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CONTENTS

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LEAF RUST ON WHEAT IN BULGARIA FOR THE PERIOD 1979-1980

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Rusts on cereals occur every year and depending on their severity they may considerably reduce wheat yields.

From the economic point of view, leaf rust, Puccinia recondita is the most important disease on wheat in Bulgaria. Breeding, directed at developing resistant varieties is closely associated with the investigation of the leaf rust race composition. Changes of varietal pattern and the introduction of resistant wheat varieties induce changes in the frequency of distribution of races.

In addition to the basic differential varieties: Malakoff, Carina, Brevit, Webster, Loros, Mediterranean, Hussar and Democrat, the differential varieties 76v, 57b, 234, Aurora, Dimitrovka 5-12 and 5517-A5-5-I, were also included.

For the purposes of the genetic differentiation, monogenic lines carrying the following genes for resistance were used.

Lr I (Thatcher^6 x Centenario)

Lr 2a (Thatcher^6 x Webster)

Lr 2d (Prelude^6 x Loros)

Lr 3 (Thatcher^6 x Democrat)

Lr 9 (Transfer x Thatcher Rl 6010)

Lr 10 (Thatcher^6 x Exchange CLR I-3)

Lr 12 (Thatcher^6 x Exchange)

Lr 13 (Thatcher^6 x Frontana)

Lr 16 (Thatcher^6 x Exchange CLR II-2)

Lr 17 (Klein Lucaro x Thatcher^6)

Lr 18 (Thatcher^7 x Africa 43)

Lr 19 (Thatcher^7 x Agropyron elongatum RL 6040)

Lr 23 (Lee 130 x Thatcher RL 6012)

Lr 24 (Agent)

Studies carried out in Bulgaria (Donchev, 1964) established that the most widely spread races for the period 1959-1962 were races 13, 77, 20, 122. Recent results show considerable increase of race 77, reaching 87.96% frequency in 1977 (Gospodinova, 1980).

During the period 1979-1980 (Table 1), 13 physiological races were identified: 12, 21, 54, 57, 58, 61, 77, 84, 122, 130, 14 167, 176.

The most common races in 1979 were race 77, (40.96%), race 21 (23.82%), race 58 (10.47%) and race 176, (4.76%). The rest of the races were of little importance.

In 1980 race 77 had declined to a frequency of 28.26%, race 21 had increased slightly to 26.63%, whereas race 167 had increased significantly to a frequency of 10.87%. The rest of the races played a minor part in race diversity.

The high incidence of race 77 was due to the appearance of virulent biotypes capable of attacking Aurora and Caucas, important wheat varieties in Bulgaria until 1976. After the removal of these varieties from production in 1976 the incidence of race 77 declined from 87.85% in 1977 to 28.26% in 1980 (Table 2).

The frequency of races 58 and 176 also increased. Some virulent biotypes damaging Bezostaya I were identified and as Bezostaya I is a parent of many new Bulgarian varieties, a much higher incidence of those races may be expected in the next few years (Gospodinova, 1980).

Eight biotypes of race 21 were identified in 1979 and 1980, 13 biotypes of races 77 in 1979 and 15 biotypes of the same race in 1980, 5 biotypes of race 122 in 1980 and 2 biotypes each of races 167 and 176.

All studies in 1979 aimed at determining the genetic differentiation (Table 3) based on Lr genes showed that of greatest frequency of occurrence was the genetic formula 9,19,23/I,2a,2d,3,16,17,18,24,12,13 (25.71%), followed by the genetic formulae 1,9,19,23/2a,2d,3,12,13,16,17,18,24 (20%) and 9,10,16,19,23/2a,2d,3,12,13,17,18,23(11.43%).

In 1980 of greatest frequency of occurrence was the genetic formula 1,9,19,23/2a,2d,3,10,12,13,16,17,18,24 (29.71%); followed by the genetic formulae 9,19,23/I,2a,2d,3,10,12,13,16,17,18,24, (25.40%); 9,10,19,23/1,2a,2d,3,12,13,16,17,18,24 (24.85%) and 9,18,19,23/I,2a,2d,3,10,12,13,16,17,24 (9.73%).

The other gene races are of insignificant frequency of occurrence. When comparing data in Table 3 it can be established that this method of differentiating the pathogen reflects the changes in population of leaf rust. The same Table presents a list of the races and the corresponding genetic formulae of virulence. A given genetic formula may correspond to different races and vice versa a race may have different genetic formulae.

The monogenic lines (Table 4) Lr 9 and Lr 19 are completely effective against all races in Bulgaria, the monogenic line Lr 23 is highly effective. The monogenic lines Lr 1, Lr 10 and Lr 18 are partly effective, and monogenic lines Lr 2a, Lr 2d, Lr 3, Lr 16 and Lr 17 are non-effective.

Most of the monogenic lines are highly effective in Canada and the USA and have low effectiveness or are non-effective in Europe and some countries in Asia and Africa (Boskovic, 1974).

CONCLUSION

1. The studies carried out in 1979-1980 have proved that of hignest incidence for both the years are races 77 and 21.

2. Monogenic lines Lr 9 and Lr 19 are completely resistant and line Lr 23 is of high resistance Lr 10, Lr 1 and Lr 18 are less effective.

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GOSPODINOVA F. - Racial and genetic differentation of wheat brown rust (Puccinia recondita Prob ex Desm. f.sp. tritici Erikss) in Bulgaria for the period 1977-1978 - Plant Science, vol XVII, No 4, 1980.

