung. Cattle obviously eat large quantities of Wynn cassia seed pods, and a mature beast could spread more than 2500 seeds a day.

In the first year, the poor growth rates of the weaner steers and the poor acceptance of Wynn cassia raised concerns about the weed potential of this new legume. *Cassia rotundifolia* is from a family (Caesalpinaceae) previously unused for commercial forage plants; many other *Cassia* species (*C. tora*, *C. occidentalis*, *C. barclayana*) can be serious pasture weeds in Queensland or throughout the tropics.

Despite its acceptance in the rat-feeding trials (Strickland *et al.* 1986), Wynn cassia was never relished by cattle in this trial and appeared to be less sought after than shrubby stylo, for example. Bitten-off stems could generally be found but rarely the rosette form of growth that indicates continuous grazing. Intake of Wynn cassia increased in autumn; in one year, cattle started to graze the dense patches of fertilised Wynn cassia only after mid-April.

The generally high content (around 25%) of C<sub>3</sub> plants in the diet of the steers grazing the Wynn paddocks could be due partly to other forbs (cf. the native pasture control), but the better weight gains suggested that Wynn cassia was a significant component of the diet.

Under the moderate grazing pressure in this trial, unfertilised Wynn cassia formed a good balance with the speargrass despite its rapid spread and low palatability. Uneven application of superphosphate did cause patchy Wynn dominance, but the extra N fixed should eventually boost grass growth. Experiences of Wynn

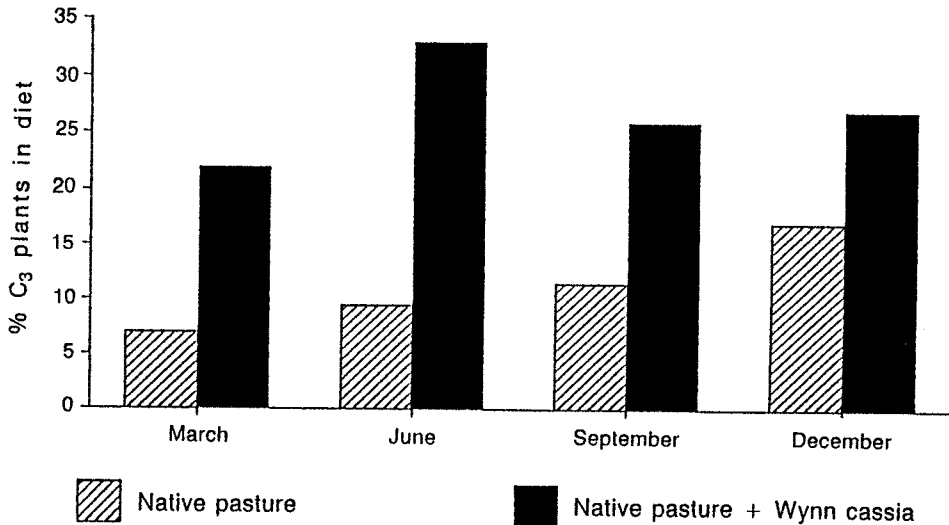


Figure 1. Proportion of  $C_3$  plants (legume + forbs) in the diet of steers.

cassia dominance elsewhere (G. Elphinstone, personal communication) have resulted in a recommendation not to plant Wynn cassia on fertile soils in high rainfall areas.

Wynn cassia responded strongly to superphosphate on this site; the uneven spread of fertiliser produced vivid dark green strips dominated by legume. While the extra weight gain of steers on fertilised legume was not significant, except in the final year, presenting the improvement in weight gain by averaging the results from both Wynn treatments might exaggerate the value of Wynn cassia. However those in the fertilised paddocks were always in better condition than those without fertiliser. Higher stocking rates on fertilised paddocks would be needed to utilise the extra pasture growth and to show an economic response.

Fertilising Wynn cassia did not appear to increase the proportion of legume in the diet despite the higher mineral concentrations and lush growth. This response differs from the effect of superphosphate on stylos (McLean *et al.* 1981), but is similar to observations of steers on a fertilised bahia grass (*Paspalum notatum*)-Wynn cassia pasture at Samford where Wynn contributed only 3-4% of the diet (R. Clements, personal communication). These comparisons suggest that low palatability *per se* rather than low digestibility is the cause of the low proportion of legume in the diet. However Wynn cassia does not appear to contain any anti-nutritional factors

(Ahn *et al.*, 1988; Quirk *et al.* 1991) and, to the human palate, *C. rotundifolia* is not bitter and has none of the obnoxious aromatic compounds found in some other *Cassia* species.

Phosphorus concentrations were generally adequate for plant and animal growth on this granodiorite soil, but S concentrations were low. In a P, S and molybdenum fertiliser plot trial later superimposed on the Wynn cassia paddock, S had the greatest effect on legume yield, while P increased yield only in the presence of S (I. Partridge, unpublished data).

If N:S ratios of around 17 indicate deficiency of S in plant material (Andrew *et al.* 1974), plant growth was often limited by low S. As the currently recommended dietary N:S ratio for cattle is 14:1 (ARC 1980), the trial cattle might also have been deficient in S, especially in the earlier period of the trial. The levels of S applied (5 kg/ha/yr) were insufficient to narrow N:S ratios quickly.

The large increases in the N concentration of the speargrass associated with Wynn cassia indicate that this legume can fix considerable amounts of N which are transferred to the grass.

Poor growth rates of animals in the first year were probably due to the use of weaners on such poor country and to the high stocking rates, but low sodium was also considered a possible cause. Very low sodium concentrations (0.03-0.05%) were recorded in our trial in herbage of both Wynn and speargrass on two occasions.

Since Wynn cassia was released, it has become

well accepted by graziers who like its rapid germination and spread and its attractive appearance. It is now sown regularly in seed mixtures in many coastal districts of Queensland. Doubts about possible toxicity have been dispelled and, although it appears relatively unpalatable, this may aid persistence and spread and so contribute to sustainable weight gains.

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