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Work quality of disc spreaders with variable dosing

Precise execution of a varying specified fertiliser dose on the basis of an application map is the precondition for a favourable yield with positive effects on farm economics and the environment. The disc spreaders common today were developed and optimised for a constant fertiliser application rate. For this reason the influence of variable quantity dosing on the quality of work of different disc spreaders was examined.

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The goal of applying fertilisers used to be to achieve the most uniform and even fertilising possible in a field. Site-specific fertilising completely changes this objective of fertiliser application. Instead, a variable and position-dependent quantity is to be applied. Bearing this fundamental change in mind, this paper examines what influence such variable quantity dosing has on the quality of work of the spreader, and whether the quality is comparable with results achieved to date using constant dosing.

Setting parameters

In order to set a disc spreader, several setting parameters are generally modified before work starts to assure adaptation to the quantity dosed, the material properties and the concentration of the fertiliser, the working width and the height of the crop. In field work with variable fertiliser dose rates, however, it is often only the dosing lever for quantity control which is altered, while all the other setting parameters remain unchanged. This is remarkable, especially since according to the manufacturer's setting recommendations for different product quantities, it is generally necessary to alter several parameters.

This inadequate adaptation of the setting parameters frequently results in unsatisfactory and non-stable spread patterns during fertiliser application. Depending on the spreader type and the nature of the fertiliser, the sensitivity of the spread characteristics differs by comparison with the quantity dosed. Since the distribution quality depends on the spread pattern, the quality of work is influenced in line with differences between the target and actual quantities.

Disc spreaders examined

There are two operating principles for disc spreaders with two spreader discs: the centreline and the off-centreline-spreaders. In the centreline types the discs rotate from the outside to the inside – viewed in the direction of travel – and thus achieve overlapping of the quantities from the individual discs of 70 to 90%. The off-centreline-spreaders only achieve an overlap of 20 to 40%, since here the discs rotate from the inside to the outside.

The different directions of rotation and mutual overlap result in an influence on the spread characteristic for a certain dose and type of fertiliser. Due to the greater overlap of the spread patterns of the individual discs, certain advantages are attributed to centreline spreaders.

Due to the lower overlap of the individual discs, the discs of the off-centreline-spreaders can be switched separately, so that the two halves of the spread width can be dosed individually. Since local application quantities of disc spreaders always result at least from a simple overlap of the spreading widths, this dosing option remains questionable as regards the quality of distribution.

The spreading tests were carried out with four different mounted disc spreaders. *Table 1* shows an overview of the most important type-related differences.

Requirements made of the distribution quality in variable dosing

The most important task of the fertiliser

Table 1: Main design parameters of investigated disc spreaders

Spreader	Type	Distribution flanges	Setting point	Position
A	Off-Centreline	fixed	manual adjustable	horizontal
B	Centreline	exchangeable	automatic with dosing rate	according to operating instructions
C	Off-Centreline	adjustable operating instructions	fixed	horizontal
D	Centreline	fixed	fixed	according to operating instructions

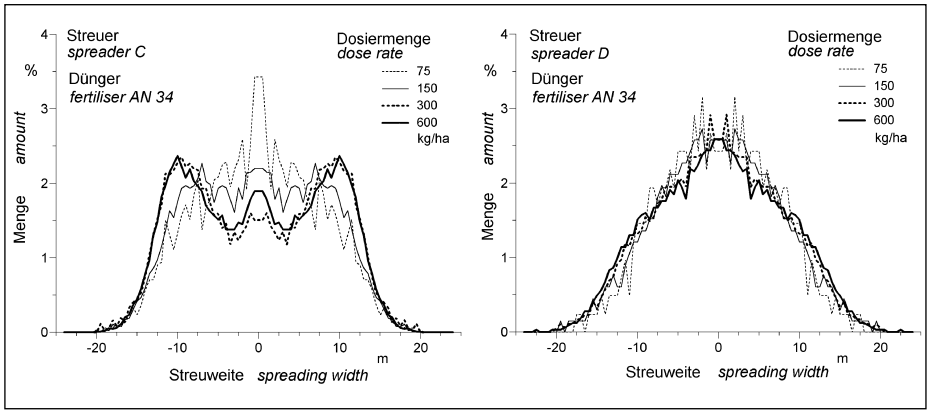

Fig. 1: Changes of spread patterns for an off-centreline and centreline spreader (spreader C + D) and AN 34

spreaders is to apply the fertiliser exactly [1]. A distinction is made between dosing and distribution quality, since the dosed quantity can be correct, while the distribution is often unsatisfactory. A variety of investigations have documented that uneven fertiliser distribution can lead to yield losses [2, 3]. Although the investigations were conducted with constant-rate fertilising, everything indicates that even in the case of variable dosing the mapped doses recommended by plant experts can be implemented exactly. This means that the deviations between the mapped, variable target quantities and the actual quantities applied must be as slight as possible.

