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# OCCURRENCE OF A NEW VIRULENT FORM 117-1 IN RACE 117 OF *PUCCINIA GRAMINIS* F.SP. *TRITICI* IN INDIA

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## SUMMARY

Virulence 117-1 (166 G2) was a new addition to group 117 of *Puccinia graminis* f.sp *tritici*. This virulence was recorded mainly from Karnataka and in a few samples from Maharashtra and Madhya Pradesh. Its virulence could overcome the resistance of many cultivars and *Sr37*. Brief information is given on its comparison to other virulences of the 117 group and sources of resistance.

## INTRODUCTION

*Puccinia graminis* Pers. f.sp. *tritici* Eriks. and Henn. has been a major pathogen of wheat worldwide. The capacity of the pathogen for adaptation to the changed environment enables it to assume alarming proportions. Its dynamism becomes conspicuous when upon introduction of a diverse genotype it increases in virulence. To keep a strict watch on the changing population of the black rust pathogen continuous monitoring is done. Ths helps reduce crop losses by assisting breeders in targeting their priorities.

## REVIEW OF LITERATURE

Race 117 was first collected from local wheat samples from Madhya Pradesh (Prasada and Lele, 1952). Pal (1966) found this race on pure line selections of wheat. The first deviation in this race (117A) was identified in 1960 from Karnataka (Patil *et al*., 1963). Another form virulent on *Sr9b* and Charter was detected from the same state in 1977 (Sharma *et al*., 1969) and was named as 117A-1.

## MATERIALS AND METHODS

Samples received during 1987 were multiplied on a universally susceptible wheat, Agra local, and inoculated onto sets of differentials (Bahadur *et al.*, 1985) to identify the virulence. Simultaneously host pathogen interaction on *Sr* lines in comparison to other variants was also recorded for differentiating characters.

## RESULTS AND DISCUSSION

It was found that this form was virulent on *Sr37*, a gene which was earlier known to be matched only by race 11A (203 G15). The differentiating reactions on sets of differentials are shown in Table 1.

Race 117-1 behaves similarly to 117A on differential sets, however, it had additional virulence for *Sr9b* and *Sr37*. Detailed differences among various members have been reflected by avirulence/virulence pattern (Table 2).

Several genes are still effective against this race. *Sr37* is a gene derived from *Triticum timopheevi* along with *Sr36*. *Sr37* has been matched by this virulence whereas *Sr36* is still immune.

When we investigated further, a number of cultivars were found harbouring this race. These were: WSM 377, HD 4502, Macs 2368, Macs 2271, CPAN 2096, HUW 234, WL 711, HD 3289, NGSI, HD 2329, EC 183687, EC 183678, EC 183683, EC 183685, EC 183692, Lal Bahadur, Bijaga Red and DWL 5023. The culture being maintained was isolated from cultivar EC 183685 from Dharwad in Karnataka.

This race was encountered in more than 15 percent of the samples analysed during the year. It is important to note that this virulence was mainly associated with the states of Karnataka, Maharashtra and Madhya Pradesh (all are adjoining states). It is very interesting to note here that analysis of about 80 samples from different parts of Nilgiris (Tamil Nadu) lacked matching virulence for *Sr37*. Therefore, some primary source of inoculum other than Nilgiris, *presumably* exists in Karnataka. This claim has further been corroborated during the 1987-88 crop season as this race was identified in 50 per cent of the samples analysed.

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Table 1 Differential reaction of variants of 117 group

| Name of race | | Response of differential hosts | | | | |
|---|---|---|---|---|---|---|
| Old | New | Sr13 | Sr9b | Sr37 | Marquis | Charter |
| 117 | 37 G3 | 4 | 2 | 1-2 | 4 | 2 |
| 117 A | 36 G2 | 2 | 2 | 1-2 | 2 | 1-2 |
| 117 A-1 | 38 G18 | 2 | 4 | 2 | 2 | 4 |
| 117-1* | 116 G2 | 2 | 4 | 4 | 2 | 2 |

