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AND

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7TH EUROPEAN AND MEDITERRANEAN CEREAL RUSTS CONFERENCE, VIENNA/AUSTRIA, 5-9 SEPTEMBER 1988

CLOSING ADDRESS BY THE CHAIRMAN, DR A BRONNIMANN

A few days ago we arrived in Vienna, looking forward to attending the 7th Cereal Rusts Conference. Since then many interesting papers and posters have been presented. Discussions have been held during sessions, breaks and outside the conference hall. Knowledge and experiences have been exchanged. I hope I can speak in the name of all of you when I say that this has been an extremely successful scientific meeting.

Apart from the scientific programme, much has been done to make our stay in Vienna a pleasant one. Both the welcome party and the performance of the Spanish Riding School were events which we will remember with pleasure. The conference will not finish with the closing session. We are still looking forward to the conference dinner at a Heurigen Restaurant tonight and the post-conference excursion tomorrow.

It is time to thank the organizers, Dr Bruno Zwatz and his team for making this conference such a success. We appreciated your hospitality very much.

I should like to take the opportunity to inform you about a few decisions which were taken by the board at recent meetings:

1. It was decided to open the cereal rusts conference to mildews. We gave a hint of this in our first circular for the '88 conference. Since many of the problems in mildews are the same as in the rusts and several of the rusts workers also deal with mildews I think this decision makes sense. Therefore the next conference will be named "8th European and Mediterranean cereal rusts and mildew conference".

2. The next conference will be held in 1992 at Weihenstephan-Munich/BRD. We are grateful to Professor Fischbeck and his colleagues for agreeing to act as organizers. As we all know, Professor Fischbeck is at home with both rusts and mildews.

3. The following changes in membership of the board of our organization will be made:

   Dr. Ph. Auriau, Versailles/France, the organizer of the '84 conference will leave the board after 8 years and be replaced by Professor Fischbeck, the organizer of the '92 conference.

Dr Norman Chamberlain, editor of the Cereal Rusts Bulletin, leaves the board due to professional changes after 6 years, being replaced by Dr Rosemary Bayles, National Institute of Agriculture Botany (NIAB), Cambridge. Please support her by sending short notes and papers to keep our bulletin alive. It is our organization's only source of income.

Professor Dr. Jan Parlevliet is retiring from his position as treasurer which he has held since 1976. He will be replaced by Ir. H. van Silfhout, Institute for Plant protection (IPO), Wageningen. Since our organization is registered in the Netherlands a Dutchman has to fulfill this function.

Dr. Roy Johnson, our secretary, is leaving his position and taking over the duties of chairman for at least 4 years. He will be replaced by Dr. Padruot M. Fried, Zurich/Switzerland.

As my last official duty I would like to thank Dr. Auriau, Dr. Chamberlain, Dr. Johnson and Professor Parlevliet cordially for everything they have done for our organization. It has been a real pleasure to work in this team in a professional and friendly atmosphere. I welcome at the same time the new board members. I am convinced that the Cereal Rusts Foundation will be in good hands in the future.

It is time for me to leave the board as chairman and to hand over the reins to an experienced board member, Dr. R. Johnson. At the end of my cereal rusts foundation career let me give a few personal recollections.

24 years ago, in 1964, I attended the first combined cereal rusts conference in Cambridge as a rust-greenhorn of course. Since then the following conferences have taken place:

68 Oeiras/Portugal
72 Prague/Czechoslovakia
76 Interlaken/Switzerland
80 Bari and Rome/Italy
84 Grignon/France
88 Vienna/Austria.

Attendance at all these conferences were highlights in my life.

Also the two 8-year periods on the board ('72-'80 as an organizer of the '76 conference in Interlaken and as chairman from '80 till '88) entailed quite a lot of work. At the same time it brought great satisfaction. This is so because of the really wonderful teamwork I found on this board. We were not only board members in the narrow sense of the word but also friends. For this I thank my colleagues very much.

In this last 24 years many aspects of cereal rusts research have changed. At the '64 conference reports of classical race identification and corresponding variety testing work were emphasized. The detached leaf method was a topic and knowledge of the differences in reaction of cereal rusts in seedling or adult plant stages were discussed.

Later on, the theory of vertical and horizontal resistance had to be digested and stimulated rust researchers. New breeding techniques were established. Electronic data processing made more precise simulation of epidemics possible which served as a basis for the development of forecasting systems. New fungicides were discovered competing to some extent with resistance breeding, at least judged in the short term, and now methods of biotechnology may open new fields of research in rusts work.

So we are still in the middle of an evolution, or are we perhaps only at the beginning? The stimulating effect of our organisation will continue to be necessary in the future. For all this future work I wish the European and Mediterranean Cereal Rusts and powdery mildew conference good luck and all the best.

23.8.88, Br/HK

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IDENTIFICATION OF A NEW VIRULENCE OF *Puccinia graminis* f.sp. *tritici* IN INDIA DURING 1985

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During the 1985 wheat rusts pathogenicity survey a variant of race 21 of *Puccinia graminis* f.sp.*tritici* was identified from the bread wheat variety UP 2224 sampled from Uttar Pradesh. The sample was inoculated onto seven day old seedlings of Agra local, a susceptible bread wheat. Inoculated plants were kept at saturated relative humidity for 48 hours and were then transferred to glasshouse benches having 20-25°C mean temperature. Pustules appeared on the inoculated seedlings after 11-12 days. Fresh uredial dust was inoculated onto the differentials and the same procedures were followed until symptoms developed on the host. The host pathogen interactions were recorded following Stakman *et al*. (1962).

So far in India, four variants of race 21 have been recorded (Bahadur 1986). The present test isolate gave reactions characteristic of group 21 (Table 1), but differed on some of the newly proposed differentials (Bahadur *et al*. 1985). The new isolate is virulent on *Sr 8* and avirulent on *Sr 11* of set A, while the lost culture race 21A is virulent on Yalta (*Sr 11*) and the reaction of *Sr 8* is not known. Virulence 21A-1 (20G-21) infects both *Sr 8* and *Sr 11*. The other variant 21A-2 (75G5) is avirulent on *Sr 8* (Table 1). Since the present isolate differs from all other earlier recorded variants, it is designated as 21-1 (24G5).

Evaluation of a number of wheat varieties for seedling resistance revealed that 52 genotypes possess resistance to this virulence. Such genotypes can be used for breeding wheats with resistance against the new isolate.

