How Effective are Crop Rotations?

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Current crop rotation recommendations suggest at least 3 non suspectable crops be grown between planting of sclerotinia suspectable crops such as canola and pea. However current pricing of pea and canola make production of these crops more profitable providing their yields are not greatly reduced by disease. Under center pivot irrigation the soil surface and plants are wetted every 2-4 days during periods of high water use; this results in a good environment for spore production and germination. Levels of sclerotinia infection were generally somewhat lower than predicted by the petal test method. Yields were not improved by the application of iprodione at 250, 500 or 700 g/ha at the 40% bloom stage. The yield levels obtained and visual observation of time and severity of stem damage indicated that the disease probably occurred late enough in the season to limit damage. No lodging occurred and sclerotinia levels were near zero in 1991 as a result of a very hot dry August. In 1992, 2 of 3 tests showed significant lodging. Sclerotinia levels increased with an increase in lodging (r^2 = 0.85* and 0.73*). Lodging reduction can be accomplished by the use of resistant cultivars and by lowering seeding rates to less than 100 seeds/m². Yields were not reduced at lower seeding rates at wider row spacings. Sclerotinia is an environmentally influenced disease which is not well controlled by crop rotations up to 5 years however its severity can be limited by reducing lodging. When canola prices are at least 1.9 times that of cereal grains, shortening rotations to 2-3 years between crops such as pea and canola could be a viable risk.

Introduction

"All canola varieties are suspectable to sclerotinia. In addition, a wide range of crop plant species including soybean, sunflower, mustard, lentil, field pea, fababean, white bean, alfalfa, clover, carrot and potato are affected to some degree. Follow a rotation of at least four years between suspectable crops. However, in fields with a history of stem rot, even a five year absence of susceptible crops has not been adequate to reduce the number of sclerotia in the soil. A rotation also does not protect the crop from infection by air-borne spores from nearby fields (Canola growers manual p1052). This statement clearly sums up the dilemma of irrigators in that growing crops other than wheat has been limited by rotation considerations as delineated above. The goal of this presentation is to present some observations on the "value" of rotations in controlling sclerotinia levels and to evaluate some agronomic measures other than rotation to enable diversification from wheat without excessive production risks.

Materials and Methods

A series of experiments were conducted where sclerotinia infection levels and other agronomic traits were measured.

Canola production package

The design of this test was a 6 replicate split block with one block being seeding method and the second being the level of fungicide. Plots were 4.25 x 30 m and the center 2.4 m of each plot was harvested for grain. In 1989 and 1990 Global canola was planted at 215 seeds/m^2 in one of the 5 following ways: 1) Amazone hoedrill 8 cm row spacing 2) Amazone hoedrill 16 cm spacing 3) solid seeded created with a deflector plate attached to the cultivator shovels of an air drill 4) broadcast and incorporated with a 3 cm depth cultivation 5) 20 cm hoedrill spacing. These seeding treatments were employed in 1992 at seeding rates of 80, 150 and 220 seeds/m^2. Nitrogen and phosphorous were applied at or slightly above soil test levels. In 1992 a 48 cm row spacing at 80 and 150 seeds/m^2 was added. Rovral Flo (iprodione 250 g/L) was applied at 40% bloom on one site in 1989 and 2 sites in 1990 at 0, 2.0 and 3.0 L/ha using 8003 nozzles in 200 L/ha of water. Potential sclerotinia infection levels were estimated using the petal test described by (Turkington et al 1991). Sclerotinia levels were measured by determining the percent of infected plants in 10 samples of 10 plants per plot. Lodging was estimated using the Belgian scale.

Effect of row spacing and seeding rate on canola production

The effect of seeding rate and row spacing on yield, lodging and sclerotinia in 1991 and 1992. The design was a randomized complete block with 6 replicates in 1991 and 8 replicates in 1992. The treatments were: 8 cm and 16 cm spacings at 3, 6 and 9 kg/ha and 3 kg/ha at 32, 48 and 64 cm row spacings. An additional treatment (3@8cm_48cm) had 3 rows 8 cm apart with a space of 48 cm between row triplets. The 3 kg/ha seeding rate was equivalent to approximately 85 seeds/m^2. Plots were 10 m long and 3 m wide. The outside one or 2 rows were removed from the plots just prior to harvest and the plots trimmed to a length of 6 m before swathing. Sclerotinia levels were estimated from 6 samples of 10 plants per plot. No effort was made to determine the degree of stem damage. Lodging was estimated by measuring the height of the canopy above the soil surface using an ultrasonic distance measuring system and a 0.5 m^2 smooth target. Three samples were taken per plot just prior to harvest.

