RUST AND SMUT DISEASES OF WHEAT IN INDIA

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Abstract

Wheat diseases in India were last summarized in 1961. During the last 2 years extensive nationwide disease surveys were made. This paper describes the current situation for rust and smuts only. The three rusts, brown, yellow and black rusts, were widespread and the most important diseases of wheat in India. Loose smut was generally distributed throughout the country, but flag smut, bunt, and karnal smut were important only in certain areas. The resistance of the major dwarf wheats to the diseases was indicated when known.

During 1968-69, India produced about 18 million metric tons of wheat, mostly Triticum aestivum, but in central India T. durum was popular, and in south India T. dicoccum was grown. The crop is grown mostly in winter between November and April on about 33 million acres, but some is grown in summer in the high valleys of the Himalayas and in the hills of south India on a few thousand acres.

Until 1965 Indian wheat production was stagnant at about 10 million tons or less per year. After dwarf wheats were introduced, annual yields steadily increased to the record of 1968-69. Interest in high yields is great and plant diseases are of major concern. The last general review of wheat in India was made in 1961 by Pal (7) and his book will be cited when we refer to older literature. To provide current information, extensive wheat disease surveys were made in 1967-68 and 1968-69 and our conclusions for rusts and smuts are summarized in this report (Table 1).

MATERIALS AND METHODS

The main wheat-growing region of India was surveyed in 1967-68 and 1968-69 at about 2-week intervals beginning in mid-December until the middle of March. The areas surveyed included the states of Himachal Pradesh, Uttar Pradesh, Delhi, Punjab, Harayana, Rajasthan, Madhya Pradesh, and the northern part of Maharashtra. The survey crews traveled along designated highways and visited farm fields at about 20-mile intervals. When necessary, diseased tissues were examined in the laboratory to help identify the pathogens involved.

More distant portions of the country were surveyed less intensively by special crews several times during the wheat-growing season, as well as during the summer. The summer surveys were made to obtain information about diseases on the summer crop and on volunteer plants. Thus, the wheat-growing regions of Mysore, southern Maharashtra, Andhra Pradesh, Gujarat, Bihar, and West Bengal were surveyed.

RESULTS AND CONCLUSIONS

Most wheat diseases in India are caused by fungi, but a few are caused by bacteria, viruses and nematodes. Because wheat is usually grown when it is cool and rainfall is limited, only a few diseases are of major importance, but not every season. Many diseases are of minor importance because they do not usually occur in the main wheat belt. Many diseases are merely reported, but their importance is not known (7).

Rust: Rusts are the most important diseases of wheat in India. Most loss estimates are based on the Barclay account (7) and are reported to vary from 1 to 10% annually. Severe epidemics in 1946-47 in Madhya Pradesh and in 1956-57 in Bihar produced famine conditions in both states. Attempts are being made to estimate losses from experimental plots. Unpublished data of Joshi and Pathak are typical and indicated 9-15% loss in the Delhi region even during years when rust developed late in the season.

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Table 1. Rusts and smuts of wheat in India, their relative importance and main areas of distribution.

Disease	Pathogen	Importance	Distribution
Yellow rust	Puccinia striiformis West.	Major	Northwestern hills and plains
Brown rust	Puccinia recondita Rob. ex Desm.	Major	General
Black rust	Puccinia graminis Pers. f. sp. tritici Eriks. & E. Henn.	Major	General
Loose smut	Ustilago tritici (Pers.) Rostr.	Major	General
Bunt	Tilletia caries (DC.) Tul.	Major	Northern hills
	T. foetida (Wallr.) Liro	Major	Northern hills
Karnal bunt	Neovossia indica (Mitra) Mundkur	Minor	Northwest plains
Flag smut	Urocystis tritici Koern.	Minor	Northern hills and adjacent plains

In 1967-68 yellow rust was severe on susceptible varieties in the extreme north. Brown rust was moderately severe on susceptible varieties in the northern half of India. Black rust was light to moderate on local varieties in the northern half. Extremely dry conditions prevented severe rust development in the south. Most of the dwarf wheats were resistant to the three rusts, except some, like Sonora 64, which were susceptible to yellow rust. During 1968-69 in the major wheat-growing areas, rust was late and developed to light severities. In the south, however, black rust was severe on irrigated wheat, including some of the previously resistant dwarf wheats.