Table 1. Details of new virulence 24G5 in comparison with other variants of race 21 of Puccinia graminis f.sp.tritici

Race / Variant	Year	Set A Effective Sr genes	Ineffective Sr genes
21 (9G5)	1934	Sr8, Sr9b, Sr9e, Sr11, Sr30, Sr37	Sr13, Sr28
21A†	1956	-	-
21A-1 (20G21)	1958	Sr9b, Sr9e, Sr13, Sr28, Sr30, Sr37	Sr8, Sr11
21A-2 (75G5)	1982	Sr8, Sr9e, Sr11, Sr37	Sr9b, Sr13, Sr28
21-1 (24G5)*	1985	Sr9b, Sr11, Sr13, Sr9e Sr30, Sr37	Sr8**, Sr28

† - Culture lost, isogenic lines not tested
* - New variant
** - Temperature sensitive. Below 15°C reaction 2+

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PATHOGENICITY SURVEY OF *Puccinia graminis* f.sp. *avenae* IN INDIA

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Oats (*Avena sativum*) are grown in Nilgiris throughout the year permitting availability of green fodder. The occurrence of stem rust (*Puccinia graminis* f. sp. *avenae*) reduces the quality of fodder. This pathogen in addition to wild oats also affects *Vulpia myuros* and *Briza minor*, the two grasses in the wastelands and pastures of the South Indian hills (Joshi and Lele, 1964). Uredial samples collected from oats during 1985 and 1986 were established on a local susceptible cultivar following the usual cereal rust inoculation procedure. Single pustule isolates were separated and multiplied prior to inoculating them onto twelve oat lines with designated genes for resistance.

Analysis of reactions of oat lines with different rust isolates indicated that virulence for the resistance genes *Pg1*, *Pg2*, *Pg3*, *Pg8*, *Pg9*, *Pg15* and *Pga* occurred. All the isolates produced avirulence on *Pg4*, *Pg10*, *Pg13*, *Pg16* and *PgRM* (Rosens mutant, CI 8159). Three avirulence/virulence combinations were distinguished based on their reaction on twelve oat lines.

Isolate 1 - *Pg* 4, 9, 10, 13, 16, a, RM/1, 2, 3, 8, 15
Isolate 2 - *Pg* 2, 4, 9, 10, 13, 16, RM/1, 3, 8, 15
Isolate 3 - *Pg* 4, 10, 13, 16, RM/1, 2, 3, 8, 9, 15, a

Four Indian cultures identified in 1964 could not be compared as they were lost in the past. Isolate 1 possibly resembles North American (NA) avirulence/virulence combination. NA 22 and its European equivalent E-9, while isolate-2 tallies with NA-18 and E-7 (Sebesta *et al.*, 1987). For breeding for disease resistance to stem rust of oats, genes *Pg4*, *Pg10*, *Pg13*, *Pg16* and *PgRM* are most important in India. However, the utility of *Pg4* is lost in the USA and Mexico due to the principal race NA-27 (Roelfs *et al.*, 1983) but is very effective in Europe (Sebesta *et al.*, 1987). Genes *Pg13* and *Pg16* have been most effective in both North American and European continents, but an isolate possessing virulence for *Pg13* and *Pg16* was detected from Poland (Brown *et al.*, 1985). *Pga* is also effective in Europe and Western Canada (Sebesta *et al.*, 1987).

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RACE COMPOSITION OF STEM AND LEAF RUSTS OF WHEAT IN ETHIOPIA

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SUMMARY

This work was conducted during the crop seasons of 1986 and 1987. The highest infection (up to 100%) of stem rust (Puccinia graminis f.sp. tritici) was registered in some locations of Ethiopia (Debre Zeit, Diksis, Robi and Ambo). Thirteen races 117, 40, 11, 68, 9, 234, 213, 15, 53, 121, 179, 189 and 219 have been recorded. The frequency of race 117 showed up to 58.5%.

Sixteen virulent genotypes of races 117, 40, 9, 11, 53 and 234 were determined. The effective host plant genes that provided resistance to all isolated races were Sr22 and Sr8. The most resistant wheat varieties to these common races were Enkoy, Dashen, K-6295.4A and ET-12-04.

Leaf rust (P.recondita f.sp. tritici) was observed everywhere, but the most intensive development (from 30%-100%) was registered at Ambo, Debre Zeit and Kulumsa. Races 1,3 and 6 were recorded during the crop season of 1987, the latter comprising 60.1% of the isolates.

The wheat lines Lr1, Lr2a, Lr24, Lr25 and wheat varieties Dashen, Gara and Batu from supplemental sets showed the highest level of resistance.

INTRODUCTION

Cultivation of wheat in Ethiopia covers more than 600,000 ha. In the main wheat growing regions of the country epidemics of stem and leaf rusts arise regularly. According to the data of SPL, epidemics of stem and leaf rusts were recorded 7 times in Arsi, Bale and Shewa regions in the years of study. The yield loss was also reported to reach above 30% (Sorokina et al, 1979; Dmitriev, 1984).

Breeding varieties with specific resistance (vertical resistance), i.e. resistance to certain races of fungus, has the been main part cereal breeding, from the beginning of the first information on race composition (Hoerner, 1919; Stakman

et al, 1922; Mains and Jackson, 1926; Martins et al, 1970; Rolfs et al, 1983) up to the present day. Discovering varieties with specific resistance occupies a central place in cereal breeding.

Breeding varieties with a specific resistance has demanded systematic studies of race composition of pathogens. The data allow timely evaluation of the appearance and accumulation of virulent races and enable the breeder to replace the susceptible varieties with resistant ones in due time.

In Ethiopia information on the composition of the rust population is rather limited (Sibilia, 1939; Dereje, 1973; Sorokina et al, 1979; Dmitriev, 1984; Solomatin, Temam Hussein, 1985).

Thus, studies on the dynamics of race composition and recording of the prevailing and virulent races of the pathogens have theoretical and practical value.

MATERIALS AND METHODS

The sites surveyed were experimental stations, state farms and farmers fields in Shewa and Arsi administrative regions. Stem and leaf rust uredospores were collected when the development of the disease reached a maximum during the main season in September and October. Wheat fields under irrigation were surveyed in April. Infected material of the susceptible variety Morocco was multiplied in the greenhouse under conditions favourable for the development of the pathogens.

For race identification, the standard sets of differential varieties for each rust pathogen and monogenic lines were used. Types of reaction for stem rust were determined using the scale of Stakman and Levine (Stackman & Levine 1922; Stakman et al 1962) and for leaf rust the scale of Mains and Jackson (1926), 14 days after inoculation. Registration of virulent races was carried out with the help of the Green method (Green, 1965). Disease scoring was conducted using the scale of Loegering (1959).

RESULTS AND DISCUSSION

The occurrence of stem and leaf rusts varied from 10-100% in all 34 surveyed areas of Shewa and Arsi regions during both the 1986/87 and 1987/88 crop seasons.

The highest stem rust pressure was recorded at Debre Zeit (100%), Diksis (70%), Ambo (50-80%). Leaf rust was severe at Ambo (30-100%), Debre-Zeit (60-80%) and Kulumsa (100%).

Such stem and leaf rust infection was registered mainly in bread and durum wheats like Triticum aethiopicum, which is widely cultivated by farmers.

At present, the bread wheat variety Dashen (Veery group) is widely cultivated on the state farms. This variety is resistant to leaf and stem rusts. In some epidemiological zones, stem rust has slightly affected the variety with different types of reaction (10-15MR, MS) at the mature stage during 1986/87. So uredospores collected from this variety were identified for race composition.

