Variable Rate Nitrogen Applications using Canopy Reflectance and Response Indices

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Summary

The optimum rate of fertilizer nitrogen (N) in canola (*Brassica napus L.*) production depends on yield potential, soil residual N, and mineralization rates of organic N. These variables are affected by a number of environmental factors and tend to vary over space and time. Precision agriculture aims to increase the efficiency of crop production by accounting for such variability. A field scale experiment was conducted near Indian Head, Saskatchewan to evaluate the agronomic and economic feasibility of using canopy reflectance measurements and N response indices to determine N top-dressing rates. A high clearance sprayer equipped with a variable rate controller and six boom-mounted, active optical sensors was used to simultaneously top-dress N and measure the crop's normalized difference vegetation index (NDVI). Top-dressed N was applied as surface-dribble banded urea ammonium-nitrate (UAN), when the canola was at mid-bolting. In-season fertilizer N requirements were estimated in two steps. First, the growth rate of the crop was calculated by dividing NDVI by number of growing degree days (GDD) accumulated between seeding and sensing, and used to estimate the yield potential of the crop. Second, the crop's potential responsiveness to additional N was estimated by comparing the NDVI of the crop being fertilized with that of an adjacent plot not limited by N. Plots in the variable rate treatment with low NDVI relative to the non-N limiting plot were assumed to have low N availability, and given additional N fertilizer at a rate determined by the NDVI – yield algorithm. The variable rate treatment was evaluated against soil placement of all N at seeding (farmer practice), fixed-rate split applications, and a reduced N treatment. NDVI increased with N rate, providing evidence of a response to N rates beyond 67 kg N ha^{-1}. Increasing N from 67 to 101 kg N ha^{-1} at seeding caused an increase in NDVI of eight percent. On average, 89 kg total N ha^{-1} was applied in the variable rate treatment, whereas the farmer practice and fixed rate / split application treatments received 101 kg total N ha^{-1}. The reduced N treatment received at 67 kg total N ha^{-1}, all of which was applied at seeding. None of the treatments evaluated had a significant effect on grain yield. Assuming equal yields and a fertilizer price of \$1.10 kg N^{-1}, the variable rate treatment showed modest fertilizer savings of \$12 ha^{-1} over the farmer practice treatment. However, considering an application cost of \$12.50 ha^{-1}, the profit of the two treatments was approximately the same. With savings of \$37 ha^{-1} over the farmer practice treatment, the reduced N treatment was the most lucrative. Although the variable rate treatment had no economic advantage over the farmer practice treatment, N fertilizer use was reduced by 12% without compromising grain yield. The apparent lack of an N-response was attributed to late season conditions being conducive for mineralization of organic N and crop uptake of N. These results should be viewed with reservation, as this was only one site and the first of three years for the study. It is likely that the benefits of this approach to N management will vary from field to field and from one year to the next.

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