except a slight stimulatory effect of the lower concentration of NaCl (0.5%) in the case of C 306 calli at 30 days. The observed response to salinity was, however, remarkably different between the two genotypes. At both the NaCl concentrations and at 30, 45 and 60 days of growth C 306 calli showed higher salt tolerance as compared to those of var HD 4502.

In vitro and *in planta* responses to salt stress were of different magnitude, as expected. Inherent differences in salt tolerance at the cellular (calli) level are likely to be modified substantially through the superimposition of anatomical/morphological features of the adult plant. Significant differences in respect of calli growth response to salinity stress suggest that genetic variability of wheat germplasm collections needs to be studied critically for salt tolerance of their calli. Confirmation of genotypic differences in salt tolerance of calli by follow-up studies will open up new possibilities in breeding efforts directed towards genetic improvement of salt tolerance in wheat varieties.

17 May 1986; Revised 2 August 1986

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VERTICAL BANDED BLIGHT—AN UNUSUAL MARASMIELLUS DISEASE OF MAIZE

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SINCE 1975, a widespread disease characterized by large, bleached, elongate lesions surrounded by irregular but vertically-oriented bands or zonations (figure 2b) has been observed to occur on maize foliage in Western Uttar Pradesh, Punjab, Haryana, Rajasthan and Madhya Pradesh in *kharif* (summer) crop season. The disease usually appears in August but no signs of a pathogen like fructifications, mouldy growth, etc are present. Periodic field observations showed that fungal fructifications develop in September particularly after rainy spells. In a gross way (with naked eye) they resemble irregularly curled but more or less discoid sclerotia of *Thanatephorus sasakii* Tu and Kimbr (*Rhizoctonia solani* Kuhn). With magnification these structures get resolved into agaricoid fructifications (basidiomata) complete with stipe and pileus. The basidiomata are highly evanescent and the time of collection is crucial for spotting them.

The association of an agaricoid fungus (Order Agaricales, Subdivision Basidiomycotina) with a leaf disease in maize is rather rare. Indeed this appears to be the first example of such a disease, though it possibly is similar to that reported by Latterell and Rossi[1] from Mexico, Costa Rica and Nicaragua in Central America. The species of *Marasmiellus*, found associated with it was not however determined. Since we have been able to collect fully mature fructifications containing basidiospores and since a technique to produce the basidiomata experimentally when needed has been devised, we document the identity and description of the species. In addition, a comparative account of symptomatology of this disease and the other caused by *Thanatephorus sasakii* (*Rhizoctonia solani*), known as Banded leaf and sheath blight, for designating the former with another common name disease, Vertical banded blight, is presented.

Marasmiellus paspali (Petch) Singer, Sydowia, 9, p. 386, 1955.

Pileus (2–5 mm in dia) (figure 1), hemispherical, unshining, pale ochraceous to light ferrugineous, feebly sulcate, pruinose; *lamellae* venose, fanning out from the stipe, white or creamish, dark brown on drying, adnate, somewhat distant, arcuate, 5 to 8 complete ones, occasionally branched; *stipe* (2–5 × 0.5–2 mm) (figure 1), eccentric, cylindric, recurved, almost black on drying, solid at first then fistulose, pruinose; *context* creamish to white, thin, usually not gelatinous; *spores* 9.0–10.5 (12.5) × 6.0–7.5 (8.0) μm ovate to subamygdaliform with a prominent apiculus, hyaline, smooth, inamyloid; *basidia* 21–32 × 6–9 μm, clavate, thin-walled, hyaline, with 4 short sterigmata (up to 3 μm long), pileal surface an epicutis having a strong *Rameales* structure formed by numerous, diverticulate almost coralloid, dark coloured pilocystidia, 14.0–36.0 × 4.5–8.0 μm; caulocystidia numerous, yellowish brown to dark brown, diverticulate, strongly *Rameales* structured; clamp connexions abundant on hyphae; basidiomata develop on adaxial leaf surfaces.

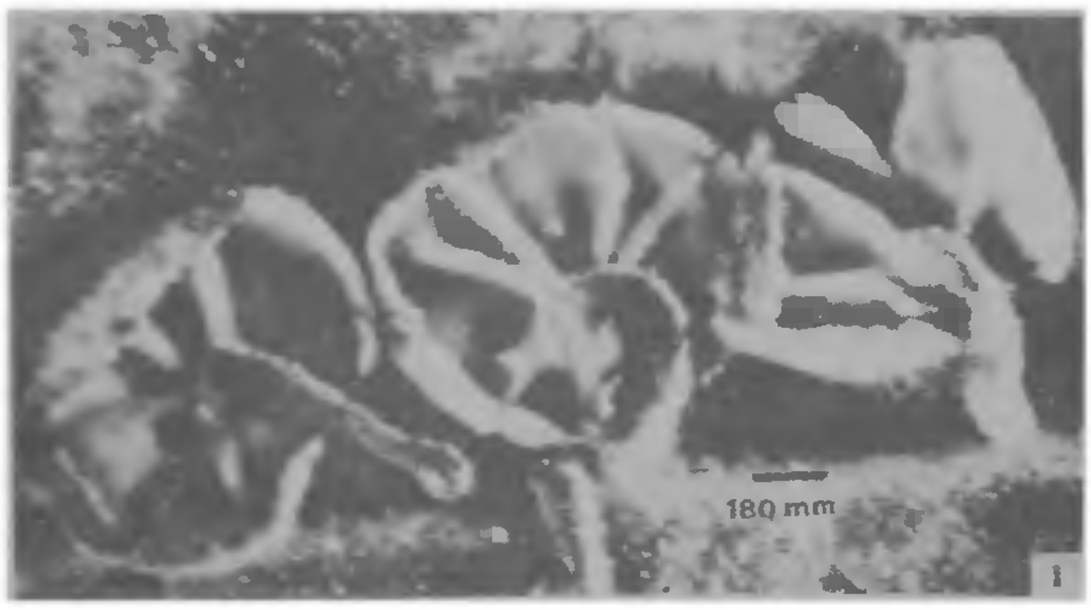

Figure 1. Three basidiomata of *Marasmiellus paspali* on a maize leaf (×9): Black bar is equivalent to 1 mm.

