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**COMPARISON OF SUMMER FORAGES AND THE EFFECT OF NITROGEN  
FERTILIZERS ON *BRASSICA* FORAGES IN TASMANIA**

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**Abstract**

Summer forage crops, and in particular *Brassica* spp., have become increasingly popular in dairy production systems in Tasmania. Field experiments were conducted for 3 years in northwestern Tasmania, in the spring/summers beginning in 1995. The study aimed to compare yield and quality of *Brassica* and *Poaceae* forages and the response of *Brassica* species to nitrogen (N) (50, 100 and 200 kg N/ha) and irrigation.

The average total yields of dryland (rainfed) crops in 1995 to 1997 experiments, were turnip (*Brassica rapa*) 9.3 t/ha, rape (*B. napus*) 5.9 t/ha, oats (*Avena sativa*) 5.2 t/ha, kale (*B. oleracea*) 5.1 t/ha, short-lived ryegrass (*Lolium multiflorum*) 5.1 t/ha, pasja (*B. campestris* × *B. napus*) 4.3 t/ha, perennial ryegrass (*L. perenne*) 4.2 t/ha, millet (*Echinochloa utilis*) 3.8 t/ha, and maize. (*Zea mays*) 2.9 t/ha.

Irrigation increased the yield of turnips by 4.8 t/ha (mainly bulbs) and millet yields by 1.4 t/ha and reduced maize yield by 1.2 t/ha. *Brassica* species were higher in ME and lower in CP than the *Poaceae* forages.

Nitrogen fertilizer increased the DM yield of tops of all *Brassica* crops in the 1997/98 experiments under irrigation, but it decreased the yield of turnips bulbs. The total yields with

50, 100 and 200 kg N/ha were 14, 15.2 and 15 t DM/ha for turnips, 7.5, 8.5 and 10 t for pasja and 10, 12 and 12.2 t DM/ha for rape, respectively. With 100 kg N/ha the average concentration of quality attributes of turnips, pasja and rape were CP 14, 22 and 19%, ME 12, 14.6 and 12.6 MJ/kg DM respectively. Nitrogen increased the CP, but had no effect on ME of any *Brassica* crops.

*Brassica* forage are superior to *Poaceae* forages for summer feed production and as a part of pasture renovation process. They are higher in their yields, quality and water use efficiency and respond well to N fertilizer.

**Keywords:** *Brassica*, forages, irrigation, nitrogen, pasja, rape, *Poaceae*, turnips

## Introduction

Low summer rainfall results in insufficient quantity and quality of pasture on dairy farms in south-eastern Australia (Moate *et al.* 1999). *Brassica* forages, and in particular turnips (*Brassica rapa* var. *rapa*), are used on more than 70% of dairy farms of the region to supplement the summer feed deficit (Stockdale *et al.* 1997). However, these crops have not been evaluated against *Poaceae* species or for their suitability within pasture renovation systems.

Previous works on the nitrogen (N) response of turnips, indicated conflicting yield responses (Pearson and Thomson 1996). Studies on the N response of rape are insufficient and for pasja are lacking.

The objective of this study was to evaluate a range of *Brassica* and *Poaceae* forage crops for their yield, nutritive quality and responses to irrigation and N fertilizer and to identify forages that can redress summer feed shortages and integrate into dairy pasture renovation practices.

## Material and Methods

Four separate experiments were conducted in cool, temperate, high rainfall region of northwestern Tasmania (145° 46' E; 41° 06' S, mean annual rainfall 1217 mm, winter dominant, 260 ± 20 mm October to January), in the spring/summer season between 1995 and 1998. The sites were on degraded permanent dairy pastures, on flat, free draining, deep clay loam ferrosol (Isbell 1996).

Prior to sowing, the sites were sprayed with herbicide, cultivated and basal dressing of phosphorus, potassium, lime and trace elements fertilizers were incorporated, but nitrogen (N) fertilizer was top-dressed.

In the 1995/96 and 1996/97 experiments, the yield of dry matter (DM) and nutritive quality, including crude protein (CP), and metabolisable energy (ME) of nine forage species (either *Brassica* or *Poaceae* spp) were compared under irrigated (20 mm water/week) and non-irrigated (rainfed) conditions. The *Poaceae* forages were oats (*Avena sativa* cv Cluan and Esk), millet (*Echinochloa utilis* cv Shirohie), short lived ryegrass (*Lolium multiflorum* cv Concord), perennial ryegrass (*L. perenne* cv Jackaroo) and maize (*Zea mays* cv SR7). The *Brassica* forages were turnips (*Brassica rapa* var. *rapa* cv Barkant), rape, (*B. napus* var. *napus* cv Bonar), kale (*B. oleracea* cv Kestral), and (hybrid *B. campestris* × *B. napus* cv Pasja). *Brassica* forages and maize were harvested once in early February and the remaining species two or three times on early December, January and February.

