# THE VALUE OF A FROST TOLERANT SETARIA COMPONENT IN MIXED PASTURES FOR AUTUMN SAVED FEED IN SOUTH-EASTERN QUEENSLAND

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## ABSTRACT

*A frost tolerant* Setaria anceps *introduction (CPI* 32930) *was compared with* Panicum maximum *cv. Gatton as a component of simple tropical grass/legume pastures with* Glycine wightii *cv. Tinaroo and* Desmodium intortum *cv. Greenleaf for autumn saved feed. Yields of total dry matter, living tissue and nitrogen were determined on undefoliated pasture at monthly intervals during three autumn/winter periods.*

*Accumulated yield increased by an average of 43% from May to August in a mild, wet year, but in a cold, dry year, it fell by 21%. Setaria pastures contained significantly higher levels ($P < 0.01$) of living tissue at the end of winter. They also retained significantly more nitrogen than Gatton panic pastures during a severe winter, despite the higher legume content in setaria pastures. Both legumes lost greater amounts of dry matter, living tissue and nitrogen than the grasses in all winters. Nitrogen content of Tinaroo glycine was always higher than that of Greenleaf desmodium, but the grasses differed little in nitrogen content.*

*The value of tropical grass/legume pastures for standover feed in south-eastern Queensland is discussed with particular reference to the use of frost tolerant setaria.*

## INTRODUCTION

Grazing of tropical pastures is an important part of the feeding programme of dairy and beef animals during autumn/early winter in south-east Queensland. However, dry matter and nitrogen losses from tropical mixed pastures during the winter period are considerable (Jones 1967). Frosting results in a large nitrogen loss and an even greater loss of digestible nitrogen (Milford and Minson 1965).

It is possible that frost tolerant introductions of *Setaria anceps* may provide better quality standover feed in autumn and winter than other tropical grasses. These introductions have the ability to retain green foliage after light frosting (Jones 1969, Hacker and Jones 1969). This study examined the performance of one such introduction, CPI 32930, comparing it to the relatively frost susceptible *Panicum maximum* cv. Gatton in grass/legume mixtures that were shut up in early autumn.

## METHODS AND MATERIALS

The experiment was a randomized block design with five replicates of four simple grass/legume mixtures planted on December 17, 1967 in plots 10.5 m × 5.3 m.

The mixtures were:—

1. *Setaria anceps* CPI 32930 with *Desmodium intortum* cv. Greenleaf.
2. *Setaria anceps* CPI 32930 with *Glycine wightii* cv. Tinaroo.
3. *Panicum maximum* cv. Gatton with *Desmodium intortum* cv. Greenleaf.
4. *Panicum maximum* cv. Gatton with *Glycine wightii* cv. Tinaroo.

The soil was a black earth formed from quaternary alluvium of mixed origin with available P levels of 597 ppm, exchangeable K levels of 1.3 m.e.% and total soluble salts of 0.05%. No quantitative data on nitrogen levels were available but the

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soil has a high nitrifying capacity. As Dickson (1965) and Dickson and Asher (1974) reported that sulphur responses on irrigated lucerne could be expected after the second year an application of 125 kg $ha^{-1}$ of superphosphate fortified with sulphur was applied to the area in 1969. A further application of 125 kg $ha^{-1}$ of superphosphate with trace elements (Cu, Zn and Mo) was applied at the same time to cover possible trace element deficiencies.

Irrigation was used to alleviate severe moisture stress, being applied only to maintain growth during summer. Over summer the area was defoliated at 15 cm every two months. The experiment was not mown or irrigated after 26th April, 1968, 2nd April, 1969 and 10th March, 1970, the pastures then being bulked up for winter.

Dry matter yield was measured monthly during autumn and winter with an electronic capacitance meter (Jones and Haydock 1970). One 0.61 m × 0.61 m quadrat was cut at random, 1.2 cm above the soil surface from each treatment. At each sampling date, this gave five readings from each pasture mixture for instrument calibration. Twenty meter readings were then taken in each treatment and converted to dry matter yield using the above calibration method. This technique for measuring dry matter reduced possible changes in the micro-environment of the standing pastures by removing as little material as possible. The advantage of the method was that it allowed 20% of the surface area to be sampled without damage. The major disadvantage was that in material with high dry matter content, meter readings were less reliable. There is evidence from Table 2 of this variability. However because of the nature of the investigation, it was decided that the advantage of a low defoliation percentage outweighed the disadvantages of instrument variability.

