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Mineral Fertilising on Field Borders

Centrifugal fertiliser spreaders are preferred for mineral fertilising. Special border spreading devices are required to reduce the overlapping zones of the spread fan. In this way optimal spreading at field borders is possible. The standard EN 13739-I/II stipulates the criteria which have to be fulfilled for spreading at field borders. Various technical solutions for border spreading devices exist. They differ regarding distribution quality, comfort and price. New developments make it possible to automatically actuate the border spreading device, combined with optimal overlapping at the headlands.

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Keywords

Centrifugal fertiliser spreaders, boundary and field-edge devices

Literature

Literature references can be called up under LT 06111 via internet http://www.landwirtschaftsverlag.com/landtech/local/literatur.htm.

In Europe for mineral fertilising centrifugal spreaders and pneumatic spreaders are used. The centrifugal spreaders have a market share of more than 90 %. The spread fan of the pneumatic spreader has a strip shape and composes of many individual spread fans - similar to nozzles of the field sprayer. The individual spread fans allow for switching off in sections. In this way the accurate spreading of mineral fertiliser at the field's border is simply done. Centrifugal fertiliser spreaders mainly consist of two metering units and two spreading discs. Both spreading discs accelerate the mineral fertiliser in such a way that two individual spread fans are created which overlap in the centre range of the machine and which again spread to the sides so that when driving to and fro overlapping zones are created in the tramlines. The realisation of border spreading requires border spreading devices, which restrict these overlapping zones.

Different fertiliser strategies at the field's border

Centrifugal fertiliser spreaders operate with large overlapping zones to achieve an optimum lateral distribution in the field, even with varying fertiliser quality and driving errors. However, at the field's borders this large spreading width is not desired. Due to the design a compromise between environmental protection and optimum yield must be found.

At border spreading the setting strictly follows the guidelines of the fertiliser ordinance [1]. The fertiliser is spread up to the field's border as accurately as possible, however by no means beyond the border. An internationally usual term for this procedure is environmental optimised spreading (EOS). In the setting, an underfertilisation at the field's border is deliberately accepted requiring a reduction of the application rate.

For edge spreading the machine is set in such a way that the underfertilisation at the field's border is avoided as far as possible. The fertilising strategy, which is designed for optimum yield, is internationally called yield optimised spreading (YOS). However this machine adjustment is only allowed where the fertiliser will not do any harm to adjacent areas.

Evaluation criteria for border and edge spreading according to standards

With the standard EN13739-I/II [2,3] a uniform job profile regarding environmental protection has been stipulated in Europe. The standardised checking and evaluation procedures allow the realisation of reproducible comparison tests [4]. Within these standards, among others, generally known test methods for the evaluation of lateral and longitudinal distribution, handling, etc. have been outlined. Completely new are the demands and evaluation procedures for border and edge spreading described in the standards. The complex conditions at the field's borders, however, do not allow the reduction of the evaluation to only one criterion, as, for example, the coefficient of variation for the lateral distribution.

Apart from the loss of fertiliser at the field's border also overfertilisation at the edge strip and the lateral distribution for the transition strip is valuated. The following criterions are valid:
1. The loss of fertiliser in the range between

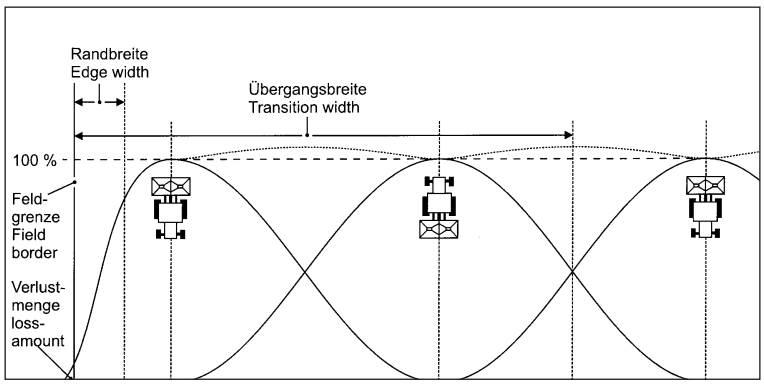

Fig. 1: Scheme of spreading pattern

the fertiliser limit and the border must be less than 3‰. Here the quantity spread beyond the border line at a length of 100m is projected and related to the quantity spread in a field with a size of 1 hectare.
2. Within the edge strip (5m) the spread rate must nowhere exceed the average spread rate by more than 20 %.
3. The coefficient for the transition strip must not exceed 25 %.

Figure 1 illustrates the schematised spread pattern in which the three zones to be valuated are indicated.

At the evaluation of border and edge spread patterns these three criteria receive a different assessment. At border spreading it has to be observed that no fertiliser is spread beyond the field's border in adjacent waters or areas. Here the criterion loss of quantity is of relative high importance. Therefore, the farmer accepts a strip at the field's border where not the full fertiliser rate is spread and where the yield will be accordingly smaller. At edge spreading one aims at the full fertiliser rate up to the field's border. The criterion distribution within the edge strip is of relatively high importance. In this case the application of slight amounts of fertilisers onto the neighbouring area is accepted.