* New Variant

Table 2 Avirulence/Virulence for group 117 and new form

| Name of race | | | |
|---|---|---|---|
| Old | New | Avirulence | Virulence |
| 117 | 37G3 | *Sr7a*, *Sr9b*, *Sr35*, *Sr37* | *Sr7b*, *Sr10*, *Sr13*, *Sr14*, *Sr16*, *Sr17*, *Sr19* |
| 117A | 36G2 | *Sr9b*, *Sr10*, *Sr13*, *Sr14*, *Sr16*, *Sr37* | *Sr7b* |
| 117A-1 | 38G18 | *Sr7b*, *Sr13*, *Sr35*, *Sr37* | *Sr7a*, *Sr9b*, *Sr10*, *Sr14*, *Sr16*, *Sr17*, *Sr19* |
| 117-1 | 166G2 | *Sr7a*, *Sr7b*, *Sr13* *Sr14*, *Sr35* | *Sr9b*, *Sr10*, *Sr17*, *Sr19*, *Sr37*, *Sr16* |

Note: 1. Genes *Sr5*, *Sr8*, *Sr12*, *Sr22*, *Sr24*, *Sr25*, *Sr26*, *Sr27*, *Sr28*, *Sr30*, *Sr31*, *Sr32*, *Sr33*, *Sr36*, are resistant whereas *Sr6*, *Sr9a*, *Sr9c*, *Sr9d*, *Sr9e*, *Sr9f*, *Sr11*, *Sr15*, *Sr21*, *Sr23*, *Sr29* and *Sr34* are susceptible to all the virulences.

2. *Sr7a*, *Sr17*, *Sr19* and *Sr35* show susceptible reaction to 117A when temperature goes over 30°C.

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# THE IMPORTANCE OF GRAMINICOLOUS RUSTS AND THEIR CONTROL IN CZECHOSLOVAKIA

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In Czechoslovakia, grasses for seed production are grown on an area of about 18,000 ha. They are amongst the most important market crops, often being used for reconstruction of old pastures. They play a significant role in the non-agricultural sphere.

The graminicolous rusts of various species, mostly the genera *Puccinia* and *Uromyces*, are serious parasites of these "young" crops. Since 1972 special investigations have been carried out within the plant pathology programme in the Grassland Research Station (Roznov). A study was made of the economic importance of pathogens, losses, possibilities of breeding for resistance and practical disease control.

The results achieved during the period of 1972-1987 have shown that the most serious species of graminocolous rusts occurring in Czechoslovakia are crown rust (*Puccinia coronata* Corda var. *coronata*), and rusts attacking *Poa* species (*Puccinia brachypodii* Otth var. *poae-nemoralis*/Otth/Cummins et Greene, and *Puccinia poarum* Nielsen). The other species are of limited importance. A common feature of graminicolous rusts is that they mostly influence crop quality both in seed and forage production (eg decrease in 1,000 kernel weight and change inthe content of WSC and some other substances).

Crown rust (*Puccinia coronata* Corda var. *coronata*) belongs to the serious obligate parasites of cultivated *Lolium* species under conditions of Czechoslovakia (mostly perennial ryegrass, Italian ryegrass, annual ryegrass, hybrid ryegrass, Italian ryegrass x tall fescue crosses), and meadow fescue, while the tall fescue is not generally attacked. The parasite may adversely affect green matter yield, depending on numerous factors, eg climatic conditions, cultivars, intensity of infection, and it evidently reduces fodder quality. Our investigations have shown that in meadow fescue crown rust infestation led to a significant 45 per cent decrease in WSC content, and a non-significant reduction in digestible dry matter content (Cagas, 1979).

In annual ryegrass and meadow fescue crown rust decreased the 1,000 kernel weight of susceptible plants by 0.56 to 22.78g and 33.7g, respectively (Cagas, 1986).

Artificial infection of 157 grass species including cereals has proved the graminocolous nature of crown rust (*Puccinia coronata* var. *coronata*). The host range comprised a total of 24 species, however, *Lolium perenne*, *Lolium multiflorum*, *Lolium remotum*, *Lolium rigidum*, *Lolium temulentum* and *Festuca pratensis* were the only ones to have practical importance for natural infection spread.

