

- MAINS, E. B., 1930.—Host specialization of barley leaf rust, *Puccinia anomala* Rostr. *Phytopathology*, 20: 873-882.
- MAINS, E. B., and JACKSON, H. S., 1924.—Aecial stages of the leaf rusts of rye, *Puccinia dispersa* Erikss. and Henn., and of barley, *P. anomala* Rostr., in the United States. *Jour. Agric. Res.*, 28: 1119-1126.
- RIDGWAY, R., 1912.—Color standards and color nomenclature. Washington, D.C., U.S.A. Publ. by Author, pp. 43, pl. 53.
- STRAIB, W. VON, 1937.—Zur Frage der auf *Hordeum murinum* L. vorkommenden Rostarten und der Selbständigkeit von *Puccinia hordei* Fuck.. *Ber. dtsh. bot. Ges.*, 55: 120-125 (not cited).
- , 1937.—*Rev. Appl. Mycol.*, 16: 524 (abstract).
- WATERHOUSE, W. L., 1927.—Studies in the inheritance of resistance to leaf rust, *Puccinia anomala* Rostr., in crosses of barley. *Jour. Proc. Roy. Soc. N.S.W.*, lxi: 218-247.
- , 1929.—Australian Rust Studies. I. *Proc. Linn. Soc. N.S.W.*, liv: 615-680.
- , 1952.—Australian Rust Studies. IX. *Proc. Linn. Soc. N.S.W.*, lxxvii: 209-258.
- WATSON, I. A., and BUTLER, F. C., 1948.—Resistance to barley leaf rust (*Puccinia anomala* Rost.). *Proc. Linn. Soc. N.S.W.*, lxxii: 379-386.
-

## DISEASES OF RICE IN AUSTRALIA.

By P. G. VALDER, Biological Branch, New South Wales Department of Agriculture.

(Plate vi, A; one Text-figure.)

[Read 27th July, 1955.]

*Synopsis.*

Apart from downy mildew (*Sclerospora macrospora* L.), which has not been recorded for many years, no parasitic diseases of rice are known in New South Wales. In this paper the occurrence is reported in northern Australia of leaf smut (*Entyloma oryzae* H. & P. Syd.) on *Oryza australiensis* Domin and *O. sativa* L. (wild and cultivated forms), brown spot (*Helminthosporium oryzae* Breda de Haan) on *O. australiensis* and *O. sativa* (wild form), and blast (*Piricularia oryzae* Cav.) on *O. sativa* (cultivated forms). Other fungi of minor importance are also recorded.

*Diseases Recorded in New South Wales.*

Apart from an old record (Noble et al., 1934) of downy mildew (*Sclerospora macrospora* Sacc.), there have not been any records of parasitic diseases of rice in New South Wales. Downy mildew has not been observed for many years and it may well be that the fungus concerned was *S. oryzae* Brizi. Padwick (1950) supports the view that this fungus is restricted to rice and is morphologically distinct from *S. macrospora*. Unfortunately herbarium specimens have not been located and the identity of the fungus remains in doubt.

In New South Wales rice is grown in two inland districts under irrigation. The climate is semi-arid and no doubt this is partly responsible for the absence of diseases caused by pathogens. However, a number of non-parasitic disorders occur, of which one of the most frequently observed is a purplish-brown pigmentation of areas of glumes and leaves. This seems to be a characteristic of the varieties concerned and has no apparent detrimental effect. A brown discoloration of the caryopses is also of common occurrence and in all the specimens examined has been associated with the presence of *Alternaria* spp. of the *A. tenuis* type. These fungi have been consistently isolated from such grains and from pieces of discoloured pericarp. Microscopical examinations have demonstrated the presence of dark hyphae within the pericarp but not penetrating the endosperm. Such hyphae are rare within the pericarps of grains of normal appearance and the condition seems analogous with black point or smudge of wheat (Shaw and Valder, 1952). Germination tests in soil and on moist filter paper have not yielded any diseased seedlings either from discoloured or apparently normal grains.

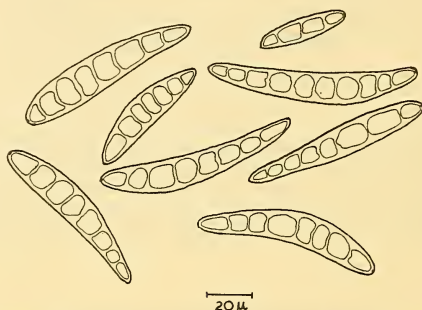
A species of *Phoma* has been noticed on bleached areas of the glumes and, although no investigations have been carried out, the appearance of the affected areas suggests that the fungus is of doubtful or weak pathogenicity. There have been instances overseas where similar fungi have been reported to have caused appreciable damage (Padwick, 1950).

Another commonly occurring condition has been described as a "blasting of the spikelets with release of starch grains". This has been found to be a mechanical injury caused by finches, which snap at the spikelets when the grain is in the "milk ripe" condition. Such spikelets frequently become overgrown with moulds, predominant amongst which is *Cladosporium herbarum* Link ex Fr.