The application map prepared for variable fertilising of a field assumes the function of target quantity specifier during spreading. Since the spreader vehicle is tied to a fixed tramline system, which is used for all care and cultivating measures, there are frequently different target quantities crossways towards the neighbouring tramlines. Since leap functions, in other words a strong rise or fall of the fertiliser quantity within a short distance (1 to 2 m), are not expedient from plant-cropping and soil-science points of view, distributions which allow a constant and linear transition between the target values are desirable between the tramlines. This has already been recommended by various authors [4, 5, 6, 7, 8].

In order to achieve this goal the spread pattern characteristic can be defined precisely. It has the form of a triangle and should result in only simple overlapping for the desired working width. Linear transitions between tramlines with differing doses can only be assured with such a spread pattern, which in turn presupposes that such a triangular distribution is independent of the dose.

The deviation of such a triangular distribution can be considered in order to describe the quality of the transverse distribution and suitability of the spreader for site-specific fertilising.

Test procedure and setting the spreaders

The spreading tests and measurements were carried out at the Research Centre Bygholm in Horsens, Denmark. The spreading hall has an area of 3400 m^2 and allows testing of spreaders with a spreading width of up to 56 m. The spreader tests are carried out in accordance with the CEN standard (TC144/WG3/N167 in draft).

The spreaders were set in accordance with the operating instructions for a spread quantity of 300 kg/hectare. With this setting, quantities of 75, 150 and 600 kg/hectare were also spread and the quality of the work was determined.

Results

The spread pattern changes as a result of quantity variations for two spreaders are shown as an example in *figure 1*. Spreader C shows great sensitivity to changes in dose, since the spread pattern at 75 kg/hectare almost corresponds to a triangle, and in the other doses very different spread pattern characteristics result. The triangle form desired with the expected good distribution quality can therefore only be achieved with the lowest dose. In the case of spreader D and the same type of fertiliser, the spread pattern is largely independent of the quantity spread and thus shows substantially more stable behaviour. In addition, on the basis of the triangular form of the spread pattern, a much better distribution quality can be achieved with this spreader.

In *figure 2* the results are shown with all fertiliser types as a function of the dose for spreaders C and D. The results show that spreader D reacts much less sensitively to changes in fertiliser type and shows altogether the lowest deviations from the ideal triangular distribution.

Of the four disc spreaders examined, the two centreline types show altogether better spreading results, which can result from a positive effect from the larger overlap of the individual disc quantities. The further results of all spreaders can be taken from [7, 8].

In the case of centreline spreaders, however, there may also be a double overlapping triangular distribution when well-granulated fertilisers are used. In the case of variable dosing this leads to a situation in which the desired dose is frequently either not achieved or exceeded in the middle of the tramline. That is why the desired ideal spread pattern is a triangular distribution with simple overlap. Investigations have shown that there are clear differences regarding the application fault between spread pattern types such as rectangular and triangular distributions, in other words differences between the applied actual quantity and the mapped target quantity [4, 5, 6]. The triangular distribution with a simple overlap showed the least faults, since the application maps are implemented best with this.

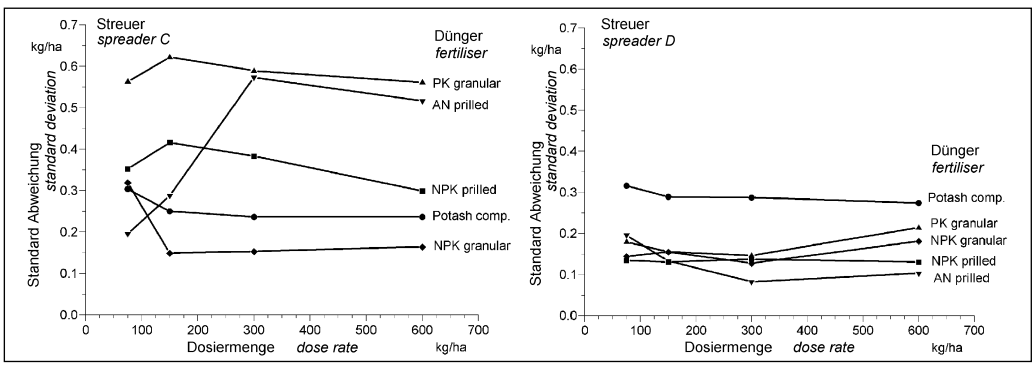

Fig. 2: Standard deviation versus dose rate for an off-centreline and centreline spreader (spreader C + D) and different fertilisers