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INDICES OF CROP WATER STRESS FROM UAV IMAGES PRECISELY MAP NITROGEN BALANCE AND RISK OF NITRATE LEACHING SPATIAL VARIABILITY

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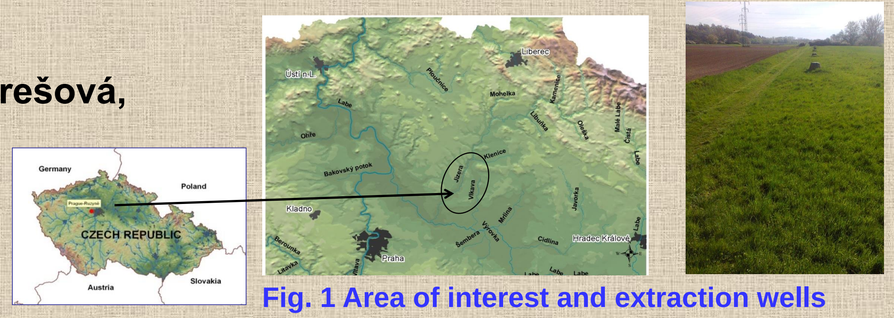


Fig. 1 Area of interest and extraction wells allong experimental field at Kochánky

INTRODUCTION

Nitrate concentration has been increasing in water extracted by bore wells in lower Jizera catchment – waterworks Káraný (Fig.1), providing 1/3 of drinking water for Prague (www.vodarnakarany.cz) (Bruthans et al. 2018).

Irrigated vegetables and potatoes, often the source of excessive residual nitrate prone to leaching, are grown in the area (Klír et al. 2017, Haberle et al. 2019).

Not irrigated crops grown alternately on the (irrigated) fields, show pronounced spatial variability due to water stress (Fig. 2)

Aim: To probe the possibility to derive map of spatial variability of N balance with UAV images

MATERIAL AND METHODS

Experimental fields: So1, So2 and So3 near Sojovice (50.2139350N, 14.7571592E) and Ko1 near Kochánky (50.2757078N, 14.7926503E) (Fig. 1, 2). Soil and plants sampled in 19 or 21 (Ko) and 43 (So) points (different numbers in years).

Soil: Soil texture to 90 cm depth was used for calculation of soil water capacity (FWC) with simple PTF (Novotný et al. 2000).

Crop: Peas at Ko1 (2017), winter wheat at So and Ko1 (2017-2019), contents of N in seeds and straw, ^{13}C discrimination ($\Delta^{13}C$). The content of soil mineral N (Nmin) was determined in grid point in selected years and fields at the onset of winter, as an indicator of risk of leaching during winter.

Simple N balance: Calculated as N inputted in fertilizers (only mineral ones were applied) minus N in grain (exported from field). All straw was left at fields and ploughed in.

RGB Images: Aircraft, UAV

Map: Regression parameters of relationships between ExG index (Woebbecke et al. 1995) and N balance were used to generate maps.