Races of stem rust

Analysing the infected material collected we identified thirteen races of stem rust (Tables 1 and 2), predominantly race 117 (58.5% of the isolates in 1986 and 34% in 1987). The highest number of isolates were recorded from the population of v. Dashen (Ambo, Debre Zeit). Race 40 (18.9% of the isolates) ranks second in frequency. It was observed on v. Dashen at Arsi Negele and Kulumsa Research Stations. Race 53, widespread in previous years (Dmitriev, 1984), was isolated only in the pathogen population from Ambo and Debre Zeit.

Isolates of stem rust races were distinguished by their high heterogeneity on the set monogenic lines. Every line had only one gene for resistance to the given rust. Eight genotypes of virulence for race 117 have been determined, four for race 40, three for race 9, two for race 11 and three for race 234. Effective resistance genes for race 117 were found to be Sr5, Sr8, Sr11, Sr14, Sr24, Sr25, Sr30, Tt1. Gt; race 9-Sr29; race-11-Sr5, Sr6, Sr7a, Sr7b, Sr8, Sr9b, Sr10, Sr14, Sr16, Sr22, Sr24, Sr25, Sr26, Sr27, Tt1, Tt2, Tt3, Gt; race 40 - Sr22, Sr30, Tt1, race 53 - Sr8, Sr11, Sr22 (Table 3).

Table 3 reveals that race 11 is slightly virulent. A line with gene Sr8 governed the resistance to nearly all isolated races.

The varieties Enkoy, Dashen, Gara, Batu, K-6295-4A, Et-12-04 and Kavkaz were resistant to all isolates of races 9, 11, 15, 117, 179, 219. Some isolates of races 9, 15, 40 and 117 affected Boohai, Dereseligh, Ashahan, Triticum aethiopicum with reaction type 3-4; race 11 - Boohai and Romany B C; race 213 - Enkoy, Kavkaz, K-6295-4A with the formation of small pustules with necrotic or chlorotic borders on leaves scored as reaction type 2-3.

Races of leaf rust

Three leaf rust races (1, 3 and 6) were identified with the prevalence of race 6 (60.1% of the isolates) (Table 4). Eighteen genotypes of virulence of race 6 and 11 genotypes of

race 3 have been determined. The data in Table 5 revealed that lines Lr1, Lr2a, Lr24 and Lr25 displayed resistance to all isolates of both races. Lines Lr9 and Lr19 were infected by some isolates but in most cases showed resistance to the identified races. Presence of virulence to these genes could be explained by a high speed of the formation processes, common to the side-by-side evolution of the parasite and host (Dmitriev, 1984).

From the additional set, high level of resistance was shown by v. Dashen, Gara, Batu, Kavkaz. Seedlings of Enkoy, Boohai, K-6295-4A and Et-13-2A were attacked by races of leaf rust with reaction type 3-4.

Thus, the investigations showed that the composition of stem and leaf rusts altered and acquired high development and distribution after the depression in the 1984/85 crop season. Stem rust race composition increased and new highly and slightly virulent races such as 68, 121, 179, 189, 213, 219 and 234 appeared. Depending on the altitude, races 117, 40 and 11 become more aggressive and severely attack durum wheat varieties and also slightly infect the previously resistant bread wheat variety Dashen. Therefore, it is necessary to observe the reaction of the new races on this variety as it is widely produced in some areas.

The race composition of leaf rust during the drought period of 1984/85 was 61, 62, 141, and 179 (SPL progress report of 1984/85), while races 1, 3 and 6 were the predominant ones in 1986 and 1987 crop seasons.

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Table 1. Races of wheat stem rust in 1986

Location	No of isolates analysed	Frequency of races									
		9	11	15	53	117	121	179	189	213	219
					Shewa						
Ambo (different varieties)	6	0	0	0	1	2	1	0	1	0	1
Ambo(v.Dashen)	17	2	0	1	0	9	0	1	0	0	0
Arsi Negele (v.Dashen)	4	1	2	1	0	0	0	0	0	0	0
Debre Zeit (different varieties)	10	0	0	0	0	10	0	0	0	0	0
					Arsi						
Diksis (different varieties)	4	0	0	0	0	1	0	0	0	3	0
Kulumsa (v.Dashen)	4	0	2	0	0	2	0	0	0	0	0
Total	41	3	4	2	1	24	1	1	1	3	1
%	100	9.7	12.9	6.4	3.2	58.5	3.2	3.2	3.2	9.7	3.2

Table 2. Races of wheat stem rust in 1987

Location	No of isolates analysed	Frequency of races					
		40	53	68	117	189	234
		Shewa					
Ambo	21	2	1	-	8	-	10
Deabre Zeit	15	-	3	5	6	-	1
Arsi Negele	1	1	-	-	-	-	-
		Arsi					
Kulumsa	9	-	-	4	4	1	-
Arsi Robi	7	7	-	-	-	-	-
Total	53	10	4	9	18	1	11
%	100	18.9	7.5	17.0	34.0	1.9	20.7

Table 3. Virulence formulae of wheat stem rust races

Location	Race	Effective/ineffective genes of the host plant
Ambo	9	5,6,7a,7b,9a,9b,9c,10,11,14,15,16,22,24,25, 26,27,29,30,Tt1,Tt2,Tt3,Gt/8,9d,13,21
	15	8,9a,11,21,24,25,27,29,30,Tt1/5,6,7a,7b,9b, 9d,9c,10,13,15,16,22,Tt2,Tt3
	40	9a,22,30,Tt1/5,6,7a,8,9b,9d,9c,10,11,15,16, Tt3,Gt
	53	7a,8,9b,9d,10,11,16,22/5,6,9a,15,30,Tt1,Tt3
	117	5,8,9b,11,14,22,24,25,26,27,30,Tt1,Tt2,Gt/6 7a,7b,9a,9c,10,13,15,16,29,Tt3
	117	6,7a,7b,9a,9d,9c,10,13,15,16,29,Tt3/5,9b,11, 14,22,27,30,Tt2
	121	7a,16,22,30,Tt1,Gt/6,8,9a,9d,9c,10,11,15,Tt3
	179	9b,13,14,24,25,29,30,Tt1,Tt2,Tt3,Gt/5,6,7a, 9a,10,11,16,21,22
	219	5,7a,8,9a,9b,9c,10,22,30,Tt1,Tt3,Gt/6,9d, 11,15,16
	234	5,7a,8,9a,11,16,22,30,Tt1,Gt/6,9b,9d,10,15, Tt3
Debre Zeit	53	7a,11,22,30,Gt/6,9a,9b,9d,9c,10,15,Tt3
	68	6,8,9a,9d,10,11,16,22,Tt3,Gt/5,9b,9c,15
	117	5,7a,8,22,Gt/6,9a,9c,15
Arsi Negele	9	8,9b,9c,22,26,29,Tt3,Gt/5,6,7a,7b,9a,9d,10,11 13,14,15,16,21,25,27,30,Tt1,Tt2
	11	5,6,7a,7b,8,9b,10,14,16,22,24,25,26,27,29,Tt1, Tt2,Tt3,Gt/14,15,21
	15	8,9b,14,15,25,27,29,Gt/5,6,9a,9d,9c,10,11,13, 16,21,22,24,26,Tt1,Tt2,Tt3
	40	22,30,Tt1,Tt3/5,7a,8,9b,9c,10
Diksis	213	8,9c,11,22,30,Tt3,Gt/5,6,7a,9a,9b,9d,10,15,16 Tt1
Kulumsa	11	5,6,7a,7b,8,9b,10,14,16,22,24,25,26,27,29,30, Tt1,Tt2,Tt3,Gt/9a,9d,11,13,15,21
	68	9b,9c,11,15,16,30,Tt1,Tt3/5,6,7a,8,9a,10
	117	7b,9d,14,15,16,24,25,26,29,30,Tt1/6,7a,8,9b, 10,13,27,Tt3.
Arsi Robi	40	15/5,6,7a,8,9a,9b,10,11,16,22,30,Tt1,Tt3,Gt

