



Information Sheet

4. HUSBANDRY

4.6 Management of frosted cane

Frost is common in the Midlands region of the sugar industry from April to October, but is most frequent in June and July. Sub-zero grass temperatures that result in frost occur in valley bottoms at altitudes above 500 m, and on flat or gently sloping ground above 800 m. Frost occurs occasionally in valleys nearer the coast.

Conditions for frost occurrence

Climatic conditions that are most conducive to frost are clear, cloudless nights when the air is relatively dry and there is little wind to mix warm and cold air. The risk of frost therefore increases during times of drought. When the soil is dry, cool overlying air masses, clear skies and light winds have the potential to cool the ground rapidly.

Frost forms when water condensate freezes up, or deposits directly as ice crystals, at temperatures below 0°C. This type of frost is white because the ice crystals contain air which reflects light. Black frost will occur when there is little or no moisture in the air. Black frost is the result of plant sap freezing up and it will cause greater damage than white frost.

Topography and wind direction will determine where frost occurs. Slight air movement, in addition to the gravitational flow of the cold air downslope (cold air is heavier than warm air), may blow away the cold air and remove the possibility of frost. However, when land breezes dam up the cold air in westerly draining valleys, heavy frost damage is caused. Cold air flowing downslope may gather in pools (frost pockets). Timber plantations often retard the flow of cold air down the slope, and only the cane uphill and adjacent to the plantation will be frosted.

Frost damage in sugarcane

Sugarcane is more tolerant of cool temperatures than many other tropical crop species. Significant differences in sensitivity to cold damage exist between sugarcane varieties. In general, the following responses can be expected to low air temperatures:

- Cold temperatures and short day lengths slow plant growth and make plants less susceptible to frost damage.
- Vigorously growing foliage is very susceptible to frost damage. If a frost occurs when there has been no prior cold weather to 'harden off' a plant, the damage will be more extensive. Therefore, the most severe damage from low temperatures generally occurs in late spring, early autumn, or any time



Short cane should not be topped higher in order to facilitate better bundling. The frosted portion of the stalk and leaf sheaths (above the meristem) will have a negative RV.

freezing temperatures occur after a warm winter period.

- The denser the leaf canopy in cane, the lower the risk of frost damage because the dense leaf canopy traps and holds warm air. This higher temperature within the canopy will prevent buds from being killed when temperatures drop below freezing point.
- Short cane generally has an open canopy and is thus more vulnerable to frost damage.
- As soil temperatures hardly ever drop below freezing in the Midlands, all subterranean buds are protected. Therefore, young plant cane and ratoons suffer little damage, even with severe frosts.
- Successive frost events during winter will increase damage to the cane canopy because of the cumulative effect of the frost on live tissue, especially if the damaged leaves have dried out.

Degrees of frost injury

The degree of damage from frost can be evaluated by inspecting the leaves, apical meristem and lateral buds. The apical meristem (or growing point) can be checked by splitting the plant lengthwise (Figure 1). The lateral buds become visible when the leaf sheath is removed. Frost damage occurs from -2°C , where sugarcane growth is affected only slightly, to -9°C ,



Figure 1. From left to right: Three stages of damage to the growing point - slight damage, severe damage, and severe damage where the growing point is dead.

where the effect on growth is severe. Crop damage can be categorised into the following stages:

Stage 1 damage – light frost (-2°C)

White striping of the green leaves, with the leaf tips dying back. Black and browning of young rolled-up leaves, with the innermost rolled leaves of the spindle uninjured and green. The growing point will have a normal 'creamy' colour, turning brown on exposure. The setback in growth will be minimal and growth will resume with the onset of favorable conditions.

Stage 2 damage – frost (-2 to -3°C)

Die-back of 40% of exposed leaves, with the innermost rolled leaves of the spindle killed, and the growing point and inner leaf bases partially damaged. The cane will survive, but will suffer a definite setback. After a few weeks new growth will be seen as a small white spike inside the spindle.

Stage 3 damage – moderate frost (-4 to -5°C)

All exposed leaves turn brown. The growing point, upper portion of the stem and the spindle leaves will be dark brown or black when freshly cut, and one or two lateral buds at the top of the stalk may be damaged. Side-shooting from the uppermost healthy buds will occur after 10-14 days (Figure 2). The stalk will die back above the side-shoots.

