Final Project Report to the NYS IPM Program, Agricultural IPM 2003 – 2004

Title:

Integrated Management of Soilborne Viruses Threatening Winter Wheat

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Type of grant:

Monitoring, forecasting, and economic thresholds

Project location(s):

Throughout the Northeast

Abstract:

Chemical seed dressings and planting date choice were assessed in field plots as potential tactics complementary to partially resistant varieties for the integrated management of *Wheat spindle streak mosaic virus* (WSSMV) and *Wheat soilborne mosaic virus* (WSBMV) in winter wheat. None of the seed treatment products that provided protection against WSBMV transmission in controlled environment laboratory experiments showed a corresponding reduction in natural transmission and disease development for either WSBMV or WSSMV in our field experiments. This suggests that seed treatment is not a reliable tactic for disease control with susceptible wheat cultivars under severe disease pressure. Seed dressings may still prove useful under less severe disease pressure and with cereal varieties with partial resistance. A laboratory-based, soil environment model for WSBMV transmission was a good predictor for WSBMV disease development, but not for WSSMV disease development in the field. Relative earliness or lateness of planting is less important as a control tactic for soilborne viruses than the specific environment in the weeks following a particular planting date. Improved models based on the post-planting environment might predict virus-induced losses of yield potential, and in some cases, growers might avoid purchase of spring inputs such as pesticides and fertilizer for fields with diminished yield potential.

Background and justification:

Soft winter wheat is an important cash crop for New York producers as it fits well into dairy, cash grain, and vegetable crop rotations and helps to disrupt the life cycles of pests that damage other predominant crops in these rotations. Rotation is the backbone of IPM for wheat in New York. However, rotation is not a useful IPM strategy against certain diseases such as the soilborne viruses (listed as a priority for IPM research by the Dairy/Field Crops IPM Committee). The development and deployment of virus-resistant or virus-tolerant varieties is the most effective IPM strategy against these diseases.

For more than 20 years, a soilborne virus called wheat spindle streak mosaic virus (WSSMV) has been a yield-limiting factor in the production of winter wheat in New York. The disease is transmitted by a soilborne protozoan, *Polymyxa graminis*, which occurs as an obligate parasite of wheat roots in all soils in New York where wheat has once been grown. The vector and the virus persist in the soil for decades, ready to infect wheat seedlings the next time they are planted in an infested soil. Significant gains have been made in the last several years in identifying adapted varieties with partial resistance to WSSMV, and then educating wheat producers so these varieties are grown.

During 1998-99, a new soilborne virus called wheat soilborne mosaic virus (WSBMV) was for the first time confirmed to be present in at least three fields of winter wheat in northwestern Tompkins/southern Seneca Co. During 200-2002, WSBMV was confirmed in more distant (from the earlier sites) locations in Cayuga, Schuyler, Seneca, Steuben, and Tompkins counties. It appears that WSBMV has a wider distribution than we suspected and may spread at a fairly high rate in the future.

Producers with confirmed infestations have already been advised to practice sanitation and avoid moving infested soil to new locations. Based on experience in other areas of North America where WSBMV occurs and on preliminary observations in New York, this virus poses a significant risk to wheat production in New York. Resistant varieties have been used successfully to diminish losses to WSBMV in other regions. Tremendous progress was made with NYS-IPM supported research over the past three years to identify adapted cereal varieties with partial resistance to WSBMV as well as to WSSMV. Cultivar evaluation continues.

We have new insights based on the scientific literature and preliminary laboratory results at Cornell that other production tactics, i.e., seed treatment and altered crop planting date, may further reduce losses to soilborne viruses when deployed in conjunction with partially resistant cultivars. Using a rapid screening process in growth chambers, we identified a number of chemical seed dressings that provided moderate protection against WSBMV transmission. If these chemicals retain efficacy in the field, growers would have the opportunity to complement moderate levels of resistance with chemical control as an effective integrated strategy. Our epidemiological studies using controlled environments indicate that each autumn after planting there are a limited number of days when the soil is both warm enough and moist enough for viral transmission to occur. We propose to assess in the field whether planting date (early versus late) can shift the risk of encountering peak virus infection levels.

Objectives:

1. Assess the efficacy of chemical seed dressings in preventing transmission of WSBMV and WSSMV in the field.
2. Determine whether altered planting date is an effective control tactic for reducing transmission of WSBMV and WSSMV.

Procedures:

Plots of wheat cultivars Harus (susceptible to WSBMV) and Pioneer 2548 (susceptible to WSSMV) were treated according to pesticide labels with a number of promising seed dressings (includes Baytan, Maxim, Omega, Tween 20, others) in replicated experiments in a WSBMV nursery in Trumansburg and a WSSMV nursery in Ithaca. Plants were rated in May 2003 for visual symptoms of each virus and were compared with untreated controls to determine seed dressing efficacy.

