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ASSESSMENT OF REAL TIME VARIABLE APPLICATION OF NITROGEN USING REMOTE SENSING SENSORS: PERSPECTIVES IN SLOVAKIA

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ABSTRACT The management of nitrogen fertilising is a common problem to many agronomists. It is an essential issue for winter wheat husbandry. Ground-based, machine-mounted sensors offer practical advantages because they are under the control of the operator. The Aim of this investigation was to evaluate variable application in Nitrogen using the Yara N sensor and justification of the use of these sensors in Slovakian conditions. Evaluation comprises almost all variable application of Nitrogen conducted in Slovakia in 2007 and 2008 at 1227.06 ha of winter wheat crop. Application at growth stage 31/32 and growth stage 39 was assessed in three regions of Slovakia: A – west – south part of Slovakia, B – west middle part of Slovakia, C – west -north part of Slovakia. Based on obtained data, it can be concluded that the application of ground based remote sensing sensors for variable application of Nitrogen brought benefits to Slovakian farmers. The amount of saved Nitrogen ranged from 7.85 to 19. 83 kg of Nitrogen per hectare at growth stage 31/32. Late application, at growth stage 39, did not bring saving on applied Nitrogen in the north part of Slovakia. However, there was significant spatial redistribution of the dose. Further research is needed combining the sensor data with historical information about the field.

Keywords: sensors, variable application of Nitrogen, winter wheat

INTRODUCTION The management of nitrogen fertilising is problem common to many agronomists. It is an essential issue for winter wheat husbandry. Nitrogen deficiency is characterized in reduced net assimilation and relative growth rates, lower leaf area, phytomass and grain yield. Over-application leads to the lodging of the crop and negative environmental impact. To determine spatial and temporal variability of the crop canopy characteristics of the field is a key factor to improve grain yield and effective site specific fertilisation. Remote sensing is one of the technologies which offer potential advantages because of its relationship with chlorophyll respectively nitrogen content in plants (Wiegand et al., 1992; Boegh et al., 2002; Aparicio, 2002; Broge & Mortensen, 2002; Wood at al 2003, Havrankova et al. 2006). Satellite, airborne and ground based methods of sensing fields are possible, however, because the cost of satellite and airborne images can be high and time is lost in processing the images; these cause delays in the variable

application of N (Wollring et al, 1998). Ground-based, machine-mounted sensors offer practical advantages because they are under the control of the operator (Scotford & Miller, 2005). This investigation extends the research conducted in UK and in Slovakia in 2006 (Havrankova, 2007). Here, the results showed that the application of Nitrogen using these sensors in the UK saved 15kg N/ha and there were potential environmental benefits through a 52% reduction of the residual Nitrogen in the soil in the UK. In Slovakia, the most significant benefit was introduced by the spatial redistribution of nitrogen using the remote sensing approach (a different application rates was applied to 80% of the field). Because of the very poor stage of the crop after long winter in the 2006, the increase and decrease in application rates for different zones in the field were almost in balance; hence the amount of nitrogen saved was trivial (1.5 kg N/ha). The usage of this sensors is not so often in Slovakia compared to UK (or Western Europe), despite the fact that the price of Nitrogen is very similar. It has to be stressed that the doses applied in Slovakia are much lower than in UK, this comes from farmer's best practice, agronomy, but also from legislative restrictions.

Aim of this investigation was to evaluate variable application in Slovakian conditions and so to state the perspective of this technology in the Eastern Europe region. As the price of Nitrogen had increased by more than 350% since 1999, there is real need to look for ways of optimisation of Nitrogen application.

MATERIAL AND METHODS

Evaluation comprises almost all variable application of Nitrogen conducted in Slovakia in 2007 and 2008 at 1227.06 ha of winter wheat crop. Application at growth stage 31/32 and growth stage 39 was assessed in three regions of Slovakia: A – west – south of Slovakia, B – west middle part of Slovakia, C – west -northern part of Slovakia (Figure 1).

