

- 6. GROGAN, R. G. 1967. Ouchterlony agar double-diffusion tests for determining specific precipitin reactions between antigens and antibodies. In A. Kelman, et al. (Ed.), Sourcebook of Laboratory Exercises in Plant Pathology. W. H. Freeman, Co., San Francisco, California. pp. 154-156.
- 7. MUELLER, W. C. 1965. Progressive incidence of alfalfa mosaic virus in alfalfa fields. (Abstract) *Phytopathology* 55: 1069.
- 8. ZSCHAU, von K., and C. 1966. Untersuchungen zur Verbreitung des Luzernemosaikvirus an Luzerne. *Pflanzenschutzdienst*. 16: 94-96.



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Pflanzenschutz-

CROPS RESEARCH DIVISION, AGRICULTURE, UNITED STATES
DEPARTMENT OF AGRICULTURE, DEPARTMENT OF PLANT PATHOLOGY, UNIVERSITY
OF MINNESOTA, ST. PAUL, MINNESOTA

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DISEASES OF WHEAT IN INDIA OTHER THAN RUSTS AND SMUTS

L. M. Joshi¹, B. L. Renfro², E. E. Saari³,
R. D. Wilcoxson², and S. P. Raychaudhuri¹

Abstract

Wheat diseases in India were last summarized in 1961. This paper describes diseases of wheat noted during the past 2 years, with the exception of rusts and smuts. Leaf spot diseases were widespread; *Helminthosporium sorokinianum* and *Alternaria triticina* were the most important pathogens. Locally, diseases caused by *Septoria tritici* and *S. nodorum* were severe. The nematode diseases, ear cockle and molya, were widespread. Other diseases, such as powdery mildew, downy mildew, black point, root rot and seedling blight, and virus diseases, occur but their importance is largely unknown.

Interest in high yields of wheat is great in India and one of the major concerns has been disease. Pal (9) made the last general review of wheat diseases in India. To provide more recent information, nationwide surveys were made in 1967-68 and 1968-69 and our conclusions are summarized in this report. Conclusions about rusts and smuts have been reported (5). The methods used for the survey have been described (5).

RESULTS AND CONCLUSIONS

Many diseases of wheat in India are merely reported (9), but their importance is not known. Our conclusions, summarized in Table 1, are based on 2 years of surveying in Himachal Pradesh, Uttar Pradesh, Delhi, Punjab, Harayana, Rajasthan, Madhya Pradesh, Maharashtra, Andra Pradesh, Gujarat, Bihar, West Bengal and Mysore.

Glume Blotch: Glume blotch was first discovered in India in 1952 (9) in the Nilgiri Hills of south India on *Triticum dicoccum* when 5% of the plants produced seed in areas where the disease was severe. Since 1952 it has been noted but has not been considered important. In the summer crop of 1969, an epidemic occurred in the Nilgiri Hills and at Mukteshwar, in the Himalayan Hills of north-central India. Many dwarf varieties were susceptible, except Sharbati Sonora and Choti Lerma.

¹Mycologist and Head of Division of Mycology and Plant Pathology, respectively.

²Plant Pathologists, The Rockefeller Foundation and University of Minnesota, respectively.

³Plant Pathologist, The Ford Foundation.

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Table 1. Diseases of wheat other than rusts and smuts in India, their relative importance and main areas of distribution.

