2006/Q01

Producer Research Report

Sustaining the Productivity of Leucaena Stands

The Leucaena Network

The primary aim of Leucaena Network was to determine whether fertilizer strategies will reverse the run-down in vigour being observed in aging leucaena stands in Queensland.

This project has achieved excellent results, and producers now appreciate that aging leucaena stands decline in vigour, especially on poorer soils, but that they respond to fertilizer application, especially phosphorus and sulphur, which increase protein content and yield.

Contact details
Mr Robin Cruikshank
124 Blackman's Yard Road
THANGOOL QLD 4716

The project

The aim of the project was to ensure the long-term sustainability and productivity of aging leucaena pastures in northern Australia by investigating plant nutrient status, soil organic carbon and total nitrogen status, and fertilizer strategies to correct emerging nutrient deficiencies.

Objectives

The principal objective of Leucaena Network was to determine whether fertilizer strategies will reverse the run-down in vigour being observed in aging leucaena stands in Queensland.

Specific objectives were:

1. Use known critical levels in plant tissue of key plant nutrients as a means of identifying nutrient deficiency;
2. Assess the contribution of long-term leucaena pastures to soil carbon and nitrogen status;
3. Measure the effects of applied fertilizers on plant nutrient and protein levels (plant analysis) and leucaena forage yields (by yield measurement); and
4. Improve the knowledge of Leucaena Network members through the *Leucaena for Profit and Sustainability* short courses to producers about how to maintain the vigour of aging leucaena stands.

What was done

A three-pronged approach to this project was used:

1. The Leucaena Network linked to eight participating producers and two research stations with leucaena stands under grazing. Soil and index leaf samples were collected using procedures validated by the University of Queensland (UQ).

   Leaf samples for analysis were also collected from producers around Queensland. These leaves were dried, ground and analysed for plant nutrient status in the Analytical Services Laboratory of the Faculty of Natural Resources, Agriculture and Veterinary Science at the University of Queensland.

   Following analysis, potential nutrient deficiencies were assessed and fertilizers added, with and without cultivation, to incorporate the fertilizer to leucaena stands on participant properties. Dry matter response was measured in the two years following application, and index leaves were collected to determine whether tissue nutrient concentrations had risen to adequate levels.

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Key Points

- Long-term leucaena stands were found to sequester high levels of soil carbon and soil nitrogen.
- Leucaena productivity (yield) often reduces in aging leucaena stands, but can be improved or restored by strategic fertilization with either phosphorus or sulphur, or both, to stimulate nitrogen fixation and consequently protein content and dry matter yield.
- Leaf tissue analysis is an excellent tool to establish the phosphorus and sulphur status of leucaena and can be used to make decisions as to whether the stand should be fertilized.

2. A randomised factorial experiment was implemented on DPI&F Brian Pastures Research Station to study the effects of phosphorus and sulphur fertilizers on protein content and yield of a 30 year old leucaena pasture. Comprehensive soil sampling was undertaken to measure organic carbon (OC) and total nitrogen (TN) status of soils under leucaena of ages 14 to 38 years old.
3. The outcomes of this project were incorporated into the UQ short courses curriculum for graziers on *Leucaena for Profit and Sustainability*. To date, over 400 graziers have attended these courses, ensuring the recommendations from the trials are widely distributed to leucaena growers.

What happened?

Long-Term Contribution Of Leucaena Pastures To Soil Organic Carbon (OC) And Total Nitrogen (TN) Accumulation

The soil organic carbon and total nitrogen data showed that:

- Compared to adjacent native pastures, leucaena soils had higher OC and TN, with an average increase of 2.79t/ha (97kg/ha/year) in OC, and 0.35t/ha (12kg/ha/year) in TN in the topsoil (0-15cm);
- Compared to adjacent cropped soils, leucaena soils increased OC by 10.53t/ha (752kg/ha/year), and TN by 0.87t/ha (62kg/ha/year) in the topsoil (0-15cm); and
- Long-term leucaena pastures are sustainable in that they contribute significantly to soil carbon and soil nitrogen status. The increase in sequestered soil carbon under leucaena pastures may eventually be recognized for carbon trading purposes. The increases in soil nitrogen will ensure the long-term vigour of associated grasses.