Based on the economic significance of crown rust in forage and grass seed production a study was started orientated towards breeding for resistance. It has been found that there are two types of populations with different virulence in Czechoslovakia (Cagas, 1984). The available collection of world meadow fescue varieties was characterized by rather a low level of resistance; nevertheless, it seemed possible to select plants bearing high resistance (Cagas, 1978). As a result, a population was obtained with a high level of resistance to be compared to the Czechoslovak registered cultivars of meadow fescue. The resistant population gave significantly higher green matter yields, the N- and Mg-content being non- significantly higher. In contrast, WSC content was on average 15 per cent lower (significantly in the first cutting year only), and the content of digestible dry matter was non-significantly reduced (Cagas, 1988). The resistant types of meadow fescue exhibited better resistance compared to Czechoslovak cultivars.

In forage grasses, breeding for resistance to graminicolous rusts appears to be a potential means of disease control to be fully exploited in the future. Tests were also carried out on efficiency of systemic fungicides against the above-mentioned pathogens. Some of them, eg Bayleton 25 WP, Tilt 250 EC, Corbel and Impact showed good results under field conditions, and could be recommended for practical application.

*Puccinia brachypodii* Otth var. *poae-nemoralis*/Otth/ Cummins et Greene and *Puccinia poarum* Nielsen belong to the most important parasites of *Poa* species (*Poa pratensis* L., *Poa palustris* L., *Poa nemoralis* L., *Poa compressa* L.) grown in Czechoslovakia. Similarly to crown rust, they can decrease fodder quality and, together with powdery mildew and spots, lead to a decrease in seed yield. Our investigations showed a 10 per cent reduction of 1,000 kernel weight in infected Kentucky bluegrass plants (Cagas, 1981).

The host range of the above-mentioned pathogens is rather small, being confined to the genus *Poa* only. The species *Anthoxanthum aristatum*, *Alopecurus myosuroides*, *Lamarckia aurea*, *Lolium temulentum* and *Phalaris minor* are also host plants, but their importance for natural spread of the infection is rather limited (Cagas and Markova, 1988).

Breeding for resistance seems to be rather difficult. There are no sources of resistance, either among registered cultivars, or among wild ecotypes (Cagas, 1983). Investigations were carried out focused on different physiological specialisation of *Puccinia brachypodii* var. *poae-nemoralis* populations in Kentucky bluegrass and swamp meadow grass (Cagas and Markova, 1985). Bayleton 25 WP has been registered for chemical disease control in Czechoslovakia.

Analysis of the economic importance of graminocolous rusts has revealed their detrimental impact on forage grasses. It is quite evident that integrated control, including breeding for resistance, is necessary. The main principles of breeding for resistance have already been postulated in the genera *Festuca* and *Lolium*.

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# STEM RUST RESISTANCE OF THE WHEAT CULTIVAR MARIS FUNDIN

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## INTRODUCTION

English wheat cultivars are used in wheat breeding programmes in various European countries. Their main advantages are high yield potential and disease resistance, particularly to yellow rust, powdery mildew, eyespot and glume blotch. Most English cultivars are susceptible to stem rust because of the low importance of this disease in the United Kingdom. However, some English cultivars also possess stem rust resistance. This can be explained by a linkage of stem rust resistance genes with genes for other agronomically important traits. Thus cultivars carrying the translocation 1B/1R e.g. Stetson, display stem rust resistance based on the gene Sr31. Nevertheless, we also found stem rust resistance in the cultivar Maris Fundin, which does not possess the 1B/1R translocation. Hence this cultivar was used in Czechoslovak wheat breeding. We carried out trials to analyse its stem rust resistance and results are summarised in this paper.

## MATERIAL AND METHODS

The seed of the cultivar Maris Fundin originated from the PBI, Cambridge, the line C possessing SrTt$_1$ (=Sr36) was obtained earlier by the courtesy of Prof. I A Watson, The University of Sydney, Australia. The seed of the cultivars Juna (CSSR) and Vuka (FRG) was obtained from the wheat collection of the Research Institute for Plant Production, Praha-Ruzyne.

Progenies of the crosses were tested in the stem rust nursery, where a high disease pressure was obtained by inoculating the spreader rows of the cultivar Michigan Amber with stem rust (isolate G 425 - race 11) by means of a hypodermic syringe. Isolate G 425 and isolate G 69 (race 21) were used for the greenhouse tests of some progenies.

## RESULTS AND DISCUSSION

The results of the field trial (Table 1) suggest that Maris Fundin has one dominant gene for stem rust resistance. This gene governs IT 0 in adult plants, however, under strong disease pressure, a small number of pustules of susceptible type occur in late vegetation. Occurrence of these pustules of a susceptible type seems to be the reason for misclassifications that might have caused deviation from the expected ratio in one case.

