ABSTRACT

Kochs postulates were performed to demonstrate that reddish-brown leaf spot of sugarcane is caused by *Curvularia eragrostidis* (P. Henn.) J.A. Meyer.

Symptoms of bacteriosis are described. The causal agent is still unknown. Cuttings of diseased stalks do not germinate, but cuttings of symptom free stalks of diseased stools germinate and produce healthy offspring. Extracts from diseased stalks cause decreased germination but do not infect cane cuttings. Wounding cane stalks may provide entrance of the causal agent(s).

In Indonesia *Puccinia kuehnii* (Kruger) Butler is dominant in Java and South Sumatra, but in North Sumatra, Kalimantan and Sulawesi *Puccinia kuehnii* and *Puccinia melanocephala* H. & P. Syd. (= *P. erianthi* Padv. and Khan) occur.

INTRODUCTION

To meet domestic sugar consumption in Indonesia it was decided by the government that 18 sugar factories should be built, of which eight factories have been established. Almost all of the sugar factories will be located outside the island of Java, which currently produces nearly all the sugar in Indonesia. Climatic and cultural conditions on the outer islands differ much from those in Java, i.e. high rainfall, rainfed areas and the growing of ratoon crops.

Two new diseases, reddish-brown leaf spot disease and bacteriosis which were observed in the new areas of the new sugar projects outside Java, and the causal agents of rust disease were investigated.

Reddish-brown leaf spot disease:

During the wet season of 1982 it was observed that at the Sugar Project Cinta Manis (Palembang, Sumatra) the varieties Co 449, CP 51-21, NCo 376, PR 1013 and PR 1059 showed reddish-brown spots scattered all over the leaf blades, (Figure 1), which mostly disappeared in the subsequent dry season.

The first symptoms are very small spots scattered over the leaf blades of the young leaves. The spots become oval shaped, with a diameter of about 1 mm and...
FIGURE 1. Symptoms of reddish-brown leaf spot.

a length up to 2 mm. Sometimes the spots coalesce. The inner part of the spots becomes reddish-brown and are surrounded by a light brown halo. Later, the reddish-brown parts of the spots dry, sometimes a greyish colour appears, and when rubbed with the finger it feels like powder. In later stages the heavily infected leaves become yellow then dry.

In the beginning the symptoms resemble those of brown spot disease, but later the lesions of the latter disease become much larger.

**Bacteriosis**

The name bacteriosis is given to a decay of cane stalks showing a discoloration (greyish, reddish, yellowish, pink) of the internodes (Figure 2) and a watersoaked appearance (Handojo²). The discoloration is most pronounced near the nodal region. The canopy of such plants often looks normal and green. Fermentation of the infected stalk tissue can produce a fizzing of the juice when the stalk is cut.

In the areas of the sugar factories Sei Semayang and Kuala Madu in North Sumatra some varieties, especially the variety F 156, showed scattered stools in which the leaf canopy of one or more plants and even of all the plants is withered with yellowing, drying or dead leaves. By splitting the affected cane stalks lengthwise, the above-mentioned symptoms occur. Also a typical shredding of the dead tissues of the stalks (Figure 3) occurs accompanied by typical holes arranged in a ring above the nodal region (Figure 4) at which the stalk breaks easily.

**Rust disease**

Rust disease of sugarcane is caused by two pathogens. *Puccinia kuehnii* (Kruger) Butler has been known since the end of the last century and is generally regarded as a weak parasite of minor importance. *Puccinia melanocephala* H. & P. Syd.
FIGURE 4
Symptoms of bacteriosis: internal internode symptoms (Figure 2); shedding of dead tissues (Figure 3); typical holes above the nodal region where stalks break easily (Figure 4).
= *P. erianthi* Padw. and Khan) was first reported by Patel et al in 1949 and causes much more damage to sugarcane.

Egan reviewed reports on *Puccinia* spp. attacking sugarcane since 1940 and reported that in several cases the pathogen was identified as *P. kuehnii*, but was in fact *P. melanocephala*. He proposed a reidentification of the rust pathogen, unless the identification was made recently.

The fungus causing rust disease of sugarcane in Java was first reported by Kruger in 1890 as *Uromyces kuehnii*. The name was changed to *Uredo kuehnii* (Kruger) Wakker and Went (Wakker and Went) and finally to *Puccinia kuehnii* (Kruger) Butler.

New identifications of the rust pathogen were done in Indonesia in 1985.

**MATERIALS AND METHODS**

**Reddish-brown leaf spot disease**

Leaf samples of the disease were examined at the Sugar Research Institute in Pasuruan.