*Diseases Recorded in Northern Australia.*

A number of rice diseases have been recorded recently in northern Australia, where cultivated varieties are being grown experimentally in several localities. Australian rice (*Oryza australiensis* Domin) and wild rice (a form of *O. sativa* L.) occur here naturally.

In 1953, at the invitation of the Commonwealth Director of Plant Quarantine, a visit was made by the author to northern Australia for the purpose of examining the rice disease position, and as a result a number of additional records was made. Further observations may well reveal the presence of other diseases.



Text-fig. 1.—Conidia of *Helminthosporium oryzae* from a leaf of *Oryza sativa* (wild form) collected on Humpty Doo Station, Northern Territory.

The diseases so far known to occur in northern Australia are as follows:

*Leaf Smut*: The recorded occurrence of Leaf Smut (*Entyloma oryzae* H. & P. Syd.) is shown in Table 1. This fungus is not considered to cause noticeable losses and is regarded by Zundel (1939) as synonymous with *E. lineatum* (Cke.) J. J. Davis, a smut occurring on *Zizania aquatica* L.

TABLE 1.  
*Records of the Occurrence of Entyloma oryzae H. & P. Syd. in Australia.*

Date.	Locality.	Host.	Collector.
March, 1951 ..	Kimberley Research Station, Ord River, W.A.	<i>Oryza sativa</i> L.	L. C. Lee.
February, 1952 ..	Lower Ord River, W.A.	<i>O. australiensis</i> Domin.	L. C. Lee.
March, 1953 ..	Lower Ord River, W.A.	<i>O. australiensis</i> Domin.	P. G. Valder.
March, 1953 ..	Kimberley Research Station, Ord River, W.A.	<i>O. sativa</i> L.	P. G. Valder.
March, 1953 ..	Humpty Doo Station, N.T.	<i>O. sativa</i> L.	P. G. Valder.
March, 1953 ..	Humpty Doo Station, N.T.	<i>O. sativa</i> L. (wild form).	P. G. Valder.

The fungus and the disease, which has a characteristic appearance, are well described by Padwick (1950). On *O. australiensis* the sori are inclined to be confluent and frequently appear longer than they do on *O. sativa*.

*Brown Spot*: Records of the occurrence of brown spot (*Helminthosporium oryzae* Breda de Haan) are set out in Table 2. At the time of the author's visit the disease was very common on *O. australiensis* and on the wild form of *O. sativa*, which was growing abundantly in and around the experimental plots in the Northern Territory. Only the leaf spot phase of the disease was present. The symptoms and the morphology of the fungus agree closely with the descriptions set out by Drechsler (1923) and by Padwick (1950), who summarizes the literature. The fungus was also easily identified using Luttrell's (1951) key. Leaves of *O. australiensis* with young lesions are shown in Plate vi, A, fig. 1.

Conidia from leaves collected in the field measured  $10-17\mu \times 12-115\mu$  with up to nine septa. Little reliance, however, can be placed on spore measurements alone as a diagnostic characteristic, as the conidial dimensions of species of *Helminthosporium* are notoriously variable, both between isolates of the one species and between conidia of the one isolate produced under different conditions. Those of *H. oryzae* are usually widest about one-third of the distance from the base, and Australian isolates show an inconspicuous hilum within the contour of the base (Text-fig. 1).

Although there was considerable variation in the cultural characteristics of the different isolates, they agreed closely in morphology and in host range as determined in glasshouse tests, whether they were isolated from *O. sativa* or *O. australiensis*. They also agreed with isolates obtained from a seed sample imported from Malaya and all proved to be capable of infecting "Federation" wheat, "Skinless" barley, "Vicland" oats, "Dawn Hybrid" maize, "Kalo" sorghum, "Caloro", "Blue Bonnet" and "Rexoro" rice and *Cynodon dactylon* (L.) Pers. but not *Pennisetum clandestinum* Hochst. Padwick (1950) states that many workers have noted the wide host range on cereals and grasses of *H. oryzae* under laboratory conditions. He considers that the resistance of grasses to species of *Helminthosporium* is relative only and can be broken down by presenting an abundance of inoculum and ideal conditions for infection. This has been found to be largely true also for various species isolated from grasses in New South Wales and it will be interesting to see whether the *H. oryzae* present on the wild rices in northern Australia will attack cultivated varieties in the field.

TABLE 2.  
*Records of the Occurrence of Helminthosporium oryzae Breda de Haan in Australia.*

Date.	Locality.	Host.	Collector.
March, 1952 ..	Lower Ord River, W.A.	<i>O. australiensis</i> Domin.	L. C. Lee.
March, 1953 ..	Lower Ord River, W.A.	<i>O. australiensis</i> Domin.	P. G. Valder.
March, 1953 ..	Humpty Doo Station, N.T.	<i>O. sativa</i> L. (wild form).	P. G. Valder.