The greenhouse test (Table 2) showed that the gene for stem rust resistance in Maris Fundin displayed only a small effect at the seedling stage to the races used. Reactions were similar to those of line C.

The greenhouse experiments (Table 3) with the cross Vuka x Maris Fundin gave inconclusive results. In the test with race 11 resistance seemed too recessive. In the test with race 21, to which Maris Fundin showed slightly lower infection type, resistance seemed to be dominant. None of the obtained ratios fitted the segregation of one gene if all infection types lower than 4 were classified as resistant. Some F2 plant showed lower infection types than Maris Fundin.

The pedigree of Maris Fundin : Vilmorin 29// Vogel 8058/Cappelle /4/C.I. 12633/ (Cappelle) Heines 110/Cappelle /3/ Nord (Zeven et al. 1976) suggests that Maris Fundin may possess *Sr*36 from C.I. 12633. To prove this suggestion, Maris Fundin was crossed with line C possessing *Sr*36 and the F2 generation was tested for segregation (Table 4). The absence of segregation in the F2 progeny would indicate the identity of genes for resistance. However, seven plants were classified as medium susceptible. This number was too small to fit the segregation ratio 15:1 expected for two different dominant genes for resistance. Classification of rust reactions in this field was difficult because of large differences in earliness of single F2 plants. Plants classified as medium susceptible in the F2 generation were harvested with 45 other randomly selected plants and tested as F3 lines in the next year. All seven progenies were classified as resistant with some susceptible pustules which indicates probable misclassification of F2 plants. All 52 lines tested in the F3 generation showed either IT 0 or a small number of pustules of susceptible type. Out of the total number of 705 plants in the F3 generation, only one was susceptible. These results, despite some variability, suggest that Maris Fundin carries *Sr*36 (=*SrTt*$_1$).

This suggestion is supported by the characteristics of *Sr*36 summarised by Roelfs and McVey (1979) who reported that the expression of resistance due to this gene varied with different races of the pathogen. With some races it gave from 0 to X- but with others a mixed reaction was recorded as 4,0 in which both hypersensitive flecks and type 4 susceptible pustules occurred together. Although the number of susceptible pustules was less than in the susceptible host lacking the gene they recorded this mixed infection as a high infection type. They also reported that in adult plants this gene resulted in few pustules of a susceptible type. According to Luig (1983) there are also conflicting reports about the number of genes controlling resistance in lines with *Sr*36. Thus, Allard and Shands (1954) suggested two duplicate dominant genes with recombination of 14.8 percent whereas Nyquist (1957, 1962) proposed a single gene located on chromosome 2B. Nyquist suggested that differential fertilisation caused deviations from conventional 3 to 1 ratios.

The suggested presence of *Sr36* in the cultivar Maris Fundin needs additional studies to be verified. Nevertheless, the cultivar Maris Fundin represents a good genetic source of adult plant resistance to the rust in addition to many other agronomically positive traits for the wheat breeding.

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Table 1. Segregation of stem rust reaction in the field trial

| Cross | Generation | No. of plants/lines R | S | Segreg. | Total | Expected ratio | $X^2$ | P |
|---|---|---|---|---|---|---|---|---|
| M.Fundin x Vuka | F1 plants | 7 | - | - | 7 | - | - | - |
| | F2 plants | 99 | 48 | - | 147 | 3:1 | 4.37 | 0.05-0.01 |
| | F3 † lines | 5 | 8 | 12 | 25 | 1:1:2 | 0.82 | 0.8-0.5 |
| M.Fundin x Juna | F1 plants | 5 | - | - | 5 | - | - | - |
| | F2 plants | 88 | 22 | - | 110 | 3:1 | 1.4 | 0.5-0.2 |
| | F3†† lines | 13 | 0 | 19 | 32 | 1:0:2 | 0.55 | 0.8-0.5 |

† F2 plants were harvested at random, irrespective of rust reaction, for F3 lines

†† Only resistant F2 plants were harvested for F3 lines

Table 2. Stem rust reactions of cultivars (lines).