TABLE 1: Races of leaf rust in 1979-1980

Race	1979 Number of isolates	Percentage frequency	1980 Number of isolates	Percentage frequency
	Detected races			
1. 12	3	2.86	-	-
2. 21	25	23.82	49	26.63
3. 54	2	1.90	2	1.09
4. 47	2	1.90	-	-
5. 58	11	10.47	8	4.35
6. 61	3	2.86	1	0.54
7. 77	43	40.96	52	28.26
8. 84	4	3.81	1	0.54
9. 122	4	3.81	14	7.61
10. 130	1	0.95	1	0.59
11. 143	1	0.95	-	-
12. 149	1	0.95	1	0.54
13. 176	5	4.76	35	19.02
14. 167	-	-	20	10.87
TOTAL	104		184	

TABLE 2: Incidence of race 77 in Bulgaria 1977-1980

Year	Incidence (%)
1977	87.85
1978	45.96
1979	40.96
1980	28.26

TABLE 3: Gene races of leaf rust in 1979-1980

	Gene Formula	1979 Frequence of Occurrence %	Standard Race	1980 Frequence of Occurrence %	Standard race
1	1,2a,9,16,19,23,24/2d,3,10,12,13,17,18	2.86	12	-	-
2	1,2a,9,19,23/2d,3,10,12,13,16,17,18,24	2.86	84	0,54	58
3	1,9,19,23/2a,2d,3,10,12,13,16,17,18,24	20.00	57,58,61 143,176	29.73	51,61,167 176
4	1,9,10,19,23/2a,2d,3,12,13,16,17,18,24	-	-	1.62	84,167, 176
5	1,9,10,18,19,23/2a,2d,3,12,13,16,17,24	-	-	0.54	176
6	1,9,18,19,23/2a,2d,3,10,12,13,16,17,24	-	-	0.54	176
7	1,9,18,19,23,24/2a,2d,3,10,12,13,16,17	-	-	0.54	167
8	9,19/1,2a,2d,3,10,12,13,16,17,18,23,24	5.71	77	-	-
9	9,10,19/I,2a,2d,3,12,13,16,17,18,23,24	-	-	0.54	21
10	9,10,19,23/1,2a,2d,3,12,13,16,17,18,24	8.57	54,21, 122	24.86	21,54,77, 122,130,149
11	9,10,16,18,19,23,24/1,2a,2d,3,12,13,17	2.86	77	-	-
12	9,10,16,17,19,23/1,2a,2d,3,12,13,18,24	2.86	77	-	-
13	9,10,16,17,18,19,23,24/1,2a,2d,3,12,13	5.71	77	-	-
14	9,10,16,19,23,24/1,2a,2d,3,12,13,17,18	8.57	77	-	-
15	9,19,23,24/1,2a,2d,3,10,12,13,16,17,18	2.86	77	1.08	21,77
16	9,10,16,19,23/1,2a,2d,3,12,13,17,18,24	11.43	21	1.62	21,77
17	9,19,23/1,2a,2d,3,10,12,13,16,17,18,24	25.71	21,77,122 130,149	25.40	21,54,77 122
18	9,19,23/1,2a,2d,3,10,12,13,16,17,18,24	25.71	21,77,122 130,149	25.40	21,54,77, 122
19	9,10,16,18,19,23/1,2a,2d,3,12,13,17,24	-	-	1.08	77
20	9,18,19,23,24/1,2a,2d,3,10,12,13,16,17	-	-	0.54	77
21	9,10,18,19,23/1,2a,2d,3,12,13,16,17,24	-	-	1.62	21

TABLE 4: Effectiveness of some genes in different parts of the world

Lr genes	Effectiveness (%)			
	Canada	USA	Europe and some countries in Asia and Africa	1979-1980 Bulgaria
Lr 1	93.5	65.4	2.8	31.2
Lr 2A	97.6	82.7	3.7	2.8
Lr 2D	88.8	73.2	0	0.4
Lr 3	3.6	10.6	0	1.4
Lr 10	53.3	32.4	0	32.3
Lr 16	95.3	95.0	12.2	7.8
Lr 17	94.1	84.6	0.2	3.5
Lr 18	76.9	95.5	22.8	18.1
Lr 9	-	-	99.42	100.0
Lr 19	-	-	93.03	100.0
Lr 23	-	-	-	99.6

OCCURRENCE OF A NEW BIOTYPE 104B (29R23) OF *PUCCINIA RECONDITA* f. sp. *TRITICI* AND SOURCES OF RESISTANCE

BY

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Brown rust of wheat caused by *Puccinia recondita* f. sp. *tritici* is prevalent all over the country and occurs both on the normal sown and off season crop. The pathogen variability has been monitored for at least 50 years. During 1979-80 leaf rust samples from the variety C306, received from Hansi, Hissar (Haryana), were identified as a new biotype of race 104. Race 104 was earlier identified from samples received from Nepal (Nayar et al., 1970). The additional differential IWP 94 is resistant to race 104 and susceptible to the present isolate. Both isolates give identical reactions on the international differentials (Johnston and Mains, 1932). Hence, single spores picked from IWP 94 were established on Agra local, a universally susceptible wheat variety. Pustules thus generated were increased separately and tested repeatedly on the International differentials and on the recently proposed brown rust identification sets (Nagarajan et al., 1981). Following the new nomencalture system race 104 group was assigned a new value and has been denoted within brackets.

Reactions of race 104 (17R23), 104A (29R31); and 104B (29R23) are given in Table 1. It can be seen that there is no difference between them on the international differentials. However race 104 (17R23) produces resistant reactions on both Thew and IWP 94; the biotype 104A (29R31) produces susceptible reactions on Thew (Nayar et al., 1977) while IWP 94 is resistant. The new biotype, produces resistant reactions on Thew and susceptible reactions on IWP 94.

By virtue of the differential reaction on Thew and IWP 94, the culture under report is neither 104 (17R23) nor 104A(29R31) and hence has been designated 104B(29R23).

Webster and Carina, differentials in the international set produce varying reactions under different light and temperature conditions (Chester, 1946). All the three races, namely, 104 (17R23), 104A (29R31) and 104B (29R23) were found to give resistant reactions on these lines at higher temperatures. In the recently proposed brown rust identification system all the three cultures are clearly separable based on their reaction in set A or B. Details on the nomencalture and deceding the assigned value of the isolate can be had from Nagarajan et al. (1981).

