Strains of Puccinia graminis Virulent on Wheat Plants Carrying Gene Sr27 Derived from Imperial Rye

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ABSTRACT

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Gene *Sr27*, present in Acosta's wheat (Chinese Spring) - rye (Imperial) translocation line WRT.238.5, was transferred by successive backcrosses to a genetic background susceptible to *Puccinia graminis secalis*. Lines obtained this way exhibited high infection types to a synthetic hybrid between *P. graminis tritici* and *P. graminis secalis*, and to several strains of scabrum rust that are putative hybrids between the two formae speciales. Further tests showed that the hybrid culture had inherited the virulence on plants with *Sr27* from its *P. graminis secalis* parent. Intervarietal crossing in *P. graminis* in relation to the transference of resistance from alien species to wheat is discussed.

Additional key words: formae speciales, somatic hybrid.

Strains of *Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn. (the causal agent of wheat stem rust) mutate from avirulence to virulence on wheat cultivars possessing single major genes for resistance. A progressive accumulation of genes for virulence by individual strains has reduced the number of genes in wheat that are useful in breeding for resistance (1). An attempt has been made to broaden the collection of effective genes for resistance in common bread wheat (*Triticum aestivum* L.) by transferring resistance from other species, such as *Agropyron elongatum* (Host) Beauv., *Secale* spp., *Aegilops umbellulata* Zhuk., and other species of *Triticum*. Whether such genes will provide more stable resistance than those transferred from resistant tetraploid and hexaploid wheats to commercially grown cultivars, is debatable. When genes for resistance to *P. graminis tritici* from the genus *Secale* are utilized, there exists a *forma specialis* of *P. graminis*, viz., *secalis* Eriks. & E. Henn. (rye stem rust) that has specialized on this genus. We (4, 5) have pointed out the potential changes in virulence that can arise from sexual or somatic hybridization between the *formae speciales tritici* and *secalis*. Generally, somatic hybrids between them are avirulent on commercial rye and wheat because, it is believed, each parent brings dominant genes into the cross (2). Strains of *P. graminis* ("scabrum rust") isolated from rough wheat grass, *Agropyron scabrum* Beauv., have pathogenic characteristics intermediate of those of *P. graminis* f. sp. *tritici* and *P. graminis* f. sp. *secalis*, which suggests that they may be hybrids between the two *formae speciales*. Certain of these hybrids are virulent on wheat lines carrying single major genes for resistance to *P. graminis tritici* in a genetic background semi-susceptible to *P. graminis secalis* (2). The present report describes high infection types in a well known wheat-rye translocation line characterized in the past by showing resistance in different geographical areas. One of the virulent strains associated with the unusual reaction is a somatic hybrid synthesized in the laboratory from the two *formae speciales*.

MATERIALS AND METHODS

Seed of the Chinese Spring Wheat × Imperial rye amphiploid (2n = 56), of the disomic alien addition line designated G70 (2n = 44), and of Acosta's translocation line WRT.238.5 (2n = 42) with resistance to *P. graminis tritici*, were kindly supplied by C. J. Driscoll, University of New South Wales, Kensington, N.S.W. To transfer this resistance to a background more susceptible to *P. graminis secalis* than Chinese Spring, WRT.238.5 was crossed with W2691 and later progenies of a derived resistant F3 line were crossed into W3498. Both, W2691 and W3498 were bred for susceptibility to strains of *P. graminis secalis*, and they also proved to be highly susceptible to all strains of *P. graminis tritici* (2). In this way lines 177 (W2691/WRT.238.5) and 214 (W3498*2/line 177) were obtained.

Recently, a committee of wheat rust workers agreed to designate the factor for resistance in the rye segment as *Sr27* (R. A. McIntosh, *personal communication*).

Seedlings of WRT.238.5 and line 177 were included in the differential set used in the cereal rust survey covering all parts of the Australia-New Zealand geographical area (1). Likewise, line 177 was added to the special set of differentials employed when dealing with field collections of scabrum rust.