After cutting, samples were sorted into component species, oven dried, and weighed. In the second year, the samples were only sorted into living and dead tissue. In the third year, the material was further sorted into living and dead, grass and legume tissue. In the first and third years, nitrogen content was determined on pasture components, but in the second year only a bulk sample was analysed. In all years, samples for nitrogen analysis consisted of both living and dead tissue.

Winter temperatures during 1968 were average, while those in 1969 and 1970 were above and below average respectively. Rainfall, frost incidence and terrestrial minimum temperatures for the period April to September were recorded 1 km from the experimental site and some 8.5 m higher (Table 1).

TABLE 1

*Rainfall (mm), frost incidence, lowest terrestrial minimum (°C) and average terrestrial minimum temperatures (°C) recorded at Gatton Research Station, Lawes during the three winter periods* 1968-1970.

| Period* | Rainfall received (mm) | Rainfall Average (mm) | No. of Frosts (days)† | Lowest Terr. Min. Temp. (°C) | Aver. Terr. Min. Temp. (°C) |
|---|---|---|---|---|---|
| 1968 | | | | | |
| 26.iv.68 to 24.v.68 | 40 | 39 | ‡ | ‡ | ‡ |
| 25.v.68 to 26.vi.68 | 5 | 50 | 10 | —3·3 | —0·2 |
| 27.vi.68 to 24.vii.68 | 48 | 36 | 11 | —6·9 | —1·7 |
| 25.vii.68 to 27.viii.68 | 53 | 34 | 17 | —9·4 | —0·3 |
| 1969 | | | | | |
| 2.iv.69 to 30.v.69 | 167 | 86 | 0 | 1·4 | 6·9 |
| 31.v.69 to 27.vi.69 | 28 | 44 | 2 | —3·3 | 4·1 |
| 28.vi.69 to 5.viii.69 | 19 | 48 | 10 | —2·8 | 2·1 |
| 6.viii.69 to 3.ix.69 | 98 | 19 | 8 | —3·9 | 2·7 |
| 1970 | | | | | |
| 10.iii.70 to 24.iv.70 | 134 | 94 | 0 | 5·0 | 10·4 |
| 25.iv.70 to 12.vi.70 | 9 | 67 | 21 | —6·1 | 0·3 |
| 13.vi.70 to 20.vii.70 | 25 | 54 | 24 | —11·1 | —4·3 |
| 21.vii.70 to 20.viii.70 | 5 | 34 | 20 | —10·6 | —2·2 |
| 21.viii.70 to 16.ix.70 | 20 | 31 | 11 | —8·9 | 0·4 |

* dates correspond to growth periods between harvests.
‡ Terrestrial thermometer inoperative until June 1968.
† No. days terrestrial minimum below 0°C.

TABLE 2

*Accumulated dry matter yield of undefoliated pasture mixtures during three winter periods (kg ha$^{-1}$)*

