# Management for optimum yield of open pollinated and hybrid canola

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***Introduction:***
Newer open pollinated and hybrid canola varieties provide higher yield potential but the management strategies necessary to achieve optimum yield are not well understood. To better understand the levels of inputs required to optimize yield and to enhance producers ability to optimize return on their investment field research trials were conducted over a three-year period (1998-2001) at Melfort, Indian Head, and Scott with the following objectives:

***Objective 1:*** To evaluate the effect of seeding rate, fertilizer addition and fungicides on the optimum yield potential of hybrid and open pollinated canola in the Thick Black, Thin Black and Dark Brown soil zones.

***Objective 2:*** To determine if more N is required to optimize yield of hybrid than OP cultivars because of the higher yield potential of hybrids.

***Materials and Methods:***
The canola management study was conducted at Melfort (Thick Black), Indian Head (Thin Black), and Scott (Dark Brown)in 1999, 2000, and 2001. The management study was lost at Melfort in 1999 as a result of damage to the growing point caused by leaching of Muster after a heavy rain. At Scott in 2000 suspected high levels of residual soil N were observed to run perpendicular across all 4 replicates of the management study resulting in abnormally high biomass and seed production. A combined analyses of results from the canola management study across years and locations was therefore confined to 2000-2001 for Melfort, 1999&2001 for Scott and 1999-2001 for Indian Head for a total of 7 site-year locations. The inclusion of Melfort-2000 however did require adjustments for shatter loss caused by wind damage prior to threshing. An additional N rate study was conducted at each location in 2000 and 2001 to evaluate a broader range of N application rates. All 6 location years for the N rate study used in a combined analyses. Studies incorporated Quantum, representing high yielding open pollinated (OP) varieties, and Invigor 2273 in 1999 and Invigor 2663 in 2000-2001 representing high yielding hybrid (HYB) varieties. Canola was direct seeded into wheat stubble using low disturbance hoe openers at Scott and knife openers at Melfort and Indian Head with on row packers. Row spacing was 20 cmat Scott, 23 cm at Melfort, and 30 cm at Indian Head. Background levels of nitrogen to 60 cm depth, phosphate to 15 cm, potassium to 15 cm and sulfur to 60 cm depth were measured each year to assist in establishing target N levels and to determine available N in the N rate study. Nitrogen was applied as urea at seeding by mid row banding at Scott and side banding at Indian Head and Melfort. A P-K-S blend was applied below the seed at Scott and beside the seed at Melfort in Indian Head. Weeds were controlled to minimize pest losses. Data collection included plant density, crop biomass and seed yield, growth staging (flowering initiation, end of flowering, 30% seed maturity) as well as percent green seed, % oil and protein (NIR). See Appendix 1 for a more detailed summary of operations, inputs and data collection dates.

The canola management study experiment was designed as a 3 level factorial with a fungicide strip. Factors in the experiment in addition to OP and HYB cultivars included three N fertility levels needed to supply 0.67, 1.0 and 1.33 X a target level and three seeding rates 2.7, 5.8, 8.4 kg/ha. A blend of P-K-S was applied at rates that increased as N rate increased. Fertility levels were categorized as low, middle, and high with target levels specific to each location. Table 1 summarizes N (soil + fertilizer) levels on the experiment between 1999 and 2001. The fungicide strip received an application of Ronilan EG (vinclozolin) for control of sclerotinia with an added application of Quadris (azoxystrbin) at Melfort. Disease surveys were conducted prior to swathing.

Table 1. Combined soil and fertilizer N levels (kg/ha) at each location for the canola management study.

| | Scott | | | | Indian Head | | | | Melfort | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1999 | 2000 | 2001 | Mean | 1999 | 2000 | 2001 | Mean | 1999 | 2000 | 2001 | Mean |
| 67 % | 58 | 100 | 76 | 78 | 110 | 91 | 125 | 109 | - | 82 | 77 | 80 |
| Target | 84 | 111 | 113 | 103 | 144 | 127 | 169 | 147 | - | 121 | 117 | 119 |
| 133 % | 110 | 123 | 150 | 128 | 184 | 163 | 212 | 186 | - | 161 | 157 | 159 |

The N rate study was designed as a factorial experiment with 6 rates of applied N; 0, 30, 60, 90, 120 and 150 kg/ha. Nitrogen was banded prior to seeding at Scott and side banded at Melfort and Indian Head at the time of seeding. Table 2 summarizes soil N levels prior to fertilizer N applications in 2000 and 2001. A single rate of a P-K-S blend was applied. Fungicides were applied when disease levels warranted. The target seed rate was 9 kg/ha.

Table 2. Soil N levels prior to fertilizer application on the N rate study.

| | Scott | | | Indian Head | | | Melfort | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | Mean | 2000 | 2001 | Mean | 2000 | 2001 | Mean |
| Soil N (kg/ha) | 74 | 22 | 48 | 45 | 30 | 29 | 68 | 61 | 65 |

Table 3. Monthly precipitation and mean monthly temperatures at Scott, Melfort and Indian Head.

| Month | Precipitation (mm) | | | | Temperature (Celsius) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1999 | 2000 | 2001 | Long Term 1950-1997 | 1999 | 2000 | 2001 | Long Term 1950-1997 |
| Scott | | | | | | | | |
| May | 66 | 24 | 18 | 34 | 9.4 | 9.4 | 11 | 10.4 |
| June | 43 | 41 | 59 | 65 | 13.6 | 13.5 | 13.9 | 14.8 |
| July | 81 | 91 | 37 | 66 | 15.1 | 17.8 | 17.7 | 17.1 |
| August | 48 | 57 | 4 | 46 | 16.8 | 15.6 | 19 | 16.1 |
| Melfort | | | | | | | | |
| May | 41 | 15 | 9 | 41 | 10.2 | 9.1 | 11.2 | 10.3 |
| June | 14 | 74 | 23 | 62 | 14 | 13 | 15.8 | 15.2 |
| July | 96 | 106 | 46 | 69 | 15.9 | 17.6 | 18.5 | 17.4 |
| August | 36 | 47 | 11 | 53 | 17 | 16.6 | 19.1 | 16.2 |
| Indian Head | | | | | | | | |
| May | 67 | 68 | 2 | 50 | 10.4 | 10.1 | 11.4 | 10.8 |
| June | 116 | 105 | 29 | 74 | 14.5 | 13.1 | 14.4 | 15.9 |
| July | 84 | 46 | 41 | 62 | 16 | 18 | 18.1 | 18.5 |
| August | 88 | 63 | 13 | 53 | 16.6 | 16.4 | 18.9 | 17.5 |

Spring soil moisture conditions were near normal with the exception of below normal at Scott and above normal at Indian Head in 2001. Long term average May-July precipitation of 165 mm at Scott, 172 mm at Melfort and 186 mm at Indian Head yielded an overall average of 175 mm. May-July precipitation in 1999 ranged from 115% of normal at Scott to 144% of normal at Indian Head, in 2000 from 95%(Scott) to117%(Indian Head) of normal, and in 2001 39%(Indian Head) to

69%(Scott) of normal. For the seven location years used in the combined analyses of management study results overall precipitation averaged 151 mm or 86% of normal. For the 6 location years of the N rate study precipitation averaged 139 mm or 80% of normal. The growing season in 1999 and 2000 were characterized by cool temperatures with above normal temperatures recorded in 2001. The combination of near to above normal precipitation with cool temperatures in 1999 and 2000 generally resulted in lush crop canopies producing normal to above normal yields. Dry conditions in May of 2000 at Scott and Melfort and at all locations in 2001 reduced plant populations with additional plant loss occurring in the management study at Melfort in 2000 as a result of frost. Below normal precipitation and above normal temperatures in 2001 reduced biomass production that generated below normal yields.

***Results and Discussion***

***1.0 Management Study Agronomic Results***

Because the same weight of seed was sown for both cultivars, and the seed size for the HYB was greater than that of OP, the number of seeds sown was lower. This was the major factor affecting cultivar differences in plant density (Table 4). In general plant densities were lower for Invigor than Quantum, while the reverse occurred for percent establishment. Biomass and grain yield with the HYB was similar or higher than OP at all location years, and averaged 12% higher for both. With above normal moisture during 1999, the grain yield differences between cultivars were relatively small. By contrast, 2001 was very dry at all locations, and grain yield differences between cultivars were quite large (Figure 1). This in itself may not be sufficient to conclude that hybrids (Invigor) are more drought tolerant than open pollinate (Quantum) cultivars. Howeve,r it does provide strong evidence that they are at least equal and possibly more drought tolerant.

**Table 4. Plant densities, plant establishment, biomass production and grain yield of Invigor and Quantum canola at Scott, Melfort and Indian Head during 1999-2001. (Data is the mean of 3 seed rates and 3 fertility levels).**

| | Plant density | | Percent establishment | | Biomass (t/ha) | | Grain yield (kg/ha) | |
|---|---|---|---|---|---|---|---|---|
| Location (year) | Invigor | Quantum | Invigor | Quantum | Invigor | Quantum | Invigor | Quantum |
| Scott (1999) | 81b | 139a | 68 | 82 | 6.69a | 5.77b | 2470a | 2360b |
| Indian He (1999) | 56b | 64a | 45 | 38 | 11.02a | 9.84b | 1750 | 1790 |
| Scott (2000) | 75a | 66b | 55 | 38 | 5.97 | 5.47 | 1690a | 1460b |
| Indian Head (2000) | 112 | 107 | 82 | 61 | 9.45a | 8.49b | 2040a | 1790b |
| Melfort (2000) | 19b | 27a | 14 | 15 | 7.27a | 6.47b | 2030a | 1870b |
| Scott (2001) | 108b | 144a | 89 | 87 | 5.82a | 5.37b | 1350a | 1200b |
| Indian Head (2001) | 41 | 40 | 34 | 24 | 6.40a | 5.59 | 1300a | 850b |
| Melfort (2001) | 45 | 46 | 37 | 28 | 6.41a | 5.47b | 1870a | 1580b |
| **8 Loc Yr Mean** | **67b** | **79a** | **53** | **47** | **7.38a** | **6.56b** | **1810a** | **1610b** |

Values followed by a different letter are significantly different at P=0.05.

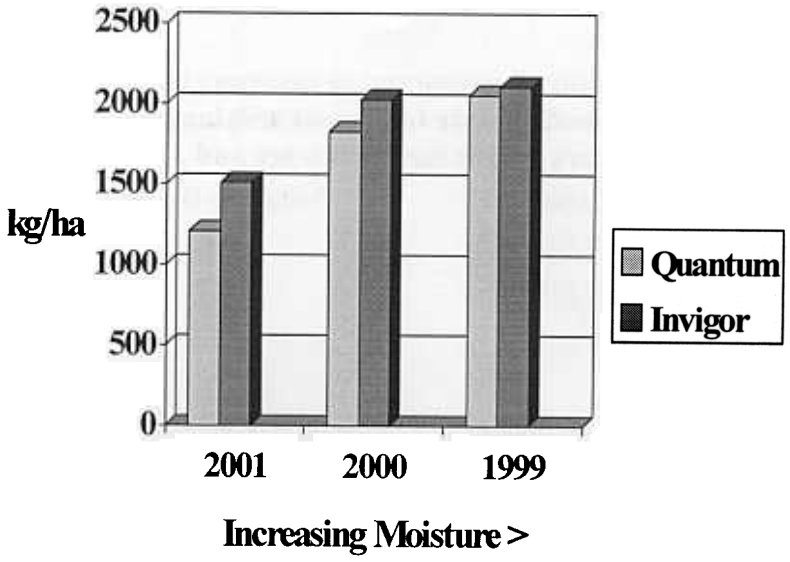


Figure 1. Impact of moisture on average yields [kg/ha] of Quantum and Invigor (Invigor 2273 in 1999 and Invigor 2663 in 2000-2001) canola at Scott, Melfort, and Indian Head.

There were small (generally 1-2 day) cultivar differences in time to start flowering and time to maturity, but the differences were not consistent across location years (data not shown). Disease incidence tended to be quite low for most location years, with one exception. At Melfort in 2000, sclerotinia incidence and sclerotinia induced seed loss (estimated) were higher for Invigor than for Quantum, although values for both cultivars were relatively low.

A combined analyses of yields revealed a consistent response among the 2 cultivars to seed rate, nutrient level, and fungicide despite the HYB producing on average 865 kg/ha more biomass and 194 kg/ha more seed than OP. Fungicide treatment alone generally failed to invoke a yield response as levels of sclerotinia were low. The interaction of fungicide with fertility level was significant at P=0.05, and there was a tendency for the seed rate x fungicide interaction to be significant (P=0.055) when analysed across location years. At the low fertility level, yield was unaffected by fungicide (Table 5), while at the mid and high fertility levels, a small yield increase was noted where fungicides were applied. This suggests that enhanced growth with higher fertility likely created an environment more conducive to sclerotinia infection and development. At Scott in 1999, and at Indian Head in 2000, sclerotinia incidence and yield loss ratings did increase with increased fertility (data not shown).

**Table 5. Yield (kg/ha) response to fungicide treatment and increasing fertility averaged across 7 location years. (Values are means for 2 cultivars and 3 seed rates).**

| | Fertility level | | |
|---|---|---|---|
| Fungicide treatment | Low | Mid | High |
| None | 1619d | 1723c | 1807b |
| Treated | 1593d | 1782b | 1856a |
| LSD (P=0.05) | | 39 | |

Values followed by a different letter are significantly different at P=0.05.

Fungicide application only increased yield at the lowest seed rate (Table 6). This would suggest that the longer flowering period associated with reduced seed rates may have allowed more time for

sclerotinia to affect the crop. However, sclerotinia incidence and severity ratings were similar for all seed rates (data not shown).

**Table 6. Yield (kg/ha) response to fungicide treatment and increasing seed rate averaged across 7 location years. (Values are means for 2 cultivars and 3 fertility levels).**

| | Seed rate (kg/ha) | | |
|---|---|---|---|
| Fungicide treatment | 2.8 | 5.6 | 8.4 |
| None | 1558e | 1751c | 1839a |
| Treated | 1618d | 1794c | 1819ab |
| LSD (P=0.05) | | 51 | |

Values followed by a different letter are significantly different at P=0.05.

Increasing seed rate and increasing fertility level generally increased yield (Table 7). Higher seeding rates however did not increase biomass indicating later emerging branches created at low plant densities were less effective at converting biomass to yield than earlier emerging branches at high seeding rates. Fertility level x seed rate interactions showed yields increased as inputs increased. At the low fertility level, yield increased when seed rate was increased from 2.8 to 5.6 kg/ha, but was not increased further when seed rate increased to 8.4 kg/ha; higher fertility was required to induce a yield response to higher seed rate. Similarly, at the 2.8 kg/ha seed rate, yield was higher for the mid than low fertility but further increases in yield were not noted for the high fertility rate; responses to high fertility only occurred at the 5.6 and 8.4 kg/ha seed rates. This provided a strong indication that higher plant densities are required to take advantage of higher fertility, and vice versa. The lack of an interaction of cultivar with seed rate or fertility level provided a good indication that both cultivars require similar seed rates and fertility to optimize yield.

**Table 7. Yield (kg/ha) response to increasing fertility and increasing seed rate averaged across 7 location years. (Values are means for 2 cultivars and 2 fungicide treatments).**

| | Seed rate (kg/ha) | | |
|---|---|---|---|
| Fertility level | 2.8 | 5.6 | 8.4 |
| Low | 1489e | 1673d | 1654d |
| Mid | 1616d | 1773c | 1868b |
| High | 1659d | 1870b | 1964a |
| LSD (P=0.05) | | 51 | |

Values followed by a different letter are significantly different at P=0.05.

Because percent emergence varied considerably across location years, an attempt was made to identify the plant densities required to achieve adequate responses to higher fertility. In general, where plant densities were less than 45 plants/$m^2$ yield responses to higher fertility were 0-6% compared with the low fertility level. Where plant densities exceeded 65/$m^2$ yield responses to higher fertility averaged 12-18%.

### *1.0.1 Grain Quality*

As with yield, treatment effects on oil concentration varied somewhat between location years. Oil concentration was higher for the Invigor hybrid than for Quantum at 5 of 7 location years. The reverse occurred at the remaining 2 location years. Oil concentration for Invigor averaged 47.0% while it was 46.4% for Quantum over all location years.

Oil concentration declined with increasing fertility level, and this trend was quite consistent across

location years (Table 8). There was also a general tendency for oil concentration to increase as seed rate increased, although this tendency was not very consistent across location years.

**Table 8. Oil concentration [%] response to increasing fertility and increasing seed rate averaged across 7 location years. (Values are means for 2 cultivars and 2 fungicide treatments).**

| Fertility level | % oil | Seed rate [kg/ha] | % oil |
|---|---|---|---|
| Low | 47.4a | 2.8 | 46.3b |
| Mid | 46.7b | 5.6 | 46.9a |
| High | 46.1c | 8.4 | 46.9a |
| LSD (P=0.05) | 0.4 | | 0.2 |

Values followed by a different letter are significantly different at P=0.05.

