DEVELOPING GUIDELINES FOR FERTILISER SPREADING ON WEST COAST HUMPS AND HOLLOWS

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Abstract

The practice of humping and hollowing has become widespread on the South Island's West Coast to improve drainage and enable more intensive dairying in the region. Fertiliser spreading patterns on humps and hollows differ from those on the flat. To improve the efficiency of fertiliser spreading on these unique landforms, fertiliser distribution patterns (of urea and superphosphate) for two types of commonly used spreaders (Coombridge & Alexander SAM and Robertson® Transpread) and three different widths of humps and hollows (30-, 40- and 60-m) were determined. A total of 48 single-pass tests using collector trays (0.5 m x 0.5 m) were conducted across the humps and hollows for the different spreader and fertiliser types and a statistical model was used to fit distribution curves to the spreading pattern data.

Uniformity of fertiliser application depended on distance between successive passes (bout width) and the driving positions on the humps, slopes or/and hollows. Bout widths and driving positions resulting in the most uniform fertiliser application on these landforms are discussed. Bout widths and driving positions required for more strategic fertiliser distribution on these landforms are also considered, based on recent field trials that indicate that there can be greater responses to fertiliser placed on the lower slopes than on the upper slopes in some hump and hollow systems.

Introduction

Poor drainage is a major constraint on agricultural production for large areas of West Coast "pakihi" soils in the South Island of New Zealand. These soils are acidic, infertile and often podsolised, with distinct impermeable iron pans (Molloy 1998). Humping and hollowing of pakihi soils is widespread on the South Island's West Coast to improve drainage and has enabled more intensive dairying in the region.

Large machinery is used to excavate the "hollows", removing the soil and breaking through the upper iron pans, creating wide surface drains. The "humps" are built up from the excavated soil which is deposited on to the original soil surface. The resulting surface layers of both the humps and hollows (H & H) start with low fertility. A fertiliser response study by Morton & Roberts (2006) on newly modified pakihi soils concluded that high rates of nitrogen, phosphorus and sulphur are required to maximise dry matter production in the early stages after development, with nitrogen rates of up to 480 kg N/ha/y recommended. As a result, fertiliser is one of the largest farm costs and uneven spreading can come at significant economic cost (Horrell *et al*., 1999). However, fertiliser spreading patterns are not well understood on the unique topography that is formed after humping and hollowing.

We discuss guidelines that have been developed to support the appropriate application of urea and superphosphate on different sized H & H systems (i.e. distance between humps) from two commonly used fertiliser spreaders on the West Coast.

Methods

Forty-eight single-pass fertiliser pattern tests were carried out on the Landcorp Weka complex 10 km east of Moana on the West Coast of the South Island. The pattern tests were conducted with two types of fertiliser (urea and superphosphate) on three sizes of H & H (30, 40 and 60 m widths). The height, width and slope of each H & H profile were measured using a surveying level and a staff. Two makes of spreaders typically used on H & H were used in the pattern tests, a SAM 4-tonne single axle (Coombridge & Alexander) and a Row Crop 770RC Transpread (Robertson® Manufacturing Farm Machinery). Both machines had been fully serviced to the manufacturers' specifications before undertaking the trials. The disk speeds were measured and set at 850 rpm in accordance with the manufacturers' recommendations.

The fertiliser spreaders were driven along the hollows, slopes and humps, and pattern measurements were made using collector trays (0.5 m x 0.5 m) placed at 1-m spacing perpendicular to the direction of fertiliser spreader travel. Fertiliser was collected and weighed from the trays across the distribution area after the spreader had passed.

GenStat 15 was used to fit a least squares polynomial regression model to the pattern test data. The spreading patterns to the right and the left of the spreader were not assumed symmetrical and where appropriate separate models were fitted. Estimated values from the fitted distribution curves were summed to represent overlapping spreading ranges across the humps, slopes and hollows to provide total estimated fertiliser applied over a given distance. The scenario combinations were then compared to determine which run combinations resulted in the most uniform, the least uniform and the most strategic spreading of urea and superphosphate for the different spreaders and H & H sizes.

Results and discussion

Topography affects fertiliser spreading

Spreading patterns on H & H differ from those on the flat because fertiliser spreaders are designed to work on predominantly flat land, not along the side of slopes, the top of a hump or in a hollow. Slopes change the way that fertiliser drops on to spinners and is ejected from the spreader, affecting the distribution on the ground. This distribution is affected by the steepness (often determined by the width between humps) and machine bout width (distance between successive passes). Spreading from the mid-slope produces asymmetrical patterns where fertiliser may be thrown over the other side of the hump (Figure 1a); driving along the top of humps increases spread width (Figure 1b); and driving in the hollows decreases the spread width as fertiliser is intercepted by the rising slope (Figure 1c).

