CEREAL RUSTS BULLETIN

EDITED BY

G. E. RUSSELL

VOLUME 7 PART 1

PUBLISHED BY
THE EUROPEAN AND MEDITERRANEAN CEREAL RUSTS FOUNDATION

CONTENTS

	Page
EDITORIAL	2
KARKI, C.B., PANDE, S., THOMBRE, S.B., JOSHI, L.M. and NAGARAJAN, S. Evaluation of a linear model to predict stem rust severity	3-7
PASQUINI, M.S., GRAS, M.A. and ZITELLI, G. Virulence genes present in populations of *Puccinia recondita* f.sp. *tritici* and *Puccinia graminis* f.sp. *tritici* in Italy during 1977 and 1978.	8-15
DONCHEV, N. The leaf rust problem on wheat in Bulgaria in 1977-78	16-20
IONESCU-COJOCARU, M. Leaf and stem rust of wheat in Romania in 1978	21-22
OBITUARY	23-24

EDITORIAL

I have now received sufficient contributions for both parts of Volume 7. It is planned to print and mail Part II within the next few weeks.

Suitable papers and articles for Volume 8 will be welcomed. Please send them to me as soon as possible at the address below.

G.E. Russell
Department of Agricultural Biology
The University
Newcastle upon Tyne NE1 7RU
England

SUBSCRIPTIONS

The Bulletin is published twice a year and is sent directly to subscribers on payment of an annual subscription. Alternatively, orders can be placed through booksellers at extra cost. Enquiries regarding subscriptions and orders should be sent to Dr J.E. Parlevliet, Treasurer, European and Mediterranean Cereal Rusts Foundation, Institute of Plant Breeding, 166 Lawickse Allee, Wageningen, The Netherlands.

EVALUATION OF A LINEAR MODEL TO PREDICT STEM RUST SEVERITY

BY C.B. KARKI
Agricultural Experimental Station, Lalitpur, Kathmandu, Nepal
S. PANDE
Vivekananda Laboratory for Hill Agriculture, Almore (U.P.), India
S.B. THOMBRE
Wheat Breeding Station, Niphad, Nasik District, Maharashtra
L.M. JOSHI AND S. NAGARAJAN
Division of Mycology and Plant Pathology, IARI, New Delhi-110012

In the United States, a linear prediction model has been developed using a Bio-Meteorological approach (Eversmeyer and Burleigh, 1970; Burleigh, Eversmeyer and Roelfs, 1972; Eversmeyer, Burleigh and Roelfs, 1973). Various types of such models to suit different climates and diseases are available (Krantz, 1974). In India, Nagarajan and Singh (1976) developed a model for stem rust appearance prediction and a linear equation to predict stem rust severity 7 days in advance (Nagarajan and Joshi, 1979). The linear equation was not tested in the field. This paper describes an attempt to evaluate the accuracy of this prediction.

EXPERIMENTAL AND DISCUSSION

Field layout, disease recording and other weather observations were made as described by Nagarajan and Joshi (1979). Epiphytotics were created at Delhi during 1975 and 1976 (cv. Lal Bahadur) at Niphad in Central India in 1976 (cv. Lal Bahadur), and at Wellington during 1975 with the same variety. Nagarajan and Joshi (1979), in their attempt to develop a 7-day forecast for stem rust, created field epiphytotics in three crop seasons. They monitored the disease development in a 30 m. sq. plot first by counting the number of pustules in each row, and later, when severity was greater than 1%, a modified Cobbs scale was used. From this they calculated the mean disease severity. The available green leaf area was also measured at weekly intervals. They used meteorological data recorded in the Agromet section which was within 300 m. of the experimental area. By keeping freshly inoculated pots and changing them after the pustules ruptured, the incubation period was noted. This was normally 7 to 8 days, except at the early stages of the epidemic when it was nearly twice as long and, towards the end, when it was only 5 to 6 days. So, Nagarajan and Joshi (1979) took the previous week mean weather and crop phenology as the concomitants and the present level as the dependent and ran a multiple regression analysis using a computer. Out of the best five combinations, the one useful in the study had a R^2 value of 0.84. The linear equation of Nagarajan and Joshi (1979) is as follows:

$$y = -29.3733 + 1.820x_1 + 1.7735x_2 + 0.2516x_3$$

y = Expected disease severity after 7 days

x_1 = Present level of disease severity

x_2 = Mean minimum temperature expected for the next 7 days

x_3 = Mean maximum RH expected for the next 7 days

-29.3733 = Constant

In the present study, the same Lal Bahadur variety was used and the same methodology was followed. At Niphad about 100 tillers were tagged and disease observations were made on them.

The linear prediction models developed under Delhi conditions were based on February to April weather conditions (Fig. 1). Despite this, the equation of Nagarajan and Joshi (1979) gave reasonably accurate predictions when tested under warm and humid, August-September conditions at Wellington in 1975 (Fig. 2). Accurate predictions were also obtained at Niphad in 1977, where March conditions were warm and dry, (Fig. 3) and at Delhi in March-April 1977. As the predictions were made after the appearance of disease, the first point where disease severity was very low has not been shown in the Figures. The higher predicted values in the early stages are because the incubation periods are much higher than the assumed 7 days, giving higher than actual mean values. This results in some deviation between predicted and observed values. In addition, concomitant variables used account for only 84% of the variability.

Accepting the limitations of a linear model, the one by Nagarajan and Joshi (1979) was found to be useful in predicting stem rust severity. This model could be applied to other varieties having a similar pattern of disease growth. An important constraint with this model is that the weekly forecast of temperature and RH by the Meteorological Department can be inaccurate. As an alternative, the 50 year mean temperature and RH readings available for the corresponding period can be used as the expected values.

The equation developed by Nagarajan and Joshi (1979) has been found to predict stem rust severity 7 days in advance with reasonable accuracy. However, there is scope for modifying the equation slightly according to local experience.

