A new generation ripper to reduce the cost of removing soil compaction

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Abstract

This study compares the draft requirements of a shallow leading tine ripper, (shallow tines attached ahead of the deep tines that rip the soil to the intended depth) with a conventional ripper (single tine). The results show that attaching a shallow leading tine ahead and in-line with the main tine and at about one third to one half of the depth of the main tine produces the largest significant decrease in draft force (up to 17.7%). Attaching more than one shallow leading tine ahead of the main tine either (a) increases the draft force when offset; or (b) decreases it insignificantly when in-line with the main tine. The advantages of the shallow leading tine ripper over the conventional (single tine) ripper, besides requiring significantly less draft force are: (i) improved soil tilth (smaller aggregate clod sizes); (ii) a wider range of soil moisture conditions and therefore increased time over which effective ripping can be done ; and (iii) less wear on tines and points.

Keywords

Draft energy, Shallow leading tine, Soil compaction; Deep ripping; Critical depth

Introduction

Soil compaction cannot be eliminated by the application of soil ameliorants and chemicals. Massive, structureless soil must be broken down physically by deep ripping (Hamza and Anderson, 2005). The cost of deep ripping compacted soils is usually high because it involves high-energy input (Kirby and Palmer, 1992). In an effort to reduce the cost of using a conventional ripper, Spoor and Godwin (1978) pioneered in the United Kingdom a shallow leading tine (SLT).. The basic idea of shallow leading tines is that this tine works ahead of a deeper tine and breaks the soil a over a shortened failure surface. This contrasts with a single deep tine that has to break a failure surface along the whole length of the tine. The operation of a SLT effectively increases the critical depth of the ripping implements (Spoor and Godwin, 1978), decreases draft forces, produces better soil tilth (Palmer and Kirby, 1992) and thus improves the work efficiency (volume soil loosened per unit drawbar draft force) of ripping **(**Lacey et al., 2001)

Materials and methods

An Agrowplow with a range of tines of different lengths was used to rip a compacted clay soil (61% clay, 8% silt and 31% sand) and a compacted loamy sand soil (16% clay, 12% silt and 72% sand). The soil moisture contents were 15.5% in the clay and 7.0% in the loamy sand. The average soil strengths of these soils were 2.32MPa and 2.28MPa for the clay and loamy sand soils, respectively. A John Deere 4240 hydraulic front wheel assist tractor fitted with a. strain gauge drawbar dynamometer (made by Gatton Collage, University of Queensland) was used to pull variously configured rippers.

Treatments

Each tine arrangement was regarded as a treatment (Table 1). Plots of sandy and clay soils 20m long and 1.78m wide were ripped once in the same direction for each treatment, and all treatments were replicated four times.

Table 1. Treatment-tine ripper depths and configurations used on clay and sandy soil.

Treatment	Clay soil			Sandy soil		
	Tine depth (cm)			Tine depth (cm)		
	Main	SLT		Main	SLT	
Classic	30			37		
SLT A	30	20	10	37	27	17
SLT B	30	10		37	12	
SLT C	30	15		37	17	
SLT D	30	20		37	22	
SLT Offset	30	15		37	22	

Results and discussion

The clay soil treatment SLT B and the sandy soil treatments SLT B and SLT C showed the statistically significant minimum force and therefore the least energy required for ripping the soil (Table 2). The minimum draft required to rip the sandy soils using the SLT ripper was 10.5 to 9.5 % less than that for the classic ripper and was 17.8 % less for the clay soil. The differences in draft requirements between the sandy and clay soils may be due to the differences in the original soil compaction, moisture content and soil type.

The data showed that attaching more than one shallow leading tine ahead of the main tine either increased the draft force or decreased it (non-significantly) depending on whether the shallow leading tines were in-line with or offset from the main tine.

Figure 1. Clods resulting from ripping sandy and clayey soils with classic ripper and SLT ripper.

Table 2. Draft force (DF) in kilonewtons (kN) for ripping clay and sandy compacted soils using classic and shallow leading tine (SLT) rippers and % change.

Treatment	Clay soil draft force (kN)	Clay soil change (%)	Sandy soil draft force (kN)	Sandy soil change (%)
Classic	29.3		29.4	
SLT A	29.4	0.3	29.3	-0.3
SLT B	24.1	-17.8	26.6	-9.5
SLT C	28.4	-3.1	26.3	-10.5
SLT D	30.5	4.1	28.0	-4.8
SLT offset	32.5	10.9	31.2	6.1
l.s.d. (p=0.05)	4.9		2.3	

The size of the clods produced by deep ripping with the SLT ripper was much smaller than those produced by the Classic ripper (Figure 1). Clod size is very important for crop establishment. Smaller clods produce greater crop establishment because they allow greater seed-soil contact and more even distribution of moisture after rain.

The decrease in draft and change in tilth produced by the SLT ripper will effectively reduce the fuel consumption. This, in turn will allow this type of ripping to be done at drier than optimum moisture contents, which will effectively lengthen the time available to rip the soil and attain the best clod size distribution. Farmers will therefore have more time in which to perform ripping after summer rains.

Conclusions

The Shallow Leading Tine ripper requires significantly less force (between 9.5 to 10.5% for sandy soil and 17.8 % for clay soil) to effectively loosen soil and will reduce the cost of ripping compacted soils. It also produces a better tilth than other ripper configurations.

The most effective tine configuration was two tines in-line with the leading tine set shallower, at about 1/3 to 1/2 the depth of the second tine.

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