

Can Non-Targeted Application of Propiconazole Improve Malt Barley Yield and Quality?

R. E. Karamanos¹, N.A. Flore¹, J.T. Harapiak^{1†} and F. C. Stevenson²

¹Viterra Inc., Calgary, Alberta, Canada; e-mail: rigas.karamanos@viterra.ca; ²142 Rogers Road, Saskatoon, Saskatchewan, Canada; [†] deceased

Objectives

- To assess the impact of the application of propiconazole on the yield, kernel plumpness and protein content of malt barley seed independently of whether there was disease pressure or not (non-targeted);
- To ascertain whether there is an interaction between propiconazole and nitrogen fertilization.

Materials & Methods

Experiments were carried out between 1989 and 1997 at 80 sites across the Canadian Prairies. The experiments were arranged in a six-replicate split-plot design with fungicide applications (0 and 543 mL ha⁻¹ propiconazole applied at flag leaf stage) as main plots and combination of four rates of N (0, 30, 60, 90 kg ha⁻¹), three of P (triple super phosphate) as P₂O₅ (0, 15 and 30 kg ha⁻¹) and three of K (potassium chloride) as K₂O (0, 15, 30 kg ha⁻¹) as sub-plots. Levels of seeding rate were assigned to main plots in factorial combination with levels of fungicide application. Sub-plot size was 2.1 m x 5.1 m.

Barley was seeded using an air-seeder with shanks spaced 22.9 cm apart equipped with 1.9-cm knives. Phosphate and potassium were side-banded 2.5 cm to the side and 2.5 cm below the seed.

Data Collection

Days for each plot to achieve maturity were calculated from (Karamanos et al. 2004): DTM = [(moisture at harvest - 35)/2.5] + days from seeding to harvest. The plots were harvested using a small-plot combine and the grain samples were dried at 60°C by forced air and weighed to determine grain yield. Plumpness was determined by measuring the percentage of both thin and plump kernels passing through a 6/64 inch (0.5 mm) slotted screen with plump kernels remaining on the screen (Edney et al. 2005). Protein was estimated by multiplying N in a Kjeldahl digest with 6.25.

Economic Analysis

The net return for barley grown at different N fertilizer rates 15/30-0 P-K fertilizer treatment combinations were calculated as follows:

Net return = (Yield x Barley price) - (N fertilizer rate x N cost per kg) - (Other operating costs per ha) - (propiconazole cost per ha when applied).

Data from the Viterra Profit Planner was used to get an estimate of operating costs (http://www.viterra.ca/static/profit_planner/viterra_profit_planner.htm). Four combinations of barley price and N fertilizer (urea) hypothetical situations we examined for net returns. The combinations or price-cost were derived from a high \$190 t⁻¹ and low 137 t⁻¹, and high (\$0.80 kg⁻¹) and low (\$0.60 kg⁻¹) N fertilizer cost.

Introduction

Farm operating costs can be divided into five categories, namely, essential (seed), enhancement (fertilizer and seed), maintenance (fertilizer and herbicide), protection (herbicide, insecticide and fungicide), and insurance (herbicide, insecticide, fungicide and fertilizer).

Post-emergent fungicide applications for barley are used when barley diseases such as net blotch, scald, etc. are present or anticipated. Past research has shown that the application of propiconazole improved yield and kernel quality parameters such as plump kernels (Entz et al. 1990; Jedel and Helm 1992; Holm et al. 2006). Entz et al. (1990) and Jedel and Helm (1992) both found that the benefits of propiconazole were dependent on environmental conditions and level of disease. However, fungicides are often applied as insurance in anticipation of the presence and/or spread of disease. Hence, information on both the agronomic and economic effectiveness of this application is required. Past research would indicate that there could be some tradeoff between high malt barley yield and kernel quality when choosing an optimal N fertilizer rate.

Conclusions

- Non-targeted application of propiconazole to malting barley cultivars resulted in significant yield increases and improvement in kernel plumpness that occurred at all nitrogen rates. The results of this study indicated that malt barley producers should not have to vary fertilizer and disease management strategies to avoid delayed maturity and consequent effects on malt yield and quality. There was no impact of propiconazole on grain protein.
- Economic benefits of non-targeted propiconazole application are dependent both on the price of propiconazole and malting barley.

