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Management of Soybean Cyst Nematode with Winter Wheat/Legume Rotations

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Introduction

Soybean cyst nematode (SCN) is the most important disease of soybeans in Ontario. It has been estimated that losses exceed $30 million annually because of this pest. Crop rotation with non-hosts is one method that is recommended for managing the disease. In southwestern Ontario, there are limited options available for rotation. One option includes winter wheat which is frequently underseeded with red clover. Although wheat is a non-host, conflicting reports have been published on ability of red clover to support reproduction of SCN. This study was undertaken to determine if wheat/red clover crops result in an increase or decrease in soil inoculums.

Materials and Methods

A) Field Studies

Field studies were conducted in microplots constructed on sandy loam soil at the Harrow research centre. Plots were constructed of untreated wood, 38 x 55 cm (1.4 m^2)and infested with Hg 1.2.5.7 (Race 2).

Wheat (cv. Rebecca) was established in fall of 1997. Wheat was planted at 3 seeding rates, 0.5, 1 and 1.5X the recommended rate (200 kg/ha). In April, plots were underseeded with red clover (cv. Double cut) at 1 and 2X the recommended rate (16 kg/ha). Treatments were replicated 10X. Soil samples were collected to determine cysts and eggs in late April and early November (**Figure 1**). SCN larvae were extracted from soil and enumerated in June, July, August and September.

In the second year (1998-99), new micro plots were established and wheat was planted in the fall at the same rates as the first year. Clover was under seeded in early April and two soybean treatments cv. Kenwood 94 (S) and cv. Bell (R) were planted in late May (**Figure2**). SCN J_2 juveniles were sampled in June, July and August (**Table 1**).

SCN cyst and egg populations in the soil were monitored by sampling 8-10 sub-samples/plot. Cysts were extracted by the floatation method. Roots were periodically subsampled and observed for the presence of cysts of SCN. Data were analyzed with Agro-base randomized block analysis program.

B) Greenhouse Experiments: Effect of wheat and red clover on SCN hatching and survival

Pot studies to determine if wheat and clover would affect SCN were also conducted in the greenhouse. Soil was collected from an infested Hg 1.2.5.7 (Race 2) field. Pots (20 cm) were filled and planted with the following treatments: 1) 100 kg/ha of wheat (cv. Freedom); 2) 400 kg/ha of wheat; 3) 800 kg/ha of wheat; 4) 400 kg/ha wheat + 11 kg/ha red clover (cv. Double cut); 5) 400 kg/ha wheat + 44 kg/ha red clover; 6) 400 kg/ha wheat + 88 kg/ha red clover; 7) 44 kg/ha red clover; 8) fallow; and 9) soybean cv.

Results and Discussion

Field Experiments

In 1997-98 winter wheat season, cysts and eggs/100 g of soil did not differ significantly among treatments in the spring or in the fall after a complete season of cropping with wheat and red clover. Infested micro plot populations resulted in moderately high levels of cysts and eggs, 87 and 5577/100 g soil respectively. In **Figure 1**, the numbers of cysts, eggs and eggs/cyst decreased in almost all wheat/red clover treatments similar to the decrease which occurred in the fallow treatment.

The weather in 1998 was warm and very dry and although plots were irrigated, soil samples for viable J_2 contained very few individuals (overall range of means of 4.6-5.7 J_2's). For the first year, there were no significant differences between treatments for J_2 juveniles monitored in April, May, June and July. Highest numbers were recorded in the April samples and the numbers decreased in mid-summer but there was no correlation with the seeding rate of wheat or clover.

