

BSES Limited



INTRODUCTION TO SUGARCANE QUARANTINE AND DISEASE CONTROL

**Instructions for staff of research organisations
involved in sugarcane research**

by

BJ CROFT, N THOMPSON and RC MAGAREY

MN11001

Contacts:

Barry Croft
Principal Research Officer
BSES Limited
90 Old Cove Road
Woodford Qld 4514
Telephone: 07 5496 3357
Facsimile: 07 5496 3266
Email: bcroft@bses.com.au

Dr Rob Magarey
Principal Research Officer
BSES Limited
PO Box 566
Tully Qld 4854
Telephone: 07 4088 0707
Facsimile: 07 4068 1907
Email: rmagarey@bses.com.au

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1 QUARANTINE

Quarantine aims to restrict the spread of unwanted pests and diseases by controlling the movement of plants, soil, contaminated machinery and other contaminated items. Effective quarantine is vital for the continued competitiveness of the Australian sugarcane industry.

All those involved in the Australian sugarcane industry should be aware of the importance of quarantine.

1.1 International

International quarantine is controlled by Australian Government laws administered by the Australian Quarantine and Inspection Service (AQIS). Sugarcane can be imported into Australia only under permit from AQIS. The conditions for importing sugarcane can be found at <http://www.aqis.gov.au/icon32/asp/homecontent.asp>.

BSES has an AQIS-approved post-entry quarantine facility in Brisbane. Cane imported by BSES is maintained in the quarantine glasshouses for 2 years and undergoes intensive visual inspections and tests for quarantinable diseases. At the end of the second year, if no diseases are detected and release is approved by AQIS, the canes are cut and dispatched to the group that requested the cane.

1.2 International travel

Researchers who travel overseas should be aware of the risks of carrying spores of some fungi and insects on their clothes, notebooks, cameras and any other equipment they may be carrying. Spores of some exotic diseases like leaf scorch and small insects such as thrips and aphids can easily be carried on clothing. All travellers who walk through cane fields should launder their clothing in hot water before returning to Australia or immediately on return. Shoes should be cleaned thoroughly by scrubbing with a hot-water and detergent mixture or swabbing with 70% methylated spirits. Other equipment should be cleaned and disinfected where possible, with particular care to remove all sugarcane residues.

1.3 Australia

In Queensland, the *Plant Protection Act 1989* (PPA) and subordinate legislation the *Plant Protection Regulation 2002* controls the movement of sugarcane between eight Sugarcane Pest Quarantine Areas (PQAs) (Figure 1) and into Queensland from other states.

Queensland legislation is administered by Queensland Primary Industries and Fisheries (QPIF; part of the Queensland Department of Employment, Economic Development and Innovation; DEEDI). Special legislation in New South Wales covers the movement of cane and machinery from sugarcane farms in Queensland to the NSW sugarcane growing area.

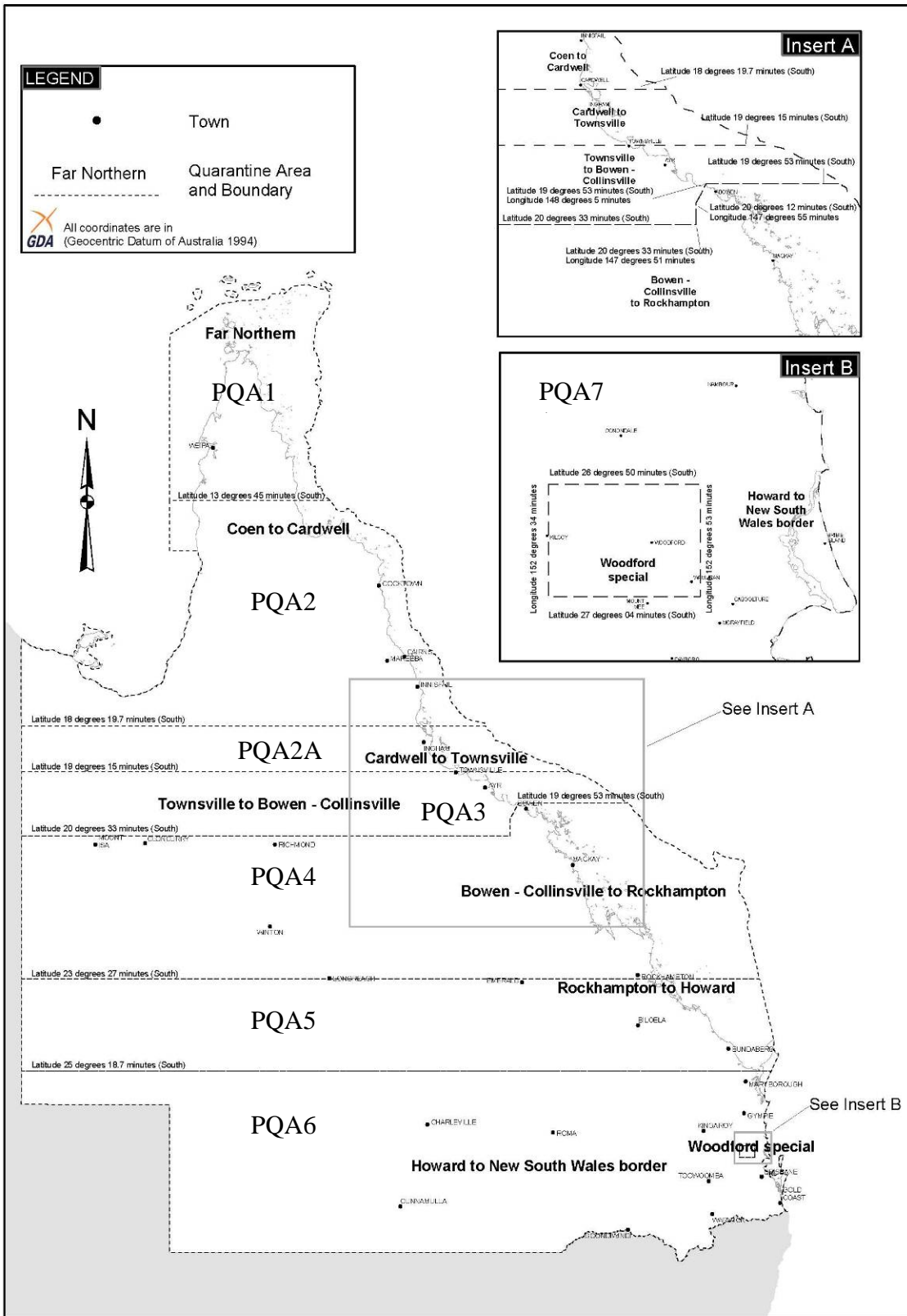


Figure 1 Sugarcane Pest Quarantine Areas as defined in the *Plant Protection Regulation 2002*