Study Conditions

Stable malt barley yield and quality in the presence of many external influences is an important objective of producers and the essence of this study. A wide range of growing conditions occurred over the course of this study, which is not atypical for the Canadian Prairies. Sites were established on a wide range of stubble types. The malting cultivars grown in the study ranged also from the once very common Harrington two-row variety to an assortment of commonly grown two and six-row cultivars.

Yield Data

Our main hypothesis was that the application of fungicide would modify the effect of N fertilizer on malt barley production. The interactive effect of fungicide and fertilizer treatment or select comparison among fertilizer treatments was not statistically significant (P<0.05) for days to maturity, yield, and quality variables. The overall effect of the fungicide and fertilizer treatments, on the other hand, clearly affected (P<0.01) barley responses, with the exception of a non-significant (P<0.05) fungicide effect for protein concentration. Applications of propiconazole improved yield by 305 kg ha⁻¹ (6%) and plump kernels by 3 g kg⁻¹ (3%) across all fertility treatments, which included all N fertilizer rates from 0–90 kg N ha⁻¹. (Fig. 1). The effect of fungicide on yield was greatest at sites with highest yield potentials (ca. 8000 kg ha⁻¹) and not statistically significant at lower-yielding sites (ca. 3000 kg ha⁻¹). Fungicide application, however, did not affect protein concentration (Fig. 1).

Malt barley required an average of 102 days to mature, but fertilizer treatment differences were no greater than about 1 day (means not shown).

Economic Analysis

Application of propiconazole improved net returns {barley revenue - (N cost + propiconazole cost + other operating costs)} by CAN\$22 ha⁻¹ with higher barley priced (CAN\$190 t⁻¹) and high yield potentials (Fig. 2). At sites with low yield potential, the application of propiconazole resulted in additional net losses of about CAN\$7 ha⁻¹ compared with not applying propiconazole. Nitrogen fertilizer rates from 0–90 kg N ha⁻¹ (15/30-0 P-K fertilizer treatment combinations) increased yield and protein concentration, and reduced plump kernels in a curvi-linear fashion when averaged across fungicide treatments. Net returns were maximized at N fertilizer rates slightly less than 90 kg N ha⁻¹, depending on the price/cost regime.

