Spectral analysis of the effect of various foliar fertilizer on winter wheat variey 'Alföld 90' (*Triticum aestivum* L.)

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Abstract: The hyperspectral remote sensing has greatly improved the efficiency of remote sensing technology, which incidentally proved to be appropriate to analyse large areas according to different quantity and quality parameters in a fast and economic way. Hyperspectral technology can be fitted exquisitely in the agricultural production, in the environment protection and in several other industrial applications according to quantity and quality evaluation methodology. In the following experiment we are analysing different nutrition levels of the 'Alföld 90' winter wheat variety using field spectroradiometer in the wavelength of 350 and 2500 nm. In the experimental arrangement different nutrition levels were applied on 10 m^2 plots which were studied according to quantity and quality parameters. The treatments were carried out in agronomic replicated blocks. In order to identify the correlations, beyond the spectral analysis we evaluated plant height (cm), ear size (cm), yield ($kg/10m^2$) and quality parameters to make comparative examinations.

Keywords: spectroradiometry, reflectance, winter wheat, nutrient supply

Introduction

Remote sensing technologies have become indispensable tools in evaluation of the balances, or processes of different natural and artificial systems. In our day the mankind causes dramatic changes to the Earth's ecosystem. These processes are no longer feasible to be traced with ordinary field sample or data collection methods. Remote sensing makes obtainable the sampling on large areas collecting data from different surface processes including several monitoring possibilities (Kardeván 2010). As a result of the evolution, the human eye itself is a remote sensing tool which works in the wavelength of 380 nm to 780 nm. The modern remote sensing technologies makes possible to detect the electromagnetic waves over beyond the visible light revealing those phenomenons that are invisible for the bare eye (Kristóf 2005), gaining several time more information. Using this method we are measuring the radiations intensity and the spectral distribution reflected by the evaluated object that depends on the absorption, the transmission and the emission referred to the certain material characteristic. Concerning to these data we can gain information according to the examined targets quantity and quality parameters. Among the optical remote sensing systems one developed technology is the hyperspectral remote sensing which works in the optical band. This technology is adequate to analyse vegetations in a fast, precise way (Fenyvesi 2008, Milics et al. 2008, Yang et al. 2009, Milics et al. 2010).

In our modern culture people pay more and more attention to their healthy lifestyle. In order to do so their demands towards healthy foods increases. To produce quality food correctly chosen production methodology is needed. Wheat is our most important grain. Beyond the vital elements bread contains the most of the vitamins, too. After all healthy and homogenous vegetation can only be produced by satisfying the nutrient demand of the plant (Jolánkai 2004). Choosing inappropriate technology and/or nutrient supply leads to serious environmental damages. Among different macro elements as nutrient supply like nitrogen, phosphor or potassium the most frequent limiting factor is the nitrogen (Németh 2006). By broadcasting nitrogen solely significant quality and quantity improvement can be resulted. Though inadequate use can cause nitrate accumulation in the subsurface water (Németh 1996). Concerning to the total land area of Hungary different nitrogen accumulation is in progress. This process threatens the subsurface water supply which can be considered as one of the renewable energy source (Nagy et al. 2008). Many nitrates accumulate in the plants and the consumption of these is dangerous to people, especially for babies (Nádasy és Nádasy 2006). This problem cannot be solved purely by reducing the nitrogen doses (Kovács és Fodor 2005). In order to avoid these problems the nitrogen dose used and its distribution in time must be chosen circumspectly. The lack of the essential micro elements are reducing the effectiveness of the N, P, K broadcasted (Bergmann és Neubert 1976). Without the sufficient quantity yield and quality depression and increasing sensibility may occur (Jagodin 1984; Bergmann és Neubert 1976). The ascending amounts of macro element supply and the higher yields are growing the importance of the micro elements. Due to the different interaction in the soil the possibility of supplying micro elements are limited, in some cases it can only be carried out by foliar fertilizers (Pecznik et al. 1976; Szentpétery et al. 2005). The effect of the foliar fertilizers wasn't exactly clarified yet. According to several experiments their effect on yield depends on many conditions (Harmati és Szemes 1982; Szalay et al. 2009). Beyond the wheat species and the foliar fertilizer applied, the weather (Erdélyi 2008, 2009; Klupács et al. 2009), the nutrient supply, the yield and the production site. These are not exactly plant protection products but important accessories of the precision agriculture. They are not used for defending the plant against the unfavourable effects, but through improve its general condition to increase the yield and different quality parameters, furthermore to result other preferential effect in the production technology (Harnos et al. 2009, Erdélyi et al. 2009). Nevertheless they can also result some repellent effect. These preparations are usually made from purely natural based ingredients of which the precise consistence cannot be identified (herbs, alga). They have complex effect and because their natural origin they can be licensed easier than other plant protection chemicals (Tőkés 2007). Both the scientific results and the cultural demands are moving the agricultural production toward an environmentally sound technology in the developed countries. The importance of the foliar fertilizers in these systems grows because there are less preparation are available to support and protect the plant. In the following trial four natural based foliar fertilizers will be evaluated which are permitted in different ecological farming. One additional artificial based foliar fertilizer (Folicare) was also tested, which is only permitted in the conventional systems.