The Queensland quarantine regulations can be summarised as:

- All cane (cane stalks, tissue culture plantlets, leaves and roots) moved between PQAs must have an approval from a PPA Inspector. Approvals can be arranged through any BSES office.
- All cane (cane stalks, tissue culture plantlets, leaves and roots) moved into Queensland from another state must have an approval from a PPA Inspector. Approvals can be arranged through any BSES office.
- Movement of cane from PQAs 4, 5 and 6 to PQAs 2, 2A and 3 (north of the Bowen/Collinsville line) is strictly controlled to prevent the spread of Fiji leaf gall. If germplasm must be moved, there is a compulsory quarantine period of at least 1 year in the BSES Quarantine Glasshouse at Brisbane, or BSES Open Quarantine plot at Charters Towers. In certain circumstances, an Inspector may allow movement of cane across this boundary for research purposes, but this must have their written approval.
- Movement of cane from PQA 6 to PQA 4 and 5 is also restricted because Fiji leaf gall is still active in PQA 6, whereas the disease has not been recorded in PQAs 4 and 5 for more than 15 years.
- Sugarcane mosaic is common in parts of PQA 5 and inspectors should consider the risk of spreading this disease to other PQAs when issuing approvals for cane movement.
- To move cane from PQA 1 you must obtain an inspector's approval from the QPIF Inspector in Cairns responsible for quarantine in Cape York.
- Movement of cane for tissue culture where it is intended that the tissue culture plantlets will be returned to the field can be summarised as follows (please note that all movements require PPA Inspectors Approval):
 - Tops are to be sourced from plant crop or first ratoon plots that are free from disease symptoms and have been hot-water treated (Section 2.4). Preferably, these tops will be sourced from Meringa, although sometimes they will be sourced from Bundaberg or other locations;
 - Tops will be sent to BSES Laboratories in Brisbane for initiation, and those for commercial micropropagation will be DNA fingerprinted (to ensure variety) and disease tested (for Fiji leaf gall and mosaic) regardless of their source;
 - Plantlets developed at Indooroopilly are considered to have a source location of where the tops were derived, (i.e. not PQA6) provided that they have not been exposed in other PQAs;
 - If the plantlets are removed from the laboratory to a non-quarantine rated glasshouse or to the field, they must undergo the compulsory quarantine period (usually one year);
 - If micropropagation is to occur outside of Indooroopilly, the plants must be transported in plates to and from the micropropagation facility. For example: in the case of Lowes, NSW, the initiated plantlets must be sent in plates to

Lowes and transported in plates from Lowes to the site of deflasking and hardening;

- Deflasking and hardening is to be done on benches in the PQA that the plants are to be planted, or in a PQA from which plants can move to the final destination with no restrictions following the other directions in this document. For example, plantlets hardened in PQA3 could move to PQAs 2 and 2A.
- If in doubt, check with a BSES pathologist before commencing your research, as this can prevent difficulties later.
- Tops for tissue culture research where there is no chance that the plantlets will be returned to the field still require an inspector's approval, but the tops can be sourced from any suitable source.
- BSES maintains a web-based Inspector's Approvals Database (PPA Approvals) that can be accessed by any BSES staff member. BSES offices can assist you to apply for an inspector's approval through this database.

1.4 BSES experiment stations

Only canes that have a history of regular inspections for diseases and have received a CSLHWT (cold-soak long hot-water treatment) or LHWT (long hot-water treatment) can be planted on a BSES experiment station. The exception to this would be cane coming from an Approved Seed plot.

Cane coming from all BSES Experiment Stations except Bundaberg should receive a CSLHWT on arrival. The cane should be sourced from a plant or first-ratoon hot-water treatment block and should be tested for RSD before dispatch.

Cane supplied to outside organisations by BSES must receive the same treatments and inspections as specified for BSES. The organisation receiving the cane should agree to follow these procedures before cane is supplied to them. Cane for glasshouse or laboratory experiments may be sent without CSLHWT, as long as it is destroyed after the experiment (by steam treatment, autoclaving, incineration or burial in land-fill).

Cane coming from an area infested with sugarcane smut into an area free of sugarcane smut should be hot-water treated (52°C for 45 min or 50°C for 3 hr) and treated with a registered fungicide (Appendix 3 Emergency use permits triadimefon and propiconazole) before dispatching. This includes cane going into the Rocky Point mill area, NSW (follow directions in permit from NSW DPI), Woodford Pathology Farm, BSES quarantine and other research groups in Brisbane.

1.5 Machinery and equipment

Machinery moving between PQAs within Queensland must be thoroughly cleaned of all soil and organic material before transport. An Inspector's approval must be obtained to move the machine between PQAs. In Queensland, cane productivity services, on request, will inspect machinery and if they are satisfied that it meets the required level of cleanliness they will provide a certificate of inspection. A check list for inspecting harvesters and other machines and a blank certificate are included in Appendix 4. This certificate is required as a condition of the inspector's approval. A fee may be charged for this service. Research staff should ensure that machinery/equipment meets these

standards and request assistance from the local cane productivity service for large machines (e.g. harvesters).

Machinery from the Ord River Irrigation Area must be thoroughly cleaned of all dirt and cane, even if this requires partial dismantling of the machinery. The equipment must be inspected by a representative of Agriculture Western Australia and be certified to be free of soil and sugarcane before leaving Western Australia. Before it enters a cane field or is sold in Queensland, the machine must be inspected again by an Inspector under the Plant Protection Act and written approval given for the machine to enter a cane field or to be sold in Queensland. This covers all appliances used on sugarcane farms in the Ord River Irrigation Area.

2 DISEASE-FREE PLANTING MATERIAL AND APPROVED VARIETIES

2.1 Approved varieties

The Director General of DEEDI approves sugarcane varieties for planting in each of the PQAs in Queensland. The Director General must assess the disease resistance of varieties being considered for approval. Only varieties approved for a PQA can be grown in that PQA. Growing non-approved varieties is an offence under the *Plant Protection Act 1989*. The list of approved varieties for each area can be found in the *Plant Protection (Approved Sugarcane Varieties) Declaration 2003* (<https://www.legislation.qld.gov.au/LEGISLTN/CURRENT/P/PlantProApDc03.pdf>).

Plant Protection Act Inspectors can authorize the planting of non-approved varieties for research purposes. In some cases, some varieties may be considered to pose a disease risk and an approval will not be issued for their planting.

