EPIDEMIOLOGICAL STUDIES ON WHEAT RUSTS IN SIMLA HILLS

SURVIVAL AND MULTIPLICATION OF YELLOW RUST INOCULUM AT THE SOURCE

by D. SURYANARAYANA*, L. B. GOEL *and* V. C. SINHA
Plant Pathological Station, Flowerdale, Simla

In cereal rusts, the availability of inoculum is a limiting factor in the growth of an epidemic and therefore it becomes the main or even sole object of forecasting research. In forecasting the cereal rust outbreaks in the plains of India the first step would be to study the survival and multiplication of rust inoculum at the source before the start of the epidemic because it is known that low rust severities at the source reduce the danger at the target area. Recently, some studies have been undertaken by the authors with a view to studying the problem of survival and multiplication of wheat rusts in Simla hills. Yellow rust is observed on self-sown plants in Galu (8,000 ft.) during the off season. As soon as a regular crop is sown (September end), it gets heavily infected with this rust, when the crop is in 2-3 leaf stage.
When the inoculum passes to the regular crop, it multiplies in a matter of few days and the spores are blown to the foothills and the nearby plains by the daily katabatic winds. Rainfall, frost and temperature are important factors in the multiplication of the inoculum at the source.

INTRODUCTION

Development and geographic distribution of plant diseases depend much upon climatic factors such as rainfall, humidity, temperature, etc. This is particularly true for those diseases which affect aerial parts and are subject to highly fluctuating environments. Wheat rusts are world-wide in their occurrence and often cause serious losses annually by reducing yields. Mehta (1959) wanted cereal rust problem to be considered as a national emergency and called for the initiation of control measures in a concerted and systematic way. Recently, some carbamates were used to control black and brown rusts in areas with dry summers. In India also, parzate and Dithane Z-78 have been used for the control of wheat rusts. More recently, chemicals containing nickel have been used successfully for the control of black and brown rusts (Forsyth and Peterson 1960) and also against yellow rust (Hardison 1963). Systemics like plant vax and vitavax have also been used successfully for controlling rusts. These chemicals are oxathiin derivatives. According to Powelson and Shanner (1966) and Hardison (1966), these chemicals give protection to the crop for several weeks.

From the foregoing, it is likely that we may soon have chemicals, chiefly compounds acting systemically, in sufficient quantities to make large-scale chemical control of wheat rusts economically feasible. The process of chemical

**Present address* : Mycology Division, Indian Agricultural Research Institute, New Delhi 110012.

control can be effective and economical only if there is a proper forecasting system.

Observations and Experimental Results

Studies were undertaken to locate specific areas where the wheat rusts, particularly yellow rust, could survive almost all the year round. For this purpose, periodical surveys were conducted in the upper Simla hills above 7,000 ft (Table I). Yellow rust was not observed at Narkanda (9,200 ft) in the colder months of January, February and March. But it was present at lower altitudes (8,200 ft) at Matiana, during these months. On the other hand, during summer months of May to September, it was present at Narkanda. However, it was absent for most of the time at Theog which is situated at lower elevations (6,500 ft). Galu (8,000 ft) appears to be the only place out of all the places surveyed which supports the yellow rust infection all the year round. In the absence of regular wheat crop during the month of July to middle of October, it flourished well on the ratoon tillers as well as on the self-sown plants near the threshing floors. It was also observed that as soon as a regular crop was sown (wheat is sown near Galu during the end of September) it was found heavily infected with this rust, when the crop is in 2-3 leaf stage during the third week of October 1968. The same situation was again observed in 1969.

Table I

Yellow rust race flora isolated from different localities in H.P.

District	Locality	Altitude (ft)	Races isolated from self-sown plants surviving off season	Races from regular wheat crop in the same area
Mahasu	Galu	8,000 ft	31, 38	13, 31, 38
,,	Narkanda	9,500 ,,	14, 38	14, 38, 57
,,	Shillaru	8,500 ,,	14, 57	14, 57
,,	Matiana	8,200 ,,	20, 38	G, 13, 38
Bolaspur	Bilaspur	3,000 ,,	—	14
Mandi	Mandi	2,500 ,,	—	14, 38
Sirmor	Dhaulakuan	1,800 ,,	—	14, 57
Mahasu	Solan	5,000 ,,	—	20

Analysis of the rust samples collected from these localities yielded races 14, 20, 38 and 57 of yellow rust from the self-sown plants surviving during the off season. The same race flora was met with from the regular wheat crop in the season both from the hilly as well as foothill regions. The presence of these races on regular wheat crop in the hills and foothill region presents evidence to show that infection in the lower hills as well as adjoining plains comes from the upper hills. Surveys were also made to follow the downward spread of the yellow rust infection. For instance, heavy infection of yellow rust was recorded on self-sown plants and regular

wheat crop at Galu (8,000 ft) in Simla hills. Its appearance was recorded at Shoghi (6,000 ft) on December 16, Gurdaspur on January 6, Dhaulakuan by January 25. By the second week of February, it was observed at several places in the Punjab, Haryana, Western U.P. and Sriganganagar in Rajasthan, according to the information given in the rust newsletters, issued by the IARI, New Delhi.

