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Tramline Depths in Cereal Crop Fields

In the vegetation period 2002 the plant mass on cereal crop fields in several farms in the region of East Germany was sensed. In addition to other parameters, the tram line depths were measured and recorded over a length of more than 140 km in 17 tests. On all fields most tram line depths were less than 5 cm, but in a few areas the maximum was more than 25 cm. During plant mass mapping in 2002 on 17 cereal crop fields on various farms in the New Federal States, the depth of the tramlines was measured technically and recorded, in addition to other variables. Of the depth measurements carried out over a length of 140 km, the fact that in all fields the biggest percentage of tramlines had a depth of less than 5 cm and only seldom were there depths of over 25 cm stood out.

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Keywords

Soil compaction, tram line depth, measuring method

If soil compaction exceeds a defined limit, structural damage is induced and depressions in plant growth can result. On much arable land it can be observed that tram lines caused by tyres are obviously areas highly exposed to the danger of soil compaction. To prevent high soil compaction during the sugar beet harvest, a sensor was developed at the FAL in Brunswick . Using a laser beam, the sensor measures the distance from a defined point on the sugar beet harvester to the soil surface and from this the tram line depth can be calculated [1]. Furthermore, manual methods were also used to measure the tramline depth in scientific investigations. This labour-intensive method substantially limits the area capacity so that insufficient data are available for confident values relating to tram line depths under practical conditions.

Material and methods

The sensor pendulum-meter developed at the Institute of Agricultural Engineering Bornim for indirect measurement of crop mass [2] was used for mapping in the vegetation season 2002 on about 1000 ha of farms in the region of East Germany. To prevent crop damage, a Hege tool carrier with a high ground clearance of 0.8 m was used for the driving platform. An important prerequisite for the measuring principle is to ensure that the pivot point of the pendulum body maintains a constant height over the soil surface. If there are already tram lines, or if tram lines are induced by the tool carrier, this can not be guaranteed without taking additional measures. Since both possibilities can not be excluded, and in fact are generally the rule, a special device had to be developed to compensate the tram line depth. A major requirement was that it should function well in established cereal crop populations too without any damaging effects.

The device developed consists of an angle-shaped sensor rod (1) which is arranged in a tube with gliding bushes (2) (Fig.). At the end of the tube two contactless inductive switches (3; 4) for steering the linear actuator (5) are mounted at a distance of about 25mm. Where there are no tram lines, the runner part of the sensor rod is immediately above the ground (zero-position) and therefore the top of the sensor rod is below the lower inductive switch (3). In the case of tram lines, the runner part of the sensor rod contacts the soil surface and the sensor rod moves upwards.

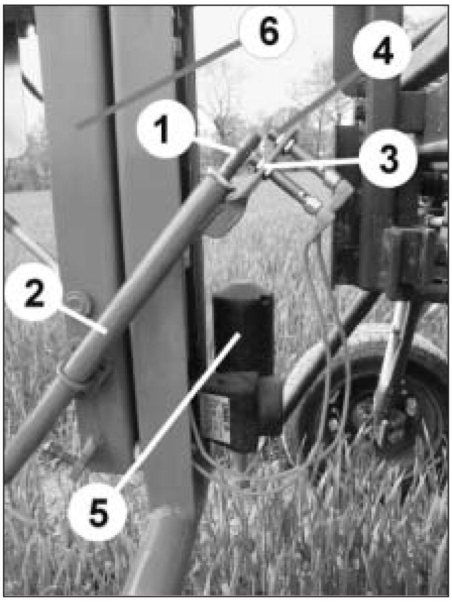

Fig. 1: Device for compensating and measuring the tramline depth

If the upper induction switch (4) is passed by the top of the sensor rod for more than 1 second, the installed linear actuator (5) pushes the movable part of the pendulum height adjusting unit (6) upwards with a velocity of 52 mm s^{-1}. This causes the inductive switches to move upwards also until the upper switch is released from the sensor rod.

In the case of constant tram line depth or reduced depth with a velocity of less than 52 mm s^{-1} the pendulum body is positioned exactly at this height.

In the case of tramline reduction (maximum to zero) with a speed higher than 52 mm s^{-1} , the top of the sensor rod falls under the level of the lower switch. The lowest position (tramline depth zero) is estimated by a dead position switch.

