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Influences on Protein Content and Grain Yield

Knowing parameters which affect yield and protein content - to use them for an optimisation - is the main interest of agricultural production. The use of new cultivation forms like precision agriculture gives a chance to obtain this in practice. Several factors determine protein content and yield level of plants. Constant - non site specific - management leads to an soil affected heterogeneity in plant growth, which is also influenced by climate. Precise, site specific applications - especially the N-fertilisation - provide for a better use of nutrients and a better nutrient balance in the soil. This could be demonstrated by many trials in different departments of science and practice [1].

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Keywords

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Influencing factors on protein and yield are genetic potential, sowing density and mostly the soil-heterogeneity and N-fertilisation. In the following, some characteristic effects should be clarified, at first the soil. The soil influence is not constant. Fortuitous events like the weather can work in one year positively and in the next year negatively, due to the heterogeneity of the location. Therefore a spatial attention at the department is on the information about the sub-field heterogeneity [2]. There are different possibilities to get this information: for instance the German soil taxation, field observations and the new indirect electromagnetic conductivity measurements, like EM 38 [3].

For a comparability of EM 38 measurements at different locations and measuring dates, a relative consideration of the conductivity is necessary. For this the measured values are divided in classes (A to E), every class covers a same measuring interval. Class A has always the smallest and class E the highest measured electrical conductivity, which correlates with the soil quality (clay content).

The data show that the yield increases with the electrical conductivity, measured in mS/m. However the dispersion of the measured values decreases. The measured values in the classes (A to E) show different processes with the regression analysis. Particularly class A with the smallest EM 38 value reveals a high correlation between yield and conductivity. The yield rises, with uniform fertilisation by around 32 dt/ha. In the classes B to E this effect cannot be seen. These soil- effects on the level of protein and yield are to become balanced by an adapted fertilisation. Above all, the N- fertilisation, which can be different on the growth stage, application date and the kind of application. The modern controlling of the online fertilisation with the N-Sensor offers new possibilities in measuring differences in the growth development and to react to them. This reaction depends on the growth stage and can be varied. At first, the small and thin plants can get more nitrogen or the strategy can be opposite, which means the good developed plants get more nitrogen for their growth, this decision depends on the in field calibration.

This working functions are shown in *Figure 2*. The N2 and N3 functions are focused on yield production, the N4 is for the quality production (reversed function).

The fertilisation was sitespecificically adapted by using the N-Sensor to measure the current N- status of the plants. Two algo-

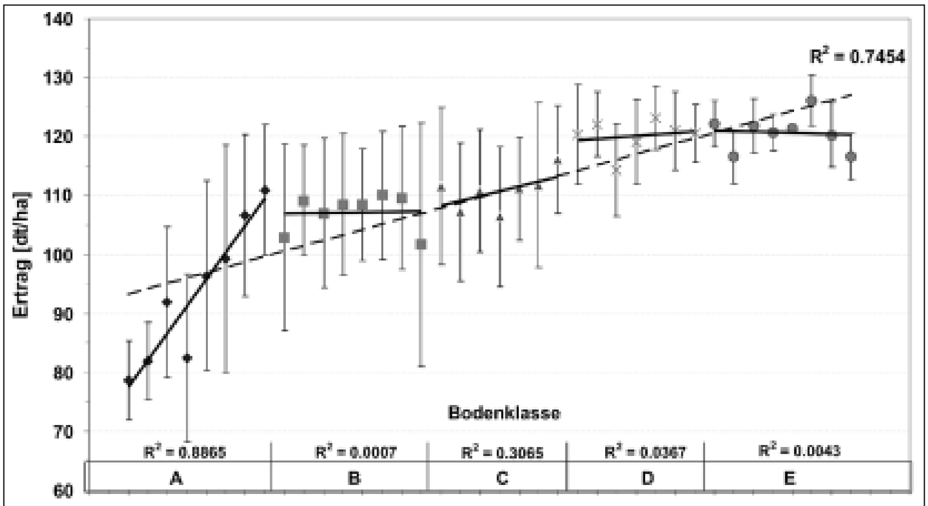

Fig. 1: Yield vs. EM 38 measurements, winter wheat trial variety Skater, constant N-fertilisation with 182 kg/ha

rithms were applied. The first is the classic algorithm, where the good developed plants get less and the thin more nitrogen. As an additional algorithm the Quality-Function (QF) was used. Here the good developed plants (in the flowering stage) are supplied deliberately with more nitrogen to achieve the quality increase by a higher protein content in the grain. The variants are in such a way that the first and second dressing are on the same level and N3 and N4 were applied with different strategies (classic and QF) of the N-Sensor.