Fig. 1. Stem rust prediction at Delhi, March - April, 1975

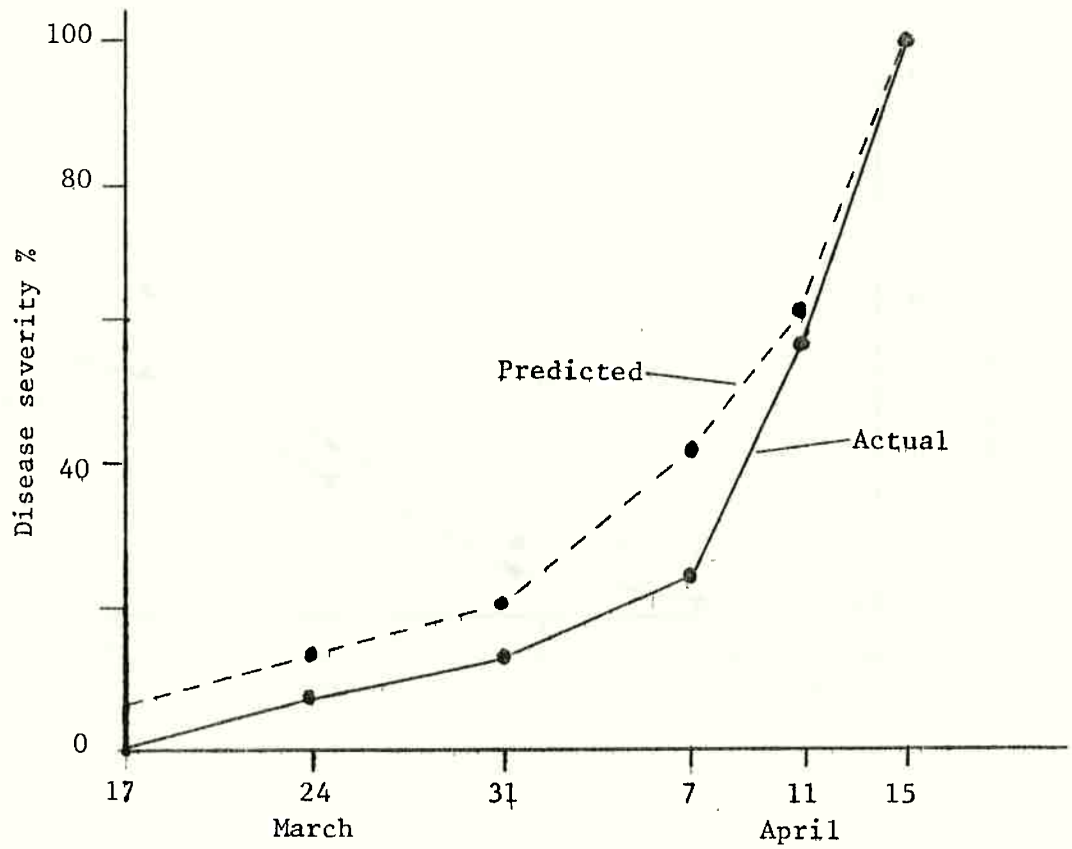


Fig. 2. Stem rust prediction at Wellington, August - September, 1975

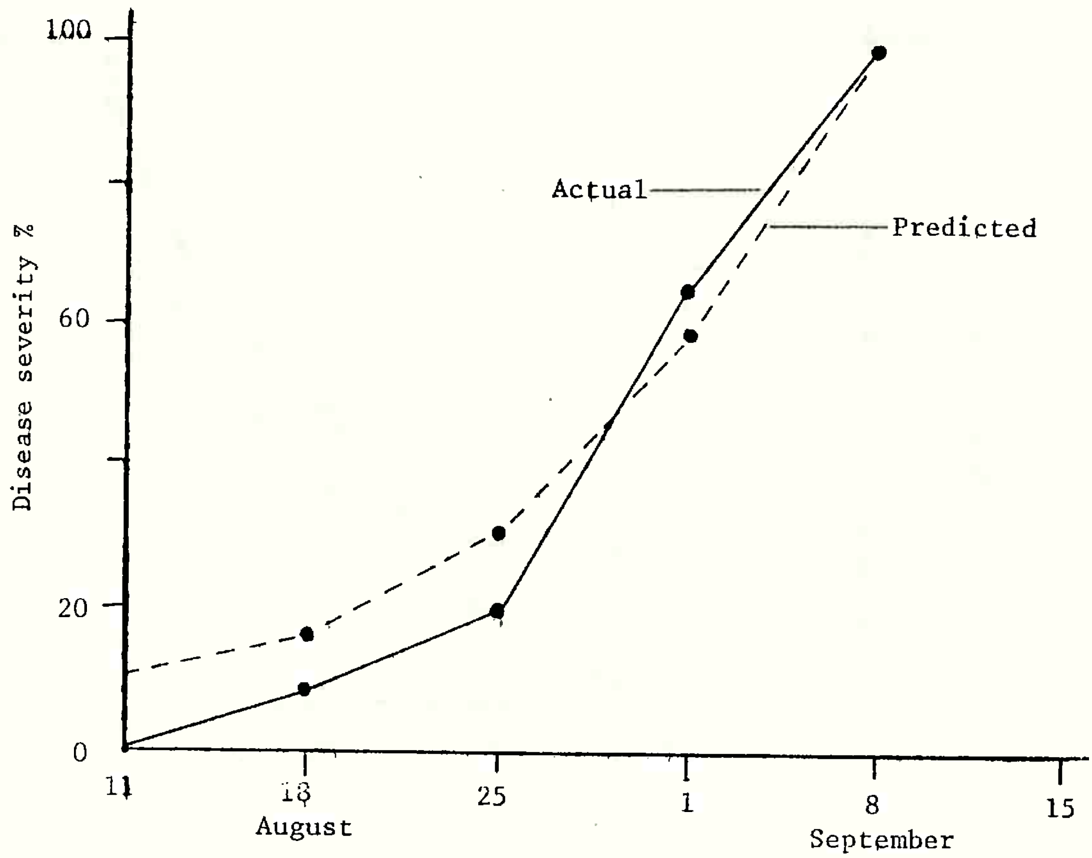


Fig. 3. Stem rust prediction at Niphad, January to March, 1977

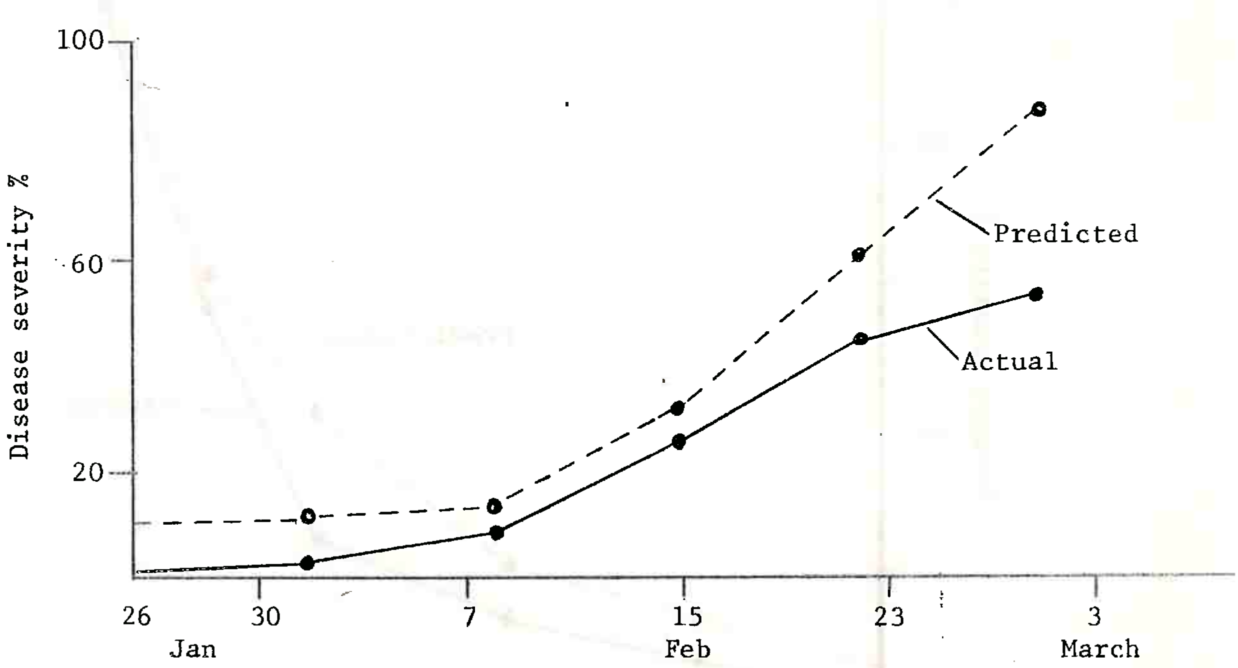
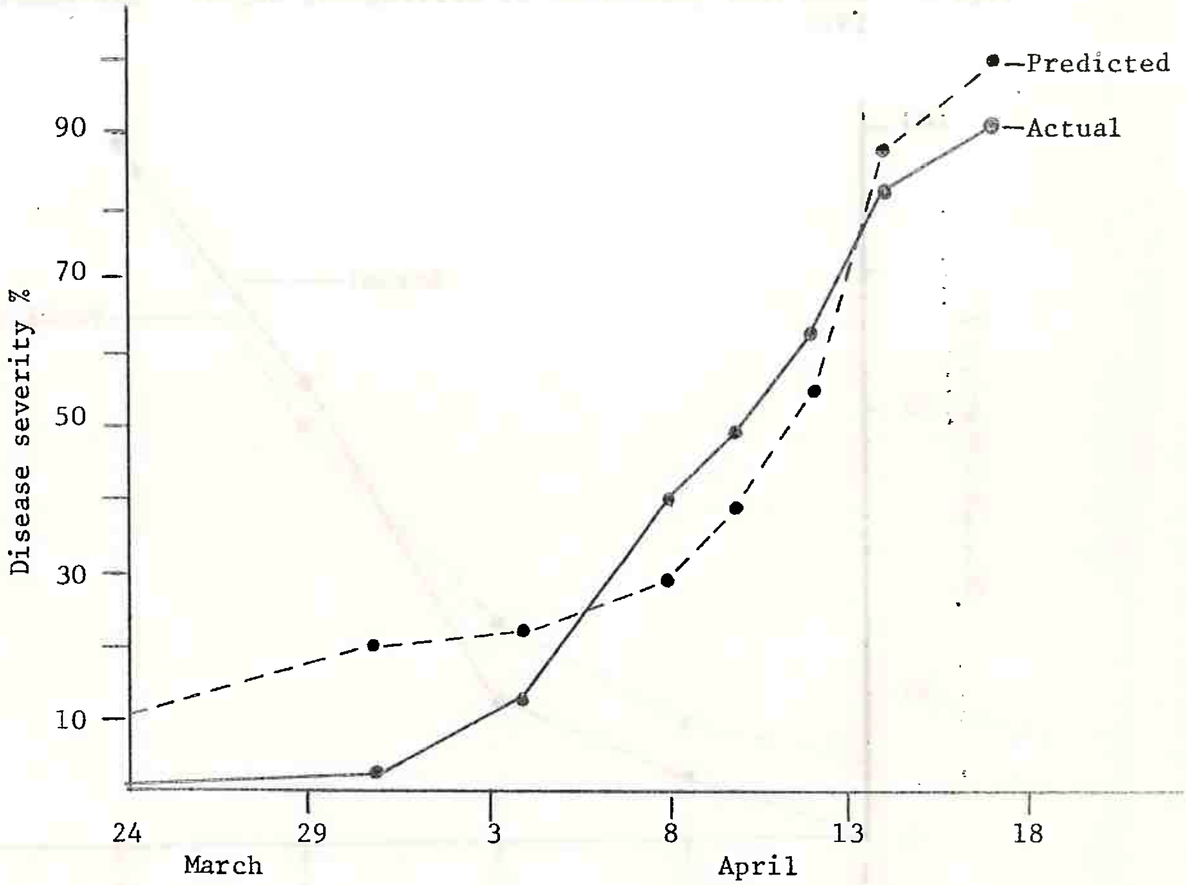


Fig. 4. Stem rust prediction at Delhi, March to April 1977



REFERENCES

BURLEIGH, J.R., EVERSMEYER, M.G. & ROELFS, A.P. (1972). Development of linear equations for predicting wheat leaf rust. Phytopathology 62: 947-953

EVERSMEYER, M.G. & BURLEIGH, J.R. (1970). A method of predicting epidemic development of wheat leaf rust. Phytopathology 60: 805-811

EVERSMEYER, M.G., BURLEIGH, J.R. & ROELFS, A.P. (1973). Equations for predicting wheat stem rust development. Phytopathology 63: 348-351

KRANTZ, J. (1974). Epidemics of plant diseases: Mathematical analysis and modelling (ed.) Ecological studies 13, Springer-Verlag, New York. 161p.

