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FORAGE PRODUCTION FROM IRRIGATED OATS OR RYEGRASS GROWN WITH ANNUAL LEGUMES OR NITROGEN IN SOUTH-EASTERN QUEENSLAND

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SUMMARY

The production of irrigated Saia oats (*Avena strigosa*) and Wimmera ryegrass (*Lolium rigidum*) grown with annual temperate legumes or nitrogen fertilizer was studied over two years on a black earth at Gatton, south-eastern Queensland.

Jemalong medic (*Medicago truncatula*) grown with oats or ryegrass, was more productive than alternative legume/grass forage combinations. Total dry matter and nitrogen yields of both Jemalong and snail (*M. scutellata*) medic mixtures were similar to those of oats or ryegrass fertilized with 205 kg $ha^{-1}N$ in 1974. In 1975, Jemalong mixtures gave higher dry matter and equivalent nitrogen yields to the respective forages fertilized with 336 kg $ha^{-1}N$. Snail medic gave the best early production, reaching maximum growth in late winter, about a month earlier than Jemalong. The other legumes did not contribute to production until spring.

In 1974, total production of oats and ryegrass was similar, but in 1975 ryegrass production was the greater.

I. INTRODUCTION

In sub-coastal south-eastern Queensland, a major shortage of high quality feed for dairy cattle occurs from April to October. Under irrigation, oats (*Avena* spp.) will supply quality feed in autumn and winter (Harbison 1964; Crofts 1966; Humphreys 1969; Anon. 1970) while annual ryegrasses (*Lolium* spp.) produce best in the winter–spring period (O'Grady and Cassidy 1976). Both forages require regular applications of nitrogen (N) fertilizer for high dry matter production. With the increasing cost of nitrogen, the use of a legume to maintain forage quality (thereby reducing fertilizer N requirements) is becoming increasingly attractive.

Annual winter legumes have previously been studied in this environment (Schroder 1959a, 1959b; Jones and Rees 1972). Medics produce feed from March to September (Russell 1969; Harrison 1970; Rees 1972) but variable winter rainfall restricts the reliability and continuity of growth (Clarkson and Russell 1976) and the amount of regeneration from seed (Jones and Rees 1972). However, if medics are sown annually and irrigated, these two major restrictions would be removed.

This study compared the productivity of a range of temperate legumes or nitrogen fertilizer used in association with irrigated oats or ryegrass.

II. MATERIALS AND METHODS

Site

Field experiments were sown in two consecutive years on a black earth (Ug5·1, Northcote 1965) at Gatton Research Station, south-eastern Queensland. The surface 10 cm had a pH of 7·0 and available phosphorus was above 120 ppm.

Design

Species were hand-sown onto prepared 25-m^2 plots on 8 May 1974 and 17 April 1975. There were three replications of each treatment in a randomized block design. All treatments (table 1) were irrigated at 21-day intervals receiving totals of 300 mm in 1974 and 350 mm in 1975.

All legumes were sown at 7 kg ha^{-1} except *Trifolium repens* cv. Ladino (white clover) which was sown at 3·5 kg ha^{-1}. *Avena strigosa* cv. Saia was planted at 22 kg ha^{-1} and *Lolium rigidum* cv. Wimmera at 7 kg ha^{-1}. *Medicago minima* (woolly burr medic) and *Trifolium subterraneum* cv. Clare (sub clover) were replaced in 1975 by *Medicago littoralis* cv. Harbinger (strand medic) and *Medicago sativa* cv. Hunter River (lucerne) because of poor establishment and performance in 1974.

In 1974, N at nil (N_0), 205 (N_{205}) and 411 (N_{411}) kg ha^{-1} was applied in three applications of nil (N_0), 56 (N_{205}) and 112 (N_{411}) kg ha^{-1} at planting and after harvests 1 and 3; after harvest 4, a further application of nil (N_0), 37 (N_{205}) and 75 (N_{411}) kg ha^{-1} was applied. In 1975, three rates (nil (N_0), 168 (N_{168}) and 336 (N_{336}) kg ha^{-1} N) were applied in seven equal split applications at planting and after each harvest.