2.2 Disease-free planting material (Approved Seed)

In each mill area or region, local industry organisations operate Approved Seed plots. Approved Seed has been hot-water treated to eliminate RSD and some other diseases and closely inspected for systemic diseases. Approved Seed, or the first progeny of Approved Seed, should be used where possible for all experiments. This includes cane to be used for guard rows and guard ends. BSES experiment stations and Plant Improvement staff will have cane of equivalent disease-free status as Approved Seed and this may be used for experiments.

Planting diseased cane can ruin your experiment, lose the goodwill of co-operators and destroy the respect of the farming community for your organization. It is an offence under the *Plant Protection Regulation 2002* to plant sugarcane infected with Fiji leaf gall, RSD, leaf scald, mosaic or striate mosaic diseases without an Inspector's approval.

2.3 Alternative planting material and inspections for diseases

2.3.1 Plant sources

In some cases, it may not be possible to obtain Approved Seed for your experiment. If planting material is obtained from another source, e.g. a co-operating farmer, **it is essential that the cane is inspected for diseases**. Even if the farmer says that the cane is clean or Approved Seed, it should be inspected. Inspections can be arranged by contacting BSES extension staff. The inspector will look for symptoms of systemic diseases and collect samples for RSD diagnosis.

Inspection for systemic diseases such as sugarcane smut, Fiji leaf gall, mosaic, chlorotic streak, leaf scald, and striate mosaic involves walking through the proposed plant source and looking for visual symptoms. Where possible, inspections should be conducted by an experienced inspector. RSD has no external symptoms so samples must be collected and sent to a laboratory for processing (see section 5.2).

2.3.2 Experiment stations and experimental plots

All field experiments and experiment station cane should be inspected for diseases at least once a year. In experiments, this can be done when taking measurements or collecting samples. Any suspect disease of unknown cause or unusual symptoms should be reported to the BSES Farm Manager, a BSES Extension Officer or a BSES Pathologist.

2.4 Hot-water treatment procedures

2.4.1 Long hot-water treatment (LHWT)

LHWT (3 hours at 50°C) is used to control RSD. This treatment will also control sugarcane smut and chlorotic streak. Any variety maintained as a plant source should be treated systematically, so that each new planting uses planting material from the plant or first-ratoon crop of a block planted with long hot-water treated cane. Cane to be treated should be stripped of trash and treated at 50°C for 3 hours in bundles of whole stalks or 1- or 2-eye setts. Temperature control is critical, with temperatures over 50°C adversely affecting germination, and temperatures below 50°C (< 49.8°C) reducing the effectiveness of disease control.

2.4.2 Cold-soak long hot-water treatment (CSLHWT)

Varieties that are susceptible to leaf scald disease or coming from an area with endemic leaf scald (i.e. all BSES experiment stations, except Bundaberg, and CSR station at Macknade) should receive a CSLHWT before planting propagation plots. This treatment will also control RSD, sugarcane smut and chlorotic streak.

- Cane stalks or 1-eye or 2-eye setts can be treated.
- Cane stalks should be stacked (loosely) in layers approximately three stalks deep with 50 mm spacers between the layers (e.g. piece of timber).
- The cane should be soaked in water at ambient temperature for at least 40 hours with a slow input of fresh water.
- Within 6 hours of removing the cane from the cold water, the cane should be treated in hot water at 50°C for 3 hours.

- Treated canes should be planted in areas considered to be at a low risk of re-infection, i.e. away from known infected blocks or large drains with heavy weed infestation.

2.4.3 Short hot-water treatment (SHWT)

In some districts, short hot-water treatment (SHWT) may be necessary to control smut or chlorotic streak or the spread of insect pests (e.g. weevil borer). SHWT follows the same procedure as LHWT but the treatment is 52°C for 30 or 45 min for smut, or 50°C for 30 min for chlorotic streak. The 50°C for 30 min treatment for chlorotic streak generally stimulates germination. These treatments do not control RSD or leaf scald.

2.4.4 Fungicide dip

In some instances a fungicide dip treatment is required after hot-water treatment to prevent re-infection with sugarcane smut during transport and germination. This treatment requires the cane to be dipped for 5 min in the fungicide. The registered fungicides are triadimefon and propiconazole (Appendix 3). Fungicides applied through planting machines are not effective at controlling smut because a lower rate is used and the cane is not in contact with the fungicide for sufficient time for effective control of smut.

3 HYGIENE

Diseases, insects and weeds can be carried on machinery and tools. It is essential that the utmost care be taken to thoroughly clean and disinfect this equipment when moving between blocks and farms. BSES harvesters and contract harvesters employed by BSES must be disinfected between blocks or trial units (e.g. three small blocks planted at the same time can be considered as one unit) and between farms. Mechanical planters can readily spread RSD and must be disinfected before and after planting experiments, propagation blocks and any field under BSES control.

Any tool that cuts the stalk, leaves or roots can spread RSD. This includes cane knives, secateurs, dibblers (for brix samples), shovels, mechanical stripping devices, corers and rind rippers. Such implements should always be disinfected between blocks. In variety trials and propagation blocks, knives, etc, should be disinfected between clones when RSD testing or cutting planting material. It is also good practice to disinfect at any break in activity, whether between or within blocks.

The method for disinfecting all implements is basically the same. The implement should be **thoroughly** cleaned of dirt, juice and trash and then thoroughly sprayed with disinfectant. For cane knives, dibblers, rind rippers, etc, 70% methylated spirits in hand-held spray packs can be used to spray the cleaned implement. For larger equipment, such as planters and harvesters, 1% Cane Knife Steriliser (active ingredient benzalkonium chloride) or Steri-maX (active ingredient didecyldimethyl ammonium chloride) should be sprayed over the implement and **left for 5 minutes** before use. Cane Knife Steriliser is deactivated by organic matter and soil and must only be used on clean equipment; solutions should be replaced when they become dirty. Steri-maX is more resistant to break down by organic matter but is still more effective on clean implements. These disinfectants are also registered for the control of the spread of sugarcane smut. Field staff should carry disinfectants in their field kit.

4 MOVEMENT OF SOILS AND INSECTS FOR RESEARCH

4.1 Soils

Soil movement into Queensland is restricted by QPIF. Consultation with Biosecurity Queensland is recommended if soil from outside of Queensland is required for experiments.

