Fuel consumption and draft force measurements on a tracked tractor during tillage and drilling

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1 Background

- Much research has focused on either reducing or eliminating tillage operations to develop sustainable crop production methods.
- The greatest costs in farm operations are associated with tillage due to greater specific energy requirement in tillage and high fuel costs.
- To improve the energy efficiency of tillage, the tillage implement effectiveness and agronomic strategies should be improved.
- Different tillage systems should be tested to determine the most energy efficient systems.

2 Objectives

- to measure basic soil properties before and after tillage to determine the effect of tillage treatments on soil parameters
- to compare the fuel consumption requirements of different treatments to
- to determine the most energy efficient method
- to compare draft force requirement in different treatments, and
- to assess the timeliness for the treatments

3 Methods

- Deep tillage (DT: 250 mm), shallow tillage (ST: 100 mm), and direct drilling (DD) treatments in wheat with three replicates were applied in 4 m wide and 80 m long plots (Fig. 1). Soil moisture content, bulk density, and penetration resistance values were similar before the tillage operations.
- Fuel consumption of the tracked tractor (Challenger MT765D) and the draft force of the tiller and drill (Vaderstad Topdown 400 and Vaderstad Rapid Drill, Fig. 2) was measured by a fuel meter (JPS Model 41) and dynamometer (Challenger 177-8910 Power Link Group).
- The treatment resulting in the least amount of fuel rate, draft force, and time requirement was determined.

Block 1	Plot 1 - DT
	Plot 2 - ST
	Plot 3 - DD
Block 2	Plot 4 - ST
	Plot 5 - DD
	Plot 6 - DT
Block 3	Plot 7 - DD
	Plot 8 - DT
	Plot 9 - ST

Figure 1. Experimental design
(DT: deep tillage, ST: shallow tillage, DD: direct drill)

(a) (b)

Figure 2. Combination tiller (a) and direct drill (b)

4 Results

- Fuel consumption (L h^{-1}) in shallow tillage was about 67% of deep tillage, suggesting significant amount of fuel saving per hectare in shallow tillage applied before drilling (Fig. 3 – Table 1).
- Deep tillage followed by drilling operation required the greatest fuel consumption (22 L ha^{-1}) per unit drilled area.
- Shallow tillage followed by drilling operation required about 27% less fuel compared to deep tillage. Direct drilling required the least amount of fuel (6.2 L ha^{-1}), corresponding to 72% and 38.5% fuel savings compared to deep tillage and shallow tillage, respectively.
- Deep tillage required more than 100% more draft force compared to shallow tillage (Fig. 4 – Table 3).
- Since no tillage was applied in direct drilling, total time needed for drilling (Table 3) was considerably less (43%).

Table 1. Fuel consumption, draft force and ground speed

Treatment	Fuel consumption (L ha^{-1})			
	Tillage	Drilling	Total	Percentage (%)
DT	16.06	6.39	22.45	100
ST	10.69	5.62	16.31	73
DD	0.00	6.20	6.20	28

Table 2. Draught force requirements in tillage

Treatment	Draft force (kN)	Ground speed (m s^{-1})
DT	68.7±6.1	2.17±0.11
ST	31.7±5.4	1.95±0.09

Table 3. Time requirements for tillage and drilling

Treatment	Total time for tillage + drilling (h ha^{-1})	Difference (%)
DT	0.82	100
ST	0.86	105
DD	0.49	57

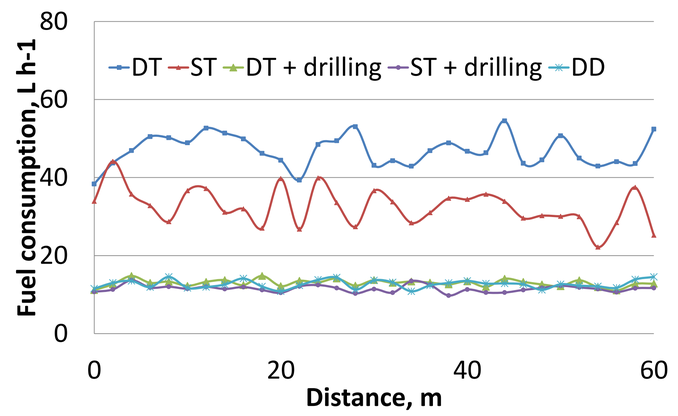

Figure 3. Fuel consumption (L h^{-1}) in tillage and drilling

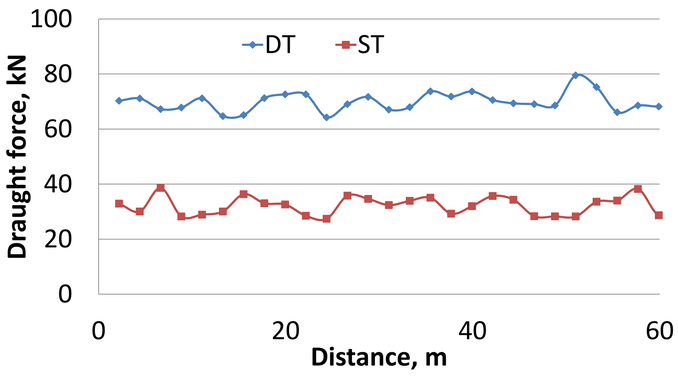

Figure 4. Draft force (kN) requirements in tillage

5 Conclusions

- Direct drilling was the most energy efficient treatment followed by shallow tillage and deep tillage.
- Draft force requirement during tillage was about 50% less for shallow tillage.
- Direct drilling reduced the total time needed for tillage and drilling considerably.

C Contact Information

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