Padwick (1950) could find no record of natural infection of any host other than *O. sativa* except *O. montana* from Togo. This record was made by Roger (1935), who did not give an authority for the name, although the Director, Royal Botanic Gardens, Kew, states, in a personal communication, that it is very probable that *O. montana* Lour., which is now regarded as a form of *O. sativa*, was intended. If this is the case, the record of the natural occurrence of *H. oryzae* on *Leersia hexandra* Sw., a grass present in Australia, in India by Chattopadhyay and Chakrabarti (1953) is the first on a host other than *O. sativa* and that on *O. australiensis* the second. It is not yet known whether the perfect stage, *Cochliobolus miyabeanus* (Ito & Kurib.) Drechs. ex Dastur, occurs in Australia.

*Rice blast*: Early in 1954 leaves of cultivated varieties from the experimental areas near Darwin were forwarded by Mr. W. Stahl, of the Department of Territories. These were carrying lesions caused by the blast fungus (*Piricularia oryzae* Cav.) (Plate vi, A, fig. 2). This disease had been reported previously from an experimental plot in Queensland in 1950. The fungus was isolated and shown to be capable of infecting "Magnolia" rice. The literature concerning the disease is summarized by Padwick (1950).

#### *Other diseases:*

*Curvularia* spp. and *Nigrospora oryzae* (Berk. & Br.) Petch are ubiquitous on dead tissues of rice in northern Australia, sometimes being associated with minute leaf spots and discoloured grains. *Phoma* spp. have also been observed. Although most of the *Curvularia* isolates are close to *C. lunata* (Wakk.) Boed. or *C. maculans* (Baneroff) Boed., there is considerable variation and many seem to be intermediate between these and other species. In glasshouse tests *Curvularia* spp. and *Nigrospora oryzae* have

produced small lesions on "Caloro". Seed rice produced near Darwin, when germinated at 30°C. on moist filter paper and in soil, gave rise to a number of seedlings with brown lesions on the coleoptiles from which *Curvularia* spp. were isolated. The subsequent development of such seedlings, however, was unaffected and it seems likely that, apart from their ability to discolour the grain, these fungi are of little importance. Cralley and Tullis (1937) and Mundkur (1946), however, credit *Curvularia* spp. with considerable virulence.

Hence it appears that while, apart from saprophytic or weakly parasitic fungi causing discolorations, there are at the present time no parasitic diseases known on rice in New South Wales, several such diseases have been observed already on wild and cultivated rice in northern Australia and, should rice growing become established in that area, there may be disease problems from which the industry in New South Wales is fortunately free.

#### Acknowledgements.

Sincere thanks are extended to Dr. T. H. Harrison, Director of Plant Quarantine, for arranging the visit to northern Australia, and to Miss J. W. Vickery, National Herbarium, Sydney, for identifying the wild rice specimens.

#### References.

- CHATTOPADHYAY, S. B., and CHAKRABORTI, N. K., 1953.—Occurrence in nature of an alternate host (*Leersia hexandra* Sw.) of *Helminthosporium oryzae* Breda de Haan. *Nature*, Lond., 172: 550.
- CRALLEY, E. M., and TULLIS, E. C., 1937.—Effect of seed treatments on seedling emergence, severity of seedling blight, and yield of rice. *Arkansas Agric. Exp. Sta. Bull.* 345.
- DRECHSLER, C., 1923.—Some graminicolous species of *Helminthosporium*. *J. Agric. Res.*, 24: 641-739.
- LUTTRELL, E. S., 1951.—A key to the species of *Helminthosporium* reported on grasses in the United States. *Plant Dis. Repr. Suppl.* 201.
- MUNDKUR, B. B., 1946.—Report of the Imperial Mycologist. *Sci. Repts. Agric. Res. Inst., New Delhi, for the Triennium ended 30th June, 1954*, pp. 57-63.
- NOBLE, R. J., HYNES, H. J., MCCLEERY, F. C., and BIRMINGHAM, W. A., 1934.—Plant diseases recorded in New South Wales. *N.S.W. Dept. Agric. Science Bull.* 46.
- PADWICK, G. WATTS, 1950.—Manual of rice diseases. Commonwealth Mycological Institute, Kew.
- ROGER, L., 1935.—Notes de pathologie végétale. *Agron. colon.*, 24: 139-147.
- SHAW, DOROTHY E., and VALDER, P. G., 1952.—A study of the microflora of wheat grains in New South Wales. *Proc. Linn. Soc. N.S.W.*, 77: 307-322.
- ZUNDEL, C. L. L., 1939.—Ustilaginales—additions and corrections. *N. Amer. Flora*, 7: 1019.

#### EXPLANATION OF PLATE VI, A.

1. Leaves of *Oryza australiensis* showing young lesions of brown spot (*Helminthosporium oryzae*).
2. Leaves of *Oryza sativa* showing lesions of rice blast (*Piricularia oryzae*).