Economically Optimal N Recommendations Based on Variable Grain and Fertilizer Pricing and Mitscherlich-Modeled Canola Yield Responses

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Abstract

Twelve site-years of canola N response trials generated Mitscherlich-modeled yield vs N supply relationships over a range of potential yields that were dictated by available water. The N supply and N fertilizer requirements were also greatly affected by residual N and N mineralization. Economically optimal N fertilizer application rates depend upon the relative crop price to N fertilizer price ratio. Various grain: N fertilizer price scenarios were evaluated using sensitivity analysis to define optimal economic N recommendations under different water regimes.

Objective

Evaluate site-year variation of maximum yield potential, soil N supply and relative prices of canola and fertilizer on N recommendations for optimizing economic returns from N fertilizer inputs for spring canola production.

Materials and Methods

- Field experiments were conducted over 12 site years 2008-2013 in eastern WA with 5 rates of N (urea), replicated 4 times in a randomized complete block design.
- Soil series were Palouse and Broadax silt loams at Pullman and Davenport, respectively.
- Spring canola (cv Dekalb Genuity RR) was grown with the exception of winter canola at Pullman in 2009, following fallow in 2008-2010, and following wheat in 2011-2013.
- N response data was fitted using the Harmsen-Mitscherlich model (Harmsen, 2000)to characterize the growth factor response for all site years:

$$Y = A * (1 - 10^{-C(X)^{(n-1)}})$$

Where: Y – yield
X – applied N + root zone residual soil N + mineralized N according to Koenig, 2005
A – theoretical maximum yield
C – efficiency factor (initial slope)
n = moisture dependent power constant

Economic optimal N supply and corresponding yield was based on \$0.227/kg N and \$0.091/kggrain

