

**BUREAU OF SUGAR EXPERIMENT STATIONS  
QUEENSLAND, AUSTRALIA**

**BS172S PATHOGEN RISK ANALYSIS TO PRIORITISE  
RESEARCH AND QUARANTINE NEEDS OF THE  
AUSTRALIAN SUGAR INDUSTRY**

**STUDY TOUR OF INDONESIAN SUGAR INDUSTRY  
TO ASCERTAIN QUARANTINE RISK TO  
AUSTRALIAN SUGAR INDUSTRY**

**by  
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## **EXECUTIVE SUMMARY**

Sugarcane smut and RSD occur at a high incidence and severity in the Indonesian sugar industry. Indonesia plans to close small factories and plantations on Java and establish new plantations on Irian Jaya, East Timor and Sulawesi. Movement of cane diseases in particular smut to these islands, which are closer to Australia, must be considered a major threat to the Australian Sugar Industry. Immediate discussions should be commenced to develop a plan to assist the Indonesians to prevent diseases from entering these new plantations, especially on Irian Jaya.

The Indonesian Sugar Research Institute strongly supports our proposed ACIAR project. The Institute has good facilities and should provide a good partner in attempts to improve quarantine in the region.

Other diseases of quarantine significance to Australia in Indonesia are leaf scorch which occurs on Sumatra and strains B and E of sugarcane mosaic. Downy mildew and Fiji disease occur in Irian Jaya, but not in commercial plantations.

Assisting the Indonesian Sugar Industry to control diseases, especially smut, is in the long term interests of Australia as this will reduce the risk of this serious disease entering Australia.

### **1.0 INTRODUCTION**

This study tour of Indonesia is a part of a project which plans to identify and review the literature on the major exotic diseases which threaten the Australian Sugar Industry and to prepare contingency plans to control these diseases if they enter Australia. First hand knowledge of the current status of diseases in Indonesia, one of our closest neighbours, is necessary to assess the risks posed and the potential to reduce those risks before an incursion of an exotic disease occurs. A major focus of the tour was discussions on sugarcane smut which is considered one of the most important sugarcane diseases. Smut occurs in almost all sugarcane producing countries except Australia, Fiji and Papua New Guinea. Smut was reported for the first time for 50 years in Indonesia in 1979 and is now considered one of the two most important diseases in the country.

A second objective of the study tour was to advance discussions on an ACIAR proposal on quarantine which would involve the Indonesia Sugar Research Institute, Papua New Guinea and BSES.

### **2.0 PASURUAN - INDONESIAN SUGAR RESEARCH INSTITUTE**

Discussions were held with the following personnel:-

Tonny Kuntohartono - Director of Agricultural Research

Irawan - Senior Pathologist

Lilik Koesmihartono Putra - Pathologist

Damar Sasongko - Head of Crop Protection (Weed Scientist)  
Suhartawan - Entomologist  
Djoko Pramono - Entomologist  
Mirzawan - Head of Plant Breeding

I only visited the Pasuruan research centre for one morning but had useful discussions with the personnel at the centre.

## 2.1 ACIAR Proposal

I discussed the proposed ACIAR project with Tonny Kuntohartono and the Crop Protection group. All were happy to be involved in the project. Tonny said that he had been to an ACIAR presentation in Jakarta in 1995 and had approached ACIAR staff at the meeting about the possibility of funding for a project on sugarcane. They advised him that ACIAR did not normally fund projects on industrial crops. Tonny was excited to hear that our proposal had a good chance of success. The areas that they would be interested in the ACIAR project are the surveys, improved quarantine facilities and control of smut and ratoon stunting disease (RSD). They will write a letter of support for the project and will approach the government official on their Board to also write in support of the proposal. They will also write to us to outline the research areas they would like included in the proposal.

## 2.2 Quarantine

One of the most important issues that emerged from discussions on quarantine in Indonesia was the plan to close smaller sugar mills and plantations on Java and develop new plantations on East Timor, Irian Jaya (south-east corner) and Sulawesi. The new plantations on East Timor and Irian Jaya would represent a significantly increased risk to the Australian Sugar Industry. Movement of cane diseases to Irian Jaya represents a major risk to the rich source of *Saccharum* species germplasm on this island. The cane plants to establish the new plantations would be sourced from Java. The cane would be inspected for diseases but the large amounts required to establish a plantation could not be guaranteed disease-free. Sugarcane smut is widespread on Java and the probability of transmission of smut to a new plantation must be considered high. The new plantations would almost certainly transfer RSD from Java since RSD occurs at high levels in many plantations. As well as the official movement of cane between islands, plantation staff have been known to unofficially move cane and this is thought to be the way smut spread to south Sulawesi and north Sumatra. Plantation staff have also imported canes unofficially from other countries.

