Peter Treue, Kiel

Yields and Nr. applications after several years of site specific management

The effects of site specific production techniques were investigated under practical conditions in fields of around 30 ha in Kiel. Arable farming results were presented from a wheat/barley/oilseed rape rotation. Firstly, spatial relief-linked yield potential was defined (Griepentrog, according to ridge, hollow, slope, level) and later in the process of the project this was more intensely specified in conjunction with advisory input, crop production and soil science.

Dipl.-Geology Peter Treue is a member of the scientific staff at the Chair of Crop Production and Plant Breeding of the CAU (H.-Rodewald-Str. 6, 24118 Kiel; e-mail: *ptreue@pflanzenbau.uni-kiel.de*) and was concerned in a project on site specific plant production in Schleswig-Holstein (director: Prof. Dr. Edmund Isensee, Institute for Agricultural Procedural Technology, CAU, Max-Eyth-Str. 5, 24118 Kiel, e-mail: *landtechnik@ilv.uni-kiel.de*)

Keywords

Site-specific technology, fertiliser application, yield

The fertiliser variants were laid out within tramline systems of 2 • 24 m (*fig. 1*). Amount of Nr. applied was determined following inspection by the advisor or according to the prognosis model N-prog. In each case there were also plots with increased and reduced Nr. applications. Utilised in this programme along with yield mapping were soil testing, plant sampling and, since 1999, air content analyses.

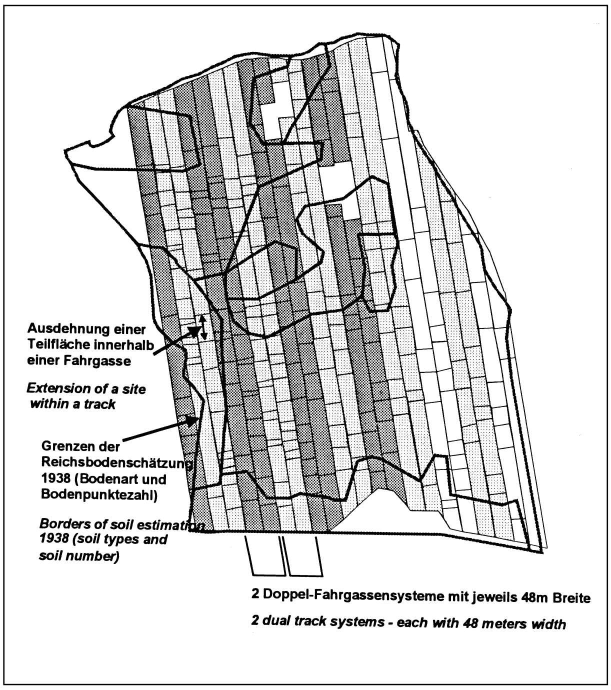

Fig. 1: Design of system experiments in a field

Site specific definition

The principle of defining spatial areas according to relief – ridge, hollow, slope and level – is grounded on the association of such elements with important soil characteristics. In 1997, 32 ha of winter wheat on the farm were site-specifically fertilised according to the relief aspects. Yield remained relatively similar on these four areas, Nr. applications of the first yield-influencing dressing were reduced. The N-reduction in the hollow areas, even in the farm-conventional variants, did not have a yield reducing effect. The N_{min}- content in the humus-rich colluvial hollows was sufficient for a high yield. Overall soil sampling confirmed that, in general, high N_{min}-amounts, compared with the average over the year, were present after the 1996 harvest. The following dry and cold winter limited any further leaching giving high levels of available Nr. at vegetation start in spring 1997.

However, individual spatial yields still considerably even in areas defined as similar (*table 1*).

Thus, in the following year (1998 w-barley) the programme was extended to include the variant N-PROG. The regression model N-Prog from Schoop and Hanus uses historical data for yield prognosis. Optimum Nr. dressings were thus estimated on the basis of soil type, soil quality points, weather, variety and rotation parameters.

Table 1: Winter wheat 1997 - application rates, yields in the part fieldsas average and extreme values (N3 and N4 with 100 to 110 kg/N/ha)

		Farm-conventional	Relief	Farm-conventional Min.	Farm-conventional Max.	Relief Min.	Relief Max.
Level	Yield [dt/ha]	107,8	105,0	77,9	141,1	85,9	134,0
	N1+N2 [kg/ha]	75,0	55,0				
Slope	Yield [dt/ha]	106,2	104,8	75,6	128,9	80,8	123,8
	N1+N2 [kg/ha]	75,0	55,0				
Ridge	Yield [dt/ha]	100,6	96,5	88,1	128,5	82,9	107,9
	N1+N2 [kg/ha]	75,0	65,0				
Hollow	Yield [dt/ha]	109,0	104,7	87,6	122,5	91,2	115,1
	N1+N2 [kg/ha]	0,0	0,0				

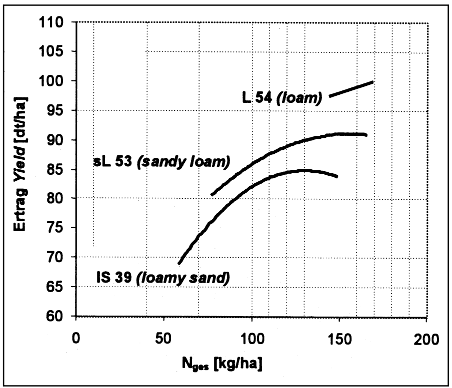

Fig. 2: Winter barley 1998: Yield functions according to soil type/soil quality

In 1998 fertiliser dressings were in general a little lower on the relief-based spatial areas compared with farm-conventional dressings without yield being reduced. In contrast to the previous year the hollows received an Nr. dressing because late mineralisation was expected and a wet autumn/winter had led to leaching.