Leaf Tissue Analysis From Properties And From Brian Pastures

Leucaena leaf tissue samples from 28 cattle properties and two research stations were analysed for plant nutritional status.

The key results were:

- Rundown in nitrogen, phosphorus and sulphur was observed in aging leucaena stands (>10 years old) at Brian Pastures Research Station, and on many properties, indicating that plants had become nutrient limited when leucaena had been intensively grazed for some years, particularly in soils of marginal fertility;
- Rundown in nutrients such as phosphorus and sulphur resulted in lower nitrogen levels in leaf tissue (protein content), indicating reduced nitrogen fixation of leucaena stands. A strong relationship was found between the phosphorus and sulphur index (P concentration x S concentration) and nitrogen concentration (an indicator of protein content) in leucaena leaf. This relationship was apparent for producer properties and the research stations; and
- The leaf tissue analysis indicated that responses to applied phosphorus and sulphur fertilizers were highly likely.

Effects Of Applied Fertilizers On Plant Nutrient And Protein Levels (Plant Analysis) And Leucaena Forage Yields

As a result of the tissue nutrient data a number of fertilizer trials were established. Phosphorus and sulphur fertilizers were applied, with and without cultivation, at 10 sites. The aim was to see if the phosphorus and sulphur fertilizers increased nitrogen percentage (protein content) and therefore dry matter yield of leucaena and associated grass.

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The key results from the fertilizer trials on nine sites were:

- The 2006/07 growing season was extremely dry. Although there was a significant increase in nitrogen content at four of the nine sites, there was a significant increase in yield of leucaena only where rainfall was adequate (eg. Mt. Cotton). Only seven of the nine trials were assessed for yield due to the lack of rainfall;
- In the 2007/08 growing season, there was more rainfall and a significant increase in leucaena yield due to fertilizer application in seven of the nine sites. In the two sites where there was no yield increase, there was very low growth for unknown reasons. This will be further investigated. The leaf tissue analysis of samples taken in this second year (2007/08) have not yet been completed due to a lack of funds;
- In the 2007/08 growing season, there was a response of leucaena to cultivation in three of the nine trials. There was also a response in grass yield in three of the nine trials – probably due to a release of nitrogen from the organic matter in the soil; and
- The fertilizer trial established in a 30 year old leucaena pasture at Brian Pastures showed a significant increase in leucaena yield due to either sulphur or phosphorus and sulphur fertilisation, but there was no difference between cultivated and non-cultivated treatments.

Discussion

Several conclusions and recommendations have been made from this work:

- Long-term leucaena stands were found to sequester high levels of soil carbon and soil nitrogen;
- Leucaena productivity (yield) often reduces in aging leucaena stands, but can be improved or restored by strategic fertilization with either phosphorus or sulphur, or both, to stimulate nitrogen fixation and consequently protein content and dry matter yield;
- Leaf tissue analysis is an excellent tool to establish the phosphorus and sulphur status of leucaena and can be used to make decisions as to whether the stand should be fertilized; and
- Additional funds are required to complete the leaf tissue analysis gathered from the second year of observations (2007/2008 growing season). These leaf tissue analyses will greatly improve the group's capacity to predict fertilizer needs of leucaena stands.

This project has achieved excellent results in that the original hypothesis has been well demonstrated so that producers now appreciate that aging leucaena stands decline in vigour, especially on poorer soils and respond to fertilizer application, especially phosphorus and sulphur, which in turn increases protein content and yield. This will directly improve the economic value of leucaena paddocks.

Producer also appreciate that continuous regular grazing of leucaena pastures will lead to loss of nutrient from their paddocks, which will require fertilizer to be applied every five years or so. Some producers did not wait until the final results were analyzed and went out immediately after viewing the response and bought and applied fertilizer.

Producers noticed that cultivation greatly increased grass yields probably due to the rapid mineralization of organic nitrogen into available plant form. This result indicated that long-term leucaena promoted grass growth, and could arrest grass run-down common in grass-only pastures in Queensland.

The positive environmental benefit of long-term leucaena stands was well demonstrated by the build-up in organic carbon and organic nitrogen over time.

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Meat & Livestock Australia
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Fax 02 9463 9393
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June 2009 / PIRD OUTCOMES