Management of compacted soils in Western Region

PROJECT DETAILS

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PROJECT TITLE: MANAGEMENT OF COMPACTED SOILS IN WESTERN REGION

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Summary

Large-scale field experiments on sandy and clay soils at Merredin, Nungarin, Tammin, Kellerberin and Corrigin shires (Western Australia) were conducted by Dr M A Hamza (in collaboration with growers) to find the optimum combination(s) of ripping depth and tine spacing for maximum yield.

The major finding was that the depth of ripping could be reduced to 30cm provided that tine spacing was no wider than 30cm. At shallower ripping, depths or wider tine spacings, soil water storage, water infiltration and grain yields were less.

The results have been extended to growers and agribusiness by the project researcher and Mr S Penny, the specialist wheat adviser at Merredin and presented at the Crop Updates (2004, 2005).

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Conclusions

Ripping depth x tine spacing

For most of the soils tested, tine spacing of 30cm and ripping depth between 30 and 40cm was most profitable (see Farmnote attachment). In general, soils ripped deeper with narrower tine spacing stored more water, allowed faster water infiltration and had lower resistance to plant roots.

Growers should consider the cost of each combination against the potential income generated by that particular combination before deciding which combination to choose. The major cost factors, which determine the economy of a particular treatment, are fuel consumption and machinery depreciation. In general, increasing ripping depth by 10cm increases fuel consumption by about two and a half times, while increasing it further by another 10cm almost doubles the fuel consumption (around four to five times more than that of the original ripping depth). Doubling tine spacing almost halved the fuel consumption.

If it is assumed that diesel cost is $0.80 per litre then the extra cost of ripping to 30cm depth instead of 10cm at a tine spacing of 33cm would be $12/ha. At a price of $180/tonne for wheat this would require a yield increase of 67kg/ha to break even on the deep ripping fuel cost in the first year. Given that previous results have indicated yields are increased for at least four years after treatment with deep ripping and gypsum, this could be profitable. It should be noted that machinery depreciation constitutes a significant portion of the cost of deep ripping and should be taken into account when determining the economic viability of the process. The nature of the data does not allow direct economic analysis for depreciation but it is fair to assume that machinery depreciation increases with increasing ripping depth and decreases with increasing tine spacing in the same manner as fuel consumption.

There was a general tendency towards fewer small grains as the ripping depth was increased and as the tine spacing was decreased, but only on clay soils. The impact of ripping depth x spacing on grain quality was fairly small and needs further study.

Shallow leading tine ripper (SLT)

The SLT ripper provided significantly decreased ripping draft, reducing the cost of ripping, improved soil tilth by reducing clod size and allowed injection of soil ameliorants at different depths. It also increased the moisture range suitable for ripping the soil thus increasing the time available for ripping, and decreased wear and tear on ripping components.

Recommendations

Ripping depth x tine spacing
Growers should consider the cost of each combination against the net profit generated by that particular combination before deciding which combination to choose. However, shallow ripping (15 cm or shallower) should be avoided because the soil will be re-compacted again in a short time.

Shallow leading tine ripper

The shallow leading tine ripper is highly recommended for ripping and injecting soil ameliorants into compacted soils because it uses less energy, improves soil tilth and can inject more than one soil ameliorant into the subsoil during the ripping operation.

Outcomes

Increased grain yield and profitability through improved physical and chemical characteristics of compacted soils in the eastern wheat belt of the Western Region.

This will be achieved through reduced costs of amelioration of compacted soils by definition of the cheapest depth x spacing configurations for deep ripping.

A supplementary outcome was addressed, facilitated by acquisition of a shallow leading tine (SLT) ripper donated by AGROWPLOW and an air-seeder bin funded by GRDC. The expected outcome is that the costs of soil amelioration by deep ripping can be reduced through less draft and fuel costs, that soil tilth can also be improved, and that more than one ameliorant can be applied during ripping at different levels in the soil (see Attachment).

Achievements/Benefits

Ripping compacted soil is the most expensive component in addressing compaction problems. This project researched the best economic combinations of tine spacing and ripping depth that give the highest grain yield. This research covered sandy, loamy and clay soils in five shires of the low rainfall area. Research data were presented at Crop Updates meetings, in AgMemos and discussed in radio interviews.

The project findings can be summarised as follows:

Soils ripped deeper with narrower tine spacing stored more water, allowed faster water infiltration, and had lower resistance to plant roots. Thus, a combination of deeper ripping depth and closer tine spacing can give higher yield increases. For most of the soils tested, tine spacing of 30cm and ripping depth between 30 and 40cm was most profitable (see Attachment) However, compacted soils, especially sandy soils, ripped to a shallow depth will be re-compacted much faster than soils ripped to a deeper depth, regardless of the presence of an aggregating agent such as gypsum. The choice of the best combination(s) of ripping depth and tine spacing will depend on soil types and the efficiency of machinery used in the operation.

A new generation ripper based on the Shallow Leading Tine (SLT) principle was developed and tested. The ripper, with a modified air-seeder, constitutes a ripping-delivery system capable, while ripping the soil, of injecting more than one soil ameliorant into top or subsoil simultaneously.

Research and observation showed that the ripper:

a. Significantly decreased ripping draft force and thus the cost of ripping
b. Improved soil tilth by significantly decreasing clod size
c. Allowed injection of soil ameliorants at different depths of the subsoil
d. Increased the moisture range suitable for ripping the soil, thus increasing the time available for the ripping process, and
e. Decreased wear and tear on ripping components.

Other research

Recommendations for future research

While methods for addressing soil compaction are well understood and researched by this and previous GRDC funded projects, a mechanism to address subsoil compaction in sodic and acidic soils is still not well developed. The key issue is to
inject soil ameliorants, gypsum in the case of sodic soil and lime in the case of acid soil, into the subsoil while ripping the soil. The practical problem is developing tools to deliver the materials required at the depths needed during the ripping process to minimise cost and soil re-compaction. The SLT ripper has shown a promising ability to address these problems. More research is needed to determine the best SLT configuration as well as test delivery system(s) that can be attached to the ripper.

Soil compaction should be addressed as a part of the overall paddock agronomy. In most cases soil compaction is a result of another agronomic problem such as lack of aggregating materials (calcium and/or organic matter). In this case even addressing soil compaction successfully might not increase yield because of other limiting factors. A project which integrates soil and plant constraints in one agronomic system and addresses all or most of the yield limiting constraints in that system will be more efficient scientifically and economically.

**Additional information**

A paper reviewing the most important achievements in soil compaction research during the past decade was published in Soil and Tillage Research. Hamza, M A and Anderson, W K (2005). Soil compaction in cropping systems. A review of the nature, causes and possible solutions. Soil & Tillage Res. 82/2. 121-145.

Attachment to the Final Report

- Farmnote - Improving compacted soils in the eastern wheatbelt