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Experiments on Front Subsoiler Operations

Combining implements in field cultivation contributes to the reduction of working time and fuel consumption. A front-mounted subsoiler, combined with a rear-mounted rotary harrow seeder combination, was the subject of experiments regarding slip, field capacity, fuel consumption and soil loosening effect.

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By order of the firm EIMI, the investigations were carried out at the experimental farm of BOKU in Groß Enzersdorf and in the agricultural school in Völkermarkt (Carinthia)

Keywords

Front subsoiler, slip, fuel consumption, effect of soil loosening

Fig. 1: Front subsoiler with rigid tines and disc coulters

Recently, saving fuel as well soil protection are essential aims in plant cropping. Increasing demands on work- and field productivity induce the development of powerful working processes in which more working steps are combined [1]. Field cultivators are more used and substitute the plough in soil tillage. Front-mounting of a subsoiler with a rear mounted combined operation of rotary harrow and seeder is an interesting alternative, in which one working step soil loosening to a depth of 30 to 35 cm and seeding is done. This combined soil tillage with a front subsoiler and seeding system is already used in humid climate zones of Austria. It allows also the mechanical removal of existing soil compaction zones. In the following first test results from Lower Austria and Carinthia including fuel consumption, field performance and loosening effect of a front subsoiler are presented.

Technical description of the front subsoiler

The front subsoiler (*Fig. 1*) is manufactured by the firm EIMI, which offers it in three different working widths (2.5 m, 3 m and 4 m). For the testing at the experimental farm Groß Enzersdorf (Lower Austria) the subsoiler EIMI FTG 300 with a working width of 3 m was used. Six fixed tines with loosening shares are mounted in a distance of 50 cm on the steel frame. Eight pivoting disc coulters are mounted on a hydraulically adjusted parallelogram, which cut the soil to a depth of 20 cm. The manufacturer expects from the pulled tines attachment a low small drawbar pull and reduced tine blockage. The front subsoiler with the disc coulters weighs 1,460 kg. The pass distance between frame and soil surface is 90 cm. The pulled tine frame demands an adjustment of the front lift system, which was done with the enlargement of the lower link to 65 cm (*Fig. 2*). The depth guidance of the tines is done with the position of the front lift system – the disc coulters are guided via the parallelogram.

Description of the investigations

The tractor (CLAAS: Ares 696; rated engine power: 104 kW) for the trial was equipped with a fuel-tank system, which allows to quantify the fuel consumption with a precise scale. For the calculation of the slip the parameters “theoretical ground speed” (v_0) and the “real ground speed” (v) are required. The theoretical speed was measured inductively with a transmission-sensor (inductively transducer) and was calibrated with an integrated radar senor in a calibration drive on a slip free asphalt road. The radar-sensor detects the real speed in a squarewave frequency being proportional to the speed (27.8 Hz per 1 kph). The signals of the transmission- and radar-sensor are scanned with 1 Hz. The engine speed signal of the inductive-sensor is also scanned with 1 Hz. For signal recording a multi-channel datalogger (Squirrel Da-

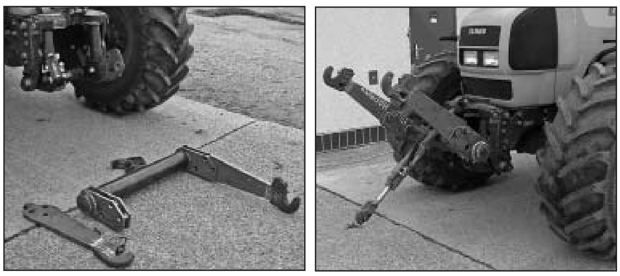

Fig. 2: Lower link adaption for the front-lift system

tenlogger 2020) was used.

The investigations were carried out on 5th October 2005 at the experimental farm Groß Enzersdorf on a harvested potato field (length: 703 m). For comparison, besides the front subsoiler, a rear mounted subsoiler (Cultiplow) with a working width of 3 m was used. In practical use it is not common to operate only with the front subsoiler. This is the reason for the investigation of the combined use of the front subsoiler with a rear mounted rotary harrow with seeder.

Results

There was an instable run in the testing with the tractor only mounted with the subsoiler. This was caused by different power to push. *Table 1* shows, that the average slip for the front subsoiler was 5.6 % and was much higher than for the rear mounted subsoiler (1.9 %).