272

Results and Discussion

Canola production package

The Outlook site had grown canola in 1987 while the Riverhurst site was being irrigated for the first season. Sclerotina measurements are quite variable due in part to the sample size but also the nature of the disease. Fungicide application reduced sclerotinia levels only at the Outlook site in 1989 (Table 1). Row spacing did not affect yields expect in 1989 and there was no interaction between row spacing and fungicide for sclerotinia infection levels or seed yield so the data were combined. Fungicide application did not result in higher yields at any site despite very high levels of inoculum as indicated by the petal test.

Table 1. Effect of fungicide treatment on sclerotinia and yields under center pivot irrigation

iprodione (g ai/ha)	Outlook 1989		Outlook 1990		Riverhurst 1990	
	sclerotinia!	yield (kg/ha)	sclerotinia	yield (kg/ha)	sclerotinia	yield (kg/ha)
250	29 a	2609 a	30 a	2446 a	11.9 a	2527 a
500	20 a	2618 a	27 a	2445 a	11.2 a	2566 a
750	15 a	2512 a	27 a	2558 a	11.9 a	2385 a
CV	51	8.6	39	6.4	42	8.2
% infected petals	83		90		71	

!Sclerotinia % infected plants

Sclerotinia infection levels were negligible for the canola production package at Outlook in 1991 and at Riverhurst in 1991 and 1992 presumably due to dry conditions (pan evaporation July 14-Aug 12, 1991 of 239 mm) and no history of sclerotinia at the Riverhurst site. The Riverhurst location was never located on fields with a history of canola production therefore the inoculum load and incidence of sclerotinia stem rot was low. In 1992 the Outlook site had sclerotinia levels ranging from 32% to 66% infected plants with the highest infection levels occurring when lodging was most severe. The highest levels of lodging occurred at higher seeding rates therefore the effects of crop density and lodging on sclerotinia can not be separated (Fig 1). Lodging was increased by higher plant populations $r^2 = .80$ df = 13 (56 to 158 plants/m^2). Yields were lower at higher seeding rates at the same time sclerotinia levels were higher (Table 2). There was no significant interaction between seeding rate and row spacing for lodging, yield or percent of plants infected with sclerotinia. Past work on seeding rates and row spacing have shown limited effects of seeding rate on yield and a negative effect of wide row spacings (Clarke and Simpson 1978, Christensen and Drabble 1984, Kondra 1975, and Morrison et al 1990). In these studies sclerotinia infection levels were not reported and therefore assumed to be of limited importance.

273

Table 2. Effect of row plant density of lodging sclerotinia infection and yield			
Seeding rate kg/ha	lodging (.2-9.0)	% plants with sclerotinia	yield (kg/ha)
80	4.0	36	3023
150	4.7	44	2885
220	6.0	54	2687
LSD	0.6	7.5	204

Effect of row spacing and seeding rate on canola production

The relationship between lodging and sclerotinia infection in this study was not as clear cut with a large number of data points being generated at the 3 kg/ha seeding rate where little lodging or sclerotinia occurred (Fig 2). Lodging as estimated by canopy height at maturity was greater at higher seeding rates but 8 cm or 16 cm row spacings had no measurable impact (Fig 3). Canola yields were lower at the 8 cm spacing and 9 kg/ha seeding rate (Fig 4). The percent infected plants was not higher at the 16 cm than the 8 cm spacing at the 9 kg/ha seeding rate but seed yields were significantly lower. Wide row spacings did not result in lower yields at the 3 kg/ha seeding rate (Table 3).

