# Effect of superphosphate on production and botanical composition of native grass pastures in Tasmania

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## ABSTRACT

The effect of application of superphosphate on the production and botanical composition of native grass pastures was assessed in paired paddock trials at three sites in the Midlands of Tasmania. Soil phosphorus concentrations (Colwell test) were maintained 5-10 mg/kg higher on the fertilised compared with the unfertilised paddock at each site. Averaged over all sites and years, application of superphosphate increased annual pasture production by 106% (from 1170 to 2400 kg DM/ha), but there was considerable variation between sites and between years. The main effect on botanical composition was an increase in clover content of the herbage in fertilised pastures, but this increase also varied between sites and years. However, there was no effect on the content of native grasses in fertilised pastures as measured by frequency. The results indicate that the productivity of native grass pastures in the Midlands of Tasmania could be increased considerably, without loss of the valuable native grasses, by the judicious use of superphosphate and careful grazing management.

## Key words

Native grass pasture, *Austrodanthonia*, clover, superphosphate, pasture production, botanical composition.

## INTRODUCTION

Superphosphate was widely used on native grass pastures in Tasmania up to the 1970s, but is used only sparingly today. Although increases in pasture production may result from application of superphosphate or other phosphatic fertilisers and introduction of clovers, there may also be adverse changes in botanical composition associated with increased fertility (6; 4). A survey of native grass pastures in Tasmania (2) showed that the cover of *Austrodanthonia* spp., the main native grass present, was negatively correlated with both the amount of superphosphate applied as well as with increasing soil phosphorus. Although increased soil fertility itself may be favourable to the native grasses (4), these grasses have been shown to be susceptible to competition from clover under increased soil fertility (8; 7). Increased soil fertility can also encourage weed invasion, particularly of annual grasses (6; 4), further increasing competition on the native grasses. Loss of the perennial native grasses can result in lowered summer production, decreased water use in summer, increased runoff, increased soil erosion and raising of water tables in catchments (5).

A research project was begun in Tasmania in 1994 to look at both the biological and economic aspects of fertilising native grass pastures. This paper presents results showing the effects of application of superphosphate on pasture production and botanical composition.

## METHODS

Trials were conducted at three sites in Tasmania, *viz*. Nile in the northern Midlands (lat. 41?36′, long. 147?23′), Pawtella in the southern Midlands (lat. 42?18′, long. 147?31′) and Bothwell in the Derwent Valley (lat. 42?26′, long. 146?57′). The trials were based on paired paddocks, one of which was fertilised while the other was left untreated. The trial at Bothwell started in May 1994 and the trials at the other two sites started in May 1995. Data are presented to May 2000.

The dominant pasture species included *Austrodanthonia* spp. at each site, *Microlaena stipoides*, *Agrostis capillaris* and *Anthoxanthum odoratum* at Nile, *Poa labillardierei* at Pawtella and *Stipa* spp. and *Poa*

*bulbosa* at Bothwell. A range of weed species was present at each site, the most notable being *Hypochaeris radicata*, *Leontodon taraxacoides*, *Erodium cicutarium*, *Carduus* spp. and *Vulpia* spp. *Trifolium subterraneum* and other annual clovers, particularly *T. dubium*, *T. glomeratum* and *T. striatum*, were common at all sites.

Extractable phosphorus was below 12 mg/kg (Colwell test) at each site prior to fertiliser application. Single superphosphate at a rate of 250 kg/ha plus sodium molybdate at a rate of 150 g/ha was applied to the fertilised paddock at each site at the start of each trial. One or two further applications of superphosphate at a rate of 125 kg/ha were applied over subsequent years to maintain extractable soil phosphorus 5 – 10 mg/kg higher on the fertilised paddock compared with the unfertilised paddock. A total of 500 kg/ha of superphosphate was applied to the fertilised paddock over the five-year period at Nile and over the six-year period at Bothwell, whereas at Pawtella 375 kg/ha of superphosphate was applied over the five-year period. Subterranean clover (cvv. Denmark and Leura) was oversown at 8 kg/ha with the initial application of superphosphate.

The paddocks were stocked with dry sheep (normally merino wethers) using a continuous grazing method, but stocking rate was adjusted periodically at each site to maintain a similar herbage mass of between 500 and 1500 kg DM/ha on the two paddocks. The paddocks were destocked completely for varying periods during drought.

