

IMPACT OF TRAFFIC ON FURROWS IN PERMANENT BEDS

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Introduction

Permanent beds are becoming popular in the cotton industry, but problems remain with matching equipment and tyre sizes to the beds and furrows. Decisions about tyre sizes and equipment matching require information about the impact of the equipment on soil compaction in the furrow and bed. In this paper we study: 1. the impact of narrow and wide tyres on the furrows in a permanent bed system; and 2. the effect of furrow shape.

Study 1: narrow and wide tyres

This study was carried out on the two-metre permanent beds at Auscott, Narrabri, in December 1993. The paddock had recently been harvested for wheat, using a header with a 4 m axle spacing. The study used a tractor with a two-metre axle spacing: one wheel ran in the same furrow as the header, whereas the other wheel ran in the furrow between the header traffic furrows. Soil stress measurements and sampling were carried out in the furrow between the header traffic furrows and in the side of the adjacent bed.

The tyre sizes used in the study were 18.4 - 42 (referred to as wide) and 16.9 - 38 (referred to as narrow).

Measurements and results

The furrow profile was measured before and after the passage of both the narrow and the wide tyres. The results are shown in Figs. 1 and 2. Both tyres caused some settlement, and a flattening and widening of the furrow bottom. The wide tyre clearly had the greater impact.

We measured stresses using a computer data logging system that we have previously described in the Australian Cotton Grower, the World Cotton Research Conference and other journals. The stress measurements are shown as contour charts in Figs. 3 and 4. The stresses beneath the narrow tyre were concentrated in the furrow bottom, whereas those beneath the wide tyre were concentrated at the edge of the bed. The stresses beneath the wide tyre also are transmitted beneath the bed.

We also obtained soil samples (in 10 cm long / 10 cm diameter cores) before and after passage of both the narrow and wide tyred vehicle. Samples were obtained beneath the centre of the furrow and the centre of the adjacent hill at depths of 1-

10, 10-20 and 25-35 cm. The density of the soil in the furrow increased as a result of the traffic. The increase near the surface was greater for the narrow tyre, consistent with the higher stresses, but generally there were no significant differences between the two tyres.

Study 2: furrow shape

The stress measuring system was used to compare the stresses beneath cotton pickers in V shaped and U shaped furrows. The results were similar to those for the narrow and wide tyres: in the U shaped furrow, significant stresses were measured both beneath the centre of the furrow and at the side (similar to the narrow tyre results shown in Fig. 3). In contrast, the stresses beneath the centre of the V shaped furrow were small, but the stresses at the side were large (similar to the wide tyre results shown in Fig. 4). The reason is that the tyre was supported mainly by the sides of the furrow, with little contact in the centre.

We also obtained samples before and after the passage of the tyres. The decrease was greater on the sides of the V shaped furrow, as expected from the greater stresses (Table 1). (However, the differences in these sets of data were significant at a probabilities of 14%, greater than the usual 5% level, but are consistent with expectations on physical grounds.) At the side of the furrow, the preconsolidation stress, which is a measure of soil strength, increased more in the V shaped furrow than in the U shaped furrow (Table 1). Thus the greater stresses measured at the sides of the V shaped furrow are associated with a greater increase in strength. (However, the differences in these sets of data were significant at a probabilities of 7.5%, greater than the usual 5% level, but are consistent with expectations on physical grounds.)

Implications for management of beds

The results of the measurements provide a basis for making decisions about tyre size in relation to furrow size and shape.

Wide tyres disrupt the sides of the bed which may lead to reduced infiltration sideways into the bed. They also compact the furrow and widen it. Narrow tyres do not require a wide furrow, nor widen a narrow furrow to the same extent, but they do lead to greater compaction in the base of the furrow. This may lead to reduced infiltration through the base of the furrow. We have shown previously (in work that reported in the Australian Cotton Grower and past cotton conferences) that compaction at depth is little affected by tyre width, for tyres supporting the same total axle load. Thus the greater soil contact pressure of the narrow tyres will not lead to greater compaction at depth.

The furrow should be flat at the base with steep sides (i.e. U shaped); a furrow that is not flat (i.e. V shaped) at the base will result in compaction at the sides and this will alter the shape so that it becomes flatter at the base.

In a bed system, narrow tyres will require less land for the laneway, leaving more for the crop, than will wider tyres. Thus, the results reported here suggest that the preferred system would have narrow tyres with U shaped furrows. However, the considerations about soil compaction have to be balanced against the cost and availability of the tyres and the advantage of wide tyres in providing greater traction.