Table 3. Effect of row spacing on canola seed yields (kg/ha)								
Year	8 cm	16 cm	32 cm	48 cm	64 cm	3a8cm_48cm	CV	F
1991	1470	1714	1620	1549	1145~	1408	17.9	ns
1992	2958	3156	3162	3061	3334	3215	11.3	ns

_2 kg/ha seeding rate

The decision on crop rotation must be based on the potential risk due to disease versus the prices and expected yields of the cropping options. At the 1.85 t/ac yield for hard red spring wheat and the expected yield of 1.05 t/ac for canola a yield reduction of 15% due to sclerotinia would be necessary before wheat production would be more profitable than canola (Fig 5). If prices of canola are near $300/tonne as they may be in 1993 and wheat prices remain near the $135/tonne 7 year mean, shorter rotations should be considered.

Literature

Canola growers manual 1984. Canola Council of Canada Phil Thomas editor P1052
Clarke, J.M., and Simpson, G.M. 1978. Can. J. Plant Sci. 58:731-737.
Christensen, J.V., and Drabble, J.C. 1984. Can. J. Plant Sci. 64:1011-1013.
Kondra, Z. P. 1975. Can. J. Plant Sci. 55:339-341.
Morrison, M.J., McVetty, P.B.E., and R. Scarth. 1990. Can. J. Plant Sci. 70:127-137.
Turkington, T. K., Morrall, R.A.A and Gugel, R.K. 1991. Can. J. Plant Pathology 13:50-59.

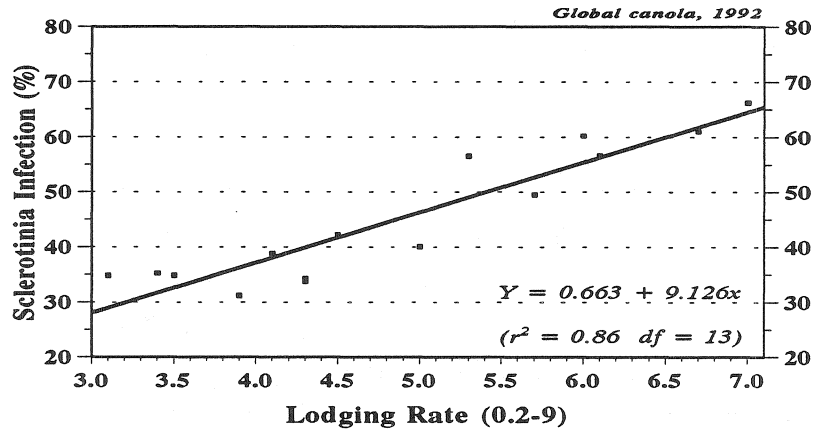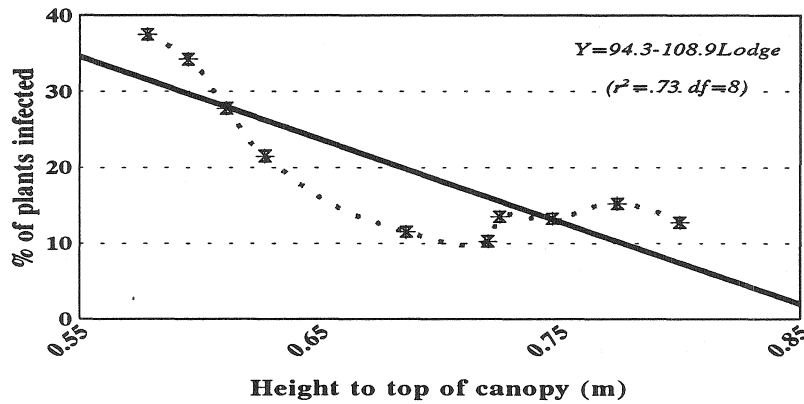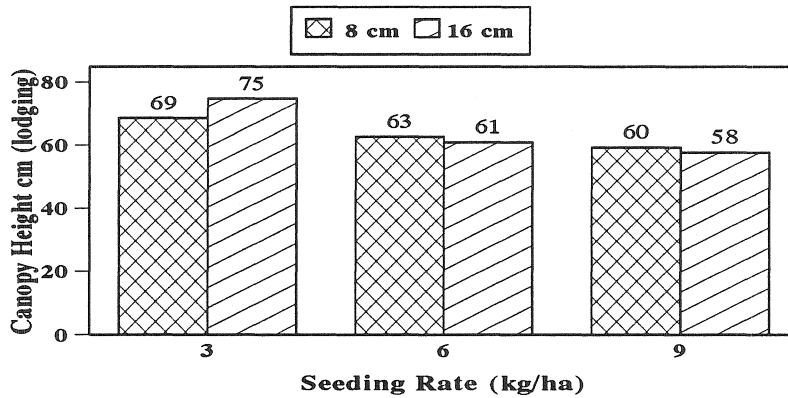## Fig 1. Relationship Between Lodging and Sclerotinia Infection of Irrigated Canola