Observations on pasture growth and botanical composition were made at random positions in four blocks (50 m by 50 m or 50 m by 20 m) in each paddock. Observations of net pasture growth (the difference between true growth and decay) were based on changes in herbage mass in cages (three cages per block) over *c.* 3-month intervals. Herbage mass was measured using the weighted disc method (1). Botanical composition was assessed once per year in the spring from herbage cut to ground level in ? $m^2$ quadrats in each of the cages and sorted into three components, *viz*. native grass, clover and "weeds" (all other species). In addition, changes in the frequency of the main pasture species were assessed in permanent ? $m^2$ quadrats (five per block). Frequency was determined from counts of the proportion of cells in a 5 by 5 grid (25 cells, 10 cm by 10 cm) placed over each quadrat, that contained rooted plants of the target species. Assessments were made in autumn and spring each year.

*Poa labillardierei* tussocks at Pawtella were not included in the observations of pasture growth, botanical composition or frequency described above. Growth and basal cover of *P. labillardeirei* were assessed separately, but the data are not presented in this paper.

Pasture production and botanical composition data were analysed using REML, with Site and Fertiliser included in the fixed model (Site + Fertiliser + Site.Fertiliser) and Year included in the random model (Year + Year.Block). Significance tests were based on the Wald statistic. Frequency data were not subjected to statistical analysis.

## RESULTS

### Pasture production

There were highly significant ($P < 0.001$) effects on annual pasture production of site and fertiliser, as well as highly significant ($P < 0.001$) interactions between these main effects. Increases in annual pasture production resulting from application of superphosphate ranged from zero to 410%, but averaged over all sites and years, the increase was from 1170 to 2400 kg DM/ha.

Differences in pasture production and the response to fertiliser between sites and between years were associated with differences in seasonal rainfall. Low spring rainfall, as at Pawtella in 1997 and 1999, limited pasture growth rates and hence the response to fertiliser (Fig. 1).

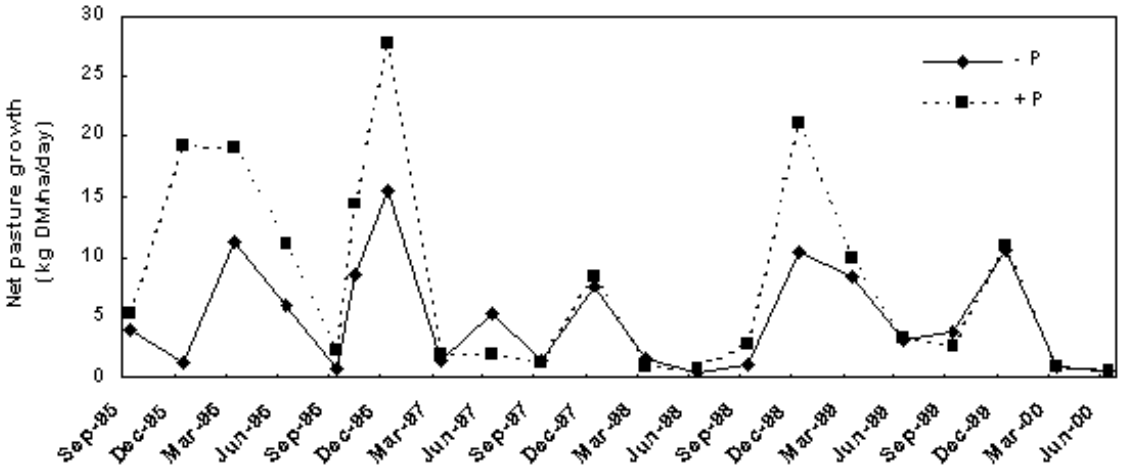


**Figure 1. Effect of superphosphate (+P) compared with no superphosphate (-P) on changes in net pasture growth at Pawtella over the period of the trial.**

**Botanical composition**

There were highly significant ($P < 0.001$) effects of fertiliser on botanical composition, but the changes observed varied between sites and between years. Increases in clover content in response to fertiliser were observed at all sites, but again the response was limited by low spring rainfall. Bothwell experienced very dry springs each year after 1996 (no harvest was taken in 1997 due to the pasture dying off in early spring), and the main effect was then an increase in weed content (mainly *Erodium cicutarium* and *Scleranthus annuus*: Fig. 2). At all sites the increase in clover content was greatest in the first year.