This major risk to the Australian Sugar Industry and to the in situ store of *Saccharum* germplasm needs a concerted response. I can see a number of possible actions which may reduce the risk.

Firstly, we could work with the Indonesian Sugar Research Institute to educate the plantation staff on the need for both internal and international quarantine. During my visit I was able to commence this education by addressing the administrator and plantation staff of Jatitujuh Sugar Mill, the largest plantation on Java. There was also a suggestion

that I return in November to address a meeting of all senior plantation staff from throughout Indonesia. This would be a good opportunity to raise their awareness of the need for quarantine and may provide contacts for future action to prevent spread of diseases.

The second action that would directly address the risk of movement of diseased cane to the new plantations would be to work with the Indonesians to ensure that they had disease-free material to commence their plantation. The most effective and efficient way would be to establish disease-free nurseries at the sites of the new plantations well before the plantation planned to commence so that disease-free material would be available on-site. Other ways of providing disease-free material may be by in vitro propagation or treatment facilities on Java to hot water treat cane before shipping. These alternatives are less attractive for logistical reasons.

Thirdly we should assist the Indonesia Sugar Research Institute to improve their internal quarantine program. This could involve upgrading their facilities for disease diagnosis (see below).

A fourth more long-term, action would be to assist the sugar industry in Indonesia to control diseases, in particular smut, so that the risk of future movement of diseases is reduced. I believe their breeding for smut resistance needs a thorough review (see below).

Many of these suggestions could be incorporated into the ACIAR project. The establishment of nurseries at the new plantations may require some direct input from the Australian Sugar Industry.

I discussed the movement of noble canes for traditional uses between the islands and the risk that they could carry diseases. They had not considered this risk and had no policy for dealing with this type of movement of cane. They said there was a lot of travel between Irian Jaya and Java and I would consider this as a risk for their industry for the introduction of downy mildew and Fiji diseases. Movement in the other direction would be a risk to Papua New Guinea and Australia. I believe it would be very difficult to do anything about this problem. Internal quarantine is limited or does not exist. Possibly some advertising at airports may raise the awareness of the problem.

### **2.3 Pathology Research and Facilities**

There are three pathologists based at Pasuruan:

Irawan, Lilik Koesmihartono Putra and Lastri Legowa. Lastri Legowa was on leave during my visit. They consider smut and RSD to be their most important diseases and subsequently most of their research focuses on these diseases.

Smut resistance screening is conducted at Jatitujuh plantation which has a high incidence of smut infection. In the current trial they have 49 varieties planted in four replicates of 20 setts. The setts are inoculated by dipping the setts in a 1g/l spore suspension for 10 minutes and then leaving the setts overnight before planting into the field. The plots are inspected for whips at monthly intervals for six months in the plant crop and for the first

six months of the first ratoon crop. Irawan agreed to include some Q canes in their smut resistance testing. Out of the recently imported clones I asked that Q124, Q127 and Q138 be included. They told me that the percentage of resistant clones is low. In the 1995 annual report 50% of clones in the smut trials were susceptible, 25% intermediate and 25% resistant. I believe that their approach to smut resistance needs some major changes. Firstly they need to test parent clones and restrict the use of susceptible crosses in the breeding program. Secondly they need to test at a much earlier stage for smut resistance and discard susceptible clones. The detailed rating that they conduct could be reduced with ratings only once or twice in six months. They should also compare the results from plant and first ratoon crops and if there is no significant difference then trials could be completed after the plant crop.

In the near future they are commencing a project to produce monoclonal antibodies to smut. This will be used to detect the fungus before the smut “whip” symptom develops. This may be useful in quarantine and for research. They showed me cultures of smut which they planned to use for production of the monoclonals. These could be sent to Ken Damann, Louisiana State University who is conducting DNA finger printing of a world collection of smut isolates. This would be useful for Australia so that we can identify the smut type present in Indonesia. We could then obtain ratings of our commercial varieties and other overseas varieties from countries with similar smut types.