Transfer of soils for research purposes between quarantine districts within Queensland should take the following precautions to prevent spread of pathogens, insects and weed species:

- Remove as much plant material as possible from the soil, preferably by sieving through a 5-10 mm sieve;
- Seal soil for transport in a heavy-duty plastic bag and place in a box or fertiliser bag;
- On arrival at its destination, the soil should be opened and handled in a sealed room. The room should be sprayed with household insecticide before opening the door. Any exposure of the soil to the environment should be kept to a minimum;
- When the soil is no longer needed, it should be sterilised by heating (100°C or greater for at least 30 minutes), fumigation (e.g. metham sodium in an airtight container), or deep burial;
- Any plant material grown in the soil should be sterilised by one of the above methods and any water that has contacted the soil should be chlorinated (pool chlorine > 1% final concentration for at least 30 minutes).

Within districts, care should be taken to prevent movement of pathogens, insects and weed species. Similar procedures to those listed above should be followed wherever possible.

In some cases, processing the soil samples on-site may be necessary to prevent risks of spread of pests. For example, sampling for earth pearls and soldier flies should be conducted on site wherever possible to prevent spread of these destructive insects.

4.2 Insects

Transfer of live insects for research should be discussed with BSES entomologists before the research commences.

Live planthoppers (*Perkinsiella saccharicida*) should never be sent from districts where Fiji leaf gall is or has known to be present (PQAs 4-6) to the northern districts (PQAs 2, 2A & 3) or from PQA 6 and New South Wales to PQAs 4 and 5.

Care should be taken when moving aphids that may carry sugarcane mosaic virus.

5 DISEASE SPECIMENS

5.1 Suspect diseases

BSES plant pathologists offer a diagnostic service for suspect diseased sugarcane. Before sending specimens, local extension officers should be consulted, because they may be able to identify the cause. The following guidelines will help the pathologist to give a satisfactory diagnosis:

- Collect a fresh specimen, preferably showing early stages of disease development. If possible, collect the specimen early in the week, so it will reach the laboratory well before the weekend.
- Seal the specimen in a plastic bag, do not allow it to become heated, and send by overnight transport. Larger specimens, such as whole stools, may be sent by road transport.
- Address specimens:
 - **For districts from Proserpine south to NSW** to Barry Croft, BSES, 90 Old Cove Rd, Woodford, Q 4514. Telephone: (07) 5496 3357, Fax: (07) 5496 3266, Mobile: 0417 613 089, Email: bcroft@bses.com.au.
 - **For districts from Mossman to the Burdekin** to Rob Magarey, BSES, Dallachy Rd, Tully, Q. 4854. Telephone: (07) 4068 1488, Fax: (07) 4068 1907, Mobile: 0407 061 760, Email: rmagarey@bses.com.au.
- Attach a completed copy of the form in Appendix 1 and advise the appropriate person that a specimen has been dispatched and the method of transport.

5.2 RSD samples

BSES operates an RSD laboratory in Mackay that uses an ELISA test. The charge for processing the samples is between \$1.90 and \$2.20 per sample plus GST, depending on the number of samples (discounts apply to bulk samples). Regular inspection of plant sources for RSD is essential for all experiments. RSD may compromise the results of your research.

5.2.1 Selection of stalks

The largest stalks in poorly grown stools (possibly poorly grown due to RSD) should be selected where there is uneven crop growth. Volunteer stools should also be sampled if they are present. The ends of rows are more likely to be diseased if planters or harvesters were the source of infection and some samples should be taken from these areas. Slicing stalks and examination for nodal marking can increase the probability of detecting disease in varieties known to show good nodal symptoms.

5.2.2 Number of stalks to sample

The probability of detecting RSD in a field that is showing no obvious stunting depends on the number of stalks examined and the sensitivity of the diagnostic technique. The probability of a correct diagnosis is greatly increased as the sample number increases. For example, to have 95% probability of detecting disease that is randomly distributed at 10% infected stools you would need 29 samples; at 1% infected stools, 298 samples; and at 0.1% infected stools, 2 996 samples. Obviously, the practicality of handling the cane and the labour available will limit the number of samples. Approved Seed plots and experimental plots will require much more rigorous sampling than routine farm plant sources. As a general rule, 16 samples should be taken from farm plant sources and 50-100 from clean seed plots. Small experimental variety plots of 4-20 m may require 4-10 samples per plot. Each variety in a field should be sampled, and, if a variety has come from different plant sources, each section should be sampled.

5.2.3 Section of the stalk to sample

Extracts for RSD diagnosis should be taken from internodes towards the base of the stalk, since bacteria are generally more concentrated in these nodes, particularly early in the season. In mature cane the first node of reasonable length, 7.5-15 cm can be sampled for ease of collection of extract.

5.2.4 Bulking of samples

Extracts from samples can be combined together to reduce the number of samples to be tested. However, this may reduce the chance of detecting the disease. For example, if 1 diseased extract is mixed with 9 healthy extracts, the bacterial concentration is 1/10 of that which was present in the diseased sample. It is possible that the diagnostic test may not be sensitive enough to detect the lower concentration of bacteria in the mixed sample. As a general rule, no more than 3-4 extracts from individual stalks should be mixed together.

5.2.5 Equipment required

1. 1 mL Titertubes or microcentrifuge tubes.
2. Preservative: Savlon; "Microshield 5" Antiseptic solution; or 30% formaldehyde.
3. Rubber milking machine inflation (rubber teat holder).
4. Air compressor - either 240-V air compressor or compressor which can be operated from a vehicle's 12-V cigarette lighter. High-pressure compressors for car tyres are suitable.
5. Lopping shears - long handled, beak blade lopping shears, must be sharp, or PVC pipe cutters - ratchet style.
6. Esky with cooler block.
7. Methylated spirits and cleaning rags.



Figure 2 Equipment used for collecting xylem extracts for RSD diagnosis

5.2.6 Procedure

1. For extraction at headland or shed, collect stalk pieces with at least 3-4 internodes. Take extracts the same day as collection. It is much more difficult to collect xylem extract if stalks are allowed to dry out.
2. Cut stalk section with one node towards the base of stalk. Cut one end square and one end at a 45° angle. If the stalk is dirty, clean the tip of angled end of internode piece and avoid getting dirt on the angled cut surface.
3. Do not select insect-damaged, rat-damaged or rotten stalks. Avoid internodes with growth cracks where possible.
4. Turn on air pump. Press flat end of stalk piece into rubber holder. Allow the xylem extract fluid to run off the angled tip of the internode directly into tube. Collect extracts from up to four stalks in the one tube. Do not completely fill tubes, since when frozen the caps will be dislodged. Add one drop of Savlon, "Microshield 5" Antiseptic solution or 30% formaldehyde as a preservative.

NOTE: Cane juice collected by squeezing stalks or with brix samplers is not suitable for RSD diagnosis by serological or microscopy methods.