Global canola, 1992

$Y = 0.663 + 9.126x$

$(r^2 = 0.86 \quad df = 13)$

Sclerotinia Infection (%)

Lodging Rate (0.2-9)

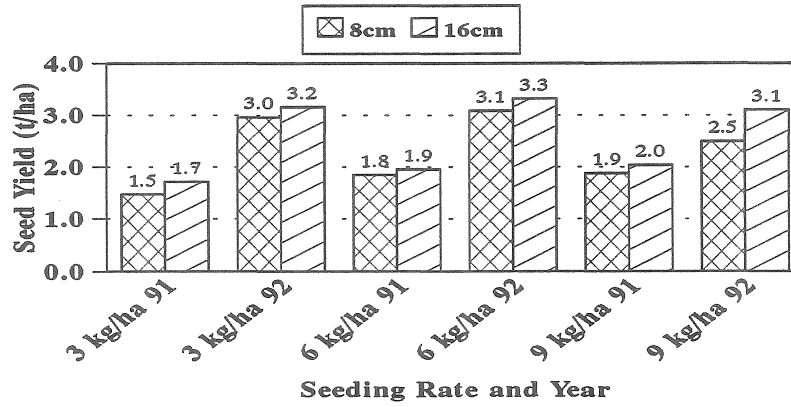## Fig 2. Effect of lodging on sclerotinia infection levels, Global 1992

$Y = 94.3 - 108.9 Lodge$

$(r^2 = .73. \; df = 8)$

% of plants infected

Height to top of canopy (m)

*Height prior to lodging 1.3 m

Fig 3. Effect of seeding rate x spacing on lodging, Global 1992

☒ 8 cm   ☐ 16 cm

Canopy Height cm (lodging)

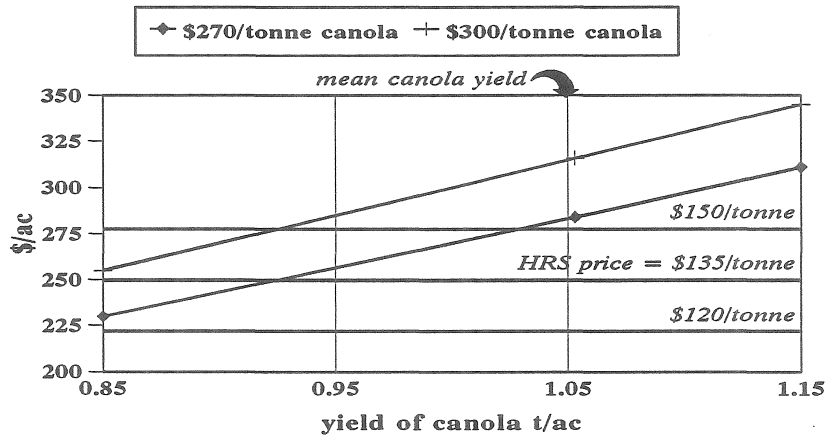| Seeding Rate (kg/ha)	8 cm	16 cm
3	69	75
6	63	61
9	60	58

Seeding Rate (kg/ha)

$LSD_{0.05} = 12$

Fig 4. Row spacing by seeding rate interaction of Global canola, Outlook 1991 and 1992

LSD91$_{0.05}$=.309   LSD92$_{0.05}$=.440

Fig 5. Effect of prices and yields on canola and wheat returns

*Hard Red Spring mean yield = 1.85 tonne/ac