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MPSG ANNUAL EXTENSION REPORT

PROJECT TITLE: **Improved Integrative Pest Management of Wireworm in Manitoba**

PROJECT START DATE: 1 April 2018 **PROJECT END DATE: 31 March 2021**

DATE SUBMITTED: 31 January 2020

PART 1: PRINCIPAL RESEARCHER

PRINCIPAL

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PART 2: EXECUTIVE SUMMARY

Outline the project objectives, their relevancy to pulse and soybean farmers, and a summary of the project to date, including methods and preliminary results.

Following the government-issued ban of the pesticide lindane, wireworm (the larval stages of click beetles) have become major pests of economically important field crops in the Canadian Prairies, including soybean. Wireworm feed on seed and below-ground tissues during the early stages of plant growth, which can result in considerable yield losses. The overall objective of the research project is to evaluate the threat wireworm pose to present and future soybean production. In 2019, we scouted wireworm in 26 crop fields across southern Manitoba at 3 stages in the production cycle. In each field, 16 wireworm bait traps (4 linear transects of 4 traps) were set and 40 soil cores were taken. Wireworm were present in 25 of the fields, and the average number per trap ranged between 0.08 and 3.38. *Hypnoidus bicolor* predominated (95% of collected wireworm), and one other known pest species was also found. Wireworm were most prevalent in the southwest region of the province. Molecular diagnostics were carried out on 330 *H. bicolor* collected from 13 populations and 3 provinces. Our preliminary results suggest that *H. bicolor* has high genetic diversity and limited dispersal among regions within Manitoba and between provinces. Semi-field feeding damage assays indicated that *H. bicolor* has the potential to severely impact soybean yields, and this is strongly influenced by density.

Our 3-year project is beneficial to farmers because it will determine the true risks posed by wireworm to Manitoba soybean production, as well as the biotic, ecological, and agronomic factors that are the greatest contributors to these risks. This information will be critical to the development of a scouting protocol and economic thresholds, allowing farmers and agronomists to make informed decisions on management options.

PART 3: PROJECT ACTIVITIES AND PRELIMINARY RESULTS

Outline project activities, preliminary results, any deviations from the original project and communication activities. You may include graphs/tables/pictures in the Appendix.

Wireworm Sampling. In 2019, 26 crop fields were scouted across southern Manitoba in the spring (pre-planting). For each field, 16 bait traps composed of germinating wheat seed and vermiculite were placed 4.5" underground in 4 linear transects. Approximately 40 soil cores (each 10 cm diameter sampled to a depth of 15 cm) were also taken per field. Overall, we surveyed 4 more fields than in 2018. Fields with a minimum of 1 wireworm per trap were also surveyed mid-summer and fall (post-harvest). Wireworm were extracted from the bait traps and soil cores manually and by using a funnel-heat lamp system. We also analyzed the soil parameters for each field (e.g., moisture, organic matter, clay/silt/sand content) to better infer whether soil type impacts wireworm abundance.

Species Composition and Abundance. Wireworm were present in 25 of the fields scouted in 2019, and the average number per trap ranged between 0.08 and 3.38. Compared to 2018, a higher proportion of fields had wireworm present (96% vs. 86%), but overall we found fewer wireworm per trap in 2019 for the fields surveyed both years (1.42 vs. 1.09). A major reason for this decrease is our most infested 2018 field declined from 9.56 to 1.63 wireworm per trap. The number of days a trap is in ground impacted wireworm counts, as those with less than the recommended 14 days tended to yield comparatively less wireworm. Table 1 displays the wireworm present in each field and their relative abundance. Similar to 2018, *Hypnoidus bicolor* predominated (95% of wireworm identified) and only one other known pest species was found (*H. abbreviatus*). Interestingly, a 2019 survey (BASF) in Saskatchewan and Alberta found nearly all wireworm were *S. destructor*, with very few *H. bicolor*. Southwest Manitoba continued to have greater wireworm infestations and species-diversity than the other scouted regions of the province. As expected, our wireworm counts were considerably lower in the summer and fall, declining by 66% and 81%, respectively. Despite our attempts to optimize the soil coring approach, the number of wireworm sampled were negligible.

Molecular Diagnostics. The cytochrome oxidase (COI) gene was sequenced (forward and reverse strands) for 330 *H. bicolor* collected from 13 populations (MB: 8, AB: 4, SK: 1). While this data is currently being analyzed, our preliminary results indicate that 1) there is substantial within-species genetic diversity, and 2) dispersal of wireworm among regions within Manitoba and between provinces appears limited.

Evaluation of Wireworm Damage to Soybean. Density-dependent assays were carried out to assess *H. bicolor* (12-14 mm in size) damage to soybean. For each trial, 10, 20, 30 or no wireworm (control) were added to separate containers containing soybean seeds (n=25) planted in field-collected soil. After 14 days, the soybean seedlings were inspected for damage. These assays were replicated 3 times using different *H. bicolor* for each trial. Figure 1 shows typical wireworm damage to the leaves, cotyledons, stem and roots, whereas Figure 2 shows the proportion of plants showing damage at each density. Our results indicate damage to seedlings dramatically increases with wireworm density, and that *H. bicolor* has the potential to severely impact soybean yields. Similar experiments will be done in 2020 to assess the effects of soil type and temperature on wireworm damage to soybean.