5. Label tube clearly with sample number.
6. Clean and sterilise lopping shears and rubber holder between cane blocks and varieties being tested by wiping off organic matter and swabbing or spraying with methylated spirits.
7. Freeze samples on return to office.
8. Send samples to the Mackay BSES RSD laboratory (BSES Mackay, Peak Downs Highway, Te Kowai, Mackay, Q 4740; Attention Janet Green; Phone: 07 4963 6806, Fax 07 4954 5167; Email: jgreen@bses.org.au) by TNT Air Express or other reliable overnight courier in an Esky with cooler blocks. Notify laboratory that samples have been dispatched and provide consignment details.

5.2.7 Placement of RSD samples in the Collection Tray/Box

1. Place tubes of juice left to right starting from the second 8 holed row in the tray. The first row is always kept vacant as this will become the CONTROL ROW. A full tray of samples will hold 88 tubes as shown in Figure 3.
2. Label tubes in the collection trays in one of two ways:
3. In each individual tray label tubes 1-88 with the Tray/Box number clearly written on the bottom half of the collection tray. (Do not label the lid as this can be easily misplaced during preparation of samples in the lab). The Tray numbers will run in a consecutive sequence. E.g. Box 1 (1-88), Box 2 (1-88), Box 3 (1-88) etc
4. Label tubes with consecutive numbers. No need to label the collection trays. Start with 1 and continue onwards. When the sample numbering reaches 1000 you can restart the numbering at 1.
5. Try to keep the 8-plug strip as a complete unit. When individually separated they are difficult to handle in the lab. Separation into 2 x 4-plug strips is OK.
6. Do not remove the little tag on the end of each strip. Ideally, it would be preferred to have all the tags facing the same way out in the trays, as this makes removal easier.
7. A tray does not have to be completely full before dispatching to the RSD Lab for analysis.
8. Send sample details to the Mackay RSD Lab. An RSD ELISA form is available in Appendix 2A, on the BSES intranet or contact jgreen@bses.com.au.



Figure 3 A completed Collection Box for RSD samples containing 88 samples

5.3 Assays for soil pathogens

BSES conducts assays for *Pachymetra*, nematodes, and beneficial mycorrhizae (VAM). A copy of the form in Appendix 2B should accompany each sample (or batch of samples). A charge, depending on the assays required and number of samples, will apply. Contact Rob Magarey for further details regarding sampling and transport requirements: Rob Magarey, BSES, Dallachy Rd, Tully, Q 4854, Telephone: (07) 4068 1488, Fax: (07) 4068 1907, Email: rmagarey@bses.com.au.

6 PINEAPPLE DISEASE CONTROL

Pineapple disease is caused by the fungus *Ceratocystis paradoxa* which is common in all sugarcane soils. The fungus can rot the setts used to plant sugarcane and prevent germination. The disease is favoured by cool, wet or dry conditions. It is characterised by a red and black discolouration of the internal tissues with a distinctive fruity smell.

Fungicides used for treating setts at planting should be used as per the label instructions. Spraying and dipping mechanisms on planters should be checked regularly to ensure that thorough coverage of fungicide on the cut end of the setts is achieved. Damaged and 1-eye setts are particularly susceptible to infection, even when fungicide is applied.

It is important to note that if recirculating fungicide sprays or dips are used these can harbour RSD bacteria and should be emptied and sterilised between blocks.

If planting setts by hand, ensure that rubber gloves are worn when handling fungicide-treated setts.

7 MAJOR SYSTEMIC DISEASES OF SUGARCANE IN AUSTRALIA

Systemic diseases are those carried within the plant, so any sugarcane developing from diseased planting material will also be diseased. The spread of systemic diseases in planting material is a major concern to the industry and all reasonable measures should be taken to avoid this spread.

7.1 Sugarcane Smut

Sugarcane smut (*Ustilago scitaminea*) is a fungal disease that is spread by wind-blown spores and by planting infected material. The fungus forces the plant to produce a modified flower that looks like a long, black whip (Figure 4). This structure is full of the black spores of the fungus. Infested plants have profuse tillering with very thin stalks, and gives the plant a grass-like appearance. This disease is found in nearly all sugarcane industries world-wide and is rated as one of the most important sugarcane diseases.

On 10 June 2006, sugarcane smut was found near Childers in Queensland. Smut spread to all sugarcane growing districts in Queensland and New South Wales by 2011.



Figure 4 Characteristic whip produced by Sugarcane smut

7.2 Leaf Scald and Ratoon Stunting Disease (RSD)

Leaf scald (*Xanthomonas albilineans*) and RSD (*Leifsonia xyli* subsp. *xyli*) are caused by bacteria that live in the xylem vessels of the plant. Both diseases can be spread by contaminated cutting implements and planting infected planting material. Leaf scald can also be spread by wind-blown rain and can survive in a range of alternative grass hosts. Both these diseases can cause extensive yield losses and great care should be taken to prevent their spread. Leaf scald symptoms include white stripes running down the vascular bundles of the leaf, death of the leaf tips, general chlorosis and side-shooting (Figure 5). RSD has no external symptoms other than stunting, but in some varieties red-orange dots can be found internally at the nodes (Figure 6).



Figure 5 Leaf scald



Figure 6 RSD nodal symptoms (RSD on left and healthy on right)

7.3 Fiji Leaf Gall (formerly Fiji disease)

Fiji leaf gall is a viral disease that can lead to major industry losses. The virus is spread by an insect (planthopper, Figure 7) and by planting diseased material. The disease causes severe stunting of infected plants, whitish galls on the undersurface of leaves (Figure 8), and stiff and shortened dark green leaves. Fiji leaf gall has never been found north of Proserpine and strict quarantine is required to prevent it from moving further north. Fiji leaf gall has not been recorded in Bundaberg/Isis and central districts for more than 15 years. It is still active in the Rocky Point, Broadwater and Harwood mill areas. Cane should not be moved from Rocky Point or New South Wales districts to other districts without passing through quarantine.

Fiji leaf gall is classed as a notifiable pest under Queensland regulations and a Plant Protection Act inspector must be notified if this disease is found.



Figure 7 *Perkinsiella saccharicida*, the planthopper vector of Fiji leaf gall



Figure 8 Characteristic galls produced by Fiji leaf gall

7.4 Mosaic

Sugarcane mosaic virus is spread by aphids and in diseased planting material. Mosaic can cause losses of 20-30% in susceptible varieties. Mosaic is fairly common in the Bundaberg/Isis region, particularly around Childers. The symptom of mosaic is an irregular mosaic pattern of lighter and darker green on the leaf blade (Figure 9). In Australia, mosaic is caused by sugarcane mosaic virus but overseas mosaic can be caused by sorghum mosaic virus or sugarcane streak mosaic virus. The two latter viruses are considered a serious risk to the Australian sugarcane industry.