The results of this trial on an area of 36 hectares are represented in *Table 1*.

Leaving out the N3 and N4 dressings results in losses in protein content and yield. The three fold N- dressing (without N4 fertilisation), which is typical for Schleswig-Holstein in 2003 shows no differences between the variants, probably due to the long dry spring. In 2002 the effects of a site specific fertilisation to N2 can be shown [4]. An additional dressing at the flowering- stage of 30 kg N/ha (BBCH 63-65) increases the yield in both variants. The important effect of the adapted N-fertilisation with the N-Sensor is noticeable: a higher yield brings also higher protein contents. So the expected dilution effect did not occur. The good subfields D and E furnished 111 and 118 dt/ha as well as 15.2 and 15.4 % protein. The variant with QF to N3 and N4 brought the best result.

The manufacturer of the N-Sensor generally recommends the Quality-Function (QF). The results show the effect of the 4th N- dressing. Using the online NIRS measurement system of the combine harvester [5], an increased yield with an higher protein content is recorded.

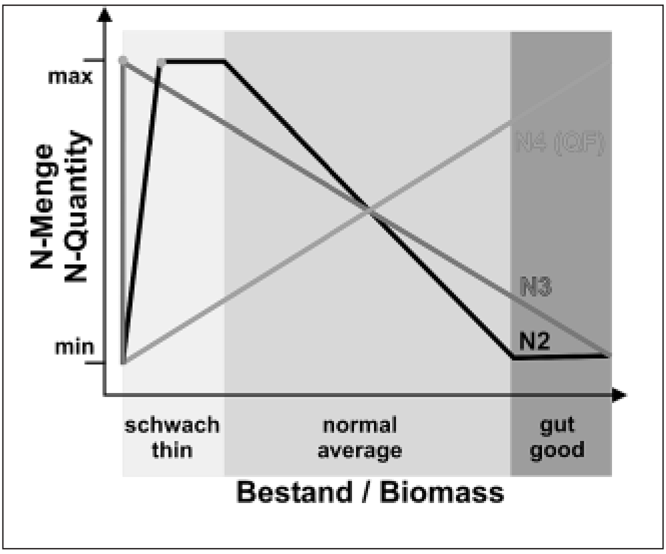

Fig. 2: Working function N-Sensor, N-quantity vs. N- status and plant growth

Conclusions

Variations in protein content and yield are very closely linked with the heterogeneity of the soil. This heterogeneity could be measured by electromagnetic conductivity measurements with the EM 38 system. The positive influence of soil quality can improved by site specific fertilisation. These results should be locked at in more trials with different weather effects.

Literature

Books are identified by •

[1] *Lassen, M.*: Betriebswirtschaftliche Bewertung der N-Sensoreffekte. Masterarbeit, Inst. f. Landw.- Verfahrenstechnik, Universität Kiel, 2004

[2] *Lamp, J. et al.*: Erfassung der kleinräumigen Heterogenität in der teilflächenspezifischen Pflanzenproduktion. KTBL Arbeitspapier 264, Darmstadt, 1999, S. 7-33

[3] • *Lück, E. et al.*: Innovative Kartiermethoden für die teilflächenspezifische Landwirtschaft. Band 7, im Selbstverlag der Arbeitsgruppe Stoffdynamik in Geosystemen, Potsdam, 2002

[4] *Reckleben, Y.*: Unterschiede in Ertrag und Protein von Weizen bei teilflächenspezifischer Bewirtschaftung. Landtechnik 58 (2003), H. 4, S. 242-243

[5] *Rademacher, J.*: Messsysteme für den Proteingehalt während des Mähdrusches. Landtechnik 57 (2002), H. 6, S. 354-355

Table 1: Results of site specific fertilisation trials, field Niedeel 2003, variety Drifter

1. N-Gave 2. N-Gave 3. N-Gave 4. N-Gave	**constant N-Sensor N-Sensor -**	**constant N-Sensor constant -**	**constant N-Sensor N-SensorQF -**	**constant N-Sensor - -**	**constant N-Sensor constant constant**	**constant N-Sensor N-SensorQF N-SensorQF**
Nges.[kg/ha]	*198*	*201*	*215*	*131*	*238*	*245*
SDev_Nges	9,7	9,0	7,8	9,7	7,8	18,1
Dry- Yield [dt/ha]	*102*	*102*	*103*	*99*	*104*	*108*
SDev_dYield	6,2	7,0	6,5	5,2	6,5	9,8
Protein [%]	*13,6*	*13,6*	*13,7*	*10,5*	*13,7*	*15,1*
SDev_Prot	0,5	0,4	0,6	0,6	0,9	1,1