The impact of fungicides on oil concentration was negligible.
Differences in protein concentration between cultivars was less consistent than for oil concentration, but Invigor averaged 24.8% while Quantum was significantly lower at 24.4%.
There was a general tendency for protein concentration to increase as fertility increased, and to decrease as seed rate increased (Table 9). This was to be expected since protein generally reflects the supply of N. Increasing N supply with greater fertility would be expected to increase protein concentration in addition to increasing yield. Increased seed rate increased yield but since the supply of N did not increase, yield would be expected to dilute protein.
Generally there is an inverse relationship between oil and protein concentrations. Factors that increase one tend to reduce the other. This provides a likely explanation for the tendency for oil to increase as seed rate increased.

**Table 9. Protein concentration [%] response to increasing fertility and increasing seed rate averaged across 7 location years. (Values are means for 2 cultivars and 2 fungicide treatments).**

| Fertility level | % protein | Seed rate [kg/ha] | % protein |
|---|---|---|---|
| Low | 24.2c | 2.8 | 24.8a |
| Mid | 24.6b | 5.6 | 24.5b |
| High | 25.0a | 8.4 | 24.5b |
| LSD (P=0.05) | 0.35 | | 0.26 |

Values followed by a different letter are significantly different at P=0.05.

Yield of total oil and total protein reflected the combined effects of treatments on grain yield and concentration of these components in the grain. In most cases, treatment effects on yield were so large that they masked effects on concentration where concentration responsess were inverse to yield responses (Table 10). In general, yield of both components was

- highest for Invigor
- increased with increased fertility
- increased with increasing seed rate from 2.8 to 5.6 kg/ha, but no further increase at 8.4 kg/ha.

**Table 10. Protein and oil yield responses to increasing fertility and increasing seed rate averaged across 7 location years. (Values are means for 2 cultivars and 2 fungicide treatments).**

| Fertility level | protein[kg/ha | oil [kg/ha] | Seed rate [kg/ha] | protein[kg/ha | oil [kg/ha] |
|---|---|---|---|---|---|
| Low | 387c | 765b | 2.8 | 392b | 741b |
| Mid | 429b | 823a | 5.6 | 433a | 835a |
| High | 456a | 849a | 8.4 | 447a | 861a |
| LSD | 24 | 42 | | 31 | 56 |

Values followed by a different letter are significantly different at P=0.05.

Green seed was also determined, and treatments did affect levels of green seed. There was a tendency for grren seed to be higher at the highest fertility level, but overall green seed levels were very low. Thus the practical significance of this is not known.

### *1.1 N Rate Study Agronomic Results*

A combined analysis of the data from all locations and years indicated that the interaction of cultivar with N rate and location-year was significant. This would suggest that the 2 cultivars did not respond to N in the same manner at all location-years. However, a closer examination of the individual location- year data did not reveal any major discrepancies. The magnitude of the responses to N varied considerably over location-years, but the general trend was for yield to increase with N rate (Appendix 17). In no case was the zero N rate signifcantly higher yielding than any of the N treatments at the same location-year. Similarly, there were instances where the OP tended to be higher yielding than the HYB at one N rate within a location year. However, in almost all cases the yield of the HYB equalled or exceeded that of the OP variety.

During 2001 when conditions were dry, overall yields were lower and 118 kg/ha of applied N was sufficient to maximize yield of both cultivars (Figure 2). Yield was not maximized even with the highest N rate under near normal moisture conditions in 2000. HYB yielded 2751 kg/ha at 150 kg/ha of N in 2000 versus 2439 kg/ha for OP at that rate in that year. In 2001 the HYB reached a maximum yield of 1734 kg/ha compared to 1411 kg/ha for OP.

Averaged over all location and years, yield of the HYB was maximized at 2198 kg/ha with134 kg/ha of fertilizer N. The yield of the OP variety was maximized 1906 kg/ha with 149 kg/ha of fertilizer N (Figure 3). HYB yielded more at all levels of applied N indicating that it used N more efficiently than the OP variety. The relative difference in yield between the 2 cultivars increased as N supply increased, yielding 10% more when no N was applied and 16.6 % more when 110 kg/ha of N was applied. The higher N use efficiency of the HYB increased yields by an average of 246 kg/ha over all N rates. These results indicate that HYB did not require more N, but it did use N more efficiently.

Harvest index values plotted against increasing levels of applied N revealed consistently greater HYB plant growth may have resulted in the HYB consuming more soil water in May and June (Figure 4). Depleted soil water reserves when not replaced by rain reduced the water available for seed fill later in the growing season. This resulted in maximum harvest index being achieved at a lower applied N rate for the HYB than OP (94 kg/ha vs 129 kg/ha). Although this may have prevented the HYB from achieving its higher yield potential, the HYB still produced more grain per unit of biomass than the OP.

### *1.1.1 Grain Quality*

The cultivar effect on oil concentration was significant and quite consistent across location years,

averaging 47.9% for Invigor 2663, and 46.3% for Quantum. This occurred despite higher grain yield for Invigor 2263, which consistently resulted in higher oil yield for this cultivar. Protein concentration was generally higher for Invigor 2663 [24.4%] than Quantum [24.1] as well, but the trend was much less consistent across location years than for oil. However, because Invigor 2663 was consistently higher yielding, protein yield was also consistently higher.
Increasing the N application rate consistently increased protein concentration, protein yield and oil yield while decreasing oil percentage (Table 11). At N rates above 90 kg/ha, oil yield showed very little added response, but protein yield continued to increase even at the highest rate.

Green seed was also determined, and there was a clear tendency for increasing N to increase green seed of both cultivars [from 0.25% at the lowest rate to 1.10 % at the highest N rate], on average across site years. This combined with a similar observation for the other experiment would suggest that the risk of downgrading due to this quality factor will increase somewhat as fertilizer N rate is increased.

**Table 11. Protein and oil concentration and yield responses to increasing fertility and increasing seed rate averaged across 6 location years for protein and 4 location years for oil.**

| N rate [kg/ha] | protein [%] | oil [%] | protein[kg/ha] | oil [kg/ha] |
|---|---|---|---|---|
| 0 | 23.5 | 49.1 | 273 | 583 |
| 30 | 23.6 | 48.7 | 351 | 767 |
| 60 | 24.1 | 47.2 | 407 | 828 |
| 90 | 24.5 | 46.3 | 466 | 868 |
| 120 | 24.9 | 45.8 | 474 | 871 |
| 150 | 25.1 | 45.3 | 501 | 878 |
| | 0.4 | 0.8 | 52 | 88 |

Values followed by a different letter are significantly different at P=0.05.

***2.0 Management Study Economics / Marginal Returns***

Economic analyses were performed on the data based on costs from the 2001 Crop Planner published by Saskatchewan Agriculture and Food (available on the Saskatchewan Agriculture and Food website). Table 12 outlines the actual expenses used in the analysis. Treatments were evaluated on the basis of profit probability as determined by canola price and N cost. Highest profit probability conditions existed at the high canola price and low N costs ($352/tonne canola- N=$0.51/kg), intermediate at high canola price and high N cost or low canola price and low N cost ($352/tonne-N=$0.75/kg, $264/tonne-N=$0.51/kg) and low profit probability at low canola price and high N cost ($264/tonne-N=0.75/kg). Assumed seed costs for HYB were $9.35/kg for HYB and $4.40/kg for OP.

The HYB averaged $24/ha more in net returns than OP at the canola price of $264/tonne and $40/ha more at $352/tonne. Under best profit probability conditions net returns of OP and HYB were maximized at the high seed rate (8.4 kg/ha) and high fertility level (net returns of $242/ha for OP vs $272/ha for HYB).

At intermediate profit probability levels high seed rates and moderate-high fertility levels maximized net returns from $79/ha for OP to $242/ha for HYB(Figure 5). Under low profit probability conditions the high seed rate in combination with moderate fertility level continued to maximize profits for OP ($58/ha) but reduced HYB net returns by $9/ha compared to mid seed rate (5.6 kg/ha) and low fertility ($79/ha). This suggests reducing inputs will lower net returns because yield is

reduced. Even at the low canola price ($264/tonne) and high N cost (N=$0.75/kg) savings from reduced inputs for HYB appeared minimal compared to the potential loss should canola prices improve (Figure 5). These results, which occurred when growing season moisture averaged across location years was below normal, suggests that the full economic value of higher yielding canola cultivars can only be realized when fertilizer and seed rates are at or above the maximum recommended rate.

**Table12. Crop production costs ($/ha) used in economic analyses (based on 2001 Crop Planner published by Saskatchewan Agriculture and Food).** [actual values are a weighted average for the Dark Brown and Black soil zones based on the number of location years of data for each soil zone].

| | |
|---|---|
| Variable expenses ($/ha)<br>Including chemicals, machinery operating, custom work and hired labour, crop insurance premiums, utilities and miscellaneous expenses, and interest on variable expenses, but excludes seed and fertilizer costs that varied across treatments. | 129.40 |
| Other expenses ($/ha)<br>Including building repair, property taxes, insurance and licences, machinery depreciation, building investment, and land investment. | 129.75 |

Net returns were also calculated using an average canola price of $310/tonne for each cultivar x seed rate x fertility level x fungicide treatment for each location year. In addition the returns per $ invested and coefficients of variability of net returns for each treatment combination was determined. To calculate an index of variability of net income, the coefficient of variability (CV)for one treatment (considered a check) was assigned a value of 1.00, and indexes for other treatments were calculated based on the magnitude of the corresponding CV relative to the check [example; if the CV for a treatment was 25% lager than for the check, the index would be 1.25]. Only selected economic data are reported here.

Not surprisingly, total costs were higher (reflecting seed costs) for the HYB than the OP variety, but the value of higher yield more than offset higher costs (Table 13), resulting in net returns that were $34/ha higher. Net income was only 2/3 as variable for the Invigor than for Quantum (index of variability of 0.67 vs 1.00), and return per $ invested was higher for Invigor. The reduced income variability reflected the relatively good yield performance of Invigor in 2001, the driest year at all locations. This is not surprising, and reflects that cultivars or other practices that perform well in dry years provide income stability. The effect of the hybrid in this study is somewhat unique in that many technologies that improve drought tolerance also restrict yield in years of favourable moisture. Technologies that restrict yield losses in dry years but perform well in wetter conditions are the most desirable of strategies to cope with drought and stabilize income.

Net returns were highest for the combination of high fertility and the highest seed rate (Table 14), and were generally low for the lowest seed rate, although it was low also for low fertility, high seed rate combination. Income variability was high and return per $ invested low for the low seed rate across all
fertility levels. Low seed rates increase the probability that plant populations are insufficient to make efficient use of moisture and inputs used to produce a crop. With high seed rates, it is important that fertility is adequate to ensure that the crop can optimize yield. Overall the mid to high fertility rates, combined with mid to high seed rates were favoured.

**Table 13. Economic Comparison of Cultivars (means for 7 location years)[Canola @ $310/tonne].**

| | Invigor | Quantum |
|---|---|---|
| Total cost ($/ha) | 400 | 373 |
| Gross return ($/ha) | 563 | 502 |
| Net return ($/ha) | 163 | 129 |
| Index of income variability* | 0.67 | 1 |
| Return per $ invested | 1.4 | 1.35 |

*Index of income variability is a relative measure of the coefficient of variability of net income over location years where the 5.6 kg/ha seed rate with mid fertility has been assigned a value of 1.00.

**Table 14. Economic comparisons of seed and fertilizer rates.**

| Seed rate (kg/ha) | Net returns ($/ha) | | | Index of income variability* | | | Return per $ Invested | | |
|---|---|---|---|---|---|---|---|---|---|
| | Fertility level | | | Fertility level | | | Fertility level | | |
| | Low | Mid | High | Low | Mid | High | Low | Mid | High |
| 2.8 | 120 | 132 | 118 | 1.2 | 1.4 | 1.92 | 1.35 | 1.36 | 1.3 |
| 5.6 | 154 | 158 | 161 | 0.96 | 1 | 1.2 | 1.42 | 1.41 | 1.39 |
| 8.4 | 130 | 168 | 172 | 0.98 | 0.95 | 1.05 | 1.39 | 1.42 | 1.4 |

*Index of income variability is a relative measure of the coefficient of variability of net income over location years where the 5.6 kg/ha seed rate with mid fertility has been assigned a value of 1.00.

### *2.1 N Rate Study Economic/Marginal Returns*

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. 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 (Figure 6). 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. A combined analysis 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 results were separated on the basis of moisture availability 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. 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.

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.

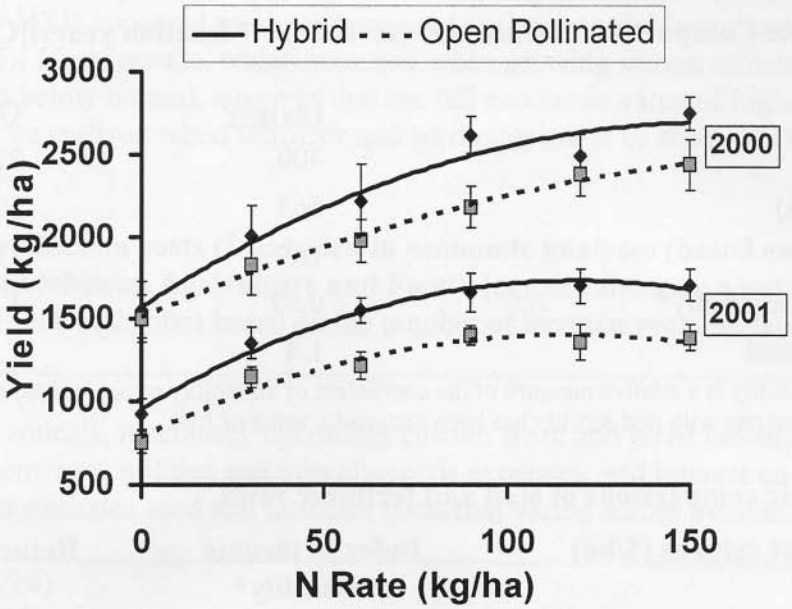


Figure 2. Yield (kg/ha) as a function of applied nitrogen under normal-above normal moisture conditions in 2000 and below normal moisture conditions in 2001.

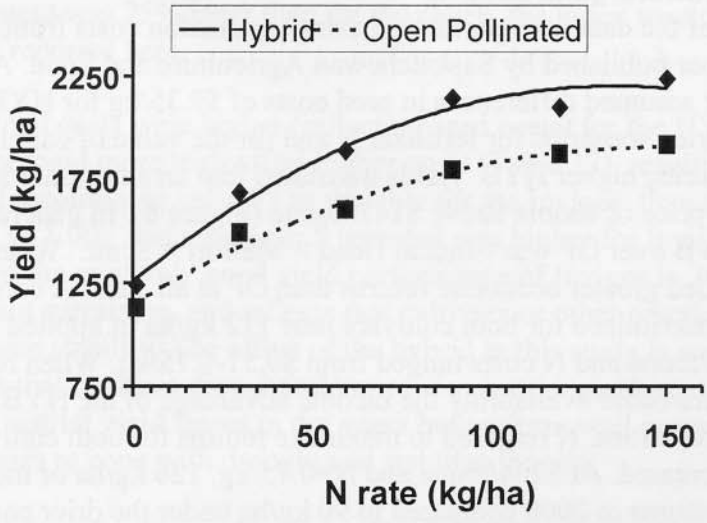


Figure 3. Yield (kg/ha) as a function of applied nitrogen.

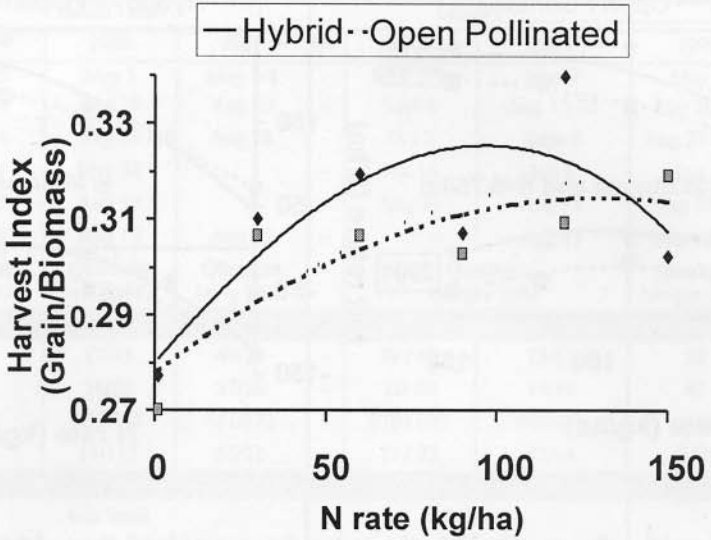


Figure 4. Harvest index as a function of applied nitrogen.

