THE GROWTH AND YIELD OF COTTON FOLLOWING SEVEN DIFFERENT ROTATIONS

J. Cooper

NSW Agriculture, Agricultural Research Centre, Trangie, NSW 2823

Abstract

A field experiment was conducted in the Macquarie Valley of NSW to compare 7 different rotations in which the whole field was planted with cotton every second year, and every other year different plots were planted with cotton, wheat, field peas, faba beans, *Lablab purpureus*, or left fallow. The treatments started in June 1993, in 1994-95 the whole area grew cotton, while a second round of rotation treatments was applied in June 1995. In 1996-97 the whole area grew cotton again. The continuous cotton rotation yielded less than all other rotations in 1994-95, and after the second cycle of rotations the differences were even greater in 1996-97.? There were few significant differences in the growth or yield of cotton amongst the other 6 rotations. Differences in cotton lint yield were strongly correlated with the incidence of black root rot disease.

Key words: Cotton, rotation, lint yield, root rot.

The long term production of cotton in the same field often leads to low yields, even with large amounts of nitrogen (N) and phosphorus (P) fertiliser. In the Macquarie Valley of NSW this is often due to soil compaction and poor soil structure (2). Initially, the problem was corrected by deep ripping the soil, but experiments have shown that drying the soil with crops such as wheat and safflower can produce similar benefits (1). Rotation crops such as wheat are also used to reduce the incidence of diseases such as Verticillium wilt.

In 1992, a survey of cotton growers in the Macquarie, Namoi and Gwydir Valleys was conducted to find out how widely rotations are used, which rotation crops are used, and what problems they had encountered with them. About 40% of the 1992-93 cotton crop followed a rotation crop, and the crop most widely grown was wheat, although many different species were used.? Other questions about the reasons for, and the benefits from the different rotation crops, showed that many growers were unsure about the value of these rotations and would like more information on the effectiveness of such systems.

The experiment reported on in this paper is one of a series of crop rotation experiments established by the CRC for Sustainable Cotton Production. These experiments have a broad aim of examining the effects of different rotation sequences on sustainability, which includes soil structure and fertility, pest and disease control, cotton yields and economic returns. This paper reports the effects of 7 different rotation sequences in the Macquarie Valley on the growth and yield of subsequent cotton crops.

Materials and methods

In 1993, a large scale field experiment with 3 replications commenced at Warren in the Macquarie Valley of NSW, to compare 7 different rotations (Table 1). Prior to the experiment starting, the field grew cotton for 3 consecutive seasons. All operations are done with commercial equipment, and each plot was 40 m wide by 700 m long. The whole field was planted with cotton every second year to facilitate comparison of the treatments.? So far the rotations have gone through 2 cycles with cotton grown over the entire field in 1994-95 and 1996-97.

The 1994-95 cotton crop (cv. Sicala V2) was planted on 3 October 1994. Prior to sowing (15 July 1994) the field received 116 kg N/ha as anhydrous ammonia, and 90 kg/ha of mono-ammonium phosphate. In December, the crop received an additional 84 kg N/ha as water run urea. The field was harvested on 26 April 1995, with a cotton module made from the centre 24 m of each plot.? Each cotton module was weighed and the yield of seed cotton calculated. It was not feasible to gin each module separately so the

3 modules from each treatment were ginned together, and the gin out % for each treatment recorded. The lint yield of each plot was then calculated using the gin out % and seed cotton yield.