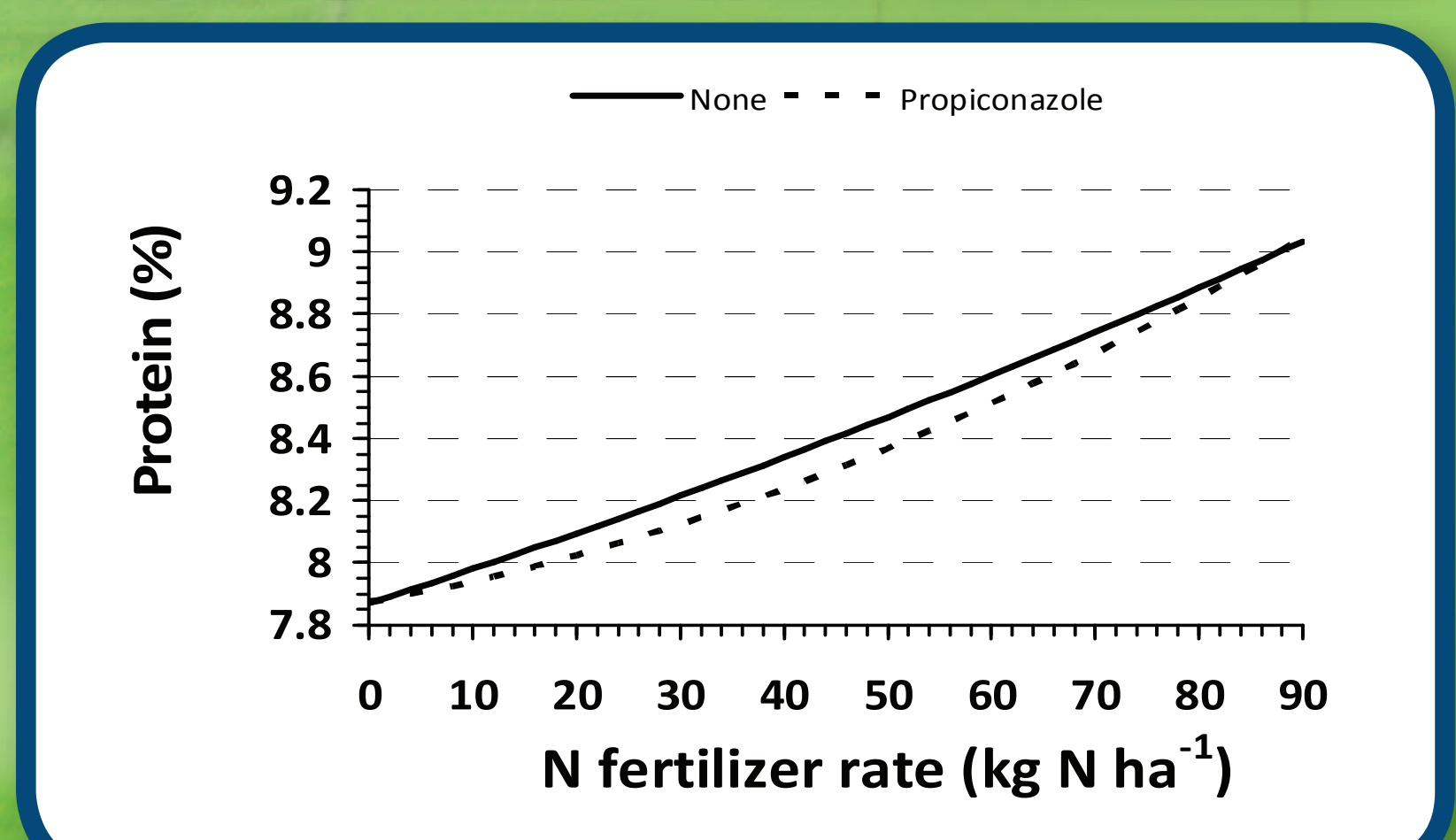
