The reaction of Thatcher wheat to Canadian races of stem rust'

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Triticum aestivum 'Thatcher' was susceptible in both adult and seedling stages to six races of *Puccinia graminis* f. sp. *tritici,* intermediate or moderately susceptible in both stages to seven races, and resistant in both stages to two older races. The genetics of Thatcher's stem rust resistance is poorly understood and its resistance to the two races *is* not due to genes it is known to carry. Thatcher does not appear to have "adult plant resistance" to the races studied.

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Les plants adultes et les plantules de *Triticum aestivum* Thatcher se sont reveles sensibles a six races de *Puccinia graminis* f. sp. *tritici.* Les deux stades ont montre une sensibilité intermediaire ou moyenne a sept autres races et ont resiste a deux races plus anciennes. On ne comprend pas encore tres bien la genetique de la resistance de Thatcher à la rouille de la tige, sa resistance aux deux races n'etant pas imputable aux genes qu'on lui connaît. A l'etat adulte Thatcher ne semble pas montrer de resistance aux races etudiees.

Triticum aestivum **L.** 'Thatcher' was the most commonly grown cultivar in western Canada from about 1935, when it was introduced, to 1967. It has been replaced by other varieties because it is susceptible to race 15B of stem rust and to most races of leaf rust. Although its commercial importance has declined it continues to play an important part in wheat production. Stem rust resistant backcross derivatives of Thatcher now predominate in western Canada and Thatcher derivatives are important parents in breeding programs in many parts of the world.

Stem rust resistance inherited from Thatcher has been an important factor in the long-lived stem rust resistance of western Canadian varieties such as Manitou and Neepawa. The stem rust resistance of Thatcher has been assessed periodically but these assessments are not normally published, and we are poorly informed on the reaction of this variety to the races that have occurred in its long history of commercial use. The results recorded here are from an assessment performed with stem rust races found in Canada up to 1972 to obtain data for decisions on how the resistance of Thatcher could be best used in breeding programs.

Materials and Methods

Seedlings were inoculated by dusting urediospores of *Puccinia graminis* f. sp. *tritici* onto them. Adult plants were inoculated by applying urediospores to the culms with the fingers. All plants were incubated in polyethylene chambers where they were sprayed periodically with water. After incubation they were placed on greenhouse benches. The purity of the rust cultures used was confirmed by tests with the differential hosts.

Seedling infection types were recorded according to the method of Stakman et al. (8). Adult plant reactions were rated by recording the infection types on each leaf sheath and calculating an average "reaction index" for each variety-race combination by using an index of 0 to 16 for increasing levels of susceptibility (3). In this index infection type 0 has a value of 1, infection type 1 is 4, infection type 2 is 7, infection type 3 is 13, and infection type 4 is 16.

The cultures selected for the investigation have been described (2). Some are worthy of comment. Race C10(15B-1) represents the race 15B that suddenly became prevalent in 1950 and seriously damaged the varieties of that time, including Thatcher. Race C17(56) predominated from 1932 to 1949 and from 1957 to 1963 inclusive. It has been one of the most important races in North America although it has occurred rarely since 1967. Race C18(15B-1LX) predominated from 1964 to 1969 and race C33(15B-1L) has predominated since 1970. Race C35(32-113) seriously damaged the variety Pitic 62 in 1971. Most races were selected because they appeared to threaten Thatcher and its derivatives. Others were selected for comparison with possibly more virulent races.

Results

The seedling infection types and the adult plant reactions (Fig. 1) agreed reasonably well with the exception of those for races C33 and C51. Thatcher was most susceptible to race C10(15B-1). It was also susceptible or moderately susceptible at both growth stages to races C18(15B-1LX), C34(32), C37(15), C40(32-113), and C42(15). Of these races, only C18(15B-1LX) is sufficiently prevalent to be important. The other races have originated since 1968 and it is clear that many of the races found in Canada in recent years are virulent on Thatcher.