Table 4. Races of wheat leaf rust in 1986 and 1987

Location	No of isolates analysed	Frequency of races		
		1	3	6
Ambo	3	0	1	12
Debre Zeit	3	1	12	0
Arsi Negele	3	0	0	3
Diksis	6	0	0	6
Total	35	1	13	21
%	100	2.8	37.1	60.1

Table 5. Virulence formulae of wheat leaf rust races

Location	Race	Effective/ineffective genes of the host plant
Ambo	3	1,2a,3ka,18,19,24,25/3,9,10,12,13,14a,16,17,21
	6	1,2a,3ka,17,18,24,25/3,9,10,12,13,14a,14b,16,21
	6	9,19,21/3ka,17,18,25
Debre Zeit	3	2a,3ka,19,21,24,25/3,10,12,13,14a,14b,16,17,18
	3	9,13,16,17,18/2a,19,21
Arsi Negele	6	1,2a,13,19,24/3,10,12,14a,14b,16,17,18
Diksis	6	2a,3ka,9,19,24,25/3,10,12,13,14a,16,17,18,21,14b

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TESTING OF PAKISTANI WHEAT GERMPLASM FOR RUST

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In the 1930's A. and G.L.C. Howard made a wheat germplasm collection on the Indian subcontinent. Twenty one of these wheats (CB lines), together with 10 wheats used as commercial cultivars in Pakistan in the 1950's (C lines) were tested as seedlings and in the field for leaf rust, stem rust and stripe rust response at the Plant Breeding Institute, Castle Hill and for leaf and stem rust response in Pakistan.

Postulated genes together with field reactions for leaf rust, and stem rust are given in Table 1 and the infection types of the lines with unidentified seedling leaf rust genes are given in Table 2. A dash (-) in the respective gene postulation columns in Table 1 indicates that the line gave IT 3+ with all 10 pathotypes of P. recondita and 10 pathotypes of P. graminis used in seedling tests. The pathotype designations in Table 2 are based on race descriptions from Johnson and Levine (1955) supplemented by 8 Australian testers listed by McIntosh et al., (1981). In addition, "9" in the supplementary tester sequence indicates virulence for Lr26.

Of the older commercial wheats (C lines), C258 (30MS) and C273 (20MS) were not excessively leaf rusted in the field at Castle Hill and C591 was heterogeneous in response. CB387, CB390 and CB402 were heterogeneous in field leaf rust response at Castle Hill, and CB403 was resistant at Castle Hill and low (20MR) in Pakistan although it had no genes for seedling resistance. All CB lines tested in the field were susceptible to stem rust at Castle Hill. C256 had an unidentified gene for seedling resistance and was resistant in the field at both Castle Hill and in Pakistan.

Table 3 gives results of seedling tests with five P. striiformis pathotypes together with the field reactions to pt. 108E141A+ at Castle Hill. The seedling resistance factors were not identified using these Australian pathotypes. Most lines including C271 and CB395 with no seedling resistance, had some stripe rust resistance in the field.

Although several of these lines have seedling or adult plant resistance to stripe rust, their susceptibility to leaf and stem rust would discourage their use as parents, as would the agronomic type of the tall CB lines. The stripe rust resistance present in these lines may also be present in other material with a more suitable habit and better leaf rust and stem rust resistance.

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Table 1. Postulated seedling leaf and stem rust genes and field response in Australia and Pakistan of 29 Punjab lines.

Line	Synonyms/Parentage	Lr gene	Lr field Australia	Lr field Pakistan	Sr gene	Sr field Australia	Sr field Pakistan
C-228	PB TYPE 9D/HARD FED	-	90S	70S	-	60S	40S
C-250	PB TYPE 9D/HARD FED	-	90S	70S	-	90S	80S
C-256	PB TYPE 8B PB TYPE 9D	-	90S	80S	U	R	10R-MR
C-258	PB TYPE 8B PB TYPE 9D	-	30MS	80S	-	90S	70S
C-269	C230/NP165	-	80S	50S	-	90S	40S
C-271	C230/NP165	-	90S	50S	11*,+U	90S	40S
C-273	C951/C207	-	20MS	40S	-	50S	70S
C-518	T9 x 8A Cross 1933	-	90S	80S	-	80S	100S
C-591	T9 x 8A Cross 1934	-	40S,R	80S	-	50S	100S
CB380	Punjab Type 1	-		50S	-		50S
C383	Punjab Type 4	-		40S	-		40S
CB385	Punjab Type 6	-	90S	60S	-	80S	60S
CB386	Punjab Type 7	-		40S	-		40S
CB387	Punjab Type 8	-	80S,R,15MR	100S	-		100S
CB388	Punjab Type 9	U	90S	100S	-	60S	100S
CB389	Punjab Type 10	-	90S	80S	-	80S	80S
CB390	Punjab Type 11	U*	90S,10MR	60-90S	-	90S	70-100S
CB391	Punjab Type 12	U*	60S	40-60S	-	90S	45-90S
CB393	Punjab Type 14	-	80S	60S	-	80S	50S
CB394	Punjab Type 15	-	60S	40S	-	90S	50S
CB395	Punjab Type 16	-	70S	100S	-	100S	100S
CB396	Punjab Type 17	-	80S	40S	-	90S	40S
CB397	Punjab Type 18	U	50S	40S		50S	40S
CB399	Punjab Type 21	-	80S	70S	-	90S	80S
CB400	Punjab Type 22	-	60S	50S	-	90S	50S
CB401	Punjab Type 23	-		-	-		
CB402	Punjab Type 24	-	30M,90S	50S	-	90S	60S
CB403	Punjab Type 25	-	R	20MR	-	90S	70S

* = heterogeneous
U = unidentified seedling genes
- = no seedling resistance

Table 2. Infection types of Punjab lines with 10 *P. recondita tritici* isolates.

