SOUTH AFRICAN SUGARCANE
RESEARCH INSTITUTE

SEEDCANE
PRODUCTION

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C O N T E N T S

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INTRODUCTION

Planting good quality, clean seedcane from a properly regulated seedcane nursery makes sound agronomic and economic sense, as it offers several benefits:

Reduced pest and disease risk. Good quality seedcane significantly reduces the risk of serious pest or disease outbreaks in commercial fields. This includes ratoon stunt (RSD), smut, mosaic and eldana.

Improved germination. Well-grown seedcane, not yet mature, is most likely to germinate quickly and evenly and improves the likelihood of high yields. Good germination leads to rapid growth of a uniform stand and allows the variety to realise its full potential. Problems of gap filling after planting are therefore minimised and weed control is aided by a full leaf canopy. Having the plant crop start off on a strong footing, with subsequent good management, will lead to prolonged ratooning before replanting, thereby significantly reducing production costs.

Varietal purity. A further benefit of good quality seedcane produced in a well-managed nursery is varietal purity. Seedcane taken from unapproved sources is often contaminated with off-type varieties. This includes unwanted varieties that may be susceptible to pests and diseases. The production of seedcane under nursery conditions allows for regular inspections and effective eradication (roguing) of unwanted stools that could harbour pests and diseases.

Ideally, growers should establish their own seedcane nurseries so that they can be guaranteed of seedcane of the *right* variety at the *right* time and of the *right* quantity for their replant programmes. A well-managed nursery expedites the introduction of new varieties by ensuring purity and providing a controlled environment for rapid bulking.

This manual provides detailed guidelines for establishing and operating a seedcane nursery, propagating single-budded sett transplants, as well as operating and managing a hot water treatment facility. It also spells out a grower's legal obligations with regards to seedcane use.

SEEDCANE REGULATIONS

Appreciating the risk of spreading pests and diseases in seedcane, the industry included two clauses in the Sugar Industry Agreement which require all growers to have seedcane approved by their Local Pest, Disease and Variety Control Committee (LPD&VCC) prior to use, sale, or movement. The LPD&VCCs have legal powers, created through the provisions of the Sugar Act and the Sugar Industry Agreement.

72. *No grower shall sell or otherwise dispose of any seedcane without the prior approval of the Local Pest, Disease and Variety Control Committee having jurisdiction over the land on which the cane is grown.*

73. *A Local Pest, Disease and Variety Control Committee may require a grower within its jurisdiction who intends to use his or her own cane for seedcane on his or her own land to obtain the Committee's prior approval therefor.*

With the LPD&VCC function being reinstated under SASA in 2015, new rules were approved by SASA Council to standardise the implementation of pest, disease and variety management across the industry.

The LPD&VCC regulations require that all commercial sugarcane fields be planted with either LPD&VCC **certified** or **approved** seedcane.

The terms 'certified' and 'approved' refer to the two different classes of nursery (or seedcane) registration described in the regulations, with certified nurseries having to conform to a higher set of standards than approved nurseries, as detailed in Table 1.

In addition to the requirements specified in Table 1, all seedcane must be well-grown, in good condition and not water- or nutrient-stressed. The purchaser must ensure that the movement, use and sale of seedcane has been authorised by the LPD&VCC prior to purchase and that the relevant certificates are available.

Seedcane schemes are often promoted as an effective method of ensuring seedcane supplies are available on an area-wide basis. While this is true, ultimately it is up to the individual grower to comply with LPD&VCC rules.

In this Manual, unless otherwise stated, the term 'seedcane' refers to both certified and approved seedcane.

Table 1. Description of the required standards for the two classes of nursery (or seedcane registration)

CLASS OF SEEDCANE	SOURCE TO ESTABLISH NURSERIES	FALLOW PERIOD	DISEASE, OFF-TYPE AND PEST LIMITS			MAXIMUM AGE AT HARVEST	HARVESTS PERMISSIBLE
			SMUT MOSAIC OFF-TYPES	RSD	ELDANA /100		
CERTIFIED SEEDCANE AND CERTIFIED SEEDCANE NURSERIES	HWT certified whole-stick seedcane OR Transplants from HWT single-budded setts cut and grown from certified seedcane OR NovaCane® plantlets	Overall, the period to be not less than 12 months with a minimum of 6 months totally free of sugarcane	Less than 0.1% on the last of THREE consecutive LINE BY LINE inspections	NIL when tested (with cane being at least nine months old)	Less than local area hazard levels when inspected at least two months before harvest date	Irrigated North and KZN Coastal <500 m above sea level: 9-12 months Midlands >500 m above sea level: 12–18 months	Plant and 1st ratoon only with use by date
APPROVED SEEDCANE AND APPROVED SEEDCANE NURSERIES	Certified seedcane	Overall, the period to be not less than 9 months with a minimum of 6 months totally free of sugarcane	Less than 0.1% on the last of TWO consecutive intensive RANDOM inspections	NIL when tested (with cane being at least nine months old)	Less than local area hazard levels when inspected at least two months before harvest date	Irrigated North and KZN Coastal <500m above sea level: 9-12 months Midlands > 500 m above sea level: 12 –18 mnths	Plant and 1st ratoon only with use by date

Growers have the following options:

- to produce certified and approved seedcane themselves,
- to source their certified seedcane from a local LPD&VCC registered co-operator for planting an approved nursery on their farm, and/or
- to source their approved seedcane for planting commercial fields from a fellow grower with an LPD&VCC approved seedcane nursery.

If seedcane is sourced from a grower outside of the LPD&VCC area, permission must be obtained from both the sending and receiving LPD&VCCs.

Ideally, each grower should establish their own seedcane nursery to produce certified and/or approved seedcane.

Forward Planning

Establishing a nursery and synchronising its outputs with the seedcane requirements of the farm can be a complex process. Seedcane production should therefore be regarded as a core component of all sugarcane production management planning.

Planning seedcane production needs to start at least two years before the seedcane is required for planting into commercial fields, as the mother seed needs to be ordered or planted at least a year before it is required for the nursery.

The nucleus or mother seedcane of an appropriate variety to be planted in the nursery should be between 9 and 12 months old in the irrigated and coastal regions and up to 18 months in the high-altitude areas. Consider the time of year for commercial planting as an essential factor in the planning process.

Identify the potential nursery site well in advance allowing enough time for inspections to confirm a 12-month fallow for a certified seedcane nursery and 9 months for an approved seedcane nursery. Inform the local Extension Specialist or Biosecurity Officer of your intention to establish a nursery. This is vital as all LPD&VCC certified and approved nursery sites need to be registered with the LPD&VCC.

Fallow = land that has been left unplanted to sugarcane. The fallow period starts from the time of physical removal of the previous crop or after the first application of glyphosate (or similar chemical).