| Harvest Date | Setaria/desmodium | | | Setaria/glycine | | | Gatton panic/desmodium | | | Gatton panic/glycine | | | Average (grass only) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Grass | Legume | Total | Grass | Legume | Total | Grass | Legume | Total | Grass | Legume | Total | Setaria | Gatton panic |
| 1968 | | | | | | | | | | | | | | |
| 24.v.68 | 1561 | 32 | 1818 | 1586 | 196 | 1872 | 3331 | 6 | 3342 | 2337 | 34 | 2389 | 1405 | 2834 |
| 26.vi.68 | 2440 | 52 | 2857 | 2251 | 84 | 2681 | 2651 | 3 | 2657 | 3569 | 51 | 3622 | 2095 | 3110 |
| 24.vii.68 | 2214 | 21 | 2552 | 2524 | 162 | 2885 | 2307 | 1 | 2439 | 3459 | 16 | 3595 | 2116 | 2883 |
| 27.viii.68 | 2834 | 6 | 3028 | 2846 | 41 | 3116 | 3046 | 0 | 3151 | 3499 | 6 | 3498 | 2536 | 3273 |
| | L.S.D. between harvest dates for any pasture mixture—Grass (5%) 592 (1%) 789 Legume (5%) 68 (1%) 91 Total (5%) 510 (1%) 680 | | | | | | | | | | | | | |
| % Change | +82 | —81 | +67 | +79 | —79 | +67 | —9 | —100 | —6 | +50 | —82 | +46 | +81 | +16 |
| 1969 | | | | | | | | | | | | | | |
| 30.v.69 | — | — | 2601 | — | — | 2961 | — | — | 1494 | — | — | 1939 | — | — |
| 27.vi.69 | — | — | 2570 | — | — | 3003 | — | — | 1579 | — | — | 1560 | — | — |
| 5.viii.69† | 2819 | 49 | 2868 | 2710 | 482 | 3192 | 2202 | 0 | 2202 | 1899 | 81 | 1980 | — | — |
| 3.ix.69 | — | — | 2975 | — | — | 3346 | — | — | 2587 | — | — | 2050 | — | — |
| | L.S.D. between harvest dates for any pasture mixture—Total (5%) 542 (1%) 722 | | | | | | | | | | | | | |
| % Change | — | — | +14 | — | — | +20 | — | — | +73 | — | — | +6 | — | — |
| 1970 | | | | | | | | | | | | | | |
| 24.iv.70 | 2081 | 55 | 2136 | 2038 | 1824 | 3861 | 2256 | 160 | 2234 | 2019 | 630 | 2650 | 1943 | 2121 |
| 12.vi.70 | 2645 | 205 | 2849 | 2904 | 2299 | 5202 | 2136 | 257 | 2259 | 1978 | 890 | 2868 | 2470 | 2041 |
| 20.vii.70 | 2387 | 169 | 2556 | 2761 | 411 | 3162 | 1879 | 246 | 2126 | 1616 | 892 | 2508 | 2576 | 1769 |
| 20.viii.70 | 2577 | 0 | 2577 | 3766 | 841 | 4068 | 2217 | 236 | 2460 | 2027 | 307 | 2334 | 2926 | 2165 |
| 16.ix.70 | 2081 | 154 | 2260 | 3929 | 513 | 4521 | 1308 | 11 | 2036 | 979 | 173 | 1680 | 3020 | 1339 |
| | L.S.D. between harvest dates for any pasture mixture—Grass (5%) 547 (1%) 725 Legume (5%) 411 (1%) 545 Total (5%) 513 (1%) 683 | | | | | | | | | | | | | |
| % Change* | —21 | —25 | —21 | +35 | —78 | —13 | —39 | —96 | —10 | —51 | —81 | —41 | +22 | —34 |

* % increase calculated from 12.vi.70 to 16.ix.70 to approximate time interval used in previous two years.
† One harvest only was sorted into component species in 1969.

The period—April to September, 1969—received 36% more rainfall than the long term average, while in 1968 and 1970, the rainfall received was 7% and 54% lower than average. Frosts were more frequent in 1970 than in 1968 or 1969 (Table 1).

## RESULTS

### *Changes in total yield*

In 1968 accumulated dry matter rose significantly ($P < 0.01$) from May to August in all pastures except panic/desmodium (Table 2). Accumulated yield of setaria/glycine and panic/desmodium pastures significantly increased ($P < 0.01$) over the period in 1969. Accumulated dry matter yields of pastures containing panic decreased from April to September 1970 although only that containing glycine decreased significantly ($P < 0.01$). On the other hand the yield of pastures containing setaria increased over the same period. The increase was only significant ($P < 0.05$) with setaria/glycine.

The percentage change in total yield is also presented in Table 2. As the experimental period in 1970 was longer than in the other two years, calculations were based on the period June 12, 1970 to September 16, 1970 to allow comparison between years. Over this period there was a 17% decrease in the yield of setaria pastures compared with a 22% loss from panic pastures. By comparison, setaria pasture yields increased by an average of 67% in 1968 and 17% in 1969. The equivalent increases in panic pastures were 21% and 40%.