| Cultivar (line) | Race (isolate) | | |
|---|---|---|---|
| | 11 (G 425) | | 21 (G 69) |
| | seedlings | adult plants | seedlings |
| Maris Fundin | 2-3, 3 | 0 | 2, 2-3, 3 |
| Line C | 3± | 0 a few 3 | 2, 2-3 |
| Juna | 4 | 4 | 0 |
| Vuka | 4 | 4 | 4 |

Table 3. Segregation for stem rust reaction of F2 generation at the seedling stage.

| Cross | Race isolate | No. of plants IT ;1 | 2 | 2-3 | 3- | 4 | Total | Expected ratio | $X^2$ | P |
|---|---|---|---|---|---|---|---|---|---|---|
| Vuka x M.Fundin | 11<br>G 425 | 0 | 2 | 5 | 37 | 197 | 241 | 1:3 | 5.68 | 0.05-<br>0.01 |
| Vuka x Fundin | 21<br>G 69 | 9 | 81 | 23 | 41 | 71 | 225 | 3:1 | 5.35 | 0.05-<br>0.01 |

Table 4. Segregation for stem rust reaction in adult plants of the cross Maris Fundin (IT 0) x line C (IT 0 a few 3) to the race 11 (G 425).

| Generation | No. of plants IT 0 | 0 a few 3 | 3- | Total | Expected ratio | $X^2$ | P |
|---|---|---|---|---|---|---|---|
| F1 | 11 | - | - | 11 | - | - | - |
| F2 | 276 | 8 | 7 | 291 | (15:1) | 11.15 | <0.01 |

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# OCCURRENCE OF A NEW PATHOTYPE OF LEAF RUST OF WHEAT AND ITS IMPACT ON WHEAT PRODUCTION IN PAKISTAN

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Leaf rust of wheat caused by *Puccinia recondita* Rob. ex. Desm. f.sp. *tritici* has become an increasingly important and widespread disease in Pakistan within the last two decades, mainly due to the extensive cultivation of semi-dwarf, high yielding and genetically homogeneous cultivars.

During the course of the annual pathogenicity survey of leaf rust, a new pathotype, not hitherto recorded in Pakistan, was identified from rust collections of the 1986-87 crop.

Field collections were established on the susceptible wheat cultivar Morocco W1103 in the greenhouse and subsequently standard differentials were inoculated and incubated for 20°-24° hours. The plants were kept in the greenhouse at 20°-24°C. Observations were recorded after 10-12 days following the recommended scale for leaf rust (Johnston and Mains, 1932).

The new pathotype produced intermediate infection types (I.T.) on Carina (*Lr*2b), Webster (*Lr*2a) and Hussar (*Lr*11) differentials in the international set proposed by Johnston and Mains (1932) and compatible reactions on the other five differential varieties.

The average I.Ts produced by the new pathotype on the standard differentials are given below:

| Malakof | ✓ Carina | Brevit | ✓ Webster | Loros | Mediterranean | ✓ Hussar | Democrat |
|---|---|---|---|---|---|---|---|
| 3+ | 2-3+ | 4 | 2-3+ or 1-3+ | 3+ | 3+ | 2-3 | 3+ |

Thus the I.Ts produced by the new pathotype on the standard differentials were similar to those of the physiologic race 104 described in the International Register of physiologic races of leaf rust (Johnston and Browder, 1966).

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Race 104 was first recorded in 1931 in the USA (Johnston et al., 1968). Later it was reported from Canada in 1938 (Johnson, 1956). Sawhney et al. (1977) reported the occurrence of race 104 in the 1972-73 wheat crop in India. According to Nayer et al., (1972), however it had been reported from Nepal earlier. Recently, this race has been reported to have become predominant in Australia (Zwer 1987).

The frequency of race 104 had been recorded as 25 percent and 26 percent respectively during the 1986-87 and 1987-88 crop seasons. The race could not be recovered earlier from Pakistan probably due to its very low frequency. The distribution of the pathotype does not appear to be restricted to any particular area in the country. It is interesting to mention that the rust samples collected during 1987-88 crop from northern Chitral close to Afghanistan border yielded race 104.

In order to study the virulence pattern of the new race, all isolates recovered during 1986-87 and 1987-88 were tested on genetic stocks known to carry single genes for resistance to wheat leaf rust. Three pathotypes of race 104 were identified. The I.Ts produced by these pathotypes on the Lr genes are given in Table 1.