The Biosecurity Inspectorate, on behalf of the LPD&VCC will carry out all the necessary fallow period inspections. It is important to note that tillage of the nursery site, other than to eradicate the crop and to plant the cover crop, is not permitted 6 months prior to planting. All lime applications must therefore be carried out at the beginning of the fallow period.

Types of Seedcane

Seedcane can take one of three forms: *whole-stick seedcane, hot water treated single-budded sett transplants* or *NovaCane® plantlets*. Growers will usually choose a particular option based on cost, availability, source, ease of handling, labour requirements, quantities required and the intended purpose of the seedcane.

Whole-stick seedcane

This is the most common form of seedcane used in the industry where the entire sugarcane stalk is planted as seedcane to establish certified and approved nurseries.

Currently both certified and approved nurseries can be harvested twice (plant and first ratoon) provided pest and disease levels remain below the accepted thresholds (Table 1).

Only hot water treated certified seedcane may be used to establish certified nurseries.

Hot water treated single-budded sett transplants

Transplants are obtained from registered transplant nurseries. They satisfy the requirements to be classified as certified seedcane and can be harvested twice (plant and first ratoon crops) provided pest and disease levels remain below the accepted thresholds (Table 1).

They have some distinct advantages, particularly for the rapid bulking up of healthy, true-to-type seed material in nurseries. Transplants can be transported easily and inexpensively over long distances, and each stool can be easily identified when roguing in the nursery.

They are not recommended for planting commercial fields. Being less hardy than whole-stick seedcane, transplants need to be handled with greater care to ensure a good stand, and watered if the nursery is not irrigated.

Comprehensive guidelines on the production and handling of hot water treated single-budded setts are provided on page 14 to 17.

NovaCane® plantlets

NovaCane® plantlets are produced via a tissue culture process in a laboratory. They satisfy the requirements to be classified as certified seedcane and can be harvested twice (plant and first ratoon crops) provided pest and disease levels remain below the accepted thresholds.

The NovaCane® process in a laboratory enables many plants to be propagated using a minimum quantity of starting material. At the time of production and before being exposed to normal field conditions, NovaCane® plantlets are free of known diseases and are true-to-type. After production in the laboratory, the plantlets are hardened off and grown in seedling trays for a period of 3-5 months. Plantlets can be transported easily and inexpensively over long distances, and each stool can be easily identified when roguing in the nursery.

The NovaCane® process is particularly useful in eliminating viruses such as sugarcane mosaic virus, which is not eliminated by conventional hot water treatment.

They are not recommended for planting commercial fields. Being less hardy than whole-stick seedcane, NovaCane® plantlets need to be handled with greater care to ensure a good stand, and watered if the nursery is not irrigated.

Seedcane for certified nurseries

For a LPD&VCC certified seedcane nursery, only certified seedcane may be used as nucleus seedcane. This cane must be hot water treated at an approved facility before planting into the nursery. Alternatively, hot water treated single-budded sett transplants or NovaCane® plantlets may be used as nucleus material.

Seedcane for approved nurseries

For a LPD&VCC approved nursery, only certified seedcane from a co-operator approved by the LPD&VC Committee may be used as nucleus seed. This seedcane does not require further heat treatment. If pest and disease levels remain below accepted thresholds and approved by the LPD&VCC, it may be used to establish commercial fields the following year and the year after.

Important notes

- Seedcane should not have flowered or have been exposed to ripeners, nor should it have swollen buds which are prone to damage and will lead to gaps in the nursery.

- All seedcane to be planted in a nursery should be treated with a fungicide to protect against pineapple sett rot and infection by smut (refer to SASRI Information Sheets *9.2 Smut* and *9.7 Pineapple sett rot* for updates on registered products).

- It is important to manage eldana in seedcane fields. This may require the application of registered insecticides to maintain levels below the area threshold.

Nursery site

There are advantages to having a **permanent site** for a nursery, situated on good, well-drained soil, and in a low-risk area i.e. areas not prone to runaway fires, grazing cattle, frost or theft. The ability to irrigate a nursery will ensure that adequate amounts of fresh, well-grown seedcane are available when needed. A permanent nursery site enables seedcane rotation to be practised without disrupting the management of commercial fields.

Often, establishing a dedicated nursery site may not be practical. Growers may then opt to use commercial fields to serve as **temporary nurseries** as they come up for replanting.

In order to be registered as either certified or approved nursery sites, these fields need to be subjected to the standard requirements for fallow and general suitability (soils, irrigation, no history of RSD, low-risk etc.). Once the permitted number of harvests for seedcane is completed, the nursery reverts to a commercial field and the next nursery site is identified from within the normal area under fallow on the farm.

The advantages of this system are that the grower does not have to eradicate high-quality seed material after the first ratoon, and the benefits of good seedcane are then maintained for the rest of the crop's life.

The disadvantages of this approach are that it might not be possible to choose the best site, and control could be compromised having the nursery site or sites in different parts of the farm each year.

Whether using a permanent or temporary site, nursery boundaries must be well-defined and clearly marked. The edges of the nursery must be wide enough to avoid contamination from neighbouring cane and to enable easy access. Where several different varieties are grown in the nursery, they must all be clearly labelled and well separated.

Permanent nursery layout and rotations

A standard, permanent nursery is normally divided into three equal portions and cycled on a three-year rotation so that, in any given year, one-third will be fallow, one-third will carry a plant crop and one-third will carry a first ratoon crop. Getting the three blocks of a nursery into this rotational cycle can be done as follows:

In Year 1, one block (Block A) is fallowed. In Year 2, Block A is planted and Block B is fallowed. In Year 3, Block A is harvested and ratooned, Block B is planted and Block C is fallowed. This system will achieve its full production in four years.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4
Block A	**fallow**	**planted**	**harvest and ratooned**	**harvested, eradicated and fallowed**
Block B		**fallow**	**planted**	**harvest and ratooned**
Block C			**fallow**	**planted**

Nursery layout showing three-block rotation.

Nursery size

The size of area required for the nursery can be determined by calculating the following:

a) the area of the farm to be replanted each year (based on replant %)
b) the amount of approved seedcane required for that area (based on planting rate)
c) the area required to produce that amount of seedcane (based on expected yield)
d) the total nursery size allowing for plant, ratoon and fallow blocks.

Here is an example showing how this calculation is done in practice if certified seedcane is purchased each year for planting into an approved nursery:

Example

For a 100 ha farm with a replant regime of 10% per annum; an average yield 60 t/ha; a planting rate of 12 t/ha using whole-stick seedcane.

a) the area of the farm to be replanted each year
= area under cane x replant %
= 100 ha x 10%
= 10 ha

b) the amount of approved seedcane required for that area (based on planting rate)
= replant area x planting rate
= 10 ha X 12t/ha
= 120 t

c) the area required to produce that amount of seedcane (based on the expected yield from the nursery)
= approved seedcane required / average yield
= 120 t ÷ 60t/ha
= 2 hectares

d) total nursery size allowing for plant, ratoon and fallow blocks

Note: Currently, approved nurseries may be harvested twice (plant and first ratoon crops), meaning that only half the nursery area required (as calculated above) needs to be replanted each year.