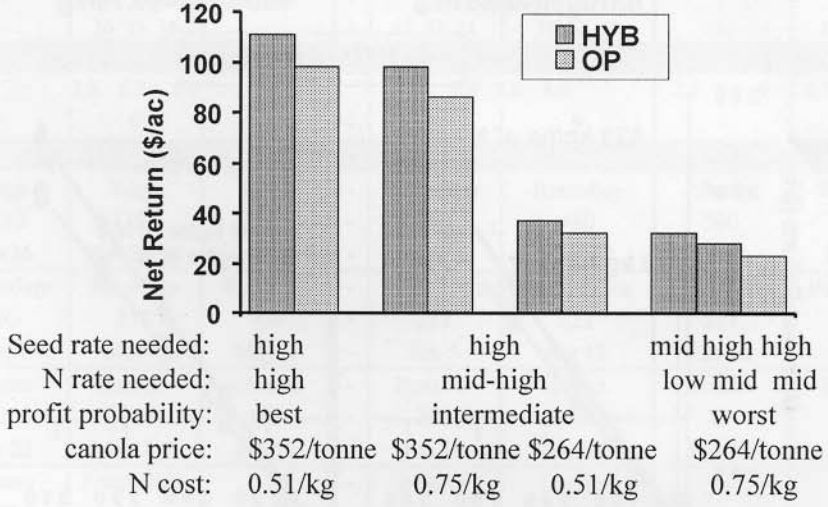


Figure 5. Net returns for variable seed and N rates when canola was priced from $352-264/tonne and N costs ranged from $0.51-0.75/kg.

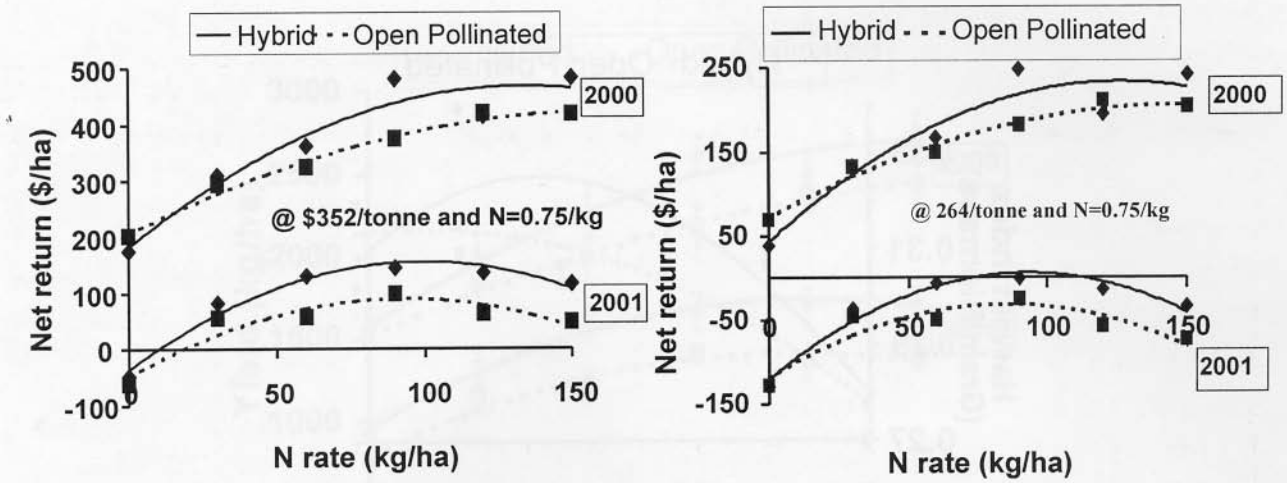


Figure 6. Maximum net returns for applied N when canola was priced from $147-352/tonne and N cost $0.51 and $0.75/kg.

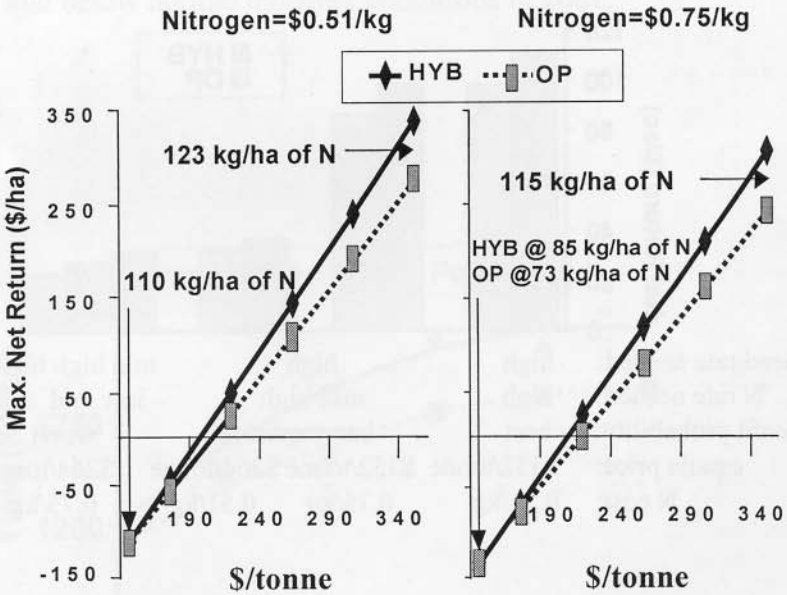


Figure 7. Impact of near normal moisture conditions in 2000 and below normal moisture in 2001 on net return($/ac) of hybrid and open pollinated canola at $264-$352/tonne and N=0.75/kg.

Appendix 1. Management and N Rate study variable inputs, operation and data collection dates.

| | Indian Head | | | Melfort | | | Scott | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1999 | 2000 | 2001 | 99 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Seeding Date | May 25 | May 3 | May 7-8 | - | May 7- 8 | May 7 | May 7 | May 12 | May 5 |
| Swathing Date | Aug 31 | Aug 15 | Aug 20 | - | Sept 6 | Aug 15-22 | Aug 20-25 | Aug 18-31 | Aug 9 |
| Harvest Date | Sept 16 | Aug 29 | Aug 28 | - | Oct 2 | Sept-4 | Aug 27-Se 4 | Sept 13 | Aug 18 |
| Plant Counts | Jun 29 | May 30 | | - | Jun 16 | Jun 4 | Jun 2 | Jun 8 | May 29 |
| Biomass | Aug 25 | Aug 14 | | - | Aug 31 | Aug 15 | Aug 19-20 | Aug 22-24 | Aug 7 |
| Dis. Survey | Aug 24 | Aug 10 | Aug 15 | - | | Aug 17 | Aug 19-23 | Aug 22 | Aug 7 |
| Canola | Quantum Invig 2473 | Quantum Invig 2473 | Quantum Invig 2663 | - | Quantum Invigor 2663 | | Quantum Invigor 2273 | Quantum Invigor 2663 | |
| Soil Test Results on Management and/or N Rate study(kg/ha) | | | | | | | | | |
| $NO_3$-N 0-60cm | 34.7 | 17/45 | 40/30 | - | 39 / 68 | 28/61 | 38 | 74 | 22 |
| $PO_4$-P 0-15cm | 11.2 | 16/22 | 27/36 | - | 21/ 60 | 19/54 | 42 | 55 | 4 |
| K 0-15cm | 571 | 557/571 | 571/571 | - | 570 / 605 | 540/456 | >600 | >600 | - |
| $SO_4$-S 0-60cm | 95 | 17/112 | 55/71 | - | 71 / 72 | 52/64 | 112 | 172 | - |
| Fertilizer Management Study (kg/ha) | | | | | | | | | |
| N Placement | side band | | | | side band | | mid row band | | |
| N target % | 66 100 133 | 66 100 133 | 66 100 133 | | 66 100 133 | 66 100 133 | 66 100 133 | 66 100 133 | 66 100 133 |
| N | 75 109 149 | 74 110 146 | 85 129 172 | - | 43 82 122 | 49 89 129 | 20 46 72 | 26 37 49 | 54 91 128 |
| $P_2O_5$ | 23 34 45 | 22 34 45 | 17 25 33 | - | 6 19 32 | 6 19 32 | 17 | 11 17 23 | 17 23 29 |
| K | 11 17 23 | 11 17 23 | 8 13 17 | - | 6 19 32 | 6 19 32 | 0 | 11 17 23 | 17 23 29 |
| S | 11 17 23 | 11 17 23 | 8 13 17 | - | 2 6 11 | 2 6 11 | 0 | 4 6 8 | 6 8 10 |
| Fertlizer N Rate study (kg/ha) | | | | | | | | | |
| N | - | 0, 30, 60, 90, 120, 150 | | - | 0, 30, 60, 90, 120, 150 | | - | 0, 30, 60, 90, 120, 150 | |
| P K S | - | 26 13 13 | | - | 33 33 11 | 33 33 11 | - | 33 33 11 | 23 23 8 |
| Seeding Rates (kg/ha) | Seed size(g/1000) 1999: Inv2273=4.5 Qtm=3.3 2000: Inv2663=4.1 Qtm=3.2 2001:Inv2663=4.6 Qtm=3.4 | | | | | | | | |
| Management | 2.8 5.6 8.4 | | | | 2.8 5.6 8.4 | | 2.3 4.5 9 | 2.7 6.5 9.4 | 3.1 6.3 9.4 |
| N Rate | - | 9 | 9 | - | 9 | 9 | - | 9 | 9.4 |
| Herbicides (Management and N Rate study) N Rate study only* | | | | | | | | | |
| #1 product | Edge | Edge | Edge | - | Roundup | Roundup | Liberty | Roundup | Roundup |
| #1 rate:g | 1130 | 1350 | 1413 | - | 659 | 440 | 500 | 440 | 1758 |
| #1 date | Apr26 | Nov22/99 | Oct 17/00 | - | May 7 | May 10 | Jun 8 | May 14 | May 8 |
| #2 product | Roundup | Roundup | Roundup | - | Poast Ultra | Poast Ultra | Poast Ultra | Poast Ultra | Poast Ultra |
| #2 rate:g | 890 | 879 | 900 | - | 222 | 222 | 211 | 211 | 145 |
| #2 date | May7 | May 4 | May 8 | - | Jun 5 | Jun 12 | Jun 12 | Jun 13 | Jun 12 |
| #3 product | Muster | Select* | Lontrel | - | Poast U | Muster | Muster | Lontrel | Muster |
| #3 rate:g | 15 | 35.6* | 153 | - | 222 | 15 | 22 | 151 | 15 |
| #3 date | Jun 22 | May 25* | Jun 11 | - | Jun 19 | Jun 12 | Jun 12 | Jun 13 | Jun 12 |
| #4 product | Assure | Poast Ultra | | - | Muster | Lontrel | | | Lontrel |
| #4 rate:g | 102 | 361 | | - | 22 | 151 | | | 151 |
| #4 date | Jun 22 | Jun 7 | | - | Jun 19 | Jun 12 | | | Jun 12 |
| #5 product | | Lontrel | | - | | Decis | | | Decis |
| #5 rate:g | | 150 | | - | | 74 | | | 62 |
| #5 date | | Jun 7 | | - | | Jul 16 | | | Jul 20 |
| Fungicides (Management Study) | | | | | | | | | |
| #1 product | Ronilan 750 | Ronilan 750 | Ronilan | - | Quadris | Quadris | Ronilan | Ronilan | Ronilan |
| #1 rate:g ai/ha | 1000 | 1000 | 400 | - | 125 | 125 | 500 | 500 | 500 |
| #1 date | Jul 22 | Jul 22 | Jul 13 | - | Jun 28 | Jun 11 | Jun 29 | Jul 7 | Jul 5 |
| #2 product | | | | - | Ronilan | Ronilan | | | |
| #2 rate:g ai/ha | | | | - | 494 | 494 | | | |
| #2 date | | | | - | Jul 14 | Jul 3 | | | |
| Seeder | Conserva-Pak - 12" row spacing | | | Conserva-Pak - 9" row spacing | | | Versatile hoe drill - 8" row spacing | | |

Appendix 2. Biomass (kg/ha)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 5916 | - | 10188 | 5365 | 6493 | 10029 | 5111.77 | 4789.48 | 6611 |
| | | 5.6 | 6336 | - | 9235 | 6702 | 7567 | 8661 | 5085.55 | 6080.76 | 6291 |
| | | 8.4 | 5982 | - | 9181 | 5263 | 6605 | 8063 | 5199.04 | 5997.79 | 5182 |
| | mid | 2.8 | 7742 | - | 9319 | 7088 | 7263 | 8967 | 6530.22 | 6924.62 | 8085 |
| | | 5.6 | 6775 | - | 11123 | 5013 | 7334 | 9742 | 6096.58 | 6248.36 | 6197 |
| | | 8.4 | 6116 | - | 9581 | 5572 | 7353 | 9102 | 6315.58 | 6883.89 | 5391 |
| | high | 2.8 | 6892 | - | 14029 | 5725 | 6912 | 10849 | 6445.91 | 6524.36 | 6687 |
| | | 5.6 | 7010 | - | 13402 | 6221 | 7689 | 9635 | 5621.47 | 7312.04 | 7263 |
| | | 8.4 | 7464 | - | 13123 | 6782 | 8220 | 10039 | 5961.39 | 6820.05 | 6004 |
| Qtm | low | 2.8 | 5732 | - | 9129 | 5486 | 4811 | 7944 | 4984.83 | 5365.68 | 5262 |
| | | 5.6 | 5417 | - | 8936 | 5360 | 6254 | 7019 | 5577.6 | 4888.86 | 5077 |
| | | 8.4 | 5267 | - | 9708 | 5234 | 6225 | 7925 | 4773.56 | 4822.56 | 4913 |
| | mid | 2.8 | 5632 | - | 9221 | 5304 | 6133 | 7825 | 5897.7 | 5108.27 | 5924 |
| | | 5.6 | 5611 | - | 10125 | 5388 | 6706 | 8690 | 5239.26 | 5706.47 | 5502 |
| | | 8.4 | 5934 | - | 9292 | 5441 | 6262 | 8530 | 5455.66 | 5882 | 5795 |
| | high | 2.8 | 6389 | - | 12329 | 5985 | 8077 | 9869 | 5332.35 | 5724.52 | 5487 |
| | | 5.6 | 5916 | - | 9085 | 5686 | 7161 | 8610 | 5386.71 | 6517.39 | 5606 |
| | | 8.4 | 6055 | - | 10725 | 5430 | 6630 | 9974 | 5636 | 6263 | 5684 |
| Inv | | | 6693a | - | 11020a | 5970 | 7271a | 9454a | 5819a | 6398a | 6412a |
| Qtm | | | 5773b | - | 9839b | 5468 | 6473b | 8487b | 5365b | 5587b | 5472b |
| $LSD_{0.05}$ | | | 361 | | 947 | | 597 | 842 | 243 | 374 | 782 |
| | low | | 5775b | - | 9396b | 5552 | 6326b | 8274b | 5122b | 5324b | 5556 |
| | mid | | 6301a | - | 9777b | 5634 | 6842ab | 8809ab | 5923a | 6126a | 6149 |
| | high | | 6621a | - | 12116a | 5972 | 7448a | 9830a | 5731a | 6527a | 6122 |
| $LSD_{0.05}$ | | | 443 | | 1160 | | 731 | 1032 | 298 | 458 | 957 |
| | | 2.8 | 6384 | - | 10703 | 5826 | 6615 | 9247 | 5717 | 5740B | 6343A |
| | | 5.6 | 6178 | - | 10318 | 5728 | 7119 | 8726 | 5501 | 6126A | 5989AB |
| | | 8.4 | 6136 | - | 10268 | 5604 | 6882 | 8939 | 5557 | 6112AB | 5495B |
| $LSD_{0.05}$ | | | 443 | | 1160 | | 731 | 1032 | 298 | 382@10 | 999@10 |
| no fung | | | 6292 | - | 10687 | 5782 | 6477 | 8893 | 5594 | 5994 | 6297 |
| fung | | | 6173 | - | 10172 | 5656 | 7267 | 9049 | 5590 | 5990 | 5587 |
| $LSD_{0.05}$ | | | 858 | | 1947 | | 1291 | 1080 | 750 | 639 | 1970 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 3. Grain yield (kg/ha)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfo | Ind | Scott | Melfort | Ind | Scott | Melfort | Indian Head |
| Inv | low | 2.8 | 2172 | - | 1511 | 1404 | 1525 | 1761 | 1143 | 1639 | 1247 |
| | | 5.6 | 2287 | - | 1614 | 1671 | 2351 | 1881 | 1224 | 1755 | 1318 |
| | | 8.4 | 2292 | - | 1662 | 1899 | 1842 | 1786 | 1294 | 1799 | 1359 |
| | mid | 2.8 | 2587 | - | 1540 | 1968 | 1884 | 1943 | 1361 | 1714 | 1103 |
| | | 5.6 | 2416 | - | 1818 | 1515 | 2146 | 2078 | 1264 | 1939 | 1431 |
| | | 8.4 | 2399 | - | 2028 | 1566 | 2101 | 2205 | 1479 | 2124 | 1455 |
| | high | 2.8 | 2651 | - | 1721 | 1610 | 1675 | 2148 | 1421 | 1814 | 1047 |
| | | 5.6 | 2701 | - | 1887 | 1832 | 2215 | 2265 | 1383 | 1930 | 1321 |
| | | 8.4 | 2702 | - | 1937 | 1668 | 2490 | 2256 | 1537 | 2123 | 1436 |
| Qtm | low | 2.8 | 2074 | - | 1649 | 1286 | 1497 | 1573 | 1046 | 1420 | 595 |
| | | 5.6 | 2217 | - | 1607 | 1156 | 1869 | 1618 | 1156 | 1636 | 897 |
| | | 8.4 | 2153 | - | 1661 | 1279 | 1848 | 1653 | 1108 | 1582 | 1126 |
| | mid | 2.8 | 2336 | - | 1611 | 1316 | 1561 | 1791 | 1161 | 1396 | 643 |
| | | 5.6 | 2391 | - | 1829 | 1466 | 1859 | 1837 | 1186 | 1692 | 942 |
| | | 8.4 | 2402 | - | 1956 | 1891 | 2234 | 1847 | 1263 | 1780 | 881 |
| | high | 2.8 | 2569 | - | 1719 | 1550 | 1495 | 1880 | 1240 | 1195 | 658 |
| | | 5.6 | 2532 | - | 1947 | 1543 | 2299 | 1958 | 1257 | 1676 | 815 |
| | | 8.4 | 2553 | - | 2089 | 1709 | 2190 | 1935 | 1359 | 1823 | 1070 |
| Inv | | | 2467a | - | 1746 | 1689a | 2025a | 2036a | 1345a | 1871 | 1302a |
| Qtm | | | 2358b | - | 1785 | 1460b | 1872b | 1788b | 1197b | 1578 | 848b |
| $LSD_{0.05}$ | | | 87 | | 54 | | 111 | 72 | 36 | 104 | 100 |
| | low | | 2199c | - | 1617c | 1427b | 1822b | 1712c | 1162c | 1638 | 1090 |
| | mid | | 2422b | - | 1797b | 1632ab | 1964a | 1950b | 1285b | 1774 | 1076 |
| | high | | 2618a | - | 1883a | 1666a | 2060a | 2074a | 1366a | 1760 | 1058 |
| $LSD_{0.05}$ | | | 107 | | 66 | | 136 | 88 | 44 | 127 | 103 |
| | | 2.8 | 2398 | - | 1625c | 1526 | 1606b | 1849b | 1228b | 1530 | 882b |
| | | 5.6 | 2424 | - | 1784b | 1521 | 2123a | 1939a | 1245b | 1771 | 1121a |
| | | 8.4 | 2417 | - | 1889a | 1677 | 2117a | 1947a | 1340a | 1872 | 1221a |
| $LSD_{0.05}$ | | | 107 | | 66 | | 136 | 88 | 44 | 127 | 103 |
| no fung | | | 2387 | - | 1708 | 1497B | 1875B | 1915 | 1306 | 1717 | 1105 |
| fung | | | 2439 | - | 1823 | 1653A | 2022A | 1909 | 1236 | 1732 | 1044 |
| $LSD_{0.05}$ | | | 177 | | 216 | | 188@10 | 139 | 169 | 316 | 298 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 4. Blackleg rating with severity increasing from 0 to 5