TABLE 1

MAIN EFFECTS OF GRASS SPECIES AND NITROGEN SOURCE ON ANNUAL OVEN DRY MATTER YIELDS (t ha^{-1}) OF GRASS, LEGUME AND TOTAL FORAGE OVER 2 YEARS

Pasture Type	1974			1975		
	Grass Yield	Legume Yield	Total Yield	Grass Yield	Legume Yield	Total Yield
GRASS SPECIES						
Oats	6·88	0·73	7·53	4·44	2·05	6·03
Ryegrass	5·68	1·10	6·65	5·23	1·86	6·71
l.s.d. (P = 0·05)	N.S.	0·21	N.S.	0·25	N.S.	0·23
NITROGEN SOURCE						
Red clover	5·57	0·87	6·71	4·30	1·76	6·28
Snail medic	5·75	1·03	6·83	4·84	1·61	6·59
Jemalong medic	5·21	1·99	7·29	4·34	3·47	7·95
Woolly burr medic	6·10	0·52	6·64	..	..	..
Harbinger medic	..	..	..	4·55	1·84	6·51
Ladino white clover	5·96	0·91	7·19	4·63	1·37	6·25
Clare sub clover	6·53	0·18	6·93	..	..	..
Lucerne	..	..	..	4·85	1·71	6·78
N_0	6·21	..	6·69	4·19	..	4·66
N_{205}	7·29	..	7·42	..	..	..
N_{411}	7·92	..	8·06	..	..	..
N_{168}	..	..	..	5·48	..	5·86
N_{336}	..	..	..	6·33	..	6·49
l.s.d. (P = 0·05)	0·70	0·37	0·71	0·52	0·37	0·48

Dry matter production was measured by cutting two 2·5-m x 0·9-m strips from each plot at 7·5 cm (ryegrass) or 10 cm (oats), at either 4-weekly (1974) or 3-weekly (1975) intervals. An extra strip was taken in 1975 to reduce experimental error. Hervested material was wieghed green in the field. Dry matter yield, botanical composition and N content were obtained from a subsample. After subsampling, plots were mown to the appropriate height and the cut material removed.

Rainfall and temperatures over the experimental period are shown in table 2. Irrigation was needed to supplement rainfall in most months. Growing conditions were good over both winters, although occasional cold periods (July 1974, May–June 1975) reduced growth rates.

TABLE 2

RAINFALL AND MEAN MAXIMUM AND MINIMUM SCREEN TEMPERATURES RECORDED AT GATTON RESEARCH STATION, LAWES, FROM APRIL TO NOVEMBER IN 1974 AND 1975 AND LONG TERM MEANS

Month	Rainfall (mm)			Mean Maximum Temp. (°C)			Mean Minimum Temp. (°C)		
	1974	1975	38–Year Mean	1974	1975	38–Year Mean	1974	1975	38–Year Mean
Apr	41	35	47	27·5	27·0	26·7	15·2	13·0	13·6
May	41	3	40	22·7	25·4	23·5	10·9	8·6	9·9
June	20	57	47	21·3	21·1	21·0	7·4	7·0	7·4
July	5	33	39	21·5	21·8	20·3	5·1	7·4	6·0
Aug	54	28	29	21·0	21·8	22·2	7·3	7·3	6·6
Sep	37	65	38	23·3	24·4	24·4	8·0	11·0	9·0
Oct	41	120	65	26·0	25·5	27·7	12·0	12·9	12·9
Nov	188	121	98	27·8	29·4	28·7	14·1	15·9	15·8

III. RESULTS

Dry matter yields

GRASS SPECIES RESPONSES

In 1974, oats treatments gave significantly higher grass and total forage yields but lower associated legume yields, than did ryegrass treatments. The reverse applied in 1975 except that associated legume yield was similar with both forages. In 1975, there was a grass species x nitrogen source interaction ($P < 0 \cdot 05$) in that the perennial legumes gave higher yields with oats than with ryegrass.

N SOURCE RESPONSES

Medicago truncatula cv. Jemalong was the highest yielding legume in both years. Total forage yields of mixtures containing Jemalong or snail (*M. scutellata*) medic were similar to those of oats or ryegrass fertilized with 205 kg ha^{-1} N in 1974. Jemalong medic combinations outyielded ($P < 0 \cdot 05$) all treatments in 1975 (table 1).

SEASONAL GROWTH

In the latter part of the season (September to November) lucerne, white clover and red clover (*Trifolium pratense*) contributed as much as Jemalong medic (data not presented).

Growth rates of selected ryegrass and oats treatments (figures 1 and 2) demonstrate the different patterns of forage production. In the period following sowing in 1974 (figure 1), yields of oats were approximately three times those of Wimmera ryegrass but at the second defoliation, ryegrass outyielded oats ($P < 0{\cdot}05$).