- *Isolations* were made on potato dextrose agar.
- *Infection trials* were carried out in the cooler mountain region of Tretes, about 700 m above sea-level, with the sugarcane varieties Ps 56, F 154 and M 442–51 by placing pieces of the agar containing the isolated fungus upon the upper or lower side of the leaf blade and then wrapping them with a plastic sheet.

- *Reisolation and identification.*

The fungus was reisolated on potato dextrose agar and the fungus was sent to "Centraal Bureau voor Schimmelcultures" in Baarn, The Netherlands for identification.

**Bacteriosis**

**Trial 1: Transmission via seedpieces.**

30 two-node seedpieces of diseased stalks and 15 two-node seedpieces of healthy stalks of the same stools showing symptoms of bacteriosis of the varieties BZ 110 and BZ 134 were planted on March 23, 1985 and April 2, 1985 respectively. On October 12, 1985 10 mother stalks were inspected for disease symptoms.

**Trial 2: Infection via infusion of diseased stalks.**

Thirty diseased stalks were chopped into small pieces, infused for 0.5 hr in 250 L water and then sieved. Fifty two-node seedpieces of the varieties F 154 and F 156 were allowed to steep in the infusion for 2 hr before planting. Control consists of 20 two-node seedpieces of each variety. The planting date was April 4, 1985. Disease inspection was done on October 12, 1985.

**Trial 3: Infection via isolated microorganisms.**

Isolation attempts of the causal agent were made at the Indonesian Sugar Research Institute in Pasuruan. The media used were potato dextrose agar, potato dextrose peptone agar and Saeh peptone agar. Four bacteria (No. 1–4) and one fungus (No. 5) were cultured.

Infection trials were carried out in the trial fields of the Indonesian Sugar Research Institute at Sampali, Medan, North Sumatra.
Inoculum consisted of tissues of diseased cane stalks and suspensions of the isolated bacteria or fungus.

The fungus suspension was made by rinsing five tubes with one month old cultures with distilled water, each tube with 10 ml. The bacterium suspension was made by rinsing four tubes with one month old cultures with 60 ml distilled water. The suspensions were then filtered with tissue paper. With the aid of an injection syringe injections with 0.3 ml suspension were carried out on April 4, 1985 and April 9, 1985. The varieties used were F 154 and BM 261 about 6 months old. The trial was inspected every 2 weeks. Each treatment consists of 10 stalks.

The six treatments were:
1. Control.
2. Injecting the cane stalks 10 cm below the highest visible dew-lap.
3. Idem 2 with distilled water.
4. Dripping the inoculum in a hole in the cane stalk about 20 cm above ground level, afterwards the holes were closed again.
5. Idem 4 with distilled water.
6. Placing diseased tissue in a hole about 15 cm below the highest visible dew-lap, the holes were then closed again.

Rust disease

Two leaf samples from different stools from 12 sugar factories, sugar projects and the Indonesian Sugar Research Institute Pasuruan were sent to Professor Dr. Pierre Baudin, Irat/Gerdat, Montpellier, France on April 22 and May 4, 1985 for identification.

The sugar factories were Cot Girek (North Sumatra), Sei Semayang (North Sumatra), Bone (Sulawesi), Gempol (West Java), Colomadu (Centre Java) and Jatiroto (East Java). The sugar projects were Cinta Manis (Lampung, South Sumatra), Ketapang (Lampung, South Sumatra), Pelaihari (Kalimantan), Camming (Sulawesi) and Takalar (Sulawesi).

RESULTS AND DISCUSSION

Reddish-brown leaf spot

- **Isolation**
  A greyish black fungus appeared on potato dextrose agar. The mycelium was transparent, septate, branched. Conidiophores bore one or more spores (Figure 5 and 6). The spores were egg-shaped, with 2-4 cells and formed after about 3-4 weeks.

- **Infection trials**
  Two-three weeks after inoculation symptoms similar to those of reddish-brown leaf spot disease appeared on the variety Ps 56. The lesions did not occur on the whole leaf blade, possibly because of the different climatic conditions, especially humidity.
TABLE I. Percent germination of seedpieces from diseased and symptomless stalks from stools with bacteriosis.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

1) Symptomless BZ 110
2) Diseased BZ 110
3) Symptomless BZ 134
4) Diseased BZ 134

- Reisolation and identification
  After reisolation on potato dextrose agar the fungus was identified as *Curvularia eragrostidis* (P. Henn.) J.A. Meyer by the "Centraal Bureau voor Schimmelcultures" in Baarn, The Netherlands.

**Bacteriosis**

**Trial I: Transmission of Bacteriosis seedpieces.**

Seedpieces taken from diseased cane stalks did not germinate (Treatment 2 and 4, Table I) but seedpieces of symptom free cane stalks of the same diseased cane stools germinated (Treatment 1 and 3, Table I) and the offspring were healthy.
TABLE II. Percent germination after bacteriosis stalks infusion for 2 hour.