Material and methods

'Alföld 90' was studied in agronomic replicated blocks. Experimental plots were sown on chernozem soil (calciustoll) at Hatvan- Nagygombos, (Central Hungary). The winter wheat variety 'Alföld 90' (1987) is a quality winter wheat in Hungary. Until the year of 2002, it was a quality standard among the early winter wheat maturity group in Hungary. The area did not receive any mineral fertilizers. The plots (10 m^2) were received different foliar fertilizer substances. Every treatment were made with four repetition. The applied foliar fertilizers (*Figure 1.*) are licensed in the ecological farming, except one, Folicare. The treatments are summarized in *Table 1*.

Figure 1.
Foliar fertilizers

Table 1.
Treatments and their designations

Ismétlés	Lombtrágya	Jelölés
4	Biomit Plussz	1
4	Bioplasma Cu	2
4	C-komplex	3
4	Hungavit G	4
4	Natur Biokál 01	5
4	Folicare 19-11-24 Cu	6
4	Kontroll	0

The experimental plots were evaluated concerning plant height (cm), ear size (cm), yield (kg/plot), and quality parameters – such as wet gluten content (%), protein (%), furthermore thousand kernel weight (g). Beyond these, wheat ears from all plots were gathered and analysed according to its spectral characteristic with an ASD Fieldspec 3 MAX spectroradiometer (*Figure 2.*) with 'ex situ' method in the wavelength of 350 and 2500 nm. The measuring process was made in the Hungarian Institue of Agricultural Engineering, in a light isolated laboratory (*Figure 3*).

Figure 2.
ASD FieldSpec 3 MAX spectroradiometer

Figure 3.
Light isolated laboratory

Results

The evaluated parameters showed moderate deviation according to the treatments applied. By composing plant height and ear size to ratio the *Figure 4*. presents the results of the three cropyears. The results show homogeneous distribution, none of the substances generated higher ratio than the control. Studying the yield we found that the Folicare alone resulted better yield than the control in the year of 2008 and 2010. In 2009 the best result obtained by the fifth, Natur Biokál 01 treatment. The data are summarized above *Figure 5.*

