

NEW VIRULENT PATHOTYPES OF SUNFLOWER RUST IN CANADA

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ABSTRACT

The incidence and severity of sunflower rust on commercial hybrids have steadily increased in the eastern Canadian Prairies during the last few years. This was the first indication of virulence changes in the pathogen. Rust cultures collected during the 1988-91 period were assessed for virulence on a set of Canadian and American host differentials. Race 4 was predominant in 1988 followed by race 3. Race 3 was predominant in 1989 and 1990, followed by races 4 and 1. Variations in races 1, 3, and 4 with additional virulence on the USA differential lines occurred in varying frequencies. These results confirmed that changes in virulence have occurred in the sunflower rust and that new races, virulent on resistance genes R1 and R2, are widely spread in the rust population.

RÉSUMÉ

L'incidence et la gravité de la rouille du tournesol chez les hybrides commerciaux ont constamment augmenté dans l'est des Prairies canadiennes au cours des dernières années. Il s'agissait de la première indication d'une modification de la virulence du pathogène. La virulence des cultures de rouille récoltées au cours de la période 1988-1991 a été testée sur un ensemble d'hôtes différentiels Canadiens et américains. En 1988, la race 4 a été prédominante, suivie de la race 3. En 1989 et 1990, c'est la race 3 qui a été prédominante, suivie des races 4 et 1. Des variations dans les races 1, 3 et 4 caractérisées par une virulence additionnelle, ont été observées sur les hôtes différentiels américains avec une fréquence variable. Ces résultats ont confirmé que des changements étaient survenus dans la virulence de la rouille du tournesol et que les nouvelles races, virulence dans le cas des gènes de résistance R1 et R2, sont largement répandues dans la population de rouille.

INTRODUCTION

Sunflower rust caused by Puccinia helianthi Schw, has been a common disease on sunflower (Helianthus annuus L.) in Canada and the United States (Fig. 1). The races 1 to 4 were identified in Manitoba prior to 1960 based on the three Canadian differentials CM-90RR (resistance gene R1), Cross 29-3 (resistance gene R2) and the universal suscept S37-388. Among isolates collected between 1955 and 1959, race 1 was the most prevalent at 62%, followed by race 2 at 22%, race 3 at 14% and race 4 at 2%

The introduction of sunflower hybrids with resistance to rust reduced the impact of the disease but also resulted in increased frequency of races with virulence on the resistant genotypes. In Texas, race 4 was predominant in 1982 and 1984, and race 3 was present only in one field in 1984. In 1987, a new isolate virulent on all resistant sunflower genotypes was designated as isolate number five (Bushland isolate). In Australia, race 3 became widespread on sunflower hybrids carrying the R1 gene. The P. helianthi population in Argentina comprises the four north American races plus other races with different virulence patterns. Recent disease surveys in Manitoba revealed a sharp increase in the incidence and severity of sunflower rust, and a change in virulence in the rust population. Similar observations were reported from North Dakota.

OBJECTIVES

- 1- To assess the incidence and severity of sunflower rust in the eastern Canadian Prairies.
- 2- To determine the race composition of the P. helianthi population and identify new races for future identification of new sources of genetic resistance.

MATERIALS AND METHODS

Incidence and Severity. A total of 35, 43 and 69 commercial sunflower fields were randomly selected and inspected throughout the eastern Canadian Prairies in southern Manitoba and south-

eastern Saskatchewan in 1988, 1989, and 1990, respectively. Rust incidence and severity were assessed from early July until early September. Each field was inspected by two persons walking 100 m in opposite directions inside the field following an 'M' pattern. Rust incidence was recorded for presence or absence of pustules, and severity was visually estimated as the actual percent leaf area infected on all inspected plants.

A total of 60, 57 and 68 commercial sunflower hybrids were evaluated for rust reaction under natural infections in 1988, 1989 and 1990, respectively. All hybrids were evaluated in a randomized complete block design with four replicates at each of the following locations in Manitoba: Lyleton (southwestern), Morden (southcentral), Holland and Neepawa (central).

Sampling and Assessment of Virulence. A total of 66 isolates of *P. helianthi* were collected during the 1988-1990 period, but only 49 isolates were recovered and investigated. Each isolate was increased in isolation on the universal susceptible S37-388. Urediospores were suspended in light petroleum oil and plants were spray-inoculated and were incubated at 100% relative humidity for 18 hr, moved into a growth cabinet with 16 hr photoperiod and day/night temperatures of 22/18° C, and were maintained for urediospore collection.

