Characterization of nitrogen use efficiency in a winter wheat collection

István Monostori[1*], Tamás Árendás[1], Fruzsina Szira[1], Gábor Galiba[1], Borbála Hoffmann[2], Attila Vágújfalvi[1]

*[1]Agricultural Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, Brunszvik u. 2., H-2462 Martonvásár, Hungary (*monostori.istvan@agrar.mta.hu)*
[2]University of Pannonia, Georgikon Faculty, Keszthely, Hungary

Agricultural Institute
Centre for Agricultural Research
Hungarian Academy of Sciences

Introduction

Winter wheat is one of the main cereals that has the greatest importance in human nutrition. It is well known that yield and quality of winter wheat could be dramatically increased through the application of N fertilizers. However, it has been also proved that only a low rate of the applied fertilizers can be utilized by the crops. Therefore, the identification of varieties with better nitrogen (N) uptake and N utilization efficiency is a very important topic. Better understanding of the N utilization capacity of the modern winter wheat varieties could lead to an appropriate fertilizer management, and the better use of N-fertilizers could help to decrease the environmental pollution and economic loss.

Material and methods

Ninety-six winter wheat varieties were investigated under field condition in 2012/2013 growing season. Two different treatments, a control (0 kg/ha) and 120 kg/ha N fertilization level were applied in three replications. Beside the measurement of N content in the grain and straw samples, the effect of N treatment was also characterized by the measurements of agronomically important characters. The main characteristic parameters for the nitrogen usage, the N-use efficiency (NUE) and its two components, namely nitrogen uptake efficiency (NUpE) and nitrogen utilization efficiency (NUtE) were also measured and calculated.

NUE: Kilogram grain dry mass at harvest per kilogram available N (from soil plus fertilizer).

NUE is a product of two definable and independent major sub-traits:

NUpE shows the ability of the crop to capture available N from the soil: Kilogram above-ground N at harvest per kilogram available N (from soil plus fertilizer).

NUtE reflects the ability of the crop to use N to produce grain yield: Kilogram grain dry mass per kilogram above-ground N at harvest.

Variety performance when **soil N supply is very low**					Variety performance **with nitrogen treatment**				
Variety	Yield	Harvest-index	Grain N%	NUE	Variety	Yield	Harvest-index	Grain N%	NUE
Mv Petrence					Mv Hombár				
GK Hajnal					Slavna				
GK Petúr					IS Karpatia				
GK Hattyú					Moskvich				
Mv Regiment					Bardotka				
Hatcher					GK Vitorlás				
GK Fény					Mv Magvas				
Moskvich					Mv Pengő				
GK Ati					Kalahari				
GK Vitorlás					Baletka				
Mv Pántlika					Dunai				
Baletka					Mv Apród				
IS Bonnet					GK Berény				
GK Csillag					GK Kapos				
Bardotka					Josef				
Karolinum					Cordiale				
Mv Palotás					Mv Ködmön				
Balaton					Krasnodarskaya-99				
GK Rozi					Mv Csárdás				
Mv Menüett					GK Rozi				

