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# FINAL REPORT



**Final report to: COTTON RESEARCH AND DEVELOPMENT CORPORATION**

**Project Number:** DAN 32L

**Title:** **IMPROVING SOIL AERATION FOR COTTON**

**Organisation:** NSW Agriculture & Fisheries
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**Aims:**

1. To assess the importance of field slope and duration of furrow irrigation in overcoming the effects of waterlogging on cotton and other crops.

2. To evaluate possible ameliorants which may rectify deficiencies or neutralize excesses of plant or soil substances induced by waterlogging.

3. To characterize the environment within soil blocks to assess their suitability for root growth.

## ✍ Summary of results:

This project continued the major study of waterlogging on heavy clay soils after furrow irrigation or heavy rainfall. The experiments concentrated on cotton, but some detailed work was also done on summer legumes to study detailed reasons for yield reduction during waterlogging.

1. The optimum field slope for furrow irrigation was 1:1000 to 1:1500

2. The best yields were obtained from running siphons for 4 h at each irrigation. Longer times of running siphons reduced yield, especially with slopes of 1:2000.

3. Foliar nitrogen fertilizer, applied prior to an irrigation which caused waterlogging, minimised the yield loss due to waterlogging, particularly with low to moderate soil N status.

4. Waterlogging-induced iron chlorosis has been found to limit crop growth of grain legumes and possibly cotton at some sites. Further research is needed on methods of identifying and reducing this effect.

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**Publications from this project**

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Loudhapasitporn, L., Hodgson, A.S., Holland, J.F., MacLeod, D.A., Herridge, D.F., and Murison, R.D. (1990). Effects of water deficit and nitrogen on furrow irrigated soybean and other grain legumes. 6th Aust. Soybean Research Workshop, Warwick, Qld. 9-11 October, 1990.

Hodgson, A.S., and Holland, J.F. (1987). Irrigate grain legumes with caution. Irrigators Newsletter N.S.W. Dept. Agric., Dec. 1987.

Hodgson, A.S. (1988). New summer grain legumes for irrigated cropping. North Western Courier Ann. Rev. December 15, 1988.

Hodgson, A.S. (1989). Don't forget your foliar N. Cotton Irrigator No. 4, p. 4, December 1989. N.S.W. Agriculture & Fisheries.

Hodgson, A.S., Loudhapasitiporn, L., Holland, J.F., Murison, R.D., MacLeod, D.A., and Herridge, D.F. (1990). New grain legumes for furrow irrigation. Cotton Irrigator No. 5, February 1990. pp. 6-8. N.S.W. Agriculture & Fisheries.

## DETAILED RESULTS

### DAN 32 L: Improving soil aeration for cotton

There were a number of different experiments in this project:

1. The interaction between soil and foliar nitrogen fertilizer in ameliorating the effect of waterlogging induced by field slope or irrigation (1987/88, 1989/90).

2. Waterlogging induced iron chlorosis: response to soil and foliar iron fertilizer (1988/89, 1989/90).

3. Cultivar sensitivity to waterlogging (1986/87, 1987/88, 1989/90).

### 1. Foliar nitrogen

The main experiment in this project involved four slopes (1:500 to 1:2000) and three durations of irrigation (siphons run for 4, 16 and 32 h). These combinations gave a large range in degree of waterlogging. Each slope/irrigation treatment was split for a range of soil and foliar nitrogen fertilizer treatments.

The optimum slope in these experiments was 1:1000, steeper slopes were penalised by two effects: (i) the operation to create the steep slope meant that the tail end of these plots was cut, exposing poorer soil; (ii) the quicker irrigations (4 h) did not wet the profile sufficiently. The 1:2000 slope was lower yielding because of waterlogging at each irrigation, or following heavy storms.

Running siphons for 32 h at each irrigation reduced yield by 12% when compared with a 4 h irrigation. That result has been consistent in these and earlier experiments.

The yield results showed that waterlogging is expressed (at least partially) by nitrogen nutrition: when a crop has low to moderate nitrogen status, there is a response to foliar N when applied prior to an irrigation which causes waterlogging.

There are two possibilities for a response to foliar N: (i) During waterlogging a lack of oxygen supply to roots reduces their N uptake. (ii) In general, cotton roots lose the ability to take up N during boll filling. Foliar N can by-pass both of these bottlenecks. Both types of responses were evident in these experiments. A summary is shown in Table 1, where a greater response to foliar N occurs at low soil N levels. There is good data relating foliar N response to petiole nitrate levels.

