Site-Specific Evaluation of Dynamic Nitrogen Recommendation Tools

S. Norquest[1], L. A. Puntel[1], L. J. Thompson[1], G. R. Balboa[1]

[1]Agronomy & Horticulture Department, University of Nebraska-Lincoln, Lincoln, NE, United States

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Abstract.

Management tools are a potential solution for increased profit and N use efficiency (NUE) in corn production. Most previous studies evaluating these tools used small plot research which does not accurately represent large scale performance and inhibits adoption. Two dynamic model-based N management tools, which were commercially available in 2021 and 2022 (Adapt-N and Granular), were tested at fifteen on-farm research locations in Nebraska. The objective of this study were to evaluate the site-specific performance of model-based N management tools. N recommendations from grower and model-based N management were replicated throughout each site in a randomized field length strip trial design. N rate blocks consisting of 4-6 N rates were embedded in the trial design to calculate site-specific Economically Optimum Nitrogen Rates (EONR) after harvest. N rate recommendations were applied and data was collected using commercial applicators and harvesters. Site-specific calculations of observed EONR were made to determine whether N recommendations were able to maximize profitability over grower N management. Quadratic plateau, Linear plateau, and Quadratic models were used for EONR determinations. The EONR rate blocks were placed in uniform soil textures for use in evaluating the model's proximity to EONR in different soil textures. Both dynamic N tools provided more accurate recommendations than the UNL N calculator (Adapt-N RMSE=30, Granular RMSE=43, UNL RMSE=69). The Adapt-N tool outperformed the grower's traditional management (RMSE=40). These results indicate good potential for data-driven dynamic model-based N management to increase the sustainability of corn production relative to Grower practice and the static university calculator, but performance varies considerably among models.

Keywords.
Granular, Adapt-N, Crop models, nitrogen recomendation

Introduction

Corn (Zea mays) production in the United States accounts for the largest share of crop land area and is the largest consumer of Nitrogen (N) fertilizers. Adoption of dynamic model-based nitrogen (N) management tools are a potential solution for increased profit and N use efficiency (NUE) in corn production. Most previous studies evaluating these tools used small plot research, which does not accurately represent large-scale performance and inhibits adoption. Two dynamic model-based N management tools, which were commercially available in 2021 and 2022 (Adapt-N and Granular), were tested at fifteen on-farm research locations in Nebraska. (Main body text uses Normal style). The objective of this study was to evaluate the site-specific performance of model-based N management tools. N recommendations from grower and model-based N management were replicated throughout each site in a randomized field length strip trial design. N rate blocks consisting of 4-6 N rates were embedded in the trial design to calculate site-specific Economically Optimum Nitrogen Rates (EONR) after harvest.

Materials and methods

N rate recommendations were applied and data was collected using commercial applicators and harvesters (Fig. 1). Site-specific calculations of observed EONR were made to determine whether N recommendations were able to maximize profitability over grower N management. Quadratic plateau, Linear plateau, and Quadratic models were used for EONR determinations. The EONR rate blocks were placed in uniform soil textures to evaluate the model's proximity to EONR in different soil textures.

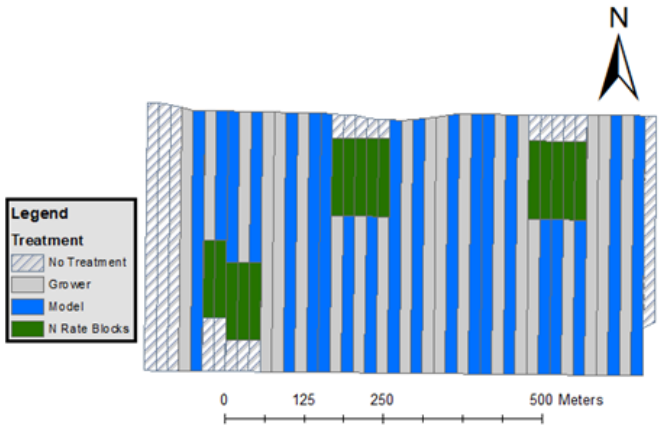

Fig 1. On-Farm Research Trial Design for dynamic model-based nitrogen management tools testing example. Blue strips indicate dynamic model nitrogen management and gray strips indicate grower nitrogen management. Bulk strips indicated areas not included in the experiment. Green strips are nitrogen rate blocks used for calculated economically optimum nitrogen rate.

Results

Both dynamic N tools provided more accurate recommendations than the UNL N calculator (Adapt-N RMSE=30, Granular RMSE=43, UNL RMSE=69). The Adapt-N tool outperformed the grower's traditional management (RMSE=40, Fig. 2).

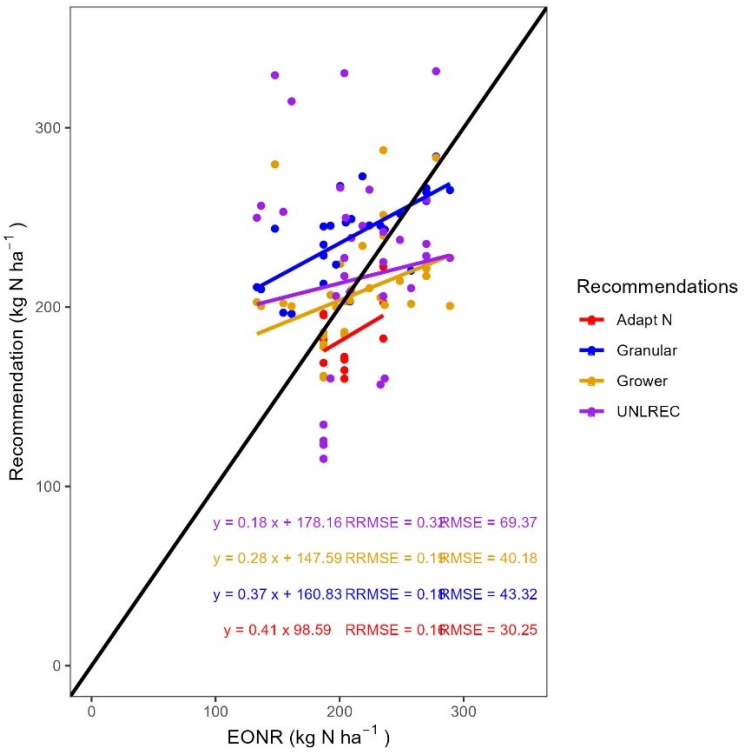

Fig 2. Adapt-N, Granular, Grower and the University of Nebraska N recommendation Tool (UNL) N rate recommendations (kg ha^{-1}) compared against the economical optimum nitrogen rate (EONR kg N ha^{-1}). Black line indicates 1:1 ratio. Linear functions were fitted for each N recommendation method following the same color code. RRMSE, relative, root mean square error. RMSE, root mean square error.

Conclusion

These results indicate good potential for data-driven dynamic model-based N management to increase the sustainability of corn production relative to Grower practice and the static university calculator, but performance varies considerably among models.

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