	PATHOTYPE									
	1	2	3	4	5	6	7	8	9	10
LINE										
C-271	3+,;	3+,0;	X++3+	3+	3+	X++3+	3+,X+	;33+C	;3+	3+
CB388	33+	3+	3+	3+	;3+	X++	33+	X++3+	X-X	23=
CB390	;3+,X	3+	3+	3+	;3+	;3+	3+	;3+	X-X,3+	33+
CB391	X++3+	3+	;3+,X+3	3+	;3+	;3+	3+	;X+3+	X-,3+	2,3-,3
CB397	33+	3+	3+	X,3+	3+	3+	3+	3+	33+	33+

Pathotypes :
1 = 162- 1,2,3,4
2 = 104- 2,3,6,9
3 = 104- 2,3,6,7
4 = 76- 2,3,(6)
5 = 10- 1,2,3,4
6 = 26- 1,3
7 = 68- 2,3
8 = 76- 0
9 = 122- 2,3,4
10 = 135- 1,2,3,4,5

Table 3. Seedling infection types produced by *P. striiformis tritici* pathotypes and adult plant field responses in Australia for 31 Punjab wheats.

LINE	104E137A-	104E137A+	108E141A+	108E141A-	110E143A+	Field
C-228	3+,;	;3, ;	;,2,3	3+, ;/3	3+, ;/3	
C-250	;/12	23N	;13	23/3, 23/;	23C	5R
C-256	2	2	;C	23	4	25R
C-258	;N/3, 3+	3	2	2+	2/3+	15R
C-269	;1/3	12	;12	;2	;/23	25R
C-271	3+	3+	3+	33+	3 +	15R
C-273	;	;	;	;	;	15R
C-288	;12, 0;	;1	;2	;2,;	23	5R
C-518	3+	3+	3+	3+	3+	
C-591	;	;	;	;	;	20R
CB380	3+	3+	3+	3+	3+	
CB381	3+	3+	3+	3+	3+	
CB382	3+	3+	3+	3+	3+	
CB383	;/3	;/3	3	;/3	2/3	
CB384	;	;	;3	; , ;/3	;	
CB385	; , 2	;	;,23	1/3	;/3 , 3	
CB386	23-,1,3+	12	12	3C		
CB387	3	3	3	3	3	40MR
CB388	;/2	;/2	; , ;/2	; , ;/2	;/2	15R
CB389	4	3+	3+	4	4	70S
CB390	;	;	;	;	;/2	10R
CB391	;	;	;	;	;/2-	TR
CB393	0;	0;	0;	;	;	TR
CB394	3+	3+	3+	3+	3+	15R
CB395	3+	3+	3+	3+	3+	60S
CB396	2+	2+	;,2+	2+	2+	20R/MR
CB399	2+	2+	2+	2+	2+	15R
CB400	3	3	3	3	3	50MS
CB401	;,3	;,3	;,3+	;,3+	;,3	50MS
CB402	;/3	;/3	;/3	;/3C	;/3	40MS
CB403	;/3	;,3	;/12 , 3	;/3	;/2	30MS

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ASEPTIC CULTURE OF PUCCINIA GRAMINIS ON LEAF EXPLANTS OF ITS BERBERIS HOST

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ABSTRACT

Barberry bushes (Berberis vulgaris) were inoculated with Puccinia graminis by exposing them to quackgrass (Agropyron repens) straw laden with telia. Infected leaf pieces placed on Gamborg's B-5 medium produced pycnia, a dense layer of mycelium covered with aerial hyphae, and in some cases, aecia. Monokaryotic hyphae were observed in samples of aerial mycelium stained with mithramycin and examined using epi-fluorescent microscopy. One mycelial colony excised from the host tissue and transferred to a medium containing Czapek's minerals, Evan's peptone and casamino acids was growing after 4 weeks.

INTRODUCTION

The worldwide importance of the stem rusts of cereals has led to interest in the study of the metabolism and genetics of the causal organism, Puccinia graminis Pers. These studies are impeded by the inability to culture the monokaryotic phase of the pathogen. Three basic approaches to overcoming this problem have been utilised with obligate plant pathogenic fungi: 1) maintaining callus cultures of the host infected with the pathogen; 2) excising fungal tissue growing external to host tissue and placing it on a medium capable of supporting axenic growth, and 3) seeding spores directly on a medium designed to support axenic growth.

A number of rusts have been maintained in callus cultures of the host, including Puccinia helianthi (9), Cronartium ribicola (6), and Melampsora lini (11). Axenic cultures have been generated from co-cultured rusts in the case of Puccinia coronata (1), Pucciniastrum agrimoniae, P. boehmeriae, and P. coryli (13). The monokaryotic stage of Gymnosporangium asiaticum was cultured from pear leaves which harboured spermagonia (12). When placed on an appropriate medium, the fungus grew out onto the substrate. Successful axenic cultures were then established by transferring the mycelium growing out onto the substrate to a complex medium.

The successful co-culture of other rust fungi suggested that this method might be suitable for the culture of the monokaryotic stage of Puccinia graminis Pers., which infects the common barberry, Berberis vulgaris L. The objective of this study was to develop a technique for establishing barberry callus cultures infected with P. graminis.

MATERIALS AND METHODS

Small barberry plants maintained in the greenhouse were used as the source of explants. Plants to be inoculated were placed in a translucent plastic enclosure over a pan of standing water. Quackgrass straw (Agropyron repens (L.) Beauv.) bearing telia of P. graminis (probably f. sp. secalis based on the host) which had been collected in Lime, Wisconsin in May of 1980 and stored at -5°C, was used as a source of inoculum. After removal from storage, the straw was soaked for 1 hr in water initially at 30°C and suspended directly above the barberry plants on a 1 cm mesh screen. The plants were kept in the enclosures at 18-22°C under low intensity light for 4-6 days. The plants, sides of the enclosure, and straw were misted several times daily with tap water.

Young infected leaves were removed near the base of the petiole with a pair of scissors. The leaves were surface sterilized with a 0.5% solution of sodium hypochlorite buffered to a pH of 6.0-6.3 with K_2HPO_4; rinsed in three 400 ml changes of sterilized, distilled water; blotted on sterilized filter paper; and cut into irregularly shaped pieces approximately 1 cm^2.

Leaf explants were cultured on plastic petri plates sealed with two layers of Parafilm-M and containing Gamborg's B-5 medium (4). The medium consists of: $(NH_4)_2SO_4$, 134.000 mg; H_3BO_3, 3.000 mg; $CaCl_2 \cdot 2H_2O$, 150.000 mg; $CoCl_2 \cdot 6H_2O$, 0.025 mg; $CuSo_4 \cdot 5H_2O$, 0.025 mg; $FeSO_4 \cdot 7H_2O$, 27.800 mg; $MgSO_4 \cdot 7H_2O$, 250.000 mg; $MnSO_4 \cdot H_2O$, 10.000 mg: KI, 0.750 mg; KNO_3, 2500,000 mg; Na_2EDTA, 37.300 mg; $(Na_2MoO_4) \cdot 2H_2O$, 0.250 mg; $NaH_2PO_4 \cdot H_2O$, 150.000 mg; $ZnSO_4 \cdot 7H_2O$, 2.000 mg; i-inositol, 100.000 mg; nicotinic acid, 1.000 mg; pyridoxine HCl, 1.000 mg; thiamine HCl, 10.000 mg; bactoagar, 6.0 g; sucrose, 20.0 g; 2,4-D, 0.5 mg; kinetin, 1.0 mg; and distilled water to make 1.0 litre. The pH of the medium was adjusted to 5.75 with 1 N HCl or 1 N NaOH before autoclaving at 121°C for 20 min. The plates were incubated at 22-24°C under low intensity light provided by soft white fluroescent bulbs. The diurnal cycle consisted of 16 hr of light followed by 8 hr of darkness. An attempt was made to raise the relative humidity of the incubation chamber by placing an open pan of water containing a 250 cm^2 cheesecloth wick in the chamber. The cultures were transferred to fresh medium every 14-28 days.

