VIRULENCE OF A MANAWATU POPULATION OF THE HESSIAN FLY TO SEVERAL WHEAT CULTIVARS

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SUMMARY

A Manawatu population of Hessian fly (*Mayetiola destructor* Say) was tested for virulence to two New Zealand wheat (*Triticum aestivum* L.) cultivars, Otane and Karamu, and to several US-bred wheats containing genes for resistance to Hessian fly. The Manawatu population of Hessian fly developed successfully on both of the New Zealand wheats but showed variability in their ability to develop on US-bred wheats containing resistance genes. Two resistance genes in wheat were identified as potential sources of resistance to the Manawatu population of Hessian fly.

Keywords: host plant resistance, *Mayetiola destructor*, *Triticum aestivum*

INTRODUCTION

After its arrival in New Zealand in the 1870s, the Hessian fly became a pest of wheat in all major cereal growing regions (Kirk 1898). Problems with the Hessian fly presumably persisted during the following decades, and, in a survey made in 1936-38 (Morrison 1938), large populations were found in wheat in South Canterbury and North Otago. At some point thereafter, New Zealand wheat breeders began breeding for resistance to Hessian fly. The use of these resistant cultivars and various cultural methods for control, such as burning of wheat stubble, presumably reduced Hessian fly populations to an acceptable level. In 1971, a New Zealand Ministry of Agriculture Bulletin on the Hessian fly stated that "though formerly important, with resistant wheat varieties it is no longer of major concern" (Anonymous 1971).

More recently, it has become apparent that the Hessian fly may again become a serious pest in New Zealand. In the late 1980s, Prestidge *et al.* (1987, 1988) identified Hessian fly as an important pest of New Zealand prairie grass (*Bromus* sp). During this same period of time, several wheat growers in Canterbury and North Otago suffered severe losses from what they thought may be the Hessian fly (D. Penno, personal communication). In March 1993, large populations of Hessian fly were observed in wheat fields in the Manawatu, South Canterbury and North Otago (Harris and Withers, unpublished data). Discussions with plant breeders (B. Griffin, N.Z. Institute for Crop and Food Research Ltd, personal communication) revealed that breeding for resistance to Hessian fly is no longer a part of wheat-breeding programmes in New Zealand.

Host plant resistance is the most important means of controlling the Hessian fly in the United States. Twenty genes that condition resistance to Hessian fly have been identified (Patterson *et al.* 1992). However, Hessian fly populations differ in their virulence to these resistance genes; thus, populations should be evaluated in terms of their virulence before any one resistance gene is bred into a wheat cultivar. This paper reports on a study of a Manawatu population of Hessian fly that was evaluated for virulence to four resistance genes obtained from US wheat-breeding programmes and to two wheat cultivars commonly grown in New Zealand.

METHODS

Insect and plant rearing

Rearing of insects and plant material and tests for biotypes were carried out during the months of March to September 1992 in a glasshouse (temperatures ranging from

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16-24°C, RH 60-90%) located on the Massey University campus. Hessian fly puparia were collected in January of 1992 from wheat (breeding line C3640 obtained from Dr B. Griffin, N.Z. Crop and Food Research Ltd, Lincoln) grown in Palmerston North. Adults emerging from these pupae were used to test biotypes and to establish a continuous culture of glasshouse-reared Hessian flies.

The wheat cultivars used in the tests included: Newton, Saluda, Norkan, Abe, Caldwell, Otane, and Karamu. The first five of these cultivars were obtained from various wheat-breeding programmes in the United States. Seeds of the last two wheat cultivars were obtained from Hodder and Tolley Ltd, Palmerston North. Wheat was grown in 5 x 5 cm square plastic pots in a pumice, peat and sand mixture with a slow-release fertiliser added in a glasshouse and used in experiments when they reached the 2-leaf stage.

Assessment of biotype frequency

Female Hessian flies emerging from wheat were placed in cages with an excess of males for 2 h. Mated females (ca. 10-20 per day, with a total of 176 females successfully tested during the 7-month test period) were then individually placed in cages (30 x 30 x 30 cm) containing five pots, each pot containing 4-5 plants of the following cultivars: Newton (a control susceptible to all known biotypes of the Hessian fly), Saluda (contains H7H8 genes), Norkan (contains H3 gene), Abe (contains H5 gene), and Caldwell (contains H6 gene). Using a second group of female Hessian flies (total of 78 females successfully tested), the number of wheat cultivars was expanded to include two widely grown New Zealand cultivars, Otane and Karamu. Forty-eight h after females were placed in cages (females lay all of their eggs within 24 h of mating (Harris and Rose 1991)), pots were removed from cages and plants within a pot were visually checked for eggs. If any one wheat cultivar within a single replicate (a replicate being the set of cultivars infested with the progeny of a single female) did not have eggs on it or had only a total of 1-2 eggs on it, all cultivars for that replicate were discarded. The remaining replicates (those in which all cultivars had eggs laid on them) were watered daily.

