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Precise application of nitrogen

Spatially-specific nitrogen fertilising according to site-specific parameters

Five different fertilising strategies were applied to a field in Saxony in 2000. Through spatially-specific metering on the basis of the HERMES model, a saving in fertiliser of around 40 kg/ha compared with conventional fertilising strategies was possible with no yield or protein penalties able to be determined. Nmin soil content sampling at the same time indicated no uniform picture regarding the effect of the dunging strategies.

Spatially-specific Nr. fertilising presents a practical possibility of reacting to differences in the growing crop whereby two components must be considered: the technical possibilities of site-specific Nr. application and the decision process regarding the amount of Nr. to be applied on each area.

This was a starting point for the research project MOSAIK with participants Südzucker AG, Amazonen Werke, Agrocom, the Centre for Agricultural Countryside and Land Utilisation Research (ZALF) and the Agricultural Engineering Institute Bornim (ATB). In the following, special attention will be given to the decision process regarding Nr. application.

Trial method

The trial featuring spatially-specific fertilising was conducted on Südzucker AG's Gut Lüttewitz, in the „Lommatzscher Pflege" region of Saxony. The field chosen for the trial, „Sportkomplex", covers around 30 ha.

Laid on the field was a fertilising grid with 8 • 8, i.e. 64, plots. The grid plots measured 54 by 54 m with a sampling point in the middle of each.

Fertilising was with 27% Nr. calcium-ammonium-nitrate (KAS) applied by an Amazone ZA-M Max centrifugal fertiliser spreader and application amount was measured by LBS compatible job computer controlled via an Agrocom ACT.

In 2000, fertilising took place on three dates April 6 and 27 and May 16 with a total five different fertilising strategies tested on the "Sportkomplex" field:

1) Zero variant (eight plots) with no fertiliser applied at any of the dates
2) LUFA/sensor variant (eight plots): first Nr. application according to the LUFA recommendation in Saxony, second and third applications according to Hydro-N sensor. Firstly the Nr. fertilising recommendations of the Hydro-N sensor were ascertained individually from the eight plots. An average value was calculated and fertiliser applied accordingly.
3) The N-model variant with fertiliser applied according to the Nr. simulation model HERMES [1]. Used for the simulation was the N_{min} content of the previous year. An average value over the field was determined for the eight plots of the variant „N-model MW". This was conducted for each of the three fertiliser applications.
4) The „N-model MW + 30%" increased the recommendations of variant 3 by 30%.
5) On 32 plots fertiliser applications were determined by the HERMES model but with the requirements of each plot individually measured, i.e. spatially-specifically. This applied to all three applications.

Accompanying investigations noted the N_{min} content [2] in the soil.

Soil samples were taken before fertiliser applications, with the N_{min} content down to

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Keywords

Fertiliser strategies, site-specific fertiliser application

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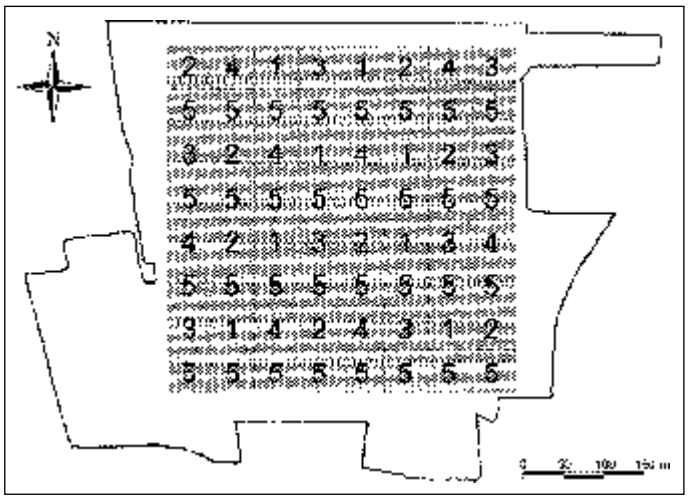

Fig. 1: The field „Sportkmplex" with the distribution of the grids and their fertiliser strategies

Fertilising strategy	1.	2. Date	3.	Total amount [kg N/ha]
1	0	0	0	0
2	70	64	45	179
		(49...79)	(35...53)	154...195)
3	25	65	46	136
4	33	85	60	178
5	26	67	46	139
	(15...30)	(40...70)	(20...57)	(75...157)

Table 1: Overview about the sharing of the fertiliser application (mean and range [kg N/ha])