The linear actuator used, LA 30 from LINAK GmbH, Nidda, has a stroke of 300 mm and this can be measured by a potentiometer. Data recorded in a geo-referenced file are the technological prerequisite for mapping of tram line depth.

Measurement passages were performed along the tramlines over 140 km in 17 tests with winter wheat, winter barley, winter rye and triticale in several regions from Mecklenburg to Saxony. The results were more than 7200 suitable data sets. Every data set was calculated from 50 single measurements per second. Considering a tool carrier driving speed of about 7.2 km h^{-1}, this one second corresponds to a path of about 2 m.

Results

To allow comparison of the results obtained for all investigated cereal crop fields, six classes of tramline depth were defined, each 5 cm wide. Under the conditions prevailing in the years 2001/2002 the basic type of tramline depth distribution in the cereal crop fields was the same (*Table 1, Fig. 2*). The mean tram line depth over all measurements was 2.8 cm at the basic settings of the sensor. Here it should be noted that depending on the basic settings of the depth compensation unit, offsets in the centimetre range are possible. These small offsets only influence the results for critical ranges of large tram line depth marginally.

In all measurement passages the highest frequency was in the depth class from 0 to 5 cm (mean value 82.4 %; minimum 49.8%).

The measurements 1; 2 and 9 did not show tram line depths of more than 10 cm.

For most fields it can be observed that tram line depths of more than 15 cm are rather seldom, accounting for a share of 4.4 %. A clear exception is formed by measurements 5 and 11 with tram line depths in the range of 25 to 30 cm.

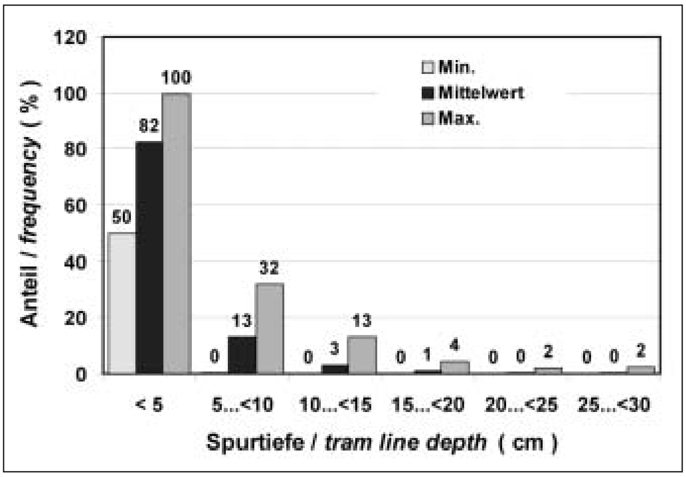

Fig. 2: Minimum, mean and maximum values for tramline depths

Conclusions

The measurement of tram line depths in cereal crop fields in the year 2002 show homologously that the most tram lines are less than 5 cm. Only a small share exceeded 25 cm. Current measurements under the conditions of the year 2003 will demonstrate whether these tendencies can be confirmed. Additional penetrometer measurements will be conducted to assess the consequences of deep tram lines on the soil structure.

Literature

[1] *Sommer, C., J. Brunotte und B. Ortmeier*: Bodenverdichtung - Felduntersuchungen zu Lösungsansätzen. ZUCKERRÜBE 2001, H. 6, S.364-371

[2] *Ehlert, D. und H. Domsch*: Sensor Pendulum-Meter in Field Tests. AGENG 2002, Budapest, paper number 02-PA-003

Measurement No.	Grain crop	Date	Number of measurements	Mean value cm
1	winter barley	May 5	6249	0,56
2*	winter barley	June 4	2432	0.96
3	winter wheat	June 11	3016	4,01
4	winter wheat	June 11	5065	3,47
5	Triticale	June 11	247	6,49
6	Triticale	June 18	2278	2,29
7	winter roe	June 21	4452	0,98
8	winter roe	June 21	2727	2,11
9	winter barley	June 25	2592	1,15
10	winter roe	June 26	2033	4,41
11	Triticale	July 5	3500	4,57
12	winter roe	July 6	6393	3,86
13	winter wheat	July 6	5648	2,77
14	winter wheat	July 13	5230	0,57
15	winter wheat	July 15	9849	2,22
16*	winter wheat	July 20	7128	1,85
17*	winter wheat	July 21	3469	4,81
total			**72208**	**2,77**

* no tillage

Table 1: Measurements of tram line depths in cereal crop field in 2002