Hermann Seufert, Heinz Bernhardt, Reinhold Müller and Kai Klimek, Giessen, with Günther Weise, Groß-Umstadt

Running properties of different trailer tyres

Trailer tyres play an important role in tractor draught requirements and fuel consumption. For this reason driving trials were carried out with a tractor to record values for high pressure and low-pressure trailer tyres during typical farming journeys. It was shown that the low-pressure tyres offered advantages for special transport tasks.

Prof. Dr. Hermann Seufert is director and Dr. Heinz Bernhardt, Rheinhold Müller and Kai Klimek members of the staff at the Institute for Agricultural Engineering, Justus Liebig University Giessen, Braugasse 7, 35390 Giessen; e-mail:*Heinz.Bernhardt@agrar.uni-giessen.de*
Dr.-Ing. Günther Weise is a member of the KWF staff, Spremberger Str. 1, 64820 Groß Umstadt.
The authors thank Bernard Krone GmbH, Spelle for its friendly support.

Keywords

Transport, driving performance, trailer tyres

A question stemming from trials held in Halle [1] and Giessen [2] on actual running performance of agricultural transport vehicles was whether the running characteristics of the trailers on unsurfaced ground could be improved by fitting low-pressure tyres. In the last years there has already been very definite developments seen in this direction with tractor tyres. At the same time there is also the question on whether trailer low-pressure tyres might not lead to poor traits on road journey, taking away the advantages of this type of tyre on unsurfaced land.

The investigation focal point was laid on the required draught power and fuel consumption comparing low and high-pressure tyres used on road and field transport. A typical farm transport unit of tractor and Krone trailers was used in the investigation. Vehicle specifications are given in *table 1*. Trailer high-pressure tyres were the standard 385/65 R22.5 and low-pressure tyres were 550/45-22.5 with associated specifications shown in *table 2*.

The tractor was fitted with radar sensor for measuring real speed and distance covered. A radar sensor also logged theoretical speed for calculation of tyre slip. Fuel consumption calculation was via Mannesmann VDO Kienzle EDM 1404 flow meter. Engine and transmission data were also recorded (engine rpm for checking power range and driving gear ratios for calculating changing procedure). To measure draught requirement extension measuring strips were fitted to the hitch fork of the first trailer. This system was chosen to enable straight hitching of trailer on the tractor drawbar and thus no deviation from real farm conditions. Calibrating the draught power system took place with a reference power recorder from HBM Darmstadt (empirical determined calibration function – $R^2 = 0.996$). The integrated angle sensor was applied for determining slopes up and down on the measurement stretch and an outdoor temperature sensor was applied for determining any possible temperature influences on the running properties of the tyres.

Measuring was carried out near Giessen on two stretches typical for agricultural transport tasks. Road travel took place on a well-surfaced and straight village street. As measuring stretch for drives on unsurfaced ground a several-years fallow area was used with grass growing ion it, having a surface comparable to that of a farm track but at the same time offering the same starting conditions for every test drive with no tracks and ruts forming during the test as would have occurred on a single track farm way. Soil type was silty loam. Average soil moisture was 39%. On both measurement stretches the rises and slopes balanced each other out. In the trials a journey was made three times for every recording option at as constant a speed as possible. With field journeys, all recorded data was with a speed deviation of > 0.2 km/h. The deviation limit for road journeys was 1 km/h. Road journeys were carried out with both trailers in train with a single trailer hitched for field journeys to reflect the usual methods on the farm.

Road journey results

The comparison of required draught power in *figure 1* for low and high-pressure tyres on the road shows that with the former (550) and empty trailers an average 0.9 kN, with loaded trailers an average 8.6 kN was required. Respective values for high-pressure tyres are 1.3 and 7.6 kN.

The lower draught requirement of the unloaded trailer with low-pressure tyres compared with the high pressure ones is at first notable, especially when one reflects that ra-

Table 1: Data of the vehicles

Tractor	**Fendt Xylon 524**
Engine performance	103 kW
Weight with measuring equipment	7.2 t
Gears changeable under load	4
Manual changeable synchronised groups	6
Permitted top speed	50 km/h; 14 m/s
Trailer	**Krone DK 225-18**
Permitted gross weight	18 t
Permitted top speed	60 km/h
Tare weight	4.4 t
Draught weight empty (T + 1A)	11.6 t
Draught weight loaded (T + 1A)	24.9 t
Draught weight empty (T + 2A)	15.9 t
Draught weight loaded (T + 2A)	41.6 t

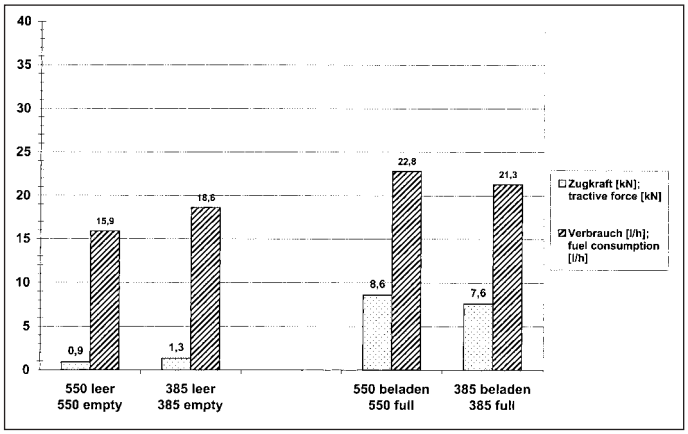

Fig. 1: Tractive power requirements and fuel consumption measured in the road section