Table 1. The 7 rotations used in the experiment

1	Continuous cotton	Grows a cotton crop every year
2	Long fallow	Cotton every second year. Cotton stubble is slashed and ground left as fallow between cotton crops.
3	Fieldpeas	Cotton every second year. Field peas are sown into standing cotton stubble which is later slashed. In October the field peas are sprayed with Roundup then ploughed in as green manure. The area remains as fallow until the next cotton crop.
4	Wheat - low input	Cotton every second year. Wheat is sown into the standing cotton stubble which is later slashed. The wheat is harvested for grain. Wheat seed rate 40 kg/ha, with 85 kg/ha of DAP fertiliser. The area remains as fallow from wheat harvest to the next cotton crop.
5	Wheat - high input	Cotton every second year. Wheat is sown into the standing cotton stubble which is later slashed. The wheat is harvested for grain. Wheat seed rate 100 kg/ha, with 85 kg/ha of DAP and 180 kg/ha of urea fertiliser. The area remains as fallow from wheat harvest to the next cotton crop. In 1993 this rotation also received 1 spring irrigation.
6	Wheat + Lablab	Cotton every second year. Low input wheat follows the cotton. After the wheat is harvested Lablab (Lablab purpureus) is sown into the wheat stubble and incorporated as green manure after 3 months growth.
7	1993 Wheat + Lablab + fertiliser 1995 Faba beans	For the first rotation cycle this treatment was the same as 6 except that extra fertiliser (11 kg N/ha, 24 kg P/ha, 73 kg K/ha) was applied prior to the 1994-95 cotton crop. In 1995 faba beans were used instead of wheat and Lablab because of problems growing Lablab. The faba beans were treated as a green manure crop the same as the field peas.

In 1996-97, Sicala V2i cotton was used. It was sown on 8 October 1996 and harvested on 24 April 1997.?? Fertiliser rates and management of the 1996-97 crop were similar to 1994-95, except that the 1996-97 crop received less insect sprays because Sicala V2i is resistant to *Heliothus*.

Plant height, dry matter, number of nodes, squares and bolls were measured at regular intervals in both seasons. Plant samples taken in December, 1996, were analysed for nutrients, while each plot was assessed for the presence of black root rot in 1994 and 1996. In March, 1997, soil samples at 0-15, 15-30, 30-45, and 45-60 cm depth were collected from all plots. These samples were analysed for air filled porosity, pH, plastic limit, organic matter, and exchangable cations.

Results and discussion

At the end of the first rotation cycle (1994-95), the continuous cotton rotation yielded less ($P<0.01$) than all others. There were differences between the other 6 rotations but these were not significant. Yields in 1996-97 followed a similar pattern to 1994-95 (Fig. 1), with continuous cotton yielding less ($P<0.001$) than all other treatments. Continuous cotton yields in 1996-97 were down 28% on those in 1994-95. For the other 6 rotations average yields were down 6% on those in 1994-95.

Continuous cotton yields seem to have gone into an accelerating decline. To look at this more closely the yields were compared with the average for the whole farm (Fig. 2). The results show that the yields have steadily declined from 1994-95 which was the 5th consecutive cotton crop in those areas.

As well as measuring lint yield, the growth of all plots was monitored throughout the season. In 1994-95, there were few significant differences between rotations in parameters such as plant height, dry matter or bolls/m^2.? However, in 1996-97, the general picture was the same as for lint yield. The continuous cotton treatment was the worst, with little difference between the other 6 rotations. Amongst these, the field pea rotation was often the best and long fallow the worst.