Axenic cultures were initiated by carefully excising mycelial colonies from the explants and removing the surrounding host tissue. The host tissue supporting the colony was readily removed by inserting a scalpel at the edge of the leaf tissue and flaking it away. Three colonies prepared in this fashion were transferred to a plastic petri plate containing 30 ml of a medium developed for axenic culture from urediospores of P. graminis f. sp. tritici (3). This medium consists of Czapek's mineral salts, 3% glucose, 1.5% agar, 0.4% Evan's peptone, and 0.4% technical grade casamino acids. The medium was adjusted to pH 6 with concentrated HCl prior to autoclaving for 20-25 min. These cultures were incubated under conditions identical to those for the infected explants with the exception that the temperature was reduced to 18.5 to 19.5°C.

Bright-field and epi-fluorescent microscopy were used to examine four fungal colonies. The specimens were prepared after the method of Anikster (2) by fixing them for at least 15 min in 5% glutaraldehyde in a 0.05 M phosphate buffer (pH 7), followed by immersion for at least 15 min in a solution containing 100 $ug.ml^{-1}$ mithramycin and 15 mM $MgCl_2$. Three of the samples were mounted by simply cuting off a portion of the colony, teasing it apart, and squash mounting it in glycerine under a cover glass. The final specimen was prepared by making a free hand section parallel to the leaf surface through the centre of a colony approximately 1 mm thick and measuring 2 mm in diameter. Two slivers perpendicular to the leaf surface were then cut from this section; one sliver was carefully squash mounted and the other was cut into 4 sections parallel to the leaf surface.

RESULTS

Callus tissue was evident along the cut edges of uninoculated leaf pieces within 14 days of being placed on the medium. Two types of callus tissue developed: a dense, chlorophyllous callus and a loose callus made up of very large, hyaline cells. After 4-6 weeks, calli attained a diameter of up to 7-8 mm. When excised from the surrounding leaf tissue and transferred to fresh medium, the calli generally stopped growing and became necrotic, although limited growth was exhibited in a few instances.

Pycnia and white aerial mycelium were evident 2-3 days after placing inoculated explants on the B-5 meidum (8 days after initial exposure of the barberry plants to telia). Pale grey-green, semi-translucent drops which may have been pycniospore-bearing honey dew were exuded from a number of pycnia. In some cases, clusters of bright yellow discs approximately 1 mm in diameter were observed.

Aerial mycelium developed on explants derived from 6 of the 8 plants which had been inoculated. One plant provided 14 uncontaminated leaf segments from which exceptional colonies emerged -- as large as 6-7 mm in diameter and at least 2 mm thick. Free hand sections of one such colony revealed that a dense, white mass of hyphae had formed on the leaf surface. There was no evidence of host cell proliferation on the upper leaf surface. The distortion of the host tissue into a dome under the mycelial mat suggested localized hypertrophy.

In a few instances, small calli bearing aerial hyphae were observed. Several of these infected calli were excised from the surrounding host tissue and transferred to fresh B-5 medium. None of these calli showed signs of growth after 4 wks.

Two of the three mycelial masses excised from the host tissue and placed in axenic culture appeared to be viable. Bare patches on the surface of the larger mycelial mass (3-4 mm in diameter) had become covered with aerial mycelium after 21 days. At 35 days, the diameter of the colony had increased and the area of contact between the compact mycelium and the medium had expanded. This colony turned light orange after being transferred to the axenic medium; at first this was thought to indicate necrosis, but the colony continued to develop. A second smaller colony (less than 2 mm in diameter) appeared healthy and had increased in size during the 35 day observation period.

Four of the explants developed aecia, the first one appeared within 20 days of first exposing the barberry plants to telia. In one case, two non-contiguous colonies on the same explant both developed aecia. The aecia appeared on the outer surface of the mycelial mats although aecia developing on the lower leaf surface may have escaped detection. The chains of bright yellow aeciospores were borne in aecidioid aecia, characteristic of P. graminis (8).

In order to determine whether the hyphae were mono- or dikaryotic, four colonies were stained with mithramycin and examined under epi-fluorescent illumination. Unpaired nuclei were observed in all the specimens studies. In several instances, a single nucleus was delimited by a septum at the terminal end of a hypha.

DISCUSSION

The supposition that the aerial hyphae and mycelial mats are P. graminis is supported by the consistent association of the aerial mycelium with pycnia as well as the emergence of aecia from the surface of the mycelial mats.

The formation of aecia poses the question of how fertilisation took place given that there was no apparent means for moving pycniospores from one pycnium to the receptive hyphae of another. In a review of the dikaryotization process in the cereal rusts, Harder (5) describes two mechanisms of interest; a) fusion of (+) and (-) basidiospore-derived hyphae, and b) fusion of pycniospores with flexuous hyphae of the opposite mating type. Littlefield and Heath (8) offered another possibility; c) fusion of pycniospores of the opposite mating type. The first mechanism, if functional in this situation, would most readily account for the number of aecia formed since adjacent colonies expanded into each other on a number of occasions. The second two mechanisms require either that a pycnium grew into contact with a drop of compatible nectar or that a drop of nectar reached compatible receptive hyphae under the influence of gravity. Either event seems possible although nectar may be so viscous as to preclude significant movement.

Several applications are suggested by the results obtained in this study. One problem encountered when making sexual crosses on the barberry bush is establishing that accidential fertilisations have not occurred (10). This difficulty might be overcome by isolating single infection sites under aseptic conditions. Rust infected explants surface sterilized before rupture of the epidermis could also serve as a source of aseptic pycniospores. Finally, the potential for initiating axenic cultures of a monokaryotic thallus may facilitate metabolic and genetic studies of the fungus.

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VIRULENCE SURVEY OF YELLOW RUST OF WHEAT (PUCCINIA STRIIFORMIS F.SP. TRITICI) AND BARLEY (P.STRIIFORMIS F.SP. HORDEI) DURING 1985-87

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SUMMARY

During the cropping seasons 1985-87, 181 samples of Puccinia striiformis f.sp tritici and 54 of P.striiformis f.sp hordei were evaluated for virulence identification. These samples were from various states of India. Race I(38S102) was dominant in Tamil Nadu and K(47S102) in North West India. Other races such as 13(67S8), 31(67S64), 14(66S0), 14A(66S64), A(70S4) and 38A(66S64-1) were also identified. In the case of barley yellow rust, races G(4S0), 24(0S0-1) and 57(0S0) were monitored. The genes Yr3b + Yr4b, Yr9 and Yr10 maintained their immunity against the prevalent spectrum of wheat yellow rust races. The utility of Yr3a + Yr4a, another previously immune gene, decreased due to its susceptibility to a widely spreading race K(47S102).