<table>
<thead>
<tr>
<th>Treatment 1)</th>
<th>% Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
</tbody>
</table>

1) F 156 seedpieces steeped in infusion
2) F 156 control
3) F 154 seedpieces steeped in infusion
4) F 154 control

**Trial 2: Infection via infusion of diseased stalks.**

Dipping seedpieces in an infusion of chopped diseased cane stalks decreased germination of the buds but the offspring were healthy (Table II).

**Trial 3: Infection via isolated microorganisms.**

Externally the growth of all cane of all treatments was normal. But by splitting the cane stalks lengthwise:

- Treatment 1, 2 and 3 did not show symptoms.
- Treatment 4 (dripping a bacterium or fungus suspension in a hole of the stalk about 20 cm above groundlevel) and treatment 6 (placing diseased cane tissue in a hole of the stalk about 15 cm below the highest visible dewlap) in general caused symptoms in the infected internode resembling symptoms of bacteriosis. The same symptoms also occurred with treatment 5, where distilled water was dripped in a hole of the cane stalk.

On August 5–6, 1985 only treatment 4 with isolate No. 3 (bacterium) on the varieties BM 261 and F 154 and isolate No. 5 (fungus) on the variety BM 261 caused disease symptoms which extended themselves to the internode above the infected one. This was also the case with treatment 6 with variety F 154.

On October 11–12, 1985 treatment 4 with isolate No. 3 and No. 5 on the variety BM 261 caused disease symptoms which were also seen in the internode above and below the infected one. With treatment 4 isolate No. 1 (bacterium), No. 4 (bacterium) and No. 5 on the variety F 154 the symptoms occurred in the internode above the infected one.

Isolate No. 3 (bacterium) especially caused some shredding of the internal stalk tissue with the variety BM 261.

**The following conclusions can be made**

- Seedpieces of diseased cane stalks do not germinate, but seedpieces of healthy cane stalks of diseased cane stools germinate and the offspring were healthy.
Infusion of chopped diseased cane stalks contain(s) an agent(s) which decrease(s) germination of the buds but do not cause bacteriosis.

- Wounding cane stalks provides entrance of microorganisms which cause symptoms of bacteriosis of the cane stalks, but the causal agent(s) need to be investigated further. This supports the occurrence of symptoms of bacteriosis in standing cane of varieties with growth cracks or when wounds were made by borers or other causes.

Rust disease

TABLE III.  *Puccinia kuehnii* and *Puccinia melanocephala* in Indonesia.

<table>
<thead>
<tr>
<th>Sugar Factory/Project, ISRI</th>
<th>Location</th>
<th>Variety</th>
<th><em>Puccinia species</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sf Gempol</td>
<td>West Java</td>
<td>M 442-51</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>Sf Colomadu</td>
<td>Centre Java</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>Sf Jatiroto</td>
<td>East Java</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>ISRI</td>
<td>East Java</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td></td>
<td>CP 31-588</td>
<td></td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>SP Cinta Manis</td>
<td>South Sumatra</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>SP Ketapang</td>
<td>South Sumatra</td>
<td>Co 853</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>Sf Cot Girek</td>
<td>North Sumatra</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>Sf Sei Semayang</td>
<td>North Sumatra</td>
<td>Q 90</td>
<td><em>P. melanocephala</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q 90</td>
<td><em>P. melanocephala</em></td>
</tr>
<tr>
<td>SP Pelaihari</td>
<td>Kalimantan</td>
<td>F 154</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td>B 4362</td>
<td><em>P. kuehnii and</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>P. melanocephala</em></td>
</tr>
<tr>
<td>SP Takalar</td>
<td>Sulawesi</td>
<td>Q 83</td>
<td><em>P. kuehnii</em></td>
</tr>
<tr>
<td>SP Camming</td>
<td>Sulawesi</td>
<td>B 4362</td>
<td><em>P. melanocephala</em></td>
</tr>
<tr>
<td>Sf Bone</td>
<td>Sulawesi</td>
<td>B 4362</td>
<td><em>P. melanocephala</em></td>
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<td></td>
<td></td>
<td>Q 90</td>
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</tr>
</tbody>
</table>

Table III shows that *Puccinia kuehnii* is dominant in Java and South Sumatra, but in North Sumatra, Kalimantan and Sulawesi *Puccinia kuehnii* and *Puccinia melanocephala* occur.
ACKNOWLEDGEMENTS

The authors thank Professor Dr. Pierre Baudin, Irat/Gerdat, Montpellier, France and the "Centraal Bureau voor Schimmelcultures", Baarn, The Netherlands for their identification of the causal organisms of rust disease and reddish-brown leaf spot disease of sugar cane respectively.

REFERENCES