Under the current rule, half of that area will be plant crop and half will be first ratoon. So, the total area required (made up of equal parts of plant, first ratoon and fallow) can be calculated as follows:

Total cane area required:

(2 ha ÷ 2) x 3
= 3 ha

Note, that you will only require seedcane for the plant block each year. In this example, at a rate of 12t/ha, 12 tons certified seedcane needs to be sourced every year.

Nursery size will vary from farm to farm but approximately 2 to 3 hectares of LPD&VCC approved nursery space is generally sufficient for every 100 ha of commercial cane with a replant of 10% per year.

Figure 1 gives an idea of the relative size of the area required for seedcane nurseries compared to the size of the total cane area.

Figure 1: Size of seedcane nursery relative to total cane area.

It should now be evident that the production of seedcane for planting commercial fields is a bulking-up process. The flow of seedcane from certified nurseries to approved nurseries and then to commercial fields is shown in Figure 2.

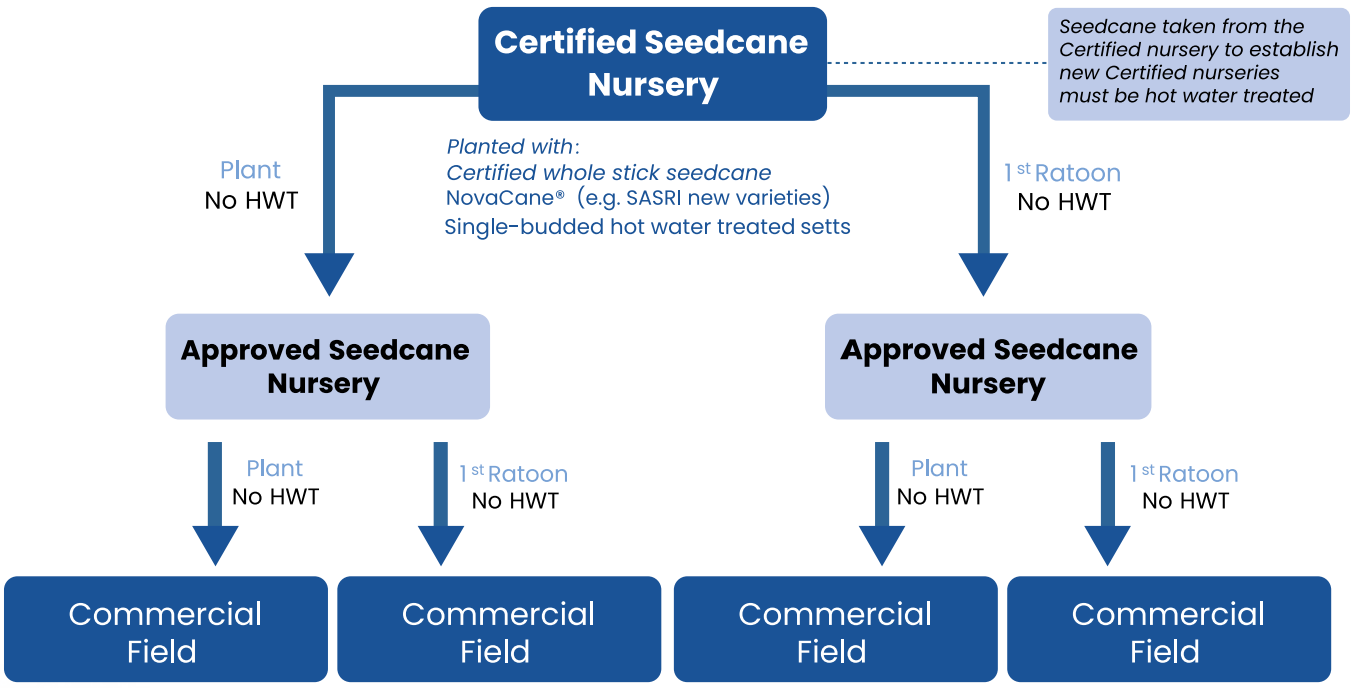


Figure 2: Certified and approved (bulking) phases of seedcane production.

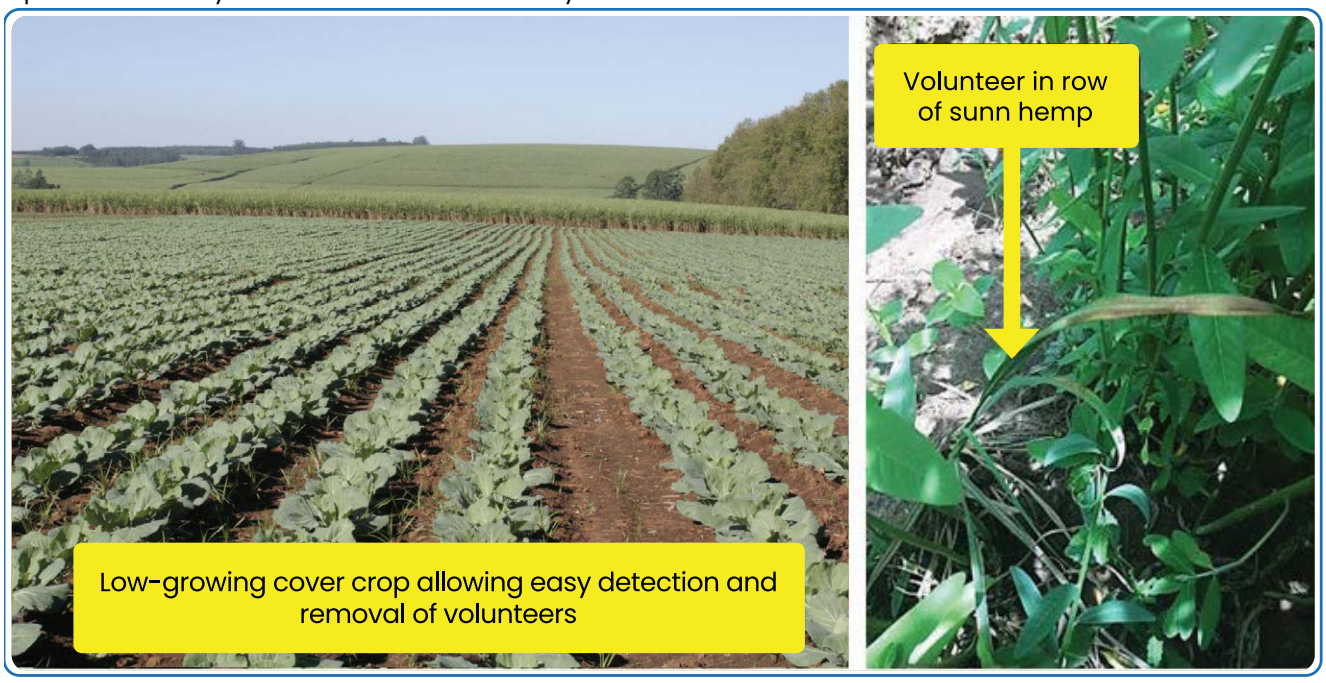
Planting

Ideal planting times are from September to March. However, avoid planting mosaic-susceptible varieties from mid-October through to the end of January to reduce the risk of virus spread by aphids. In addition, avoid planting smut-prone varieties from September to November.