**Table 1.** The response to soil and foliar N applications by cotton. Average lint yields (kg $ha^{-1}$) over two seasons.

| Soil N rate (kg $ha^{-1}$) | Foliar N rate (kg $ha^{-1}$) | | |
|---|---|---|---|
| | 0 | 20 | 40 |
| 120 | 1250 | 1294 | 1316 |
| 160 | 1343 | 1334 | 1345 |
| 200 | 1424 | 1419 | 1392 |

## 2. Iron research

Initial interest in Fe nutrition at Narrabri started several years ago during waterlogging studies of irrigated grain legumes. Some of the species tested were highly sensitive to waterlogging, and showed classic Fe deficiency symptoms of young leaves following furrow irrigations. Painting the yellow leaflets with a ferrous sulphate solution regreened them within 2-3 days. The symptoms were similar to the yellowing of young cotton leaves, which commonly follows the first 2-3 crop irrigations.

In the first experiments, foliar sprays of Fe chelates were applied to crops either after heavy rain or just before furrow irrigations. Despite burning of leaves at heavy rates, encouraging responses to 200g Fe $ha^{-1}$ sprays were recorded (Table 2). A single spray before the first irrigation at Auscott in 1988-89 increased lint yield by 6%, whereas two foliar sprays on Oakville increased yield by 11%. In 1989-90, foliar sprays changed yields by 1% at Myall Vale and 2% at Oakville, whereas soil application before sowing increased yields by 5% and 6%, respectively. In commercial test-strips conducted by Stuart Murray in 1989-90, responses to three foliar sprays of 200 g Fe $ha^{-1}$ were 5% and 16% on Doreen and The Myalls, respectively. These responses to Fe gave an average return of \$90 $ha^{-1}$ when costs of Fe fertilizer and application were subtracted from the extra lint yield. The soil treatments were not cost-effective.

**Table 2.** Summary of results from applying iron to cotton in field experiments and commercial test strips. Costs include the price of Fe plus \$5 per application. Returns assume \$1.60 $kg^{-1}$ lint.

| Treatment | Yield increase % | Yield increase kg $ha^{-1}$ | Costs \$ $ha^{-1}$ | Return \$ $ha^{-1}$ | Profit \$ $ha^{-1}$ |
|---|---|---|---|---|---|
| **Field experiments** | | | | | |
| Auscott '88-89 foliar 200 g Fe $ha^{-1}$ x 1 | 6 | 127 | 48 | 203 | 155 |
| Oakville '88-89 foliar 200 g Fe $ha^{-1}$ x 2 | 11 | 190 | 53 | 304 | 251 |
| NARS '89-90 foliar 200 g Fe $ha^{-1}$ x 2 | 1 | 6 | 40 | 10 | -35 |
| Oakville '89-90 foliar 200 g Fe $ha^{-1}$ x 1 | 2 | 28 | 20 | 45 | 25 |
| *Average* | **5** | **88** | **40** | **141** | **99** |
| NARS '89-90 soil 5 kg Fe $ha^{-1}$ x 1 | 5 | 59 | 384 | 94 | -290 |
| Oakville '89-90 soil 5 kg Fe $ha^{-1}$ x 1 | 6 | 69 | 1076 | 110 | -966 |
| *Average* | **6** | **64** | **730** | **102** | **-628** |
| **Test strips** | | | | | |
| Doreen '89-90 foliar 200 g Fe $ha^{-1}$ x 3 | 5 | 96 | 144 | 154 | 10 |
| The Myalls '89-90 foliar 200 g Fe $ha^{-1}$ x 3 | 16 | 175 | 144 | 280 | 136 |
| *Average* | **11** | **136** | **144** | **217** | **73** |

## 3. Cultivar comparisons

Table 3 shows the yield of Siokra and DP90 as affected by waterlogging treatments averaged over three seasons. In one season there was a trend for DP90 to have a greater reduction in yield with waterlogging. Plant disease assessments by Dr S J Allen showed that effect was due to greater Bacterial Blight in DP90 when waterlogged.

**Table 3.** Lint yield of two cultivars as affected by waterlogging.

| | Waterlogging level | | |
|---|---|---|---|
| Cultivar | Low | Medium | High |
| Siokra | 1570 | 1513 | 1550 |
| DP90 | 1293 | 1244 | 1224 |