The test run with the combination of the front subsoiler and a rear mounted combined rotary harrow and seeder (*Fig. 3*) shows an improvement of the traction properties. The average slip was 3 %. The entering forces by the front subsoiler induce an additional load on the front axle, which improve the transmission of drawing power. The measured fuel consumption (*Table 2*) of 14.5 l/ha is, compared to other investigations on soil tillage operations with seeding [2], relatively low. This fuel consumption of 14.5 l/ha could not be attained with the separate use of the two machines because the seeding operation with the combined rotary harrow has usually a fuel consumption of 15 l/ha [3].

Calculations of the field related soil stress according [4] show a track share of 79 % with a stress index of 30.1 t •km/ha.

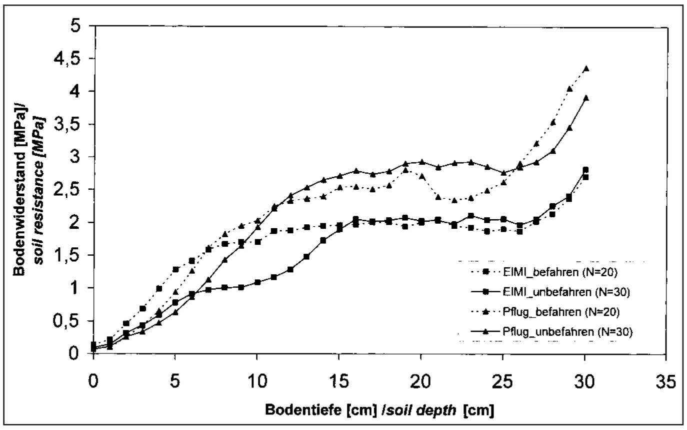

Fig. 4: Soil resistance versus soil depth

Physical soil parameters

A field trial for the determination of yield effects was established in 2006 in Völkermarkt (Carinthia). Measurements to soil hardness [5] with a penetrometer (Eijkelkmap, Agrisearch) were done in the cropped silage maize on July 3th 2006. In each of the two variants (conventional tillage with plough and tilled with subsoiler) 20 penetrations were done on the trafficked track share and 30 penetrations on the untrafficked field share. The results shows clearly (*Fig. 4*), that a hardened soil layer exits at the depth of 27 cm, indicating a plough pan. The soil tillage system with the front subsoiler shows a significant reduction of the soil resistance in the depth between 6 cm and 30 cm (end of the penetration). The increased re-compression to the depth of 15 cm of the front subsoiler system is the result of the higher loosening effect and the increased front axle load.

Conclusion

There are many reserves in agricultural engineering (e.g. combination of more operations in one run) to reduce fuel consumption and working time. In first investigation testing a front mounted subsoiler combined with a rear mounted rotary harrow seeder shows good results regarding slip, field performance and fuel consumption were attained. The loosening effect was clear to a depth of 30 cm in comparison to the soil tillage system with plough. On the established field trial the yield effects will be determined in the next season, too.

Literature

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Fig. 3: Combined use of a front subsoiler with seeding combination (total weight: 9040 kg)

Table 1: Comparing operation parameters of a front subsoiler with a rear subsoiler at 2 drives (each 703 m) with 1 turn; tilled area: 0.42 ha

	Front subsoiler EIMI	Rear mounted subsoiler CULTIPLOW
Gear shifting	4. gear; 2. powershift	
Engine speed [rpm]	1400 – 1500	
Real speed [km/h]	Ø: 7.15 (s: 0.81) Median: 7.48	Ø: 9.47 (s: 0.40) Median: 9.61
theoretical speed [km/h]	Ø: 7.58 (s: 0.85) Median: 7.79	Ø: 9.65 (s: 0.34) Median: 9.70
Average slip [%]	5.6	1.9
Fuel consumption [l/ha]	10.7	8.3
Field capacity [ha/h]	2,2	2,8

Table 2: Operation parameters for four drives (each 703 m) with three turns; tilled area: 0.84 ha

Gear shifting	4. gear; 2. powershift
Engine speed [rpm]	1500 – 1600
Real speed [km/h]	Ø: 5.69 (s: 0.56); Median: 5.87
theoretical speed [km/h]	Ø: 5.88 (s: 0.60); Median: 6.06
Average slip [%]	3
Fuel consumption [l/ha]	14,5
Field capacity [ha/h]	1,68