Varietal resistance to RSD was being studied in a yield loss trial on the Pasuruan research station. This was providing useful information on reaction of commercial varieties but is too cumbersome for routine testing. They had also tested the dot-blot RSD serological assay developed by Mike Davis, USA. They had found the test quite successful but had difficulty defining a cut-off in faint reactions. The test had been used for survey work. They had a phase-contrast microscope of reasonable quality but they were not confident in its use for RSD and used an EM based at Yogyakarta at the University Gajah Mada for confirmation of results. The conditions for maintenance of microscopes were not good even though they had a sealed case for their microscope. They had cultures of RSD which they intended to use to make antiserum. These cultures should be available for Steve Brumbley’s study of variation in C.x.x.

At Pasuruan they also test for leaf scald resistance by dipping setts in diseased juice and for mosaic by the Sein technique. They showed me their collection of strains A,B and E of sugarcane mosaic. Strains B and E do not occur in Australia and should be considered a quarantine risk to Australia.

Leaf scorch is currently confined to the island of Sumatra where it has caused significant yield losses. This disease could cause some disruption and losses if it entered Australia.

Generally the pathology facilities were good with laminar flow, microscope, incubators and general laboratory equipment. Their active cooperation with the university in Yogyakarta provided access to more elaborate facilities. They have budgeted for an ELISA plate reader and have general equipment needed for ELISA procedures. The EB-EIA assay used by BSES for RSD diagnosis I believe would improve their RSD diagnosis.

A copy of a number of publications on diseases in Indonesia and annual reports of the Indonesian Sugar Research Institute were obtained and are listed in Appendix 2.

### **3.0 PUTERAN, MADURA QUARANTINE FACILITIES**

International quarantine is conducted at Puteran, Madura. This is a small island off the large island of Madura (Appendix 1.). Madura can be reached by ferry from Java and it is possible to travel to the quarantine plot by car with a short boat ride to the island of Puteran. There is no commercial sugarcane on Madura but small clumps of cane were present in a few places. On Puteran the quarantine plot consisted of a well fenced area with a open shade house with a concrete floor where the imported cane is disinfected with mercuric chloride and planted into pots. The plants are held in the pots for a few months and then planted into the field. The clones are grown in the field for 12 months, then the cane is hot water treated and planted into the plot again for a second 12 months. After the second crop the cane is sent to Pasuruan where it is hot water treated again and grown in the field for a further 6 months before it is released to the plant breeding group. All plots are inspected regularly but no indexing is conducted. The quarantine plot was managed on a part-time basis by a local resident with assistance from a field labourer. The plot was very well maintained. One concern would be that *Imperata*, an alternative host of a number of sugarcane diseases was the main weed at the plot. Smut was detected recently in cane from Thailand. The disease was found in the young germinating plants in the shade house and also in the field. These canes were destroyed and no further findings have occurred. Other diseases detected have been mosaic, leaf splitting and symptoms like gumming disease.

During my visit I was able to inspect 97 clones of *S.officinarum*, *S.spontaneum*, *S.edule*, *S.robustum* and *Erianthus* collected from Irian Jaya in 1995. A number of the wild clones were showing marked freckling and some had large red leaf blotches. One clone had straw coloured streaking on the stalk. None of these conditions were considered to be contagious diseases by Irawan, the pathologist who accompanied me. Other clones in quarantine included 11 clones from Australia, a number of clones from Taiwan, Japan and Myanmar. The clones from Myanmar were renamed clones from other countries including Q89 from Australia. One stool of Q129 had faint symptoms similar to yellow leaf syndrome (YLS). No other clones had symptoms of YLS. Woolly aphids were present on a number of plants in the quarantine plot.

The open quarantine I believe is adequate but could be improved by a initial 6-12 months closed quarantine in a glasshouse or insect proof mesh house. Cooling of a glasshouse would be difficult because the island has no electricity. A mesh house may be the best option for their situation. The Director of Research, Tonny Kuntohartono, was interested in the BSES closed quarantine glasshouse only 30-50 km away from commercial fields. A quarantine glasshouse closer Pasuruan would save them a lot of time and expense. It took 6-7 hours to travel to Puteran.

Another improvement would be the introduction of indexing for important diseases such as RSD, mosaic, leaf scald and Fiji disease. The ACIAR project could include assistance in setting up this indexing.