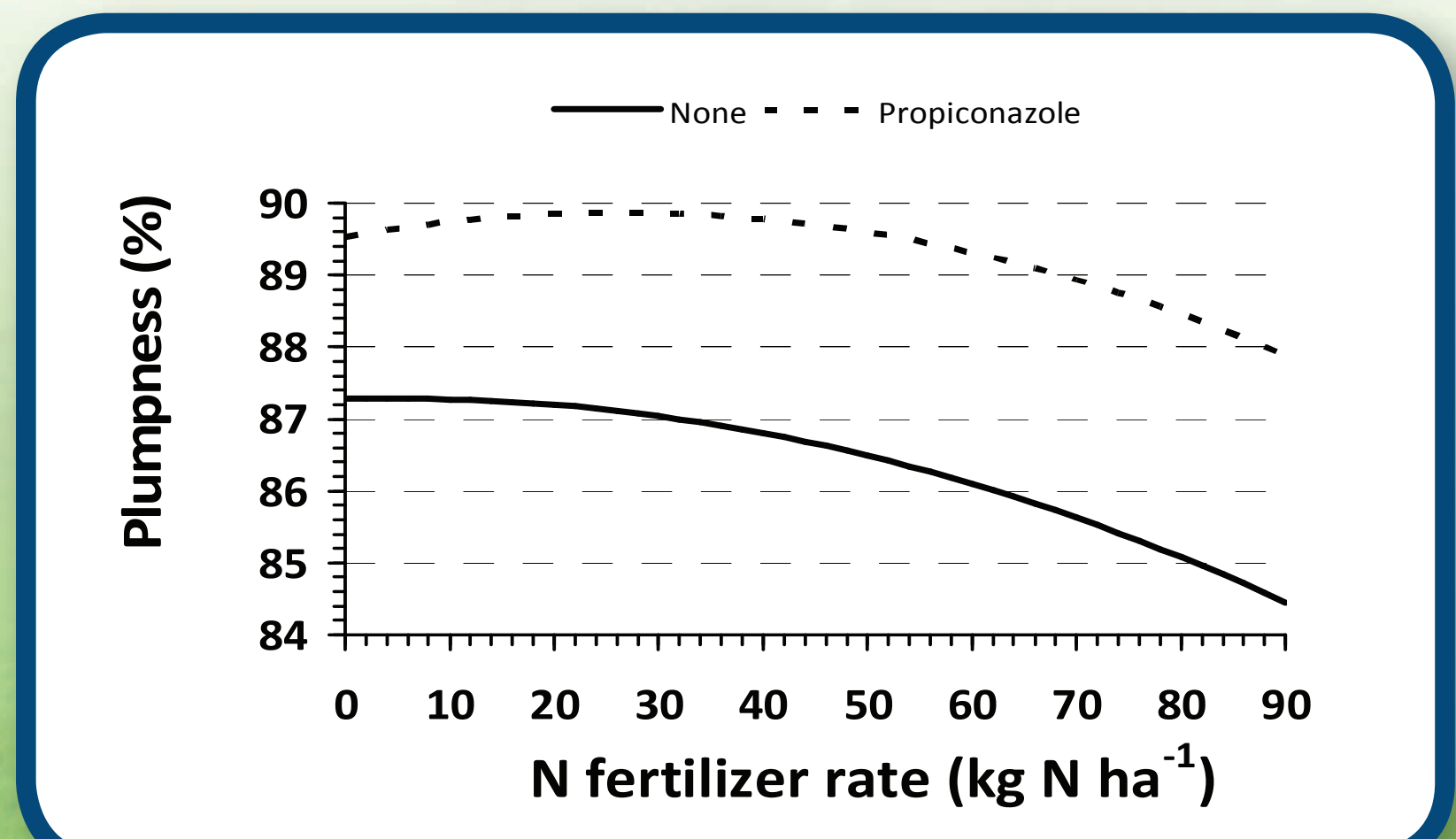
