Nitrogen Response and Nitrogen Use Efficiency of High Yielding Canola Cultivars

D. Ulrich[1], S. Brandt[1], G. Lafond[2], S. Malhi[3], A. Johnston[4]

[1] AAFC Scott Research Farm, SK, [2] AAFC Research Farm Indian Head, SK,
[3] AAFC Research Farm Melfort SK., [4] Potash and Phosphate Institute of Canada, Saskatoon, SK

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Introduction

Several new canola varieties have much higher yield potential than those grown in the past. For example, the yield potential of highest yielding varieties listed in the Varieties of Grain Crops booklet for 2001, published by Saskatchewan Agriculture and Food are as much as 35% greater than for the check variety AC Excel. One question that arises is whether such varieties require greater inputs of fertilizer nutrients, particularly nitrogen (N), to realize optimum economic returns.

Materials and Methods

To address this issue, a study was initiated in 2000, and repeated in 2001at Scott (Dark Brown Soil Zone), Melfort (Black Soil Zone), and Indian Head (Thin Black Soil Zone). To evaluate responses to fertilizer N, Quantum was selected as being representative of high yielding open pollinated varieties (OP), and Invigor of high yielding hybrid varieties (HYB). They were direct seeded into wheat stubble using low disturbance hoe or knife openers with on-row packers. Available soil N, P, K, and S were measured prior to seeding. Treatments consisting of 0, 27, 53, 80 ,107, and 134 lb/ac of actual N were applied in the form of urea at seeding by mid row banding at Scott and side banding at Indian Head and Melfort. All treatments received a P-K-S blend applied at a uniform rate below the seed at Scott and beside the seed at Melfort and Indian Head. Weeds and disease were controlled to minimize pest losses. Spring soil moisture conditions were near normal over 4 of 6 location years, but below normal at Scott, and above normal at Indian Head in 2001. May-July precipitation in 2000 ranged from 95% of normal at Scott to 117% of normal at Indian Head. In 2001 May-July rainfall ranged from 39% of normal at Indian Head to 69% of normal at Scott. Overall May-June precipitation averaged 5.5 inches or 80% of normal. If both cultivars had similar N use efficiency, any yield increase of one over the other due to higher genetic yield potential, would be associated with a greater demand for N.

Results and Discussion

Soil tests showed an average residual soil N on wheat stubble of 53 kg/ha to 30 cm in 2000 and 41 kg/ha in 2001, of which 50 % was assumed to be available. Harvest yields indicated 118 kg/ha of applied N was sufficient to maximize OP and HYB yields under the dry conditions of 2001 but failed to maximize yield under near normal moisture conditions in 2000 (Fig. 1). At the high N rate of 150 kg/ha of N in 2000 HYB yielded 2751 kg/ha versus 2439 kg/ha for OP. In

2001 the HYB reached a maximum yield of 1734 kg/ha compared to 1411 kg/ha for OP. Averaged over all location years, HYB yielded 15% more than OP. Also HYB yielded more at all levels of applied N indicating the hybrid used N more efficiently in producing canola seed than OP. The higher N use efficiency of the HYB increased yields by an average of 244 kg/ha over all N rates. These results indicate that HYB used N more efficiently and did not require higher N application rates.

An economic evaluation of the data was performed using production costs from the 2001 Saskatchewan Crop Planner published by Saskatchewan Agriculture and Food. Additional functions were added to account for assumed differences in seed costs of $9.35/kg for HYB and $4.40/kg for OP. In addition, several price scenarios for fertilizer N and for the value of canola were evaluated. A combined analyses showed net returns were maximized for both cultivars near 112 kg/ha of applied N, when canola was priced between $220-352/tonne and N costs ranged from $0.51-0.75/kg. When maximizing net returns, higher HYB yields translated into an additional $15.10/ha for every $50/tonne increase in the price of canola above $147/tonne (Fig. 2). In general, the economic benefit of growing the HYB over OP was >Indian Head > Melfort > Scott. When adequately N fertilized, the HYB provided greater economic returns than OP at all sites. The income advantage of the HYB was retained under below normal moisture conditions. N required to maximize returns for both cultivars however decreased as moisture decreased (Fig. 3). At $264/tonne and N=0.75/kg, 126 kg/ha or more of applied N was required to optimize net returns in 2000 compared to 90 kg/ha under the drier conditions of 2001. These results indicate many producers are setting lower target N levels than are required to optimize returns for canola on wheat stubble even when moisture and canola prices fall short of expectations.

Conclusions

These results indicate that target N levels for canola grown on wheat stubble in a moisture limited environment should be the same for a higher yielding hybrid as they are for a high yielding open pollinated variety. It also suggests that high yielding varieties should be receiving more fertilizer to maximize yield and optimize net economic return than is currently being applied by many producers. Net economic returns were greater for the HYB than the OP, despite higher seed costs, as a consequence of increased N use efficiency that resulted in higher yields.