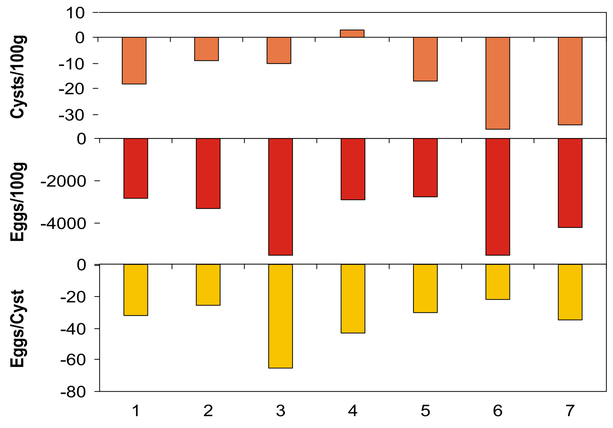

Figure 1. Effect of wheat and red clover on populations of SCN in field microplots, 1997-98. Treatments - See Table 1 treatment numbers 1-7.

New micro plots were established in the fall of 1998 with higher SCN populations. Micro plots were infested with a high level of cysts and eggs, averaging 317 and 60,800/100 g soil respectively. Cyst and egg populations were monitored in November 1998, May and October, 1999. Changes in populations were significantly different for the number of cysts/100 g from November,1998 to October, 1999 (**Figure 2**). Cysts decreased significantly in the fallow treatments and increased the greatest in the susceptible variety treatments. Changes in populations of eggs/100 g soil and eggs/cyst (**Figure 2**) decreased as wheat/red clover seeding rates increased but treatments were not significantly different from fallow and soybeans.

In 1999, J_2 juveniles were more numerous in micro plots (**Table 1**) during the growing season than in 1998. Irrigation was applied more frequently and drought stress was not evident. Soil samples from both soybean treatments stimulated significantly higher hatching numbers of J2 larvae than wheat, red clover or fallow treatments. Susceptible Kenwood 94 (S) stimulated more hatching than resistant Bell (R). In general J_2 activity was low in other treatments from the 1998-99 field micro plot wheat/red clover treatments.

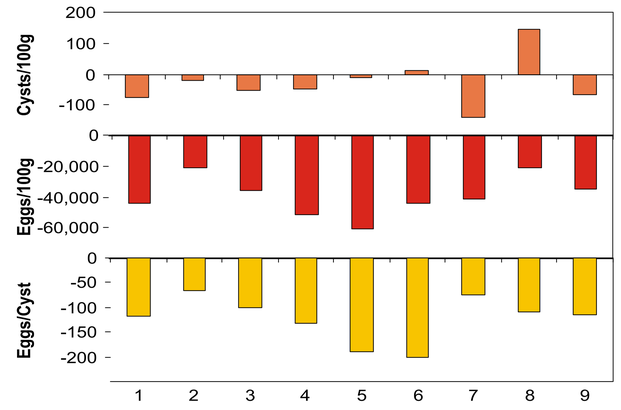

Figure 2. Change in SCN populations in soil in wheat/red clover field microplots November, 1998 to October, 1999. Treatments - See Table 1, treatment numbers 1-9.

Table 1. SCN, J_2 juveniles in wheat/clover microplots during the growing season, 1999.

	Date			
Treatment	June 23	July 27	August 18	Mean
1 0.5W + 1RC	42*	60	47	50
2 0.5W + 2RC	65	80	27	57
3 1W + 1RC	85	45	51	60
4 1W + 2RC	48	36	49	44
5 1.5W + 1RC	44	67	23	45
6 1.5W + 2RC	62	41	38	47
7 Fallow	51	51	19	40
8 Kenwood 94 (S)	116	756	172	348
9 Bell (R)	33	334	167	178
Mean	59	101	48	
$LSD_{0.05}$	42	136	12	
CV	88	130	31	
PR>F	0.22	0.00	0.00	

* J_2/10 g dry soil

Greenhouse Studies

Two trials were conducted in greenhouse pots with similar results. J_2 larvae were sampled 3X during the experiment and highest activity was recorded on April 8 approximately 8 weeks after seeding (**Table 2**). At that sample date highest numbers of J_2 were found in pots with the higher rates of clover and susceptible soybeans. Soybeans (cv. Williams) appeared to stimulate activity during all three sample dates compared to wheat and clover treatments and had significantly more J_2 than the other treatments on each sample date. In general J_2 activity was low in other treatments.