In a third set of tests, 20 females were placed in a cage with two larger pots (8 cm diam) containing wheat of one of the three cultivars: Norkan, Abe or Saluda. This last set of tests, in which a larger number of females was used to infest cultivars, was conducted to increase sample size and to improve chances of detecting low frequencies of virulence genes to resistance genes H3, H5, and H7H8 within the Manawatu population of Hessian flies. The disadvantage of this method of testing is that one cannot be certain that each of the twenty females in fact oviposited on the cultivar; thus, actual frequencies of virulence to a particular resistance gene cannot be accurately calculated.

Twenty days later each cultivar within a replicate was checked for the presence of live Hessian fly larvae. Plants were uprooted and the outer leaves removed to reveal larvae feeding at the base of the plant. Cultivars were also checked for reactions to feeding. Plants resistant to Hessian fly retain their bright green colour and continue growing past the 2-leaf stage. Susceptible plants turn a darker green and the plant ceases growing at the 2 to 3-leaf stage. Replicates in which no live larvae were found feeding on the susceptible control cultivar Newton (79 out of 333 replicates) were not included in data analysis.

RESULTS AND DISCUSSION

The Manawatu population of Hessian fly was made up of several genotypes that differed in their virulence to resistance genes in wheat (Table 1). The largest proportion of the population (55%) was avirulent for all of the resistance genes tested, i.e., no larvae survived on wheats containing the H3, H5, H6, or H7H8 genes. The second largest proportion of the population (43%) were virulent on wheats containing the H6 gene but avirulent on wheats containing the H3, H5, or H7H8 genes. A small number of Hessian flies (2%) were virulent both on wheat containing the H6 gene and on wheat containing the H3 gene, but avirulent on wheats containing the H5 or H7H8 genes.

Only one plant containing the H5 gene (out of over 1000 plants tested) was found to be infested. This one infested plant may represent a very low frequency (0.4%) of virulence genes for the H5 resistance gene in the Manawatu Hessian fly population (as shown in Table 1); however, it is also possible that this one infested wheat plant resulted from a volunteer seed. None of the plants containing the H7H8 genes were infested by Hessian fly. Of the individual females given the New Zealand cultivars, Otane and Karamu, all (78/78) had progenies virulent to these wheats.

In the United States, Hessian flies differing in patterns of virulence to resistance genes in wheat are called biotypes. According to the nomenclature of Patterson *et al.* (1992), which is based on host plant sets composed of three differentials, the Manawatu population of Hessian flies probably contains three, and possibly four, biotypes (Table 1).

TABLE 1: Levels of virulence in a Manawatu population of Hessian fly to various resistance genes found in wheat and biotype designations.

Virulence to resistance genes:				Proportion of individuals	Biotype designation
H7H8	H3	H6	H5		
no	no	no	no	139/254 (55%)	1(R--)-0
no	no	yes	no	110/254 (43%)	2(R--)-0
no	yes	yes	no	4/254 (1.6%)	4(R--)-0
no	no	yes	yes	1/254 (0.4%)	2(S--)-0

When larger numbers of Hessian flies were used to infest pots of wheat containing the H3, H5, and H7H8 genes, low levels of virulence (11/300 females= 3.7%) to the H3 gene were again found (note: this proportion is conservative in that it is calculated by assuming that, if infested wheat plants were found in a pot, the infestation represented the progeny of a single female out of the group of 20 females used to infest the pot); however, progenies from all of the flies tested in larger groups were avirulent for the H5 and H7H8 genes (240 and 280 females were tested, respectively).

In conclusion, two of the wheats most commonly grown in New Zealand, Otane and Karamu, showed no resistance to feeding by larvae of a Manawatu population of the Hessian fly when in the early stages of growth (2-leaf stage). Since the susceptibility of these wheats was not tested during the later stages of growth, it is possible that some resistance to Hessian fly may develop as the plant matures. However, informal surveys of pest populations in mature wheat plants (Otane, Karamu) in the Manawatu, Canterbury, and North Otago in late March 1993 (Harris and Withers, unpublished data) indicated that this was not the case as large numbers of Hessian fly larvae and pupae were found in these plants. These findings indicate the need for reintroducing Hessian fly resistance into New Zealand wheats. For populations of Hessian fly found in the Manawatu, the H5 and H7H8 genes present in United States wheat breeding lines are potential sources of host-plant resistance. The effectiveness of these genes in controlling populations of Hessian flies found in the South Island of New Zealand will be determined during the 1993-1994 season. Additional sources of resistance to Hessian fly may be available from some of the Hessian fly-resistant wheat cultivars (e.g. 'Hilgendorf', Burnett, 1984) formerly grown in New Zealand.

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