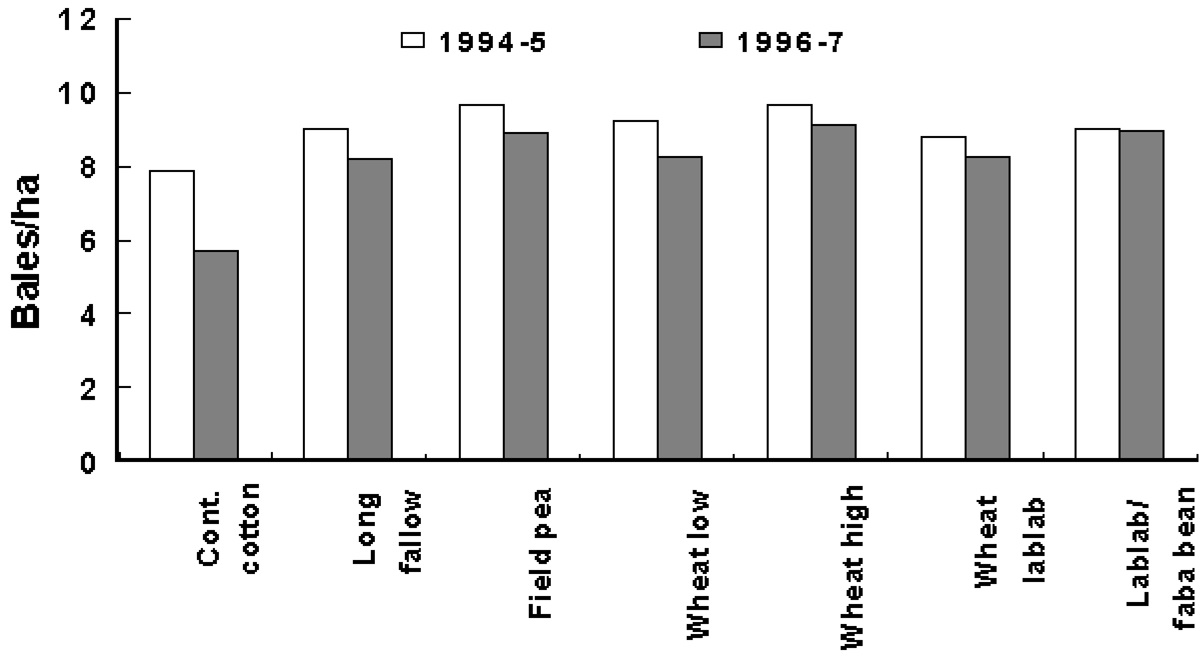


Figure 1

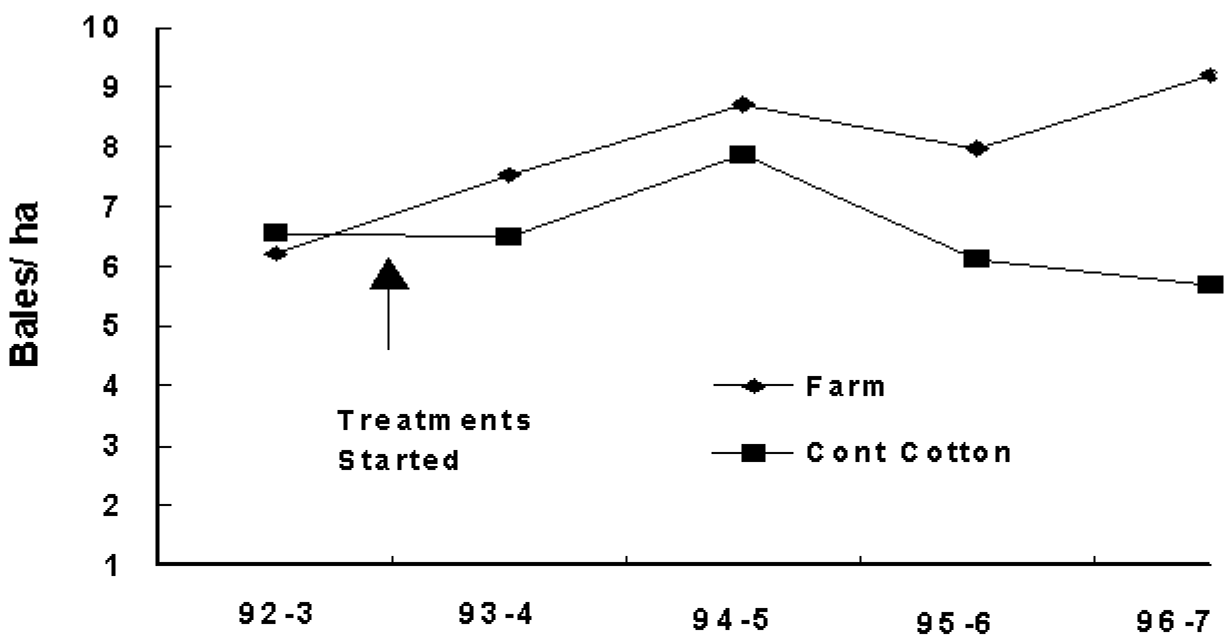
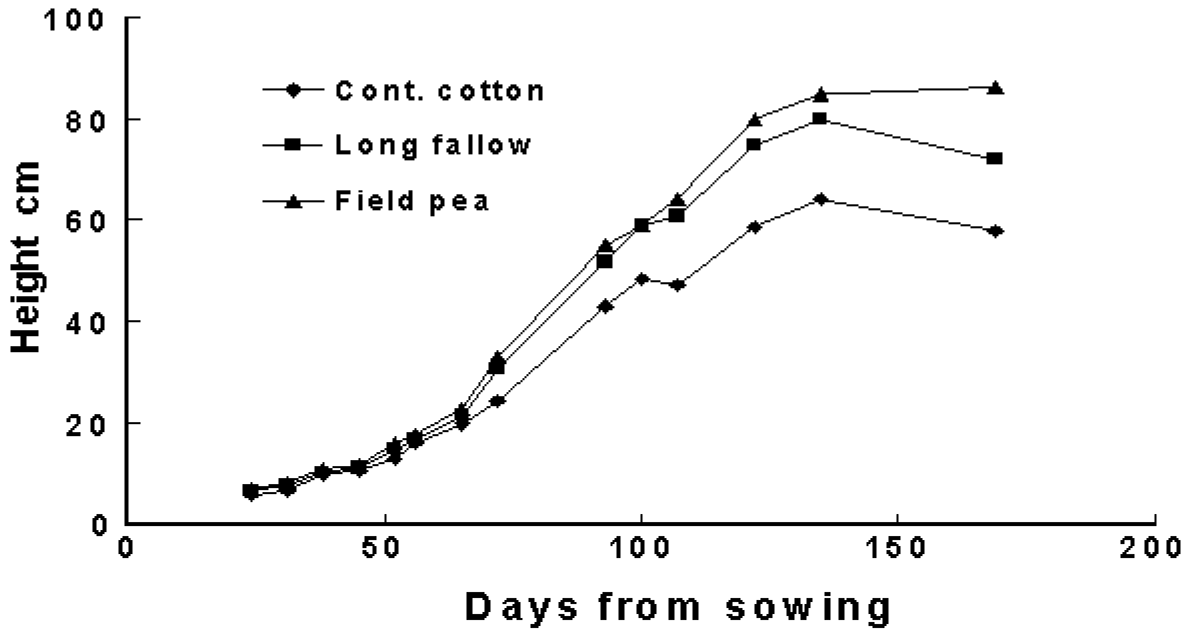