### *Changes in yield of living (green) material*

Significant loss of living tissue occurred in both 1969 and 1970 ($P < 0.01$) with all pasture mixtures. In 1969 losses from panic pastures were greatest during May, yields remaining low for the rest of the experimental period. On the other hand significant losses ($P < 0.01$) from setaria pastures did not occur until August.

In 1970, only minor losses of living tissue occurred up to June. However, after June, panic pastures remained almost devoid of living tissue. By contrast, at least 50% of the total material present in setaria pastures in September was still green.

**TABLE 3**

*Yield of living tissue remaining (dry matter) in undefoliated pastures during two winter periods (kg ha$^{-1}$)*

| Harvest date | Setaria/desmodium | Setaria/glycine | Gatton panic/desmodium | Gatton panic/glycine |
|---|---|---|---|---|
| 1969 | | | | |
| 30.v.69 | 2601 | 2961 | 1494 | 1939 |
| 27.vi.69 | 2168 | 2325 | 510 | 843 |
| 5.viii.69 | 2243 | 2697 | 993 | 788 |
| 3.ix.69 | 1404 | 1550 | 328 | 338 |
| | L.S.D. between harvests for any pasture mixture 5%—867; 1%—1156 | | | |
| % Change | —46 | —48 | —78 | —83 |
| 1970 | | | | |
| 24.iv.70 | 2136 | 3861 | 2234 | 2650 |
| 12.vi.70 | 1980 | 4601 | 1291 | 2188 |
| 20.vii.70 | 1693 | 2285 | 0 | 54 |
| 20.viii.70 | 1195 | 1972 | 156 | 32 |
| 16.ix.70 | 1188 | 2600 | 124 | 142 |
| | L.S.D. between harvests for any pasture mixture 5%—333; 1%—441 | | | |
| % Change† | —40 | —44 | —90 | —94 |

† % Change calculated from 12.vi.70 to 16.ix.70 to approximate time interval in previous year.

*Changes in botanical composition*

Although the contribution of the legume in each pasture fell substantially over the early winter period (Table 2), there was no evidence that legume plants were killed by severe frosting. In fact legume yields increased from 1968 to 1970. For example, the legume content of the setaria/glycine pasture rose from 12% in May 1968 to 47% in April 1970. The proportion of grass was highest in panic mixtures, the growth of legumes being suppressed to a greater extent than in setaria pastures.

Legumes were more severely damaged by frost than grasses (Table 4). Although only data for 1970 were sufficiently detailed to allow the effects of frosting on components to be assessed, visual assessments in the previous two years indicated that a similar result had occurred.

Table 4 also demonstrates the difference between setaria and panic in resistance to low temperature. By August (1970) setaria had retained 50% of living tissue whereas only 2% of panic could have been regarded as living and most of this was tiller and stem bases.

TABLE 4

*Percent of living tissue present in the foliage of pasture components at the beginning and end of the experimental period in 1970.*

| Harvest date | % living tissue | | | |
|---|---|---|---|---|
| Component | Setaria/desmodium | Setaria/glycine | Gatton panic/desmodium | Gatton panic/glycine |
| 24.iv.70 | | | | |
| Grass | 100 | 100 | 100 | 100 |
| Legume | 100 | 100 | 100 | 100 |
| 12.vi.70 | | | | |
| Grass and Legume | 68 | 77 | 53 | 65 |
| 20.vii.70 | | | | |
| Grass | 70 | 83 | 0 | 3 |
| Legume | 4 | 0 | 0† | 0† |
| 20.viii.70 | | | | |
| Grass | 49 | 52 | 3 | 1 |
| Legume | 0 | 3 | 0† | 0† |

† Legume component present in these treatments (*Medicago polymorpha*-burr medic) was not included.

*Changes in nitrogen content of pasture components*

In 1968 the level of nitrogen in both grasses fell considerably from May to August (Table 5). In 1969 only a bulk analysis of grass and legume was taken. There was a fall in this composite nitrogen sample of 17% for the setaria pastures and 14% for the Gatton panic pastures from July to September of this year. In 1970, the nitrogen content of both grasses fell until July. However, whereas that of setaria continued to fall until September, the nitrogen content of panic rose substantially during August and September. There was a considerable fall in the nitrogen content of both legumes in 1968 and 1970 (Table 5).