Generally more Nr. was applied in the N-PROG variant without, however, achieving yield increase on all the previously defined spatial areas: the spatial definition according to soil type and ground points overlooking, in this form, small-area heterogeneities of surface characteristics. On the other hand, wide ranges in yields were in general produced by the individual areas. The extent to which yield functions can be determined was investigated. For this purpose, data from yields and applied amounts of Nr. according to soil type were selected and separately evaluated (*fig. 2*). While the optimum was already reached by 120 kgN/ha on sandy loam (39 points), on 54-point loam yield was still sub-optimal with 150 kg N/ha.

Persistent areas

Further spatial differentiating occurred in 1999 using previous yield mapping and computer-processed aerial photographs delivering important data on plant density of rape following w-wheat.

The trial field included a certain proportion of yield persistent areas, linked to certain types of soil and topographical characteristics, indicating with high probability and to a large extent independently from relevant parameters, relatively high or low yields within the total area. This „historical“ information can be applied along with actual crop information. Thus, there are specific areas with different yield potentials.

On the one half Zenith oilseed rape was grown and fertilised according to the now extended prognosis model N-PROG. The fertilising of the other half (Express rape) was according to the relief principle and advisor input.

On the N-PROG variants areas with historically high yield potential and showing dense plant density in spring according to aerial photographs received more fertiliser. In the RELIEF variants areas with assumed high remainder-N (hollows) received less fertiliser compared to those with assumed reduced yield potential (ridges).

One sees in the results (*fig. 3*) that both variants react differently to an increase in Nr. application. In the N-PROG variants, an increase of 100 kg/ha led to a yield increase of around 6 dt/ha, compared with 2.5 dt/ha from the RELIEF variants. Here, the differing distribution of the adjusted Nr. fertilisation seemed to have an effect. The absolute difference of 5 dt/ha reflected the varietal difference in 1999.

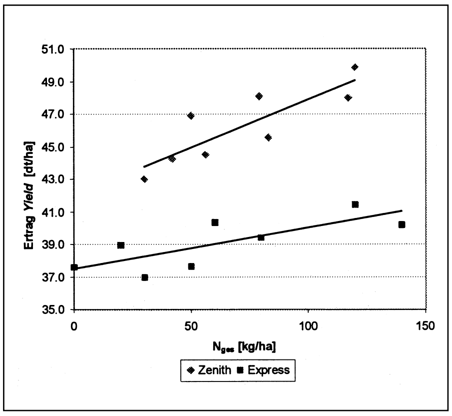

Fig. 3: Winter canola 1998: Cultivar effects of N-fertilization

The continuation of the practice in 2000 led to results regarding the definition of spatial areas and their management. The aerial photograph analyses were applied in association with soil sampling and yield maps from the previous year. On large area portions there was agreement on yield potential over several years. From 2000 the sensor from the Institute for Agricultural Procedural Technology was also applied. This defined N-applications according to an individual calibration system (Landtechnik 4/2001, p. 278).

Yields from the system differed only slightly in 2000. In own soil-based variants, the second Nr. application was in part greatly reduced on areas with higher N_1-application. This did not generally have the wished-for success.

Summary

The overview of four years (*table 3*) enables optimising potential to be recognised and this can be seen on the system total yields. However the chance of increasing the yield on good soil is still not fully exploited.

		Farm-conventional	NPROG	Relief
Level	Yield [dt/ha]	87,1	88,9	84,1
	N_{ges} [kg/ha]	140,0	155,0	130,0
Slope	Yield [dt/ha]	83,4	87,7	86,5
	N_{ges} [kg/ha]	140,0	155,8	140,0
Ridge	Yield [dt/ha]	82,2	82,4	83,0
	N_{ges} [kg/ha]	140,0	165,7	110,0
Hollow	Yield [dt/ha]	78,4	95,6	76,7
	N_{ges} [kg/ha]	46,0	157,5	

Table 2: Winter barley 1998: N amount and yields on spatial sites (including 21 kg N/ha)

Table 3: Yield of the total field, whose part fields were differently fertilised

Fertiliser	1997 W-wheat kg N/ha	dt/ha	1998 W-barley kg N/ha	dt/ha	1999 W-rape kg N/ha	dt/ha	Variants	2000 kg N/ha	dt/ha
Farm-conventional	196	110	161	83	199	42		237	97
Site-specific	164	105	129	83	211	41		191	92
Spatially reduced	135	107	97	85	173	43	NPROG	230	101
Spatially increased			152	90	221	42	Sensor	188	94