Disease	Pathogen	Importance	Distribution
Glume blotch	<i>Septoria nodorum</i> (Berk.) Berk.	Minor	North and South hills
Speckled leaf blotch	<i>Septoria tritici</i> Rob. ex Desm.	Minor	Northern hills
Leaf blight	<i>Alternaria triticina</i> Prasada & Prabhu	Major	General, especially in east and south-central India
Leaf spot	<i>Helminthosporium sorokinianum</i> Sacc. ex Sorokin	Major	General, especially in eastern U.P., Bihar and West Bengal
	8 other pathogens	Reported	
Powdery mildew	<i>Erysiphe graminis</i> DC. f. sp. <i>tritici</i> Em. Marchal	Minor	North and South hills and adjacent plains
Downy mildew	<i>Sclerospora macrospora</i> Sacc.	Reported	Northwest plains
Black point	<i>Alternaria tenuis</i> Nees ex Cda.	Minor	
Root rot and seedling blights	11 pathogens	Reported	
Ear cockle	<i>Anguina tritici</i> (Steinbuch) Chitwood	Major	General in North
Tundu	<i>Anguina tritici</i> and <i>Corynebacterium tritici</i> (Hutchinson) Bergy, et al.	Major	General in West
Molya	<i>Heterodera avenae</i> Wollenweber	Major	General in West
Virus diseases	Wheat streak mosaic plus 2 others	Minor	General

Speckled Leaf Blotch: This disease is prevalent (17) in the hills of north India, in Punjab, Haryana and Himachal Pradesh and possibly Rajasthan and Uttar Pradesh. It first appears in January and reaches its peak in March, when it is checked by rising temperatures. The pathogen does not survive in soil, but is found on seed and in crop debris. Resistant varieties provide the best means of control and the dwarf wheats Kalyan Sona, PV 18, Lerma Rojo, Sonora 63, Sonora 64, Safed Lerma and Choti Lerma were free from infection at Gurdaspur in 1967-68 when a local epidemic occurred (20).

Leaf Blight: *Alternaria triticina* is widely prevalent and destructive in many parts of the country (12). In Andhra Pradesh entire fields have been destroyed. Symptoms usually appear when plants are about 8 weeks old (Fig. 1). The disease is more severe when cultural practices are used that produce weakened plants. Thus, drought and lack of fertilizer greatly aggravate it. The pathogen is seedborne and this source of inoculum may be important in development of some epidemics; seed lots of some varieties have contained up to 12% infected seed. Not much is done to control leaf blight except to utilize good cultural practices. Seed treatments are not completely effective. Soaking seed in water for 4 hours, plus chemical treatment is effective but not used (12). Resistance is known in some varieties such as Agra Local, but many varieties and lines, including the dwarf wheats, are susceptible.

In greenhouse trials the dwarf wheats Choti Lerma, Safed Lerma, Sonalika, Kalyan Sona, Sonora 64, Sharbati Sonora and Lerma Rojo 64A were susceptible. Because the severity of the disease varies with cultural practices, it is possible that some of these wheats may be tolerant in the field when good agronomic practices are employed. Races of the pathogen may occur. Because of lack of facilities, breeding for resistance to leaf blight has not advanced very rapidly.

Leaf Spot: At least nine pathogens have been reported to cause leaf spots on wheat in India (9): *Helminthosporium sorokinianum* Sacc. ex Sorokin [= *H. sativum*], *H. spiciferum* (Bain) Nicot., *H. tritici-repentis* Died., *H. nodulosum* Berk. & Ant., var. *tritici* Patel, Kamel & Padhye (10), *H. atypicum* Deshpande & Deshpande (3), *Dilophospora* sp. (6), *Piricularia oryzae* Cav., *Phoma* sp., and *Stagonospora hennebergii* (Kuehn) Petrak & Syd. *H. sorokinianum* is most frequently encountered. Leaf spot is found throughout the country and is especially important in the eastern part, in Bihar and West Bengal. Little has been done to control leaf spot except to look for resistance. NP 710 and NP 790 and some other older varieties were moderately resistant, but the dwarf wheats of current interest are susceptible: Choti Lerma, Safed Lerma, Sonalika, Kalyan Sona, Sonora 64, Sharbati Sonora and Lerma Rojo 64A.