INTRODUCTION

Yellow rust is the main yield constraint of wheat and barley in the cooler parts of North West India and the Nilgiri hills of Tamil Nadu. The pathogen spectrum has been continuously monitored in the past (Bahadur, 1986). With the same objective, 181 isolates of wheat yellow rust and 54 of barley yellow rust were evaluated for their pathogenicity during 1985, 1986 and 1987. Such surveys help in keeping a constant watch on the frequency and evolution of the pathogen, as well as enabling better exploitation of the resistance genes.

MATERIALS AND METHODS

Samples of wheat and barley yellow rust were received from cooperators or were collected from farmers' fields. Samples were inoculated onto their respective susceptible hosts (ie. Kathia local and Barley local) to multiply uredospores and get enough dustings for inoculating differentials. Fresh uredospores available after 15-20 days were inoculated onto week

old seedlings of differential sets. A free film of water was created by spraying the seedlings with fine mist. Each set was then kept in a moist chamber for 48 hours and later transferred to the glasshouse. On full expression of reactions, virulences were identified following Nagarajan et al., (1985). To assess the performance of various genes/lines (differential sets A and B) against the prevailing pathogen population, the percentage of virulent and avirulent isolates on each gene/line was worked out.

RESULTS AND DISCUSSION

Results of virulence surveys conducted during 1985-87 are given in Table 1. In 1985 all the samples from Nilgiri Hills in Tamil Nadu yielded race I(38S102). This race was also detectable throughout North India in a low proportion compared to the dominant race K(47S102). During the years 1986 and 1987, the pathogen spectrum did not exhibit any change in the Nilgiris. Such a dominance of race I(38S102) has also been reported during the earlier years (Bahadur et al.,1982; Nagarajan et al.,1986b). It appears that this race has been dominating the rust flora of Nilgiris for nearly a decade.

A wide spectrum of races was identified from North West India during 1986 and 1987. The majority of the samples analysed during both years were of races K(47S102), 14A(66S64), A(70S4), 31(67S64), 14(66S0), 20A(70S64) and 13(67S8). During the years under report, the dominance of K(47S102) over North West India was in accordance with the expectations of Nagarajan et al., (1984) who described it as a "potential threat" to wheat cultivation. The wheat breeding programme in North West India must therefore be directed towards achieving resistance to race K(47S102) as the percentage of isolates yielding this race is rapidly increasing.

Races A(70S4), 31(67S64), 14(66S0), 14A(66S64) and 38A(66S64-1) which were widespread in the past (Bahadur, 1986 and Nagarajan et al., 1986b) declined during the present survey. Race 20(70S0) earlier reported to be declining in North West India (Nagarajan et al., 1986b) was now below the detectable level.

The percentage effectiveness of the various Yr genes in conferring resistance to the field isolates received for analysis is shown in Table 2. It clearly indicates that the efficiency of these genes differ markedly. What is most important is to keep a continuous watch on the effectiveness of these genes to see whether or not the isolates matching them increase in frequency. This has happened with race K(47S102) which increased from 15-21% frequency during 1981-83 (Nagarajan et al., 1984) to 50% during 1985-87 in North West India.

Table 2 indicates that Yr3b + Yr4b, Yr9 and Yr10 confer complete resistance against the present spectrum of yellow rust races detected over North West India and Nilgiri hills. Yr1 was matched by 75.49% isolates in North West India and thus is practically of no use for the breeders. However, in combination with other genes it can be used as a resistance source in South India, being susceptible to a single race I(38S102). Yr3a + Yr4a being susceptible to a single race K(47S102) can still give the necessary level of resistance and can be used in areas where K(47S102) does not occur. The present information on the utility of Yr genes is consistent with earlier reports (Nagarajan et al., 1986b). Another gene Yr5 (Triticum) spelta var. album) available in Khapli wheats can also be exploited appropriately as only race 13(67S8) infects it (Nagarajan, et al., 1986a).

No practical generalisation could be made on the 54 isolates (Table 1) of P.striiformis f.sp hordei belonging to races G(4S0), 24(0S0-1) and 57(0S0) (Bahadur et al. 1982; Singh et al., 1979).

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Table 1 Results of virulence survey of the yellow rust pathogen conducted during 1985-1987

Year	State	*Puccinia striiformis* f.sp *tritici*											*P.striiformis* f.sp *hordei*			Total
	Virulence	A	I	K	13	14	14A	20	20A	31	38	38A	G	24	57	
		70S40	38S102	47S8	67S8	66S0	66S64	70S0	70S64	67S64	66S0-1	66S64-1	4S0	0S0-1	0S0	
1985	Himachal Pradesh	–	1	6	–	–	–	–	–	–	–	–	1	8	–	16
	Punjab	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
	Tamil Nadu	–	25	–	–	–	–	–	–	–	–	–	–	–	–	25
	Total	–	27	6	–	–	–	–	–	–	–	–	1	8	–	42
1986	Himachal Pradesh	–	1	28	–	–	1	–	1	–	–	1	6	9	3	50
	Punjab	–	–	–	–	–	–	–	2	–	–	–	–	–	–	2
	Uttar Pradesh	–	–	–	1	1	1	–	–	–	–	–	–	–	–	3
	Tamil Nadu	–	3	–	–	–	–	–	–	–	–	–	1	–	–	4
	Total	–	4	28	1	1	2	–	3	–	–	1	7	9	3	59
1987	Himachal Pradesh	5	–	59	1	5	10	–	–	–	1	–	8	16	2	107
	Haryana	–	–	3	–	–	–	–	–	–	–	–	–	–	–	3
	Punjab	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2
	Rajasthan	–	–	2	–	–	–	–	–	–	–	–	–	–	–	2
	Uttar Pradesh	2	–	4	–	–	5	–	–	–	6	–	–	–	–	17
	Tamil Nadu	–	3	–	–	–	–	–	–	–	–	–	–	–	–	3
	Total	7	3	70	1	5	15	–	–	–	7	–	8	16	2	134
Grand Total		7	34	104	2	6	17	–	3	–	7	1	16	33	5	235

Table 2 Reaction of differential cultivars/Yr genes to yellow rust isolates analysed during 1985-87.

Differential cultivar	Gene	Virulent isolates (%)		Avirulent isolates (%)	
		West North India	Nilgiris	North West India	Nilgiris
Chinese 166	Yr1	75.49	0	24.50	100
Heines VII	Yr2	71.52	100	28.47	0
Vilmorin	Yr3a+Yr4a	69.53	0	30.46	100
Hybrid 46	Yr3b+Yr4b	0	0	100	100
Triticum spelta var. album	Yr5	1.32	0	98.67	100
Heines Kolben	Yr6	84	100	15.66	0
Lee	Yr7	100	100	0	0
Compair	Yr8	80.79	100	19.20	0
Riebesel-47/51	Yr9	0	0	100	100
Moro	Yr10	0	0	100	100
Sonalika	Yr2	71.52	100	28.47	0
Strubes Dickkopf	Yr (strubes Dickkopf	71.52	100	28.47	0
Kalyansona	Yr (KS)	90.66	100	9.33	0
Suwon 92xOmar	-	28	0	72	100

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RUST RESISTANCE GENES IN CZECHOSLOVAK WHEATS.