Figure 9 Typical leaf symptoms of sugarcane mosaic

7.5 Chlorotic Streak

Chlorotic streak is a disease of unknown cause that is spread by infested water and in diseased planting material. Chlorotic streak infested cane germinates poorly and yield is reduced by 20-30%. The disease is characterised by irregular chlorotic streaks on the leaf blade (Figure 10) and red discolouration of the vascular bundles within stalks, above and below the nodes.



Figure 10 Chlorotic streak

7.6 Striate Mosaic

Striate mosaic is a viral disease that is restricted to some farms in the Burdekin district. The disease is believed to be associated with certain soils and can be spread in diseased planting material. Symptoms of the disease are unthrifty growth and fine chlorotic striations over the leaf blade (Figure 11). Infected cane often dies, leaving large bare patches in fields.



Figure 11 Striate mosaic

8 OTHER IMPORTANT DISEASES

The following important diseases are not systemic, are widely distributed, and are therefore of lesser quarantine significance. However, they can cause significant yield losses and susceptible varieties should be avoided in experiments.

8.1 Brown and Orange Rusts

Brown rust is caused by the fungus *Puccinia melanocephala*. The fungus causes a brown elongated lesion on the leaves of the plant (Figure 12). The lesions erupt to release the brown spores of the fungus and the spores are spread by the wind. Fine weather with heavy dews at night favour the disease. The disease most commonly affects cane that is 3-6 months of age and can cause losses of 20-30% in susceptible varieties. Control is by planting resistant varieties.

Orange rust is caused by the fungus *Puccinia kuehnii* which favours warm humid conditions. Orange rust was considered a disease of minor importance until an epidemic in 2000 that was believed to be associated with a new strain of the fungus. In 2000 and the years following, the disease caused extensive yield losses of at least 40% in susceptible commercial varieties, including Q124 which was the major variety at the time. The main symptom of the disease is elongated lesions that erupt to release orange spores (Figure

12). Fungicides have been used as an interim control measure, but long-term control is achieved by resistant varieties.



Figure 12 Brown and orange rust

8.2 Pachymetra Root Rot

Pachymetra root rot (*Pachymetra chaunorhiza*) is a soil-borne fungal disease that is unique to Queensland and NSW cane fields. Typical symptoms include a soft flaccid rot of the larger (primary) roots of the cane plant (Figure 13). High disease levels lead to a poor and inadequate root system, with a loss of plant anchorage. Rotted roots are typically filled with the characteristic oospores of the fungus. The disease is controlled by planting resistant varieties. Pachymetra has been found in all mill areas in Queensland except for Rocky Point and was recently found in the Condong mill area in NSW. The disease only occurs on isolated farms in the Burdekin.



Figure 13 Pachymetra root rot

8.3 Yellow Spot

Yellow spot is a fungal leaf disease (*Mycovellosiella koepkei*) found in the high-rainfall, tropical cane growing region of Tully-Babinda, although it can be seen in the Herbert, Burdekin, and Central districts in some favourable years. Symptoms include irregular, roughly circular lesions on the leaf blade characterised by their yellow to brick-red colouring (Figure 14). Lesions may be seen equally well on both the upper and lower leaf surfaces. Symptoms are best seen during the wet season; timing depends on the start of the wet. The disease reduces yield and sugar content early in the season. Yellow spot is controlled by planting resistant varieties.



Figure 14 Yellow spot

9 EXOTIC DISEASES

Australia is free of a number of important sugarcane diseases. A brief description of a few of these diseases follows. **If cane is found with symptoms similar to those described below a BSES pathologist should be contacted immediately.** Do not move the cane until instructed by the pathologist.

9.1 Downy Mildew

Downy mildew is a fungal disease that is spread by spores carried on air currents and by diseased planting material. The fungus stunts infected plants and causes red-brown streaks on the leaves (Figure 15). On warm humid nights, a white down, formed by the spores of the fungus, is produced. Downy mildew is found in Fiji, Papua New Guinea, the Philippines and Taiwan.



Figure 15 Downy mildew

9.2 Ramu Stunt

Ramu stunt is a viral disease that caused severe damage to cane at the Ramu Agri-Industries plantation in Papua New Guinea in the mid-1980s. The disease is spread by a planthopper insect. It causes yellow-green leaf mottling or striping, severe stunting and death in highly susceptible varieties (Figure 16).



Figure 16 Ramu stunt

9.3 Phytoplasma diseases

There are three diseases of sugarcane caused by phytoplasmas (grassy shoot, white leaf and green grassy shoot) that cause devastation in the Indian sub-continent and south-east Asia. The symptoms of the three diseases are very similar. Plants are severely stunted, grassy and can show chlorosis of the leaves (Figure 17).



Figure 17 White leaf

10 INSECT PESTS

Insect pests of particular quarantine interest include those that are exotic and with a distribution that is still expanding, and those that are likely to survive in samples. Exotic sugarcane pests that have established in Queensland include sugarcane weevil borer and African black beetle. Pink ground pearl may also be in this category.

10.1 Sugarcane Weevil Borer

Sugarcane weevil borer (*Rhabdoscelus obscurus*) originated in Papua New Guinea and is now well established in central and northern Queensland (Figure 18). However, it is not found in southern Queensland or NSW. Larvae can survive in sugarcane billets, but are killed by hot-water treatment. Untreated planting material must not be moved into, or planted in weevil-free areas.



Figure 18 Weevil borer damage to cane stalk

10.2 African Black Beetle

African black beetle (*Heteronychus arator*) is an exotic pest that was introduced into New South Wales 70 years ago and is expanding its range northwards. It now occurs as far north as Maryborough, where it was found in 1990 and would probably establish in areas further north if introduced there. It can be moved as eggs, larvae or adults in soil. Particular care should be taken with soil moved from Maryborough to the neighbouring Isis and Bundaberg districts (Figure 19).



Figure 19 African black beetle

10.3 Pink Ground Pearl

Pink ground pearls (*Eumargarodes laingi*) are a pest found mainly on the red volcanic soils (krasnozems) near Bundaberg. They also occur on some sandy soils around the Bundaberg district and in some small areas as far south as Condong, New South Wales (Figure 20). It is possible that they could establish in areas where they are presently unknown. Pink ground pearls are highly transportable in samples or in soil on machinery, vehicles and sampling equipment. The eggs are minute, and the pearls can survive for months without food, they are not readily damaged by handling, and are resistant to

desiccation. Precautions must be taken against the spread of pink ground pearl not only between districts, but also between farms and blocks on infected farms in the Bundaberg area.