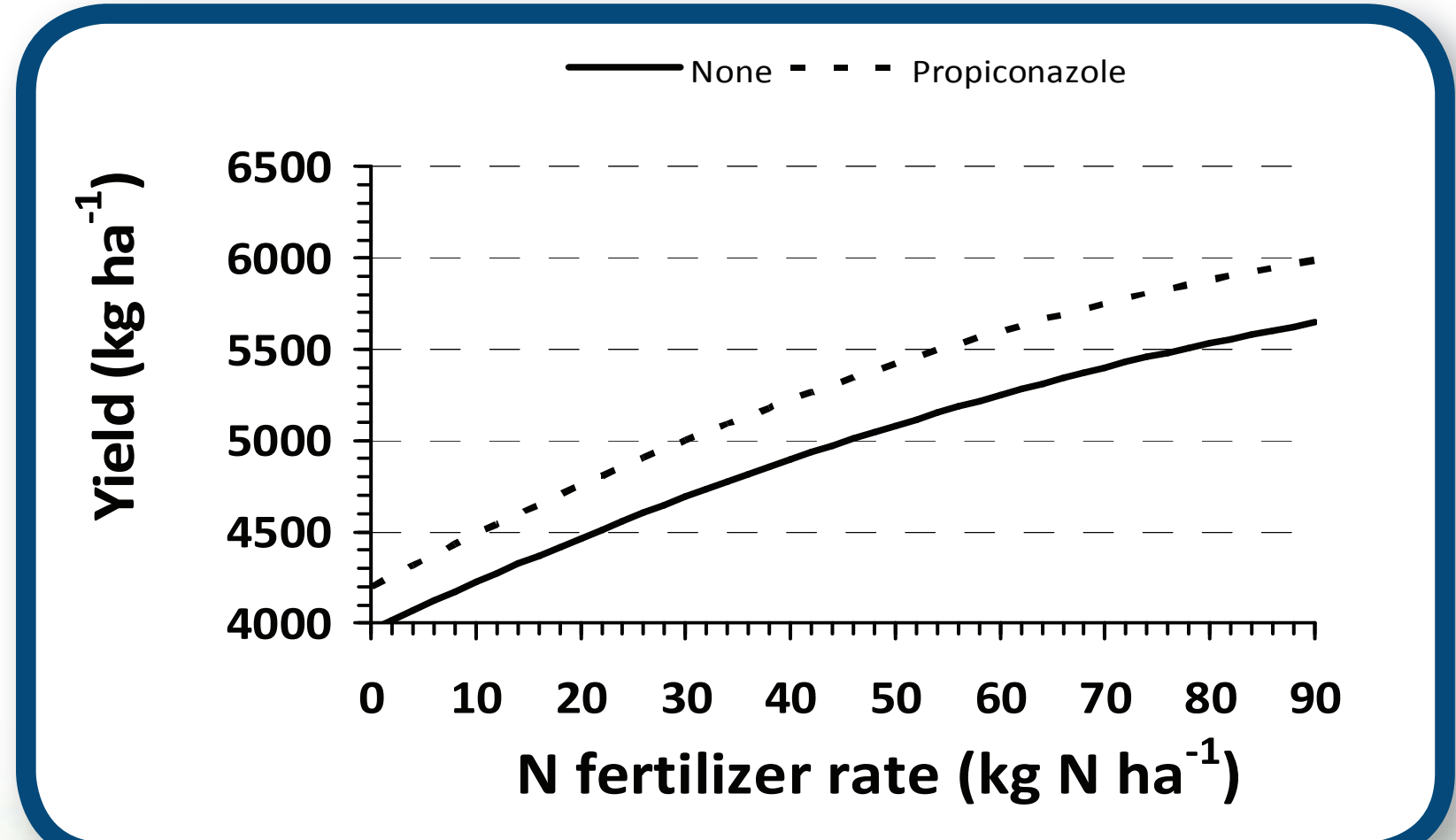