Results

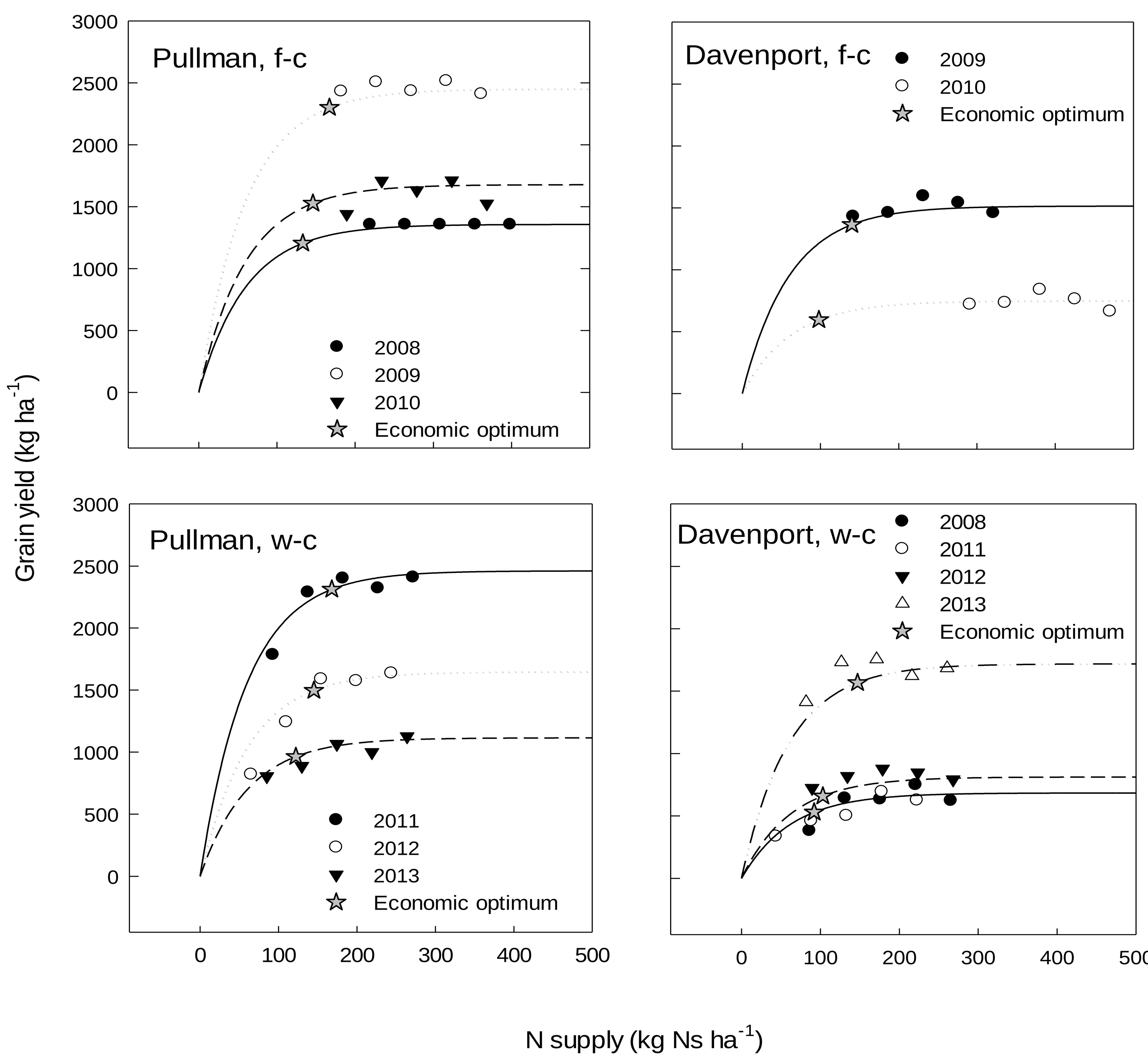

Figure 1. Location x crop sequence responses of canola following fallow (f-c) and wheat (w-c) at Pullman and Davenport modeled by the Harmsen-Mitscherlich equation (from Pan et al., in review). Stars represent economically optimal N supply (EONS) at economically optimal yields (EOY), based on canola price: fertilizer N price ratio of $\delta Y\$/\delta X\$ = 0.091/0.227$.

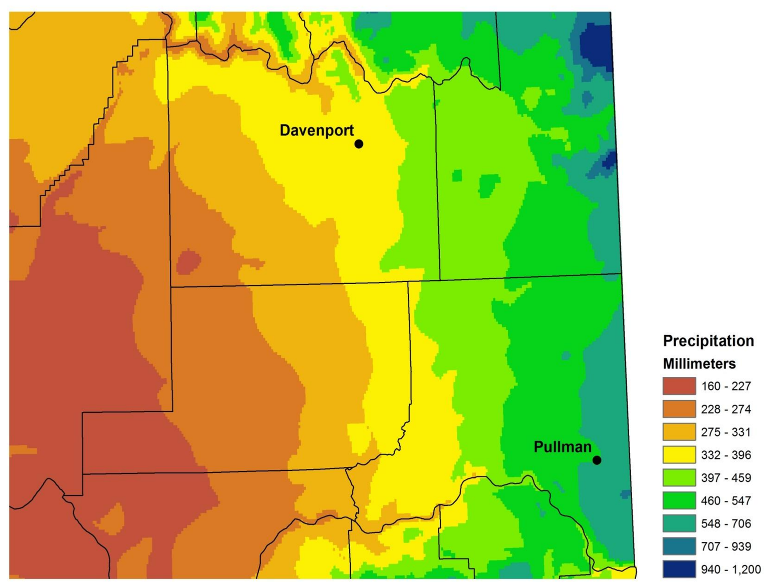

Figure 2. Study sites fell within the Cascade mountain range rain shadow.