In the spring/summer of 1997/98, an irrigated field study was conducted to investigate the effect of three rates of N fertilizer applications (50, 100, 200 kg N/ha) on the yield, nutritive quality of turnips, pasja and rape. Most yield and quality attributes were measured at 9, 12, 14 and 16 weeks for turnips and before each of the two grazing for rape and pasja.

## Results

The total DM yield of all 9 forages after 13 weeks averaged over the two years in the rainfed treatment are given in Figure 1. Between *Poaceae* forages only oats was ready for harvest in early December, and produced 1.4 t DM/ha (Fig 1). Total yields of oats and short-rotation ryegrass was higher than perennial ryegrass and millet. Turnip yields were highest, followed by rape, pasja and kale, which were similar and maize yields the lowest.

The responses of total yield to irrigation were largely non-significant ( $P > 0.05$ ), with only turnips (mainly bulbs) and millet showing a positive and maize a negative yield response to irrigation. On average over two years, irrigation increased turnips and millet yields by 4.8 and 1.4 t DM/ha respectively. *Brassica* species were higher in ME and lower in CP than the *Poaceae* forages, and of the *Poaceae* forages, millet was consistently of higher CP (21%) than ryegrass species.

Turnip yields increased with time until the last harvest date at 16 weeks after sowing, but the highest growth rate (240 kg DM/ha.day) was observed in the 9-12 weeks period. Nitrogen fertilizer increased the DM yield of tops of all *Brassica* crops, but decreased the yield of turnips bulbs. Turnip yields with 50, 100 and 200 kg N/ha were 14, 15.2 and 15 t DM/ha. The corresponding yields for pasja were 7.5, 8.5 and 10 t and for rape were 10, 12 and 12.2 t DM/ha, respectively.

At 100 kg N/ha the average concentration of quality attributes of turnips, pasja and rape were CP 14, 22 and 19%, ME 12, 14.6 and 12.6 MJ/kg DM for the 3 N fertiliser rates, respectively. Nitrogen increased CP content, but had no effect on ME of either crop. Two weeks after application of up to 200 kg N/ha, the nitrate-N in the tops of *Brassica* crops (<3500 mg/ kg) was below the conventional threshold of toxicity.

## Discussion

Irrigated turnips, rape and pasja were superior yielding than the *Poaceae* species and were equivalent to barley grain in feed value (Moate *et al.* 1998). The high ME and CP content of these crops could be employed advantageously to supplement the low CP and ME, high fibre feed usually produced by rainfed ryegrass/clover pasture during late spring and early summer periods. Turnip bulbs being low in CP if fed as a high proportion of the diet, could induce a protein deficiency in a high producing dairy herds (SCA 1990). This may not be of a problem with grazing of turnips where high CP in leaves may compensate for low bulb CP.

Where forage is required through the summer, establishing pasja and rape is advantageous to any *Poaceae* spp or turnips. However, if additional forage is required from late January, then turnips are clearly superior to the other forages evaluated.

*Brassica* spp were 2-3 times more efficient in production of DM/unit of water (rain and irrigation) than *Poaceae* spp producing 35-50 kg DM/ha.mm water.

Nitrogen fertilizer, at 100kg N/ha, and in case of pasja at 200 kg/ha, may be used as a tool to tailor the DM yield and quality to animal requirements. A cost/benefit analysis indicated that *Brassica* forages could produce equal quality feed at a third of the cost of purchasing feed barley.