Figure 20 Pink ground pearl cyst (left) and adult females (right)

10.4 Soldier Flies

Soldier flies are another robust pest that can survive for months in soil without food (Figure 21). Two species of soldier fly commonly occur in sugarcane: the yellow soldier fly in the central and Burdekin districts; and the sugarcane soldier fly found across most mill areas.



Figure 21 Soldier fly

10.5 General

Precautions should be taken against the transport of any live insects in soil or plant samples. It is possible that the geographical distribution of any pest species could be increased if it was taken to another cane-growing area where it is not normally found. This applies even to native insects, which may have had a restricted distribution under natural conditions, but which may be able to proliferate over a wider area under the artificial conditions of sugarcane culture.

11 WEEDS

In Queensland, the Department of Environment and Resource Management is responsible for control of declared weeds. Declared weeds are listed under five categories:

- **P1** Prohibited from introduction into the state.
- **P2** Must be destroyed.
- **P3** Number of plants to be reduced.
- **P4** Plants are to be prevented from spreading.
- **P5** Controlled on Government land.

The weeds that fall into these categories which are of particular concern to the sugarcane industry are:

Alligator weed	<i>Alternanthera philoxeroides</i>	P1 & P2
Giant sensitive weed	<i>Mimosa invisa</i>	P2
Milkweed	<i>Euphorbia heterophylla</i>	P4 (P2 in some parts of Qld)
Parthenium weed	<i>Parthenium hysterophorus</i>	P2 (P3 & P4 some central Qld Shires)
Siam weed	<i>Chromolaena odorata</i>	P1 & P2 (Only found in Tully district)
Sicklepod	<i>Cassia obtusifolia</i>	P3 & P4 (P2 in some parts of Qld)
Tobacco weed	<i>Elephantopus mollis</i>	P2 (Near cane areas near Sarina)
Witchweeds	<i>Striga</i> species	P1 (parasitic to plants)

In addition to the declared weeds, some weeds are of particular concern for the sugarcane industry, such as itch grass (*Rottboelia cochinchinensis*) and nut grass (*Cyperus rotundus*). These plants have limited distribution and are particularly difficult to control in cane fields.

Movement of machinery, tools and soil contaminated with seeds or other propagules of weed species should be avoided; the guidelines provided above should reduce the risk of pest spread.

12 RESOURCES – BOOKS AND MANUALS

Sugarcane Disease – Field Guide (2006)

Magarey R.C., Lonie, K.J. and Croft B.J. BSES Limited, Indooroopilly

A Guide to Sugarcane Diseases (2000)

Eds Rott, P., Bailey, R.A., Comstock, J.C., Croft, B.J. and Saumtally, A.S.
CIRAD and ISSCT, Montpellier France.

Diseases of Sugarcane: Major Diseases (1989)

Eds Ricaud, C., Egan, B.T., Gillaspie, A.G. Jr., Hughes, C.G.
Elsevier Publishing Company, Amsterdam.

Sugarcane Diseases of the World

(1961) Vol. 1 Eds Martin, J.P., Abbott, E.V. and Hughes, C.G.
Elsevier Publishing Company, Amsterdam.

(1964) Vol. 2 Eds Hughes, C.G., Abbott, E.V. and Wismer, C.A.
Elsevier Publishing Company, Amsterdam.

Weeds in Australian Cane Fields

BSES Bulletin, October 1988 No. 28.

Australian Sugarcane Pests (1997)

Ed. Agnew, J.R.
BSES, Indooroopilly.

APPENDIX 2A – RSD ELISA FORM



ELISA SAMPLE DETAILS FOR: _____

Tray identification: _____

Date: _____

Contact Person: _____

A1 Blank	A2 1	A3 9	A4 17	A5 25	A6 33	A7 41	A8 49	A9 57	A10 65	A11 73	A12 81
B1 Blank	B2 2	B3 10	B4 18	B5 26	B6 34	B7 42	B8 50	B9 58	B10 66	B11 74	B12 82
C1 Blank	C2 3	C3 11	C4 19	C5 27	C6 35	C7 43	C8 51	C9 59	C10 67	C11 75	C12 83
D1 Blank	D2 4	D3 12	D4 20	D5 28	D6 36	D7 44	D8 52	D9 60	D10 68	D11 76	D12 84
E1 Positive Control	E2 5	E3 13	E4 21	E5 29	E6 37	E7 45	E8 53	E9 61	E10 69	E11 77	E12 85
F1 Negative Control	F2 6	F3 14	F4 22	F5 30	F6 38	F7 46	F8 54	F9 62	F10 70	F11 78	F12 86
G1 Positive Control	G2 7	G3 15	G4 23	G5 31	G6 39	G7 47	G8 55	G9 63	G10 71	G11 79	G12 87
H1 Negative Control	H2 8	H3 16	H4 24	H5 32	H6 40	H7 48	H8 56	H9 64	H10 72	H11 80	H12 88

Please email form to jgreen@bSES.com.au or send to Janet Green, BSES Limited Mackay, PMB 57, MMC, Qld 4741 (26135 Peak Downs Highway, Te Kowai Qld 4741)
 Phone 49636806 Fax 49545167
 Mackay RSD Lab use only: Date Rec'd:..... Date Results sent:..... Plate ID #:.....

APPENDIX 2B – ASSAY REQUEST FORM

TULLY SOIL BIOLOGY LABORATORY

ASSAY REQUEST FORM

Please ensure that all requested details are supplied

BSES, 'CPPB' or Sugar Services use only Office of origin:..... Phone:..... Fax:..... Contact person:..... Email:..... Project code.....
--

Farmer/Site name: _____

Charge to Name: _____

Address: _____

***ABN:** _____ **Email/Fax:** _____ **Phone No:** _____

Date sampled: _____ **Date samples sent:** _____

Method of despatch: _____

Depth of sampling: _____ **cm**

Block number: _____

Variety/crop class: _____

Soil type: _____

<u>Please tick appropriate box:</u>	
<input type="checkbox"/>	Current Services Agreement with BSES \$40.00 + GST/sample
<input type="checkbox"/>	No Services Agreement with BSES \$80.00 + GST/sample
<input type="checkbox"/>	BSES staff \$40.00/sample

Assay required	Minimum assay time	Minimum soil required
<input type="checkbox"/> Nematode	7 days	250 g
<input type="checkbox"/> Pachymetra	14 days	200 g

Other information: _____

Tully Station office use only Date sample(s) received:..... Date result(s) returned:.....

Please fax this form to Judy Bull c/- BSES Tully, fax 07 4068 1907, and attach a copy directly to each sample.