| Treatment | | | 1999 | | | | | | 2000 | | | | | | 2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | |
| | | | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Inv | low | 2.8 | 0.3 | 0.3 | . | . | 0.3 | 0.2 | 0.1 | 0.1 | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 |
| | | 5.6 | 0.3 | 0.3 | . | . | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 | 0.3 | 0.3 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 0.4 | 0.3 | . | . | 0.1 | 0.1 | 0.0 | 0.0 | 0.3 | 0.2 | 0.2 | 0.4 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 |
| | mid | 2.8 | 0.3 | 0.3 | . | . | 0.3 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 0.3 | 0.3 | . | . | 0.0 | 0.1 | 0.1 | 0.1 | 0.4 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| | | 8.4 | 0.3 | 0.3 | . | . | 0.1 | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| | high | 2.8 | 0.4 | 0.4 | . | . | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 |
| | | 5.6 | 0.6 | 0.4 | . | . | 0.3 | 0.1 | 0.0 | 0.1 | 0.1 | 0.3 | 0.1 | 0.4 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| | | 8.4 | 0.4 | 0.3 | . | . | 0.1 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.2 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| Qtm | low | 2.8 | 0.1 | 0.1 | . | . | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.3 | 0.1 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 0.1 | 0.1 | . | . | 0.1 | 0.0 | 0.1 | 0.1 | 0.4 | 0.2 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 0.2 | 0.2 | . | . | 0.0 | 0.0 | 0.2 | 0.1 | 0.4 | 0.4 | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| | mid | 2.8 | 0.2 | 0.1 | . | . | 0.0 | 0.1 | 0.1 | 0.1 | 0.5 | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 0.1 | 0.2 | . | . | 0.0 | 0.0 | 0.0 | 0.1 | 0.4 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 0.2 | 0.1 | . | . | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.1 | 0.1 | 0.1 | 0.1 | 0 | 0.0 | 0.0 | 0.0 |
| | high | 2.8 | 0.1 | 0.2 | . | . | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | 0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 0.1 | 0.2 | . | . | 0.0 | 0.0 | 0.2 | 0.2 | 0.3 | 0.4 | 0.1 | 0.2 | 0.1 | 0.1 | 0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 0.1 | 0.1 | . | . | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| Inv | | | 0.3a | | - | | 0.1a | | 0.1 | | 0.2b | | 0.2a | | 0.1 | | 0.1a | | 0 | |
| Qtm | | | 0.1b | | - | | 0.0b | | 0.1 | | 0.3a | | 0.1b | | 0.1 | | 0.0b | | 0 | |
| $LSD_{0.05}$ | | | 0.03 | | | | 0.05 | | | | 0.09 | | 0.06 | | 0.03 | | 0.02 | | 0.007 | |
| | low | | 0.2b | | - | | 0.1 | | 0.1 | | 0.3 | | 0.2 | | 0.1 | | 0 | | 0 | |
| | mid | | 0.2b | | - | | 0.1 | | 0.1 | | 0.3 | | 0.1 | | 0.1 | | 0 | | 0 | |
| | high | | 0.3a | | - | | 0.1 | | 0.1 | | 0.2 | | 0.2 | | 0.1 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.04 | | | | 0.06 | | | | 0.1 | | 0.07 | | 0.03 | | 0.02 | | 0 | |
| | | 2.8 | 0.2 | | - | | 0.1 | | 0.1 | | 0.3 | | 0.1 | | 0.1 | | 0.02b | | 0 | |
| | | 5.6 | 0.2 | | - | | 0.1 | | 0.1 | | 0.3 | | 0.1 | | 0.1 | | 0.04ab | | 0 | |
| | | 8.4 | 0.2 | | - | | 0 | | 0.1 | | 0.3 | | 0.2 | | 0.1 | | 0.05b | | 0 | |
| $LSD_{0.05}$ | | | 0.04 | | | | 0.06 | | | | 0.1 | | 0.07 | | 0.03 | | 0.02 | | 0 | |
| no fung | | | 0.2 | | - | | 0.1 | | 0.1 | | 0.3 | | 0.1 | | 0.1 | | 0.1 | | 0 | |
| fung | | | 0.2 | | - | | 0.1 | | 0.1 | | 0.3 | | 0.2 | | 0.1 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.09 | | | | 0.06 | | | | 0.09 | | 0.2 | | 0.05 | | 0.07 | | 0.02 | |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 5. Blackleg incidence (%)

| Treatment | | | 1999 | | | | | | 2000 | | | | | | 2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | |
| | | | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Inv | low | 2.8 | 13 | 18 | . | . | 10 | 6 | 5 | 5 | 19 | 9 | 9 | 9 | 6 | 4 | 3 | 3 | 1 | 0 |
| | | 5.6 | 12 | 13 | . | . | 2 | 2 | 4 | 4 | 13 | 12 | 18 | 8 | 6 | 7 | 1 | 0 | 1 | 0 |
| | | 8.4 | 11 | 11 | . | . | 5 | 2 | 1 | 2 | 9 | 6 | 10 | 24 | 5 | 3 | 4 | 1 | 1 | 1 |
| | mid | 2.8 | 13 | 17 | . | . | 8 | 2 | 2 | 6 | 10 | 10 | 7 | 8 | 7 | 9 | 0 | 0 | 0 | 2 |
| | | 5.6 | 13 | 15 | . | . | 2 | 5 | 4 | 6 | 16 | 13 | 10 | 12 | 9 | 6 | 4 | 2 | 0 | 0 |
| | | 8.4 | 12 | 12 | . | . | 3 | 2 | 5 | 9 | 11 | 11 | 18 | 8 | 9 | 5 | 3 | 3 | 0 | 0 |
| | high | 2.8 | 18 | 18 | . | . | 2 | 4 | 4 | 6 | 8 | 7 | 9 | 11 | 6 | 9 | 3 | 2 | 1 | 2 |
| | | 5.6 | 24 | 19 | . | . | 9 | 3 | 2 | 4 | 8 | 12 | 5 | 19 | 8 | 7 | 4 | 2 | 0 | 1 |
| | | 8.4 | 12 | 11 | . | . | 6 | 2 | 3 | 3 | 8 | 13 | 11 | 16 | 7 | 6 | 2 | 2 | 1 | 1 |
| Qtm | low | 2.8 | 4 | 4 | . | . | 1 | 0 | 3 | 2 | 17 | 15 | 8 | 12 | 8 | 4 | 3 | 0 | 0 | 0 |
| | | 5.6 | 3 | 4 | . | . | 3 | 1 | 4 | 3 | 14 | 10 | 3 | 12 | 3 | 5 | 2 | 1 | 0 | 2 |
| | | 8.4 | 7 | 6 | . | . | 1 | 1 | 9 | 6 | 13 | 11 | 13 | 6 | 2 | 5 | 2 | 0 | 0 | 0 |
| | mid | 2.8 | 6 | 5 | . | . | 2 | 2 | 4 | 4 | 22 | 12 | 6 | 2 | 9 | 9 | 0 | 2 | 2 | 0 |
| | | 5.6 | 4 | 6 | . | . | 0 | 2 | 1 | 2 | 19 | 11 | 4 | 6 | 7 | 6 | 2 | 1 | 0 | 0 |
| | | 8.4 | 8 | 5 | . | . | 0 | 1 | 2 | 1 | 16 | 17 | 7 | 6 | 7 | 7 | 0 | 1 | 0 | 0 |
| | high | 2.8 | 5 | 6 | . | . | 1 | 0 | 1 | 5 | 14 | 12 | 12 | 7 | 7 | 11 | 1 | 0 | 0 | 0 |
| | | 5.6 | 6 | 6 | . | . | 1 | 1 | 7 | 6 | 14 | 16 | 6 | 11 | 8 | 5 | 1 | 0 | 0 | 1 |
| | | 8.4 | 5 | 4 | . | . | 2 | 1 | 1 | 8 | 13 | 11 | 7 | 10 | 4 | 8 | 4 | 1 | 0 | 1 |
| Inv | | | 0.125 | | - | | 4.0a | | 4 | | 11B | | 0.458333 | | 6 | | 0.08333 | | 1 | |
| Qtm | | | 5b | | - | | 1.0b | | 4 | | 0.08333 | | 7b | | 6 | | 1B | | 0 | |
| $LSD_{0.05}$ | | | 1.2 | | | | 1.6 | | | | 3.0@10 | | 3.3 | | 1.3 | | 0.7@10 | | 0.4 | |
| | low | | 8.8b | | - | | 3 | | 4 | | 12 | | 11 | | 5b | | 2 | | 1 | |
| | mid | | 9.6b | | - | | 2 | | 4 | | 14 | | 8 | | 0.291667 | | 1 | | 0 | |
| | high | | 11.1a | | - | | 2 | | 4 | | 11 | | 10 | | 0.291667 | | 2 | | 0 | |
| $LSD_{0.05}$ | | | 1.5 | | | | 2 | | | | 4.5 | | 4 | | 1.7 | | 1 | | 0.5 | |
| | | 2.8 | 10.7a | | - | | 3 | | 4 | | 13 | | 8 | | 7 | | 1 | | 1 | |
| | | 5.6 | 10.2a | | - | | 2 | | 4 | | 13 | | 9 | | 6 | | 2 | | 0 | |
| | | 8.4 | 8.5b | | - | | 2 | | 4 | | 11 | | 11 | | 6 | | 2 | | 0 | |
| $LSD_{0.05}$ | | | 1.5 | | | | 2 | | | | 4.5 | | 4 | | 1.7 | | 1 | | 0.5 | |
| no fung | | | 10 | | - | | 3 | | 3 | | 13 | | 9 | | 6 | | 2 | | 0 | |
| fung | | | 10 | | - | | 2 | | 4 | | 11 | | 10 | | 6 | | 1 | | 0 | |
| $LSD_{0.05}$ | | | 2.5 | | | | 1.9 | | | | 5.5 | | 10.6 | | 3.2 | | 2.5 | | 1 | |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 6. Sclerotinia induced yield loss (%)

| Treatment | | | 1999 | | | | | | 2000 | | | | | | 2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | |
| | | | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Inv | low | 2.8 | 0.9 | 1.0 | . | . | 0.0 | 0.0 | 0.0 | 1.3 | 3.4 | 2.6 | 0.4 | 0.0 | 1.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 1.0 | 0.7 | . | . | 0.0 | 0.0 | 0.1 | 0.0 | 9.6 | 3.6 | 1.5 | 0.0 | 0.5 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 |
| | | 8.4 | 1.3 | 1.4 | . | . | 0.0 | 0.0 | 0.0 | 1.0 | 6.2 | 4.1 | 0.1 | 0.0 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | mid | 2.8 | 1.4 | 0.9 | . | . | 0.1 | 0.0 | 1.3 | 1.8 | 7.2 | 5.6 | 2.1 | 0.5 | 0.5 | 0.5 | 0.0 | 0.0 | 0.1 | 0.0 |
| | | 5.6 | 1.2 | 1.3 | . | . | 0.3 | 0.0 | 0.3 | 0.3 | 7.2 | 3.6 | 0.2 | 0.1 | 0.8 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 2.5 | 2.3 | . | . | 0.0 | 0.0 | 0.6 | 0.5 | 5.7 | 4.0 | 0.9 | 0.0 | 1.0 | 1.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| | high | 2.8 | 0.8 | 0.8 | . | . | 0.0 | 0.0 | 0.0 | 0.0 | 4.3 | 1.4 | 3.7 | 0.1 | 1.4 | 0.8 | 0.0 | 0.0 | 0.1 | 0.0 |
| | | 5.6 | 1.9 | 1.8 | . | . | 0.0 | 0.0 | 0.8 | 1.3 | 7.8 | 4.4 | 3.2 | 0.3 | 1.0 | 0.8 | 0.0 | 0.5 | 0.1 | 0.0 |
| | | 8.4 | 2.0 | 3.1 | . | . | 0.0 | 0.0 | 0.0 | 0.3 | 6.8 | 4.9 | 3.3 | 0.5 | 1.3 | 0.5 | 0.0 | 0.0 | 0.1 | 0.0 |
| Qtm | low | 2.8 | 1.1 | 0.9 | . | . | 0.0 | 0.0 | 0.3 | 0.3 | 2.2 | 1.1 | 0.1 | 0.5 | 0.5 | 0.5 | 0.0 | 0.0 | 0.1 | 0.0 |
| | | 5.6 | 1.0 | 1.1 | . | . | 0.0 | 0.0 | 0.3 | 0.8 | 5.7 | 4.6 | 0.0 | 0.0 | 1.3 | 0.8 | 0.0 | 0.0 | 0.2 | 0.0 |
| | | 8.4 | 2 | 1.4 | . | . | 0.0 | 0.0 | 0.3 | 0.3 | 4.4 | 2.4 | 0.2 | 1.6 | 1.3 | 0.5 | 0.0 | 0.0 | 0.1 | 0.0 |
| | mid | 2.8 | 1.2 | 1.3 | . | . | 0.0 | 0.0 | 0.3 | 0.3 | 1.2 | 3.6 | 0.0 | 0.1 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 5.6 | 1.5 | 1.2 | . | . | 0.3 | 0.0 | 0.0 | 0.5 | 3.3 | 2.3 | 0.0 | 0.1 | 0 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 1.3 | 1.3 | . | . | 0.0 | 0.0 | 0.5 | 0.5 | 3.7 | 2.9 | 0.0 | 0.0 | 0.3 | 1.6 | 0.0 | 0.0 | 0.1 | 0.0 |
| | high | 2.8 | 0.8 | 0.9 | . | . | 0.0 | 0.0 | 1.0 | 0.0 | 4.5 | 2.7 | 1.0 | 0.0 | 1.0 | 0.8 | 0.0 | 0.1 | 0.0 | 0.0 |
| | | 5.6 | 1.2 | 1.9 | . | . | 0.0 | 0.0 | 0.0 | 0.8 | 1.9 | 1.5 | 0.8 | 0.0 | 0.8 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | 8.4 | 0.9 | 1.0 | . | . | 0.0 | 0.0 | 0.0 | 0.8 | 4.7 | 2.7 | 1.2 | 0.0 | 1.5 | 0.5 | 0.0 | 0.0 | 0.1 | 0.1 |
| Inv | | | 1.5 | | - | | 0 | | 0.5 | | 5.1a | | 0.9a | | 0.7 | | 0 | | 0 | |
| Qtm | | | 1.2 | | - | | 0 | | 0.4 | | 3.1b | | 0.3b | | 0.7 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.03 | | | | 0.04 | | | | 0.9 | | 0.5 | | 0.3 | | 0.06 | | 0.03 | |
| | low | | 1.1b | | - | | 0 | | 0.4 | | 4 | | 1.2a | | 0.6 | | 0 | | 0 | |
| | mid | | 1.46a | | - | | 0 | | 0.6 | | 4 | | 0.4b | | 0.6 | | 0 | | 0 | |
| | high | | 1.41ab | | - | | 0 | | 0.4 | | 4 | | 0.3b | | 0.8 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.04 | | | | 0.05 | | | | 1.1 | | 0.6 | | 0.9 | | 0.07 | | 0.03 | |
| | | 2.8 | 1 | | - | | 0 | | 0.5 | | 3.3b | | 0.7 | | 0.6 | | 0 | | 0 | |
| | | 5.6 | 1.3b | | - | | 0 | | 0.4 | | 4.6a | | 0.5 | | 0.6 | | 0 | | 0 | |
| | | 8.4 | 1.7a | | - | | 0 | | 0.4 | | 4.3ab | | 0.6 | | 0.8 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.04 | | | | 0.05 | | | | 1.1 | | 0.6 | | 0.9 | | 0.07 | | 0.03 | |
| no fung | | | 1.3 | | - | | 0 | | 0.3 | | 5.0a | | 1.0a | | 0.8 | | 0 | | 0 | |
| fung | | | 1.3 | | - | | 0 | | 0.6 | | 3.2b | | 0.2b | | 0.6 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 0.7 | | | | 0.06 | | | | 1.5 | | 0.4 | | 1.5 | | 0.09 | | 0.1 | |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 7. Sclerotina incidence (%)