Table 2. Effect of wheat, red clover and soybeans on SCN J_2 juveniles in greenhouse pots, planted in February 1999.

	Date			
Treatment**	March 12	April 8	April 26	Mean
1 Wheat 1X	3.7*	3.3	1.4	2.7
2 Wheat 4X	2.2	2.0	2.7	2.3
3 Wheat 8X	3.3	12.1	1.0	5.3
4 Wheat 4X + Clover 1X	2.7	2.3	1.4	2.0
5 Wheat 4X + Clover 4X	3.3	11.9	2.1	5.7
6 Wheat 4X + Clover 8X	2.1	1.3	2.4	1.7
7 Clover 4X	8.9	5.8	2.4	5.7
8 Fallow	6.9	7.5	2.2	5.3
9 Williams (S)	38.6	316.6	82.1	146.0
Pr>F	0.00	0.00	0.00	0.04
*Mean	7.96	40.3	10.7	19.6
$LSD_{0.05}$	10.79	76.01	16.7	70.6
CV	127	176	186	252

* J_2/10 g dry soil
** Planting rate adjusted for pots: Wheat 1X = 100 kg/ha, clover 1X = 11 kg/ha, soybean = 70 kg/ha

In the second trial an additional treatment, SCN resistant soybean cv. Bell was included. At the end of the experiment the numbers of cysts and eggs decreased by -77 cysts and -8,243 eggs/100 g of soil (**Figure 3**). There were no significant differences among treatments for any of the parameters measured. However, a large decrease in eggs/100 g occurred in the resistant soybean treatment 10, the high rate of clover with wheat, treatment 6 and treatment 7 clover alone.

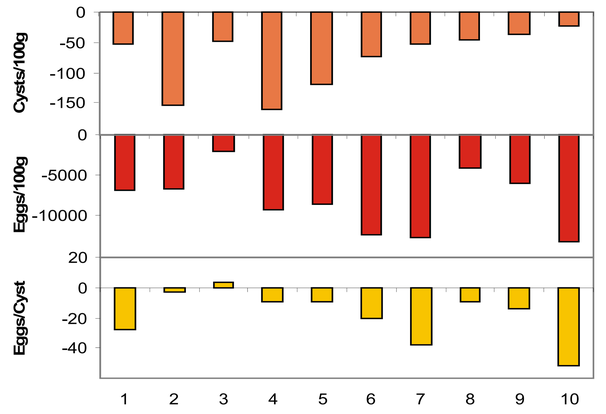

Figure 3. Effect of wheat/red clover and soybeans on populations of SCN in greenhouse pots, 1999. Treatments - See Table 2, treatments 1-9; Tmt 10 = Bell (R).

Conclusions

Micro plots were successfully established at Harrow and plots contained sufficient populations to infect soybean under normal field conditions and comparable to a number of fields in Southwestern Ontario. In 1998 drought conditions interfered with plant growth and restricted hatching of SCN based on J_2 larvae counts in micro plots. Population decreases in soil from all wheat-clover treatments decreased to the same degree as in the fallow plots. This suggests that the wheat-clover treatments were neutral in effect on SCN soil populations.

In the 1999 field experiment, microplots were established with a higher population of cysts. Cyst and egg populations decreased in all plots from November to the next October. Cysts and eggs increased significantly in plots planted with the susceptible soybean Kenwood 94. An examination of roots at mid-season and at harvest revealed cysts only on soybean roots. Cysts were not observed on clover or wheat roots.

Soybean treatments contained the highest numbers of SCN J_2 larvae. Clover or wheat did not stimulate hatching when compared to fallow control plots.

Results from greenhouse trials were similar to field trials in that wheat and/or red clover did not appear to stimulate or depress hatching and activity of SCN. Wheat and red clover seeding rates in the greenhouse affected soil borne populations in the same manner as a fallow season or resistant soybean variety such as Bell. Under-seeding winter wheat with red clover is therefore considered a good practice which will not increase SCN soil populations.

Reference: http://res2.agr.ca/london/orep/anderson_16_rep_e.htm

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