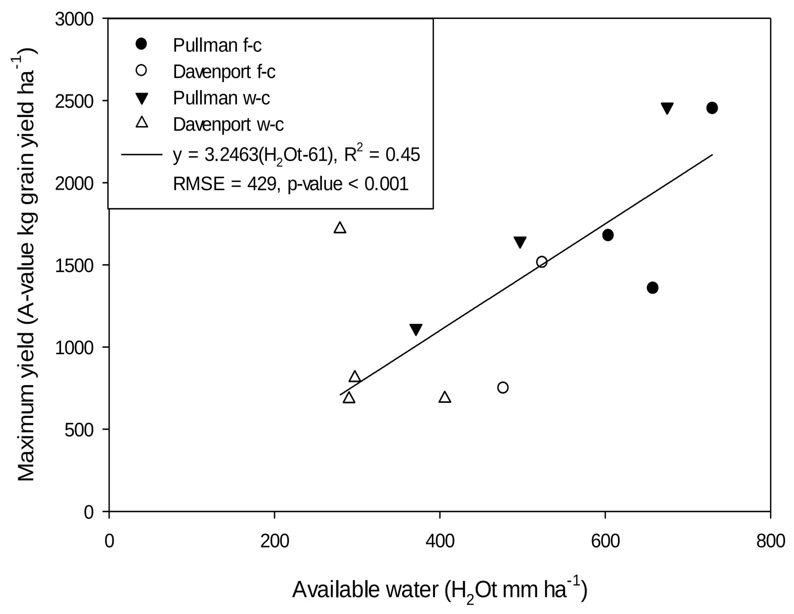

Figure 3. Yield potential was enhanced by increasing annual precipitation.

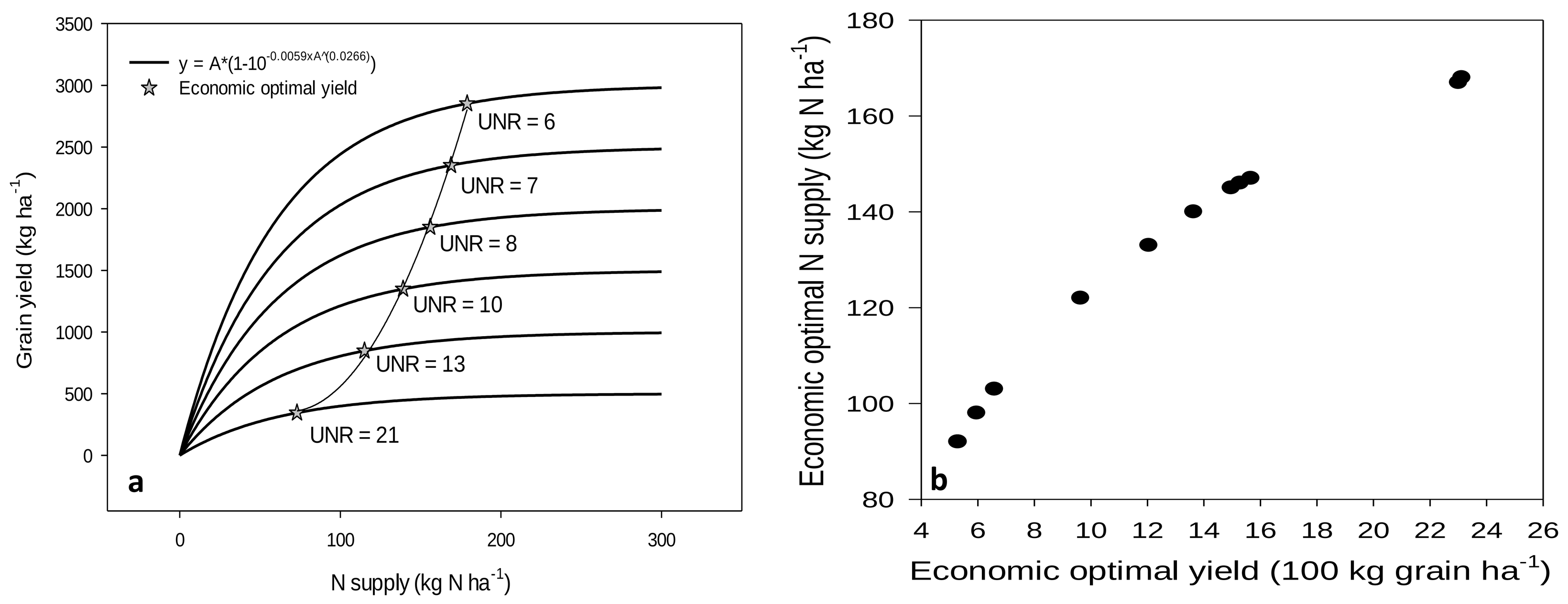

Figure 4. Modeled variation of unit N recommendations for spring canola as affected by (a) yield potential at (b) economic optimal yields with a price: fertilizer price ratio of $\delta Y\$/\delta X\$ = 0.091/0.227$