Figure 4.
Height and ear ratio

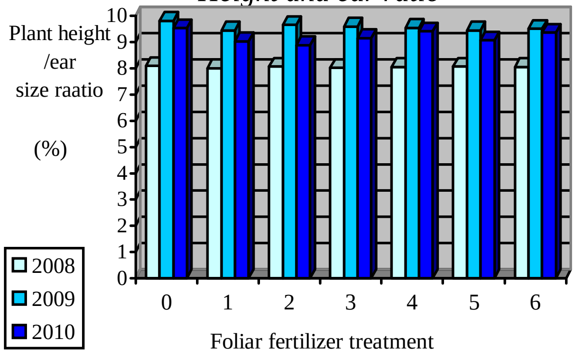
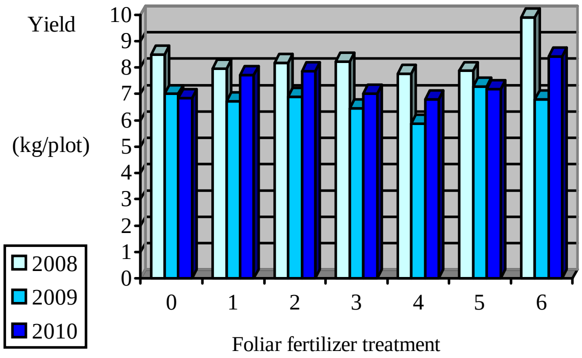


Figure 5.
Yield



In case of the quality parameters the tendency of the data shows that the foliar fertilizers have positive effects. The fifth treatment resulted the highest protein values in 2008 and 2009, but in the year of 2010 the Folicare fertilizer made slightly the best results. Data are summarized in *Figure 6.*

Figure 6.
Protein

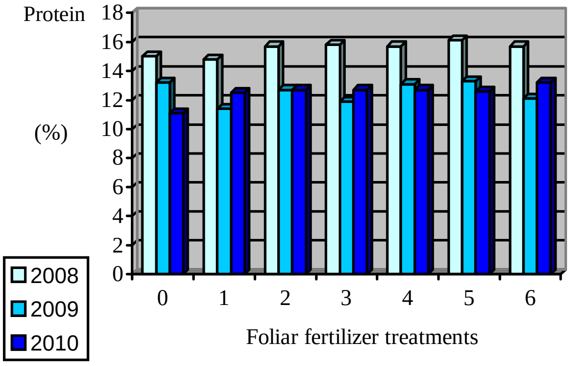
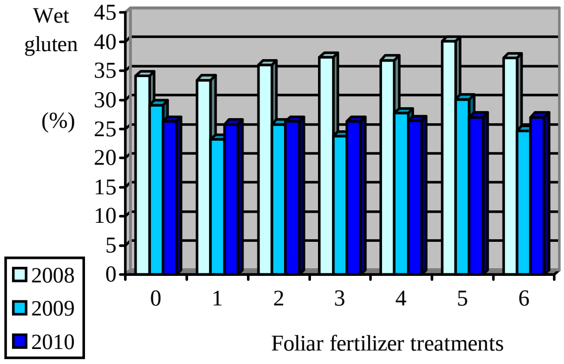
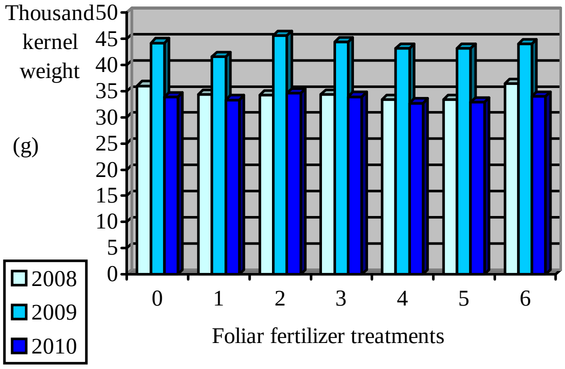


Figure 7.
Wet gluten



Studying the wet gluten the Natur Biokál 01 treatment showed the highest values in two cropyear, in the third year the Folicare resulted equal wet gluten values. Data are compared in *Figure 7.* The thousand kernel weights show that in the 2008 the Folicare, while in the other two cropyears the Bioplasma fertilizers resulted the best effect on the wheat. Data are illustrated in *Figure 8.*