Table 1 Void ratios and preconsolidation stresses at the side of furrows beneath picker tyres, depth 5 - 15 cm.

	Before traffic	After traffic			
		U furrow	V furrow	sed *	p #
Preconsolidation stress	56	83	100	16.78	.075
Void ratio	1.13	1.0	0.88	.114	.141

Notes:

* sed is the standard error of the difference

p is the probability that the means are the same

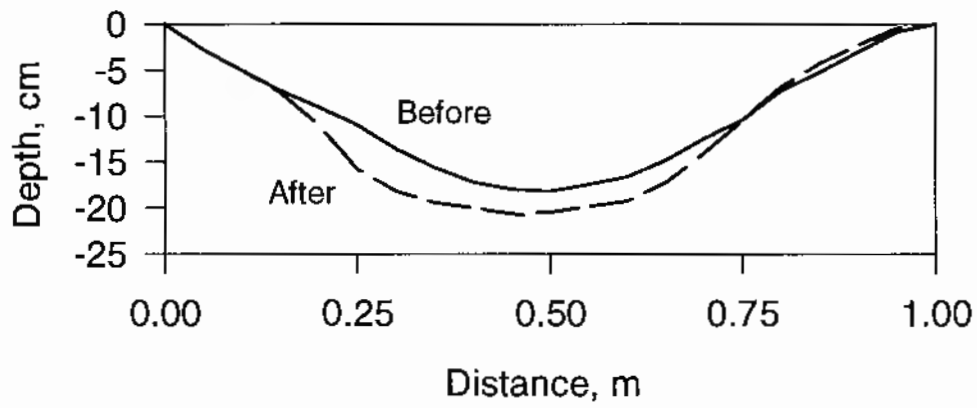
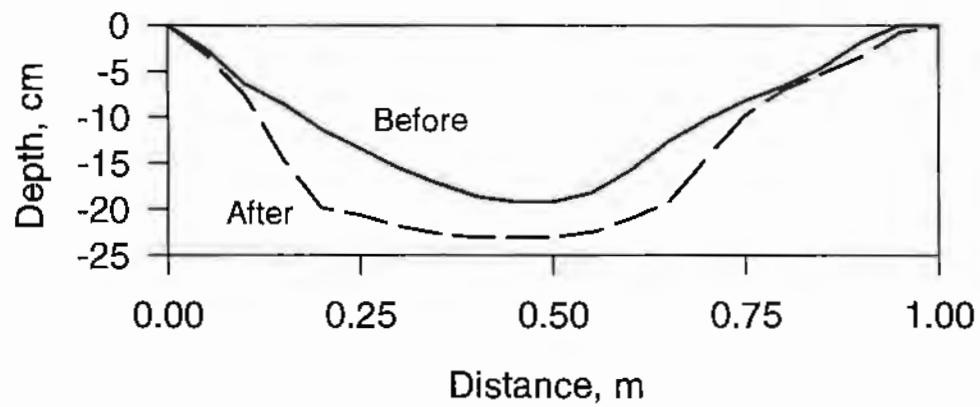
Fig. 1 Impact of narrow tyre on furrow**Fig. 2 Impact of wide tyre on furrow**

Fig. 3 Stresses beneath narrow tyre

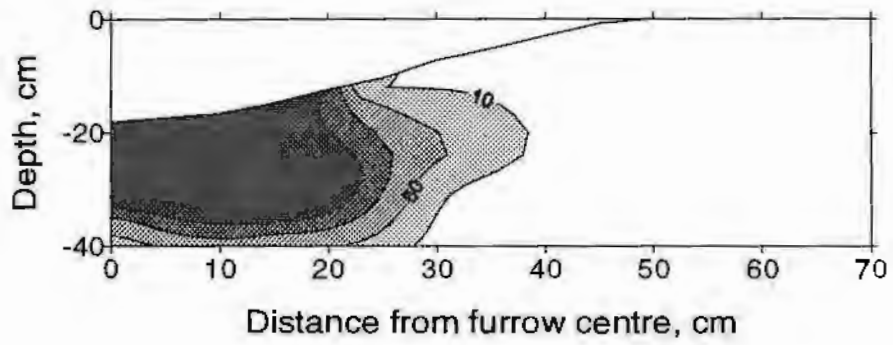


Fig. 4 Stresses beneath wide tyre