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In the Czechoslovak registered wheats the most common genes for rust resistance are those carried by 1B/1R translocation, i.e. Sr31, Lr26 and Yr9. Of the stem rust resistance genes, Sr29, Sr11, Sr5, probably Sr6 and several undetermined genes also occur. Of the leaf rust resistance genes, Lr3 and several undetermined genes are present in addition to Lr26. Yellow rust resistance in many cultivars is of the adult plant type. Of specific resistance genes, Yr 1,2,3a+4a and several undetermined genes, as well as resistance of Heine IV, Carsten V, Suwon 92 and Siete Cerros type occur in registered cultivars in addition to Yr9, either alone or in various combinations (Table 1).

In the stem rust population virulence on Sr5 prevailed in the last decade (over 90% of isolates). Races 11 and 34 were the most frequent. Of races avirulent on Sr5 (less than 10% of isolates), races 14 and 21 prevailed. Most isolates were virulent on Sr6, whereas virulence on Sr11 was sporadic. In the leaf rust population over 60% of isolates were virulent on Lr26, represented mainly by race 77 SaBa until 1980, later on by race 61 SaBa and 14 SaBa. The smaller part of the population was represented by the same races avirulent on Lr26 (i.e. 77,61,14). No virulence on Lr19 was found. Virulence on Lr9 was sporadic (Table 2).

New sources of resistance to rusts and powdery mildew have been developed using a resistant Triticum monococcum strain from Gatersleben (GDR). Provisional designations of the resistance genes that have been transferred into the hexaploid winter wheat cultivar Yubileynaya 50 and the spring wheat cultivar Zlatka, as well as effectiveness of the resistance genes to Czechoslovak isolates of rusts and mildew are summarized in Table 3. The method of triploid bridge was used for the transfer of resistance genes (Table 4). Genes $SrTm_2$, $LrTm_1$ and $PmTm_1$ are new genes. $LrTm_1$ has been located on the wheat chromosome 3A.

Table 1.

Genes for rust resistance in registered wheats

Cultivar	Genes Sr	Lr	Yr
Agra	31, +	3,26	9, Ad
Branka	31	3,26,+	9, Ad
Danubia	31,(+?)	26,+	9
Hana	29	3	2
Hela	29	-	Ad
Iris	31,11,6?	26	9
Kosutka	+	+	+
Mara	29	3	Ad
Mironovska 808	Tmp	3	Ad
Odra	-	3	2,+
Regina	-	-	1,2,H IV.
Roxana	31	26,+	9,+
Sabina	31	26	9, CV
Selekta	31	26	9, Ad
Slavia	29	-	2
Sparta	31	26,3	9, Ad
Vala	29	-	Ad
Viginta	5, +	3	2,3a+4a
Zdar	+	-	3a+4a, CV
Spring wheats			
Jara	+	-	Suwon 92
Sandra	+	+	Siete Cerros
Sylva	11,+	+	Siete Cerros

Yr Genes postulated according to the results by:
R.Johnson (PBI Cambridge) and R W Stubbs (IPO Wageningen)
Ad. = Adult plant resistance
H IV = Heine IV
C V = Carsten V

Table 2.

Wheat stem and leaf rust races

Stem rust

Year	Races (%)							
	virulent on Sr5				avirulent on Sr5			
	34	11	other	total	14	21	other	total
1977	54	33	3	90	6	4	-	10
78	40	47	-	87	2	11	-	13
79	20	17	47	84	-	3	13	16
80	46	42	-	88	-	-	12	12
81	87	8	-	95	5	-	-	5
82	23	77	-	100	-	-	-	0
83	60	40	-	100	-	-	-	0
84	71	26	-	97	-	-	3	3
85	20	60	10	90	-	-	10	10
86	24	20	48	92	8	-	-	8
87	16	84	-	100	-	-	-	0

Most isolates were virulent on Sr6
Virulence on Sr11 was sporadic

Leaf rust

Year	Races (%)										
	virulent on Lr 26						avirulent on Lr 26				
	77 SaBa	61 SaBa	14 SaBa	53 SaBa	other SaBa	total	77	61	14	other	total
1977	70	-	-	-	-	70	4	15	11	-	30
78	66	4	-	-	-	70	4	11	11	4	30
79	31	3	-	-	-	34	17	6	9	34	66
80	25	14	-	-	-	39	-	61	-	-	61
81	12	30	-	-	-	42	-	52	-	6	58
82	-	46	-	-	-	46	-	35	6	13	54
83	-	49	3	-	-	52	-	34	14	-	48
84	4	67	-	-	1	72	-	20	5	3	28
85	4	30	3	-	16	53	-	23	4	20	47
86	6	39	11	-	16	72	2	14	11	1	28
87	8	24	6	19	21	78	2	13	7	-	22

No virulence on Lr19 was found
Virulence on Lr9 was sporadic

Table 3.

New sources of resistance derived from T.monococcum

Provisional Designation		Effectiveness
$LrTm_1$	chromosome 3A	All isolates
$SrTm_1$	= Sr35	Most isolates
$SrTm_2$		Some isolates
$PmTm_1$		All isolates

Table 4.
Transfer of leaf rust resistance from T.monococcum

Year	♀		♂
1978	T.durum 3574 (28)	x	T.monococcum 1995/9 (14)
1979	F_1 (21)	x	T.durum 3574 (28)
1980	BC_1 (28-29)	x	T.aestivum Chinese Spring (42)
1981	F_1' (35-36)	x	T.aestivum Chinese Spring (42)
1982	BC_1' (38)	x	T.aestivum Zlatka, Jubilejná (42)
	BC_2' (40-41)	x	T.aestivum Zlatka, Jubilejná (42)
1983	BC_3' TMR/ (42)	x	T.aestivum Zlatka, Jubilejná (42)
	BC_4' (42)		
1984	S_1BC_4' (42)		
1985	S_2BC_4' (42)		
1986	S_3BC_4' (42)		

PREPARATION OF PAPERS FOR PUBLICATION IN THE CEREAL RUSTS AND POWDERY MILDEWS BULLETIN

1) All types of papers on cereal rusts and powdery mildews are acceptable, including variability of the pathogens, genetical and physiological studies and breeding for resistance. Papers may be of standard form or as letters and short notes on any relevant subject including the occurrence of epidemics and evolution of new races.

2) Papers should be typed double-spaced on A4 (the same size as the Bulletin) or similar sized sheets and have a 3cm margin at the top, bottom and both sides.

3) It is especially important for Tables to be presented so that they can easily be fitted to an A4 sheet. They must have a 3cm margin all round, and not have so much on that they cannot be copied into the format for the journal.

4) Figures must be presented in photo-ready condition.

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6) In future the length of papers must not exceed 12 pages including all tables, figures and references, but should preferably be shorter. The 12 pages will be measured at single spaced typing.

7) Most papers are accepted for publication, but the editor retains the right to reject papers that are of poor quality or too long.

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