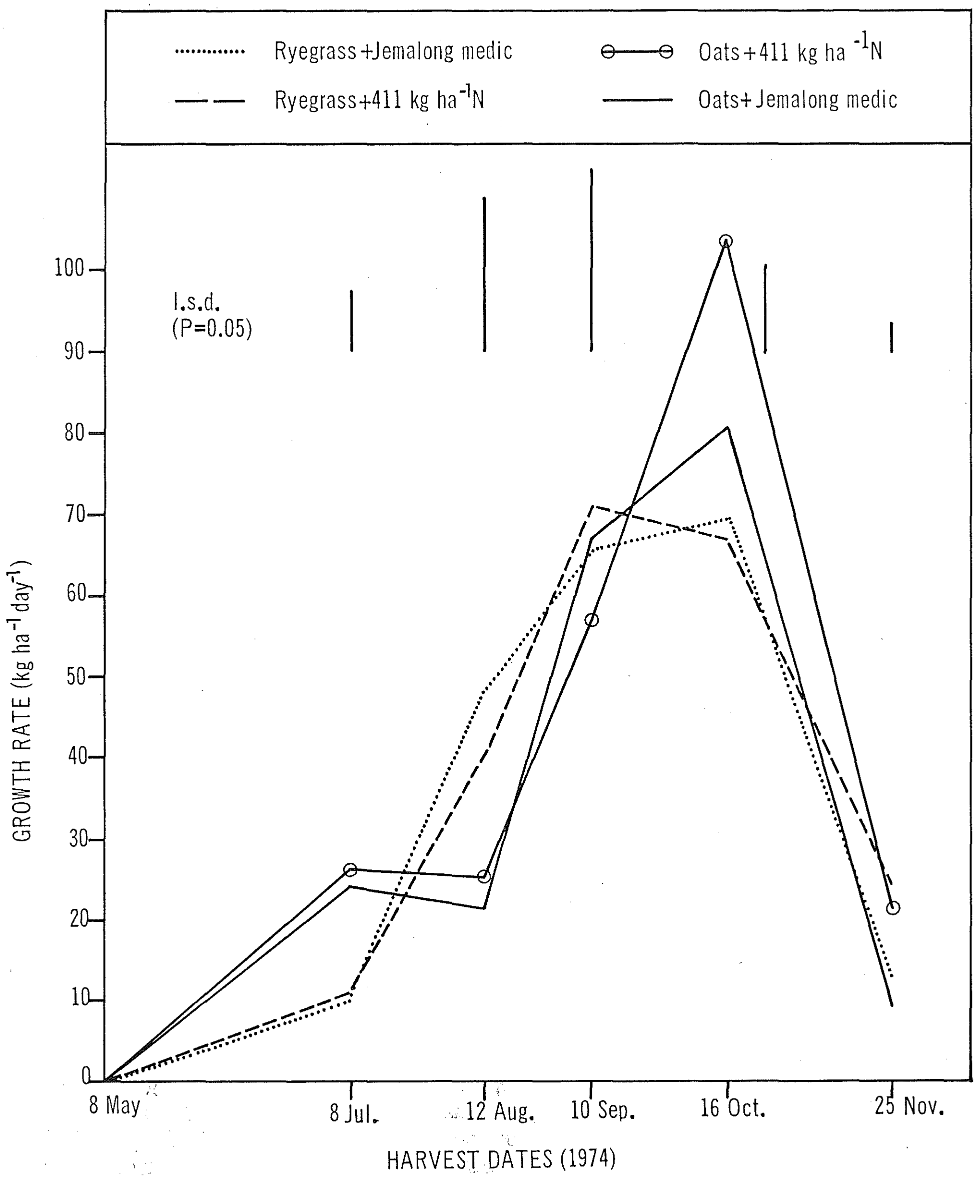

Figure 1.—1974 growth rates of oats and ryegrass with Jemalong medic or nitrogen.