Fertilising strategy	Average yield (t/ha)	Yield range (t/ha)
1	5,4	2,0..8,7
2	8,1	7,3..8,9
3	8,0	6,6..8,9
4	8,2	7,7..8,8
5	8,0	5,3..9,3

Table 2: Yield in the year 2000 on field „Sportkomplex"

Table 3: Protein content in the year 2000 on field „Sportkomplex"

Fertilising-strategy	Average protein content %	Range %
1	11,5	10,2..13,8
2	14,2	11,6..15,5
3	14,2	12,9..15,1
4	14,4	12,2..15,5
5	14,0	12,5..15,3

Table 4: Mean and range of soil nitrogen content [kg/ha] of the various fertiliser strategies

Fertilising strategy	-	1.	2. Date	3.
1		37,3	27,6	13,4
		(13,1..52,3)	(22,1..31,7)	(10,6..15,7)
2		62,8	60,4	83,1
		(27,9..110,5)	(29,6..99,9)	(24,7..126,9)
3		40,3	35,6	40,2
		(21,6..70,1)	(25,0..62,4)	(19,0..36,2)
4		32,7	33,5	26,4
		(16,1..46,3)	(26,5..39,1)	(19,0..36,2)
5		43,6	36,6	45,1
		(28,2..59,8)	(21,0..52,2)	(20,8..95,9)

90 cm depth determined in spring for all three dates from 22 selected points.

To determine the effect of the Nr. fertilising on grain quality, hand samples were taken at harvest from all 64 plots and tested for protein content.

A Claas yield measuring system (CEBIS) was used for yield recording with the yield for each of the 64 plots calculated via a special algorithm [3].

Results and discussion

Table 1 shows the results of the fertilising. Noticeable here is the range widths of the second fertilising strategy LUFA/sensor in the second and third application date. These can be traced to the most different crop developments. Despite the uniformly high first fertiliser application of 70 kg N/ha the Hydro-N sensor differentiated between the plots and gave fertilising recommendations of up to 79 kg/ha for the second and up to 53 kg/ha for the third application.

In the fertilising strategies 3, 4 and 5 the HERMES model started with a cautious first application of Nr. and then put the priority on the second and third dates.

In comparison to the fertilising strategy LUFA/sensor (strategy 2) the spatially-differentiated application according to HERMES model (strategy 5) allowed an average 40 kg N/ha to be spared.

These savings must naturally be regarded to the background of the targeted yield and quality. In *table 2* the distribution of yield on the Sportkomplex field is presented according to the fertilising strategy.

As shown in *table 2* the yield of fertilising strategy 1 (zero fertilising) was significantly lower than the yield of the other four strategies. Simultaneously, the wide range of yields was noticeable. Especially in the southern part of the field, the yields of the zero plots were just as high as the fertilised variants. On one hand this could be explained through the field topography which was run through by a gully in the southern area through which leaching from the fertilised plots to the zero plots was possible. On the other hand, this could be evidence of high Nr. content already present in the soil.

A further important aspect was the quality of the harvested winter wheat. Alongside yield *(table 2)* this played an equally important role.

The picture depicted was similar to that of yield. Samples from variant 1 (zero fertilising) showed a significantly lower protein content than those from the other four variants *(table 3)* which indicated a similarly-high protein content of around 14%.

The measurement of soil Nr. content during vegetation indicated no uniform picture. Only the soil Nr. content (N_{min} value) of the zero plots reduced during the vegetation period. Tendentially, the N_{min} values in strategy 2 (LUFA/sensor) were higher than the others *(table 4)*.

In summary it can be determined that through applying the HERMES model fertiliser savings of around 40 kg/ha are possible without quality and yield penalties. The technology used for spatially-specific Nr. application no longer caused difficulties.

Literature

[1] *Kersebaum, K.C.*: Application of a simple management model to simulate water and nitrogen dynamics. Ecological Modelling 81(1995), S. 145 – 156

[2] *Wehrmann, J., J. Wollring, H. C. Scharpf, H. D. Molitor und M. Böhmer*: Praktische Erfahrung und neue Ergebnisse mit der N_{min}-Methode. DLG-Mitteilungen 94 (1979), H. 2, S. 67-70

[3] Jürschik, P., A. Giebel und O. Wendroth: Processing of point data from combine harvesters for precision farming. Proceedings Precision Agriculture 1999, Odense/Dk, 1999, S. 297 - 307