*Changes in accumulated nitrogen yields*

In 1968, setaria pastures increased their yield of nitrogen from May to August while those containing panic decreased (Table 6). In 1969, only the panic/desmodium pasture showed a significant nitrogen yield increase ($P < 0.05$).

A significant decrease ($P < 0.01$) in the yield of nitrogen was recorded in both pastures containing glycine in 1970.

TABLE 5

*Nitrogen content (% d.m.) of pasture (both dead and living tissue) from undefoliated mixed tropical pastures during the winter months.*

| Pasture Component | Harvest Date | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 24.v.68 | 26.vi.68 | 24.vii.68 | 27.viii.68 | % Change | 24.iv.70 | 12.vi.70 | 20.vii.70 | 20.viii.70 | 16.ix.70 | % Change |
| *Grasses* | | | | | | | | | | | |
| Setaria | 1·90 | 1·50 | 1·41 | 1·45 | —24 | 1·23 | 1·08 | 1·01 | 0·96 | 0·87 | —29 |
| Gatton panic | 2·00 | 1·63 | 1·43 | 1·40 | —30 | 1·07 | 1·00 | 1·18 | 1·23 | 1·23 | +15 |
| *Legumes* | | | | | | | | | | | |
| Greenleaf desmodium | 2·58 | 2·50 | 2·01 | † | — | 2·58 | 2·47 | 1·57 | 1·87 | 1·74 | —33 |
| Tinaroo glycine | 2·88 | 2·48 | 2·17 | † | — | 2·75 | 2·68 | 1·71 | 1·80 | 1·80 | —35 |

| | Harvest Date | | | |
|---|---|---|---|---|
| | 27.vi.69 | 5.viii.69 | 3.ix.69 | % Change |
| *Pasture mixtures* | | | | |
| Setaria/Greenleaf desmodium | 1·33 | 1·15 | 1·18 | —11 |
| Setaria/Tinaroo glycine | 1·25 | 0·87 | 0·98 | —22 |
| Gatton panic/Greenleaf desmodium | 1·30 | 1·04 | 1·15 | —12 |
| Gatton panic/Tinaroo glycine | 1·30 | 1·33 | 1·08 | —17 |

† insufficient material for analysis.

TABLE 6

*Accumulated nitrogen yield in undefoliated tropical mixed pastures during three winter periods (kg ha⁻¹)*

| | Setaria/ desmodium | Setaria/ glycine | Gatton panic/ desmodium | Gatton panic/ glycine |
|---|---|---|---|---|
| 1968 | | | | |
| 24.v.68 | 30·5 | 35·2 | 65·1 | 47·7 |
| 26.vi.68 | 37·9 | 38·5 | 43·2 | 58·2 |
| 24.vii.68 | 33·6 | 36·5 | 31·5 | 54·7 |
| 27.viii.68 | 44·5 | 44·9 | 45·7 | 47·2 |
| L.S.D. between harvest dates for any pasture mixture—5% — 8·8; 1% — 11·9 | | | | |
| % Change | +46 | +28 | —30 | —1 |
| 1969 | | | | |
| 27.vi.69 | 33·4 | 37·6 | 21·1 | 20·2 |
| 5.viii.69 | 25·2 | 39·0 | 22·8 | 26·9 |
| 3.ix.69 | 35·1 | 34·7 | 29·8 | 22·2 |
| L.S.D. between harvest dates for any pasture mixture—5% — 7·1; 1% — 9·5 | | | | |
| % Change | +5 | —8 | +41 | +10 |
| 1970 | | | | |
| 24.iv.70 | 25·9 | 77·5 | 21·4 | 40·2 |
| 12.vi.70 | 28·7 | 92·0 | 29·9 | 32·3 |
| 20.vii.70 | 23·4 | 38·8 | 23·1 | 38·5 |
| 20.viii.70 | 22·3 | 54·7 | 29·2 | 32·1 |
| 16.ix.70 | 19·4 | 47·0 | 13·8 | 17·2 |
| L.S.D. between harvest dates for any pasture mixture—5% — 10·8; 1% — 14·4 | | | | |
| % Change† | —32 | —49 | —54 | —47 |

† % Change calculated from 12.vi.70 to 16.ix.70 to approximate time interval in previous years.