A replicated planting date experiment was planted in both the WSBMV and WSSMV nurseries. The experimental design for the experiment was to plant two susceptible and one resistant check per planting date per nursery over the course of twelve planting dates beginning September 19, 2002 and concluding November 25, 2002. Soil matric potential and soil temperature at 4 in. were recorded from planting until soil freeze and correlated with disease incidence in May.

Results and discussion:

None of the seed treatment products that provided protection against WSBMV transmission in controlled environment laboratory experiments showed a corresponding reduction in natural transmission and disease development for either WSBMV or WSSMV in our field experiments (Table 1). This suggests that seed treatment is not a reliable tactic for disease control with susceptible wheat cultivars under severe disease pressure. However, it may be useful to test the same materials when applied to seed of cultivars with partial resistance to soilborne viruses, especially if disease pressure in a particular environment may be less severe than in our 2002-03 tests.

The autumn of 2002 was relatively warm and wet. Forty-five autumn days were warm enough for WSBMV transmission and only four of those days were not wet enough for transmission according to our laboratory model. Our model predicted that wheat planted at all dates would have experienced conducive windows for WSBMV transmission, though the last planting date only experienced the tail end of the final conducive window. The conducive windows were significantly positive predictors of WSBMV disease incidence. The overall average WSBMV disease incidence for Harus wheat was 58% and for Presto triticale was 76%.

The WSSMV nursery was drier than the WSBMV nursery with 29 days predicted by the WSBMV model to have conducive conditions. Only the first conducive window was a positive predictor of WSSMV disease incidence. The overall average WSSMV disease incidence was 53% for Pioneer 2548 wheat. There was a linear decline in WSSMV disease incidence with planting date that paralleled the decline in soil temperature. Wheat planted on the fourth planting date emerged during a dry spell and averaged only 38% disease incidence compared with the other six of the first seven planting dates average of 67%.

Our results show that, as a control tactic for soilborne viruses, relative earliness or lateness of planting is less important than the specific environment in the weeks following a particular planting date. Improved models based on the post-planting environment might predict virus-induced losses of yield potential, and in some cases, growers might avoid purchase of spring inputs such as pesticides and fertilizer for fields with diminished yield potential.

Project goals and progress were featured at the Small Grains Management Field Day in June 2003. Results have been shared with wheat producers, seed treatment manufacturers, wheat seed company and certified seed cooperative personnel as well as with Cornell extension educators.

Acknowledgements:

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Table 1. Effect of seed treatments on incidence of soilborne virus symptoms in wheat plants.

Seed treatment, rate per 100g seed	Percent infected stems		
	WSBMV Core[z]	WSBMV Field (check)[y]	WSSMV Field (check)[x]
Untreated control	73.8	33.0[*] (36.4)	88.3 (89.4)
Apron XL LS, 40μL	84.6[w]	n/d[u]	n/d
Baytan 30F, 94μL	50.0[*v]	42.2 (41.9)	86.4 (85.3)
Maxim 4FS, 10μL	49.4[*]	38.1[**t] (45.0)	85.6 (81.9)
Omega 500F, 40μL	nd	49.7 (48.6)	87.5 (91.1)
Tilt 3.6E, 40μL	64.1[*]	32.2[**] (39.4)	85.8 (89.7)
Tween 20, 500 μL	37.5[*]	47.5 (46.9)	90.7 (85.9)

[z] Average percent of WSBMV-infected plants, detected by ELISA, from infested soil cores maintained in the growth chamber at 15C and -5 kPa or wetter for 31 days. Comparisons are made to the untreated control.
[y] Average percent of WSBMV-symptomatic Harus stems (n=30) from 1m rows, randomly sampled with 12 replications in Trumansburg, NY. In order to account for disease gradients in the field, comparisons are made to the parenthetical check, which is untreated Harus grown in the 3rd row of the same six-row subplot as the treatment.
[x] Average percent of WSSMV-symptomatic NY88036-8082 stems (n=30) from 1m rows, randomly sampled with 12 replications in Caldwell Field, Ithaca, NY. In parentheses is the average percent incidence of WSSMV in untreated 'NY 88036-8082' grown within the same subplot as each of the replicates.
[w] Phytotoxicity resulted in reduced seedling emergence.
[v*] denotes significant reduction in WSBMV transmission at P=0.05, using logistic regression (with contrasts for field studies).
[u] not determined
[t**] denotes significant reduction in WSBMV transmission at P=0.005, using logistic regression (with contrasts for field studies).