Race 104B(29R23) in the very first year of its detection had a frequency of 12.1%. It has found in samples, from Haryana, M.P., Punjab, Jammu and Kashmir, U.P., Rajasthan, Gujarat, Bihar Delhi and Mahrashtra, but it was not detected south of Maharashtra. During 1980-81 the frequency of 104B (29R23) increased further to 27.0% and it became the second most prevalent race in the country (Fig. 1). By then, samples from Karnataka and Tamilnadu were also identified as race 104B(29R23) which shows that this biotype is widely distributed through out the country.

Cultivars that were hitherto resistant to all the brown rust races were tested for their reaction to race 104B(29R23).

1. Wheat varieties possessing seedling resistance to 104B (29R23) and all the other prevalent races of India:

B-93, B-107, B-108, BSM-11, Burgas-2, CMM-67, CPAN-1796, CPAN-1839, HUW-37, HUW-55, HUW-107, HUW-108, HUW-117, IWP-503, J-325, K-7835, KLM-4-8-2-18, KLM-4-8-1-38, L-9, M-12, M-13, M-14, Raj-1762, Raj 1802, Raj-1865, SPPSN-9, VL-456, VL-464, and WL-3063.

2. Varieties possessing specific resistance to 104B (29R23) only: Sonalika, Bijaga Yellow, Shailja, Raj-1582, Raj-1665, BM-173, HD-383, IBWSN-134, IBWSN-149, IBWSN-270, HI-779, HI-784, HI-843, HI-7643, HD-94 and HD-190.

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Fig 1 - Frequency fluctuations of virulence 17R23(104), 29R31(104A) and 29R23(104B) marked as A, B and C respectively. Note that the frequency of one race declines, while the other increases.

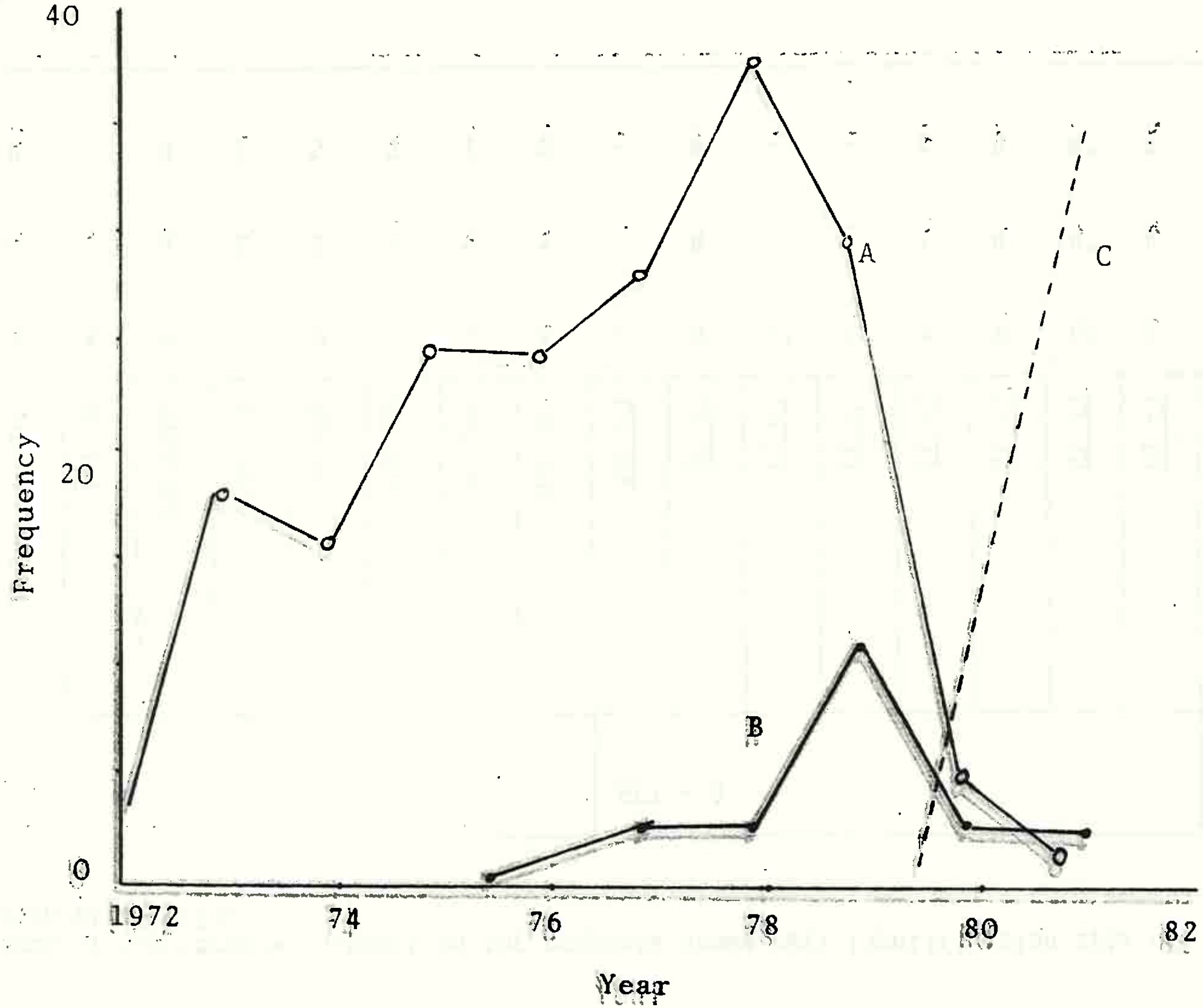

Table 1: Reactions of the three virulences on the proposed brown rust identification sets of Nagarajan et.al. (3).