Figure 1. Regions of Slovakia (Eastern Europe) where the evalutaion was conducted (www.googlemaps.com).

All application was carried out with passive N sensor (Yara) (Figure 2).

Figure 2. Yara N sensor.

Data were analyzed from following aspects:
- distribution of values of biomass,
- distribution of applied Nitrogen doses per hectare,
- difference between variable application and uniform application in terms of Nitrogen saving,
- spatial redistribution of applied Nitrogen.

The applied Nitrogen doses were compared with traditional "farmer best practice" (FBP) doses. These are for the growth stage 31/32 as follows:
- 45 kg per hectare in regions A and B,
- 60 kg per hectare in region C.

Late application, at growth stage 39, was conducted in region C at seed winter wheat. The variable application was compared with uniform dose of 20 kg Nitrogen per hectare. This is suggested dose by agronomy guidelines (Ložek, 1998).

RESULTS

Evaluated applications are summarized in Table 1. Each application is divided into three intervals (less than limit, limit and more than limit). The limit interval is equal to the farmer's best practice or to the recommended dose for the particular application. Areas with particular applied doses were calculated. Uniform application was calculated as theoretical application at the particular area. Total applied Nitrogen at particular area was compared and savings were calculated.

Table 1 Review of variable nitrogen application in Slovakia in years 2007 and 2008

growth stage		variable application				uniform application	saved Nitrogen	
		less	limit	more	sum		kg in total	kg N/ha
	area, ha	44.00	44.94	35.88	124.82	*		
31	applied N, kg	1 298.33	2 022.50	1 208.22	3 906.01	5 616.93	- 1 710.92	- 13.71
	area, ha	124.34	80.42	19.54	224.31	*		
31	applied N, kg	4 036.39	2 808.12	803.34	7 647.85	10 093.77	- 2 445.93	- 0.90
	area, ha	218.64	117.01	16.32	351.98	*		
32	applied N, kg	5 299.32	3 107.63	453.57	8 860.52	15 838.95	- 6 978.43	- 19.83
	area, ha	66.03	4.80	48.04	118.87	**		
31	applied N, kg	2 936.64	294.29	2 968.03	6 198.96	7 132.20	- 933.24	- 7.85
	area, ha	14.69	166.98	73.90	255.57	***		
39	applied N, kg	321.11	4 154.96	2 081.15	6 557.22	5 111.40	1 445.82	5.66
	area, ha	7.80	48.77	94.94	151.51	***		
39	applied N, kg	167.86	1 185.27	3 315.18	4 668.32	3 030.26	1 638.06	10.81

* uniform dose 45 kg N/ha; ** uniform dose 60 kg N/ha; *** uniform dose 20 kg N/ha

Application at growth stage 31/32

Four applications on almost 820 ha were assessed at growth stage 31/32. Passive ground based sensor applied the dose ranged from 10 to more than 60 kg of N per hectare. Lower dose (compared with FBP) was applied at more than 55%, higher dose was applied only at 14 % of the area. Figures 3 to 6 show the distribution of biomass and Nitrogen doses during particular fertiliser applications. Saved amount of nitrogen ranged from 7.85 to 19.83 kg of Nitrogen per hectare.

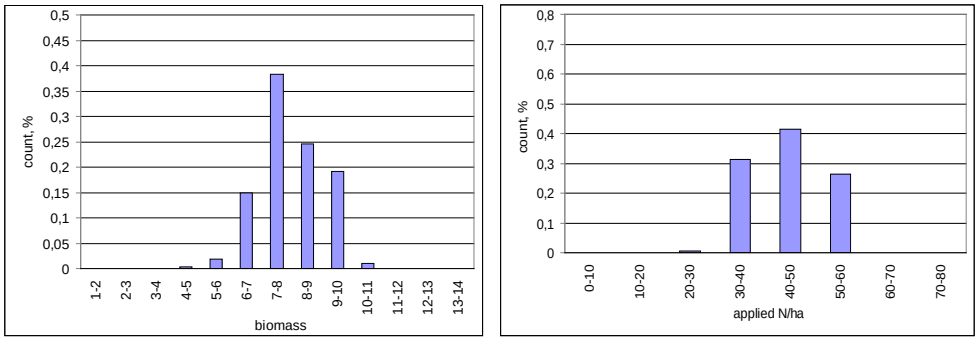

Figure 3. Distribution of value biomass and applied N per hectar at growth stage 31/32 in region A, year 2007.

