Mechanics of deep ripping and inclusion plates

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Key messages (Mechanics of deep ripping)

- **At 600 mm ripping depth, the draft increased by 31% and drawbar power by 2.3-fold from 4 to 7 km/h.**
- **At 4 km/h speed, the draft and drawbar power increased by 2.7-fold from 400 to 600 mm depth.**
- **At 4 km/h, adding wings increased draft and drawbar power by 42% and 23% at 400 and 600 mm, respectively.**
- **The loosened area increased by 69% from 400 to 600 mm depth, 49% and 53%, respectively, by adding wings.**
- **Working to the shallowest depth identified and using wings maximises the energy efficiency (= loosened area per horsepower) of a ripping operation.**
- **The cost ($/ha) of deep ripping is directly influenced by drawbar power and work rate and can be optimised via tine design (wings) and operation (depth, speed).**

Key messages (Mechanics of inclusion plates)

- **At 600 mm ripping depth, a 290 mm tall inclusion plate set at 155 mm below the undisturbed surface raised tine draft by 38 and 40% at 4 and 7 km/h, respectively.**
- **In comparison, a 440 mm tall inclusion plate extending 150 mm deeper into the profile and able to maximise the depth of topsoil inclusion, created a 68 and 81% draft increase, respectively.**
- **Increasing forward speed decreased both the extent and depth of surface soil inclusion, while a 170 mm longer inclusion plate improved the extent of surface soil inclusion, even at the higher speed.**
- **The position of the plate upper edge controls the thickness of the topsoil layers that will be included. This inclusion occurs as a full layer collapse over the plate edge and not as a 'surface-first' shedding process. Setting it to match the layer of interest targeted for inclusion is critical, while very shallow settings can render inclusion over-sensitive to surface undulations.**
- **The extra cost of operating inclusion plates must be weighed against additional crop yield responses over time.**
- **DEM computer simulations help improve the understanding of the topsoil inclusion process and provide a useful basis to optimise the inclusion plate design (See: https://www.youtube.com/watch?v=A0eApjfCtoM)**

Why do the trial?

Soil compaction and hard setting layers significantly reduce root growth and prevents access to water and nutrients in deeper layers. Deep rippers should optimally be set to just below the depth of the constrained layer in order to alleviate these physical constraints. The use of a tine ripper requires high-power, drastically increasing with operating depth and forward speed. Operating the ripper too deep, such as below its critical depth, can lead to lateral soil compression at depth, characterised by a visual compacted slotting effect and significantly higher draught requirements.

Inclusion plates, pioneered in WA in early-mid 2010s, can be fitted to the rear of the ripper tines allowing the top soil layer (including surface applied amendments) to be incorporated down a deep slot. The aim of inclusion plates is to create a column of improved soil down the profile to sustain deeper root growth. While there is considerable interest in inclusion plates, little is known on how to optimise topsoil backfilling and on the changes to the draft force of a deep ripping operation.

Field experiments conducted in May 2019 at Caliph in the SA Mallee quantified the impact of ripper tine, wings and inclusion plate geometry, operating depth and forward speed on energy requirements and soil loosening/ inclusion performance. Details of trial implementation and results can be found at https://ingrain.partica.online/ingrain/vol-1-no-5-summer-20192020/flipbook/20/ .

Further work is required to develop more detailed adoption guiding messages.

Acknowledgements

Funding from GRDC (DAW00243) and SAGIT (MSF219). The support from Tilco Ag-Systems, Frontier Farming Systems, Robin Schaeffer of Bulla-Burra Farms and Mallee Sustainable Farming are gratefully acknowledged.