*** if > 20 samples.**

APPENDIX 3 – EMERGENCY USE PERMITS FOR FUNGICIDES FOR SUGARCANE SMUT

CONDITIONS OF USE

Product to be used:

GENFARM TRIADIMEFON 125 FUNGICIDE

Plus other registered products

Containing: 125g/L TRIADIMEFON as their only active constituent.

Directions for Use:

Crop	Pest	Rate
SUGARCANE	SUGARCANE SMUT (<i>Ustilago scitaminea</i>)	400mL product/100L water

Critical Use Comments:

Make up treatment solution by adding required amount of product to hot water (50°C) or cold water (ambient temperature) to obtain a solution containing 500mg active ingredient/L water. Treat sugarcane planting material by immersing in treatment solution for the appropriate length of time.

For a hot water treatment, immerse the planting material in the treatment solution at not less than 50°C, for between 30 and 180 minutes. It is recommended that the temperature of the treatment solution not exceed 54°C.

For a cold water treatment, immerse the planting material in the treatment solution for between 1 and 30 minutes.

The choice of treatment (water temperature and length of treatment) depends on the local conditions applying in the area. For example, if ratoon stunting disease (RSD) is also present, a hot water treatment for 180 minutes is appropriate to control both smut and RSD.

Withholding Period:

Not required when used as directed.

Jurisdiction:

NSW, QLD, WA only.

Additional Conditions:

THIS PERMIT provides for the use of a product in a manner other than specified on the approved label of the product. Unless otherwise stated in this permit, the use of the product must be in accordance with instructions on its label.

PERSONS who wish to prepare for use and/or use products for the purposes specified in this permit must read, or have read to them, the details and conditions of this permit.

Safety directions

Poisonous if swallowed. Will irritate the eyes. May irritate the skin. Avoid contact with the eyes and skin. Do not inhale vapour.

When opening the container and preparing dip, wear cotton overalls buttoned to the neck and wrist and a washable hat, elbow length rubber gloves, goggles and half facepiece respirator with organic vapour cartridge or canister.

When using the prepared dip, wear cotton overalls buttoned to the neck and wrist and a washable hat, elbow length rubber gloves.

After each day's use, wash gloves, goggles, contaminated clothing and respirator, and if rubber, wash with detergent and warm water. After use, and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water.

Re-handling

Do not re-handle treated planting material until fully dried unless wearing cotton overalls and chemical resistant gloves.

Disposal

Dispose of used/excess solution in an authorized disposal facility.

CONDITIONS OF USE

Product to be used:

TYRANT FUNGICIDE

NUFARM THROTTLE FUNGICIDE

Containing: 250 g/L PROPICONAZOLE as their only active constituent.

NUFARM THROTTLE 500 FUNGICIDE

Containing: 500 g/L PROPICONAZOLE as its only active constituent.

Directions for Use:

Crop	Disease	Rate
SUGARCANE SETTS	SUGARCANE SMUT (<i>Ustilago scitaminea</i>)	Products containing 250g/L propiconazole apply 100ml/100L water
		Products containing 500g/L propiconazole apply 50mL/100L water

Critical Use Comments:

Make up dip solution with cold (ambient temperature) water. Make one application to cane setts as a dip treatment for five minutes prior to planting.

Otherwise than described in this permit, follow all Instructions, Safety Directions and Re-handling instructions included on the product information leaflet attached as Attachment 1 (Tyrant Fungicide) or Attachment 2 (Nufarm Throttle Fungicide) to this permit.

Withholding Period:

NOT REQUIRED WHEN USED AS DIRECTED.

Jurisdiction:

NSW, QLD, WA only.

Additional Conditions:

THIS PERMIT provides for the use of a product in a manner other than specified on the approved label of the product. Unless otherwise stated in this permit, the use of the product must be in accordance with instructions on its label.

PERSONS who wish to prepare for use and/or use products for the purposes specified in this permit must read, or have read to them, the details and conditions of this permit.

APPENDIX 4 – INSPECTION CHECK LIST FOR HARVESTERS AND OTHER MACHINES.

Plant Protection Regulation 2002

Subordinate Legislation 2002 No.205

Section 118 Moving sugarcane appliances (machinery)

Machinery that has been in contact with a sugarcane plant or soil on which a sugarcane plant is or has been growing must have an inspector's approval to move between sugarcane pest quarantine areas. The Pest quarantine areas are:

- Torres Strait to Coen
- Coen to Cardwell
- Cardwell to Townsville
- Townsville to Bowen-Collinsville
- Bowen-Collinsville to Rockhampton
- Rockhampton to Howard
- Howard to NSW border
- Woodford special pest quarantine area

The purpose of this regulation is to prevent the movement of the important sugarcane pests: leaf scald disease, ratoon stunting disease, sugarcane Fiji disease virus, sugarcane mosaic virus and sugarcane striate mosaic virus.

The legislation does not apply to movement of weed seeds or other pests. The Inspector's approval in relation to this act does not imply freedom of weed seeds or other pests.

How to comply with the QLD regulations

- After its last use, clean the appliance (machine) thoroughly using the attached checklist.
- Contact your local Productivity Service or BSES office to arrange an inspection. At least a one-week notice should be given before you intend to move the machine. An inspector or his assistant will make the inspection using the attached checklist.
- When the inspector or his assistant is satisfied that the machine is free of visible cane residues and soil an Inspector's approval to move the machine will be issued.
- Ideally a copy of the Inspector's approval should accompany the machine when it is moved but in some cases this may not be possible. If it is inconvenient to get the hard copy of the approval to the applicant before the machine is moved he should be advised of the approval number and the person transporting the machine should note this number.

The legislation requires that an inspector be satisfied that the machine does not present a risk of spreading the diseases listed above. Generally this means that the machine should be visibly free of all plant material and soil. The inspection does not imply that the machine is absolutely free of plant material or soil and only covers inspection of areas of the machine that can be inspected without dismantling of the machine.

Haul-outs, cane-tainers and bins		
All outside surfaces, panels and windows		
Tractor or prime mover-as above		
Wheels – particularly inside of rims		
Suspension under bin		
Flights, boot, hopper on elevator bins		
Inside and outside of bin, container		

Further comments, cleaning requirements and inspections:.....
.....
.....
.....
.....

Plant Protection Regulation 2002
Subordinate Legislation 2002 No.205

Section 118 Moving sugarcane appliances (machinery)
--

(owner).....
(type).....
(make and model).....
(serial number).....

I certify that the machine as described above was free of visible plant material and soil when I inspected it on:

Date:

.....
Inspector/Assistant

.....
Organisation

Note: A new certificate will be required if this appliance comes in contact with sugarcane or sugarcane fields before it is moved.