	SET - C									SET - A								SET - B (Condensed international set)				
Virulence	Agra local	Karchia mutant	WL 711	Sonalika	K. sona	IWP 94	NI 5439	Jai raj	HD 4502	Lr 14a	Lr 24	Lr 31	Lr 13	Lr 17	Lr 15	Lr 10	Lr 19	Loros (Lr 2c)	Webster (Lr 2a)	Democrat (Lr 3)	Thew (Lr 20)	Malakoff (Lr-1)
104 (17R23)	S	R	±	R	S	R	S	S	±	-	R	R+	R+	±	R	R+	R	-	±	-	R	-
104 A (29R31)	S	R	±	R	S	R	S	S	±	-	R	-	-	±	R	R+	R	-	±	-	-	-
104 B (29R23)	S	R	-	R	S	S	S	S	±	-	R	-	-	±	R	R+	R	-	±	-	R	-

S = Susceptible
R = Resistant
* = X reaction, but variable
+ = Temperature and light sensitive
- = no data

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PATHOGENICITY SURVEY OF *PUCCINIA GRAMINIS* F.SP. *TRITICI* IN PAKISTAN DURING 1982

BY

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SUMMARY

Thirty field cultures of *Puccinia graminis* Pers. f.sp. *tritici* Eriks & E. Henn were evaluated on twenty six backcross lines each with a single gene for resistance, to study the virulence pattern of the natural population. Over 23 percent of isolates were found virulent on a combination of eight host genes. Near isogenic lines *Sr26*, *Sr27* and *SrGt* were resistant to all isolates, while only one isolate could attack *Sr24*. Wheat lines with genes *Sr5*, *Sr9e*, *Sr10*, *Sr11*, *Sr22*, *Sr24*, *Sr26*, *Sr27*, *Sr29*, *SrTt2* and *SrGt* were resistant to the greatest percentage of isolates and provide the best protection against stem rust. Association of virulence for gene *Sr9d* with *Sr6*, *Sr9a*, *Sr9b* and *Sr15* was observed.

INTRODUCTION

Among major diseases occurring on wheat in Pakistan, stem rust (*Puccinia graminis* Pers.f.sp. *tritici* Eriks & E. Henn) was one of the most serious. The incidence declined due to extensive cultivation of resistant cultivars. Now it usually occurs in the coastal regions, upland of Baluchistan, Punjab and North West Frontier provinces wherever old varieties are still grown.

Mehta(1940) and Hak(1957) produced the earliest information on the occurrence of physiologic races of Puccinia graminis f.sp. tritici in Pakistan. The periodic investigations undertaken by this Institute on the prevalence and distribution of stem rust races revealed the presence of races 9,11,15,15B,17,21,24,34,40,42 and 117 (Hassan & Kirmani, 1963; Hassan, 1965; Hassan et al., 1965, 1967; Hassan & Kirmani, 1971; Hassan & Hussain, 1975).

The method of identifying physiologic races using 'International Standard' differential varieties used, is good for detecting new races but does not provide information about the range of pathogenicity in the parasite. The usefulness of more recent methods through the use of near isogenic wheat lines to study the physiology and genetics of wheat rusts has been discussed (Rowel et al., 1963; Browder, 1971). Watson & Luig (1961) also emphasized the importance of identifying strains having increased virulence. Such information could be useful in breeding disease resistant cultivars. These techniques were used to study the variability in the sub-population of stem rust in Pakistan. Hassan et al. (1977) identified virulences in stem rust for resistance genes on the basis of field reactions on isogenic lines. This is the first account of identification of virulence factors at the seedling stage, prevalent in the stem rust population of Pakistan.

MATERIALS AND METHODS

Stem rust samples were collected from farmers' fields, experimental plots and wheat germplasm material during spring 1982. Field collections were established on the universally susceptible wheat cultivar Morocco W.1103 in the green house. Mono-pustule isolates were taken from each sample for pathogenicity surveys. Transparent polyethylene cages were used to ensure purity of rust cultures during increase and virulence analysis. Six to ten grains per entry were planted in each set. After emergence the seedlings were treated with 3% growth retardant 'Maleic Hydrazide' solution in water. Usual innoculation techniques were employed (Browder 1971). Tween 20 (Polyoxyethylene Sorbitan monolaurate), one ml.in 99ml. of tap water was atomized onto the first leaf surface before the plants were incubated in the dark at approximately 100 percent r.h. for about 18-22 hours. Innocuated sets were subsequently removed to the greenhouse maintained at 25 ± 4° C. Rust reactions were classified 12-14 days later according to the previously described infection types (Stakman et al., 1962).

A total of 30 cultures was analysed by using 26 backcross lines of wheat with single genes for resistance namely Sr5, Sr6, Sr7a, Sr7b, Sr8, Sr9a, Sr9b, Sr9d, Sr9e, Sr10, Sr11, Sr12, Sr13, Sr14, Sr15, Sr16, Sr17, Sr22, Sr24, Sr26, Sr27, Sr29, Sr30, SrTt1, SrTt2 and SrGt along with susceptible check Morocco to study the frequency and distribution of virulence in the stem rust population. The cultures analysed were stored in liquid nitrogen in the cryogenic (Model ET 39) for future use.

RESULTS AND DISCUSSION

The results of 30 cultures on 26 backcross lines for low reaction indicated a range of virulence spectrum (Table-1). The resistant genes Sr26, Sr27 and SrGt were completely effective against the pathogenic population of stem rust. Similar results were also obtained in United States (Roelfs et al., 1978). Of these, Sr26 and Sr27 were also found effective in India (Sawhney & Goel, 1980).

The incidence of virulence for the near isogenic lines having Sr11, Sr24 and Sr29 was low (less than 7%). The gene Sr11 was found effective in Pakistan previously (Hassan et al., 1977). No virulence for gene Sr24 was detected in India and Russia and for genes Sr24 and Sr29 in the United States (Guseva, 1981; Roelfs et al., 1978; Sawhney & Goel,1980). A lower frequency of virulence was reported in Mexico, Bulgaria and recently in Russia on Sr11 (Guseva 1981; Kurzhin, 1981; Kurjin, 1980; Roelfs et al. 1978). However it was ineffective in the United States and Canada (Green, 1978; Roelfs et al., 1978).