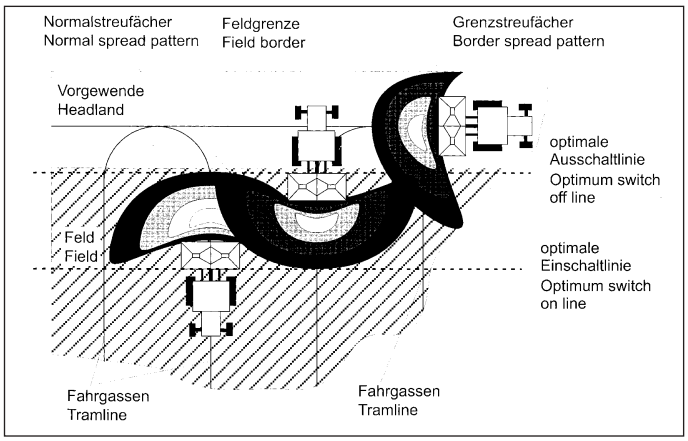

Fig. 3: Schematic representation of three dimensional spread pattern at the headland

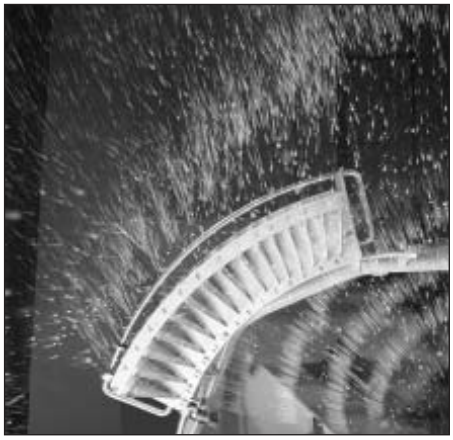

Fig. 2: Deflected spread fan in the boundary area

Technologies for border and edge spreading

Border and edge spreading can be carried out by placing the first tramline right at the field's border or with half the bout width. The tramline directly at the field's border requires the half side of the spreader shut off and the reduction of the inner overlapping zone of the spreading unit being switched on. This is done with the aid of a centrally placed spread deflector. In practice, this procedure is hardly used any more, as this requires the one side boom folding at the following crop protection measures. The current method is border and edge spreading with half bout width. For this procedure many new border spreading devices have been put on the market during the last four years (*Table 1*). Here, preferably the comfortable handling from the tractor seat is given special emphasize. Spread deflectors which can be controlled from the tractor seat, for example, controls the deflection of the spread fan within the border range. The relevant spread pattern is shown in *Figure 2*. Meeting the limits outlined in the standards requires the reduction of the application rate at the border side. This can simply be automated with the aid of a setting motor which is accessed from the on-board computer. Hydraulically driven spreaders allow the very comfortable and accurate border spreading. Here the disc rev. speed of the spreader unit at the border side is reduced and automatically the application rate is optimally adjusted. This border spreading procedure allows easily matching with changing border distances and to react flexibly to ecologically sensible borders (e.g. waters). The control is carried out via the key pad of the on board computer.

Boundary and field-edge spreading device	Control from tractor cab	Engageable during application	Quality of operation	Cost
1 st tramline: 1/2 tramlining spacing from field's boundary				
Spreading disc	no	no	++	+
Adjustable spreading vanes	no	no	++	++
Spreading deflector	yes	yes	+	o
Tilting the fertiliser broadcaster	yes	yes	o	o
Cange of feed-on-point	yes	yes	o	o
One sided reduction of disc speed (hydraulically)	yes	yes	++	-
One sided change of spinning sense of the spreading discs (mechanically)	yes	no	+	o

Table 1: Equipment for environmentally- and yield optimised border-spreading

Automated switching procedures at the headlands

The spread fan of a centrifugal spreader features a three dimensional expansion - it extends almost semicircular to the rear. When driving to and fro in the field this is unproblematic, the mutually overlapping spread fans sum up to a uniform application rate. More difficult are the conditions at the headlands. Here, not only the spread fans of the spreader driving to and fro overlap but also the border spread fan created diagonal across the direction of driving (*Fig. 3*). Due to the selected adjustment of the border spreading device this might quite well have also at the field side an other characteristic than the normal spread fan [5].

The optimum points for switching the fertiliser spreader on and off can only be determined, if detailed information about the three dimensional expansion of the normal but also of the border spread fan are known. For this, information about the fertiliser specific spread fans have to be stored in the on-board computer. With the aid of a GPS location it is possible to optimally carry out the border spreading procedure. Additionally at the headlands the switching on and off positions in the field for the driving to and fro of the spreader are determined in such a way that the overlapping with the border spread fan results in an optimum distribution. The switching procedures for the metering and border spreading device are carried out fully automatic by the on-board computer. Compared with pneumatic spreaders this system allows the creation of smooth transitions with the aid of overlapping spread fans, also at the headlands. Metering errors which would result in damage at the headlands, for example lodge grain or nutrients leaching into the ground water, are thus avoided.