Ground level and aerial sensors to detect crop N status and adjust fertilizer application

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Abstract

Remote sensing has potential for adjusting crop fertilization. Our goal was to compare the ability of several indices obtained from aerial (hyperspectral camera on aircraft) and ground levels sensors (Dualex® and Greenseeker®), for identifying N fertilizer rates and the residual N effect from fertilizers. A field trial with a maize/wheat rotation and various N-fertilizer treatments was conducted in Central Spain. Vegetation indices discriminated between fertilizer rates, but only ground level sensors identified the residual N effect.

Keywords: remote sensing, vegetation indices, fertilizer, wheat

1. Introduction

The use of mineral fertilizers increased the last decades, but >50% of N applied is not assimilated by crops, contributing to environmental pollution (Tilman et al., 2002). Sensoring crop performance could contribute to adjust N fertilization and to increase N recovery.

The objective of this work was to evaluate the ability of ground level sensors and remote sensing to assess crop N status and to adjust fertilization. Specific objectives were: i) to identify different N levels, ii) to compare the residual N effect with and without nitrification inhibitors.

2. Materials and methods

A two-year field experiment (maize/wheat rotation) was established in Central Spain. Maize was sown in sixteen plots (8 x 10.5 m) randomly distributed in 4 treatments: calcium ammonium nitrate enriched with sulphur (CAN(S)), ammonium sulphate nitrate (ASN) blended with 3, 4-dimethylpyrazole phosphate (DMPP) (ASN+DMPP), CAN(S) blended with 3,4-dimethylpyrazole succinic (DMPSA) (CAN(S)+DMPSA) and not-fertilized, with 4 replications. After maize harvest, wheat was planted and each plot was split into three subplots, that received CAN(S) either at a recommended N rate (N2), a reduced rate (N1) or no N (N0). The residual N effect was evaluated by comparing wheat response (N content and yield) at flowering and harvest.

Vegetation indices obtained from ground-level (Dualex®, Greenseeker®) and aerial sensors (Micro Hyperspec VNIR model mounted on an aircraft) were compared with wheat parameters.

3. Results

Differences in wheat response to N rates were detected by ground and aerial sensors at various growth stages (Fig. 1), being significant already at stem elongation. Residual N effect was observed in wheat at flowering in N0 treatments, as the biomass and N content were higher following maize fertilized with CAN+DMPSA and ASN+DMPP compared to the control. At wheat harvest, the residual effect was observed in grain N content and %N.

This residual effect was detected by ground level sensors at stem elongation, but not by indices calculated from aerial sensors.

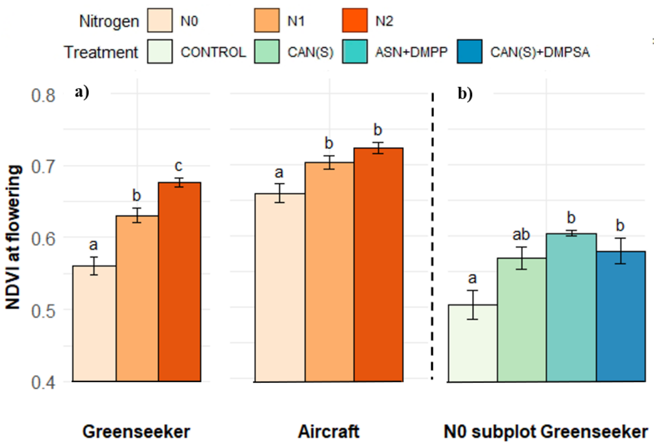

Fig. 1: NDVI from various sensors and treatments a) N rates b) residual effect at flowering ($\alpha \leq 0.05$)

4. Conclusions

Ground level and aerial sensors detected differences in wheat N status at stem elongation, opening the opportunity to adjust N fertilization rates to crop demand. However, only ground sensors detected differences in N fertilizer residual effect. Further research is needed to identify indices more sensitive to crop N status.

Acknowledgements

Supported by grant FPU17/01251 and EuroChem Agro.

References

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