The rate of growth of varieties may influence the time of planting of nurseries, particularly in the Midlands. However, since there is a two-year bulking-up process to get to the point where commercial fields can be planted with approved seedcane, some forward planning is required to ensure the correct varieties are chosen. A local SASRI Extension Specialist can be of considerable help in selecting the most suitable varieties for a farm, and in calculating the quantities of seedcane required.

Planting into a nursery must take place only after the previous cane crop or nursery has been destroyed. This is best achieved using glyphosate or imazapyr-based herbicides that are registered for cane destruction, followed by the required fallow period for certified and approved nurseries (Table 1).

During this break, the field can be left fallow, or a low-growing crop can be grown, allowing the easy recognition and eradication of any sugarcane regrowth from the previous crop. Suitable crops include vegetables, green manure crops such as cowpeas, or an annual crop for cattle to graze. Avoid planting tall crops such as sunnhemp in potential nursery sites as volunteers are easily missed.



If the nursery cannot be irrigated, plant using water (2 to 3 litres per metre of row) or apply a suitable composted organic material in the furrow to obtain good germination and rapid establishment of the seedcane crop.

Seedcane nurseries must never be 'gapped up' to compensate for patchy germination, due to the high risk of introducing diseases and off-types from other seedcane sources.

Planting whole-stick seedcane in nurseries

With good soil conditions, the setts or stalks of seedcane can be spaced slightly apart in the planting furrow, thus allowing the most economical use of the valuable seedcane and facilitating roguing operations in the nursery.

Hot water treated cane has no apical dominance. **Whole-stalks must therefore not be cut into setts when being planted after hot water treatment** as this could re-introduce diseases such RSD.

Planting hot water treated single-budded sett transplants and NovaCane® plantlets

In their final stages, before release from the nursery, NovaCane® plantlets are similar to transplants grown from single-budded setts. The following planting guidelines therefore apply to both hot water treated single-budded sett transplants and NovaCane® plantlets (Refer to SASRI Information Sheet *1.4 NovaCane® Planting Guide* for further details).

- Order plants at least a year before the planned planting date.
- The number of required plants per hectare differs depending on the row spacing. Plants are usually planted up to 40 cm apart.
- Vehicles transporting the plants should be covered and the plants should not be exposed to high temperatures.
- Avoid transporting plants in plastic bags.
- If there are delays in delivery, the consignment should be removed from the delivery vehicle and stored in a cool shaded place and kept moist.
- Plant within 24 hours of delivery.
- If possible, plants that are hardened off in trays with plastic inserts should be kept in the inserts up to the time of planting to further reduce stress.
- Always plant in the best soils with some form of irrigation available.
- The soil should be clod-free to avoid air-pockets forming around the roots, regardless of whether ploughing or minimum tillage has been used as a form of crop eradication.
- Fertiliser (phosphorus and potassium) should be applied and incorporated into the soil prior to planting to avoid the possibility of root scorch. Nitrogen fertiliser should be top-dressed after the plants are established.
- A wooden peg and hammer are required to make the hole for each plant. There are also both hand-and tractor-mounted implements designed specifically for planting trees and other seedlings, and these can be used to speed up the planting process if necessary.
- If the soil is dry and friable (easily crumbled), a small amount of water will be required to allow the planting hole to remain open long enough while the plant is positioned and planted. It is also a good idea to water each plant after planting. There are also commercially available water-retaining gel products which can be applied in the planting hole that make water available to the plant during the very early stages of growth.
- The depth of planting should be just below the lowest leaf of the plant to ensure that tillering occurs below soil level. This will give the roots a good start and reduce stress to the plant.
- Gentle foot pressure needs to be applied around the plants after planting.
- Apply a nematicide in sandy soils, and insecticides if necessary. Refer to SASRI Information Sheets for updates on registered products.
- The field should be irrigated after planting.

Weed control

Fields should be hand-weeded for at least one month after planting, allowing the plants to establish. NovaCane® and transplants are very sensitive to herbicides. Application of products such as metribuzin + diuron are safe for use if directed into the interrows, so that the spray swath covers only the base of each plant. Use a suitable shield to ensure that spray is directed into the interrow. Spray operations should be done in still weather conditions to reduce the risk of drift. It is important for the hand weeding and spray operations to be closely supervised to minimise the risk of damage to the plants.

Fields with a history of problems with creeping grasses should not be planted to NovaCane® plants or transplants.

Pest and disease inspections

All nurseries must be registered with the relevant LPD&VC Committee. The SASRI Biosecurity Inspectorate will then inspect the nurseries regularly for pests, diseases and off-types.

Disease inspections are performed in young cane (when the canopy is knee to shoulder high – about 1.5 m) by walking between the cane lines and carefully examining the plants. At least three line-by-line inspections are conducted by the Inspectorate in certified nurseries, and diseased stools and off-types are marked for roguing. Ideally, a roguing team should follow the inspectors and remove the marked stools immediately. Approved nurseries require at least two intensive random disease surveys by the Inspectorate for the seedcane to be registered. For comprehensive information on the many pest and disease threats facing our industry, consult SASRI publications such as the Pest and Disease Identification Guide and the various SASRI Information Sheets on pests and diseases available at www.sasri.org.za/e-library.

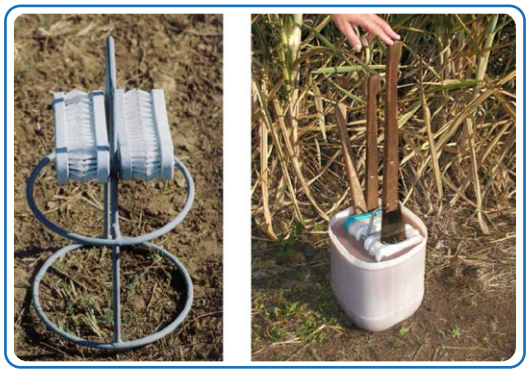
Growers are advised to supplement the required pest and disease inspections by conducting their own inspections. On request, personnel from the Biosecurity Inspectorate or instructors from the Shukela Training Centre will train farm staff to recognise and eradicate diseased and off-type stools. It is important for every farm to have its own trained staff to manage nurseries and carry out the necessary field hygiene procedures. The Biosecurity Inspectorate teams will routinely inspect for the more common and important pests and diseases such as smut, mosaic, MSV and eldana, and collect stalk samples for RSD diagnosis.