Upper-quarter
Inter-quarter
Inter-quarter
Lower-quarter

***Figure 3.:* Performance of wheat varieties under two different N treatment**

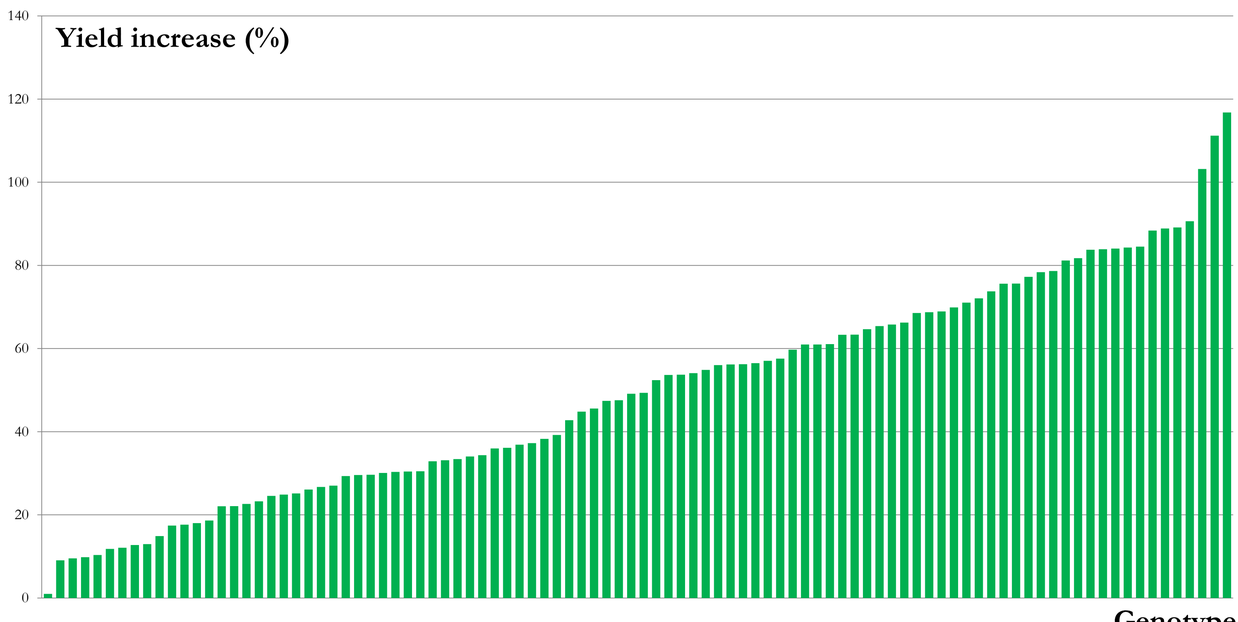

***Figure 4.:* The impact of nitrogen treatment on grain yield**

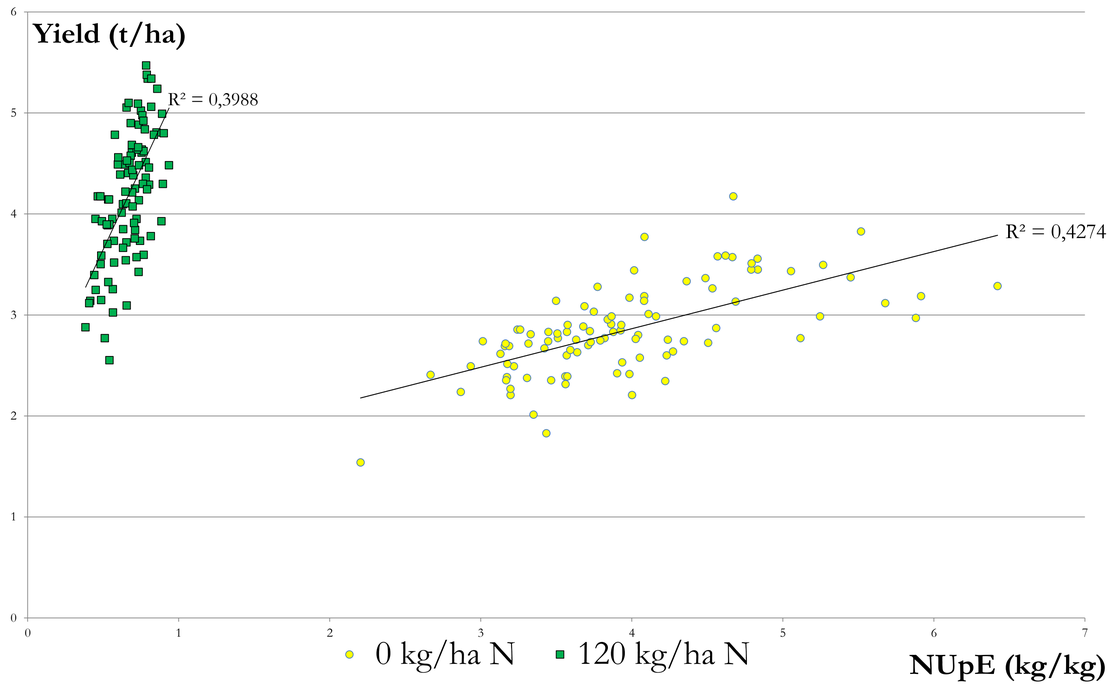

***Figure 1.:* The impact of nitrogen uptake efficiency on yield**

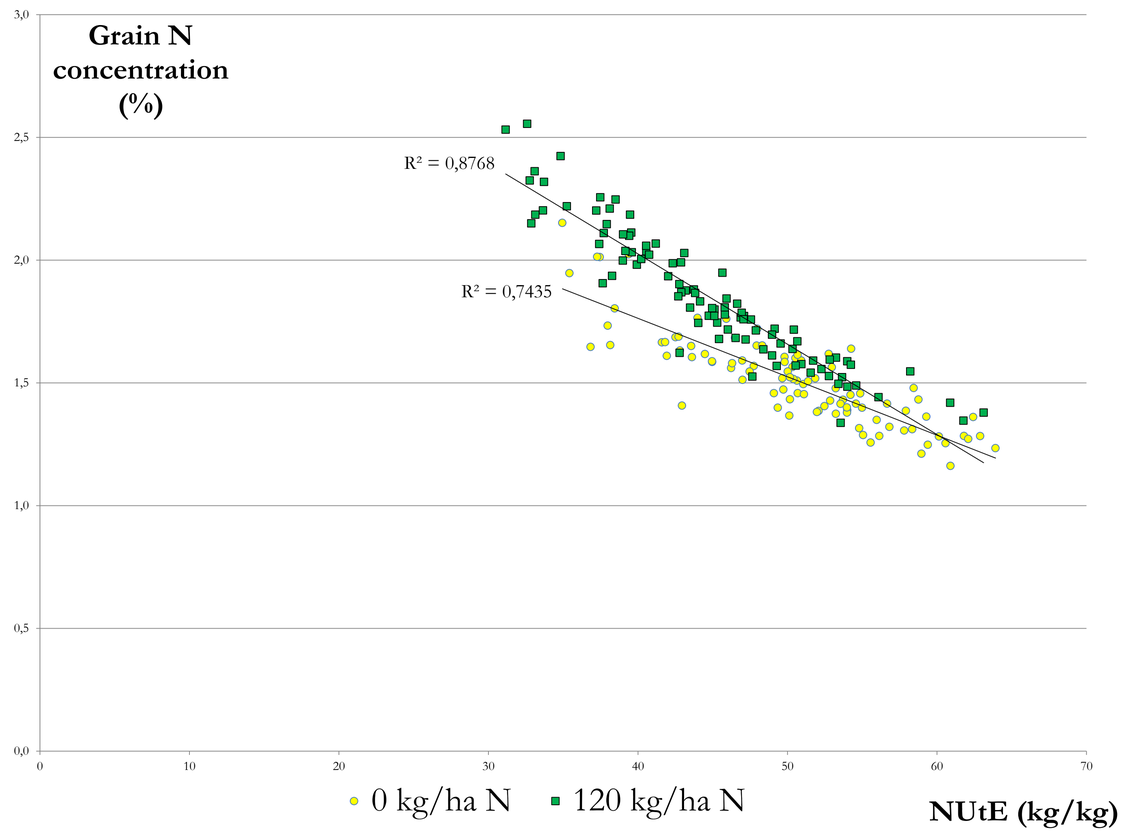

***Figure 2.:* The impact of nitrogen utilization efficiency on grain quality**

Results and discussion

The NUpE had a powerful effect on the yield of our winter wheat collection in 2013 (Figure 1.), while the effect of the NUtE on yield was much less. The vegetation period was very dry (130 mm precipitation), and warm in 2013. On the other hand the availability of the nutrients was low, so the plants suffered from nutrient deficiency. Under this unfavourable circumstance the NUpE parameter was dominant.

Figure 2. shows that the increased NUtE had a negative effect on grain N concentration. We also observed a negative correlation between yield and grain N concentration and a positive relationship between yield and NUtE (data not shown). According to our data this population (mostly the high-yielding varieties) requires increased nutrient supply to maintain good yield quality (protein content).

On Figure 3. the performance of the varieties were scored based on the four most important agronomical traits recorded: yield, harvest index, grain N% and NUE. The quartile performance of the varieties for each of the trait is indicated. The red colour indicates the good performance in the population in a specific trait, while blue colour shows weak performance. It was concluded that different varieties performed better when N was supplied, but it was shown also that several varieties were able to adapt to both conditions (indicated with green colour).

Figure 4. shows the diversity of the nitrogen use potential in the winter wheat population. Because of this polymorphism, the population will be suitable for the forthcoming association mapping planned on the three year screening and DNA-based genotyping data.

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