NAGARAJAN, S. & SINGH, J. (1976). Preliminary studies on forecasting wheat stem rust appearance. Agric. Meteorol. 17: 281-289

NAGARAJAN, S. & JOSHI, L.M. (1979). A linear model for a seven day forecast of stem rust severity. Indian Phytopath. 30 (in press)

VIRULENCE GENES PRESENT IN POPULATIONS OF PUCCINIA RECONDITA F.SP. TRITICI AND PUCCINIA GRAMINIS F.SP. TRITICI IN ITALY DURING 1977 AND 1978

BY M. PASQUINI, M.A. GRAS AND G. ZITELLI

Istituto Sperimentale per la Cerealicoltura, Rome, Italy

The main purpose of these studies is to provide information on the evolution of virulence genes in populations of *Puccinia recondita* (Rob. L. Desm. f.sp. *tritici* Erikss. and Henn.) and *Puccinia graminis* (Pers. f.sp. *tritici* Erikss. and Henn.) in Italy during 1977 and 1978. In breeding work it is important to identify new and rare pathogen virulence genes, so that the stability of resistance genes in commercial varieties can be predicted.

In Italy brown and black rust attacks were quite frequent in both years, although yellow rust epidemics limited the development of *P. recondita* in some places.

MATERIALS AND METHODS

Rust samples were collected each year from the field in different parts of Italy and those coming from varieties or lines carrying known resistance factors or from trap-varieties were examined. The rust samples were then multiplied on highly susceptible varieties to produce sufficient urediospores for the inoculation of a set of differential varieties. Such sets included the 'classical' differentials, some near-isogenic lines and additional varieties which carry 'interesting' resistance genes. Infected seedlings were kept in an incubation chamber for almost 12 hours under high moisture conditions before they were placed in a greenhouse at about $20^{o}C$, when necessary, under artificial light, using the methods suggested by Stakman *et al.* (1962) and Browder (1971). The reaction types were classified after 15 days on the following 0-4 scale: R (resistant) = 0;/1, MR (moderately resistant) = 2/X, MS (moderately susceptible) = 3, S (susceptible) = 4.

In order to identify single biotypes present in field samples of both pathogens, a number of monopustule isolates were maintained on detached leaves kept in tubes containing a 100 p.p.m. benzimidazole solution at about 18^{o}C and under artificial light.

RESULTS

Puccinia recondita

Table 1 shows the reactions only of the most widely used resistance genes; those of the 'classical' differentials are not reported here because the different virulence genes in them could not be differentiated in this study (Watson, 1977). Twenty different biotypes, obtained from 98 isolates were identified.

The following conclusions could be drawn from the reactions to different biotypes of lines or varieties used in the present study:

1) The variety Agatha was highly resistant, and none of the biotypes examined was able to attack it. This variety carries the resistance gene *Lr 19*, transferred by induced translocation from *Agropyron elongatum* (Browder, 1972).

2) Klein Lucero, which was immune to all biotypes tested, and Klein Aniversario, moderately susceptible only to biotype B8, appeared good sources of resistance. However, their near-isogenic lines, carrying respectively *Lr 17* and *Lr 3all* genes, were less resistant than these two varieties. This shows that Klein Lucero and Klein Aniversario each carry more than one resistance gene. Agent W3564 (*Lr 24*), Elia and Ardito Sel. Klein were also resistant to most of the biotypes used in this study.

3) The results confirmed the efficacy of Lr 1 ('Centenario') gene (Cariello *et al.*, 1977) which was susceptible only to biotypes B9 and B8, both ascribable, according to the 'classical' differentials, to race '77'; gene *Lr 2a* ('Webster') too, was susceptible only to three biotypes: B9, B8 and B2.

4) Variable reactions to the various biotypes were observed with the *Lr 3* ('Democrat') gene.

5) Valgerardo, a variety of the 'Val' group of high-yielding Italian durum wheats, was resistant to all the biotypes tested. This variety has been resistant for many years under controlled and field conditions. Other varieties of the 'Val' group were also tested against some of the biotypes. The results of these tests are also shown in Table 1.

Table 1. Seedling reactions* of the differential set and of some commercial varieties to 20 biotypes of P. recondita

Differential set and commercial varieties		B5	B1	B15	B16	B21	B17	B25	B10	B4	B3	B9	B8	B7	B26	B11	B14	B22	B2	B12	B23
Physiologic races		12							56	61		77		141	165	211			218	223	
Lr1 'Centenario'		R	R	R	R	R	R	R	R	R	R	S	S	R	R	R	R	R	R	R	R
Lr 2a 'Webster'		R	MR	R	R	R	R	R	R	R	R	S	S	R	R	R	MR	R	S	R	R
Lr2d 'Loros'		S	S	MS	S	S	S	MS	MR	MS	S	S	S	S	MR	MS	S	MS	S	S	MS
Lr3 'Democrat'		MS	MS	MS	MS	S	MS	S	R	S	S	S	MS	S	R	R	R	MR	R	R	MR
Lr3all 'Aniversario'		R	MR	MS	R	MR	MS	MS	R	MS	R	MR	S	MS	MS	MR	MS	MS	R	R	MS
Lr17 'Klein Lucero'		MR	MS	R	R	MS	R	S	R	MR	R	MS	MS	MR	R	R	MR	R	S	R	R
Agent W3564 (Lr24)		R	R	R	R	R	R	R	R	R	MS	MR	R	MS	R	MR	R	R	MR	R	R
Ardito Sel. Klein		R	R	R	R	R	R	R	–	–	R	R	–	R	–	MS	MS	R	R	R	R
Klein Aniversario		R	R	R	R	R	R	R	R	R	R	MR	MS	R	R	MR	R	R	R	R	R
Klein Lucero		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Sinvalocho		S	R	MS	S	MS	S	S	R	R	S	–	MS	S	–	R	R	S	S	R	R
Elia		R	R	R	MS	R	S	R	R	R	R	R	MS	R	R	R	R	R	MR	R	R
Agatha (Lr19)		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Valgerardo		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Valselva		R	R	MR	R	R	R	R	MR			R	R		R		R	MR			
Valnova	(Sel.156xCapp.)	R	R	R	R	R	R	R	MR			R	R		R		R	MR			
Valriccardo	x Capp.2-Yuma	R	R	R	R	R	R	R	MR			R	R		R		R	R			
Valforte		R	R	R	R	R	R	R	MR			R	R		R		R	R			
Valsacco		R	MR	R	R	R	R	R	MR			R	R		MR		R	MR			
Valfiora	(Sel.156xCapp.)	MR	MS	S	R	MR	MR	R	S			MR	R		MS		R	MS			
Valgiorgio		MR	S	S	MR	S	MR	R	S			MS	R		S		MR	S			
Valitalico	(Sel.156xCapp.) x Capp^2-Ld390	R	R	MR	R	R	R	R	MR			R	R		MR		R	MR			