To demonstrate that somatic hybrids between Australian cultures of formae speciales *tritici* and *secalis* of *P. graminis* resemble strains of scabrum rust, two such hybrids, CL and NL (=culture 70-L12), were synthesized in the laboratory from a mixture of culture 69090 of *P. graminis secalis* and culture 68-L6, a yellow variant of the common strain 21-2 of *P. graminis tritici* (2).

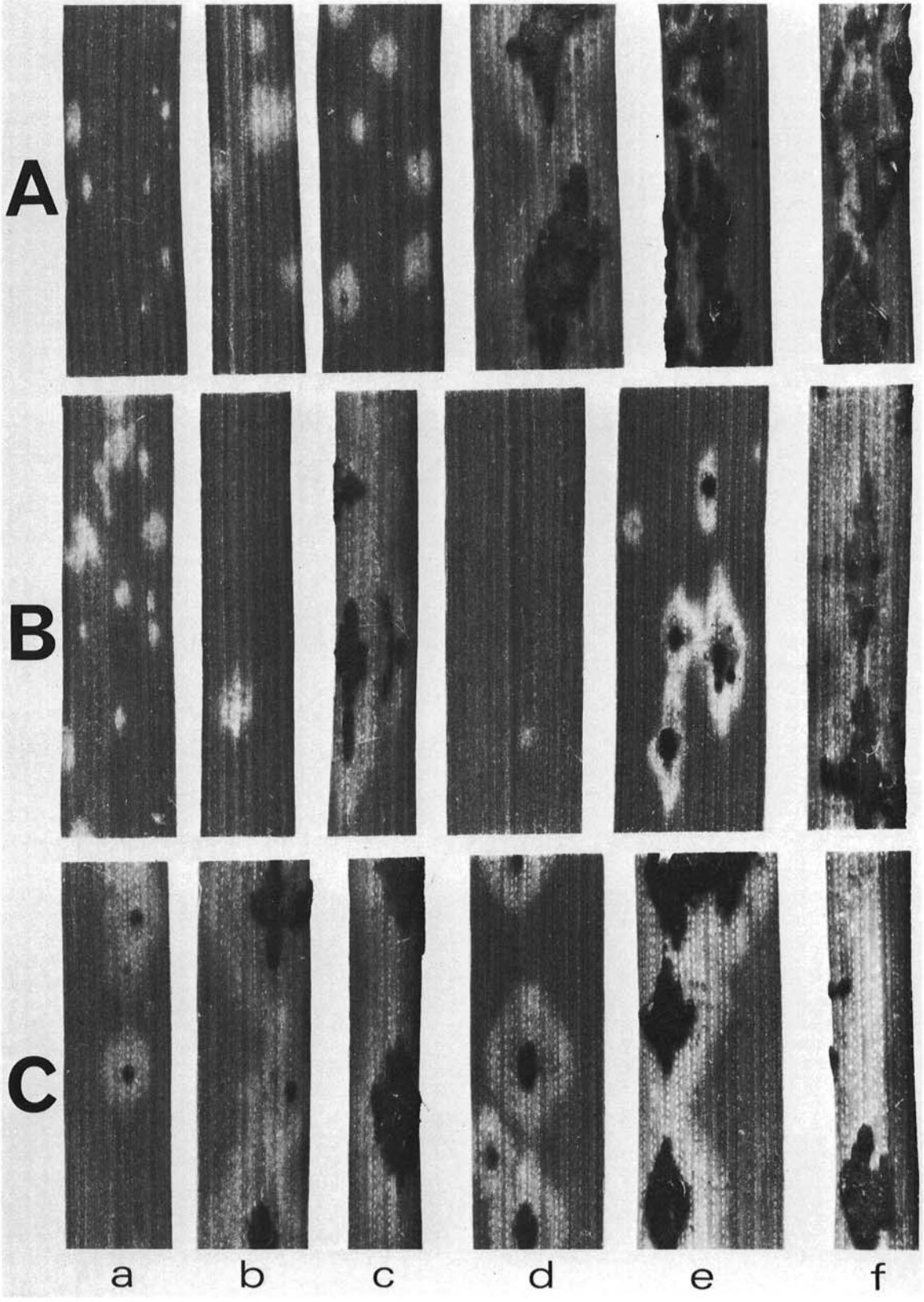

Fig. 1-(A to C). Infection types produced by cultures: **A)** 68-L6 of wheat stem rust; **B)** 69090 of rye stem rust; **C)** 70-L12 of wheat-rye stem rust hybrid on seedlings of wheat lines **a)** WRT.238.5 (Imperial rye/Chinese Spring), **b)** 177 (WRT.238.5/W2691), **c)** 214 (177/2*W2691), **d)** Chinese Spring, **e)** W2691, and **f)** W3498. The first three lines possess gene *Sr27*.