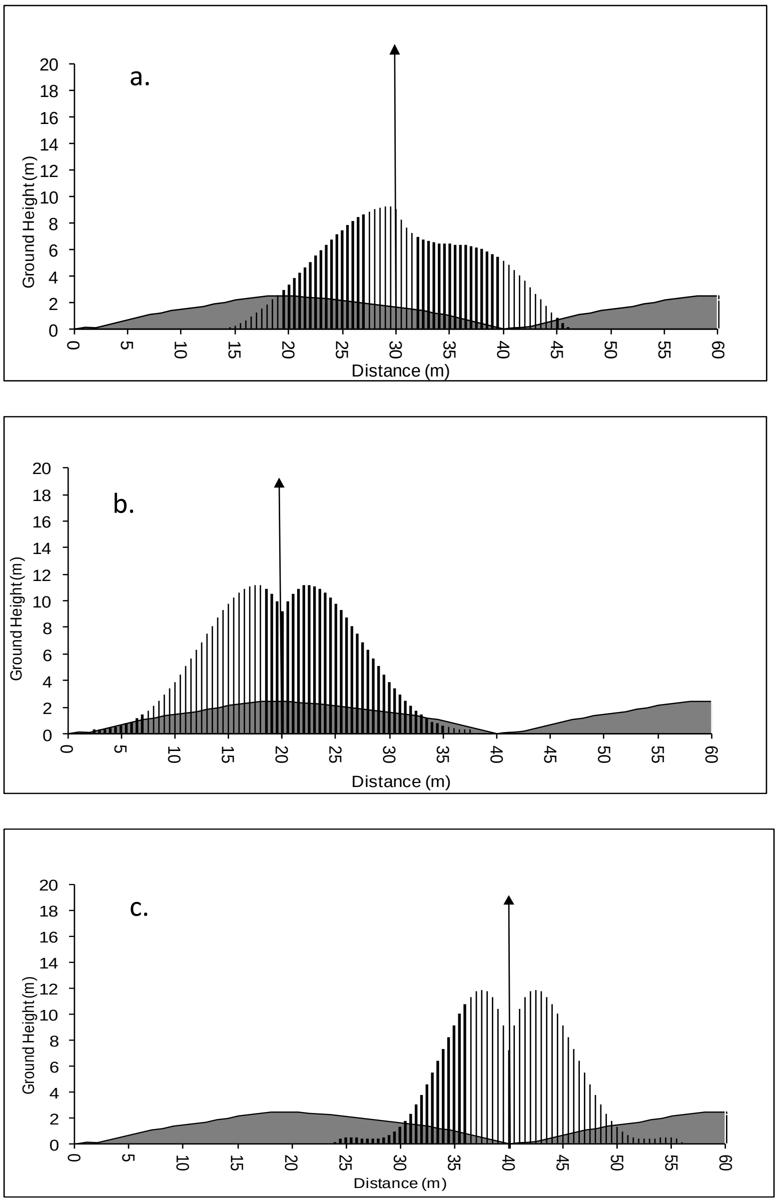

Figure 1. Single-pass distribution patterns when fertiliser is spread from a) mid-slope, b) along the hump, and c) along the hollow of a 40-m wide hump and hollow soil system. Vertical arrow indicates the centre of the spreader.

Overlapping these patterns allowed spreading patterns to be determined for a number of scenarios to give guidance on fertiliser applications:

Guide to uniform fertiliser distribution

The least uniform distribution for both fertilisers came from applying just to the hump or just to the hollow. Figure 2 illustrates the driving positions that gave the most uniform applications of fertiliser. For both fertilisers and for both spreaders for the 30- and 40-m sized H & H, driving along the slopes resulted in the most uniform application. For the SAM spreader on the 60-m sized H & H, both fertilisers were most uniformly spread by driving on the hump, mid-slope and hollow. For the Transpread spreader on the 60-m sized H & H, urea was most uniformly spread by driving on the hump, mid-slope and hollow, but superphosphate was most uniformly spread by driving on the hump and lower slopes only.

These spread patterns provide guides based on the well-maintained and calibrated spreaders used in these tests. Spreading patterns are influenced by spreader performance (e.g. disk speed), fertiliser quality (e.g. moisture content and particle sizes), and weather (e.g. wind and moisture).