#### 4.0 CIREBON AND JATITUJUH SUGAR MILL AND PLANTATION

##### Personnel

##### *Cirebon Indonesian Sugar Research Institute*

Baidory Mubien, Head of the Station and Irrigation Research

Abdul Rifal, Entomology and Pathology

Surprato, Plant Breeding

Rukanta Utip Suryodadi, Weed Science

##### *Jatitujuh Research Centre*

Slamet Riyanto, Coordinator and Soil Science

Nina Trisnawati, Tissue Culture

Dwicahya Ariwibowo, Pests, diseases, weeds and biological control

Awan Setiawan, Agronomy

Joko Sugeng, Chemistry

##### *Jatitujuh Mill and Plantation*

Rustandi Zakaria, Administrator

#### 4.1 Smut, RSD and other pests

My visit to the Jatitujuh plantation enabled me to inspect the smut resistance trials, to observe smut disease in the field and to discuss the importance of quarantine and disease control with plantation staff.

Jatitujuh is the biggest plantation on Java with approximately 9600 ha of cane. The plantation suffers from periods of drought and waterlogging and yields are approximately 40 t/h with 6% sugar content. Apart from the environmental problems the plantation has severe disease problems with RSD in greater than 50% of the plantation in a recent survey and 50% of the plantation is planted to a variety which is highly susceptible to smut. During my visit I was taken to a plant field of M442-51, the major variety on the plantation, which had at least 30% smut infected stools. The infected stools were severely stunted and had very thin stalks with many whips. I also visited a fifth ratoon field of PS60, a resistant variety, that had only a very low level of smut infection. This showed that smut can be controlled by resistant varieties but the yield of the resistant varieties was low and the plantation staff were reluctant to plant these varieties. Until higher yielding resistant varieties are available the plantation staff are likely to continue to plant the susceptible M442-51.

An isolated nursery area would assist the plantation in control of smut. However the availability of land on Java is extremely limited and it would be almost impossible to find land outside the plantation. Careful selection of sites on the plantation upwind of sources of smut inoculum and surrounded by smut resistant varieties may provide a means to reduce primary smut infection.

Of interest I was shown a plant of *Rottboelia* (Itch grass) infected with smut. They had assumed that it was sugarcane smut but this had not been confirmed by microscopic



examination of the spores. *Imperata* a reported host of smut was present throughout the plantation on headlands and the edges of drains.

Good control of smut in Indonesia is important to the Australian Sugar Industry. If the level of the disease is low in Indonesia the likelihood of spread to Australia is reduced. Currently plantations like Jatitujuh are a source of massive amounts of smut spores which could be carried to Australia by high altitude winds or acts as a source of infected cane which could be moved to islands closer to Australia.

RSD was found in a recent survey in greater than 50% of samples. In the extreme environmental conditions on the plantation I would expect RSD to be causing very high losses. The plantation had just completed the construction of an excellent hot water treatment facility. It consisted of a cold water tank and an oil furnace heated hot water treatment tank with insulated sides, a lid and good circulation pump. An overhead pulley on a rail was available for loading the wire cages used to hold the cane setts. The whole unit was housed in a shed. This unit had yet to be used for treating cane but should provide the right facility for HWT for RSD control.

The many field workers used to manually harvest the cane and to do other operations such as cutting borer affected tops off young cane could all spread RSD. It would take a lot of education and careful management to prevent spread of RSD in this system. RSD resistant varieties may be an alternative. Plough-out replant after a few weeks is used in all commercial fields adding to the difficulty of controlling RSD and smut.

During my visit I was asked to talk to the administrator who was in charge of both the mill and plantation about the importance of quarantine and disease control and to the plantation manager and his staff of about 30 sectional managers. Raising the awareness of these staff should help in reducing disease levels on the plantation. However until they have good yielding smut resistant varieties it is difficult for them to make the choice between smut control and higher yielding smut susceptible varieties. As mentioned earlier visits to Indonesia to talk to plantation managers about quarantine should be followed up to raise the awareness of the importance of quarantine for the region.

Other problems at the plantation included rat damage of young ratoons. Five thousand rats were caught by hand the night before my visit. Weed control was a problem during their wet season with *Rottboelia* being a major pest. Top and stalk borers were also important insect pests.