Roguing

It is the grower's responsibility to remove diseased stools (clumps of infected shoots) and off-types that have been identified by the Biosecurity Inspectorate. Provided these stools are not infected with smut, they can be dug out and left to dry beside the field (stool roguing). Unwanted stools may also be chemically rogued in the field by spraying with a 10% glyphosate solution sprayed over as much of the unwanted stool as possible. Care must be taken to avoid spraying the surrounding stools. Staff performing chemical roguing must be well-trained. Sprayed stools will die off after four to eight weeks.

If smut is observed, emerging whips must first be cut from the infected plants and placed in bags so that the spores are not spread during the roguing process. The bags of whips should be closed and taken as far from the field as possible and burnt or buried. Whips must not be left in or beside the field. In the case of chemical roguing, it is important to remove both incipient and emerging whips by cutting about halfway up the stalk before spraying with glyphosate, leaving enough green leaf material for the chemical to be effectively absorbed.

Refer to SASRI Information Sheet 9.12: *Roguing* for further information.



Harvesting

When harvesting seedcane, frequent knife decontamination (preferably after every metre of row cut) is necessary. Extra knives should be allocated to each cutter when harvesting seedcane to ensure that the knives are decontaminated properly to minimise the risk of RSD spread. A foaming quaternary ammonium compound (QAC) containing benzalkonium chloride and didecyl dimethyl ammonium chloride (3% solution) can be used for this purpose. Jeyes Fluid (10% solution) or methylated spirits (75% solution prepared in a knapsack) are also effective. A contact time of at least five minutes is required for QACs and Jeyes Fluid. Refer to Table 2 for information on suitable disinfectants.

Table 2. Disinfectants to use on sett cutters and implements in the nursery

Disinfectant	Active ingredients	Concentration (%v/v)	Minimum contact time	Farm implements	Mechanical harvesters	Sett cutting machines
Jeyes Fluid	Carbolic acid	10	5 min	Yes	Not recommended	Yes
Quaternary ammonium compound	Benzalkonium chloride; didecyl dimethyl ammonium chloride	3	5 min	Yes	Yes	Yes
Methylated spirits	Methanol; ethanol; denaturant	75	10 secs	Yes	No	No

Knives used for cutting seedcane must be kept separate from those used in commercial fields. The handles of the seedcane knives can be painted to allow easy identification.

Mechanical harvesters that are assigned to harvest commercial fields must not be used to harvest certified or approved seedcane.

Seedcane harvested from the nursery should be handled carefully to avoid damage to the buds and it should be planted without delay.

Loading and transport

Vehicles used for moving the seedcane from nurseries to the fields for planting must be thoroughly cleaned before use to minimise the risk of varietal mixing or pest and disease transmission. This is particularly important if the transport is also used for haulage to the mill.

Loading of seedcane should preferably be done by hand, and handling should be kept to a minimum. Mechanical grab-loaders may cause significant damage to buds. Once loaded, the trailer should be moved slowly and carefully over rough road surfaces to avoid damage to the buds.

PRODUCING HOT WATER TREATED SINGLE-BUDDED SETT TRANSPLANTS

Certified seedcane to produce single-budded sett (SBS) transplants must be obtained from a registered certified seedcane nursery. Only the plant and first ratoon crops in these nurseries may be used for SBS transplant production. SBS that are damaged by borer or are infected with stalk rot fungi should be discarded.

Cutting of single-budded setts

An operator should be assigned to a specific sett cutter and should be responsible for the cleanliness and maintenance of the machine. The blades of the sett cutter should be sprayed frequently with a suitable disinfectant (Table 2) to reduce the risk of disease spread, particularly RSD. Some nurseries use a 10-minute buzzer as a reminder.

The sett cutter should be thoroughly cleaned after each batch of seedcane is processed and at the end of each day. A broom should be used to remove plant and soil debris from the cutter, including the chute, before spraying with a suitable disinfectant. The blades of the sett cutter should be sharpened at least weekly. Blunt blades will shred the edges of the SBS, making them more prone to fungal infections.

The SBS should be collected in ventilated plastic boxes (LUG boxes) for transfer to the hot water treatment (HWT) tank. The LUG boxes should be disinfected with a suitable disinfectant (Table 2) after each batch of seedcane is processed.

Hot water treatment (HWT)

All SBS must be hot water treated for 40 minutes at 52°C for RSD control. A datalogger should be fitted to the unit to continuously monitor the temperature of the tank. It is essential to check the accuracy of the thermostat in the tank at least monthly and calibrate as necessary.

The HWT time only commences when the temperature of the tank has returned to 52°C after the cane has been added. Do not overload the tank as this will increase the length of time taken to reach the desired temperature and will also reduce the flow of water through the tank.

Ensure that the circulation in the tank is adequate to maintain a uniform temperature. Replace the water before it sours.

Reduce the temperature of the SBS as they are removed from the tank as quickly as possible by dipping in or spraying with cold water. Leave them uncovered in the shade to cool further.

Handling of SBS after HWT

The buds should be allowed to harden overnight in ventilated plastic boxes before handling the SBS. Softened buds are easily damaged after removal from the HWT tank, and this often results in poor germination.

Trays of SBS should be placed on racks or wooden blocks in the germination room to improve air circulation. They should not be placed directly on the floor.

Good results have been obtained when SBS are transferred after 24 hours to transplant trays that have been half-filled with moistened growing medium and left uncovered to germinate, ensuring that the growing medium remains moist. Those SBS that do not germinate are discarded and replaced with germinated SBS of the same variety from other trays. Fill the trays with growing medium and transfer them to the outside benches.

The ideal temperature range for germination is 28-32°C. Germination is generally slow at lower temperatures, which may allow sett rot fungi to infect the setts. However, temperatures above 32°C encourage the growth of bacteria and yeasts when humidity is high, which may also affect germination.

Transplant trays

Multicellular seedling trays (usually 72- or 98-cell) with a depth of 10 – 12 cm are recommended for propagating SBS transplants. Wash the trays thoroughly to remove plant and soil debris and spray with sodium hydrochloride e.g. Jik (15% v/v solution) or a similar disinfectant before each use.

If polystyrene trays are used, they must be treated with a copper-based root pruning solution before use to prevent the roots growing into the trays. This will limit damage to the SBS transplants when they are removed from the trays. The trays must be raised at least 30 cm off the ground to allow light to penetrate underneath, preventing the roots from growing through the drainage holes of the tray cells.

Growing medium

Composted pine bark and well-composted bagasse are commonly used. Perlite may be added to the medium to improve percolation. No field soil should be added to the mixture, to limit the risk of introducing pests and pathogens.