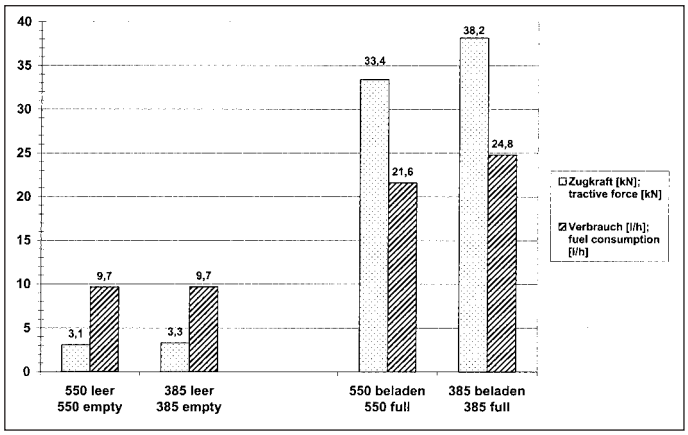

Fig. 2: Tractive power requirements and fuel consumption measured in the field section

dial tyres on the road are generally recognised as easier to pull. A closer look at the individual tyres and especially the tread form showed, however, that the low-pressure tyres had a rougher tread and, through this, despite greater width, represented less profile standing areas in unloaded condition. This should lead to less friction with the road surface and thus less draught requirement.

With loaded trailers the high-pressure tyres showed the lesser draught requirement. The reason for this is long- known and results from the lower tyre pressure of 3.8 bar compared with the high-pressure tyres' 9 bar.

The technically-caused average speed with empty trailers was 38 km/h and 26 km/h with loaded ones. Here, only insignificant differences were determined between the tyre types. The fuel consumption comparison in figure 1 shows that with low pressure tyres and empty trailers this averaged 15.9 l/h and with loaded ones 22.8 l/h. The average for the high-pressure tyres was 18.6 l/h and 21.3l/h respectively. This showed that fuel consumption with constant engine rpm runs in line with the draught requirements.

Field results

Figure 2 shows comparisons of draught requirements in the field journeys. With high pressure tyres the trailer requires on average 3.30 kN draught when empty at 9.2 km/h and the respective figures for the loaded trailer are 39.17 kN and 8.2 km/h. With low pressure tyres the appropriate figures are 3.08 kN at 9.2 km/h and 39.17 kN at 8.5 km/h respectively.

The lesser draught requirement for the low pressure tyres and loaded trailer could be explained through the larger tyre/ground contact area causing less sinking into the soil and thus less rolling resistance. The sinking depth of both tyre types on the undriven-on ground was 2 to 3 cm with loaded trailer and low-pressure tyres and 8 to 10 cm with the high pressure ones. This means a lower wall of soil was pushed before the low-pressure tyres when in forward motion.

The slightly less draught requirement with low pressure tyres and empty trailer compared with the high pressure tyres also could be explained through the different sinking depth of both types. Even with empty trailers, the high-pressure tyres caused tracking clearly leading to an increase in the draught requirement curve, whilst the low-pressure tyres with empty trailer left only lightly visible tracks.

When measuring the field journeys it was shown that during gear selection, draught requirement peaks on the tractor could rise to 60 kN.

The comparison of fuel consumption (fig. 2) gives an average with the high-pressure tyres of 9.69 l/h with empty trailer and 24.8 l/h with full. The respective figures for the low-pressure tyres are 9.65 l/h and 21.1 l/h. Here too it was shown once again that fuel consumption at constant engine rpm was in line with the draught requirements.

Table 2: Data of the tyres

High-pressure tyres	**385/65 R22.5**
Air pressure	9 bar
Tyre/ground contact area (unloaded)	442 cm^2
Low-pressure tyres	**550/45-22.5 16PR**
Air pressure	3.8 bar
Tyre/ground contact area (unloaded)	251 cm^2

Conclusions

As expected, the lower pressure tyres had the advantage over the high pressure ones on unsurfaced ground with regard to draught requirement and fuel consumption, the latter being 17.6% lower. On the road with loaded trailers these results were turned on their head. Here, the universal high-pressure tyres perform better than the specialised low pressure ones which resulted in a 6.6% higher fuel consumption.

The lower draught requirement of the low-pressure tyres with empty trailers on the road can be type-specific through the low total tyre/road surface contact of 251 cm^2 and is therefore not transferable to the low pressure of the tyres alone.

The decision between low and high pressure trailer tyres depends on the proportion of road travel and here the costs of the tyres and well as fuel have to be included in any calculations.

Literature

[1] *Hermann, A., P. Pickel und N. Fröba*: Transportgeschwindigkeiten von Traktoren. Landtechnik 55 (2000), H. 5, S. 338-339

[2] *Weise, G.*: Praktische Fahrleistungen landwirtschaftlicher Transportfahrzeuge. Landtechnik 55 (2000), H. 5, S. 340-341