Discussion

In cereal rusts the availability of inoculum is a limiting factor in the growth of an epidemic and, therefore, becomes an important object of forecasting research. In forecasting, the cereal rust outbreaks in the plains of India, the first step would be to study the survival and multiplication of rust inoculum at the source before the start of the epidemic because it is known that the low rust severities at the source reduce the danger at the target area. In India most of the wheat is grown in the Indo-Gangetic plains. Mehta (1940) has shown that there is no local source of infection in the plains and every year inoculum into the plains blows down from certain foci in the hills. When the inoculum from the self-sown plants passes to regular crop, it is soon multiplied and the spores are blown into the foothills and the nearby plains by daily katabatic winds. Katabatic winds flow down from the hills every night in the clear weather. If there is enough inoculum on the out-of-season plants or on the regular crop sown in the hills near out-of-season plants then rust outbreaks follow on the foothills. Mehta on the basis of the study of a large number of wind trajectories came to the conclusion that rust outbreaks have followed the course of prevalent winds in relation to spore shower.

In the present studies the races of yellow rust have been the same as those isolated from the subsequent regular crops in the hills as well as foothills of Simla. In view of this, it appears logical to conclude that yellow rust survives in the hills during the off season and is responsible for its reoccurrence on the regular crop in the foothills and nearby plains.

Rainfall is an important factor in the establishment and subsequent multiplication of the inoculum on the regular crop in the hills. Most of the wheat under Simla hills is grown as a rain-fed crop as the irrigation facilities are very scarce. The wheat is sown during the months of September to October in different parts of this area. The successful germination and growth of the crop depends entirely on the rainfall. In some areas, cultivators start wheat sowings after the first showers; if there are no rains many of them do not undertake sowings at all. In the latter case, the inoculum cannot pass from the self-sowns and it will die out. Even if the inoculum passes from the self-sown plants to the regular crop by their side, it will die out along with the host, if the subsequent rains are not there. Such a situation has been observed by the authors at several places. During 1970, so far we have not had any rains since October; in contrast to this, in the previous years 1968 and 1969, comparatively, there were more rains and surveys undertaken showed more yellow rust infection. From this situation, it can be reasonably assumed that the foothills of Simla region and the adjoining plains will suffer little from the ravages of yellow rust in the wheat season.

Frost is another important factor that has to be considered while discussing the multiplication of the inoculum at the source. Frost of −3°C does not harm the

rust but moderate frost reduces rust development by killing the sporulating parts of the leaf. Simla region has about 50–60 frost days during the month of December, January and February. From this it is clear that frost retards the multiplication of the inoculum at the source.

At low temperature, yellow rust was found to survive as slow-growing mycelium in the Galu and other regions. Similar reports were made by Straib (1938) and Zadoks (1961) and this mycelium will survive under the snow cover also, which is received in this area usually between the 2nd half of December, January and 1st half of February. It is only after snow cover melts that the incipient infection becomes manifested and this is responsible for damage caused by the yellow rust in the hill crops. It does not, however, account for the infection in the plains which can be traced to the pre-snow cover infection on the hill crop.

ACKNOWLEDGEMENTS

The authors are very thankful to Dr. S. P. Raychaudhuri, Head of the Division of Mycology and Plant Pathology, Indian Agricultural Research Institute, New Delhi, for his keen interest and constant encouragement in these studies.

REFERENCES

Forsyth, F. R., and Peterson, B. (1960). Control of leaf and stem rust of wheat by Zineb and inorganic nickel salts. *Pl. Dis. Reptr.*, **44**, 208-211.

Hardison, J. R. (1963). Commercial control of *Puccinia striiformis* and other rusts in seed crops of *Poa pratensis* by nickel fungicides. *Phytopathology*, **53**, 209-216.

———— (1966). Systematic activity of two derivative of 1–4 Oxathiin against smut and rust diseases of grasses. *Pl. Dis. Reptr.*, **50**, 624.

Mehta, K. C. (1940). Further studies on cereal rusts in India. Part I. *Scient. Monogr. Coun. agric. Res. India*, **14**, 224 pp.

———— (1950). Control of rust epidemics of wheat in India. A national emergency. *Sci. Cult.*, **15**, 263-270.

Powelson, R. L., and Shanner, G. E. (1966). An effective chemical seed treatment for the systematic control of seedling infection by strips rust (*Puccinia striiformis*). *Pl. Dis. Reptr.*, **50**, 806-807.

Straib, W. (1938). Untersuchungen zum verlauf der Herbstinfektion und Uberwinterung des Gelbrostes auf weizen und Greste. *Phytopath. Z.*, **11**, 331-359.

Zadoks, J. C. (1961). Yellow rust on wheat : Studies in epidemiology and physiologic specialization, *Neth. J. Pl. Path.* (formerly *Tijdschr. PlZiekt*), **67**, 69-256.