| Treatment | | | 1999 | | | | | | 2000 | | | | | | 2001 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | | Scott | | Melfort | | Ind Hd | |
| | | | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| Inv | low | 2.8 | 7 | 7 | . | . | 0 | 0 | 0 | 3 | 22 | 19 | 3 | 0 | 2 | 1 | 1 | 0 | 1 | 0 |
| | | 5.6 | 6 | 4 | . | . | 0 | 0 | 1 | 0 | 45 | 22 | 4 | 0 | 1 | 1 | 0 | 0 | 0 | 2 |
| | | 8.4 | 5 | 5 | . | . | 0 | 0 | 0 | 2 | 26 | 25 | 1 | 0 | 2 | 0 | 1 | 1 | 1 | 0 |
| | mid | 2.8 | 9 | 7 | . | . | 1 | 0 | 3 | 4 | 34 | 26 | 9 | 5 | 1 | 1 | 0 | 0 | 2 | 0 |
| | | 5.6 | 8 | 8 | . | . | 0 | 0 | 1 | 1 | 33 | 25 | 2 | 2 | 2 | 3 | 0 | 0 | 1 | 0 |
| | | 8.4 | 8 | 7 | . | . | 0 | 0 | 2 | 1 | 27 | 21 | 4 | 0 | 2 | 2 | 0 | 0 | 3 | 0 |
| | high | 2.8 | 5 | 6 | . | . | 0 | 0 | 0 | 0 | 25 | 11 | 12 | 1 | 3 | 2 | 0 | 0 | 1 | 0 |
| | | 5.6 | 9 | 10 | . | . | 0 | 0 | 2 | 3 | 38 | 22 | 10 | 1 | 2 | 2 | 0 | 2 | 1 | 0 |
| | | 8.4 | 6 | 9 | . | . | 0 | 0 | 0 | 1 | 35 | 21 | 10 | 2 | 3 | 1 | 0 | 0 | 2 | 1 |
| Qtm | low | 2.8 | 7 | 5 | . | . | 0 | 0 | 1 | 1 | 18 | 9 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 |
| | | 5.6 | 5 | 5 | . | . | 0 | 0 | 1 | 2 | 30 | 29 | 0 | 0 | 3 | 2 | 0 | 0 | 2 | 0 |
| | | 8.4 | 8 | 7 | . | . | 0 | 0 | 1 | 1 | 15 | 13 | 1 | 4 | 3 | 1 | 0 | 0 | 1 | 1 |
| | mid | 2.8 | 8 | 9 | . | . | 0 | 0 | 1 | 1 | 11 | 20 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 1 |
| | | 5.6 | 7 | 7 | . | . | 0 | 0 | 0 | 2 | 15 | 14 | 1 | 2 | 0 | 1 | 0 | 0 | 1 | 1 |
| | | 8.4 | 6 | 5 | . | . | 0 | 0 | 1 | 2 | 20 | 19 | 1 | 1 | 1 | 4 | 0 | 0 | 2 | 0 |
| | high | 2.8 | 4 | 6 | . | . | 0 | 0 | 2 | 1 | 21 | 18 | 3 | 0 | 2 | 2 | 0 | 1 | 0 | 1 |
| | | 5.6 | 5 | 7 | . | . | 0 | 0 | 0 | 2 | 9 | 11 | 3 | 0 | 2 | 1 | 0 | 0 | 0 | 0 |
| | | 8.4 | 5 | 5 | . | . | 0 | 0 | 0 | 2 | 18 | 14 | 4 | 1 | 3 | 1 | 0 | 0 | 2 | 3 |
| Inv | | | 7 | | - | | 0 | | 1 | | 26.2a | | 3.4a | | 2 | | 0 | | 1 | |
| Qtm | | | 6 | | - | | 0 | | 1 | | 16.6b | | 1.2b | | 1 | | 0 | | 1 | |
| $LSD_{0.05}$ | | | 1.1 | | | | 0.09 | | | | 3.7 | | 1.5 | | 0.7 | | 0.2 | | 0.5 | |
| | low | | 5.8b | | - | | 0 | | 1 | | 22 | | 1.2b | | 1 | | 0 | | 1 | |
| | mid | | 7.4a | | - | | 0 | | 1 | | 22 | | 2.0ab | | 1 | | 0 | | 1 | |
| | high | | 6.4ab | | - | | 0 | | 1 | | 20 | | 3.6a | | 2 | | 0 | | 1 | |
| $LSD_{0.05}$ | | | 1.3 | | | | 0.1 | | | | 4.6 | | 1.8 | | 0.9 | | 0.25 | | 0.6 | |
| | | 2.8 | 7 | | - | | 0 | | 1 | | 19b | | 2.9 | | 1.4 | | 0 | | 0.5ab | |
| | | 5.6 | 7 | | - | | 0 | | 1 | | 0 | | 1.8 | | 1.3 | | 0 | | 0.4b | |
| | | 8.4 | 6 | | - | | 0 | | 1 | | 21ab | | 2.1 | | 1.7 | | 0 | | 1.1a | |
| $LSD_{0.05}$ | | | 1.3 | | | | 0.1 | | | | 4.6 | | 1 | | 0.9 | | 0.25 | | 0.6 | |
| no fung | | | 6 | | - | | 0 | | 1 | | 0 | | 0.166667 | | 2 | | 0 | | 1 | |
| fung | | | 7 | | - | | 0 | | 1 | | 19b | | 1b | | 1 | | 0 | | 0 | |
| $LSD_{0.05}$ | | | 1.7 | | | | 0.16 | | | | 5.6 | | 1 | | 3.1 | | 0.3 | | 1.8 | |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 8. Plant density (#/m$^2$)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 39 | - | 44 | 46 | 12 | 68 | 85 | 32 | 32 |
| | | 5.6 | 65 | - | 50 | 52 | 36 | 115 | 104 | 56 | 50 |
| | | 8.4 | 159 | - | 81 | 117 | 26 | 171 | 145 | 71 | 37 |
| | mid | 2.8 | 35 | - | 31 | 53 | 7 | 58 | 85 | 21 | 36 |
| | | 5.6 | 62 | - | 61 | 66 | 15 | 102 | 100 | 32 | 37 |
| | | 8.4 | 130 | - | 66 | 114 | 24 | 174 | 137 | 62 | 56 |
| | high | 2.8 | 34 | - | 39 | 40 | 12 | 55 | 79 | 24 | 23 |
| | | 5.6 | 68 | - | 51 | 76 | 12 | 121 | 107 | 33 | 45 |
| | | 8.4 | 140 | - | 81 | 113 | 28 | 150 | 134 | 71 | 56 |
| Qtm | low | 2.8 | 60 | - | 55 | 40 | 14 | 61 | 99 | 28 | 42 |
| | | 5.6 | 128 | - | 70 | 57 | 29 | 95 | 134 | 53 | 43 |
| | | 8.4 | 229 | - | 83 | 78 | 52 | 143 | 226 | 72 | 44 |
| | mid | 2.8 | 56 | - | 42 | 47 | 12 | 84 | 94 | 25 | 30 |
| | | 5.6 | 112 | - | 61 | 52 | 20 | 145 | 155 | 45 | 64 |
| | | 8.4 | 273 | - | 82 | 96 | 33 | 126 | 188 | 62 | 30 |
| | high | 2.8 | 58 | - | 42 | 50 | 15 | 88 | 98 | 23 | 33 |
| | | 5.6 | 115 | - | 67 | 61 | 30 | 91 | 135 | 37 | 31 |
| | | 8.4 | 221 | - | 73 | 113 | 42 | 133 | 170 | 73 | 45 |
| Inv | | | 81b | | 56b | 75a | 19b | 112 | 108b | 45 | 41 |
| Qtm | | | 139a | | 64a | 66b | 27a | 107 | 144a | 46 | 40 |
| $LSD_{0.05}$ | | | 7.2 | | 4.7 | | 5.4 | 14.1 | 11 | 6.5 | 7.1 |
| | low | | 113 | | 64a | 65b | 28a | 109 | 132A | 52a | 41 |
| | mid | | 111 | | 57b | 71ab | 19b | 115 | 126AB | 41b | 42 |
| | high | | 106 | | 59ab | 76a | 23ab | 106 | 121B | 43b | 39 |
| $LSD_{0.05}$ | | | 8.9 | | 5.8 | | 6.6 | 17.3 | 9.2@10 | 7.9 | 8.7 |
| | | 2.8 | 47c | | 42c | 46c | 12c | 69c | 90c | 25c | 33b |
| | | 5.6 | 92b | | 60b | 61b | 24b | 111b | 122b | 43b | 45a |
| | | 8.4 | 192a | | 78a | 105a | 34a | 149a | 167a | 68a | 45a |
| $LSD_{0.05}$ | | | 8.9 | | 5.8 | | 6.6 | 17.3 | 13.5 | 7.9 | 8.7 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 9. Days to flowering

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 53 | - | 51 | 55 | 63 | 61 | 55 | 59 | 58 |
| | | 5.6 | 53 | - | 51 | 54 | 61 | 61 | 55 | 58 | 58 |
| | | 8.4 | 53 | - | 49 | 54 | 60 | 61 | 55 | 57 | 58 |
| | mid | 2.8 | 53 | - | 51 | 56 | 63 | 62 | 55 | 60 | 59 |
| | | 5.6 | 53 | - | 51 | 55 | 62 | 61 | 55 | 60 | 58 |
| | | 8.4 | 53 | - | 51 | 54 | 61 | 61 | 55 | 57 | 58 |
| | high | 2.8 | 53 | - | 52 | 55 | 64 | 61 | 56 | 61 | 59 |
| | | 5.6 | 53 | - | 51 | 56 | 63 | 62 | 55 | 60 | 59 |
| | | 8.4 | 53 | - | 51 | 54 | 61 | 61 | 55 | 60 | 58 |
| Qtm | low | 2.8 | 49 | - | 50 | 53 | 64 | 61 | 55 | 59 | 59 |
| | | 5.6 | 49 | - | 49 | 53 | 64 | 61 | 54 | 57 | 59 |
| | | 8.4 | 49 | - | 49 | 52 | 60 | 61 | 53 | 56 | 57 |
| | mid | 2.8 | 49 | - | 51 | 52 | 64 | 61 | 55 | 59 | 60 |
| | | 5.6 | 49 | - | 50 | 52 | 63 | 61 | 54 | 59 | 58 |
| | | 8.4 | 49 | - | 49 | 51 | 61 | 61 | 54 | 57 | 58 |
| | high | 2.8 | 49 | - | 50 | 53 | 65 | 61 | 55 | 59 | 59 |
| | | 5.6 | 49 | - | 49 | 52 | 63 | 61 | 54 | 59 | 59 |
| | | 8.4 | 49 | - | 49 | 52 | 63 | 61 | 54 | 57 | 58 |
| Inv | | | 53a | - | 51a | 55 | 62b | 61 | 55a | 59a | 58 |
| Qtm | | | 49b | - | 49b | 52 | 63a | 61 | 54b | 58b | 58.0 |
| $LSD_{0.05}$ | | | 0 | | 0.3 | | 0.5 | 0.3 | 0.2 | 0.5 | 0.5 |
| | low | | 51 | - | 49.6b | 53 | 62.1b | 60.9B | 54 | 57.6b | 57.9B |
| | mid | | 51 | - | 50.5a | 53 | 62.4ab | 61.0B | 55 | 58.7a | 58.4AB |
| | high | | 51 | - | 50.4a | 54 | 62.8a | 61.3A | 55 | 59.1a | 58.5A |
| $LSD_{0.05}$ | | | 0 | | 0.4 | | 0.6 | 0.3@10 | 0.3 | 0.6 | 0.5@10 |
| | | 2.8 | 51 | - | 50.7a | 54 | 64a | 61 | 55.0a | 59.4a | 58.8a |
| | | 5.6 | 51 | - | 50.2b | 54 | 63b | 61 | 54.5b | 58.8b | 58.4a |
| | | 8.4 | 51 | - | 49.7c | 53 | 61c | 61 | 54.1c | 57.3c | 57.7b |
| $LSD_{0.05}$ | | | 0 | | 0.4 | | 0.6 | 0.4 | 0.3 | 0.6 | 0.6 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 10. Length of flowering

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | - | - | - | 20 | 28 | - | 16 | 21 | 21 |
| | | 5.6 | - | - | - | 21 | 28 | - | 16 | 21 | 20 |
| | | 8.4 | - | - | - | 20 | 28 | - | 17 | 20 | 20 |
| | mid | 2.8 | - | - | - | 22 | 28 | - | 16 | 22 | 25 |
| | | 5.6 | - | - | - | 20 | 27 | - | 16 | 19 | 22 |
| | | 8.4 | - | - | - | 19 | 28 | - | 16 | 22 | 22 |
| | high | 2.8 | - | - | - | 22 | 28 | - | 16 | 22 | 23 |
| | | 5.6 | - | - | - | 20 | 27 | - | 16 | 20 | 23 |
| | | 8.4 | - | - | - | 19 | 28 | - | 16 | 20 | 23 |
| Qtm | low | 2.8 | - | - | - | 24 | 27 | - | 16 | 22 | 29 |
| | | 5.6 | - | - | - | 22 | 27 | - | 17 | 23 | 28 |
| | | 8.4 | - | - | - | 22 | 28 | - | 18 | 24 | 24 |
| | mid | 2.8 | - | - | - | 24 | 29 | - | 17 | 24 | 27 |
| | | 5.6 | - | - | - | 24 | 29 | - | 17 | 22 | 27 |
| | | 8.4 | - | - | - | 23 | 27 | - | 17 | 23 | 28 |
| | high | 2.8 | - | - | - | 24 | 29 | - | 16 | 24 | 28 |
| | | 5.6 | - | - | - | 23 | 28 | - | 17 | 24 | 27 |
| | | 8.4 | - | - | - | 23 | 27 | - | 17 | 23 | 27 |
| Inv | | | - | - | - | 20b | 28 | - | 16b | 21b | 22b |
| Qtm | | | - | - | - | 0.45833 | 28 | - | 0.20833 | 0.45833 | 27a |
| $LSD_{0.05}$ | | | | | | | 0.7 | | 0.2 | 0.7 | 1.0 |
| | low | | - | - | - | 22 | 28 | - | 17 | 21.6 | 23.6b |
| | mid | | - | - | - | 22 | 28 | - | 16 | 21.8 | 24.9a |
| | high | | - | - | - | 22 | 28 | - | 16 | 22.2 | 25.1a |
| $LSD_{0.05}$ | | | | | | | 0.9 | | 0.3 | 0.8 | 1.1 |
| | | 2.8 | - | - | - | 22.5a | 28 | - | 16.0c | 22.5a | 25.4a |
| | | 5.6 | - | - | - | 21.6b | 28 | - | 16.5b | 21.2b | 44.5ab |
| | | 8.4 | - | - | - | 21.0b | 28 | - | 16.9a | 21.9ab | 23.9b |
| $LSD_{0.05}$ | | | | | | | 0.9 | | 0.3 | 0.8 | 1.1 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 11. Days to Maturity