The results indicate that the three pathotypes were identified on the basis of differential reaction on Kenya 1483 (Lr15) and Thew (Lr20). These pathotypes were invariably avirulent on Lr9, Lr19 and Lr24 and virulent on Lr1, Lr10 and Lr23.

To study the impact of virulence of race 104, Pakistani commercial cultivars as well as candidate wheat varieties included in the National Uniform Yield Trials (NUWYT) 1987-88, were evaluated against the new race in the seedling stage. Cultivars Faisalabad 85, Kohinoor 83, Khyber 87, Pak 81, Pirsabak 85, Punjab 85, Rawal 87 and Sutlej 86, which possess Lr26 either singly or in combination with other genes, remained resistant to this race. Wheat cultivars carrying Lr13 singly or in combination with Lr1 and/or Lr3 produced either resistant or intermediate reactions. These cultivars included Arz, Bahawalpur 79, Blue Silver, Faisalabad 83, Lyallpur 73, Pari 73, Shalimar 88, Sind 81, Yecora 70, Zamindar 70 and ZA 77. Only three cultivars, namely Barani 83 (Lr3), Jauhar 78 (Lr23) and Sind 83 were susceptible as seedlings.

Similarly 36 entries included in the NUWYT were tested against races 104 and 144 as well as against race 77, the most frequent and virulent race. Race 104 was found to be virulent on only 2 entries, whereas 11 entries were susceptible as seedlings to race 77.

Since this race is unable to overcome the resistance genes Lr13 or Lr26, most commonly occurring in Pakistani cultivars, (Hussain et al, 1988) it may not pose any danger to wheat production immediately.

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Table 1: Infection types produced by pathotypes of race 104 on genetic stocks carrying leaf rust resistance (Lr) genes.

| Stock | Lr gene | Race and pathotype | | |
|---|---|---|---|---|
| | | 104-1 | 104-2 | 104-3 |
| Tarsa W 3572 | *Lr1* | 3+ | 4 | 3+ |
| Transfer | *Lr9* | 0 | 0; | 0; |
| CS/Timstein 1A | *Lr10* | 3+ | 3+ | 3+ |
| Kenya 1483 | *Lr15* | 3+ | 3+ | ;1N |
| 7Ag # 2 | *Lr19* | 0; | 0; | 0; |
| Thew W 203 | *Lr20* | 3+ | ;1N | 3+ |
| CS/KF-2B | *Lr23* | 3+ | 3+ | 3+ |
| Vasco | *Lr24* | 0 | 0; | 0; |

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# NEW RACES OF *PUCCINIA STRIIFORMIS* IN THE UNITED KINGDOM IN 1988

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## SUMMARY

The 1988 epidemic of *Puccinia striiformis* in the UK was associated with a large acreage of the winter wheat cultivar Slejpner, which possesses the specific resistance WYR 9, and a sharp increase in the frequency of the corresponding virulence, WYV 9, in the pathogen population. For the first time, isolates possessing the virulence combination WYV 6 + WYV 9 were identified and these overcame the resistance of a number of previously resistant cultivars, such as Hornet.

## INTRODUCTION

The 1988 epidemic of *Puccinia striiformis* on wheat in the United Kingdom (UK) was the most severe experienced since 1974. The most seriously affected areas were the eastern coastal regions of England and Scotland, where the risk of yellow rust infection is usually at its highest. Amongst factors contributing to the epidemic were unusually favourable weather conditions and the widespread cultivation of a susceptible cultivar, Slejpner. The wet autumn and mild winter of 1987/88 allowed carry-over of inoculum and early initiation of infection. Conditions continued to favour yellow rust development throughout the spring and summer, resulting in intense disease pressure and high levels of infection in crops.

The acreage of the cultivar Slejpner had expanded rapidly from 7% in 1987 to around 22% in 1988 (Anon 1987; Anon 1988). Slejpner possesses the specific resistance WYR 9, derived from Rye, together with a degree of adult plant resistance, some component of which may be race-specific. The virulence WYV 9 was first identified in the UK in 1974. However, with the exception of a temporary peak in 1983 and 1984, it had remained at low levels in the UK population, with a frequency of only 5% in 1987 (Bayles, Channell and Stigwood, 1988).