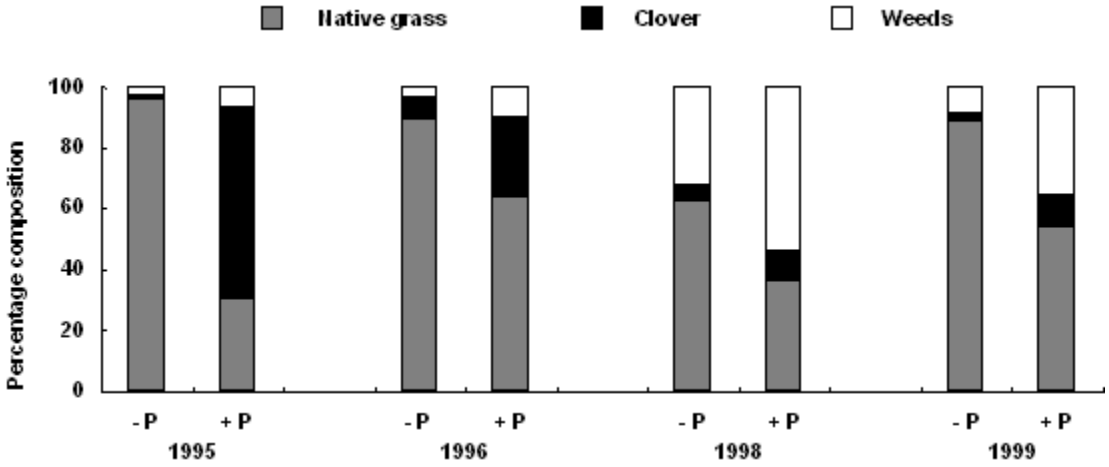


**Figure 2. Effect of superphosphate (+P) compared with no superphosphate (-P) on the botanical composition of the pasture at Bothwell in the spring of 1995, 1996, 1998 and 1999.**

Over the period of the trial, there were no substantial changes in frequency of the main species or species groups at any site. The frequency of *Austrodanthonia* spp. remained close to 60% at Nile, between 80% and 90% at Pawtella, and between 50% and 60% at Bothwell.

**DISCUSSION**

Whether application of superphosphate to native grass pastures is justified economically will be largely determined by the increases in pasture production resulting from fertilisation. In this study, application of superphosphate more than doubled pasture production, averaged over all sites and years. However, the results show that in low-rainfall years the response is likely to be greatly reduced. The southern Midlands and Derwent Valley experienced some of the driest years on record during this study, which resulted in no response to superphosphate in two out of five years for Pawtella and four out of six years for Bothwell. The importance of favourable seasonal conditions for clover growth in determining the response of native grass pasture to fertiliser has been noted previously (6).

An increase in the nutritive value of fertilised compared with unfertilised pasture was observed in these trials (unpublished data), which will further increase the potential returns from the fertilised pasture. For example, lactating or growing stock may be run on fertilised native grass pasture that previously only supported dry stock.

The increase in variability of pasture production between seasons and between years, which was a feature of the fertilised pastures, makes them less suitable for fine wool production, as this variability can affect wool fibre diameter and seriously downgrade the quality of fine wool. No measurements of wool quality were made in these trials, but an adverse effect of the fertilised pasture on wool quality was noted at one site (A. Gibson, pers. comm.).

Although large increases in the content of clover occurred on some sites in some years in these trials, there were no apparent adverse effects on the native grasses. There were also no increases in weed populations as shown by the frequency measurements, although the weed content of the herbage did increase in some instances.

The potential for clover dominance at high fertility levels was illustrated by the high clover contents observed at all sites in the first year following application of 250 kg/ha of superphosphate, when extractable soil phosphorus increased to 25 – 35 mg/kg. Clover content of the fertilised paddocks was probably limited subsequently by maintaining extractable soil phosphorus below 25 mg/kg (7).

In these trials we also attempted to control clover growth in the spring by increasing grazing pressure, but this was not always achieved. Grazing management is an important tool in manipulating the botanical composition of native grass pastures (3), and is essential in fertilised pastures to control clover dominance and ensure the persistence of the native grasses (7).

The study, which was conducted at three sites with differing botanical composition over periods of up to six years, has shown that native grass pastures in Tasmania are capable of large increases in pasture production in response to application of superphosphate, without loss of the valuable native grasses. The increases in carrying capacity that were achieved are presented in another paper (Friend *et al.*, this conference), together with an economic analysis of the costs and returns.

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