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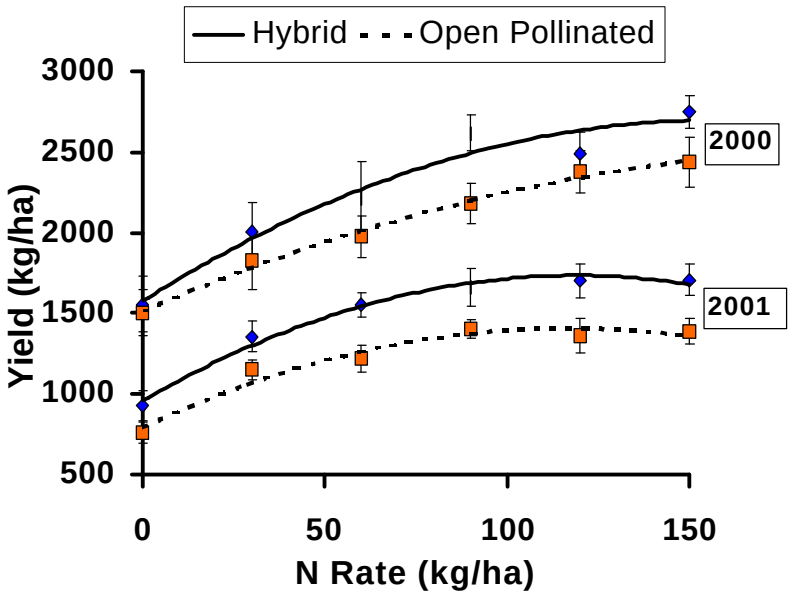

Figure 1. Yield (kg/ha) as a function of applied nitrogen.

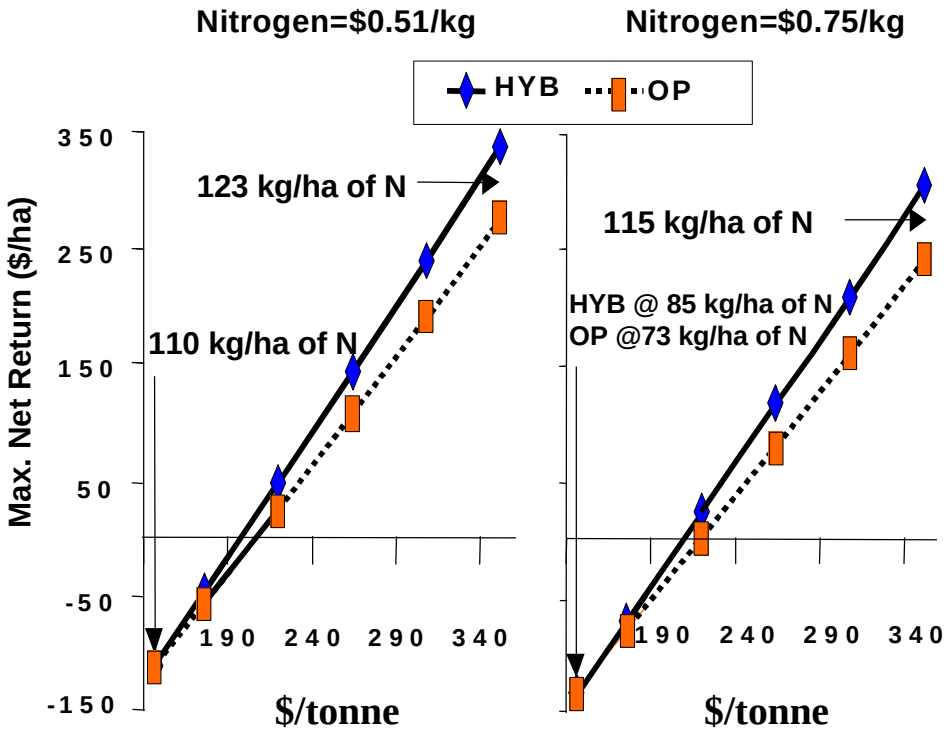

Figure 2. Maximum net returns for applied N when canola was priced from $147-352/tonne and N cost $0.51/kg and $0.75/kg.

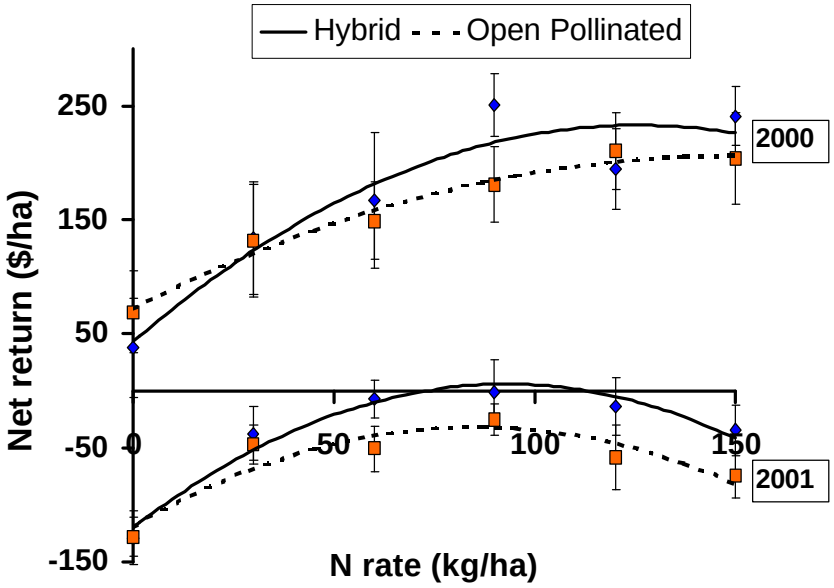

Figure 3. Net return ($/ha) for HYB and OP at $264 /tonne and N=0.75/kg at increasing rates of N under dry conditions in 2001 and near normal moisture conditions in 2000.