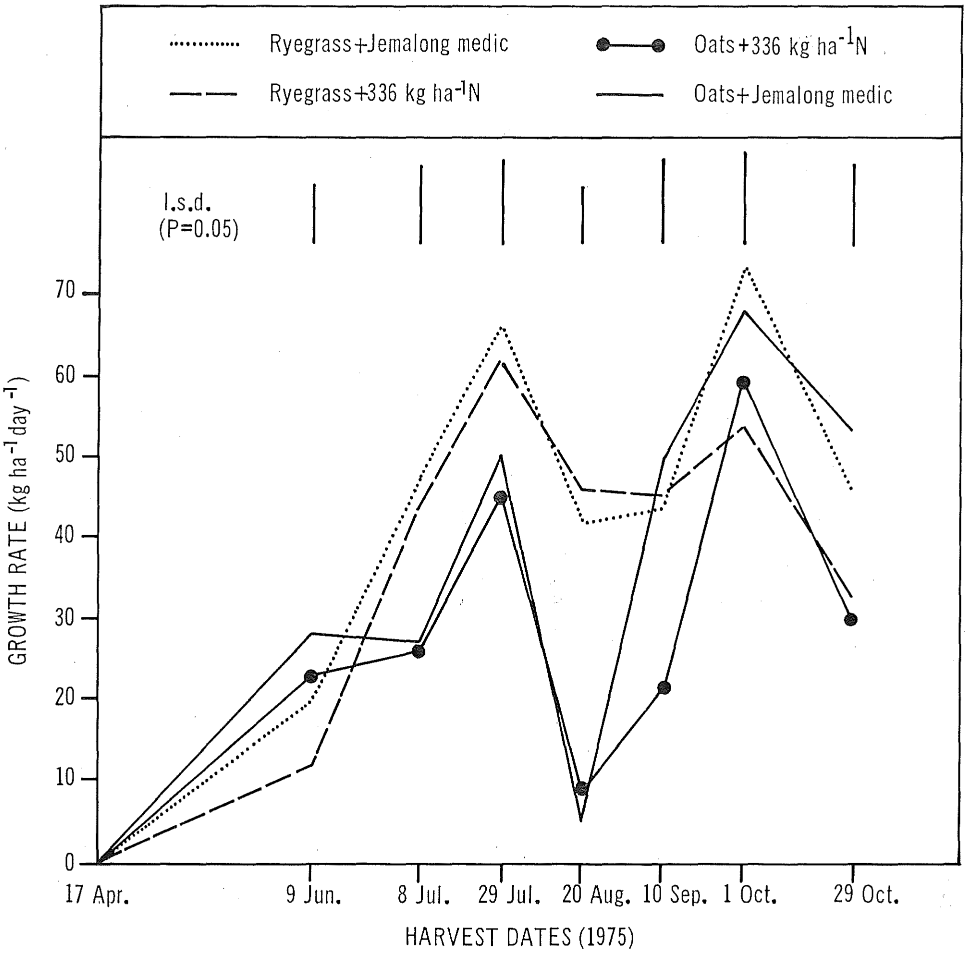

Figure 2.—1975 growth rates of oats and ryegrass with Jemalong medic or nitrogen.

There were no significant differences between the respective N-fertilized and medic treatments until October 1974 (figure 1) and September 1975 (figure 2). In 1974, the growth rate of N-fertilized oats was higher than that of the medic treatment in the last two samplings ($P < 0{\cdot}05$). However, in 1975, the growth rates of oats and ryegrass combined with Jemalong were superior to those of the corresponding N-fertilized treatments after September.

Nitrogen content and yield

Forage nitrogen content varied considerably throughout the season, particularly in those treatments fertilized with nitrogen. However, nitrogen content of N-fertilized grasses (seasonal average) was not substantially different from grasses grown with legumes. The nitrogen content of legumes did not vary greatly throughout the growth period (data not presented).

In 1974 there was no difference ($P < 0{\cdot}05$) between the total nitrogen yields of forages planted with legumes and those fertilized with the highest N rate (table 3). However, in 1975, total nitrogen yields of the forage/Jemalong mixtures gave higher ($P < 0{\cdot}05$) yields than all other treatments.