* See text for explanation of reaction symbols

Table 2. Seedling reactions* of the differential set and of some commercial varieties to 21 biotypes of P. graminis

Differential set and commercial varieties		Physiologic races: 11						14	17		24					34						116
		Biotypes: N20	N12	N13	N6	N5	N21	N15	N4	N2	N18	N7	N14	N17	N8	N9	N3	N10	N11	N1	N19	N16
I Sr5 - Ra (C.I.14159)		S	S	S	S	MS	S	R	R	S	MR	R	R	MR	R	S	MS	S	MS	S	S	R
I Sr6 - Ra (C.I.14163)		S	S	S	S	S	S	S	R	S	S	S	S	MS	S	S	S	S	S	S	S	S
I Sr8 - Ra (C.I.14167)		R	MS	MS	S	S	S	R	S	MR	MR	R	R	MS	MS	R	S	S	R	S	MS	S
I Sr 11 - Ra (C.I.14171)		R	R	R	R	R	S	R	R	S	R	R	R	R	R	R	R	S	MS	R	R	R
Sr13 W2691 (C.I.17387)		S	R	MS	S	S	S	R	MS	MS	MS	MS	R	MS	S	R	R	R	R	MR	S	R
Sr14 Kapt. M10 1a 1.2		MS	R	S	S	MS	S	R	MS	MS	R	MR	S	MS	MS	MS	MS	S	S	S	S	R
SrTt-1 W2691 (C.I.17385)		S	MS	R	S	S	S	S	MR	S	MR	MR	MS	S	S	MS	S	R	MS	S	S	R
Mentana Sr8		MR	S	R	S	MS	MS	R	S	MR	MR	R	R	MS	MS	R	S	MS	R	MS	MS	S
Hope		S	S	S	S	MS	S	R	R	MS	MR	MS	–	R	MS	S	S	S	S	S	S	MR
Agrus		R	R	–	MS	R	R	R	R	R	R	R	–	R	R	R	R	R	R	R	R	R
Agatha		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Lee		R	R	R	R	R	MS	R	R	MS	R	R	R	R	R	R	R	S	MS	R	R	R
Valgerardo		R	MS	MS	R	MS	S	S	MR	S	MS	S	MS	MS	MS	R	MS	MR	S	MS	MS	R
Valselva		MR					S	S	MR	S	MR			R	MS		MR			MR	MS	R
Valnova	(Sel.156 x Capp.)	MR					S	S	MR	MS	MR			MS	R		R			S	MS	R
Valriccardo	x Capp.2-Yuma	MR					S	S	R	MS	MS			MR	MR		MS			MS	MS	MR
Valforte		MS					S	S	R	MS	R			MR	R		MS			MS	MS	R
Valsacco		R					R	R	R	R	R			R	R		R			R	R	S
Valfiora	(Sel.156 x Capp.)	R					R	R	R	R	R			MR	MR		MR			R	MR	MS
Valgiorgio		R					R	R	R	R	R			MR	MR		R			R	R	S
Valitalico	(Sel. 156xCapp.) x Capp.2 x Ld390	R					R	R	R	R	R			R	R		R			R	R	S

* See text for explanation of reaction symbols

Valselva, Valnova, Valriccardo and Valforte, which were derived from the same cross as Valgerado, i.e. (Sel. Romana 156 x Cappelli) = Giorgio 324 x (Cappelli^2 x Yuma), were resistant or moderately resistant. However, Valfiora and Valgiorgio, derived from the cross (Sel. Romana 156 x Cappelli) were more susceptible than Valsacco, which has the same parentage. Valitalico, from the cross (Sel. Romana 156 x Cappelli) = Giorgio 364 x (Cappelli^2 x Ld390) was resistant or moderately resistant to all biotypes tested.

It can be concluded that biotypes B17, B25 and B8, which are very aggressive on some bread wheat lines carrying very important resistance genes to brown rust, are completely avirulent on the 'Val' group of durum wheats. The results suggest that there are some resistance genes in Cappelli and in its derivative Capeiti. However, some rust biotypes, for example B10 and B26, were more virulent on some durum wheats (Valfiora and Valgiorgio), than on the differential set of bread wheats.

<u>Puccinia graminis</u>

The reactions of near-isogenic lines and of varieties carrying known resistant genes to 21 biotypes of black rust derived from 85 isolates are shown in Table 2. There is a significant differentiation between the 21 biotypes according to the reactions of the 'classical' differentials, and they could be grouped into 6 physiologic races. However, there were very large differences between biotypes of the same race, for example between N20 and N21 and between N4 and N2 (race 17).

The following conclusions can be drawn from the data reported in Table 2:

1) Agatha, carrying the <u>Sr 25</u> gene, which is closely linked with the <u>Lr 19</u> gene (McIntosh, 1973) was completely immune. Agrus was moderately susceptible only to the N6 biotype (Physiologic race 11).

2) Gene <u>Sr 11</u> conferred good resistance being ineffective only against biotypes N21, N2, N10 and N11 of those tested. The reactions of the near-isogenic line carrying <u>Sr 11</u> were similar to those of the variety Lee, which also carries <u>Sr 11</u>.

3) Near-isogenic lines carrying <u>Sr 13</u>, <u>Sr 14</u>, <u>SrTt</u> and <u>Sr 8</u> responded in different ways to different biotypes. <u>Sr 8</u> is present also in the variety Montana, and can be used to discriminate between many biotypes, even if it is not likely to be very useful in breeding programmes in Italy.

4) Wheats carrying gene <u>Sr6</u> were susceptible to all the biotypes examined except N4. This gene is obviously very race specific and is also thermolabile.