If using bagasse, prepare as follows: to one cubic metre of bagasse, incorporate 3 kg of dolomitic limestone and 2 kg of 2:3:4(24) fertiliser. Mix thoroughly and moisten the stack. Turn over every 2 weeks for the first 6 weeks. Enrich with further nutrients at a rate of 2 kg 2:3:4(24) per cubic metre. Continue aerating the stack by turning at least once a month. After 4-5 months, the bagasse would have shrunk considerably, turning black. It is advisable to send a sample to a registered laboratory for nutrient and pH analysis before using for SBS transplant propagation.

Irrigation

Irrigation schedules will vary across regions and seasons, but trays should be irrigated up to 4 times daily for 3-7 minutes. Care must be taken to avoid irrigating excessively as this can result in waterlogging, leaching of nutrients and can lead to the development of algae on the surface of the growing medium. Irrigation schedules must be adjusted in the cooler winter months.

Fertigation

Fertigation is necessary due to leaching and is generally carried out every 2 to 3 days in summer and once a week during the winter months. The following nutrient concentrations are recommended when fertigating: nitrogen (N): 0.1 g/L; phosphorous (P) and potassium (K): 0.06 g/L; calcium (Ca): 0.05 g/L; magnesium (Mg) and sulphur (S): 0.03 g/L; pH 4.5-6.0. Slow-release fertilisers are also available that can be incorporated into the medium before planting.

SBS transplants are particularly prone to nutrient deficiencies such as iron chlorosis as they mature. It is important that transplants are well fertilised before transferring to the field.

Trimming

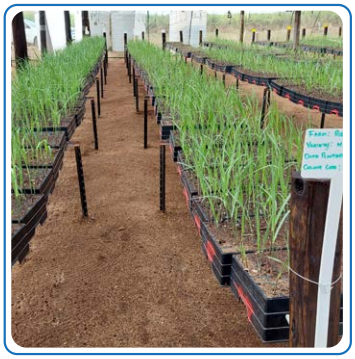
Transplant leaves should be trimmed 4-6 weeks after planting. Thereafter, plants should be trimmed every month. A light trimming a day or two before transplanting facilitates handling and reduces transplant stress. To prevent the spread of RSD, cutting tools should be regularly dipped in a disinfectant (see Table 2) during this operation. All cutting implements must be disinfected at least between batches of transplants, but preferably after each tray, to reduce the risk of RSD spread.

Length of time in the nursery

This is region and season dependent, ranging from 6 to 12 weeks in summer and 8 to 20 weeks during the winter period. The development of a firm root plug is essential before transferring to the field, but SBS transplants must not become root bound. This can be checked by examining the root plug periodically.

General nursery hygiene and practice

The nursery should be fenced and gated to prevent casual access. Protection of the plants from wind and hail with side and overhead netting is also recommended. Tools and equipment must be dedicated for use in the nursery and not used or brought in from outside the nursery. People employed in the nursery must be specially trained in hygienic seedcane production practices, such as disinfection of implements. Special care must be taken to avoid mislabelling and mixing of varieties during the preparation of SBS and after transfer of the trays to the benches. Only one variety should be prepared at a time and trays of different varieties must be well marked and separated on the benches. Colour coded labels specific for each variety in the nursery will assist with easy identification.



Pests and diseases in the transplant nursery

Disease inspectors must be thoroughly familiar with pest and disease symptoms in the SBS transplants, and the trays should be carefully inspected every two weeks. Any incidence of a pest or disease must be recorded. A final inspection by the Biosecurity Inspectorate must be done within one week of dispatch to the grower. The Biosecurity Officer and/or Extension Specialist must be notified should virus symptoms e.g. mosaic or maize streak be observed in the nursery. Rust infections may be treated with a registered fungicide. Ratoon stunt (RSD) samples must be taken periodically. This can be arranged through the local Biosecurity Officer or Technician. Insect pests such as aphids and thrips should be controlled by routine applications of registered pesticides. Any grasses surrounding the nursery should be cut back or burnt regularly. This will reduce aphid populations in the vicinity. No maize should be grown near the nursery and surrounding sugarcane fields should be inspected regularly and be free from diseases such as mosaic and smut.

HOT WATER TREATMENT (HWT)

Seedcane used to establish certified nurseries is treated in hot water, mainly to eliminate ratoon stunt (RSD). Hot water treatment (HWT) for 2 hours at 50°C (±0.5°C) should eliminate populations of viable RSD bacteria in the seedcane that were too low to be detected through routine testing. The 2-hour treatment period should commence only when the water temperature has reached 50°C. The time should be strictly controlled, and a constant temperature maintained for the treatment to be effective.

Do not hot water treat cane that has tested positive for RSD. Fields that have tested positive for RSD may not be used a seedcane source as HWT is not completely effective in eliminating the RSD bacteria in severely infected stalks. Recycling certified seedcane through the certified nursery system is the best way to ensure that RSD is not re-introduced.

It should be noted that treatment for 2 hours at 50°C provides little control of leaf scald and may increase the susceptibility of certain varieties to smut and mosaic. Where smut is common, HWT of smut-susceptible varieties may result in more rapid re-infection. To counter this effect, seedcane of susceptible varieties should be treated with a registered fungicide when these varieties are planted in areas where smut is prevalent. Refer to SASRI Information Sheet *9.2 Smut* for updates on registered chemicals.

Loose dead leaf material should be removed before HWT, but it is not necessary to strip the seedcane completely. Leaving the leaf-sheath bases at the nodes gives some protection to the buds which become soft during hot water treatment.

Seedcane should be handled carefully after HWT. Softened buds are easily damaged after removal from the tank, and this often results in poor germination.

Heat treated cane has no apical dominance. Seedcane treated as whole stalks must not be cut into shorter setts when planted in the nursery as this could re-introduce diseases.

Some varieties are sensitive to HWT and may germinate slowly after treatment, particularly under cool conditions. It is important to treat these varieties with a fungicide before planting. Refer to SASRI Information Sheet *9.7 Pineapple sett rot* for updates on registered fungicides.

There are some obvious cost benefits to growers co-operating and producing their combined seedcane requirement in conjunction with a shared heat treatment plant.

Hot water tanks

Continuous output (Upfold) plant

A continuous output HWT plant comprises a tank and several baskets, each of which holds 60-70 kg of seedcane. Baskets are added successively to the tank at appropriate intervals (10–15 min, depending on the tank size) and are slid on rails from the input to the output end of the tank as treatment progresses.

When a basket has been in the tank for two hours, it is removed, and a new basket is added. By adding relatively small baskets at short intervals, the substantial temperature fluctuations which result from adding large loads of cold seedcane are avoided.

Heating is achieved by electric elements (usually 18 kW) and the temperature is controlled by a thermostat assisted by good water circulation which avoids hot and cold areas within the tank.