Figure 1. Polynomial regression trends for malt barley responses to N fertilizer rate for plots receiving and not receiving Propiconazole for data collected at sites across the Prairies Provinces, 1989–2007. Only data for 15/30-0 P-K fertilizer treatment combinations was used. Regression equations (inset in the respective charts) include coefficients and SE in brackets after each coefficient.

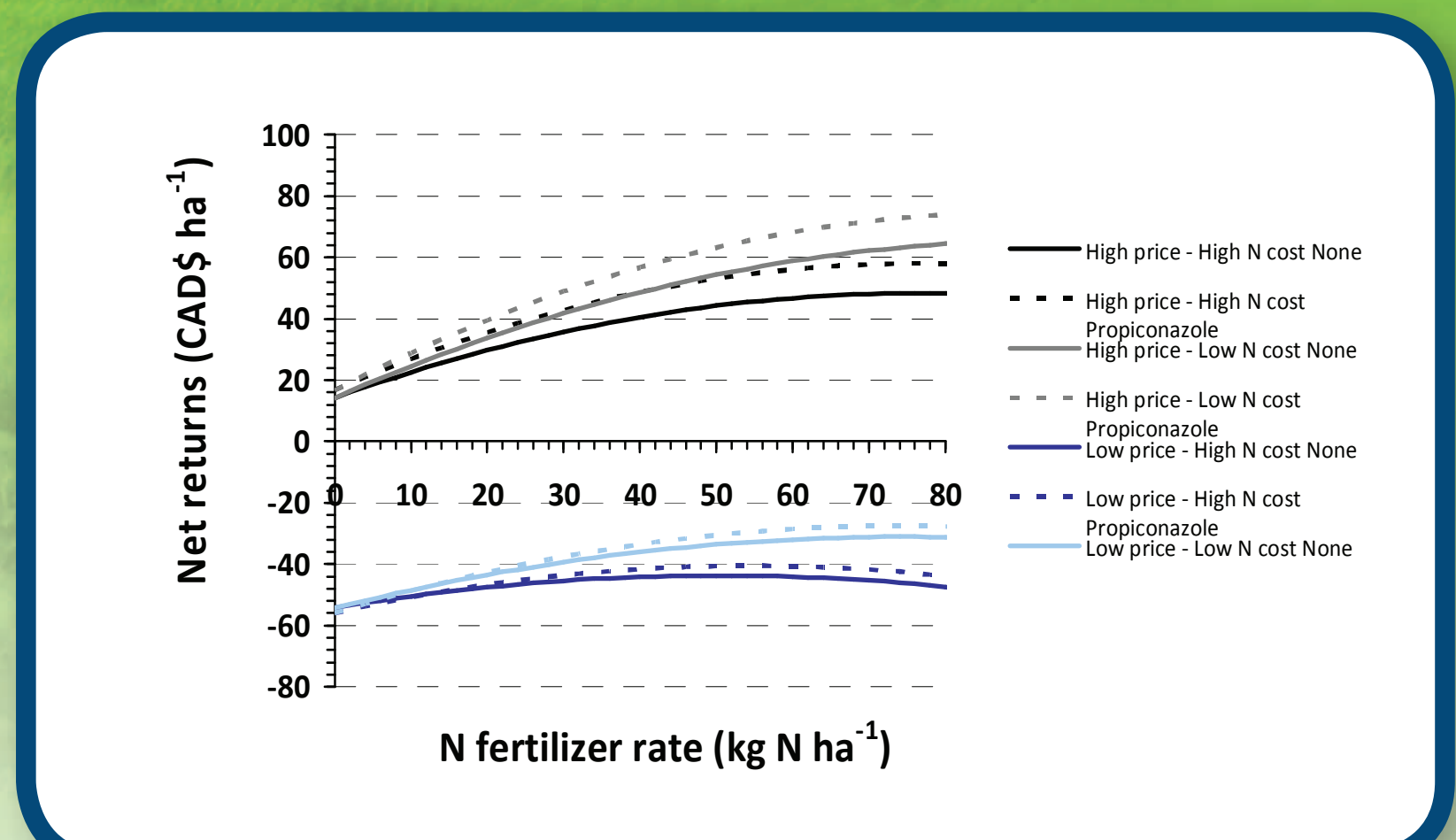


Figure 2. Polynomial regression trends for malt barley net return responses to N fertilizer rate for plots receiving and not receiving Propiconazole for data collected at sites across the Prairies Provinces, 1989–2007. Only data for 15/30-0 P-K fertilizer treatment combinations was used. Regression equations (inset in the respective charts) include coefficients and SE in brackets after each coefficient. See Materials and Methods for a definition of the four combinations of barley price and N fertilizer cost.

References

- Edney, M. J., Izdorzcyk, M. S., Symons, S. J. and Woodbeck, N. 2005. Measuring barley kernel colour and size to predict end use malt quality. Canadian Grain Commission [Online]. Available: <http://www.grainscanada.gc.ca/research-recherche/edney/bcsq-ctoq/bcsq-ctoq-eng.htm>
- Entz, M. H., Van Den Berg, C. G. J., Stobbe, E. H., Rossnagel, B. G., Lafond, G. P. and Austenson, H. M. 1990. Effect of late-season fungicide application on grain yield and seed size distribution in wheat and barley. Can. J. Plant Sci. 70: 699–706.
- Helm, P. A., Zentgraf, R. P., Thomas, A. G., Sagsford, K., Lagère, A., Gossens, B. D., Olfert, O., and Entson, J. V. 2006. Agronomic and economic responses to integrated weed management systems and fungicide in a wheat-canola-barley-pea rotation. Can. J. Plant Sci. 86: 1281–1295.
- Jedel, P. E. and Helm, J. H. 1992. Agronomic response of six-row barley cultivars to supplemental fertilization and late-season fungicide treatments. Can. J. Plant Sci. 72: 1121–1130.
- Karamanos, R.E., Harapiak, J.T., Flore, N.A. and Stonehouse, T.B. 2004. Use of N-(n-butyl) Thiophosphoric Triamide (NBPT) to Increase Safety of Seed-Placed Urea. Can. J. Plant Sci. 84: 105–116.