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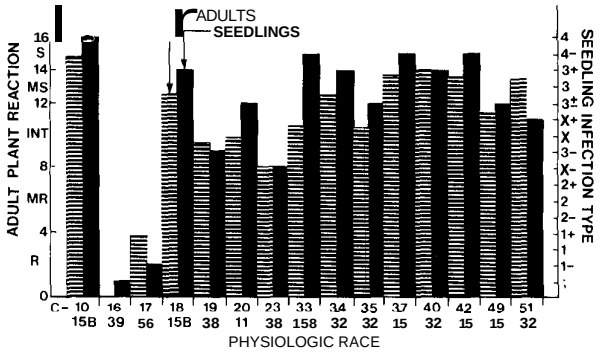

Figure 1. Seedling infection types and adult plant reaction of Thatcher wheat to 15 races of stem rust. Formula numbers are in the line starting C—. The "standard" race numbers are below them.

Thatcher was susceptible in the seedling stage but intermediate in the adult plant stage to race C33(15B-1L), which has predominated in Canada since 1970, and moderately susceptible in the adult stage and intermediate in the seedling stage to the rare race C51(32). It was intermediate in both seedling and adult plant stages to races C19(38), C20(11), C23(38), C35(32-113), and C49(15). Most of these races were first found prior to 1964 when the formula method of race identification (1) came into regular use.

Thatcher was resistant only to the old races C16(39) and C17(56).

Discussion

Despite the importance of Thatcher wheat as a commercial variety and as a parent in breeding programs its genotype for stem rust resistance is poorly understood. It carries the identified genes *Sr5, Sr16*, and possibly *Sr12*. *Sr5* is a well-known and well-documented gene. It usually produces an immune reaction (infection type 0) with avirulent races. Gene *Sr16* has been isolated in a susceptible background but it conditions a low level of resistance and has not shown potential practical importance in tests at Winnipeg. The status of gene *Sr12* is less secure. A gene originally thought to be complementary to gene *Sr11* was numbered *Sr12* (4) but later was found to be nonexistent (5). The number was then used for an hypothesized gene on Thatcher chromosome 3B (7). A later investigation of this chromosome failed to reveal a gene for stem rust resistance (6).

None of these genes confer resistance to the wide assortment of races that are avirulent on Thatcher. The variety may have adult plant resistance that is not effective in the seedling stage, but authors usually have been vague on this point when describing the resistance of Thatcher. All of the races used here are virulent on genes *Sr5* and *Sr16*. The effectiveness of gene *Sr12*, if it exists, is unknown. It was identified with avirulent race 111 (7) and may not be effective against the races studied.

In this test the adult plant and seedling reactions were similar except for small differences with races C33 and C51. The results do not demonstrate clearly that Thatcher 'is susceptible in the seedling stage and resistant in the adult stage to certain races as is implied by the term "adult plant resistance." There is no explanation, in genetic terms, of the high resistance of both seedlings and adult plants of Thatcher to races C16(39) and C17(56).

The frequent isolation in recent years of stem rust races virulent on Thatcher suggests that this variety would be heavily rusted if grown commercially today.

Acknowledgments

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Literature cited

1. Green, G. J. 1965. Stem rust of wheat, barley, and rye in Canada in 1964. Can. Plant Dis. Surv. 45:23-29.
2. Green, G. J. 1972. Stem rust of wheat, barley, and rye in Canada in 1972. Can. Plant Dis. Surv. 52:162-167.
3. Green, G. J., and T. Johnson. 1955. Specificity in the effect of high temperature on the adult plant reaction of wheat varieties to races of stem rust. Can. J. Bot. 33:197-201.
4. Knott, D. R. 1959. The inheritance of rust resistance. IV. Monosomic analysis of rust resistance and some other characters in six varieties of wheat including Gabo and Kenya Farmer. Can. J. Plant Sci. 39:215-228.
5. Loegering, W. Q., and E. R. Sears. 1963. Distorted inheritance of stem-rust resistance of Timstein wheat caused by a pollen-killing gene. Can. J. Genet. Cytol. 5:65-72.
6. Loegering, W. Q., and E. R. Sears. 1973. The gene for low reaction to *Puccinia graminis tritici* in the Thatcher-3B substitution line. Crop Sci. 13:282.
7. Sheen, S. J., and L. A. Snyder. 1964. Studies on the inheritance of resistance to six stem rust cultures using chromosome substitution lines of a Marquis wheat selection. Can. J. Genet. Cytol. 6:74-82.
8. Stakman, E. C., D. M. Stewart, and W. Q. Loegering. 1962. Identification of physiologic races of *Puccinia graminis* var. *tritici*. United States Dep. Agr., Agr. Res. Serv., Bull. E617 (Revised 1962).