Backcross lines with single genes Sr5, Sr9e, Sr10, Sr22 and SrTt2 were resistant to the greatest percentage of isolates. Sr5 virulence was reported high in the United States, Canada, Mexico and Bulgaria (Green, 1978; Kurjin, 1980; Roelfs et al., 1978).

Virulence on Sr7a, Sr7b, Sr9a, Sr9d, Sr14, Sr15, Sr17, Sr30 and SrTt1 predominated in the stem rust populaCion. The high frequency of virulence on the above genes for low reaction could probably be related to the presence of these genes in the commercial cultivars and the area sown with them (Browder & Eversmeyer, 1977; Watson & Luig, 1963). The studies on the identification of the genotype for stem rust resistance recently concluded, also gave support to the above assumption. The resistance of host genes Sr9a, Sr9d and Sr15 was also overcome by all the prevalent races in India (P. Bahadur, Personal communication). Despite the geographic isolation a high virulence percentage on genes Sr9a, Sr9d, Sr15, Sr17 and Sr7b, Sr9b, Sr17 and SrTt1 was reported from Mexico and the United States and Canada respectively (Green, 1978; Roelfs et al. 1978). High frequencies were also recorded on Sr9b, Sr14 and Sr15 in Bulgaria (Kurjin, 1980).

Host gene combinations overcome by P. graminis f.sp. tritici isolates revealed that more than 23% of isolates were found to be virulent on a combination of eight genes (Sr7a, Sr9a, Sr9d, Sr14, Sr15, Sr17, Sr30, SrTt1) and 47% on five genes (Sr7a, Sr9a, Sr9d, Sr14, SrTt1). Association of virulence for gene Sr9d with Sr6, Sr9a, Sr9b and Sr15 was observed. The data (Table-2) support the findings of Vanderplank (1982) for Mexico and the United States.

Of the standard races identified so far from Pakistan, races 9, 17, 21, 24, 42 and 117 produce low infection types (avirulent) on differential cultivar 'Reliance' (Sr5) and high infection type (Virulent) recorded for races 11, 15, 34 and 40. During 1982 avirulence on Sr5 was over 83% (Table-1), indicating the predominance of race(s) 9, 17, 21, 24, 42 and 117.

Most of the wheat cultivars presently grown in Pakistan constitute parents developed by Centro Internacional de Mejoramiento de Maiz Y Trigo (CIMMYT). They are resistant and occupy a large acreage. Host genes Sr10 and Sr11 have been reportedly used in the wheat germ plasm of CIMMYT (Anonymous, 1979; Roelfs & McVey, 1979). The resistance to stem rust in most of the cultivars in Pakistan could therefore be due to the presence of either or both of these gene(s) in the host populations. However, the data analysed in this study suggest that combined virulence for these genes is low which could increase due to a possible directional selection by the pathogens as a result of large scale cultivation of host genotypes possessing the genes Sr10 and Sr11 (Johnson, 1961; Watson, 1970). Efforts should therefore be continued to watch the situation arising out of the possible changes in the pathogen population to avert future losses. Failure to take note of this evidence could lead to a situation similar to that observed in North America for race 15B and races 21-Anz-1,2 and 21 Anz-2 in Western Australia (Reeves, 1964; Stakman & Harrar, 1957).

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TABLE 1: Virulence of 30 isolates of *Puccinia graminis tritici* on backcross containing single genes for resistance to wheat stem rust in Pakistan during 1982.

S. No.	Resistance gene	Total number of virulent isolates	Percent virulent isolates
1	SrTt1	27	90.0
2	Sr9a	25	83.3
3	Sr9d	25	83.3
4	Sr14	25	83.3
5	Sr7a	24	80.0
6	Sr15	23	76.7
7	Sr30	23	76.7
8	Sr7b	22	73.3
9	Sr17	20	66.7
10	Sr16	17	56.7
11	Sr6	13	43.3
12	Sr9b	13	43.3
13	Sr13	13	43.3
14	Sr12	12	40.0
15	Sr8	10	33.3
16	Sr22	8	26.7
17	Sr5	5	16.7
18	Sr93	5	16.7
19	Sr10	5	16.7
20	SrTt2	5	16.7
21	Sr11	2	6.7
22	Sr29	2	6.7
23	Sr24	1	3.3
24	Sr26	0	0.0
25	Sr27	0	0.0
26	SrGt	0	0.0

TABLE 2: The percent of isolates of *Puccinia graminis tritici* in Pakistan, virulent for the wheat stem rust genes Sr6, Sr9a, Sr9b, Sr9d and Sr15 singly and in combination in 1982.

Host gene(s)	Percent virulent isolates
Sr6	43.3
Sr9a	43.3
Sr9b	83.3
Sr15	76.7
Sr6 + Sr9d	100.0
Sr9a + Sr9d	88.0
Sr9b + Sr9d	92.3
Sr15 + Sr9d	87.0

A SIMPLE METHOD FOR THE RELIABLE INFECTION OF ADULT CEREAL LEAVES WITH PUCCINIA RECONDITA

BY

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For the study of the mono-cyclic infection process of cereal rust fungi it is necessary that the conditions during the early stages of infection should be standardized. A major problem is the production and maintenance of adequately high levels of relative humidity. For experiments involving seedlings this problem is often overcome by enclosing the plants in a suitable container, such as a sealed propagator within which the humidity can be determined. However, with adult plants such techniques can be difficult or inappropriate, sometimes involving the use of many large chambers. Furthermore, enclosing adult cereal plants frequently results in some areas of leaves touching either other leaves or the sides of the chamber. This may cause a film of standing water to persist at these areas and so introduces non standard conditions for spore germination, germ-tube growth and appressorium development.

One technique for avoiding such problems involves the use of small chambers which enclose only the portion of the leaf being studied. The chambers, consisting of four strips of double sided adhesive foam (Scotch 3M, Fixing Pads), arranged in a rectangular configuration on a glass coverslip, can be placed on leaf surfaces immediately after inoculation in a settling tower. A high relative humidity rapidly develops as a result of normal transpiration. The chambers can be removed 24 hours after innoculation.