5) Valgerardo was susceptible to all biotypes corresponding to race 24. However, this variety was resistant to some biotypes of other races and susceptible to others. On the basis of the reactions of Valgerardo, some black rust biotypes were chosen to examine the behaviour of the other 'Val' varieties. Table 2 shows that Valsacco, Valfiora, Valgiorgio and Valitalico were resistant to all the biotypes used except N16 (physiologic race 116). The group of five varieties whose black rust resistance is derived from Yuma showed a similar reaction to certain biotypes but a different reaction to others.

CONCLUSIONS

The results obtained indicate that during the last two years there has been little variation in populations of *P. recondita*. Physiologic races 12 and 61 were the most prevalent, while biotypes from race 77 occurred only sporadically. The data are therefore generally in agreement with those reported in Europe during the last 20 years (Basile, 1971a; Basile *et al.*, 1972b; Paradies *et al.*, 1977; Salazar *et al.*, 1976), except that in Eastern Europe race 77 was the most prevalent (Bošković, 1976; Bócsa, 1972).

There was more evident variation in the populations of *P. graminis* both because of the many biotypes which have been identified and because of the drastic change in racial composition during the last 20 years (Basile, 1971b; Basile *et al.*, 1972a; Bócsa, 1972; Kostić *et al.*, 1972; Salazar *et al.*, 1972). The appearance of new virulence genes able to attack Valgerardo and its derivatives emphasises the necessity of searching for new resistance genes before these biotypes become widespread on new high-yielding varieties.

ACKNOWLEDGEMENTS

We are grateful to the late Professor Jose Vallega, who suggested additional material to include in our differential set of wheats.

REFERENCES

BASILE, R. (1971a). Prevalenza e distribuzione delle piu importanti razze fisiologiche di *Puccinia recondita* var. *tritici* nelle diverse regioni italiane negli anni 1953-1965. *Ann.Ist.Sper.per la Pat.Veg.* II: 39-68.

BASILE, R. (1971b). Prevalence and distribution of the most important physiologic races of *Puccinia graminis* var. *tritici* in various regions of Italy during the years 1953-1965. *Ann. Ist. Sper. per la Patol. Veg.* II: 19-38

BASILE, R., LEONORI-OSSICINI, A. & ZITELLI, G. (1972a). Rapporto biennale sulle razze fisiologiche di *Puccinia graminis* var *tritici* identificate in Italia durante gli anni 1968-1969. *Ann. Ist. Sper. per la Patol. Veg.* III: 1-11

BASILE, R., LEONORI-OSSICINI, A. & ZITELLI, G. (1972b). Rapporto biennale sulle razze fisiologiche di *Puccinia recondita* var. *tritici* identificate in Italia durante gli anni 1968 e 1969. *Ann. Ist. Sper. per la Patol. Veg.* III: 1-5

BÓCSA, F. (1972). Physiological specialisation of wheat leaf and stem rust in Hungary. *Proc. Europ. and Medit. Cereal Rusts Conf. Praha.* II: 109-113

BOŠKOVIĆ, M.M. (1976). International pathogenicity survey of *Puccinia recondita* f.sp. *tritici*. *Proc. 4th Europ. and Medit. Cereal Rusts Conf. Switzerland*, p. 75-78

BROWDER, L.E. (1971). Pathogenic specialization in cereal rust fungi, especially *Puccinia recondita* f.sp. *tritici*: concepts, methods of study and application. *Techn. Bull. 1432, U.S. Dept. of Agric.*, pp. 51.

BROWDER, L.E. (1972). Designation of two genes for resistance to *Puccinia recondita* in *Triticum aestivum*. *Crop Sci.* 12; 705-706

CARIELLO, G., CASULLI, F. & VALLEGA, J. (1977). Razze, efficacia di alcuni geni di resistenza e comportamento di alcune varietà di grano duro (*T. durum* Desf.) e di grano tenero (*T. aestivum* L.) verso *Puccinia recondita* f.sp. *tritici*, in Italia. *Phytopat. Mediter.* XVI: 51-64

KOSTIĆ, B., JOKSIMOVIĆ, S. & STOJANOVIĆ, S. (1972). Physiologic races of *Puccinia graminis tritici* and reaction of some wheat varieties. *Proc. Europ. and Medit. Cereal Rusts Conf. Praha* I: 161-165

McINTOSH, R.A. (1973). A catalogue of gene symbols for wheat. *Proc. 4th Int. Wheat Genetic Symp. Missouri*, pp. 893-938

PARADIES, M., CASULLI, F.,&CARIELLO, G. (1977). Appunti sulle razze fisiologiche di *Puccinia recondita* f.sp. *tritici* identificate in Italia nel 1976 e sul comportamento in serra verso alcune di esse di frumenti duri (*Triticum durum* Desf.). *Ann. Fac. Agr. Univ. Bari* XXIX: 139-145

SALAZAR, J. & BRAÑAS, M. (1972). Physiologic specialisation of wheat black rust (*Puccinia graminis* Pers. var. *tritici* Erikss. et Henn.) in Spain. Years 1968-1971. *Proc. Europ. and Medit. Cereal Rusts Conf. Praha I*: 239-242

SALAZAR, J., BRAÑAS, M. & MARTINEZ, M. (1976). Physiological specialisation of wheat leaf rust in Spain, 1972-1975. *Proc. 4th Europ. and Medit. Cereal Rusts Conf. Switzerland*: 90-92.

STAKMAN, E.C., STEWART, D.M. & LOEGERING, W.Q. (1962). Identification of Physiologic Races of *Puccinia graminis* var. *tritici*. *U.S. Dept. Agric. Res. Ser.*, *E617* (Revised): 54 pp.