RESULTS

WRT.238.5 and line 177 showed low infection types when inoculated with about 1,000 Australasian collections representing about 35 different strains of wheat stem rust. Before being included as a universally resistant type in the survey the line had been tested with many key strains from the Australian-New Zealand collection, but low infection types had resulted in all cases. These data suggested that the pathogen sampled in this geographical area was uniformly avirulent on plants possessing *Sr27*.

Breeding line WRT.238.5 also gave low infection types when tested with several cultures of rust from *A. scabrum*. However, when line 177 was tested with the synthetic hybrid 70-L12, the infection type was "23-". Further tests showed that the same culture also gave infection type "2=" on WRT.238.5, the wheat-rye amphiploid, and the addition line G70. When line 214 became available, and culture 70-L12 and its parents 68-L6 and 69090 were used to infect it, the resulting infection types indicated that culture 70-L12 had inherited the ability to attack plants with *Sr27* from its *P. graminis secalis* parent. Figure 1 shows the infection types produced by the three cultures on lines WRT.238.5, 177, and 214 and on Chinese Spring, W2691, and W3498 that entered the pedigrees of these lines, respectively.

In due course, 13 different cultures of the rust fungus from *A. scabrum* were tested on line 177. Eight were avirulent (infection type ";"). Five produced infection types ranging from "2+" to "3". Assuming that the cultures from *A. scabrum* are F_1 hybrids between *P. graminis tritici* and *P. graminis secalis,* and that the latter forma specialis is virulent on plants with *Sr27,* avirulence on plants with this gene can be explained on the basis of heterozygosity for a corresponding dominant gene for avirulence in the Australian strains of *P. graminis tritici.*

The differences in infection types observed on lines WRT.238.5, 177, and 214 with culture 70-L12, and with strains of scabrum rust virulent on plants with *Sr27,* can be attributed to genes in Chinese Spring, which recognize the corresponding genes for avirulence in these cultures.

DISCUSSION

The current investigation confirms the hypothesis of Watson and Luig (4) that sexual or somatic hybrids between *P. graminis tritici* and *P. graminis secalis* could render ineffective genes used as sources of resistance, especially those transferred from rye to wheat. Whatever the origin of the scabrum rust strains, the synthetic hybrid provides unequivocal evidence for such a happening.

The results further suggest that a broad resistance to *P. graminis* in wheat-rye translocation lines could be based on two or three systems. Firstly, on the presence of a rye segment carrying a gene(s) which recognizes a gene(s) for avirulence in *P. graminis tritici* but does not recognize any in *P. graminis secalis.* Resistance to the former and susceptibility to the latter is shown. The second system comprises a series of genes common in wheat, which interact with corresponding genes in *P. graminis secalis* but are not recognized by genes in *P. graminis tritici.* A third system would involve genes that differentiate between strains of *P. graminis tritici* or *P. graminis secalis.* One example of a gene in the third category is *Sr11*, which has world-wide usage in the differentiation of strains of *P. graminis tritici.* There is no a priori evidence suggesting that wheat-rye translocation stocks with a three system resistance are necessarily more protected against hybrid rusts than those possessing a resistance based on two systems only.

The finding that some strains of scabrum rust are virulent on plants with *Sr27* whereas others are not, further supports the hypothesis (2) that strains of this rust had their origin in somatic crossing between wheat and rye stem rust. Gene *Sr27*, though very effective against strains of *P. graminis tritici,* did not have the ability to recognize genes for avirulence in *P. graminis secalis.* In this it resembles certain genes identified within the genus *Secale* (3).

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