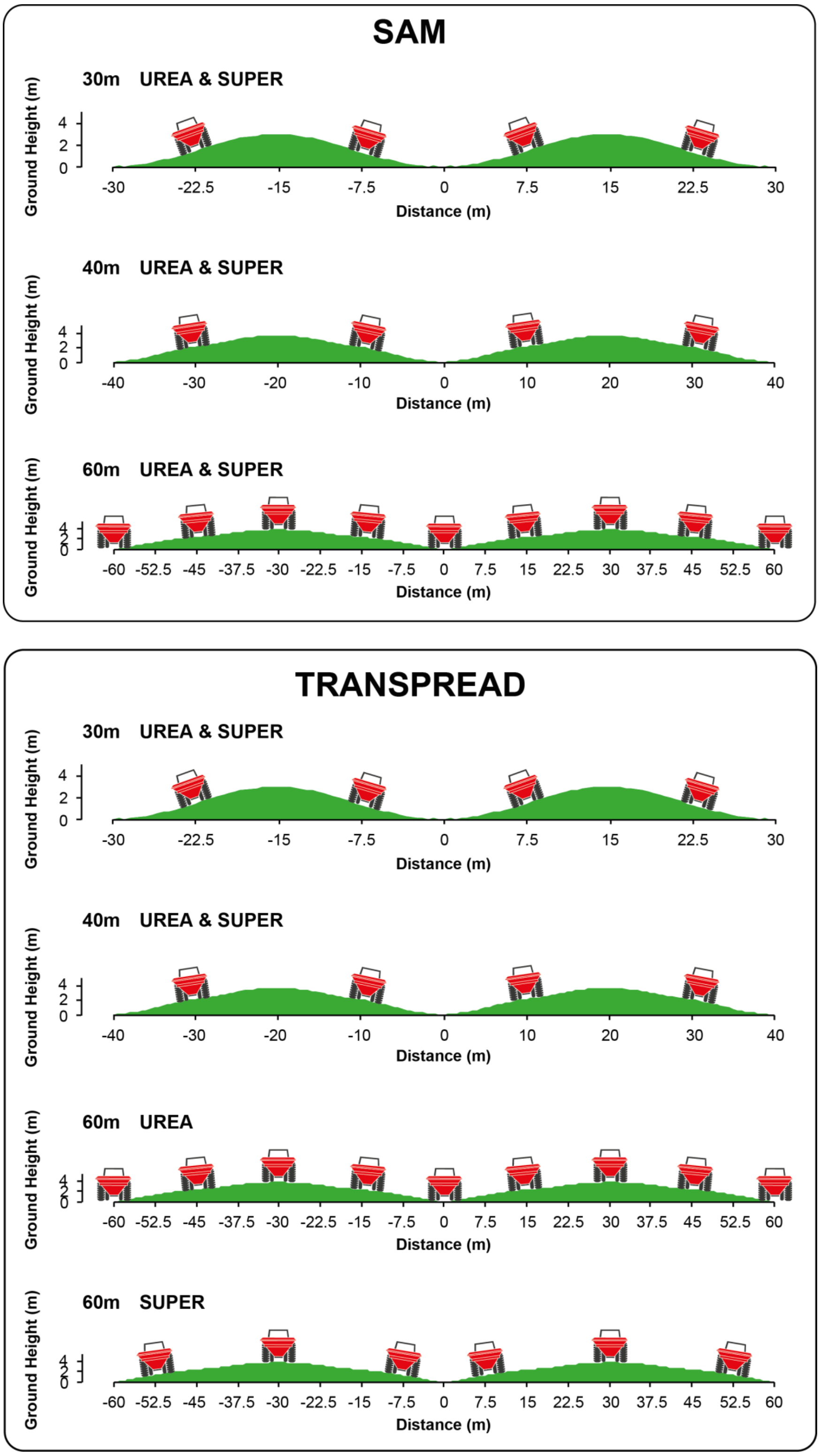

Figure 2. Fertiliser spreader driving positions that achieved the most uniform spread of urea and superphosphate for SAM and Transpread spreaders where soil humps were 30, 40 or 60 m apart.

Guide to strategic fertiliser distribution

Recent field trials have shown that although there is greater pasture production on the upper slopes, there are greater responses to nitrogen fertiliser on the lower slopes in some H & H systems (Thomas *et al*. 2015). Where this is the case, more pasture can be produced if relatively more nitrogen fertiliser is applied to the lower slopes. Table 1 indicates strategic spreader driving position and bout widths for applying more fertiliser to the lower slopes; however, such tactical application of nitrogen fertiliser should not be applied if there is high surface runoff or if water is accumulating in the hollow.

Table 1: Recommended bout widths and hump and hollow spreader positions for urea and superphosphate for SAM and Transpread spreaders enabling increased fertiliser application to the lower soil slopes than to the humps.

SAM Spreader

Product	Hump width (m)	Spreader position	Bout width (m)	Average bout width for calibration (m)
Urea & Superphosphate	30	Hump & hollow	15	15
Urea	40	Slope & hollow	10, 20	13
Superphosphate	40	Slope	20	20
Urea & Superphosphate	60	Hump, lower slope & hollow	10, 20	15

Transpread Spreader

Product	Hump width (m)	Spreader position	Bout width (m)	Average bout width for calibration (m)
Urea & Superphosphate	30	Slope	15	15
Urea	40	Slope & hollow	10, 20	15
Superphosphate	40	Hump & hollow	20	20
Superphosphate	60	Hump, mid slope & hollow	15	15

Conclusion

Spreading fertiliser on hump and hollows is not the same as spreading on the flat, as distribution patterns are affected by topography. Factors that influence this include distance between humps, steepness of the slopes, type of product, and quality of product. The fertiliser distributions predicted here can be used to assist in spreading fertiliser more uniformly or for targeting more fertiliser to the lower slopes. Based on these findings, we have developed a guide to applying fertiliser on hump and hollows, which can be viewed at www.westland.co.nz.

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