WATSON, I.A. (1977). The national wheat rust control programme in Australia. *Pl. Breed. Inst., Univ. Sydney*: pp. 24

THE LEAF RUST PROBLEM ON WHEAT IN BULGARIA IN 1977-78

BY NENO DONCHEV

Institute for Wheat and Sunflower, Tolbuhin, Bulgaria

Leaf rust (*Puccinia recondita tritici*) is a problem of utmost importance for wheat production in Bulgaria. It is a common disease of wheat in that country because the agroclimatic conditions favour its development. The pathogen can also spend the summer and winter months in the uredospore stage on wheat volunteers and on new sowings. These factors make the problem of leaf rust much more important than that of stem rust (*P. graminis tritici*) or yellow rust (*P. striiformis*) which, although potentially more destructive and harmful to wheat plants, are not so important, mainly because they occur only sporadically. Thus in the last 20-25 years stem rust has not been widespread in the main wheat-growing areas in Bulgaria and has not caused any serious damage. The following factors are probably responsible for this situation:

1. The pustules (uredinia) of stem rust are not able to survive the unfavourable conditions of the summers and winters with a consequent decrease in numbers of initial foci of infection.
2. The barberry (*Berberis* spp.), an intermediate host of this pathogen, is common only in two regions of Bulgaria and these are far away from the main wheat-producing areas. *Berberis* is therefore unimportant.
3. The initial infection of wheat in spring is caused by uredospores carried on winds originating from South Greece, Italy and North Africa. The relative unimportance of stem rust in Bulgaria could be due either to the absence in these countries of races of *P. graminis* that are virulent towards the wheat varieties grown in Bulgaria or to the resistance of most wheat varieties grown there to stem rust. This would limit and delay the multiplication of inoculum.

Yellow rust is a problem in most regions along the Black Sea coast and in the north-eastern part of Bulgaria. This disease is virtually absent in the rest of the country. Epiphytotics in the regions mentioned above have been recorded in the years of 1914, 1961 and 1964. These epiphytotics were mainly related to the growing of highly susceptible commercial wheat varieties and to a combination of climatic factors which favoured the spread of yellow rust. Oversummering and overwintering of yellow rust at the uredospore stage has not been experimentally proved, but *P. striiformis* can probably survive in this way on some related grasses (*Agropyron*, *Hordeum*, etc.).

There was little development of leaf rust (*Puccinia recondita tritici*) in the spring and summer of 1978 in Bulgaria and the disease caused little damage. The following two factors seem to be responsible for this unusual situation: 1. Winter wheat seed germinated late in the autumn of 1977 and wheat plants grew very slowly during the autumn-winter period. This limited the amount of leaf rust infection in the autumn and strongly impeded the build up of inoculum in the spring.
2. About 50% of the wheat acreage was sown with varieties possessing a very high level of adult plant resistance to leaf rust. This also slowed down the multiplication of inoculum and the development of *P. recondita* during the spring.

To determine the races of leaf rust present, 45 initial samples of *P. recondita* uredospores were collected in the spring of 1977 from different parts of the country. Out of all these, 114 monopustule cultures were obtained and identified. Identification was carried out using the standard differentials, six additional varieties and monogenic lines carrying known genes for resistance. In this way it was possible to differentiate 15 standard races, 10 subraces and 14 gene races of *P. recondita*.

Table 1 shows the standard races of *P. recondita* which were identified in 1977, together with their frequency of occurrence in the survey. It can be seen that most populations (60.5%) of leaf rust in 1977 were identified as race 77. This race was widespread throughout the country and was identified in 84.4% of the initial samples collected. Race 21 was the second most common race. Several subraces of these two races were identified (Table 2). The most frequent subraces were 77-a, 77-d and 21-c, a situation that has been relatively constant in Bulgaria during the past 4-5 years.

Table 3 gives the gene formulae of the cultures isolated and identified by us. All 114 cultures were differentiated in 14 gene races. Gene race no. 13 was the most common and was identified in 45.6% of all the different cultures. Gene races no. 11 and no. 10 were the second and third most common gene races with frequencies of

Table 1. Standard wheat leaf rust physiologic races and their distribution in Bulgaria in 1977

Races	Frequency of occurrence in: Monopustule cultures		Different parts of the country		Initial samples	
	number	%	number	%	number	%
6	1	0.87	1	10	1	2.2
13	3	2.68	3	30	3	6.6
20	3	2.68	2	20	3	6.6
21	14	12.30	6	60	10	22.2
26	1	0.87	1	10	1	2.2
42	1	0.87	1	10	1	2.2
58	1	0.87	1	10	1	2.2
76	10	8.70	5	50	5	11.1
77	69	60.50	10	100	38	84.4
84	2	1.75	2	20	2	4.4
85	1	0.87	1	10	1	2.2
114	2	1.75	2	20	2	4.4
122	4	3.50	2	20	4	4.4
184	1	0.87	1	20	1	2.2
186	1	0.87	1	20	1	2.2

Table 2. Reactions of the additional differential varieties against different biotypes of the standard races 21 and 77 of *Puccinia recondita tritici* in 1977

Biotypes and subraces	% from monopustule cultures	Additional differential varieties: 76^c	57^b	Kneja 234	Av-rora	Dimi-trovka 5-12	5517 A5-5 -1-1
21	0.87	0	0-1	0;	0	0;	0;
21^a	1.75	4	3-4	0;	4	0-1	0;
21^b	5.3	0	0-1	0;	4	0;	0;
21^c	0.87	0	3	0	4	0;	0;
21^d	0.87	4	3-4	0;	4	0;	4
21^e	2.7	4	0-1	0;	4	0;	0;
77	6.1	4	0-2	0;	0	0;	4
77^a	44.7	4	0-2	0;	4	0;	4
77^b	1.7	0-1	0-2	0;	4	0;	4
77^c	0	4	3	0;	0	0;	4
77^d	7.9	4	2-4	0;	4	0;	4

Table 3. Gene races of *Puccinia recondita tritici* and their frequency of occurrence in Bulgaria in 1977

Gene race no.	Gene or avirulence/ virulence formulae	Frequency of gene race in isolates	Which standard races and subraces they include
1	1, 3, 9, 16, 19/2a, 2d, 10, 17, 18	0.8	26
2	1, 2a, 9, 19/2d, 3, 10, 16, 17, 18	3.5	76,84,85
3	1, 9, 16, 19/2a, 2d, 3, 10, 17, 18	2.6	76
4	1, 9, 19/2a, 2d, 3, 10, 16, 17, 18	6.1	58,76
5	3, 9, 10, 16, 19/1, 2a, 2d, 17, 18	0.8	184
6	3, 9, 16, 19/1, 2a, 2d, 10, 17, 18	6.1	13,21
7	9, 10, 16, 17, 18, 19/1, 2a, 2d, 3	0.8	42
8	9, 10, 16, 17, 19/1, 2a, 2d, 3, 18	8.0	$21^b,21^d,77^a$,122
9	9, 16, 18, 19/1, 2a, 2d, 3, 10, 17	3.5	$77^a,77^g$
10	9, 10, 16, 19/1, 2a, 2d, 3, 17, 18	11.4	$21^b,21^v,21^d,77^a$,77
11	9, 16, 17, 19/1, 2a, 2d, 3, 10, 18	0.8	77^a
12	9, 18, 19/1, 2a, 2d, 3, 10, 16, 17	0.8	77^a
13	9, 16, 19/1, 2a, 2d, 3, 10, 17, 18	45.6	$21^a,21^d,77^a,77^b$, 77^g,114,i 122
14	9, 19/1, 2a, 2d, 3, 10, 16, 17, 18	10.5	$77^a,77^g$