Using this technique plant growth cabinets lacking the facilities for relative humidity control can be used for studying the mono-cyclic infection process. The cabinets used in this study, which involved Puccinia recondita and winter wheat, often operate at approximately 50 to 60% relative humidity, a range too low for successful infection.

The percentage uredospore germination and the percentage of germinated spores which subsequently formed appressoria suing this technique, are presented in Table 1, for a range of winter wheat cultivars. Fifty spores were assessed on each of 6 leaves for each cultivar.

TABLE 1: Percentage germination and appressorium formation of Puccinia recondita uredospores. (Arcsin transformed data).

Cultivar	Germination ± s.e.	Appressorial Formation ± s.e.
Armada	69.7 ± 2.3	76.5 ± 1.9
Atou	68.8 ± 2.3	74.6 ± 3.2
Bouquet	66.2 ± 2.7	74.2 ± 2.9
Cappelle-Desprez	65.7 ± 2.2	66.2 ± 3.0
Maris Freeman	69.9 ± 3.2	66.7 ± 2.5
Holdfast	64.7 ± 3.7	69.7 ± 4.0
Waggoner	65.9 ± 2.6	65.8 ± 3.6
Overall mean	67.3 = 85.1%	70.5 = 88.9%

Acknowledgement: The data presented in Table 1 were obtained during an investigation supported by a Grant from the Agricultural Research Council.

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RUST REACTION OF SOME EXOTIC BREAD WHEAT VARIETIES CULTIVATED IN ITALY (ROME, 1982)

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Evaluation of genetic resources is an important approach to developing new varieties provided with adequate levels of genetic disease resistance in crops.

In 1982, in Italy, some wheat varieties from Kenya, from Saharian oases, and from Tibet (China) were tested both for their yield performance and their reaction to rusts.

MATERIALS AND METHODS

The following bread wheat (Triticum aestivum L.) varieties were tested in a field near Rome: Fahari and Kifaru from Kenya; Boush, Gendouba-Gebel Nefoussa, Ghat;Barakat, Haroun, and Khressi from Libya; Bani, Fartas Ferzaouata, Fartas Tafilalet, Fartas Ternata from Morocco; Hoggar Tidikert, Tinghert, Taouat, Ougnat, from Algeria; Line 1, Line 2, Line 3, from Tibet.

Wheat is grown in Kenya at high altitudes which provide the cool temperature needed for its development during early growth stages. Wheat grows throughout the year and rusts develop on a wide range of genotypes, introduced to control rust losses (Martens, 1975). The two lines analysed here represent two subsequent generations of breeding activities, Kifaru being the most recent one.

North African lines can all to be considered as land varieties except Ougnat, the result of recent breeding efforts, involving material coming from CIMMYT. These land varieties are samples taken from Sahara oases. They are resistant to high temperatures, dry air, high light intensity, and relatively low night temperatures.

Wheats from Tibet are interesting for their resistance to low temperatures and represent rather primitive wheat types.

Data were taken on the yield of these varieties and their susceptibility to natural rust infections; moreover they were analysed for their seedling reaction to *Puccinia graminis* Pers. f. sp. *tritici* Eriks. et Henn. (races 34 and 116) in the greenhouse.

RESULTS

In 1982, the season in Italy, was not particularly favourable for the development of rust epidemics. *Puccinia striiformis* West. occurred only sporadically, while *P. recondita* Rob. ex Desm. f. sp. *tritici* Eriks. et Henn. developed on bread wheats in other trials in the same location (Zitelli et al., 1982), but never severely. A slight attack of stem rust, late in the season, was noted at the beginning of July but the exceptionally high temperatures induced teliospore formation and stopped the infection. Table 1 shows data obtained in the field and in the greenhouse.

The reaction to rust infection of the varieties from Africa and Tibet was different from Italian varieties, in several aspects, in particular the date of infection. The records for brown rust infection on all the foreign varieties were taken at the end of May, twenty days earlier than on the Italian varieties at the same location.

In the first half of May, *P. striiformis* was first noted on Taouat from Algeria, while *P. recondita* first developed on Taouat, Tidikert, Tinghert (from Algeria); Fartas

Fafilalet, Fartas Ternata (from Morocco); Boush, Gendouba-Gebel Nafoussa, Haroun (from Libya).

The lines from Tibet were susceptible to both yellow rust and brown rust in the field, while the varieties from Africa were generally highly susceptible to brown rust. Only Fahari from Kenya and Ougnat from Algeria were completely resistant (Table I).

All the varieties were tested at the seedling stage with two races (34 and 116): only Fahari and Ougnat from Algeria were resistant; all the others were susceptible.

DISCUSSION

Lines obtained from Tibet do not represent material of interest as a source of rust resistance. Most likely the environmental conditions of Tibet are not suitable for rust development and the race spectrum in China is certainly quite different to that present in the Mediterranean basin.

Land races from in the Sahara oases are all heavily attacked by rusts. One variety, however, (Gendouba-Gebel Nefoussa, from Libya), is interesting because it was high-yielding, despite high susceptibility to rust; it could be an example of a tolerant variety. The low air humidity present in the Sahara oases is likely to prevent infection and spread of rusts. Therefore, no natural selection for these diseases occurs in this specific agro-ecological area. In fact, Saharian oases could be considered quite apart from North African cereal areas. Recent race surveys in Egypt and Near East countries (Abdel Hak et al, 1982) indicated the prevalence of some genes for virulence similar to those shown from surveys in Italy (Corazza and Basile, 1980, 1980a), and in France (Massenot, 1978).

These results corroborate the assumption of some authors (Santiago and Salazar, 1960; Santiago, 1965; Corazza, 1979), that rust inoclum originates in North Africa and migrates with south/north winds to Southern Europe.

