

Depth of placement of sowing nitrogen fertiliser on rice in the Burdekin Valley

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Summary

Five trials were conducted over three seasons on the clay soils of the Burdekin River flood plain to determine the effect of depth of placement of N fertiliser at sowing on rice grown under flooded conditions. 88 kg N/ha as ammonium sulphate was applied at sowing at 0, 12.5, 25, 50 and 75 mm depth. When the data were pooled grain yield increased linearly from 4714 to 5323 kg/ha as depth of placement of the fertiliser increased from 0 mm to 75 mm. There were no significant differences in 1000 grain weights, grain moisture, number of panicles per square metre, dry matter, or N and P uptake of the whole plant at harvest. N and P uptake of the grain was greater at 75 mm than 0, 12.5 or 50 mm depth of placement of fertiliser.

INTRODUCTION

Rice is grown in the Lower Burdekin Valley (19°30'S, 147°30'E) under flooded conditions (paddy). The climate of the area is characterised by a dry winter (temperature range 5° to 32°C) and a wet summer period (temperature range of 22° to 36°C). Most of the annual rainfall (80%) is received from December to March.

In the early years farmers usually drilled 88 kg N/ha as ammonium sulphate with the seed at a depth of 0 to 20 mm. By 1972 the whole industry used N rates of 130 kg/ha or more in split application, half at sowing and half broadcast at panicle initiation. The fields are flushed to germinate the rice seed.

Rice crops often yellowed prematurely. The erratic nature of this occurrence was thought to be due to differential nitrogen loss through nitrification and subsequent denitrification during the flush irrigation periods. Fertiliser N which nitrified during this process is rapidly denitrified when the soil is permanently flooded (Ponnamperuma 1964).

Deep placement of fertiliser reduces N loss in comparison with shallow applications (Broeshart 1971; Aleksic *et al.* 1968) and increases grain yields (Thenabadu 1969; Velly 1964; Simsiman *et al.* 1967; Lee *et al.* 1960; and Craswell 1979).

A series of five experiments were conducted to determine whether deep placement of N fertiliser had any beneficial effect on rice production in the Lower Burdekin valley.

MATERIALS AND METHODS

Experiments 1 and 3 were planted on a farm at Claredale (30 km south of Ayr) and Experiments 2, 4 and 5 at Millaroo Research Station (60 km south of Ayr). The soils were of the Oakey series as described by Reeve *et al.* (1960). Experiments 1 and 2 were planted in the summer of 1970-71, Experiments 3 and 4 in the winter of 1971 and Experiment 5 in the summer of 1971-72.

In all experiments ammonium sulphate was applied at 88 kg N/ha, a rate known to produce an intermediate yield response, (J. Barnes, unpub. data) in order to avoid luxury levels of N that could possibly mask treatment effects. All the fertiliser was applied in 175 mm drills with a combine. Depths of placement were 0, 12.5, 25, 50, or 75 mm. Placement deeper than 75 mm was impracticable because of the limits of the machine.

Depth of fertiliser placement was controlled manually using the main wheels of the combine drill. Plot sizes ranged from 16 m² to 21 m². A randomised block design was used with four replications in each experiment. Rice seed (cv. Bluebonnet 50) was sown on the soil surface at 125 kg/ha with 15 kg P/ha as single superphosphate.

In order to germinate the seed, the rice bays were filled with water and then drained. There was one flush irrigation in the summer experiments (1, 2 and 5) and two in the winter experiments (3 and 4). The plots were sprayed with propanil at 11 L/ha to control weeds, and permanent flood was then applied to the rice bay at approximately 16 days for the summer crops and 30 for the winter crops. This flood was maintained until maximum grain weight when the field was drained and allowed to dry out prior to harvest.

At maturity dry matter yield was determined from a one square metre quadrant from each plot. Whole plant tissue was dried at 80°C, ground and analysed for N and P. The plots were machine harvested using a small combine harvester. Grain was weighed and samples retained for determination of moisture content, 1000 grain weight and N and P concentration (Kjeldahl digestion and colorimetric methods).

Analysis of variance was done on individual trials and because of similar trends the data were pooled and regression analysis conducted. Data were also compared over seasons.

RESULTS

In Experiments 3 and 5 there was a significant response in grain yield ($P=0.05$) to placement of ammonium sulphate at 25 mm or deeper compared with surface application (Table 1). Trends were similar in the other experiments but the differences were not significant.