## DISCUSSION

The pastures based on *Setaria anceps* CPI 32930 retained greater quantities of live and total dry matter and more nitrogen in 1969 and 1970 than those based on Gatton panic as predicted by Hacker and Jones (1969). Changes in total dry matter during winter were considerable, varying from a decrease of 21% over all pastures in 1970 to an increase of 43% in 1968. The decrease in yield (1970) occurred in the only winter during the experiment where temperatures consistently fell below average.

Considerable difference was shown between the accumulated yields of the four pasture mixtures in May of each year. This was associated with differences in soil and weather conditions in the period prior to the commencement of sampling. High yields in May 1968 were due to initially high soil nitrogen levels associated with cultivation. Average yields in 1969 were lower than those of 1968, because of low rainfall recordings prior to May. These were inadequately compensated by irrigation. Low April yields in 1970 were associated with cool conditions during the pre-sampling period.

As in the work of Jones (1967), the legume component was more severely affected by frost than the grass. In 1968, 86% of the legume material was lost as a result of frosting and subsequent leaching and decomposition. In 1970, an average of 70% of the legume material was lost by September, although material remaining was entirely stem and of little value to animals. Jones (1967) found that between June and August of two consecutive years, 67 and 75% of the legume material in his pastures had been destroyed.

There were large differences between the two grasses in their ability to remain green after frosting. In the cold 1970 winter, setaria pastures contained significantly more living tissue than did panic pastures, and most of this was grass. This was despite the greater loss of legume from an initially higher legume component. In the mild 1969 winter, results were similar. By July all legume had been frosted while only 42% of the panic and 82% of the setaria foliage remained green.

The reduction in nitrogen content of grasses and legumes over winter was similar to that measured by Jones (1967). The increase in nitrogen content of panic in the latter stage of the 1970 winter was the only exception. This may have been due to the contribution of nitrogen to the soil by naturally occurring burr medic (*Medicago polymorpha*). In the final winter, burr medic growth was considerable but limited to pastures containing panic.

In the present experiment, the nitrogen yield reduction in 1970 (45%) was the only one similar in magnitude to the 36% reduction demonstrated by Jones (1967). In 1968 and 1969, nett gains in nitrogen (of 21% and 12% respectively) were obtained. Under average climatic conditions in 1968, setaria pastures attained a nett gain in winter (37%) while panic pastures sustained a nett loss (15%). This result and the much greater loss of nitrogen by panic compared to setaria pastures during the 1970 winter indicates the value of setaria based pastures under frosted conditions. The results, however, are confounded by legume content differences. Setaria pastures contained more legume than panic pastures and irrespective of the grass, glycine made a greater contribution than desmodium. Although the nitrogen yield changes reflect these trends, the data still show the superior performance of setaria.

This study has shown that autumn saving of mixed tropical pastures is a practical proposition even in severely frosted areas. The final quantity and quality of the material on offer will be a result of stage of maturity, and temperatures and rainfall over the winter period. The decision as to when to lock up a paddock in autumn will be made on the basis of quantity and quality of the material required.

The commercial cultivar, Narok, was not tested in the present experiment. Comparisons between introductions have shown that CPI 32930 was superior in frost tolerance (Hacker 1972) and similar in autumn/winter growth to CPI 33452 (Rees 1972, Hacker 1972), the introduction from which Narok was derived. As Narok was specifically selected for frost tolerance (Hacker 1972) it would appear to have a similar potential to CPI 32930 for autumn saving.

*Setaria anceps* CPI 32930 was capable of greater growth in the period between June and August than panic (Lowe 1974) although this may amount to no more than 200 to 500 kg $ha^{-1}$. However both species have been shown capable of making further growth after being cut back by frost (Jones 1969). Therefore the use of a frost tolerant line of setaria may have little advantage in increasing the bulk of feed on offer to animals during a cold winter. However, most of the advantage of a frost tolerant line will undoubtedly stem from the fact that the growth produced in autumn will remain greener than that of other tropical grasses.

There was little difference between the two tropical legumes, both losing all green material early in winter. A loss of nitrogen was associated with this frost damage. However, the results indicate that a pasture with a high legume content will still present a higher nitrogen yield to the grazing animal after frosting than one with a small legume component.

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