Powdery Mildew: Powdery mildew is prevalent in the hills of north and south India. Sporadic outbreaks may occur in the plains; in 1968-69 a severe epidemic occurred at Pantnagar, and it was observed at Delhi. The mode of survival and origin of primary inoculum is not known, although it is assumed that the fungus moves up and down the mountains as the seasons change in a manner similar to that of the rust fungi (9). Some collections of mildew differ pathogenically from others and varietal differences in resistance occur (11). Breeding materials are screened for resistance, but no other control measures are being developed or used. The dwarf wheats Choti Lerma, Safed Lerma, Sonalika, Kalyan Sona, Sonora 64, Sharbati Sonora, and Lerma Rojo 64A are susceptible.

Downy Mildew: This disease has been reported only from the Gurdaspur, Punjab area (19).

Black Point: Black point is not economically important in India in most years. In 1967-68, however, prolonged wet weather prevailed over much of the wheat-growing area just before harvest time and black point was widely prevalent. *Alternaria tenuis* was most commonly associated with the disease, along with *A. triticina*, *H. sorokinianum*, and other fungi (2, 4). There was little black point in 1968-69.

Root Rot and Seedling Blights: The importance of these diseases is not fully known, although they have been reported from time to time. The diseases have received little attention other than to note their presence and to describe pathogens. Eleven pathogens have been reported (1, 8, 9, 16, 18), *Helminthosporium bicolor* Mitra, *H. halodes* Drechs., *H. sorokinianum*, *H. tetramera* McKinney, *Fusarium culmorum* (W.G. Sm.) Sacc., *Rhizoctonia* sp., *Ophiobolus* sp., *O. graminis* Sacc., *Sclerotinia sclerotiorum* (Lib.) d By. *Sclerotium rolfsii* Sacc., and *Pythium graminicola* Subramaniam.

Nematode Diseases: Molya disease, caused by *Heterodera avenae*, a cyst-forming nematode, attacks roots, thereby producing stunted yellow plants. Its known distribution is in western India. Infection occurs during November when seedlings are small. Some varieties like Agra Local, NP 718, NP 771 and Sonora 64 appear to be tolerant. *H. avenae* has a number of grass hosts, which makes control by cultural practices difficult, but crop rotation may have some benefit (15).

Ear cockle, caused by *Anguina tritici*, is widespread in India in the main wheat belt. It was common in 1967-68 but rare in 1968-69. When weather is warm and dry, ear cockle develops, but when it is humid and cool, tundu develops. Tundu is caused when both *Corynebacterium tritici* and *A. tritici* attack wheat. The bacterium is carried on the body of the nematode as a contaminant.

Control of ear cockle and tundu is achieved by floating the nematode galls away from the seed in salt water. Early planting reduced the incidence of tundu. Among the dwarf wheats, Lerma Rojo, Sonora 64 and Kalyan Sona are tolerant. Other nematodes reported on wheat are *Pratylenchus thornei* Sher & Allen, *Tylenchorhynchus* sp. and *Hoplolaimus* sp. (9).

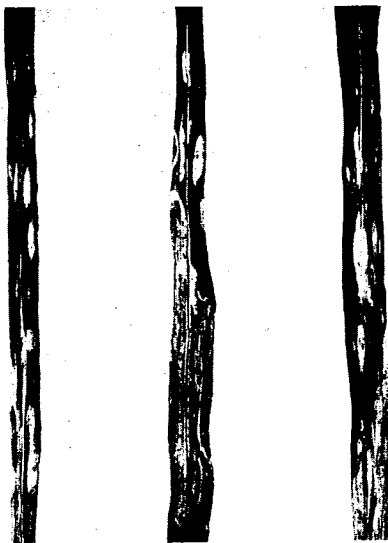


FIGURE 1. Leaf blight of wheat caused by *Alternaria triticina*.



FIGURE 2. Symptoms on wheat incited by wheat streak mosaic virus.

Viruses: Virus diseases are of little known importance to wheat in India. Wheat streak mosaic occurs in most parts of the country on many plants including soybean, cardamon, ginger, orchid and wheat (Fig. 2) but not on rice, oats, barley, or maize. The virus is transmitted by the aphids Rhopalosiphum maidis, R. padi, Brachycadus helichripi and Sitobion avenae. All of the dwarf wheats are susceptible, but some older wheats such as Ridley are resistant (13, 14). Barley yellow dwarf and barley mosaic are reported on wheat, but their distribution and importance are not known (7).