TABLE 3

ANNUAL NITROGEN YIELDS (KG HA^{-1}) OF THE VARIOUS WINTER FORAGE COMBINATIONS AT GATTON RESEARCH STATION, 1974 AND 1975

Treatment	1974			1975		
	Grass	Legume	Grass + Legume	Grass	Legume	Grass + Legume
Oats + red clover	204	27	231	175	114	289
Ryegrass + red clover	179	43	222	197	40	237
Oats + snail medic	236	37	273	195	50	245
Ryegrass + snail medic	168	54	222	213	80	293
Oats + Jemalong medic	210	71	281	182	147	329
Ryegrass + Jemalong medic	161	100	261	184	170	354
Oats + woolly burr medic	251	15	266	..	..	..
Ryegrass + woolly burr medic	174	32	206	..	..	..
Oats + Harbinger medic	..	..	..	196	52	248
Ryegrass + Harbinger medic	..	..	..	186	94	280
Oats + white clover	236	29	265	201	80	281
Ryegrass + white clover	192	48	240	189	45	234
Oats + Clare sub clover	244	6	250	..	..	..
Ryegrass + Clare sub clover	197	10	207	..	..	..
Oats + lucerne	..	..	..	187	96	283
Ryegrass + lucerne	..	..	..	224	67	291
Oats + N_0	249	..	249	159	..	159
Ryegrass + N_0	179	..	179	157	..	157
Oats + N_{205}	266	..	266	..	..	..
Ryegrass + N_{205}	254	..	254	..	..	..
Oats + N_{411}	302	..	302	..	..	..
Ryegrass + N_{411}	265	..	265	..	..	..
Oats + N_{168}	..	..	..	216	..	216
Ryegrass + N_{168}	..	..	..	262	..	262
Oats + N_{336}	..	..	..	250	..	250
Ryegrass + N_{336}	..	..	..	310	..	310
l.s.d. ($P = 0{\cdot}05$)	37	20	37	34	23	34

IV. DISCUSSION

The results demonstrate that the combination of an annual legume (Jemalong) and oats or ryegrass was capable of similar production to that of oats or ryegrass fertilized with up to 336 kg ha^{-1} N. Total production of the highest yielding treatments (8 000 kg ha^{-1}) was similar to yields from a range of planting rates from 10 to 40 kg ha^{-1} of ryegrass (S. Stillman, personal communication; M. Fay, personal communication). However, they were lower than yields of high density ryegrass fertilized with considerably higher levels of nitrogen (O'Grady and Cassidy 1976).

The fact that nitrogen source x forage species interactions were recorded in legume and total dry matter yields in 1975 but not in 1974 appears to be associated with different cutting management in the two years. The more frequent defoliation in the second year allowed better legume growth, especially of the later maturing perennial legumes. These performed better in spring with the rapidly thinning oats stand than with the more vigorous ryegrass.

Jemalong medic gave the highest legume dry matter yield and the best seasonal distribution, and was compatible with oats and ryegrass. This agrees with the results of rain-grown experiments in similar sub-tropical environments (Russell 1969; Rees 1972; Jones and Rees 1972; Clarkson 1977; Younger 1978) and also in temperate areas (Scott and Brownlee 1976). Snail medic produced well in winter and early spring, but late spring production was low. It would be a useful component to increase autumn–winter production. The normally perennial species (lucerne, white clover and red clover) only became productive in spring but from then on they produced as much as Jemalong. This is contrary to the findings of Hendricksen (1970) that under continuous grazing, lucerne yields did not increase in spring. However, in Hendricksen's experiment the crop was rain-grown and moisture may have limited spring growth.

Harbinger medic (*M. littoralis*) grew very well early in the season, but its growth was very poor from August onwards. Scott and Brownlee (1976) found that Harbinger did not perform as well on heavy soils as on light soils. Its poor performance may have been associated also with its inability to withstand the temporary waterlogging which follows irrigation on heavy soils (Clarkson 1977). Clare subterranean clover grew poorly despite early successes at Gatton (Schroder 1959a; 1959b).

At Gatton, burr medic (*M. polymorpha*) re-establishes naturally in most years. In low density forage sowings, it can contribute substantially to yields, but its performance is influenced by rainfall and irrigation. In this experiment, good burr medic germination occurred in 1974, but in planted medic treatments its growth was suppressed by the more vigorous sown medics.

The high nitrogen yields achieved by Jemalong mixtures were due to high dry matter yields of the mixture and the high nitrogen content of Jemalong (4·4% N). As a nitrogen content of 2·4% is the minimum requirement for high dairy cow production (Kemp 1974), the inclusion of Jemalong in unfertilized forage mixtures may be necessary to raise the overall quality of feed at least to this level.

V. CONCLUSIONS

The use of Jemalong medic as a means of producing winter feed without N fertilizer appears to have value for irrigated areas of sub-coastal south-eastern Queensland. However, Jemalong is badly damaged by blue-green aphid (*Acyrthosiphon kondoi*). As snail medic provides some aphid resistance (Franzman *et al.* 1979), it may be a better choice, thus obviating the need for chemical control measures. In areas where aphids are not a problem, combinations of Jemalong with oats or ryegrass can provide a lower cost alternative to N-fertilized forages.

As yields of 10 000 to 12 000 kg ha^{-1} have been achieved from high density medic sowings in southern Queensland (N. M. Clarkson, personal communication), manipulation of forage species/medic planting rates may increase yields above the values achieved here. This seems a valuable avenue for future research.

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