Communication Activities: Farmers were made aware of their wireworm data as soon as results became available. In 2019, our data was disseminated at CROPS-A-PALOOZA, Prairie University Biology Symposium, Entomological Society of America annual meeting, Western Committee on Crop Pests and MPSG Getting it Right, using a variety of platforms (posters, handouts, etc.). We also had an article published in Pulse Beat.

Deviations from the Original Project: We scouted more fields than proposed in the spring (26 vs. 15), but reduced the number in the summer/fall (only fields with >1 per trap) since wireworm numbers are much lower at those times. Soil coring continues to produce small numbers of wireworm in comparison to bait trapping despite our attempts to optimize this approach.

APPENDIX

Figure 1 (left). Typical damage to soybean seedlings due to wireworm damage to leaves, cotyledons, stem and roots.

Figure 2 (right). Results of soybean grown under different wireworm densities, compared to a control (no wirerworm). Box plots (95% CI) show significant differences between densities in terms of damage to soybean seedlings.

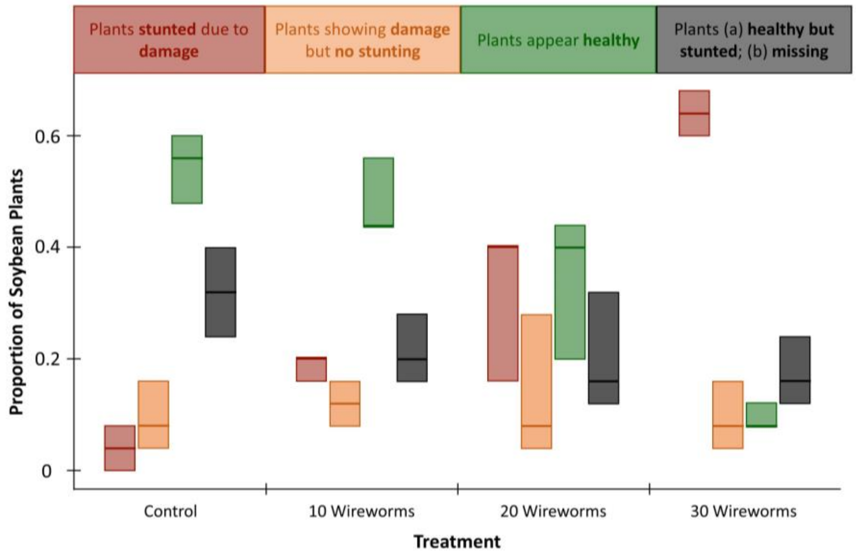

Table 1. Relative abundance and species composition of wireworm sampled in 26 southern Manitoba crop fields in 2018 and 2019. The numbers are based on bait trapping in the spring (pre-planting).

Field ID	Region	Crop		Wireworm per trap		Species Present (2018 and 2019)
		2018	2019	2018	2019	
HS-1	Northwest	Soybean	Wheat	1.29	0.06	*H. bicolor, H. abbreviatus*
HS-2		Canola	Soybean	0.88	0.63	*H. bicolor, Dalopius* sp.
ES-1	Southwest	Soybean	Wheat	2.06	3.00	*H. bicolor, H. abbreviatus*
ES-2		Wheat	Soybean	N/A	1.63	*H. bicolor*
MZ-1		Soybean	TBA	0.19	0.81	*H. bicolor*
MZ-2		Wheat	TBA	0.38	3.38	*H. bicolor, Hemicrepidius* sp.
ED-1		Flax	Barley	N/A	0.08	*H. bicolor, H. abbreviatus*
ED-2		Soybean	Wheat	9.56	1.63	*H. bicolor*
ED-3		Barley	Soybean	N/A	2.67	*H. bicolor, H. abbreviatus*
MN-1		Soybean	Canola	2.63	0.88	*H. bicolor, L. californicus*
PK-1		Barley	Soybean	0.44	0.94	*H. bicolor*
BR-1		Canola	Potato	N/A	0.63	*H. bicolor*
BR-2		Soybean	Potato	N/A	0.00	
WH-1		Potato	Wheat	3.67	0.27	*H. bicolor*
MY-1		Wheat	TBA	1.63	2.63	*H. bicolor, H. abbreviates, L. californicus*
RB-1	South-central	TBA	Potato	N/A	1.94	*H. bicolor, H. abbreviatus*
RB-2		TBA	Beans	N/A	0.06	*H. bicolor*
HD-1		Canola	Wheat	1.00	1.13	*H. bicolor, H. abbreviatus*
WB-1		Corn	Canola	0.13	0.63	*H. bicolor*
PM-1		Hay	Potato	0.13	0.94	*H. bicolor*
DK-1		Canola	Soybean	0.80	0.50	*H. bicolor*
HM-1		Canola	Soybean	0.00	0.19	*H. bicolor*
LQ-1		Corn	Barley	1.38	0.50	*H. bicolor*
LQ-2		Corn	Barley	0.54	0.36	*H. bicolor*
LQ-3		Corn	Barley	0.31	1.47	*H. bicolor*
FR-1	Southeast	Corn	Canola	0.33	0.13	*H. bicolor*