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 108 | - | 98 | 102 | 115 | 104 | 92 | 107 | 104 |
| | | 5.6 | 103 | - | 98 | 101 | 112 | 104 | 91 | 107 | 104 |
| | | 8.4 | 101 | - | 98 | 102 | 111 | 104 | 92 | 107 | 104 |
| | mid | 2.8 | 109 | - | 98 | 104 | 115 | 104 | 94 | 107 | 104 |
| | | 5.6 | 109 | - | 98 | 102 | 113 | 104 | 92 | 107 | 104 |
| | | 8.4 | 99 | - | 98 | 101 | 114 | 104 | 92 | 107 | 104 |
| | high | 2.8 | 112 | - | 98 | 102 | 115 | 104 | 93 | 107 | 104 |
| | | 5.6 | 108 | - | 98 | 102 | 114 | 104 | 93 | 107 | 104 |
| | | 8.4 | 100 | - | 98 | 101 | 112 | 104 | 92 | 107 | 104 |
| Qtm | low | 2.8 | 105 | - | 98 | 103 | 116 | 104 | 92 | 107 | 104 |
| | | 5.6 | 101 | - | 98 | 102 | 114 | 104 | 91 | 107 | 104 |
| | | 8.4 | 100 | - | 98 | 101 | 111 | 104 | 91 | 107 | 104 |
| | mid | 2.8 | 109 | - | 98 | 102 | 118 | 104 | 93 | 107 | 104 |
| | | 5.6 | 103 | - | 98 | 102 | 116 | 104 | 92 | 107 | 104 |
| | | 8.4 | 97 | - | 98 | 102 | 112 | 104 | 92 | 107 | 104 |
| | high | 2.8 | 104 | - | 98 | 103 | 116 | 104 | 93 | 107 | 104 |
| | | 5.6 | 103 | - | 98 | 103 | 114 | 104 | 93 | 107 | 104 |
| | | 8.4 | 102 | - | 98 | 102 | 114 | 104 | 92 | 107 | 104 |
| Inv | | | 105a | | 98 | 102 | 113b | 104 | 92 | 107 | 104 |
| Qtm | | | 102b | | 98 | 102 | 114a | 104 | 92 | 107 | 104 |
| $LSD_{0.05}$ | | | 1.5 | | 0 | | 0.9 | 0 | 0.3 | | 0 |
| | low | | 102.7b | | 98 | 102 | 113b | 104 | 91.3b | 107 | 104 |
| | mid | | 104.1ab | | 98 | 102 | 114a | 104 | 92.3a | 107 | 104 |
| | high | | 104.7a | | 98 | 102 | 114a | 104 | 92.6a | 107 | 104 |
| $LSD_{0.05}$ | | | 1.8 | | 0 | | 1.1 | 0 | 0.4 | | 0 |
| | | 2.8 | 108a | | 98 | 103a | 116a | 104 | 92.7a | 107 | 104 |
| | | 5.6 | 104b | | 98 | 102ab | 114b | 104 | 91.9b | 107 | 104 |
| | | 8.4 | 100c | | 98 | 101b | 113c | 104 | 91.6b | 107 | 104 |
| $LSD_{0.05}$ | | | 1.8 | | 0 | | 1.1 | 0 | 0.4 | | 0 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 12. % oil

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 47.8 | - | 46.7 | - | 46.8 | 46.3 | 47.8 | 49.5 | 45.5 |
| | | 5.6 | 48.6 | - | 48.0 | - | 47.9 | 47.1 | 47.9 | 49.7 | 45.8 |
| | | 8.4 | 49.3 | - | 47.7 | - | 48.4 | 47.4 | 47.9 | 49.8 | 45.4 |
| | mid | 2.8 | 48 | - | 45.5 | - | 46.1 | 46.6 | 47.2 | 48.4 | 44.7 |
| | | 5.6 | 48.2 | - | 47.1 | - | 46.8 | 46.8 | 47.3 | 48.6 | 45.0 |
| | | 8.4 | 49.2 | - | 46.3 | - | 46.9 | 46.1 | 47.3 | 48.8 | 44.8 |
| | high | 2.8 | 47.5 | - | 43.7 | - | 45.5 | 45.9 | 47.0 | 48.1 | 44.5 |
| | | 5.6 | 48.4 | - | 45.3 | - | 46.1 | 45.7 | 46.6 | 48.3 | 44.8 |
| | | 8.4 | 48.5 | - | 44.8 | - | 46.8 | 46.1 | 47.0 | 48.0 | 44.7 |
| Qtm | low | 2.8 | 49.7 | - | 46.6 | - | 45.7 | 46.6 | 49.2 | 47.3 | 42.9 |
| | | 5.6 | 50.9 | - | 46.9 | - | 46.8 | 45.9 | 49.0 | 47.5 | 43.3 |
| | | 8.4 | 51 | - | 47.1 | - | 47.2 | 45.3 | 49.0 | 47.4 | 43.3 |
| | mid | 2.8 | 49.9 | - | 43.7 | - | 45.3 | 45.6 | 48.7 | 46.9 | 41.9 |
| | | 5.6 | 50.5 | - | 45.7 | - | 45.9 | 45.3 | 48.4 | 46.6 | 43.1 |
| | | 8.4 | 50.4 | - | 44.8 | - | 46.7 | 45.3 | 48.8 | 47.0 | 42.9 |
| | high | 2.8 | 48.7 | - | 42.2 | - | 44.7 | 44.3 | 48.0 | 46.2 | 42.7 |
| | | 5.6 | 49.7 | - | 44.4 | - | 45.6 | 45.5 | 48.3 | 46.2 | 42.8 |
| | | 8.4 | 50 | - | 44.0 | - | 45.9 | 44.1 | 48.4 | 46.0 | 43.2 |
| Inv | | | 48.4b | - | 46.1a | - | 46.8a | 46.4a | 47.3b | 48.8a | 45.0a |
| Qtm | | | 50.1a | - | 45.1b | - | 46.0b | 45.3b | 48.6a | 46.8b | 42.9b |
| $LSD_{0.05}$ | | | 0.3 | | 0.4 | | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 |
| | low | | 49.5a | - | 47.2a | - | 47.1a | 46.4a | 48.5a | 48.6a | 44.4a |
| | mid | | 49.3a | - | 45.5b | - | 46.3b | 46.0b | 47.9b | 47.7b | 43.7b |
| | high | | 48.8b | - | 44.1c | - | 45.8c | 45.3c | 47.6c | 47.1c | 43.8b |
| $LSD_{0.05}$ | | | 0.3 | | 0.4 | | 0.3 | 0.5 | 0.2 | 0.2 | 0.25 |
| | | 2.8 | 48.6c | - | 44.7c | - | 45.7c | 45.9 | 48 | 47.7 | 43.7b |
| | | 5.6 | 49.4b | - | 46.3a | - | 46.5b | 46.0 | 47.9 | 47.8 | 44.1a |
| | | 8.4 | 49.7a | - | 45.8b | - | 47.0a | 45.7 | 48.1 | 47.8 | 44.1a |
| $LSD_{0.05}$ | | | 0.3 | | 0.4 | | 0.3 | 0.5 | 0.2 | 0.2 | 0.3 |
| no fung | | | 49.3 | - | 45.6 | - | 46.2B | 45.8 | 48.2 | 47.8 | 44.0 |
| fung | | | 49.1 | - | 45.6 | - | 46.6A | 46.0 | 47.8 | 47.8 | 44.0 |
| $LSD_{0.05}$ | | | 0.4 | - | 0.3 | - | 0.37@10 | 0.6 | 0.7 | 0.9 | 0.3 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 13. Oil Yield (kg/ha)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 1038 | - | 705 | - | 716 | 815 | 47.8 | 811 | 569 |
| | | 5.6 | 1110 | - | 773 | - | 1127 | 887 | 47.9 | 873 | 604 |
| | | 8.4 | 1126 | - | 793 | - | 891 | 847 | 47.9 | 896 | 618 |
| | mid | 2.8 | 1239 | - | 701 | - | 871 | 904 | 47.2 | 831 | 494 |
| | | 5.6 | 1165 | - | 856 | - | 1006 | 974 | 47.3 | 944 | 645 |
| | | 8.4 | 1179 | - | 939 | - | 986 | 1017 | 47.3 | 1038 | 653 |
| | high | 2.8 | 1258 | - | 751 | - | 764 | 987 | 47.0 | 873 | 467 |
| | | 5.6 | 1306 | - | 854 | - | 1021 | 1035 | 46.6 | 932 | 593 |
| | | 8.4 | 1310 | - | 868 | - | 1165 | 1039 | 47.0 | 1019 | 643 |
| Qtm | low | 2.8 | 1028 | - | 770 | - | 687 | 731 | 49.2 | 672 | 256 |
| | | 5.6 | 1126 | - | 754 | - | 874 | 742 | 49.0 | 775 | 390 |
| | | 8.4 | 1096 | - | 782 | - | 871 | 747 | 49.0 | 750 | 490 |
| | mid | 2.8 | 1164 | - | 707 | - | 708 | 816 | 48.7 | 655 | 272 |
| | | 5.6 | 1205 | - | 837 | - | 854 | 832 | 48.4 | 789 | 407 |
| | | 8.4 | 1208 | - | 877 | - | 1044 | 839 | 48.8 | 836 | 379 |
| | high | 2.8 | 1252 | - | 727 | - | 669 | 833 | 48.0 | 552 | 281 |
| | | 5.6 | 1259 | - | 865 | - | 1049 | 889 | 48.3 | 775 | 349 |
| | | 8.4 | 1277 | - | 920 | - | 1006 | 852 | 48.4 | 838 | 465 |
| Inv | | | 1192 | - | 804 | - | 950a | 945a | 636 | 913a | 587a |
| Qtm | | | 1179 | - | 804 | - | 863b | 809b | 583 | 738b | 365b |
| $LSD_{0.05}$ | | | 45 | - | 27 | - | 53 | 32 | 17 | 49 | 45 |
| | low | | 1087c | - | 763b | - | 861b | 795c | 563 | 796B | 488 |
| | mid | | 1193b | - | 820a | - | 912ab | 897b | 615 | 849A | 475 |
| | high | | 1277a | - | 831a | - | 946a | 939a | 650 | 832AB | 466 |
| $LSD_{0.05}$ | | | 55 | - | 33 | - | 64 | 39 | 21 | 50@10 | 55 |
| | | 2.8 | 1163 | - | 727c | - | 736b | 848b | 589 | 732b | 390b |
| | | 5.6 | 1195 | - | 823b | - | 988a | 893a | 596 | 848a | 498a |
| | | 8.4 | 1199 | - | 863a | - | 994a | 890a | 643 | 896a | 541a |
| $LSD_{0.05}$ | | | 55 | - | 33 | - | 64 | 39 | 21 | 60 | 55 |
| no fung | | | 1174 | - | 778 | - | 869B | 818 | 629 | 821 | 489 |
| fung | | | 1197 | - | 831 | - | 944A | 876 | 590 | 831 | 463 |
| $LSD_{0.05}$ | | | 86 | - | 100 | - | 95@10 | 71 | 94 | 142 | 128 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 14. Protein (%)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 23.3 | - | 24.6 | 23.1 | 25.9 | 24.1 | 23.2 | 25.3 | 25.5 |
| | | 5.6 | 22.9 | - | 23.6 | 23.9 | 25.4 | 23.7 | 23.4 | 25.5 | 25.5 |
| | | 8.4 | 22.5 | - | 23.8 | 24.7 | 25.0 | 23.8 | 23.3 | 25.3 | 25.8 |
| | mid | 2.8 | 23.3 | - | 25.4 | 24.7 | 26.6 | 23.9 | 24.1 | 25.5 | 26.0 |
| | | 5.6 | 23.3 | - | 24.3 | 23.5 | 26.0 | 23.7 | 23.8 | 25.4 | 25.9 |
| | | 8.4 | 23 | - | 24.8 | 23.3 | 26.0 | 23.8 | 24.0 | 25.6 | 25.9 |
| | high | 2.8 | 23.8 | - | 26.7 | 23.8 | 26.6 | 24.7 | 24.1 | 25.4 | 26.1 |
| | | 5.6 | 23.4 | - | 25.4 | 24.1 | 26.5 | 24.1 | 24.6 | 25.5 | 25.9 |
| | | 8.4 | 23.2 | - | 25.7 | 22.7 | 25.9 | 24.2 | 24.4 | 25.8 | 26.1 |
| Qtm | low | 2.8 | 23.3 | - | 23.2 | 23.4 | 25.9 | 23.5 | 23.2 | 24.3 | 25.9 |
| | | 5.6 | 22.8 | - | 22.9 | 23.7 | 25.3 | 23.7 | 23.4 | 24.2 | 25.6 |
| | | 8.4 | 23 | - | 22.4 | 23.7 | 25.0 | 24.1 | 23.6 | 23.9 | 25.4 |
| | mid | 2.8 | 23.3 | - | 24.7 | 23.1 | 26.2 | 23.7 | 23.8 | 24.5 | 26.1 |
| | | 5.6 | 23.1 | - | 23.7 | 23.5 | 25.9 | 23.9 | 24.0 | 24.5 | 25.8 |
| | | 8.4 | 23.4 | - | 24.3 | 24.4 | 25.2 | 23.5 | 23.7 | 24.4 | 25.6 |
| | high | 2.8 | 24.1 | - | 25.9 | 23.9 | 26.4 | 24.9 | 24.3 | 24.9 | 26.2 |
| | | 5.6 | 24 | - | 24.4 | 23.6 | 25.9 | 24.1 | 24.0 | 24.7 | 25.8 |
| | | 8.4 | 23.7 | - | 24.7 | 23.7 | 25.7 | 24.5 | 24.3 | 24.7 | 25.7 |
| Inv | | | 23.2b | - | 24.9a | 23.8 | 26.0a | 24.0 | 23.9 | 25.5a | 25.9 |
| Qtm | | | 23.4a | - | 24.0b | 23.6 | 25.7b | 24.0 | 23.8 | 24.5b | 25.8 |
| $LSD_{0.05}$ | | | 0.2 | - | 0.3 | - | 0.2 | 0.3 | 0.2 | 0.09 | 0.14 |
| | low | | 23.0c | - | 23.4c | 23.6 | 25.4b | 23.8b | 23.4c | 24.7c | 25.6b |
| | mid | | 23.2b | - | 24.5b | 23.8 | 26.0a | 23.7b | 23.9b | 25.0b | 25.9a |
| | high | | 23.7a | - | 25.4a | 23.7 | 26.2a | 24.4a | 24.3a | 25.2a | 26.0a |
| $LSD_{0.05}$ | | | 0.24 | - | 0.4 | - | 0.2 | 0.4 | 0.2 | 0.1 | 0.17 |
| | | 2.8 | 23.5a | - | 25.1a | 23.7 | 26.3a | 24.1 | 23.8 | 25 | 26.0a |
| | | 5.6 | 23.2b | - | 24.1b | 23.7 | 25.8b | 23.8 | 23.9 | 25 | 25.7b |
| | | 8.4 | 23.1b | - | 24.3b | 23.8 | 25.5c | 24.0 | 23.8 | 25 | 25.7b |
| $LSD_{0.05}$ | | | 0.2 | - | 0.4 | - | 0.2 | 0.4 | 0.2 | 0.1 | 0.17 |
| no fung | | | 23.5a | - | 24.6A | 23.4 | 26.0a | 24.0 | 23.6 | 25 | 25.8 |
| fung | | | 23.1b | - | 24.3B | 24 | 25.7b | 24.0 | 24.1 | 25 | 25.9 |
| $LSD_{0.05}$ | | | 0.2 | - | 0.3@10 | - | 0.2 | 0.7 | 0.7 | 0.4 | 0.2 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 15. Protein yield (kg/ha)