As the epidemic progressed, a number of cultivars which had previously been resistant to all UK isolates became infected, providing the first indications of a new race of *P.striiformis*. Most of these cultivars were still at an early stage in the official trials system, but one, Hornet, was already being grown commercially on a limited scale.

This paper reports the results of tests carried out by the UK Cereal Pathogen Virulence Survey to identify the virulence of 1988 isolates and in particular to examine the new race or races virulent on Hornet.

## METHODS

71 isolates of P.striiformis, made from infected leaf samples collected during 1988, were tested in seedling virulence tests, using the methods described by Priestley, Bayles and Thomas (1984). The differential cultivars used are listed in Table 1. Hornet was included as an additional cultivar in all tests.

## RESULTS

The results of seedling tests on 71 isolates are shown in Table 2. Five new isolate types were identified (WYV 1,2,3,4,7; WYV 1,2,3,6,9,Ho; WYV 2,3,4,6,9,Ho; WYV 1,2,3,4,6,9,Ho; WYV 1,2,3,6,Ho; - where Ho indicates virulence for Hornet), accounting for 32 isolates. Of these 32 isolates, 30 possessed the virulence combination WYV 6,9, which had not been detected previously in the UK. All isolates possessing WYV 6,9 were also virulent on Hornet. In addition, a single isolate possessing WYV 6 but lacking virulence for the WYR 9 differential Clement (WYV 9) was virulent on Hornet (WYV 1,2,3,6,Ho).

## CONCLUSIONS

The frequency of the virulence WYV 9 in the UK population of P.striiformis rose sharply in 1988 to approximately 66%, from its 1987 level of 5%. This was associated with a substantial increase in the acreage of the wheat cultivar Slejpner which possesses the corresponding resistance WYR 9.

For the first time, isolates combining virulence for WYR 9 and WYR 6 were detected and these isolates were also virulent on the previously resistant cultivar Hornet. The most probable explanation is that Hornet possesses the resistances WYR 6 and WYR 9, which would be consistent with its parentage. However, a single Hornet - virulent isolate was identified, with virulence for WYR 6 but not for the WYR 9 differential Clement (WYV 1,2,3,6,Ho). It has been suggested (R.Johnson, pers. comm) that Clement may infact possess WYR 9 together with WYR 2 and an additional unnamed resistance for which virulence is common. This being so, the isolate WYV 1,2,3,6,Ho could be an unusual type which lacks virulence for this unnamed resistance, thereby rendering it avirulent on Clement.

The new races detected in 1988 demonstrate the increasing complexity of virulence combinations in the UK population of P.striiformis. It is becoming correspondingly more difficult for the farmer to diversify effectively between cultivars with different specific resistances.

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Table 1

Resistance factors to Puccinia striiformis (WYR factors), corresponding Yr genes and differential cultivars used in seedling tests of 1988 isolates.

| WYR Factor | Gene | Differential Cultivar(s) |
|---|---|---|
| WYR 1 | Yr 1 | Chinese 166, Maris Templar |
| WYR 2 | Yr 2 | Heine VII, Brigand |
| WYR 3 | Yr 3a+4a | Cappelle Desprez |
| WYR 4 | Yr 3b+4b | Hybrid 46, Avalon |
| WYR 6 | Yr 6 | Heines Kolben, Maris Ranger |
| WYR 7 | Yr 7 | Tommy |
| WYR 9 | Yr 9 | Clement |
| ? | ? | Hornet |

Table 2 Virulence of isolates of P.striiformis collected in the UK during 1988

| Virulence Combination | Virulence for cv. Hornet * (Ho) | Number of Isolates | New Identification (N) |
|---|---|---|---|
| WYV 2,3,4 | - | 2 | - |
| WYV 1,2,3,6 | - | 6 | - |
| WYV 1,2,3,4,6 | - | 11 | - |
| WYV 1,2,3,4,7 | - | 1 | N |
| WYV 2,3,4,6,7 | - | 3 | - |
| WYV 1,2,3,9 | - | 8 | - |
| WYV 2,3,4,9 | - | 9 | - |
| WYV 1,2,3,6,9 | Ho | 1 | N |
| WYV 2,3,4,6,9 | Ho | 9 | N |
| WYV 1,2,3,4,6,9 | Ho | 20 | N |
| WYV 1,2,3,6 | Ho | 1 | N |

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