Three Canadian differential cultivars CM-90RR (R1 resistance gene), Cross 29-3 (R2 resistance gene) and S37-388 (universal susceptible), and five USA inbred lines HA-R1, HA-R2, HA-R3, HA-R4, and HA-R5, resistant to the four races of *P. helianthi*, were used to evaluate the virulence of all isolates. Ten seedlings of each differential were established in a greenhouse soil for testing each differential/isolate combination. The 2-wk-old seedlings were spray-inoculated with a urediospore suspension in petroleum oil, incubated and maintained as described above. Assessment of reactions, 12 days after inoculation, was based on infection types 0 to 4: 0 = Immune reaction, ; = flecking or hypersensitive reaction, 1 = very small uredia of 0.1-0.2 mm, 2 = small uredia of

0.3-0.4 mm, 3 = medium-sized uredia of 0.5-0.6 mm, and 4 = large uredia >0.6 mm. Single pustule isolates were obtained from the 1989 collection and were tested on all differentials. Isolates were classified into various races based on their reaction on the differentials in comparison with the reaction of the four known races of P. helianthi.

RESULTS AND DISCUSSION

Incidence and Severity. Rust incidence and severity varied between years and were the highest in 1989 (Table 1). Severity of infections ranged from trace in most fields in eastern Manitoba to >60% leaf area infected in western Manitoba and southeastern Saskatchewan in 1988 and 1989. Rust was less severe in 1990 than in the previous two years. The high levels of rust severity were observed only in some fields towards the end of the season.

All commercial sunflower hybrids tested under natural infection conditions in Holland, Lyleton, Neepawa and Morden in Manitoba were infected (Table 2). Only five hybrids showed trace to 5% leaf area covered with rust in 1990, indicating the moderate resistance in these hybrids to prevalent rust races. The high severity of rust on all hybrids in 1988, on 95% of hybrids in 1989, and on 93% of hybrids in 1990, confirmed the susceptibility of the commercial hybrids to the prevalent races of P. helianthi in the eastern Canadian Prairies.

Assessment for Virulence. Race 1 was identified in 11% of the 1989 and 1990 isolates but was not recovered from the 1988 isolates (Table 3). All race 1 isolates from 1989 and half of those from 1990 were virulent on HA-R1 and were designated as sub-race 1-1. Race 3, based on the Canadian Differentials, was recovered from 33% of the 1988 isolates, from 74% of the 1989 isolates, and from 72% of the 1990 isolates. Race 3 isolates with additional virulence on HA-R5, HA-R1/HA-R2, or HA-R1/HA-R5 were identified in 1989 and were designated as sub-races 3-1, 3-2, and 3-3, respectively. Other race 3 isolates with additional virulence on HA-R1, HA-R4, HA-

R1/HA-R4, or HA-R1/HA-R4/HA-R5 were identified in 1990 and were designated as sub-races 3-4, 3-5, 3-6, and 3-7, respectively.

Race 4 was identified from 67% of the 1988 isolates, from 15% of the 1989 isolates, and from 17% of the 1990 isolates. Race 4 isolates with additional virulence on HA-R1/HA-R5 were identified in 1988-1989, and were designated as sub-race 4-1. Other race 4 isolates with additional virulence on HA-R5, HA-R1/HA-R4/HA-R5 or HA-R4/HA-R5 were identified in 1989-1990, and were designated as sub-races 4-2, 4-3, and 4-4, respectively. Differences in frequencies of races 3 and 4 from 1988 to 1990 may be attributed to the small number of collections in 1988, the sampling error, and incomplete representation of the rust population.

Race 2, avirulent on CM-90RR, and virulent on Cross 29-3 and S 37-388, was not recovered during this period. This indicates that race 2 may have been eliminated from the rust population or may be present at a very low frequency.

CONCLUSIONS

- 1- Races 1 and 2 are no longer predominant on the eastern Canadian Prairies. These races were predominant in the 1960's and 1970's.
- 2- Races 3 and 4, based on the original Canadian differentials, are the most common components of P. helianthi population in western Manitoba and southeastern Saskatchewan.
- 3- New races similar to races 1, 3 and 4, with additional virulence on the USA lines were present at various frequencies. These were designated as sub-races of 1, 3 and 4 for differentiation.
- 4- Most of the commercial hybrids, with the R1/R2 resistance genes were susceptible to the new races; only a few were moderately susceptible.

