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Comparison of different no-till seeding techniques

There are special seeders used in no till seeding systems, with different opener designs. Four different no till seeding systems where compared exemplarily. The target was to determine the effect of different seeding techniques on draught force requirement, working quality as well as crop specific parameters. Therefore, in growing season 2007/2008, a field study to winter wheat was conducted in Lüttewitz, Saxony. There were significant effects found in draught force requirements. The systems also differed in seeding depth quality and spatial distribution. The seeding system had no impact on grain yield in this study.

Keywords

No-till seeding techniques, winter wheat, draught force requirements, seeding depth, longitudinal seed distribution

Abstract

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Farming systems with total abdication of tillage achieved worldwide importance because of economical and ecological benefits [1]. To run this system well a holistic approach, including wide crop rotations, cover crops and new fertilizer management systems, is necessary. Here the seeder becomes the most important machine.

Experimental set-up

The experiment (~6.5 ha) was conducted on a Südzucker AG farm near Lüttewitz, Saxony. The winter wheat cultivar Hermann (TSW 50 g) was sown with a seed rate of 250 kernels m^{-2}. The experimental design was a randomized strip trial with four variants and five repetitions. The variants were four different commercial no-till seeders (**figure 1**) with different opener styles.

Materials and methods

The different opener styles, chisel opener, hoe tine opener, cross slot opener and single disc opener are shown in **figure 2**. The hoe tine opener creates an intensive soil disturbance in the seed row, therefore it can rather be seen as conservation tillage system.

Measurements in drought force requirement, seeding depth accuracy, longitudinal seed distribution and yield acquisition were conducted for all seeding systems. The results were statistically analyzed and compared. Forces were measured with a six-component draught measurement frame. The seeding depth was detected with a scraper and seeds per sample were counted. The longitudinal seed distribution was measured with a cable measurment system and the coefficient of variation was calculated. The yield measurements were done with a plot combine.

Results

Draught force requirement. To compare the results the draught force requirement was given in meter working width. The means and standard error for the draught force requirements [kN m^{-1}] are shown in **figure 3**.

The lowest draught forces were measured for the chisel 2.19 kN m^{-1} and single disc opener 2.17 kN m^{-1}. The required draughts for the hoe tine opener 5.7 kN m^{-1} was 2.5 as much as the chisel and single disc opener. The draught force requirements of the cross slot opener 9.09 kN m^{-1} was four times higher than the chisel and single disc opener. The average working speed during the experiment was 9.4 km h^{-1}.

For disc openers the draught forces depends mainly on the

Fig. 1

Engaged no-till seed drills (source Gall)

Tab. 1

Coefficients of variation for the longitudinal seed distribution of different seeding systems

	Chisle opener	*Hoe tine opener*	*Cross slot opener*	*Single disc opener*
VK [%] *CV [%]*	71	84*	84	89

** the data of the hoe tine opener are not comparable, because of band seeding.*

soil characteristics and the working depth [6]. Rather the thickness of the disc, and the angle to the driving direction as well as the shape of the cutting edge and the numbers of discs have an impact on the draught force requirements [7]. The working speed had just little impact on the draught force requirement [8]. The draught force requirements of tine openers mostly depend on shape and width of the tine, rake angle and working depth. In opposition to disc openers the draught force requirements for tine openers increase with increasing working speed [9].

With the cross slot opener the tooling-layout effects the draught force requirements. In this study both winged Bio-Blades were put on the opener. The disc was decelerated by the Bio-Blades, that's the reason why the discs typical low draught force requirement has been deregulated. Using this tooling-layout the draught forces increase with an increase in working speed [10]. By just using one Bio-Blade the working speed has just little impact on the draught force requirement. The data from the tine opener seed drill can be compared with a field cultivator of the same working width.

Seeding depth. For seeding depth quality evaluation the standard deviation [mm] was calculated as dimension unit of the variation to the mean. The results are shown in **figure 4**. The lower the value the more uniform is the seeding depth.

The parallelogram linkage as well as the near depth wheel placement permits a good surface adaption of the furrow opener. This results in low standard deviations of the chisel (7,4 mm), the cross slot (8,3 mm) and the single disc (7,7 mm) systems. The largest variation in seeding depth was found for the hoe tine opener (13,3 mm).

Longitudinal seed distribution. The coefficients of variation (cv) of the longitudinal seed distribution for the different seeding systems are shown in **table 1**.

For evaluation of the longitudinal seed distribution the cv were compared. The values ranged between 71 and 81 % and are evaluated as good till very good [11]. The results of the hoe tine opener must be seen apart from the others. Here the seed was distributed in a seed band. The measurements were just made lengthwise therefore the results don´t show the real spatial distribution of the plants.