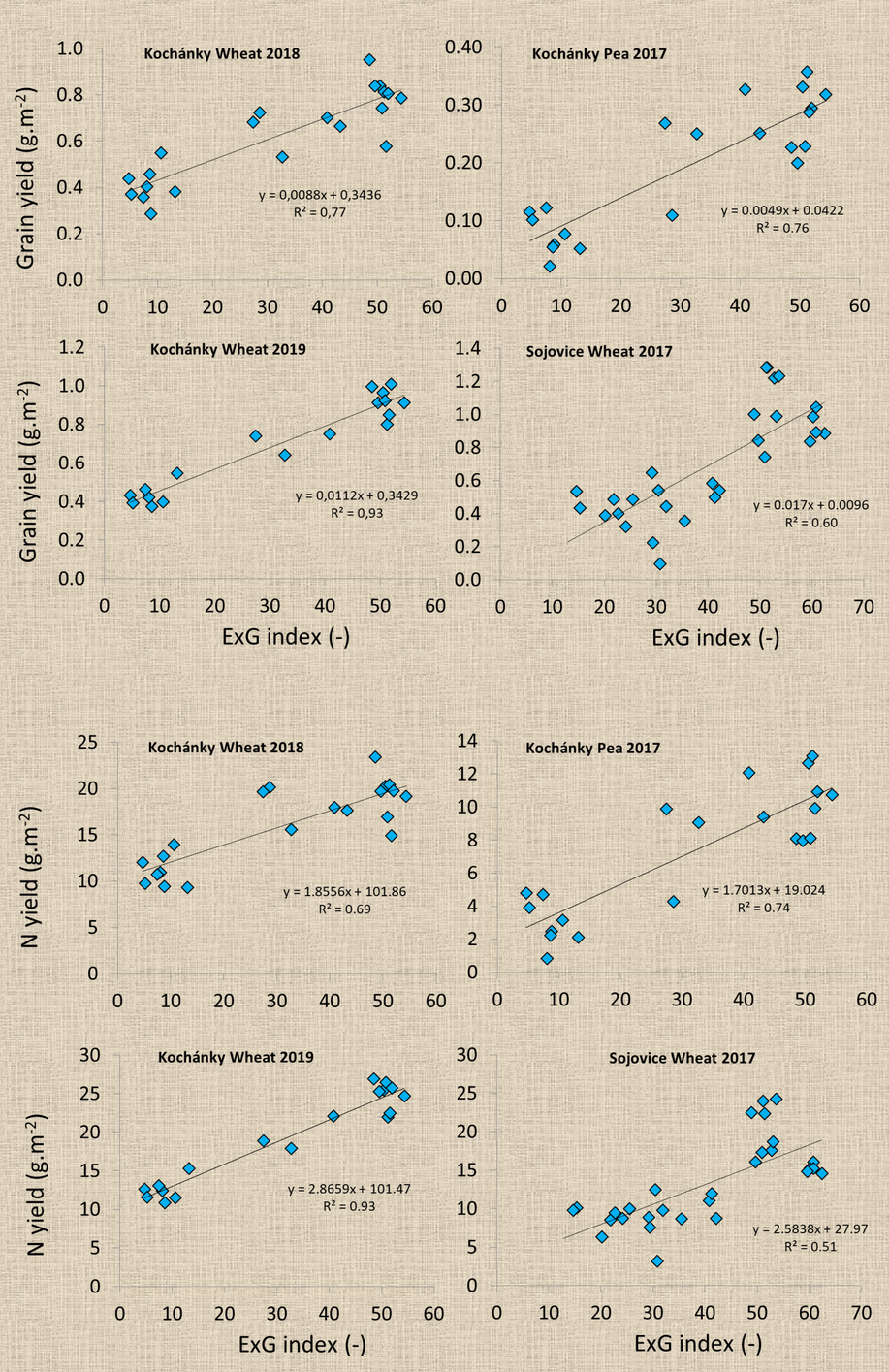
The significant relationships among soil field water capacity of root zone (down to 90 cm), total biomass or grain yields and $\Delta^{13}C$ (indicator of water shortage) were observed in all fields and years (Haberle et al. 2018, 2020).

RESULTS AND DISCUSSION

- Grain and N yields (Fig. 3), and N balance of wheat and pea significantly corrrelated with ExG index calculated from UAV and aircraft images (Fig. 4) Including N in straw in the balance did not changed the relationships signficantly
- Nmin before winter (start of December) did not correlated significantly with N balance (not shown)