Table 4. Efficiency of leaf rust resistance genes in laboratory and field conditions

Genes for resistance	On seedlings - % monopustule isolates to which the respective gene was resistant	On adult plants - % leaf area infected by leaf rust
Lr_1	13.0	100/S
Lr_{2a}	3.5	100/S
Lr_3	7.7	100/S
Lr_9	100.0	0
Lr_{10}	21.0	45/M
Lr_{16}	80.4	65/M
Lr_{17}	9.6	25/M
Lr_{18}	5.1	5/R
Lr_{19}	100.0	0
Lr_{12}	0.0	0
Lr_{13}	0.0	0

SHORT COMMUNICATION

LEAF AND STEM RUST OF WHEAT IN ROMANIA IN 1978

LEAF RUST

Detected five years ago, race 77-73 of P. recondita (Cereal Rusts Bulletin 1, 35, 1974) has become the main component of the Romanian leaf rust spectrum, now comprising over 90 per cent of the total population. However, a new race, designated R 58-77D, which is specific to a durum wheat strain, DF 19-71, has been detected in experimental fields at Fundulea, but the newly released winter durum wheat variety TOPAZ is still fully resistant to leaf rust.

Due to the release and the widespread use of some new Romanian winter wheat varieties possessing either adult plant and/or seedling resistance (Table 1), no significant attacks of leaf rust have been reported during the period 1974-1978.

Table 1 Reaction to leaf and stem rust of some Romanian wheat varieties at Fundulea, 1978*

Variety	Leaf rust		Stem rust	
	Seedling reaction	Adult plant reaction	Seedling reaction	Adult plant reaction
DACIA	S	VR	S	S
CERES	S	VR	S	S
ILEANA	S	R-MR	X,S	MR-MS
IULIA	S	MR,MS	S	S
DIANA	S	VR	X,S	MS
DOINA	S	VR	S	S
MONTANA	S	VR	S	S
SILVANA	S	VR	S	S
POTAISSA	S	R-MR	S	S

* VR = very resistant
R = resistant
MR = medium resistant
MS = medium susceptible
S = susceptible

STEM RUST

Although stem rust is present in Romania in most years, there have not been severe attacks of stem rust since 1944-45.

The main component of the stem rust population of Romania is still race 34 which, since 1971, has made up over 50 per cent of the population of *P. graminis*.

Usually late in the season, stem rust attacks are kept at very low levels in Romania not by resistant varieties, but by the earliness of the Romanian winter wheat varieties which are otherwise susceptible to this rust (Table 1). However, new domestic strains and varieties of wheat which possess fully effective genes for resistance to stem rust are being produced and will be released in the next few years. These should give a better protection against possible attacks of stem rust.

M. Ionescu-Cojocaru
Research Institute for Cereals and Industrial Crops
Fundulea
Romania

OBITUARY

DR. IR. WILLEM FEEKES (1907 - 1979)

Willem Feekes was born 27 December 1907 in Meester Cornelis, Java, Indonesia. He died 9 February 1979 in Groningen, The Netherlands.

His studies started at the Landbouwhogeschool (Agricultural University) in Wageningen. After receiving his Ingenieursdiploma (equivalent to an MSc degree) in 1930 he worked as a scientific consultant in the laboratory of the "Zuiderzeewerken". With the publication "De ontwikkeling van de natuurlijke vegetatie in de Wieringermeerpolder, de eerste grote droogmakerij van de Zuiderzee" he received in 1936 his doctorate at the Landbouwhogeschool and had also published many other papers in this field. He had the gift of observation that marks the real naturalist.

In 1934 he became a member of the "Technische Tarwe Commissie" after which he devoted his main interest, energy and enthusiasm to cereals. In several reports he published results, observations and ideas. His "De tarwe en haar milieu" (Groningen, 1941) became a standard work about experimentation with cereals. It also included the "Feekes Scale" for the growth stages of cereals which has been used throughout the world for more than 30 years.

In 1938 Dr. Feekes joined the firm G. Geertsema in the Nordoost-polder and Groningen as the scientific head of cereal breeding, a post which involved much travelling. The main purpose certainly had been to broaden the Dutch variety spectrum and to find material from other countries which would be useful in the Netherlands, but as it turned out he became a European catalyst. He was involved in 1950 in the founding of the "Stichting voor Coordinatie van Cultuur en Onderzoek van Broodgraan (CocoBro)" (changed in 1955 into "Stichting Nederlands Graan-Centrum") (Netherlands Grain-Centre; a non-profit foundation), of which he was President during his last years. His knowledge of varieties, diseases, pests, ecotypes, conditions, and last but not least, people, together with his generosity and enthusiasm made him also one of the founders of the European and Mediterranean Cereal Rusts Foundation.

With the background of the Netherland Grain-Centre, Feekes, together with the late Dr. S. Broekhuizen, initiated in 1955 the European Yellow Rust Trials Project followed by the First European Yellow Rust Conference, held in Braunschweig in 1956. He always maintained an interest in work on cereal rusts, and kept in close touch with his colleagues, communicating, critically discussing and sharing his experiences. Whenever possible, Feekes attended meetings on wheat. When the work of the day was done, he rapidly became the centre of a cheerful circle from which many new scientific ideas were generated.

Dr. Feekes has been honoured on several occasions: the last and most important for him was in 1978 when he became an "Officier de l'Ordre Grand-Ducal de la Couronne de Chêne". The Foundation wants to honour this outstanding scientist, practitioner and friend with the assurance that his work and his personality will never be forgotten.

Eva Fuchs
Braunschweig