## 4.2 Tissue culture

The Jatitujuh Mill research group had an impressive tissue culture facility employing 4 laboratory staff and capable of holding 6000 tissue culture tubes. The aim of the facility is to provide disease-free nursery cane for the plantation. For every hectare they wish to plant they produce 300 tissue culture tubes. From each tube they obtain 15 plants which are planted into plastic bags filled with soil. After transplanting the plants are divided four times and transplanted again into plastic bags before finally being planted in the field. They plant 20,000 plants per hectare with 1.2 m row spacing. The planting into the pots is all done by hand by labourers. They showed me 6 ha they had planted to the tissue culture plants and they planned to plant 20 ha next year. They told me they have had few problems with somaclonal variation even though they use callus to produce their tissue culture plants. They had noted however that the first crop of the transplanted tissue culture derived plants showed abnormal growth characteristics. These characteristics they found to disappear in the first ratoon crop. The affected plants had excessive tillering, shortened nodes and erect leaf habit.

Although this tissue culture derived nursery should provide good disease-free material, it seems an expensive operation in comparison to conventional hot water treatment for establishing disease-free nurseries. For Australian labour costs I would estimate that it would cost us at least \$10,000/ ha to use this system. They have also the problem of reinfection by smut since they cannot plant the tissue culture plants in an isolated area. I think that they also need to more critically assess whether the tissue culture derived plants have not suffered some somaclonal variation, either visual changes or non-visual changes.

## 5.0 RECOMMENDATIONS

1. Develop a program in consultation with Indonesian Sugar Industry to ensure new plantations closer to Australia, particularly in Irian Jaya, are free of smut, RSD and other systemic diseases. This may require some high level discussions because the issue is a very high risk to the Australian Sugar Industry.
2. Assist the Indonesian Sugar Industry through the ACIAR project to improve their internal and international quarantine.
3. Assist the Indonesian Sugar Industry to reduce the level of smut infection by improving their breeding for smut resistance and improved establishment of disease-free nurseries. This should be a focus of the ACIAR project.
4. Raise the awareness of the Indonesian plantation managers of the need for internal and international quarantine by addressing them at their combined meeting later this year and providing follow-up literature.
5. A formal request be prepared for the Indonesian Sugar Research Institute to include a selection of Australian varieties in their smut resistance trials.

6. Stevens Brumbley should request RSD isolates from Irawan for his study of RSD variability.
7. We should contact Ken Damann and ask him to include an Indonesian isolate of smut in his study of variation of smut isolates from around the world.
8. Surveys of sugarcane diseases and pests in Indonesian islands where commercial plantations are not present should be conducted to determine the distribution of diseases as part of the ACIAR project.

## **APPENDIX 1**

### **Map of Indonesia**

Map of Indonesia showing existing commercial sugar plantations and the site of the quarantine plot.

## APPENDIX 2

### List of Publications

The following publications of the Indonesian Sugar Research Institute were obtained and are available on request from the author.

#### Annual Reports of Indonesian Sugar Research Institute

1993 Annual Report - English Summary

1994 Summary of Annual Report - Indonesian

1995 Annual Report - Indonesian (list of staff included)

#### Diseases of Sugarcane Publications (Indonesian)

Handojo, H (1982) Penyakit Pembuluh Di Indonesia (Booklet on RSD)

Suwarno (1992) Peta Penyakit - Penyakit

Tebu Penting di Indonesia (Distribution of diseases in Indonesia)

Irawan (1993) Pedoman Identifikasi Penyakit

Tebu di Indonesia (Identification of diseases present in Indonesia)

Suwarno, Lastri Legowo, H. Handojo and Djoenadi

Samoedi (1993) Petunjuk Teknis Pengendalian Luka Api (Booklet on smut with varietal ratings)

Handojo, H (1986) Penyakit Leaf Scorch/

Penyakit Daun Hangus (*Stagonospora sacchari* Lo dan Ling) (Booklet on Leaf Scorch)

Irwan and Lastri Legowo 1994 Sejarah

Penelitian Strain Mosaik di Indonesia (Booklet on Mosaic strains)

Lastri Legowo 1993 Rangkuman Hasil Uji Ketahanan

Jenis Terhadap Penyakit Mosaic,

Blendok, dand Pokkahbung Selama 28 Tahun (1964-1992)

(Booklet on methods for screening for resistance to mosaic, leaf scald and Pokkah boeng)