BUREAU OF SUGAR EXPERIMENT STATIONS
QUEENSLAND, AUSTRALIA

FINAL REPORT
SRDC PROJECT BS37S

IMPROVING THE EFFICIENCY OF NITROGEN FERTILISATION OF SUGARCANE UNDER MINIMUM TILL AND TRASH CONSERVATION CULTURAL CONDITIONS

by
LS Chapman[1], J R Freney[2], O T Denmead[2],
A W Wood[3], P G Saffigna[4]

SD92002

[1] BSES, Mackay
[2] CSIRO, Canberra
[3] CSR, Ingham
[4] Griffith University, Brisbane

This Project was funded by the Sugar Research Council/Sugar Research and Development Corporation during the 1989/90 and 1990/91 financial years.

BSES Publication
SRDC Final Report SD92002 **July 1992**

CONTENTS

1. INTRODUCTION

Trash retention following green cane harvesting is gaining acceptance as a crop management practice in northern Queensland because of the many benefits which include weed control, moisture conservation and increased soil organic matter. However, the presence of crop residues on the soil surface poses a problem for the management and efficient use of urea fertiliser, the preferred nitrogen source for sugarcane, because of the high urease activity of the cane residues.

More ammonia is lost when urea is applied to soil covered with plant residues than to bare soil, due to faster hydrolysis of urea and fewer sites for the sorption of ammonia.

Other processes which could contribute to inefficiencies of fertiliser-N use are leaching and denitrification. Experiments at Proserpine showed that cane yields were often higher when urea was broadcast compared to burying it in the interrow. These results suggest that other processes such as denitrification could be significant when wet soil conditions prevail.

2. OBJECTIVES

- Determine the extent of NH_3 volatilisation when urea and ammonium sulfate are applied to the surface of a trash blanket in four cane-growing regions.
- Evaluate the effect of various placements of urea in a trash blanket under wet and dry moisture regimes by quantifying the amount of N recovered in the soil-plant system.

3. MATERIALS AND METHODS

3.1 **Ammonia loss experiments** (see Denmead *et al*, 1990; Freney *et al*, in press; Freney *et al*, 1991 for details)

Experiments using urea and sulfate of ammonia (broadcast at 160 kg N ha^{-1}) were established soon after harvest in four climatic zones of tropical Queensland in August 1989. Experiments using urea (160 kg N ha^{-1}), broadcast or band applied soon after harvest, broadcast on fields with a developing canopy, and broadcast on recently harvested fields and washed into the soil with sprinkler irrigation, were established in September 1990.

Ammonia losses from treated areas were determined by a micrometeorological, mass-balance method. Ammonia samples were used to measure the flux of ammonia. Measurements commenced immediately after fertiliser addition and continued for nine days to six weeks.

3.2 Urea placement experiments (see Chapman *et al*, 1991 for details)

This trial was conducted on a Calen soil type at Mackay using ^{15}N labelled urea in a trash mulched field. The crop was harvested green in 1988 and 1989 with the trash conserved on both occasions.

The four treatments consisted of urea buried either in the row or in the interrow, with two levels of soil water provided by irrigation, and replicated three times. Urea labelled with ^{15}N was buried 100 mm deep in bands in November 1989. Sampling was carried out at 30, 43, 57 and 72 days after fertilising. Samples taken were cane, stubble and roots, and soil at three depths.

4. RESULTS AND DISCUSSION

4.1 Ammonia loss experiments (Denmead *et al*, 1990; Freney *et al*, in press; Freney *et al.*, 1991 provide full results and discussion)

The results showed that the pattern, rate and extent of ammonia loss were controlled by the availability of water in the trash and its evaporation. Water added by dewfall, rainfall or condensation of evaporated soil moisture dissolved some of the urea and allowed it to be hydrolysed to ammonia by the urease enzyme in the sugarcane residues; when the water evaporated, ammonia was lost to the atmosphere.

In the dry climatic zone, where no rain or dew fell, water addition to the trash by condensation of evaporated soil moisture was not sufficient to dissolve much urea so very little ammonia was lost. In the cool and warm moist zones, small additions of water to the trash from dew, light rain and condensation maintained a slow loss of ammonia over a period of six weeks. Thirty-two per cent and 39% of the applied nitrogen were lost in the cool and warm moist zones respectively. In the wet zone, heavy rainfall apparently washed the urea from the trash layer into the soil and limited ammonia loss to 17% of the applied nitrogen.

Substitution of ammonium sulfate for urea reduced ammonia loss to less than 1.8% of the applied nitrogen.