Results, continued

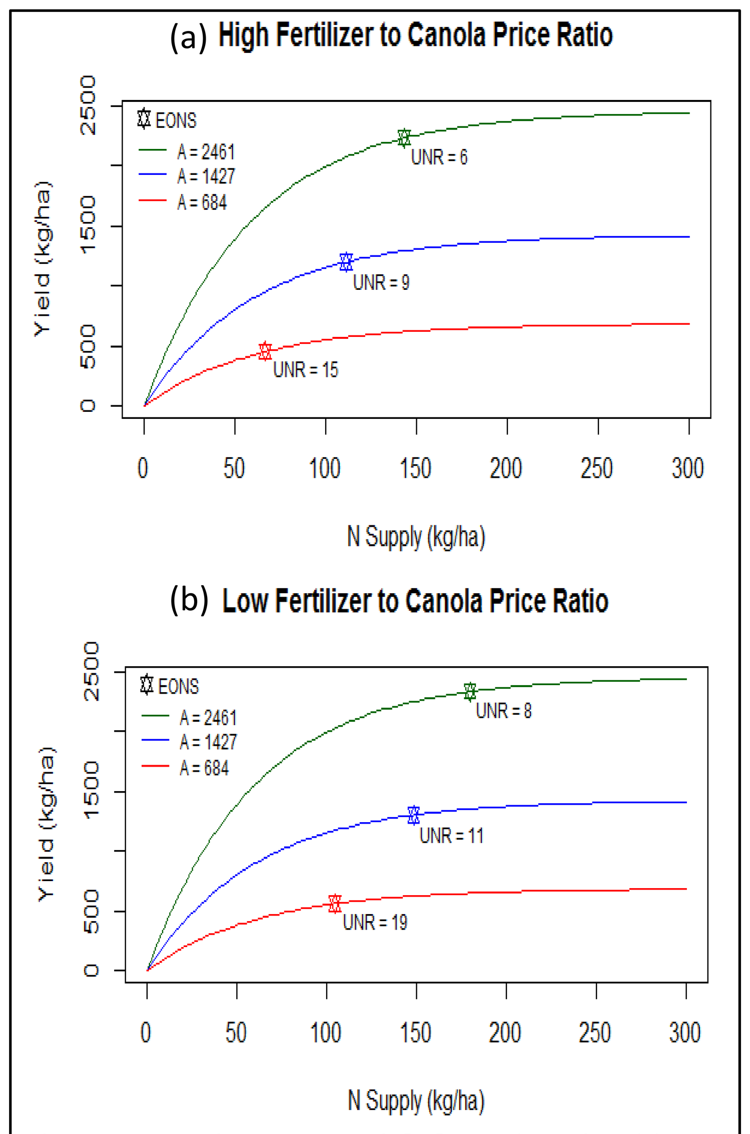

Figure 5. Influence of (a) a high fertilizer to canola price ratio and (b) a low fertilizer to canola price ratio on the unit N requirement (UNR) of spring canola