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Table 1. Incidence and severity of sunflower rust in the eastern Canadian Prairies

	Fields	Disease	Disease Severity*	
	Surveyed	Incidence*	Mean	Range
1988	35	57%	12%	1-60%
1989	43	86%	10%	1-60%
1990	69	68%	5%	1-40%

* Disease incidence is the percentage of fields with rust.
Disease severity is the actual percentage of leaf area infected.

Table 2. Rust severity on commercial sunflower hybrids.

	Disease Severity*/Number of Hybrids				
	Trace-5%	6-20%	21-40%	41-60%	>60%
1988	0	0	5	27	28
1989	0	3	43	11	0
1990	5	32	23	6	2

* Disease severity is the actual percentage of leaf area infected.

Table 3. Virulence patterns among sunflower rust isolates from the eastern Canadian Prairies.

	NORTH AMERICAN RACES				GROUP CULTURES*																				
	1	2	3	4	1988						1989						1990								
<u>Canadian differentials</u>																									
6 CM-90RR	R	R	S	S	S	S	R	S	S	S	S	S	S	S	R	R	S	S	S	S	S	S	S	S	
7 29-3	R	S	R	S	R	S	R	R	R	R	R	S	S	S	R	R	R	R	R	R	R	S	S	S	S
8 S37-388	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
<u>USA lines</u>																									
10 HA-R1	R	R	R	R	NT	S	S	R	R	S	S	R	S	S	R	S	R	S	S	S	R	S	R	S	S
11 HA-R2	R	R	R	R	NT	R	R	R	R	S	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
12 HA-R3	R	R	R	R	NT	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
13 HA-R4	R	R	R	R	NT	R	R	R	R	R	R	R	R	S	R	R	S	R	S	S	S	S	S	S	S
14 HA-R5	R	R	R	R	NT	S	R	R	S	R	S	S	S	S	R	R	R	R	R	S	S	S	S	S	S
16 Frequency (%)	33	67	11	37	26	5	5	5	5	5	6	6	6	6	12	47	6	12							
17 Identified races	3	4	1	3	3	3	3	4	4	4	1	1	3	3	3	3	4	4							
18 Additional virulence [†]					V1	V1		V5	V1	V1	V5	V1	V1		V1	V4	V1	V1	V1	V4	V4	V4	V4	V4	V4
19 on USA lines					V5			V2	V5		V5	V4								V4	V4	V5	V4		
20																						V5	V5		
21 Proposed race designation	4-1	1-1			3-1	3-2	3-3	4-2	4-1	4-3	1-1	3-4	3-5	3-6	3-7	4-4	4-3								

* Each column represents a group of cultures having the same virulence pattern.

† Additional virulence indicated by V1, V2etc means virulent on lines HA-R1, HA-R2 ...etc.

References

- Antonelli, E. F.** 1985. Variabilidad de la poblacion patogena de Puccinia helianthi Schw. en la Argentina. Pages 591-596 in: Int. Sunflower Conf. 11th Vol. 2 I.S.A. Mar del Plata, Argentina.
- Gulya, T., R. Venette, J. R. Venette and H. A. Lamey.** 1990. Sunflower rust. NDSU Extension Service PP-998, 4pp.
- Kochman, J. K. and K. C. Goulter.** 1984. The occurrence of a second culture of rust (Puccinia helianthi) in sunflower crops in eastern Australia. Aust. Plant Pathol. 13:3-4.
- Miah, M. A. J. and W. E. Sackston.** 1970. Genetics of rust resistance in sunflower. Phytoprotection 51:1-16.
- Rashid, K. Y.** 1990. The prevailing rust races of sunflower in Manitoba in 1988/89. Page 105 in: Proceedings of the Sunflower Research Workshop. January 9-10, 1990, Fargo, ND, USA.
- Rashid, K. Y.** 1991. Incidence and virulence of Puccinia helianthi on sunflower in western Canada during 1988-1990. Can. J. Plant Pathol. 13:356-360.
- Sackston, W. E.** 1962. Studies on sunflower rust. III. Occurrence, distribution, and significance of cultures of Puccinia helianthi Schw. Can. J. Bot. 40:1449-1458.
- Yang, S. M., and T. Gulya.** 1986 prevalent races of Puccinia helianthi in cultivated sunflower on the Texas High Plains. Plant Dis. 70:603.