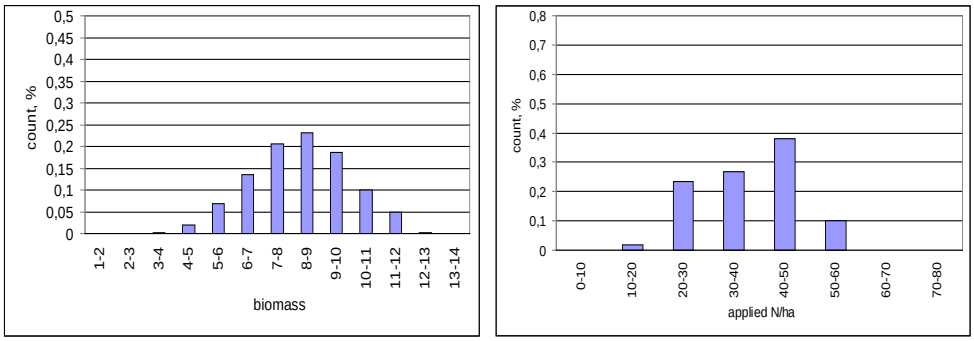

Figure 4. Distribution of value biomass and applied N per hectar at growth stage 31/32 in region B, year 2007.

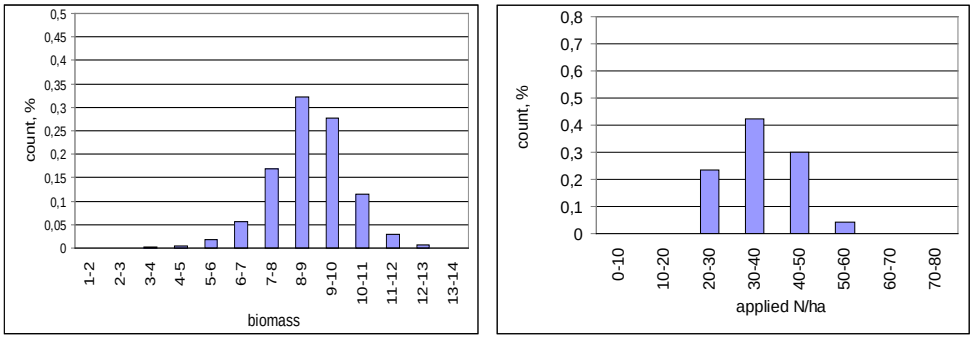

Figure 5. Distribution of value biomass and applied N per hectar at growth stage 31/32 in region B, year 2008.

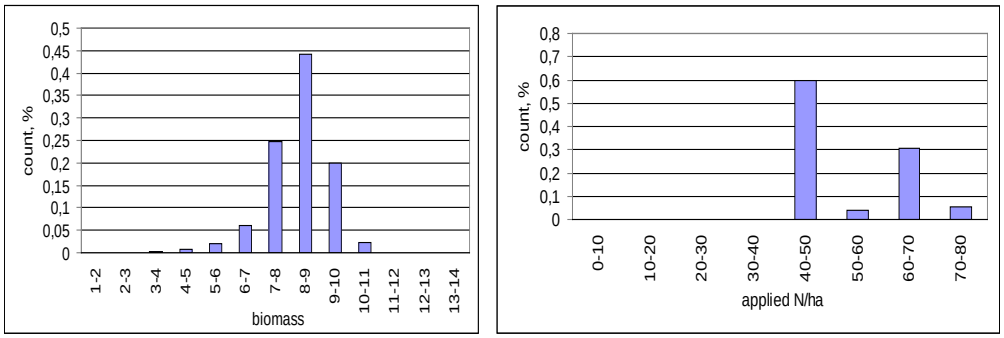

Figure 6. Distribution of value biomass and applied N per hectar at growth stage 31/32 in region C, year 2008.