Figures 2A and B. A leaf piece of maize showing symptoms of horizontal banded blight. A leaf piece of maize showing symptoms of vertical banded blight.

On living leaves of *Zea mays* Linn (many genotypes, experimental breeding materials etc), Pantnagar, District Nainital, Uttar Pradesh, *Payak*, September 18, 1976 (HCIO No. 37167; also at Royal Botanical Gardens, Kew, UK).

The fungus was readily culturable and developed on potato-dextrose-agar (PDA) white to creamish, dense growth radiating in a fan-like manner on the glass walls (of the containers). The hyphae were 1.5–3.0 μm wide and the majority of them showed the presence of clamp connexions. After two weeks the growth becomes interspersed with dark, somewhat wavy streaks or strands demarcating irregular zonations.

Abundant growth was also produced on autoclaved whole barley grains in Erlenmeyer flasks. Extensive caking occurred and more than two-week old cultures showed dark lines or streaks similar to those observed in old cultures on PDA.

Pathogenicity tests were conducted in the field and on excised leaf pieces (30–40 cm length) together with sheaths of hybrid Ganga 5. The sheaths were submerged to a depth of 2 to 3 cm in 100 ppm kinetin solution in 100 ml Erlenmeyer flasks with the laminae projecting in free humid air in covered cylindrical jars. Bits of mycelial inoculum were stuck on adaxial surfaces of leaf blades. In about 6 days small white spots had developed; the lesions increased in size and zonations or bands formed subsequently in 7 days. The banded appearance of lesions was identical to that observed in nature.

Controlled production of fructifications (basidiomata) of *Marasmiellus paspali* was carried out in glasshouse. Whole barley grains with one-month old growth were removed and separated individually, placed on soil surface in 9 cm plastic pots, seeded

with four maize kernels/pot 2–3 days prior to inoculation. The pots contained a mixture of fine river sand and lateritic clay loam soil in equal proportion. The initiation of the primordia of basidiomata was observed in 5–7 days and fully mature fructifications developed after another 5 or 6 days; the process of production thus was completed in about 12 days in an ambient temperature regime of 25 to 30°C. The basidiomata thus produced agreed in all characters with those found on leaf lesions in nature except that they were more robust and had larger pilei and stipes.

The fungus under discussion was first recorded by Petch[2] from Sri Lanka on *Paspalum dilatatum* Poir as *Marasmius paspali* which was transferred to *Marasmiellus* by Singer[3]. The same fungus was found to be associated with an identical leaf disease of maize in Guinea[4] and in Sierra Leone[5].

Inability to determine the taxon at species level by Latterell and Rossi[1] possibly might have been due to non-availability of mature fructifications possessing basidiospores. In the Indian material, mature fructifications (figure 1) were spotted on maize leaves after considerable search and only on occasions following rainy spells in the field. In fact, as indicated earlier, most often no fructifications are seen on the leaf lesions; the etiology of the disease thus remains obscure. The problem was overcome by devising a method to induce basidiomata production at will from cultures on whole barley grains. This has helped in species determination and gaining information on its geographical distribution. It is clear that the pathogen is present not only in Central America but also in Asia and Africa. During a visit to Venezuela in 1977, one of the authors (MMP) observed the occurrence of this disease also in South America.

Latterell and Rossi[1] described the Marasmiellus disease under the Spanish name of 'borde blanco' (white border). The name alluded to the appearance and development of lesions near the margins of leaf blades. In their description of the symptoms, they did not emphasize the banded or zonate appearance of the lesions although they mention the presence of 'black elliptical rings' and 'fine black lines' in the lesions. It is these which delineate the zonate or banded character, a noteworthy aspect of symptomatology.

A comparison of symptoms of the Marasmiellus disease with the Banded leaf and sheath blight, alluded to earlier, will be instructive. In the latter disease the lesions and blotches show alternating purple or tan zones which result in the characteristic banded lesions[6]. In the Marasmiellus disease also a similar zonate or banded aspect of the lesions is apparent. The symptoms of the two diseases are shown juxtaposed in figure 2. On the left can be seen the symptoms of the Rhizoctonia disease (figure 2A) while on the right (figure 2B) those of the Marasmiellus disease are exhibited. An important difference can be visualized. The banding or zonations are oriented perpendicularly to the midrib or the long axis of the leaf in the Marasmiellus disease. Bands radiate more or less horizontally in the Rhizoctonia disease but they do so vertically in the new Marasmiellus disease.

The foregoing discussion suggests the need for a redesignation of the new disease by an additional or alternate common name—*Vertical banded blight* as opposed to *Horizontal banded blight* induced by *R. solani*. 'Borde blanco', though appropriate *per se*, fails to differentiate the disease caused by *Rhizoctonia solani*—a disease quite widespread in India and which occurs intermixed with the new disease. Indeed at one maize experimental station in India, the new disease caused by *Marasmiellus paspali* is confused with that caused by *R. solani*, and notes on incidence are recorded under the heading of the latter disease.

Grateful acknowledgement is due to Dr D. N. Pegler, Royal Botanical Gardens, Kew, UK for the identification of the basidiomycetous fungus.

11 August 1986

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A NEW TECHNIQUE FOR BIOASSAY OF NATURAL PLANT PRODUCT

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UTILIZATION of natural plant products is assuming importance in combating various phytopathogenic