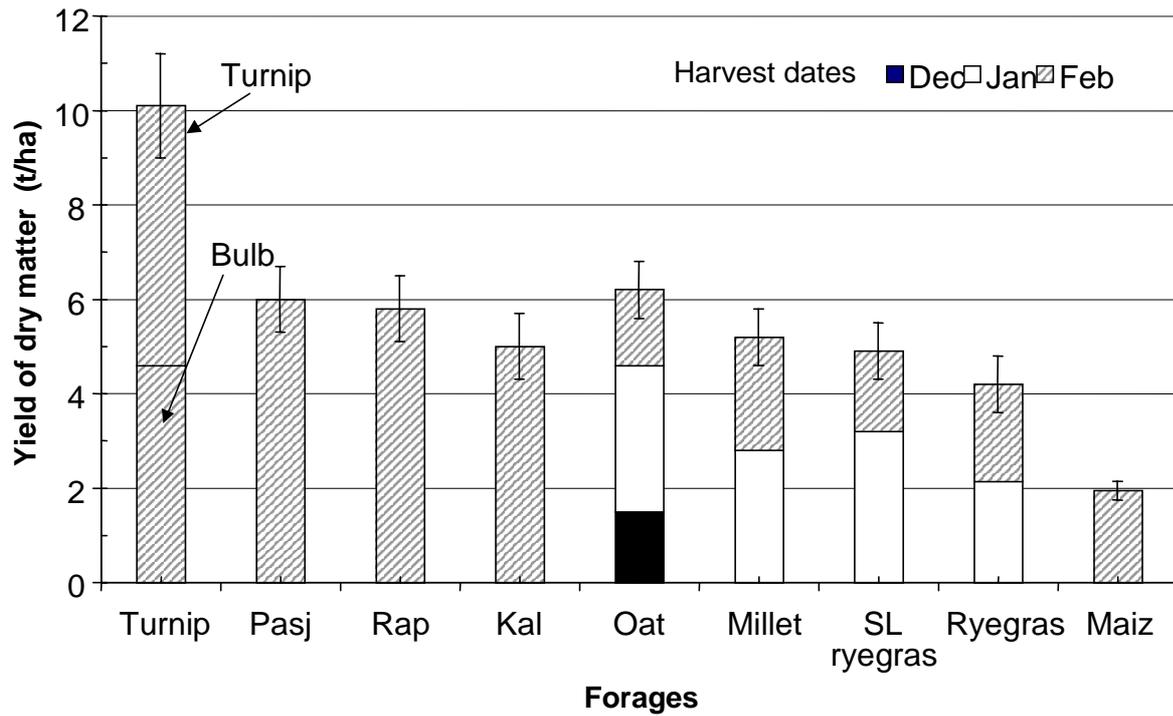
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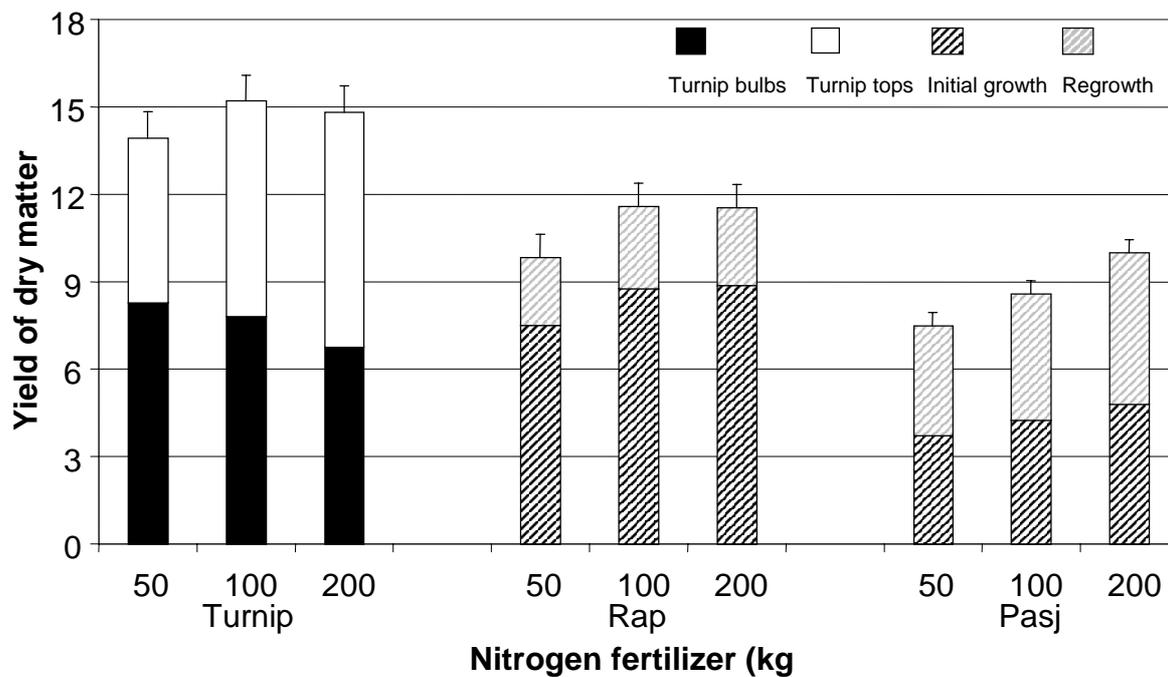
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**Figure 1** - The total DM yield of 9 rainfed forage crops after 13 weeks, averaged for the 1996-97 years. SL ryegrass stands for short-lived ryegrass. Vertical bars indicate least significant difference (l.s.d<sub>0.05</sub>) for comparisons between forages.



**Figure 2** - Effects of rate of nitrogen fertilizer (kg N/ha) on the dry matter yield of 3 *Brassica* forages after 16 weeks. Vertical bars indicate l.s.d.<sub>0.05</sub> for comparisons between the total yields of forages and rates of N.