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Literature Cited

1. AGRAWAL, A. C., and S. P. SINGH. 1968. Foot rot disease of wheat in Madhya Pradesh. Pest Articles and News Summaries Sect. B. 14: 147-151.
2. DASTUR, J. F. 1932. Foot rot and black point diseases of wheat in the Central Provinces. Agr. Livestock in India 2: 275-282.
3. DESHPANDE, K. S., and K. B. DESHPANDE. 1966. Contribution to the taxonomy of genus *Helminthosporium* I. Sydowia 20: 39-46.
4. DHARAMVIR, K. L. ADLAKHA, L. M. JOSHI, and K. D. PATHAK. 1968. Preliminary note on the occurrence of black point disease of wheat in India. Indian Phytopath. 21: 234-235.
5. JOSHI, L. M., B. L. RENFRO, E. E. SAARI, R. D. WILCOXSON, and S. P. RAYCHAUDHURI. 1970. Rust and smut diseases of wheat in India. Plant Disease Repr. 54: 391-394.
6. MUNJAL, R. L., and T. N. KAUL. 1961. Dilophospora leaf spot of wheat. Indian Phytopath. 14: 13-15.
7. NAGAICH, B. B., and K. S. VASHISTH. 1963. Barley yellow dwarf: a new viral disease for India. Indian Phytopath. 16: 318-319.
8. PADWICK, G. W. 1940. A new disease of wheat in India. Curr. Sci. 9: 179-180.
9. PAL, B. P. 1966. Wheat. Indian Council of Agricultural Research, New Delhi. 370 pp.
10. PATEL, M. K., M. N. KAMAT, and Y. A. PADHYE. 1953. A new *Helminthosporium* on wheat. Indian Phytopath. 6: 15-26.
11. PRABHU, A. S., and R. PRASADA. 1963. Physiological races of wheat powdery mildew in Simla and Nilgiri hills. Indian Phytopath. 16: 201-204.
12. PRABHU, A. S., and R. PRASADA. 1966. Pathological and epidemiological studies on leaf blight of wheat caused by *Alternaria tritricina*. Indian Phytopath. 19: 95-112.
13. RAYCHAUDHURI, S. P., V. V. CHENULU, and B. GANGULY. 1969. Electron microscopy on rice and wheat viruses in India. Internat. Symp. on Electron Microscopy in Life Sciences. Calcutta. pp. 25-26.
14. RAYCHAUDHURI, S. P., and B. GANGULY. 1968. A mosaic streak of wheat. Phytopath. Zeitschr. 62: 61-65.
15. SESHADRI, A. R. 1968. Research on diseases of wheat caused by nematodes --nematode bacterium and nematode fungus complexes. Seventh All-India Wheat Research Workers Workshop. Pantnagar.
16. SHARMA, O. P., and A. C. JAIN. 1967. Root rot of wheat in Madhya Pradesh. Indian Phytopath. 20: 267-269.
17. SINGH, S., and A. SINGH. 1967. *Helminthosporium* blight in Mexican wheats. Sixth All-India Wheat Research Workers Workshop. Delhi.
18. SUBRAMANIAN, C. V. 1962. Foot rot disease in wheat. Curr. Sci. 31: 46-49.
19. TYAGI, P. D., and S. C. ANAND. 1968. Downy mildew of wheat in India. Plant Disease Repr. 52: 569.
20. TYAGI, P. D., L. M. JOSHI, and B. L. RENFRO. 1969. Reactions of wheat varieties to *Septoria tritici* and report of an epidemic in North Western Punjab. Indian Phytopath. 22: 175-178.

DIVISION OF MYCOLOGY AND PLANT PATHOLOGY, INDIAN AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, INDIA