Epidemiological studies made in India by Mehta (5) are the basis for many present concepts. Rusts do not survive the summer on the Indian plains because of heat. Our surveys indicate two major sources of primary inoculum in India. One source is in the north where yellow, brown and black rusts oversummer in the Himalayan hills on summer-grown wheat and possibly on grasses. During early January, yellow rust moves onto the plains along the foothills in Punjab and spreads south as the season progresses. Its southward spread is checked near Delhi by hot weather in February. Brown rust spreads onto the plains in early January, usually in the eastern portion of the country south of Nepal, and then spreads northwest and south. Mehta reported (5) black rust comes out of the Himalayan hills, but our survey suggests the Himalayan hills were a minor source of black rust inoculum during the last 2 years. In 1967-68 and 1968-69 black rust was first observed in northern India during the first 2 weeks of March.

The hills of south India appear to be the second major source of primary inoculum for rusts. In these hills only brown and black rusts of wheat occur, but they are present throughout the year on self-sown and cultivated wheat. The importance of grasses is not fully known. In early January the rusts are found in the hills of Mysore and Maharashtra and they rapidly spread northward, covering the entire country. By mid-March the northward moving epidemic of brown rust usually meets the southward moving epidemic and it is no longer possible to distinguish the two.

The distribution of yellow rust in India is restricted by temperature. On wheat in the northern plains it does not occur south of Delhi or east of Bihar. It is extremely destructive in some years, however, and susceptible varieties usually cannot be grown profitably. Yellow rust is absent from wheat in central and south India. Durum and bread wheats developed in south and central India are usually destroyed by yellow rust when grown in north India.

Black rust occurs throughout India. It may persist throughout the year in the Himalayan hills and in the hills of south India. In the north, epidemics generally develop late in the spring probably because, earlier in the year, it is too cold in the hills to favor rapid multiplication of inoculum and because it is too cool on the plains to favor stem rust development before late February or March. Our 2 years' observations indicate that a good deal of the inoculum for epidemics comes from the southern parts of India. Sometimes severe outbreaks of black rust occur in November in Mysore, making it impossible to cultivate susceptible varieties profitably.

Brown rust is also distributed throughout India. Because it is more tolerant of cold weather than is black rust, it appears earlier in the north. It oversummers both in the northern and southern Indian hills. In most years it is probably more destructive than is black rust.

Yellow rust races 13, 19, 20, 24, 31, 57, A, D, E, F, G, and H have been identified. Brown rust races D, 10, 11, 12, 17, 20, 26, 61, 63, 70, 77, 106, 107, 107-A, 108, 131, 162, 162-A, 162-B have been identified. Black rust races 11, 14, 15, 15-C, 17, 21, 21-A, 21-A-1, 24, 34, 34-A, 40, 42, 42-A, 42-B, 72, 75, 117, 117-A, 122, 126, and 194 have been identified (6, 8). Work with yellow rust races has been greatly hampered because at Simla, where races are identified, temperatures are favorable for only 3 months. Thus, we know little about the distribution of yellow rust races in India. At present, brown rust races 12, 77, and 162 and black rust races 21, 34, and 42 are most prevalent. Conclusions about the distribution of races have to be tentative because less than a thousand samples are identified each year. Present information, however, suggests that virulent races may be distributed over the country in a few years after their discovery. The virulence capabilities of races of brown and black rusts have not been fully determined, but races 11, 15-C, 17, 34-A, 42-B and 122 of black rust and races 77, 107-A and 162-A of brown rust are considered to be most virulent in India.

New races of rusts arise but their origin is not known. We have not adequately sampled the rust populations and thus continue to find new races. The alternate hosts of brown and black rusts are not important in India; at least they have never been found infected with rust capable of attacking wheat. Mutation and parasexual processes may be sources of variation (9).

Resistant varieties have been the major means for controlling wheat rusts (7). At one time the wheats NP 718, NP 790, NP 809, Ridley and others were resistant to one or more of the rusts, but they are susceptible at present. In recent years dwarf wheats which had their origin in Mexico were introduced. At present, Kalyan Sona is the most widely grown of these dwarf wheats. When released, it was resistant to black and yellow rusts but susceptible to brown rust. It is now susceptible to brown and black rusts. The disease reactions of the important dwarf wheats are shown in Table 2. Whether the races attacking these new wheats will become widespread and destructive remains to be seen.