A major advantage of this type of tank is that damage due to excessive handling of the seedcane is minimised. If enough baskets are available, they could be used to transport seedcane directly to the field after treatment, thereby further reducing handling and possible damage.

Table 3: Available continuous output HWT tank sizes.

Model	Water capacity (litres)	Number of baskets	Interval between baskets(min)	Output per 10 h stift (kg)
3 ton	3300	9	15	2 800
5 ton	4800	13	10	4 700

(* Assuming 70 kg seedcane per basket and no downtime)

Large batch tanks

SASRI recommends the use of the continuous output HWT plant described above because the time to reach the required temperature is reduced and a constant temperature is maintained during the process. However, large batch tanks are also available.

Step-by-Step HWT Procedure: Continuous Output (Upfold) Tank

Prior to start-up

1. Check that the building housing the HWT tank is in good condition. Repair as necessary. Ensure that the tank is protected against excessive draughts which can affect temperature control.

2. Check that the seedcane baskets are in good condition. Ensure that the sides are sufficiently screened to prevent billets from falling out (see point 5 under 'Treatment').

3. Arrange a mechanical audit.

   3.1. Before filling the HWT tank

   - Check the general condition of the tank (internally and externally) as well as all pipes, electronic control panel and monitors.

   - Place 13 empty baskets in the tank (see point 1 under 'Treatment' below).

   3.2. Fill the tank and allow to reach temperature (~50°C) before checking that:

   - The tank, pipes and seals are not leaking.

   - The circulation systems are functioning correctly.

   3.3. Using a digital thermometer with 1m probe, check that:

   - the temperature of the water near the corners of the tank (near the surface, halfway down and bottom) is 50°C (±0.5°C)

   - the overall temperature of the tank matches the digital display on the external electronic monitor.

   3.4. Ensure that the swivel/gantry cranes to load and unload the baskets into and from the tank, if available, are in good working order.

   3.5. Ensure that the Y-shaped pull-through ropes are in good condition. Replace if necessary.

   3.6. Ensure the cooling / fungicide dipping tank is positioned correctly to receive treated baskets from the tank.

   3.7. Check the timing of the buzzer. It should sound every 10 min.

   3.8. Repair or make adjustments as required.

4. Once the tank and all other equipment required are confirmed to be in sound working order, treatment of seedcane can begin.

Treatment

1. Before filling with water, hang 13 empty baskets in the empty tank. This is done in case any baskets fall off the rails while being inserted. This can easily happen if a basket turns a little sideways somewhere in the tank but is avoided when the tank is filled with 13 baskets. A fallen basket is very difficult to retrieve in a tank full of water. NB: Do not hang full baskets on the longitudinal spray pipes unless the tank is full of water.

   While inserting the baskets, attach the Y-shaped pull- through rope (it will be difficult to do this after all the baskets are inserted). The rope must lie on top of each basket. Hooks must be at the output end of the tank. In some cases, poles are used to push the baskets forward from the input end of the tank.

2. Fill the tank with clean water to a few millimetres below the longitudinal spray pipes.

3. Close the input and output lids, switch on the tank and allow the water to reach 50°C (this will take about 6 hours if starting from 20°C). Do not switch on unless the tank is at least 25% full of water or the pump and elements may be damaged.

4. Remove most of the dead leaf material from the stalks but leave the leaf-sheath bases in the nodal region to protect the buds. There should be no loose trash on the stalks that could clog the filters.

5. Cut the seedcane into 1m lengths. These can be placed in the skeletal baskets. Any shorter pieces must be placed into mesh-lined baskets. Fill the baskets to level with the top of the basket end plates. This will allow free flow of the water circulation over the top of the baskets.

6. Weigh the baskets if required.

7. Once the buzzer sounds, open the lid at the output end of the tank and remove one empty basket. Slide all the baskets along the rails from the top end of the tank to the output end to fill the gap.

8. Close the lid at the output end.

9. Insert a full basket into the space made at the input end of the tank.

10. Ensure no seedcane is protruding above the water line before closing the lid.

11. When the buzzer sounds, open the lid at the output end of the tank and remove another empty basket. Slide all the baskets along the rails to close the gap and make space at the input end. Close the lid.

12. Insert another full basket at the input end and close the lid.

13. Repeat every 10 minutes on the buzzer, until 13 full baskets have been placed in the tank.

14. As empty baskets are removed and full baskets are placed into the tank, the water level will rise. Drain the tank at intervals to keep the water level a few millimetres below the pipe rails.

15. When the buzzer next sounds, indicating that 10 mins have passed, remove the first full basket that was placed in the tank – it will now be at the output end of the tank - and place another basket in at the input end the tank. There must always be 13 baskets in the tank. This gives an actual 2 hr 10 min treatment (13 x 10 minutes), 10 minutes to allow the cane time to reach 50°C before timing the 2-hour treatment.

16. Transfer the treated basket that has just been removed from the HWT tank to the cooling / fungicide dipping tank.

17. When the buzzer sounds, remove the next basket from the tank, slide all baskets along and place a new basket into the tank.

18. Remove the first basket from the fungicide dipping tank and transfer to the holding area.

19. Transfer the second basket that was removed from the HWT tank to the fungicide dipping tank.

20. Continue the process until all the seedcane has been treated.

21. Two hours before knockoff time, on the buzzer, start placing empty baskets into the tank at 10-minute intervals. After two hours, the tank will be full of empty baskets ready for the next day. During this process, the water level will drop. To compensate for the water drop and to prevent any seedcane from protruding above the water line, slowly add water making sure the temperature does not drop. It is critical to keep the temperature constant throughout the process.

Temperature monitoring during operation

The temperature of the tank should be tested manually during operation, preferably once a month.

1. Take a temperature reading at the input end of the tank as the lid is removed to add a new basket by inserting the temperature probe as far into the tank as possible.

2. Record the temperature, remove the probe and replace the lid.

3. Repeat for the output end of the tank.

4. Compare the manual readings with the electronic control panel readings.

5. Once the next basket of seedcane is placed in the tank, insert the probe as far into the basket of seedcane as possible. Record the temperature.

6. Leaving the probe in the same position, record the time it takes for the temperature to return to 49.5 and 50°C.

7. Remove the probe and replace the lid.

8. Compare the manual readings with the electronic control panel readings.

9. Just before the 10-minute buzzer is due to sound, remove the lid from the output end of the tank.

10. Take a temperature reading by inserting the probe as far into the basket of seedcane as possible.

11. Record the temperature, remove the probe and replace the lid.

12. Compare the manual reading with the electronic control panel reading.

13. Repeat the process (from 6 onwards) to confirm readings.

14. Adjustments will need to be made by a qualified technician if 1) the temperature readings fall outside the 50°C (±0.5°C) range; 2) the manual readings do not match the electronic control panel readings; 3) the time taken for the temperature to return to 50°C after a basket has been added to the tank is more than 2 minutes (methods to improve circulation within the tank may be required).