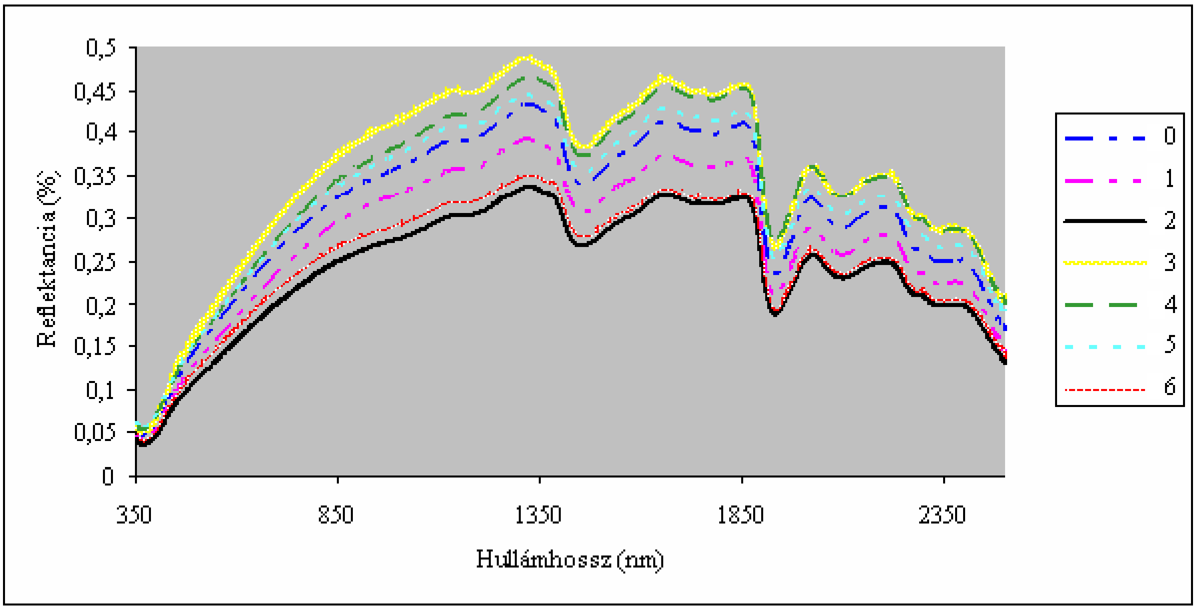
Figure 8.
Thousand kernel weight



According the protein and the wet gluten the results of the three years the tendency of the data show that mainly in the year of 2008 and 2010 the positive modifying effect of the foliar fertilizer expressed. Though in the case of the wet gluten in the year of 2010 the improvement compared to the control was smaller.

The collected wheat ears were measured with ‘ex situ’ method in the light isolated laboratory in the wavelengths between 350 and 2500 nm. After recording the reflectance, which originates in the irradiation of the laboratory lamp that illuminates the samples and the radiation reflected by the wheat ears, we composed the mean spectrums of the different foliar fertilizer treatments. According to these spectral curves the spectral characteristic of the different treatments are diverge. The spectrums received in the different treatments are illustrated in the following graph (*Figure 9.*).

Figure 9.
The reflectance curves of the ears, which were collected from plots which were treated with different foliar fertilizers



Conclusions

Generally true that the nutrient deficiency expresses more intensively during dry periods especially in the parameters examined. The foliar fertilizers applied mainly improve the general condition, the nutrient uptake and the leaf are of the plant. The typically rainy weather itself also enhances the nutrient uptake moderating, or masking totally by that the effect of the different foliar fertilizers. According to these results the effect of the foliar fertilizers known as yield and quality improving ability greatly depends on the precipitation, therefore the rate of the financial return of their application are strongly connected with the certain cropyear. According to the spectral evaluations, or rather the reflectance curves recorded at the different treatment levels - despite of the moderate quantity and quality differences measured – are diversiform. In order to identify the correlations further process of the data are required.

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