With the introduction of the dwarf wheats, a number of seed farms came into being, and there is now considerable interest in fungicides to control rust. Dithiocarbamates have been promising (2) and 2,3-dihydro-5-carboxanilido-6-methyl-1,4-oxathiin-4,4-dioxide (Plantvax) has been studied. There is considerable interest in aerial application of pesticides in India and it may be that chemical control of rusts and other foliage diseases of wheat will soon be attempted on a large scale.

Loose Smut: Loose smut occurs in the hills and on the plains wherever wheat is grown. In 1967-68 about 7% of the plants in northwestern India were infected, and some fields had as many as 50% infected plants. In 1968-69 only about 2% of the plants were infected, probably because of the widespread cultivation of Kalyan Sona, which appears to have field resistance. It is easy to miss infected plants because the peduncle of infected dwarf plants does not elongate and the diseased ears usually are below the level of the crop.

Little is done to control loose smut in India other than to attempt to utilize resistance (7). A number of older varieties were resistant, but most of the dwarf wheats were susceptible (4). Kalyan Sona and PV 18 have field resistance, but other dwarf wheats are susceptible in the field. Hot water treatments are not often used any more. The value of 2,3-dihydro-5-carboxanilido-6-methyl-1,4-oxathiin (Vitavax) has been confirmed but it is not available in India (1).

Table 2. Disease reactions of important dwarf wheats in India in the field with natural infection.

Variety	Brown rust	Black rust	Yellow rust	Loose smut	Flag smut
Choti Lerma	S	R[a]	R	R	S
Safed Lerma	S	R[a]	R	S[b]	S
Sonalika	R[c]	S	R	R	S
Kalyan Sona	S	S	R	R[b]	S
Sonora 64	S	R	S	S	S
Sharbati Sonora	S	R	S	S	S
Lerma Rojo 64A	S	R[a]	R	S[b]	S

[a]Susceptible in a nursery at Wellington. R indicates resistance.
[b]Has field resistance.
[c]Not tested at Wellington, an area in south India where many resistant materials prove susceptible.

Bunt: Common bunt is caused by Tilletia caries and T. foetida and karnal (not kernel) bunt is caused by Neovossia indica; dwarf bunt does not occur in India. Bunt may cause severe damage. Mitra found 30-40% loss in 1935 (7); frequently 10% loss occurs. We have seen fields with 50% of the heads smutted. Bunt is mainly restricted to the hills in the western Himalayas and in Kashmir. It occurs very rarely in the plains where the source of infection is presumed to be through contaminated seed from the hills. Chances of inoculum surviving in the plains from year to year appear to be small due to heat. T. foetida occurs between 3500 and 5000 ft above sea level, while T. caries occurs above 5000 ft. It has not been reported from south India.

Attempts to produce bunt-resistant varieties have been made, and Kalyan Sona was resistant at Simla. Mercurial seed treatments control the disease, but this method is not widely utilized (3).

Karnal Bunt: Karnal bunt is endemic to India (7) in Delhi, Haryana, Punjab, western Uttar Pradesh, Himachal Pradesh, Rajasthan and Kashmir. Incidence of the disease is quite low in all these areas. In 1967-68, 0.2% of seeds from local wheat markets were infected. The disease differs from common bunt in several important characteristics: it is not seedborne, it is not systemic, it is floral infecting but each floret is infected individually, kernels may be only partially infected, and spores are produced in the same year that infection occurs.

Karnal bunt probably is best controlled by resistant varieties, but none have been produced. The pathogen is difficult to handle and artificial epidemics cannot be easily induced. Many popular older varieties such as NP80.5 and Pb.C 591 were susceptible, as are the new dwarf varieties. A few durum wheats offer promise as sources of resistance.

Flag Smut: The disease has been known since 1906, but little has been done with it (7). It occurs in some parts of Punjab, Himachal Pradesh, Rajasthan and Uttar Pradesh. The pathogen is externally seedborne and inoculum may remain viable in soil for at least a year. Seedlings may escape infection when sown early when the temperature is about 28°C. Seed treatment with fungicides effectively reduced infection. The dwarf wheats were all susceptible at Gurdaspur, Punjab.

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