Application at growth stage 39

Two applications at growth stage 39 were assessed covering more than 400 hectares. Both were in region C (north-west Slovakia). Comparing the variable application with the guidelines for agronomist for this growth stage (dose 20 kg /ha), there were not any savings on applied nitrogen achieved. However, 52% of the area received similar amount of Nitrogen and 41 % of the area received more (Figures 7 and 8).

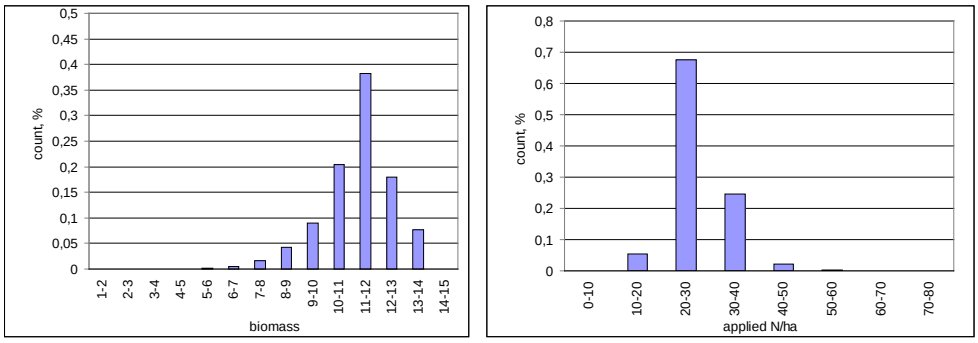

Figure 7. Distribution of value biomass and applied N per hectar at growth stage 39 in region C, year 2007.

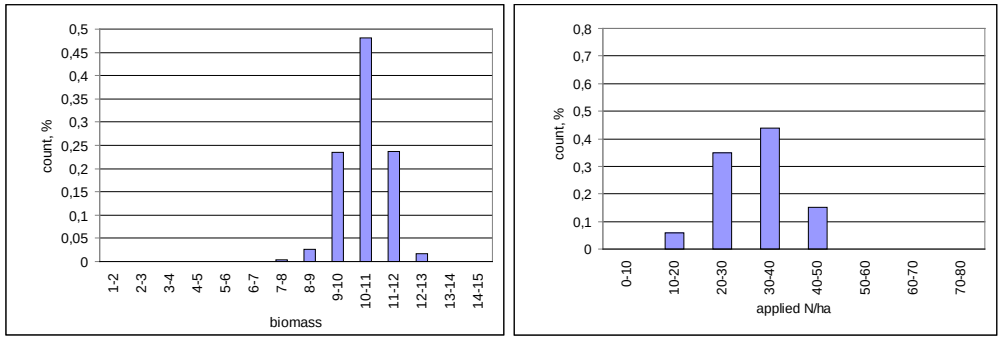

Figure 8. Distribution of value biomass and applied N per hectar at growth stage 39 in region C, year 2008.

CONCLUSION Based on data obtained, it can be concluded that the application of ground based sensors for variable application of Nitrogen brought benefits to Slovakian farmers. The amount of saved Nitrogen ranged from 7.85 to 19.83 kg of Nitrogen per hectare at growth stage 31/32. The late application with N sensor did not bring any saving on applied Nitrogen in the particular region. However, there was significant spatial redistribution of the Nitrogen fertiliser. Further research is needed combining the sensor data with historical information about the field. This will be investigated in further research under the research project ITEPAg co-funded from EU funds.

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