Banding the urea resulted in larger losses of ammonia than broadcasting. An application of more than 16 mm of irrigation water is required to leach the urea from the trash to the soil to minimise ammonia losses.

Delaying applications of urea until a substantial crop canopy has developed will reduce ammonia loss, but not prevent it.

4.2 **Urea placement experiments** (Chapman *et al*, 1991 gives full results and discussion)

Sixty per cent of the applied N was lost 72 days after fertilising when urea was buried in the interrow and high soil water levels were maintained by irrigation. Denitrification was probably the chief method for N loss. The loss of N was reduced to 40% when urea was banded in the cane row under drier rainfed conditions. The row placement gave the cane quicker access to fertiliser-N than the interrow placement, so increasing uptake by the crop.

5. DIFFICULTIES

The difficulties encountered were mainly associated with dry weather conditions following the application of nitrogen to trials in both years. Significant rain fell during the experiments at only one site in Tully. Consequently, ammonia volatilisation losses were not measured under hot humid conditions which are typical of the fertilising season.

6. RECOMMENDATIONS FOR FURTHER RESEARCH

It was anticipated that as the leaf canopy developed, ammonia volatilisation losses from urea would decrease, and this proved to be the case. It was also expected that an increase in ammonia volatilisation would occur if urea was banded along the cane row, but the losses by banding were larger than anticipated. As the banding of urea in the row is a popular practice when the canopy is approximately one metre high, there is a need to evaluate volatilisation losses by applying urea under these conditions. This will be carried out as an extension of this project.

However, the objectives of this project were limited in extent, and part of a broader scene. Further research on the efficient use of nitrogeneous fertilisers is necessary and a Project Application SRDC 91/17 was submitted in January 1991 to cover this. The objectives were to -

- measure N responses for several rates, methods and times of application over various environments
- estimate N cycling in a range of production environments
- develop and calibrate an N cycling model using results from previous projects (CSC3S, BS13S, BS37S) and the new one, as a new basis for fertiliser recommendations

7. DISSEMINATION OF INFORMATION

Four papers have been published on this project. Two videos also were produced by BSES with support from SRDC. These videos were: 'Nitrogen fertilisation research - losses from volatilisation', and 'Nitrogen fertiliser - strategies to reduce losses'. Both videos have been extensively viewed by canegrowers and sugar industry groups.

8. INDUSTRY SIGNIFICANCE

The Australian sugar industry is a major consumer of nitrogenous fertilisers and each year uses approximately 60 000 tonnes of nitrogen, valued at $50M. The use of nitrogen fertilisers is a major cost component for cane growers. In recent years, cultural practices have changed to include trash conservation from burnt cane and green cane harvesting with minimum or zero cultivation. With these changes in cultural practices, there has been a change in the techniques of applying fertilisers. This has posed several questions concerning the efficacy of nitrogen fertiliser consumption by the cane plant. Growers prefer to use urea, because of its convenience and low cost. Because of the difficulty of injecting fertiliser into the soil through the trash cover, many growers have applied urea fertiliser onto the surface of the trash blanket.

As a consequence of this research, the losses by ammonia volatilisation have been quantified for various application strategies. Most cane growers are aware of this research and are now able to make management decisions about fertilising strategies with more confidence.

9. LIST OF PUBLICATIONS ARISING FROM PROJECT

Chapman, L S, Haysom, M B C, Saffigna, P G and Freney, J R (1991). The effect of placement and irrigation on the efficiency of use of ^{15}N labelled urea by sugarcane. Proc. Aust. Soc. Sugar Cane Technol., 1991 Conf., pp 44-52

Denmead, O T, Freney, J R, Jackson, A V, Smith, J W T, Saffigna, P G, Wood, A W and Chapman, L S (1990). Volatilisation of ammonia from urea and ammonium sulfate applied to sugarcane trash in north Queensland. Proc. Aust. Soc. Sugar Cane Technol., 1990 Conf., pp 72-78.

Freney, J R, Denmead, O T, Saffigna, P G, Wood, A W, Chapman, L S, and Hurney, A P (1991). Ammonia loss from sugarcane fields as affected by fertiliser placement, irrigation and canopy development. Proc. Aust. Soc. Sugar Cane Technol., 1991 Conf., pp 38-43.

Freney, J R, Denmead, O T, Wood, A W, Saffigna, P G, Chapman, L S, Ham, G J, Hurney, A P and Stewart, R L (199?). Factors controlling ammonia loss from trash covered sugarcane fields fertilised with urea. Fertiliser Research (submitted).