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Differences in Wheat Yield and Protein Content with Site-specific Cultivation

With yield and moisture site-specific data gathering, newly adapted forms of cultivation (precision farming) become possible [1, 2, 3]. This method can become even more precise, if additionally, the quality is continuously registered. Knowledge about the contents (protein, starch, and oil) generally has a considerable effect on the utilisation of the harvested product, whether as feed-, bread- or malt grain.

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The classification into different using groups (quality classes) has a major influence on the revenues achieved by the producers. Especially with bread grain, the knowledge of the protein content and the parameters which can be indirectly derived from it, such as the gluten content or the baking quality, is of great interest for the processor. Furthermore, the differing content of protein in the nutrient balance can also play a role and contribute to the more exact measurement of the use of nitrogen.

The measuring system, which is based on NIR spectroscopy, was integrated into the combine harvester by Rademacher in the institute. This enables the protein content to be measured during harvesting and illustrated spatially together with the yield and moisture using the GPS position [3]. The tests are to clarify the variability in protein content and the reasons for it.

The influences of the variety and N fertilisation are known. The results for yield-emphasised varieties of wheat vary in the field between 10 and 12.5 %, and for quality-oriented varieties between 12 and 16 %. The goal is now to recognise the reason for high and low contents in order to derive production-related measures [4, 5].

Generally, the following applies:

- with N fertilisation, in particular the last N application increases the protein content [6],
- an increasing yield results in lower protein contents (dilution effect)

Many trials were conducted in the fields of local farmers in which the crops were cultivated according to various fertilisation strategies and harvested with specially equipped NIR combine harvesters. In the following, effects are to be explained using characteristic examples. First the soil influence will be discussed.

Based on the data in the *table 1* it is apparent that especially soil types with a moderate sand content (Ls-l and Sl/S) produce a smaller yield, however have a somewhat higher protein content. Where the texture has a higher silt and loam (U and L) content, the yields increase considerably, while the protein contents only drop slightly.

Soil-related differences [6] can be compensated with selective site-specific cultivation, as is shown in the example of a trial conducted last year. Here the fertilisation was adapted using a reflection sensor: during the 2nd and 3rd N application the good crops received less nitrogen and the poor crops more. During the last application (ear emergence top dressing) different strategies were then compared with each other and the following variants established:

V1 - no fertiliser
V2 - N sensor
V3 - constant, usual for the farming operation
V4 - N sensor with quality application function

The last variant differs from the usual setting. The good, strong green crops received an increased N amount in this case in order to selectively promote the quality.

The results are shown in *Table 2*.

The elimination of the ear emergence top dressing (0 Variant) results in decreased yield and quality. The site-specific adaptation of fertiliser application leads to a homogenisation of the crops with regard to the protein content and yield. The standard deviation in the constant variant usual for the farming operation (V3) was 2 % and in the N sensor variants (V2) 1 % and (V4) 0.76 %. The N sensor fertilisation with a quality function achieves the highest yields (+10 dt/ha) and the highest protein contents (+0.4 %). This means the last application increases

Table 1: Yield and quality versus texture, winter wheat trial 2000, field Achterkoppel (variety Ritmo), constant N-fertilisation with 227 kg N/ha

Texture	TI	Sl/S	Sl	Ls-l	Ul/l	l-Lt
Yield [dt/ha]	112	100	111	118	129	135
Raw protein [%]	10,68	11,61	11,00	11,46	10,93	10,53

	Crop Application Variants			
	V1 (0- Variant)	V2 (N-Sensor)	V3 (constant)	V4 (N-Sensor QC)
N-total [kg/ha]	*147*	*196*	*218*	*211*
Protein [%]				
Maximum	11.68	12.63	13.40	12.70
Mean	*10.06*	*11.50*	*11.60*	*11.97*
Minimum	8.74	10.68	9.37	11.19
Standard Deviation	1.48	0.98	2.02	0.76
Yield [dt/ha]				
Maximum	102	116	117	117
Mean	*78*	*86*	*87*	*98*
Minimum	59	66	54	63
Standard Deviation	*22*	*25*	*31*	*27*

Table 2: Results of last site-specific N-application (ear complete) trial, field Holzkoppel 2002, variety Ritmo

the quality and yield, and no dilution occurs. This phenomenon will be investigated in further trials.

The site-specific differences in the yield and quality are caused by the soil. They can be reduced with selective site-specific N fertilisation. In addition, there are indications of a homogenisation of the yield and quality. The selectively increased quality application appears to be of particular interest. These results must be verified in 2003 and expanded by posing additional questions (e.g. influence of varieties and fertilisation date).

Literature

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