Ouguat, together with the two Kenyan varieties tested, can represent a valuable source of rust resistance, and given their improved agronomic characteristics (particularly Ougnat), their use in a breeding programme could be recommended. Fahan, a tall type, proved to be highly resistant to both field and greenhouse rust infections; it could be profitably used if crossed with a short strawed line, well adapted to Italian or Mediterranean agro-ecological conditions.

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TABLE 1 - Field reaction to the rusts and seedling reaction to races 34 and 116 of stem rust.

Variety	Origin	Field reaction to *P. striiformis*	Field reaction to *P. recondita*	Field reaction to *P. graminis*	Seedling reaction to *P. graminis* races 34	Seedling reaction to *P. graminis* races 116
Line 1	Tibet(China)	20 MS	80 S	0	3+	3+
Line 2	Tibet(China)	20 MS	80 S	0	3+	3+
Line 3	Tibet(China)	30 MS	80 S	40 S	3+	3+
Fahari	Kenya	0	0	0	0	0
Kifaru	Kenya	0	60 MS	0	0	0
Boush	Libya	0	70 S	40 MS	3	3+
Gendouba-Gebel Nefoussa	Libya	0	70 S	0	3	3+
Ghat-Barakat	Libya	0	80 S	0	3+	3+
Haroun	Libya	0	80 S	0	3+	3+
Khressi	Libya	0	90 S	0	3+	3+
Bani	Morocco	0	80 S	0	3	3
Fartas Ferzaouata	Morocco	0	50 MS	0	3+	3+
Fartas Tafilalet	Morocco	0	50 MS	0	3+	3+
Fartas Ternata	Morocco	0	80 S	40 MS	3	3+
Hoggar	Algeria	0	60 S	0	3+	3+
Tidikert	Algeria	50 S	80 S	0	3	3+
Tinghert	Algeria	0	60 S	0	3+	3+
Taouat	Algeria	30 MS	60 S	0	3+	3+
Ougnat	Algeria	0	TR	0	0	0

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GENES FOR RESISTANCE TO PUCCINIA GRAMINIS TRITICI IN HEXAPLOID TRITICALE

BY

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The inheritance of stem rust resistance in triticale has been studied infrequently. Morrison, Larter and Green (1977) described the inheritance of resistance to Puccinia graminis Pers.f.sp. tritici Eriks. and Henn. in one cultivar and four lines of hexaploid triticales (x Triticosecale Wittmack). They found 5 resistance genes designated Tsr 1 - Tsr 5. In our study of one resistant cultivar and 3 lines of hexaploid triticales (Stuchlikova and Bartos, 1980) two resistance genes were found. One dominant gene (designated A) was determined in all four triticales. Two of them possessed in addition to the gene A one partially dominant gene (designated B), effective only in the seedling stage. The present study was undertaken to compare the resistance genes described in Canada and Czechoslovakia.

MATERIALS AND METHODS

The triticales from Canada (designated CAN) were obtained by courtesy of Dr. Larter, Winnipeg, two samples (designated CS) originate from the Czechoslovak collection of triticales (Table 1).

The reaction of triticales was tested with six isolates of stem rust, representing races 11, 14, 15B, 21, 34 and 214 in the greenhouse and with one isolate of race 11 in the field. The triticales received from Canada were crossed with Rosner (CS) and Bokolo (CS) in which resistance genes A and AB, respectively, have been described by the authors. The chromosome number in the parents used for the crosses was determined by Feulgen staining of root tips; it was found to be 42 in all of them. The ears of parental plants and of F1 progeny were bagged to prevent outcrossing. The survival and seedset of some F1 plants was low as well as the germination, and therefore the number of F2 plants in some combinations is rather limited. No seed from the cross with 6A 190 was obtained. The F2 progenies of the crosses were tested in the greenhouse and one of them in the field rust nursery.

RESULTS AND DISCUSSION

The inoculation with 6 stem rust isolates revealed that all triticales were resistant to all rust isolates (Table 1). The infection types produced were 0 -; with the exception of the isolate G334 (race 34) that produced IT up to 1 on 70 HN 470 and IT up to 2 on 6TA 204. In the greenhouse tests (Table 2) the segregation in the F2 progeny of the cross 6TA 204 a Rosner (CS) fits the 15R:1S ratio, indicating two genes for resistance (one from 6TA 204 and one from Rosner (CS), whereas the F2 progeny of the cross Bokolo x 6TA 204 segregated in the 63R:1S ratio, indicating three genes (one from 6TA 204 and two from Bokolo). In the field test (Table 2) the segregation of the second progeny fits the 15R:1S ratio, because one gene in Bokolo is effective only in the seedling stage. This indicates that the gene for resistance in 6TA 204 is not identical with the gene for resistance in Rosner (CS) and Bokolo. In Rosner (CAN) resistance genes Tsr 1 and Tsr 2, and in 6TA 294 gene Tsr 2 have been described by Morrison et al., (1977). Our results show that Rosner (CS) has only one gene for resistance. Hence 6TA 204 possesses Tsr 2, the resistance gene in Rosner (CS), designated A by us, seems to be Tsr 1.

The crosses where no segregation in F2 progeny has been observed, includes parents one of which possesses gene Tsr 1 (alone or with another gene) and the second one the gene A (alone or with the gene B). The limited number of plants does not enable a reliable statistical evaluation of individual crosses. However, the results contribute to the conclusion that the gene A found by us in hexaploid triticales Rosner (CS), B271-R-72 Bokolo A2 (= Bokolo) as well as in 108 6 x short and B 415-R-72 Tomzsi A3 (Stuchlikova and Bartos, 1980) is identical with Tsr 1 described by Morrison et al. (1977).

An electrophoretic study on gliadins of triticales (Sasek et al., 1979) revealed that Bokolo (as well as 108 6x short) had the block Gld 1B3. This block is characteristic for the segment of 1R rye chromosome that carries the gene Sr 31 (Poperelja and Babajanc 1978) governing stem rust resistance in many wheat cultivars, 1B/1R translocations or substitutions (Sasek and Bartos 1980). The gene Tsr 1 may be therefore identical or closely linked with Sr 31.