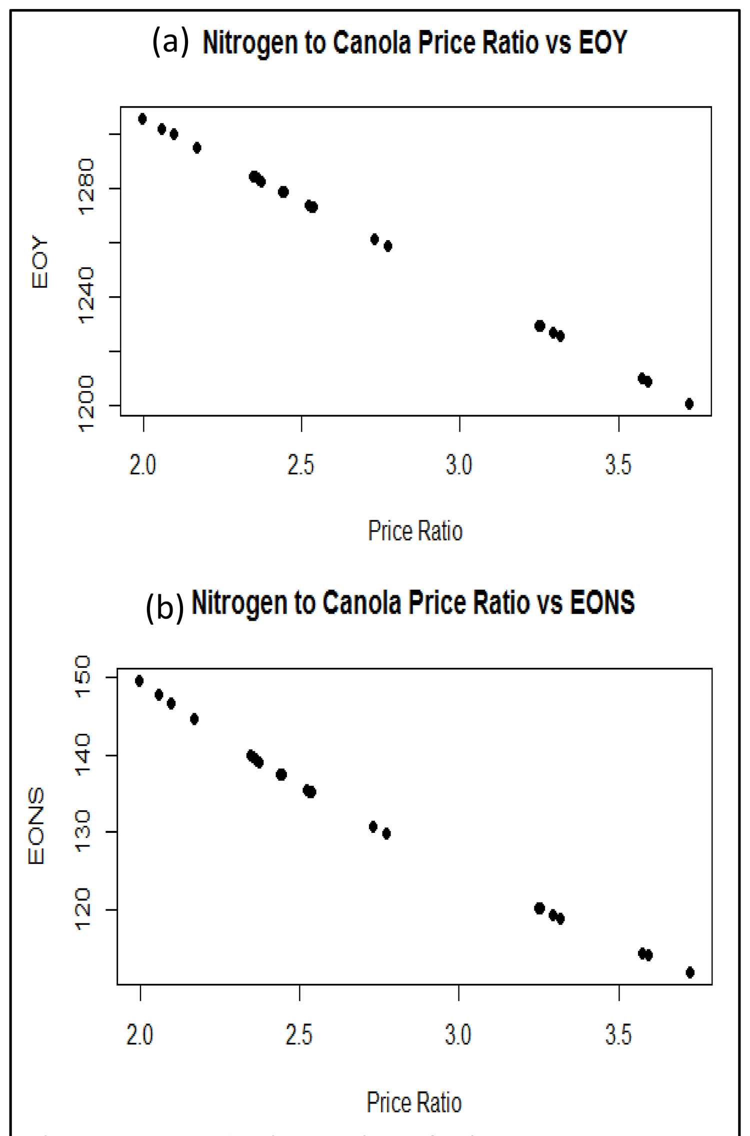

Figure 6. Relationship of nitrogen to canola price ratios to (a) economic optimal yield (EOY) and (b) N supply (EONS) at a 1427 kg ha^{-1} yield potential

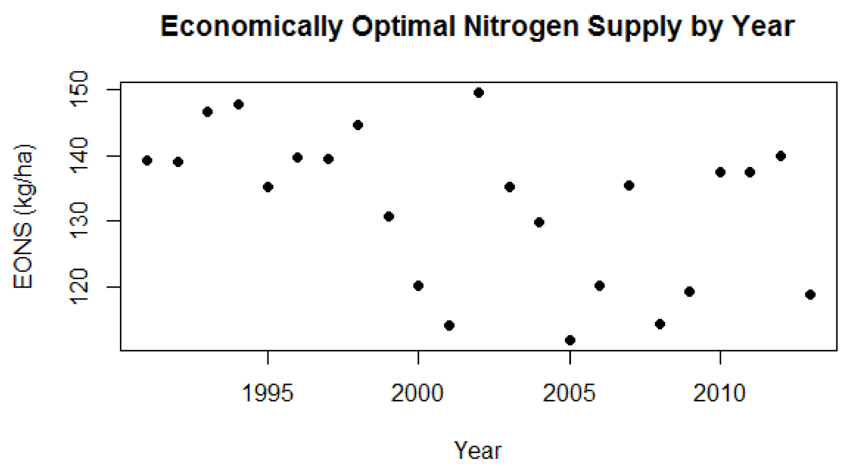

Figure 7. Variability of economic optimal nitrogen supply across 23 years given a 1427 kg grain ha^{-1} potential yield

Conclusions

•Spring canola did not respond to additions of fertilizer N when following fallow due to high contributions of residual N (Figures 1).
•The yield potential of spring canola was driven by available water within the precipitation gradient of Eastern WA (Figure 2 and 3)
•Spring canola did not have a single unit N requirement (UNR), which decreased as yield potential increased (Figure 4).
•Increases in the fertilizer to canola price ratios resulted in lower economic optimal yields, and thereby lower unit N requirements (Figure 5) and economic optimal N supply (Figure 6).
•The year-to-year price ratio is variable, which results in fluctuations in economic optimal yield. Considerations of the relative price ratios is essential when economically optimizing N fertility management.

Literature Cited

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Acknowledgements

The authors thank the following support of this research: WSU ARC project 9024, NSF IGERT Award 0903714 (NSPIRE), WA Biofuel Cropping Systems Project 3016, USDA NIFA Award #2011-68002-30191 (REACCH).