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 509 | - | 371 | 329 | 395 | 426 | 265 | 414 | 317 |
| | | 5.6 | 524 | - | 381 | 404 | 597 | 444 | 286 | 446 | 336 |
| | | 8.4 | 515 | - | 395 | 469 | 461 | 425 | 301 | 456 | 350 |
| | mid | 2.8 | 603 | - | 390 | 486 | 499 | 464 | 328 | 436 | 287 |
| | | 5.6 | 562 | - | 442 | 359 | 558 | 493 | 301 | 492 | 370 |
| | | 8.4 | 553 | - | 503 | 367 | 546 | 526 | 354 | 543 | 377 |
| | high | 2.8 | 631 | - | 459 | 384 | 445 | 531 | 342 | 459 | 273 |
| | | 5.6 | 631 | - | 480 | 442 | 587 | 545 | 341 | 491 | 341 |
| | | 8.4 | 628 | - | 497 | 379 | 646 | 544 | 374 | 548 | 374 |
| Qtm | low | 2.8 | 485 | - | 382 | 302 | 387 | 370 | 242 | 345 | 154 |
| | | 5.6 | 505 | - | 368 | 278 | 473 | 384 | 271 | 397 | 228 |
| | | 8.4 | 497 | - | 373 | 305 | 461 | 397 | 260 | 379 | 285 |
| | mid | 2.8 | 545 | - | 397 | 304 | 408 | 424 | 276 | 342 | 167 |
| | | 5.6 | 552 | - | 433 | 345 | 480 | 439 | 284 | 415 | 242 |
| | | 8.4 | 564 | - | 474 | 465 | 561 | 434 | 299 | 433 | 225 |
| | high | 2.8 | 619 | - | 443 | 372 | 394 | 467 | 301 | 296 | 172 |
| | | 5.6 | 608 | - | 474 | 366 | 595 | 471 | 302 | 414 | 210 |
| | | 8.4 | 605 | - | 515 | 411 | 562 | 474 | 329 | 450 | 275 |
| Inv | | | 573A | - | 435 | 404a | 526a | 489a | 321a | 476a | 336a |
| Qtm | | | 553B | - | 429 | 348b | 480b | 429b | 285b | 386b | 218b |
| $LSD_{0.05}$ | | | 18@10 | - | 13 | | 28 | 20 | 8 | 26 | 25 |
| | low | | 506c | - | 378c | 341b | 462b | 408c | 271c | 406b | 278 |
| | mid | | 563b | - | 440b | 391ab | 509a | 463b | 307b | 443a | 278 |
| | high | | 620a | - | 478a | 397a | 538a | 505a | 332a | 443a | 274 |
| $LSD_{0.05}$ | | | 26 | - | 16 | | 35 | 25 | 10 | 32 | 31 |
| | | 2.8 | 565 | - | 407c | 364 | 421b | 447 | 293b | 382b | 228b |
| | | 5.6 | 564 | - | 430b | 363 | 548a | 463 | 298b | 442a | 288a |
| | | 8.4 | 560 | - | 459a | 402 | 540a | 466 | 320a | 468a | 314a |
| $LSD_{0.05}$ | | | 26 | - | 16 | | 35 | 25 | 10 | 32 | 31 |
| no fung | | | 551 | - | 421 | 355b | 487 | 459 | 309 | 429 | 284 |
| fung | | | 575 | - | 443 | 398a | 519 | 458 | 297 | 433 | 269 |
| $LSD_{0.05}$ | | | 46 | - | 50 | | 47 | 35 | 39 | 84 | 76 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 16. % green seed

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 0.8 | - | 3.3 | - | 0.4 | 0.6 | 0.1 | 0 | 1.3 |
| | | 5.6 | 1.1 | - | 3.0 | - | 0.5 | 1.0 | 0.5 | 0 | 1.8 |
| | | 8.4 | 1.3 | - | 3.3 | - | 0.4 | 1.0 | 0.3 | 0.1 | 1.9 |
| | mid | 2.8 | 1.9 | - | 2.8 | - | 0.3 | 0.9 | 0.1 | 0.3 | 3.2 |
| | | 5.6 | 1.1 | - | 3.8 | - | 0.4 | 0.6 | 0.5 | 0.1 | 2.1 |
| | | 8.4 | 1.1 | - | 3.2 | - | 0.3 | 1.0 | 0.4 | 0.1 | 1.5 |
| | high | 2.8 | 1.9 | - | 4.3 | - | 0.5 | 0.6 | 1.0 | 0.3 | 2.6 |
| | | 5.6 | 1.3 | - | 3.7 | - | 1.4 | 0.6 | 0.3 | 0.1 | 2.9 |
| | | 8.4 | 1.3 | - | 3.4 | - | 0.4 | 0.7 | 1.0 | 0 | 2.0 |
| Qtm | low | 2.8 | 1.1 | - | 2.3 | - | 0.6 | 1.0 | 0.6 | 0 | 4.1 |
| | | 5.6 | 0.6 | - | 2.5 | - | 0.5 | 1.5 | 0.4 | 0 | 4.6 |
| | | 8.4 | 1 | - | 2.1 | - | 0.3 | 0.9 | 0.4 | 0.1 | 2.4 |
| | mid | 2.8 | 1.4 | - | 3.2 | - | 0.5 | 1.2 | 0.4 | 0.3 | 5.2 |
| | | 5.6 | 1.5 | - | 3.1 | - | 0.4 | 1.0 | 0.4 | 0 | 2.6 |
| | | 8.4 | 1.9 | - | 3.1 | - | 0.4 | 1.1 | 0.4 | 0 | 3.0 |
| | high | 2.8 | 1.8 | - | 3.8 | - | 1.0 | 1.5 | 0.1 | 0.3 | 7.4 |
| | | 5.6 | 1.3 | - | 3.3 | - | 0.5 | 1.3 | 0.5 | 0.4 | 4.5 |
| | | 8.4 | 1.9 | - | 3.3 | - | 0.5 | 1.5 | 0.3 | 0.1 | 3.8 |
| Inv | | | 1.3 | - | 3.4a | - | 0.5 | 0.8b | 0.5 | 0.1 | 2.1b |
| Qtm | | | 1.4 | - | 3.0b | - | 0.5 | 1.2a | 0.4 | 0.1 | 4.2a |
| $LSD_{0.05}$ | | | 0.4 | | 0.3 | | 0.3 | 0.2 | 0.2 | 0.12 | 0.7 |
| | low | | 1 | - | 2.7c | - | 0.4ab | 1.0 | 0.4 | 0.05B | 2.7b |
| | mid | | 1.5b | - | 3.2b | - | 0.3b | 1.0 | 0.4 | 0.1AB | 2.9b |
| | high | | 1.5a | - | 3.6a | - | 0.7a | 1.0 | 0.5 | 0.2A | 3.9a |
| $LSD_{0.05}$ | | | 0.46 | | 0.3 | | 0.3 | 0.25 | 0.3 | 0.12@10 | 0.9 |
| | | 2.8 | 1.5a | - | 3.3 | - | 0.5 | 1.0 | 0.4 | 0.2 | 4.0a |
| | | 5.6 | 1.4 | - | 3.2 | - | 0.6 | 1.0 | 0.4 | 0.1 | 3.0b |
| | | 8.4 | 1.4 | - | 3.1 | - | 0.4 | 1.0 | 0.4 | 0.1 | 2.4b |
| $LSD_{0.05}$ | | | 0.5 | | 0.3 | | 0.3 | 0.25 | 0.3 | 0.14 | 0.9 |
| no fung | | | 1.7a | - | 3.2 | - | 0.5 | 1.0 | 0.3 | 0.1 | 3.0 |
| fung | | | 1.0b | - | 3.2 | - | 0.5 | 0.9 | 0.5 | 0.1 | 3.3 |
| $LSD_{0.05}$ | | | 0.5 | - | 0.1 | - | 0.3 | 0.3 | 0.4 | 0.2 | 1.3 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 16. % green seed

| Treatment | | | 1999 | | | 2000 | | | 2001 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop | N | Seed | Scott | Melfort | Indian | Scott | Melfort | Indian | Scott | Melfort | Indian |
| Inv | low | 2.8 | 0.8 | - | 3.3 | - | 0.4 | 0.6 | 0.1 | 0 | 1.3 |
| | | 5.6 | 1.1 | - | 3.0 | - | 0.5 | 1.0 | 0.5 | 0 | 1.8 |
| | | 8.4 | 1.3 | - | 3.3 | - | 0.4 | 1.0 | 0.3 | 0.1 | 1.9 |
| | mid | 2.8 | 1.9 | - | 2.8 | - | 0.3 | 0.9 | 0.1 | 0.3 | 3.2 |
| | | 5.6 | 1.1 | - | 3.8 | - | 0.4 | 0.6 | 0.5 | 0.1 | 2.1 |
| | | 8.4 | 1.1 | - | 3.2 | - | 0.3 | 1.0 | 0.4 | 0.1 | 1.5 |
| | high | 2.8 | 1.9 | - | 4.3 | - | 0.5 | 0.6 | 1.0 | 0.3 | 2.6 |
| | | 5.6 | 1.3 | - | 3.7 | - | 1.4 | 0.6 | 0.3 | 0.1 | 2.9 |
| | | 8.4 | 1.3 | - | 3.4 | - | 0.4 | 0.7 | 1.0 | 0 | 2.0 |
| Qtm | low | 2.8 | 1.1 | - | 2.3 | - | 0.6 | 1.0 | 0.6 | 0 | 4.1 |
| | | 5.6 | 0.6 | - | 2.5 | - | 0.5 | 1.5 | 0.4 | 0 | 4.6 |
| | | 8.4 | 1 | - | 2.1 | - | 0.3 | 0.9 | 0.4 | 0.1 | 2.4 |
| | mid | 2.8 | 1.4 | - | 3.2 | - | 0.5 | 1.2 | 0.4 | 0.3 | 5.2 |
| | | 5.6 | 1.5 | - | 3.1 | - | 0.4 | 1.0 | 0.4 | 0 | 2.6 |
| | | 8.4 | 1.9 | - | 3.1 | - | 0.4 | 1.1 | 0.4 | 0 | 3.0 |
| | high | 2.8 | 1.8 | - | 3.8 | - | 1.0 | 1.5 | 0.1 | 0.3 | 7.4 |
| | | 5.6 | 1.3 | - | 3.3 | - | 0.5 | 1.3 | 0.5 | 0.4 | 4.5 |
| | | 8.4 | 1.9 | - | 3.3 | - | 0.5 | 1.5 | 0.3 | 0.1 | 3.8 |
| Inv | | | 1.3 | - | 3.4a | - | 0.5 | 0.8b | 0.5 | 0.1 | 2.1b |
| Qtm | | | 1.4 | - | 3.0b | - | 0.5 | 1.2a | 0.4 | 0.1 | 4.2a |
| $LSD_{0.05}$ | | | 0.4 | | 0.3 | | 0.3 | 0.2 | 0.2 | 0.12 | 0.7 |
| | low | | 1 | - | 2.7c | - | 0.4ab | 1.0 | 0.4 | 0.05B | 2.7b |
| | mid | | 1.5b | - | 3.2b | - | 0.3b | 1.0 | 0.4 | 0.1AB | 2.9b |
| | high | | 1.5a | - | 3.6a | - | 0.7a | 1.0 | 0.5 | 0.2A | 3.9a |
| $LSD_{0.05}$ | | | 0.46 | | 0.3 | | 0.3 | 0.25 | 0.3 | 0.12@10 | 0.9 |
| | | 2.8 | 1.5a | - | 3.3 | - | 0.5 | 1.0 | 0.4 | 0.2 | 4.0a |
| | | 5.6 | 1.4 | - | 3.2 | - | 0.6 | 1.0 | 0.4 | 0.1 | 3.0b |
| | | 8.4 | 1.4 | - | 3.1 | - | 0.4 | 1.0 | 0.4 | 0.1 | 2.4b |
| $LSD_{0.05}$ | | | 0.5 | | 0.3 | | 0.3 | 0.25 | 0.3 | 0.14 | 0.9 |
| no fung | | | 1.7a | - | 3.2 | - | 0.5 | 1.0 | 0.3 | 0.1 | 3.0 |
| fung | | | 1.0b | - | 3.2 | - | 0.5 | 0.9 | 0.5 | 0.1 | 3.3 |
| $LSD_{0.05}$ | | | 0.5 | - | 0.1 | - | 0.3 | 0.3 | 0.4 | 0.2 | 1.3 |

Mean values followed by the same letter are not different at P=0.05 (lower case, or at P=0.10 (upper case).

Appendix 17. Impact of cultivar selection and N rate on plant density, total biomass and grain yield.

| | 2000 | | | | | | | | | 2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scott | | | Melfort | | | Indian Head | | | Scott | | | Melfort | | | Indian Head | | |
| N | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean |
| plant density (#/m$^2$) | | | | | | | | | | | | | | | | | | |
| 0 | 141 | 146 | 144a | 164 | 212 | 188B | 167 | 178 | 172 | 124 | 138 | 131 | 89 | 113 | 101ab | 97 | 74 | 85a |
| 30 | 126 | 126 | 126ab | 172 | 227 | 200A | 159 | 146 | 152 | 154 | 135 | 145 | 110 | 121 | 116a | 62 | 72 | 67ab |
| 60 | 137 | 128 | 132ab | 161 | 196 | 178AB | 169 | 150 | 159 | 119 | 157 | 138 | 94 | 93 | 94ab | 77 | 68 | 72ab |
| 90 | 125 | 137 | 131ab | 168 | 206 | 187AB | 167 | 162 | 164 | 137 | 153 | 145 | 76 | 81 | 79c | 82 | 81 | 82a |
| 120 | 115 | 135 | 125ab | 153 | 191 | 172B | 191 | 160 | 176 | 154 | 141 | 147 | 49 | 84 | 66c | 55 | 55 | 55b |
| 150 | 109 | 127 | 118b | 175 | 188 | 181AB | 168 | 165 | 166 | 126 | 132 | 129 | 74 | 91 | 83bc | 55 | 68 | 62b |
| mean | 126 | 133 | | 165b | 203a | | 170 | 160 | | 136 | 143 | | 82b | 97a | | 71 | 70 | |
| $LSD_{0.05}$ | 12 | | 23 | 11 | | 29@10 | 29 | | 35 | 19 | | 37 | 11 | | 24 | 13 | | 20 |
| Biomass (kg/ha) | | | | | | | | | | | | | | | | | | |
| 0 | 4267 | 4585 | 4426c | 6801 | 6330 | 6566 | - | - | | 3298 | 3153 | 3225c | 3175 | 2666 | 2921d | - | - | |
| 30 | 6329 | 6325 | 6327b | 8320bc | 7096de | 7708 | - | - | | 4729 | 4520 | 4624b | 4394 | 3728 | 4061c | - | - | |
| 60 | 7000 | 5481 | 6241b | 8842b | 8485bc | 8664 | - | - | | 5226 | 4425 | 4825ab | 4762 | 3869 | 4316bc | - | - | |
| 90 | 7547 | 6993 | 7270a | 9029ab | 8988b | 9009 | - | - | | 5796 | 5518 | 5657a | 4983 | 4318 | 4651b | - | - | |
| 120 | 7013 | 6367 | 6690ab | 8254bc | 8692b | 8473 | - | - | | 5256 | 5077 | 5166ab | 5138 | 5755 | 5447a | - | - | |
| 150 | 7746 | 6808 | 7277a | 9993a | 7839cd | 8916 | - | - | | 5687 | 4992 | 5339ab | 5783 | 5548 | 5666a | - | - | |
| mean | 6650a | 6093b | | 8540 | 7905 | | | | | 4999a | 4614b | | 4706a | 4314b | | | | |
| $LSD_{0.05}$ | 469 | | 654 | 976 | | | | | | 369 | | 875 | 379 | | 412 | | | |
| Grain yield (kg/ha) | | | | | | | | | | | | | | | | | | |
| 0 | 1350 | 1311 | 1330d | 2263cd | 2120d | 2192 | 1053f | 1079ef | 1066 | 775 | 673 | 725c | 719 | 605 | 662c | 1274 | 989.8 | 1132c |
| 30 | 2286 | 1943 | 2114c | 2530c | 2471cd | 2501 | 1198ef | 1068f | 1133 | 1005 | 1080 | 1043b | 1578 | 1230 | 1404b | 1487 | 1138 | 1312bc |
| 60 | 2162 | 1928 | 2045c | 3093a | 2461cd | 2777 | 1388def | 1545cd | 1467 | 1266 | 926 | 1096b | 1727 | 1427 | 1577ab | 1672 | 1306 | 1489ab |
| 90 | 2371 | 2212 | 2291ab | 3068a | 2623bc | 2846 | 2414ab | 1718cd | 2066 | 1278 | 1272 | 1275a | 1729 | 1548 | 1639ab | 1982 | 1386 | 1684a |
| 120 | 2492 | 2274 | 2383a | 2967ab | 2905ab | 2936 | 2011bc | 1960bc | 1986 | 1328 | 1299 | 1314a | 1878 | 1594 | 1736a | 1897 | 1196 | 1546a |
| 150 | 2594 | 2265 | 2430a | 2981ab | 3105a | 3043 | 2676a | 1947bc | 2312 | 1319 | 1290 | 1304a | 1917 | 1570 | 1743a | 1884 | 1304 | 1594a |
| mean | 2209a | 1989b | | 2817 | 2614 | | 1790 | 1553 | | 1162 | 1090 | | 1591a | 1329b | | 1699a | 1120b | |
| $LSD_{0.05}$ | 74 | | 230 | 366 | | | 470 | | | 91 | | 219 | 139 | | 261 | 123 | | 202 |

Mean values or cultivar* N rate values followed by the same letter are not different at P=0.05 (lower case), or at P=0.10 (upper case).