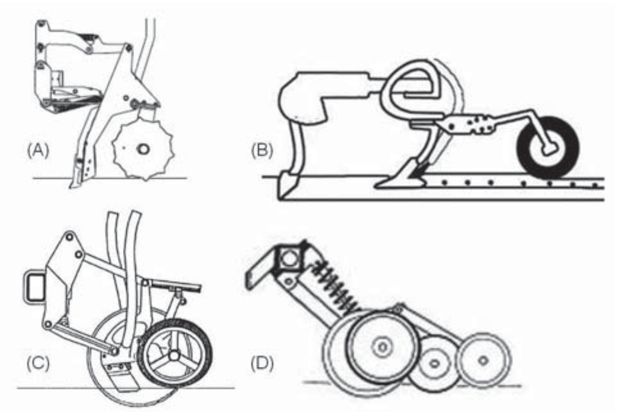
Grain yield. The results for the grain yield measurements are shown in **figure 5**. The mean grain yields ranged between 83,62 and 87,94 dt ha^{-1} and didn't differ significantly. The seeding system had no impact on grain yield in this study.

Conclusion

The *chisel opener* had comparatively low draught force requirement, an exact seed placement and a very good longitudinal seed distribution. To achieve an optimal quality of work a good residue management (short chaff and good lateral distribution) is necessary.

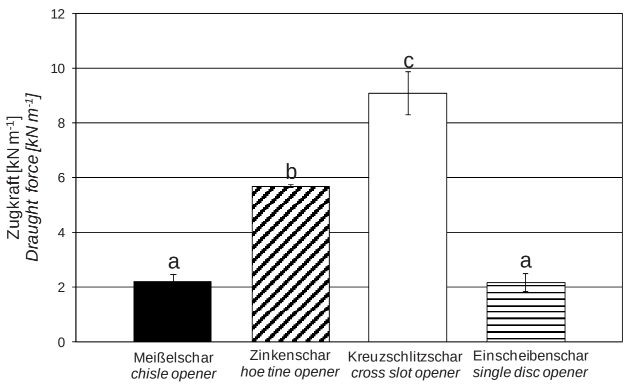
The *hoe tine opener* is classified to conservation tillage systems. The tool design as well as the draught force requirements is comparable to field cultivators with sweep or duck-foot tools. Because of band seeding an exact measurement of longitudinal

Fig. 2



(A) Chisel opener, (B) Hoe tine opener, (C) Cross slot opener, (D) Single disc opener, according to [2; 3; 4; 5]

Fig. 3



Draught force in kN m^{-1} working width, means and standard error, columns with different letters differ significant (t-test, p = 5%)

seed distribution was not possible. The seed depth quality was nonsatisfying.

The *cross slot opener* is a complex construction design and had the highest draught force requirement. This sophisticated technology is characterized by a precise seeding depth and a good longitudinal seed distribution. One opener can be ballasted with up to 500 kg. This seeding system promises to work well under heavy duty no till conditions.

The *single disc opener* is a simple and reliable technique with low draught force requirement and constant seeding depth. There are problems to close the seed row when seeding into wet soil conditions.

The seeding system had no impact on grain yield in this study.

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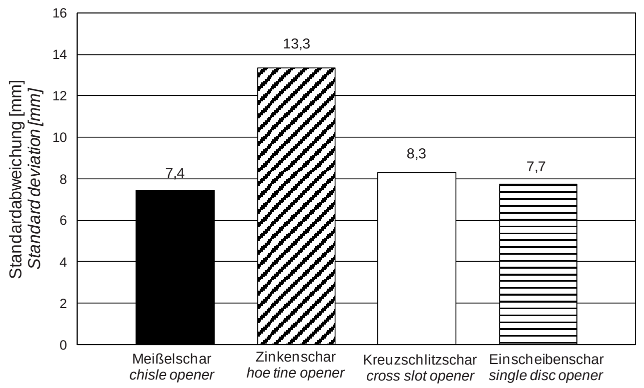
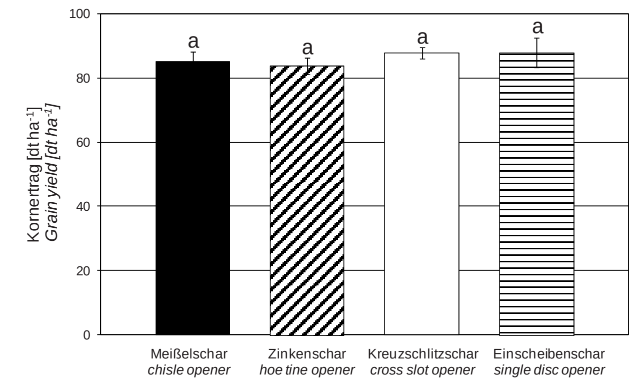
Fig. 4



Standard deviation of the seeding depth with different no-till seeding systems

Fig. 5



Grain yield [dt ha^{-1}], means and standard error, columns with different letters differ significant (t-test, p = 5%).