Fig. 2 Spatial variability of drought impact

Fig. 3 Relationships between grain and N yield and ExG Index



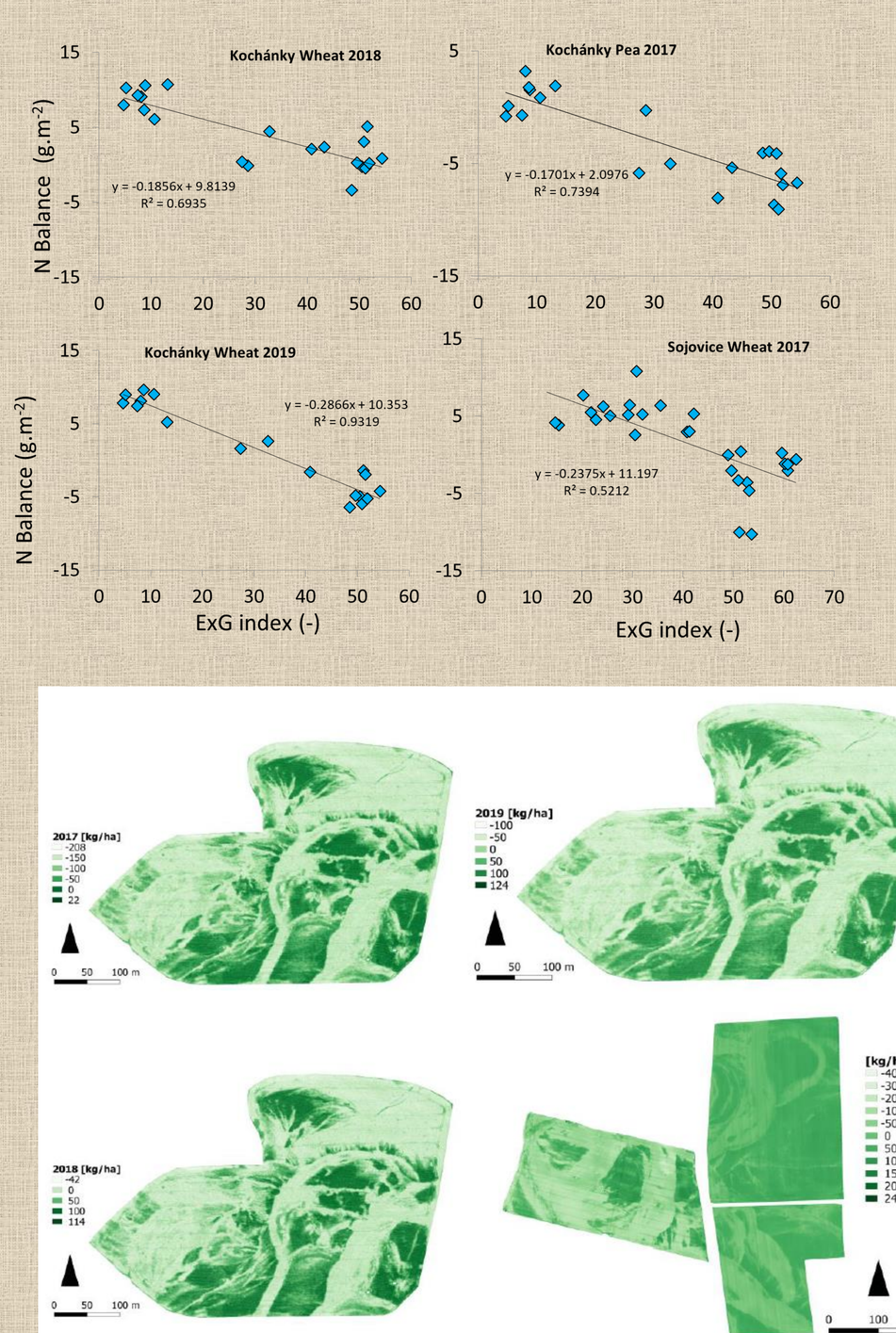


Fig. 4 Relationships between N balance and ExG Index

Fig. 5 Map of N balance at Kochánky (2017-2019) and at Sojovice (2017, bottom right)

CONCLUSIONS

- ✓ Simple N index derived form RGB images of the crops correlated significantly with grain and N yield, and N balance
- ✓ The index enabled to generate detailed maps of N balance (Fig. 5), suggesting variable soil residual N
- ✓ Nmin content before winter did not significantly correlated with N balance probably due to leaching during already at summer and autumn
- ✓ The maps may serve for spatially variable irrigation and fertilization, yet not used in vegetable production. The results suggest the need for the use of precision agriculture approaches in the area to reduce risk of high residual N content and nitrate leaching

Literature: Bruthans J. et al. 2018 Factors controlling nitrate concentration in space and time in wells distributed along an aquifer/river interface (Káraný, Czechia) Hydrogeology Journal 1-16. https://doi.org/10.1007/s10040-018-1854-7. Haberle J. et al. J 2019 Distribution of mineral nitrogen in soil in relation to risk of nitrate leaching in farms with irrigated vegetables and early potatoes Journal of Horticultural Research 10.2478/johr-2018-0015. Haberle J. et al. 2018 Plant growth indicates soil spatial variability related to water shortage and nitrate leaching vulnerability In: Proc. of 20th Nitrogen Workshop, Rennes, France 2018, 68-69. Haberle J. et al.The 13C Discrimination of Crops Identifies Soil Spatial Variability Related to Water Shortage Vulnerability. Agronomy 2020, 10, 1691. Klír J. et al. 2017. The distribution of mineral nitrogen in soil in relation to risk of nitrogen leaching in farms with irrigated vegetables, in: Dalgaard T. et al. (Eds), Innovative solutions for sustainable management of N, June 2017. Křížová K. et al. 2018: The possibility of soil electrical conductivity to be explained by remotely sensed thermal data. Agronomy Research 16(3), 784-793. Novotný M. et. al. Irrigation of Field and Special Crops, 1st ed.; Príroda: Bratislava, Slovak Republic, 2000 (in Slovak). Woebbecke D. et al. 1995. Color indices for weed identification under various soil, residue, and lighting conditions. Transaction of ASAE 38 (1): 271–281.

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