Appendix 18. Impact of cultivar selection and N rate on seed quality.

| | 2000 | | | | | | | | | 2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scott | | | Melfort | | | Indian Head | | | Scott | | | Melfort | | | Indian Head | | |
| N | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean |
| Protein content (%) | | | | | | | | | | | | | | | | | | |
| 0 | 23.0 | 23.1 | 23.1c | 24.6 | 23.9 | 24.3de | 22.7 | 23.4 | 23.1b | 22.8 | 23.1 | 22.9b | 24.2 | 23.6 | 23.9d | 23.8 | 23.0 | 23.4c |
| 30 | 24.1 | 24.6 | 24.3abc | 24.5 | 23.8 | 24.1 | 23.2 | 22.7 | 23.0b | 22.7 | 23.1 | 22.9b | 24.2 | 23.5 | 23.8d | 24.6 | 23.7 | 24.2b |
| 60 | 23.6 | 23.8 | 23.7bc | 24.9 | 24.1 | 24.5cd | 23.0 | 23.2 | 23.1b | 24.4 | 24.4 | 24.4a | 24.5 | 24.3 | 24.4c | 24.7 | 24.2 | 24.4b |
| 90 | 23.9 | 24.3 | 24.1abc | 24.8 | 24.5 | 24.6c | 23.4 | 23.5 | 23.5ab | 24.4 | 24.8 | 24.3a | 24.8 | 24.9 | 24.9b | 25.3 | 25.3 | 25.3a |
| 120 | 24.9 | 24.7 | 24.8ab | 25.3 | 24.8 | 25.0b | 23.7 | 23.7 | 23.7a | 24.6 | 24.8 | 24.7a | 25.9 | 25.2 | 25.6a | 26.0 | 25.6 | 25.8a |
| 150 | 24.9 | 25.5 | 25.2a | 25.7 | 25.1 | 25.4a | 24.3 | 23.6 | 24.0a | 24.8 | 24.2 | 24.8a | 25.8 | 25.0 | 25.4a | 26.0 | 25.8 | 25.9a |
| mean | 24.1 | 24.3 | | 25.0a | 24.3b | | 23.4 | 23.3 | | 24.0 | 24.0 | | 24.9a | 24.4b | | 25.1a | 24.6b | |
| $LSD_{0.05}$ | 0.27 | | 1.3 | 0.2 | | 0.3 | 0.3 | | 0.6 | 0.2 | | 0.7 | 0.2 | | 0.4 | 0.3 | | 0.6 |
| Oil content (%) | | | | | | | | | | | | | | | | | | |
| 0 | | | - | 51.2 | 49.4 | 50.3a | | | - | 49.8 | 47.7 | 48.8a | 50.4 | 48.5 | 49.4a | 49.7 | 47.0 | 48.3a |
| 30 | | | - | 50.8 | 49.1 | 49.9a | | | - | 48.4 | 48.4 | 48.4a | 50.4 | 47.9 | 49.2a | 48.3 | 46.2 | 47.2b |
| 60 | | | - | 49.6 | 47.7 | 48.7b | | | - | 46.5 | 44.4 | 45.5bc | 49.4 | 46.6 | 48.0b | 48.1 | 45.6 | 46.8b |
| 90 | | | - | 48.5 | 47.0 | 47.8c | | | - | 45.7 | 45.9 | 45.8b | 48.1 | 46.0 | 47.1c | 45.6 | 43.4 | 44.5c |
| 120 | | | - | 47.6 | 46.8 | 47.2d | | | - | 44.4 | 45.9 | 45.1bc | 48.1 | 45.8 | 46.9c | 45.2 | 42.6 | 43.9cd |
| 150 | | | - | 46.8 | 45.9 | 46.3 | | | - | 44.7 | 44.2 | 44.4c | 47.6 | 46.0 | 46.8c | 45.2 | 42.4 | 43.7d |
| mean | - | - | | 49.1a | 47.6b | | - | - | | 46.6 | 46.1 | | 49.0a | 46.8b | | 47.0a | 44.5b | |
| $LSD_{0.0}$ | | | | 0.3 | | 0.5 | | | | 0.9 | | 1.1 | 0.2 | | 0.5 | 0.3 | | 0.6 |
| Green seed (%) | | | | | | | | | | | | | | | | | | |
| 0 | | | - | 0.0 | 0.0 | 0b | 0.4 | 0.8 | 0.6BC | 0.0 | 0.0 | 0b | 0.0 | 0.0 | 0.0 | 0.5 | 0.9 | 0.7d |
| 30 | | | - | 0.0 | 0.3 | 0.1b | 0.5 | 0.6 | 0.5C | 0.3 | 0.0 | 0.1ab | 0.0 | 0.3 | 0.1 | 0.1 | 1.8 | 0.9d |
| 60 | | | - | 0.3 | 0.3 | 0.3b | 0.7 | 1.1 | 0.9ABC | 0.3 | 0.3 | 0.3ab | 0.0 | 0.0 | 0.0 | 1.0 | 1.3 | 1.1cd |
| 90 | | | - | 0.0 | 0.0 | 0b | 1.7 | 1.1 | 1.4AB | 0.3 | 0.5 | 0.4a | 0.0 | 0.0 | 0.0 | 1.4 | 3.1 | 2.3bc |
| 120 | | | - | 0.3 | 1.5 | 0.9a | 0.7 | 1.1 | 0.9ABC | 0.0 | 0.0 | 0b | 0.3 | 0.0 | 0.1 | 2.3 | 3.8 | 3.0ab |
| 150 | | | - | 0.3 | 0.3 | 0.3b | 0.8 | 2.1 | 1.5A | 0.0 | 0.0 | 0b | 0.3 | 0.0 | 0.1 | 2.5 | 4.9 | 3.7a |
| mean | - | - | | 0.1b | 0.4a | | 0.8 | 1.1 | | 0.1 | 0.1 | | 0.1 | 0.1 | | 1.3b | 2.6a | |
| $LSD_{0.0}$ | | | | 0.28 | | 0.58 | 0.6 | | 0.8@10 | 0.2 | | 0.37 | 0.2 | | 0.3 | 0.7 | | 1.2 |

Mean values or cultivar* N rate values followed by the same letter are not different at P=0.05 (lower case), or at P=0.10 (upper case).

Appendix 19. Impact of cultivar selection and N rate on protein and oil yield (kg/ha)

| | 2000 | | | | | | | | | 2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scott | | | Melfort | | | Indian Head | | | Scott | | | Melfort | | | Indian Head | | |
| N | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean |
| Protein yield (kg/ha) | | | | | | | | | | | | | | | | | | |
| 0 | 312 | 304 | 308c | 557cd | 506d | 532 | 239g | 253fg | 246 | 176 | 155 | 165d | 174 | 142 | 158c | 303 | 228 | 265d |
| 30 | 551 | 479 | 515b | 619c | 589cd | 604 | 278fg | 242g | 260 | 226 | 250 | 234c | 381 | 288 | 335b | 365 | 270 | 317c |
| 60 | 512 | 460 | 486b | 772a | 593cd | 683 | 318efg | 357def | 338 | 309 | 226 | 267c | 423 | 347 | 385ab | 413 | 316 | 365bc |
| 90 | 567 | 536 | 551ab | 761a | 641bc | 701 | 565ab | 405cde | 485 | 311 | 307 | 309ab | 430 | 385 | 408a | 501 | 350 | 426a |
| 120 | 621 | 562 | 591a | 750a | 719ab | 735 | 477bc | 464bcd | 471 | 323 | 319 | 321a | 486 | 402 | 444a | 493 | 304 | 398ab |
| 150 | 646 | 578 | 612a | 767a | 779a | 773 | 649a | 461bcd | 555 | 326 | 318 | 322a | 493 | 392 | 443a | 488 | 335 | 412ab |
| mean | 535a | 486b | | 704 | 638 | | 421 | 364 | | 279 | 263 | | 398a | 326b | | 427a | 300b | |
| $LSD_{0.05}$ | 17 | | 68 | 91 | | | 112 | | | 21 | | 50 | 34 | | 66 | 30 | | 49 |
| Oil yield (Kg/ha) | | | | | | | | | | | | | | | | | | |
| 0 | | | - | 1157fg | 1046g | 1101 | | | - | 387 | 322 | 354b | 362 | 295 | 328b | 632 | 465 | 549c |
| 30 | | | - | 1285cdef | 1211efg | 1248 | | | - | 490 | 524 | 507a | 795 | 589 | 692a | 719 | 525 | 622bc |
| 60 | | | - | 1536a | 1174fg | 1355 | | | - | 589 | 411 | 500a | 853 | 665 | 759a | 804 | 594 | 699ab |
| 90 | | | - | 1489ab | 1233def | 1361 | | | - | 587 | 585 | 586a | 832 | 713 | 772a | 903 | 602 | 753a |
| 120 | | | - | 1411abc | 1360bcde | 1386 | | | - | 595 | 597 | 596a | 903 | 730 | 816a | 858 | 512 | 685ab |
| 150 | | | - | 1394abcd | 1426abc | 1410 | | | - | 592 | 570 | 581a | 914 | 721 | 817a | 851 | 554 | 702ab |
| mean | - | - | | 1379 | 1242 | | - | - | | 540 | 502 | | 777a | 619b | | 795a | 542b | |
| $LSD_{0.05}$ | | | | 173 | | | | | | 50 | | 103 | 66 | | 128 | 54 | | 92 |

Mean values or cultivar* N rate values followed by the same letter are not different at P=0.05 (lower case), or at P=0.10 (upper case).

Appendix 20. Impact of cultivar selection and N rate on growth stage.

| | 2000 | | | | | | | | | 2001 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scott | | | Melfort | | | Indian Head | | | Scott | | | Melfort | | | Indian Head | | |
| N | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean | Inv | Qtm | mean |
| days to flowering | | | | | | | | | | | | | | | | | | |
| 0 | 54.3 | 52.3 | 53.3bc | 56.5 | 56.3 | 56.4c | 59.0 | 59.0 | 59.0b | 54.5 | 53.5 | 54.0c | 53.5 | 52.0 | 52.8e | 55.3 | 55.3 | 55.3c |
| 30 | 54.3 | 52.0 | 53.1c | 57.0 | 57.0 | 57.0c | 60.0 | 60.0 | 60.0a | 54.5 | 54.5 | 54.5bc | 55.5 | 54.0 | 54.8d | 56.0 | 56.0 | 56.0bc |
| 60 | 54.8 | 52.3 | 53.5ab | 58.0 | 57.0 | 57.5bc | 60.0 | 60.0 | 60.0a | 55.0 | 54.3 | 54.6abc | 57.0 | 55.0 | 56.0cd | 55.8 | 56.0 | 55.9bc |
| 90 | 54.8 | 53.0 | 53.9a | 58.5 | 57.3 | 57.9bc | 60.0 | 60.0 | 60.0a | 55.0 | 54.8 | 54.9ab | 57.0 | 57.0 | 57.0bc | 56.5 | 57.0 | 56.8ab |
| 120 | 55.0 | 52.3 | 53.6ab | 59.0 | 57.8 | 58.3ab | 60.0 | 60.0 | 60.0a | 54.5 | 55.3 | 54.9ab | 60.0 | 57.8 | 58.9a | 56.8 | 57.5 | 57.1a |
| 150 | 55.0 | 52.5 | 53.8ab | 61.5 | 57.8 | 59.6a | 60.0 | 60.0 | 60.0a | 55.8 | 54.8 | 55.3a | 58.0 | 57.0 | 57.7ab | 56.0 | 56.5 | 56.3ab |
| mean | 54.7a | 52.4b | | 58.4a | 57.2b | | 59.8 | 59.8 | | 54.9a | 54.5b | | 56.8a | 55.5b | | 56.0b | 56.4a | |
| $LSD_{0.05}$ | 0.3 | | 0.5 | 0.9 | | 1.7 | 0 | | 0 | 0.35 | | 0.7 | 0.6 | | 1.2 | 0.3 | | 0.9 |
| length of flowering (days) | | | | | | | | | | | | | | | | | | |
| 0 | 21.8f | 23.3d | 22.6 | 21.5 | 21.8 | 21.7b | 21.0 | 21.0 | 21b | 16.5 | 17.5 | 17.0a | | | | 18.0e | 18.8de | 18.4 |
| 30 | 21.5f | 24.8bc | 23.1 | 23.0 | 22.5 | 22.8ab | 21.0 | 21.0 | 21b | 16.5 | 16.5 | 16.5ab | | | | 17.5e | 18.3e | 17.9 |
| 60 | 22.3ef | 25.8ab | 24.1 | 26.0 | 23.0 | 24.5a | 22.0 | 22.0 | 22a | 16.0 | 16.8 | 16.4abc | | | | 17.8e | 18.8de | 18.3 |
| 90 | 22.8de | 24.5c | 23.7 | 25.5 | 22.8 | 24.2a | 22.0 | 22.0 | 22a | 16.0 | 16.3 | 16.1bc | | | | 20.5cd | 22.0bc | 22.3 |
| 120 | 22.8de | 25.8ab | 24.3 | 25.0 | 24.3 | 24.7a | 22.0 | 22.0 | 22a | 16.5 | 15.8 | 16.1bc | | | | 19.0de | 25.8a | 22.4 |
| 150 | 22.8de | 26.0a | 24.4 | 22.5 | 24.3 | 23.4ab | 22.0 | 22.0 | 22a | 15.3 | 16.3 | 15.8c | | | | 18.8de | 24.0ab | 21.4 |
| mean | 22.3 | 25 | | 23.9 | 23.1 | | 21.7 | 21.7 | | 16.1b | 16.5a | | | | | 18.6 | 21.3 | |
| $LSD_{0.05}$ | 1 | | | 0.9 | | 1.7 | 0 | | 0 | 0.35 | | 0.7 | | | | 0.8 | | 2.1 |
| days to maturity | | | | | | | | | | | | | | | | | | |
| 0 | 98.5 | 96.8 | 97.6d | 108.0cd | 107d | 107.5 | 104.0 | 104.0 | 104 | 90.3 | 90.3 | 90.3e | | | | 101b | 104a | 103 |
| 30 | 101.8 | 100.8 | 101.3c | 108.0cd | 107d | 107.5 | 104.0 | 104.0 | 104 | 91.0 | 91.0 | 91.0de | | | | 104a | 104a | 104 |
| 60 | 101.8 | 100.8 | 101.3c | 108.5bc | 108.0cd | 108.3 | 104.0 | 104.0 | 104 | 91.5 | 91.5 | 91.5cd | | | | 104a | 104a | 104 |
| 90 | 103.0 | 102.3 | 102.6b | 109.8b | 109.5b | 108.7 | 104.0 | 104.0 | 104 | 92.3 | 92.3 | 92.3bc | | | | 104a | 104a | 104 |
| 120 | 104.3 | 103.3 | 103.8a | 113.0a | 109.0bc | 111 | 104.0 | 104.0 | 104 | 92.5 | 92.5 | 92.5ab | | | | 104a | 104a | 104 |
| 150 | 104.5 | 104.0 | 104.3a | 113.0a | 113.0a | 113 | 104.0 | 104.0 | 104 | 93.3 | 93.3 | 93.3a | | | | 104a | 104a | 104 |
| mean | 102.3a | 101.3b | | 111 | 108.9 | | 104 | 104 | | 91.8 | 91.8 | | | | | 104 | 104 | |
| $LSD_{0.05}$ | 0.5 | | 1.4 | 1.3 | | | 0 | | 0 | 0.2 | | 1.0 | | | | 0.6 | | 1.1 |

Mean values or cultivar* N rate values followed by the same letter are not different at P=0.05 (lower case), or at P=0.10 (upper case).