Figure 2



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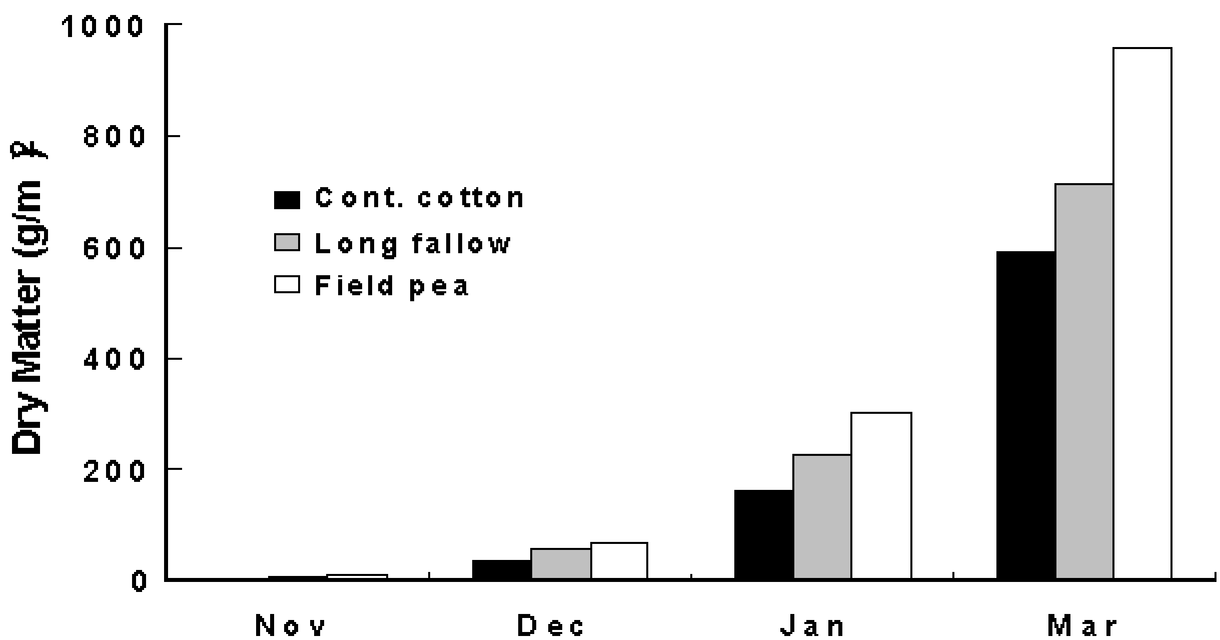