The segregation 63:1 in the cross Bokolo x 6TA 204 indicates that the gene B is not Tsr 2. Other conclusions about the gene B are not possible.

SUMMARY

Hexaploid triticales from Canada, in which genes for stem rust resistance have been described by Morrison et al., (1977) were compared with hexaploid triticales from the Czechoslovak collection in which genes for stem rust resistance have been also determined (Stuchlikova and Bartos, 1980). All triticales were resistant to all 6 wheat stem rust isolates representing 6 races. Analysis of F2 progenies of the crosses between triticales from Canada and from the Czechoslovak collection showed, that the resistance gene in the triticales from the Czechoslovak collection designated A was

identical with Tsr 1 after Morrison et al.,(1977). Electrophoretic analysis of triticales (Sasek et al. 1979) indicates that Tsr 1 may be identical or closely linked with gene Sr 31.

TABLE 1 - Reactions to 6 stem rust isolates

Cultivar/line	Source*	Infection type - rust isolates		
		Greenhouse		Field
		G425, G702 G15B, G69,	G334	G425
Rosner	CS	0	0	0
B 271-R-72 Bokolo A2	CS	0 - 0;	0;	0
Rosner	CAN	0	0	0
MT 36-2	CAN	0	0	0
6A 190	CAN	0 - 0;	0;	0
70 HN 470	CAN	0 - 0;	0; - 1	0 (1-2 tr)
6TA 204	CAN	0; - 1	1 - 2	1 - 2 tr

* CS - Czechoslovak collection

CAN - supplied by Dr. Larter, Winnipeg, Canada

TABLE 2 - Segregation of rust reaction in F2 populations of the crosses

Cross	Race	Number of resist-ant	Number of suscep-tible	Expected ratio	χ^2	P
Rosner (CAN) x Bokolo	14(G702)	528	-	-		-
Rosner (CAN) x Rosner (CS)	"	57	-	-		-
70 HN 470 x Bokolo	"	60	-	-		-
MT 36-2 x Rosner(CS)	"	88	-	-		-
MT 36-2 x Bokolo	"	537	-	-		-
6TA 204 x Rosner (CS)	"	304	19	15:1	0,0760	0,80-0,50
Bokolo x 6TA 204	"	344	5	63:1	0,0461	0,95-0,80
Bokolo x 6TA 204	*11(G425)	48	2	15:1	0,4161	0,60-0,50

* Field trial

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OBITUARY

The well-known Portuguese plant pathologist and uredinologist Prof. Branquinho d'Oliveira died on 3rd January, at 78 years of age. His wife Dra. M. Lourdes d'Oliveira, bacteriologist, had already died in August 1980.

He was head of the Plant Pathology Department of the Estacao Agronomica Nacional (National Agronomic Research Station) until 1971 and Director of the Centro de Investigacao das Ferrugens do Cafeeiro (Coffee Rusts Research Centre) at Oeiras until 1973. He was also Professor of Plant Pathology at the School of Agriculture, Lisbon from 1942 until 1947, in which year his contract was not renewed due to political disagreements with the Government of the time.

He developed, in collaboration with his wife, all the branches of Plant Pathology in Portugal, promoting specialisation in these different fields of quite a number of students. Early in his career, Prof. d'Oliveira devoted himself to the study of the rust fungi. Particularly noteworthy are his contributions to the characterisation of the aecidial hosts of a number of rusts and their implications in the physiologic specialization and epidemiology of these rusts. These investigations allowed him to develop the theory that the evolution of the heteroecious rusts should be studied in regions where the centres of origin of both the main and alternate hosts coincide. According to d'Oliveira "The host-parasite relations being necessarily congenial in the case of rusts, any change of the host to adapt itself to different ecological conditions, would naturally induce a parallel evolution of the rust to insure congeniality and survival. Such evolutionary tendencies, since the cereal rusts are heteroecious, must be sought both in the sporophytic and the gametophytic hosts. Thus, when considering the centres of origin of the different geographical groups or races of a cereal, the possibility of the existence of aecidial hosts adapted to these phytogeographic regions cannot be neglected. The absence of an aecidial host from regions where a given rust exists, seems only to indicate that the sporophytic host as well as the rust, have been introduced recently."

As a recognition for his services to Plant Pathology he was appointed, in 1968, Vice President for Western Europe of the First International Congress of Plant Pathology, held in London and in 1975, the Consociatio Phytopathologica Mediterranea conferred upon him a gold medal of merit.

His most remarkable task, however, because of the international impact achieved, was perhaps that initiated in 1952 on the study of the coffee leaf rust (Hemilcia vastatrix Berk & Br.). The Centro de Investigacao das Ferrugens do Cafeeiro, which he founded in 1955, centralised in Portugal, the studies of this disease. Under his guidance it produced basic knowledge on this tremendously important coffee disease and attained world leadership in this field of phytopathological research. Thanks to his investigations on this subject, d'Oliveira was awarded in 1956 the "Diploma al Merito Cafetalero" by the Federacion Cafetalera de America "como recomocimiento a su meritoria labor y come estimulo a su apostolado cafetalero" and in 1972 the "Award of Merit-Distinguished Service to Tropical Plant Pathology" by the American Phytopathological Society (Carribean Division).

Prof. D'Oliveira was able to put in to practice for the coffee rust research what he always advocated for the cereal rusts and other plant diseases, i.e., very strong international co-operation of those countries interested in the same phytopathological problems.

The scientific work of d'Oliveira was like his mind; creative, original and independent.

C. J. Rodrigues Jr
Director
Estacao Agronomic Nacional
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Papers, short notes on topics such as Pathogen virulence surveys, Breeding for resistance, Sources of resistance, Control of cereal rusts, Techniques or any subject of possible interest are required for the Bulletin to maintain its function of rapid dissemination of rust information.

Papers - typed double spaced should be sent to me at the following address:

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