Table 1. Effect of depth of placement of ammonium sulphate on grain yield (kg/ha)

Treatment depth (mm)	Experiment 1 Claredale summer 1970-71	Experiment 2 Millaroo summer 1970-71	Experiment 3 Claredale winter 1971	Experiment 4 Millaroo winter 1971	Experiment 5 Millaroo summer 1971-72
0	5490.0a*	5240.3a	5692.2c	4514.6a	2632.9c
12.5	5805.0a	5289.7a	6147.6bc	4477.5a	2784.7bc
25	5641.1a	5595.5a	6648.8ab	5010.5a	2957.5ab
50	5654.0a	5426.7a	6406.5ab	4775.3a	3095.7a
75	5898.2a	5677.2a	6924.1a	5037.3a	3080.2ab
l.s.d. $P=0.05$	444.7	529.1	605.2	570.2	298.9

* Treatment followed by the same letter are not significantly different at 0.05 level.

The regression for the pooled data is shown in Figure 1.

The significant linear response to depth of placement of nitrogen is given by the regression line:

$$y = 4812.7 + 6.7x$$

y = grain yield kg/ha, x = depth of placement of nitrogen fertiliser (mm), standard error = 1.21 ($P = 0.01$).

Depth of placement had no significant effect on grain moisture, 1000 grain weight, head number per m², grain number per head, dry matter yield, or whole plant N and P content. Grain N and P contents were higher when depth of placement was 75 mm ($P=0.05$ Table 2).

No effect of seasons was observed.

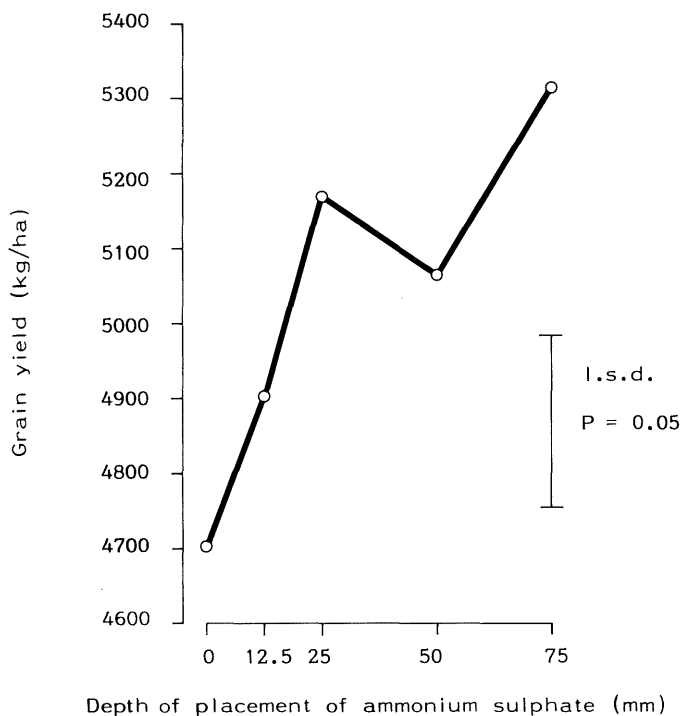


Figure 1. Effect of depth of placement of ammonium sulphate on grain yield (pooled data from 5 experiments).

Table 2. N and P uptake in grain at harvest (pooled data)

Depth mm	Nitrogen kg/ha	Phosphorus kg/ha
0	55.0c*	12.4b
12.5	55.3c	12.4b
25	61.8ab	13.7ab
50	58.8bc	13.0b
75	63.9a	14.9a
l.s.d. $P=0.05$		1.6

*Treatment followed by the same letter are not significantly different at 0.05 level.

DISCUSSION

The results confirm the responses to deep placement of nitrogen fertiliser obtained with rice elsewhere (Thenabadu 1969; Velly 1964; Aleksic *et al.* 1968; Craswell and Vlek, 1979). The higher uptake of N in the grain when ammonium sulphate is placed at 75 mm indicates that N losses were reduced by this practice.

Leaching beyond the root zone is unlikely in these soils (Gardner and Coughlan 1982). The major losses probably occurred during the wetting and drying cycles during the flush irrigation phase. During each cycle the soils crack to a depth of 100 to 150 mm

allowing aeration to at least that depth along or adjacent to the cracks. Thus some nitrification of N fertiliser could be expected to occur in these experiments. Rapid denitrification after reflooding (Ponnamperuma 1964) would mean that little of this nitrate would be available to the young plants which, at that stage, are too small to take up much N.

Losses of N as ammonia can still occur from flooded fields even when ammonium sulphate is placed in the reduced zone (Pande and Adak 1971). Positive yield responses and higher N uptake from fertiliser placement at depths up to 150 mm at sowing were recorded by Simsiman *et al.* (1967), and Savant *et al.* (1982).

ACKNOWLEDGEMENTS

The author wishes to thank the staff of Millaroo Research Station, Messrs J and P Shadforth on whose farm two of the experiments were conducted, Agricultural Chemistry Branch for the plant and grain analyses and Messrs. P. O'Rourke and R. Shepherd of Biometry Branch for the statistical analyses.

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(Accepted for publication 15 October 1985)

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