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On-Farm Evaluation of an Active Optical Sensor Performance for Variable Nitrogen Application in Winter Wheat

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Abstract. Winter wheat (Triticum aestivum L.) represents almost 50% of total cereal production in the European Union, accounting for approximately 25% of total mineral nitrogen (N) fertilizer applied to all crops. Currently, several active optical sensor (AOS) based systems for optimizing variable N fertilization are commercially available for a variety of crops, including wheat. To ensure successful adoption of these systems, definitive measurable benefits must be demonstrated. Nitrogen management strategies developed based on small-scale plot research are not always meaningful for large-scale farm conditions. In 2010–2012 (5 site-years) on-farm study was implemented in northern Poland utilizing a strip-trial design. The objective was to evaluate the performance of AOS in combination with a built-in algorithm for variable N rate fertilization. In this study, the reference uniform N rates (farmer’s practice) were comparable to optimum variable N rate recommendations. Side-by-side comparisons of uniform and variable N application revealed inconsistent benefits in terms of grain yield, grain protein content (GPC), N use and N use efficiency (NUE). Anticipated yield increases and/or reduced N rates are typical drivers for AOS adoption. Significant yield increases are not easily attained on farms with winter wheat yields already close to maximum yield potential. Thus, sensor-based variable N rate recommendations for fields previously fertilized with relatively low uniform N rates would often entail more appropriate allocation (redistribution) of the same amount of total N. This would minimize N surplus in areas of lower productivity and to improve the sustainability of N management overall.

Keywords. Winter wheat, variable nitrogen application, financial benefits, on-farm research

The optimal amounts of N to be applied can vary highly from field to field and within a field. Differences in plant N content between years are mainly due to varying weather conditions, while differences in plant N status within a field is mainly attributed to varying soil conditions. Uniform (blanket) N applications do not account for spatial variations in soil N supply, crop N uptake, and crop response to N. Currently, the majority of the winter wheat fields worldwide are fertilized with a uniform N rate without taking into account the substantial variability in soil N and crop response. Several sensor-based systems for variable N application are currently commercially available. These systems are very capable of identifying and mapping in-field variability in crop N status and biomass and assist in precise on-the-go variable N rate application. Variable N application is recommended for fields showing substantial differences in soil and topography heterogeneity contributing to spatial variability in N uptake and crop response to N applied within fields. Five on-farm strip-trials in winter wheat were conducted in 2012 – 2011 in northern Poland. Wheat was fertilized alternately with a uniform (check strips) or variable N rate (treatment strips), which allowed for unbiased, easy side-by-side comparison of the two N fertilization methods evaluated in similar soil conditions. Two in-season topdress N applications were made. The variable N rates were prescribed using the Crop Circle™ ACS-210 sensors and the sensor-based algorithm (Holland Scientific, Lincoln, NE).

CONCLUSIONS

Side-by-side evaluations of uniform and variable N application showed inconsistent results regarding grain yield, N use, NUE, and GPC across five site-years.

The lack of strong, positive response of winter wheat to variable N application based on AOS could have been due to the following: 1) challenge of predicting rain-fed winter wheat yield potential due to water deficit symptoms masking N status; 2) difficulty in increasing grain production in already high-yielding areas; 3) variable N rates recommended by the algorithm were applied to the fields previously fertilized with relatively low uniform N rates, which made impossible to substantial reduce topdress N rates.

Utilization of AOS for variable N fertilization in such conditions often entails more appropriate distribution of the same total amount of N to minimize N surplus in areas of low productivity and to improve the sustainability of N management overall.

In our experiments, higher variable N rates did not always result in higher grain yields. This increased N surplus in some areas of the field.

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