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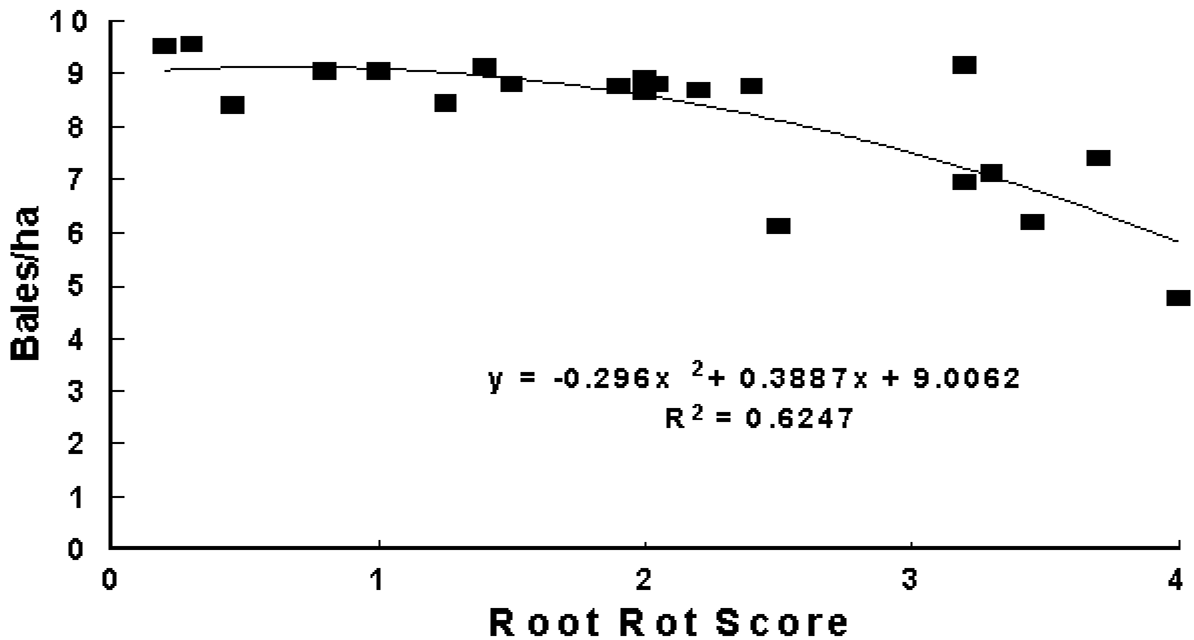

Figure 5

Plant height was the first and most consistent parameter to show significant differences between the rotations.? Just 24 days after sowing, plants in the continuous cotton rotation were shorter than all other rotations. Over time the differences became greater, and by 135 days after sowing the long fallow rotation was significantly (P<0.01) shorter than the field pea rotation (Fig. 3).

The continuous cotton rotation had less nodes/plant at 72 days from sowing, and most sampling dates after that. There was no significant difference between the other 6 rotations. Throughout most of the season, continuous cotton had less squares/unit area, with no difference between the other rotations. Although continuous cotton consistently had the lowest number of bolls/unit area, the differences were only significant at 2 dates because the data were highly variable. At all sampling dates, the field pea rotation had the most dry matter,? followed by the long fallow rotation, with continuous cotton having the least dry matter (Fig. 4).

Plant samples collected on 16 December 1996 were analysed for N, P and K to try and explain the observed differences in crop growth. There was no significant difference between any rotations in the levels of N, P or K. Changes in soil properties showed little correlation with differences in cotton yield either. This is probably because minimum tillage and permanent hills were used with all rotations since the experiment started. Under this management system there are few machinery passes to damage soil structure, which is also helped by the retention of all crop residues. What does explain most of the difference in cotton lint yields is the severity of black root rot disease. All plots were scored for the incidence of black root rot in November 1996, and these scores correlated strongly with cotton yields (Fig. 5).

Conclusions

If cotton is grown in the same field every year, yields are likely to decline, even with management practices designed to minimise any damage to soil structure. In the Macquarie Valley of NSW the decline in cotton yield was associated with an increase in black root rot disease.

Acknowledgments

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