Post Treatment

1. After every 20-30 hours (or when the water is foul), drain the tank, wash thoroughly and refill before commencing with further HWT. A routine should be established where, for example, the tank is drained at the end of the day on Wednesdays and rinsed out before re-filling. Then, when the tank is drained on Fridays, it is cleaned more thoroughly before re-filling. The fungicide/ cool water tank is drained every day.

2. The circulating pump is a domestic pool pump and has a built-in filter basket. Depending on cane cleanliness, this filter basket gets clogged. Clean the basket every time the tank is emptied.

3. There is a stainless-steel screen on the suction plate inside the tank. This can get blocked by trash. This screen can only be cleaned by draining the tank. A drop in pressure can be seen by a reduced flow from the spray pipes onto the baskets. This indicates a blocked pump filter or screen. A reduced flow will seriously affect circulation and temperature control. On start-up, take note of the jet of water from the spray pipes and use this as an indication a few times per day to monitor circulation.

4. Handle HWT seedcane carefully to avoid damaging the buds which soften during the HWT process. If seedcane is to be transported over long distances and/or on rough roads, the likelihood of bud damage is high so special care should be taken under these circumstances.

5. Allow the seedcane to cool completely after HWT, preferably overnight, before further handling to limit bud damage.

6. Transfer seedcane to the field in the baskets used for HWT if possible.

Step-by-Step HWT Procedure: Large Batch Tank

Prior to start-up

1. Check that the building housing the hot water treatment tank is in good condition. Repair as necessary. Ensure that the tank is protected against excessive draughts which can affect temperature control.

2. Ensure that all the operators are provided with the correct PPE, and that the PPE is still in good and safe working condition (lifting heavy baskets overhead).

3. Check that the seedcane baskets are in good condition. Ensure that the sides are sufficiently screened to prevent billets from falling out (see point 5 under 'Treatment' below).

4. Arrange a mechanical audit.

   4.1. Before filling the HWT tank, check the general condition of The HWT tank (internal and external) and all pipes and the electronic control panel and monitors.

   4.2. Fill the tank and allow to reach temperature (~50°C) before checking that:

   - The tank, pipes and seals are not leaking.
   - The circulation systems are functioning correctly.

   4.3. The large batch tanks need to have enough working elements to get the water back up to 50°C quickly, shortly after a basket of seedcane has been placed in the tank. You do not want to treat the cane for an extended period. Using a digital thermometer with 1m probe, check that:

   - the temperature of the water near the corners of the tank (near the surface, halfway down and bottom) is 50°C (±0.5°C)
   - the overall temperature of the tank matches the digital display on the external electronic monitor.

5. Ensure that the overhead gantry crane to load and unload the baskets into and from the tanks is in good working order.

6. Make sure that the load test certificate for the overhead gantry is still valid. A load test needs to be conducted on an annual basis.

7. Ensure that the slings used to lift the baskets are in good condition. Replace if necessary.

8. Ensure the cooling/fungicide tank is positioned correctly to receive treated baskets from the tank.

9. Repair or adjust as required.

10. Once the tank and all other equipment required during the HWT process is confirmed to be in sound working order, the treatment of seedcane can begin.

Treatment

1. Fill the tank with clean water.

2. Place the lid on the tank, switch on and allow the water to reach 50°C (this will take about 6 hours if starting from 20°C). Do not switch on unless the tank is at least 25% full of water or the pump and elements may be damaged.

3. Remove most of the dead leaf material from the stalks but leave the leaf-sheath bases in the nodal region to protect the buds. There should be no loose dead leaf material on the stalks that could clog the filters.

4. Make sure that the person cutting the seedcane is aware if the baskets can only handle whole sticks or if the baskets can also accommodate billeted cane. It is very important that the large batch baskets are not packed tightly and right to the top with seedcane, especially if the seedcane is straight. The basket needs to be packed loosely to allow the hot water to reach the centre of the basket.

5. Ensure no seedcane is protruding above the water line before closing the lid.

6. The timing of the 2-hour heat treatment starts when the water temperature is back up to 50°C after the basket of seedcane has been placed inside the tank. Once the 2 hours is complete, remove the lid and lift the basket out of the tank.

7. Transfer the basket to the cooling/fungicide tank.

8. Place a new basket into the tank and repeat the process.

9. Once the heat-treated basket has cooled off in the fungicide tank, remove and place in the holding area for loading.

10. The operator must keep checking the water level in the HWT tank after inserting and removing baskets. The water level can be topped up to ensure that the baskets are always fully submersed or lowered to maintain the water level below the longitudinal spray pipes.

Temperature monitoring during operation

The temperature of the tank should be tested once a month.

1. Take temperature readings at regular intervals while heat treating a basket of seedcane by inserting a 1m temperature probe through cut outs in the lid.

2. Compare the manual readings with the electronic control panel readings.

3. Once the next basket of seedcane is placed in the tank, insert the probe as far into the basket of seedcane as possible. Record the temperature.

4. Leaving the probe in the same position, record the time it takes for the temperature to return to 49.5 and 50°C.

5. Remove the probe and compare the manual readings with the electronic control panel readings.

6. Adjustments will need to be made by a qualified technician if 1) the temperature readings fall outside the 50°C (±0.5°C) range; 2) the manual readings do not match the electronic control panel readings; 3) the time taken for the temperature to return to 50°C after a basket has been added to the tank is more than 5 minutes (methods to improve circulation within the tank may be required).

Post Treatment

1. After every 10 baskets (or when the water is foul), drain the tank, wash thoroughly and refill before commencing with further HWT.

2. It is best practice to change the water before heat treating seedcane for a different grower, even if only a few baskets were heat treated for the previous grower and the water still looks relatively clean. This reduces the risk of contaminating the new batch of seedcane with other varieties and diseases.

3. The circulating pump is a domestic pool pump and has a built-in filter basket. Depending on cane cleanliness, this filter basket gets clogged. Clean the basket every time the tank is emptied.

4. There is a stainless-steel screen on the suction plate inside the tank. This can get blocked by dead leaf material. This screen can only be cleaned by draining the tank.

5. A drop in pressure can be seen by a reduced flow from the spray pipes onto the baskets. This indicates a blocked pump filter or screen. A reduced flow will seriously affect circulation and temperature control. On start-up, take note of the jet of water from the spray pipes and use this as an indication a few times per day to monitor circulation.

6. Handle HWT seedcane carefully to avoid damaging the buds which soften during the HWT process. If seedcane is to be transported over long distances and/or on rough roads, the likelihood of bud damage is high so special care should be taken under these circumstances.

7. Allow the seedcane to cool completely after HWT, preferably overnight, before further handling to limit bud damage.

8. Transfer seedcane to the field in the baskets used for HWT if possible.

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