Stage 4 damage – severe frost (-5 to -7°C)

The growing point and the top six buds on the stalk are killed, as are all the green leaves. Photosynthesis ceases and cane quality will deteriorate rapidly. Side-shooting will occur from below the last damaged bud. Often two or more strong side-shoots will emerge, which could add to cane yield in the following season; however, cane quality may be negatively affected. The stalk will die back above the side-shoots. Bull shoots may be evident, contributing to poor cane quality the following season.

Stage 5 damage – extreme frost (-7 to -9°C)

The growing point, all the green leaves and most of the buds on the stalk are killed (Figure 3). The contents of the stalk turn glassy and deterioration is extremely rapid. The entire stalk will die back. Prolific tillering may occur and regrowth may be in the form of bull shoots. Cane yield and cane quality will be severely affected in the following season.

Long term effects of frost damage

Widespread frost damage will have a 'knock-on' effect in the following season. There will be a loss due

to the immediate effect of the frost on the present crop, and a potential loss of 40% in yield in the following crop due to retarded growth and having to harvest younger cane with side-shoots. Cane quality will be negatively affected due to bull shoots and side-shooting.

It is important to remember that cane frosted at 6-12 months of age that is carried through to the following season for harvest will be immature, even though the age at the time of harvest in the following season indicates maturity.

Cane that is severely frosted at 9 months of age results in a total loss of 9 months growth, as this cane may not be millable and will die back. Regrowth will be in the form of bull shoots with very low quality, and this cane may be rejected by the mill.

The availability of seedcane becomes very limited after a widespread frost. The use of frost damaged cane as seed should be avoided.

Due to the loss of canopy, weeds become a major problem in frost-damaged cane, and it is important then that an appropriate herbicide programme is followed.

Eldana levels are likely to increase rapidly in mature frost damaged cane if it is carried over.

Harvesting of frosted cane

Frosted cane should be managed according to the degree of damage experienced. The first issue to consider is the length of stalk, in order to determine whether the cane is millable. A stalk of less than



Figure 2. An example of rapid deterioration of the stalk where the growing point, leaves and buds have been killed by frost. Such cane should be harvested as soon as possible after the frost.

500 mm is considered unmillable. Every attempt should be made to cut all millable frosted cane first.

Start with the oldest, tallest, most severely damaged cane (Stage 5) as it has the most value and will deteriorate rapidly, and work down to the youngest, shortest, least damaged cane using the following guidelines:

Stage 5: Cane must be harvested immediately. Do not use as seed (Figure 2).

Stage 4: Cane should be harvested as soon as possible or within a week. Do not use as seed.

Stage 3: Cane should be harvested within 2-3 weeks. Top cane below damaged portion of stalk. Side-shooting will occur in the upper section of the stalk. Harvest before it side-shoots. This cane can be used as seed only if options are limited!

Stage 2: Can carry over if eldana is not a problem. Cane will ripen and then form side-shoots (Figure 3). Harvesting can be delayed by 4-6 weeks but should take place before side-shoots appear. Top at normal topping height. This cane can be used as seed.

Stage 1: there is no need to harvest, as regrowth will occur.

Bear in mind that cane only becomes millable after about 8 months of age, depending on the growing season, and becomes economical to harvest after about 9 months of age, depending on the RV price. If in doubt, it is better to mill frosted cane and allow the ratoon to regrow during the optimum growth period.



Figure 3. Side-shoots will form if frost kills the growing point. Side-shoots can increase leaf area and may contribute significantly where the crop is carried over.

Fertilising frosted cane

The nutritional requirements of cane that has been frost-damaged will depend on its age and whether it is to be harvested or carried through to its normal cutting age.

Cane cut at 12 months of age or less at the time of frost and to be cut again the following season:

- Nitrogen – reduce applications for the following crop by 20 kg on N category 2 soils and 30 kg on N category 3 soils. No reduction is necessary on N category 1 soils.
- Phosphorus – use previous or current soil analysis results and only apply if there is a possibility that the soil P is likely to be <31 ppm.
- Potassium – it is advisable to re-sample the soil as the crop has been harvested early. There should be none required; however, where results are borderline, apply 50% of the recommended rate.

Cane to be carried over from 8-12 months of age:

- Apply 50% of the normal N requirement according to N category. There is no need to apply P or K.

In both cases, N should ideally be applied at the onset of the first rains.

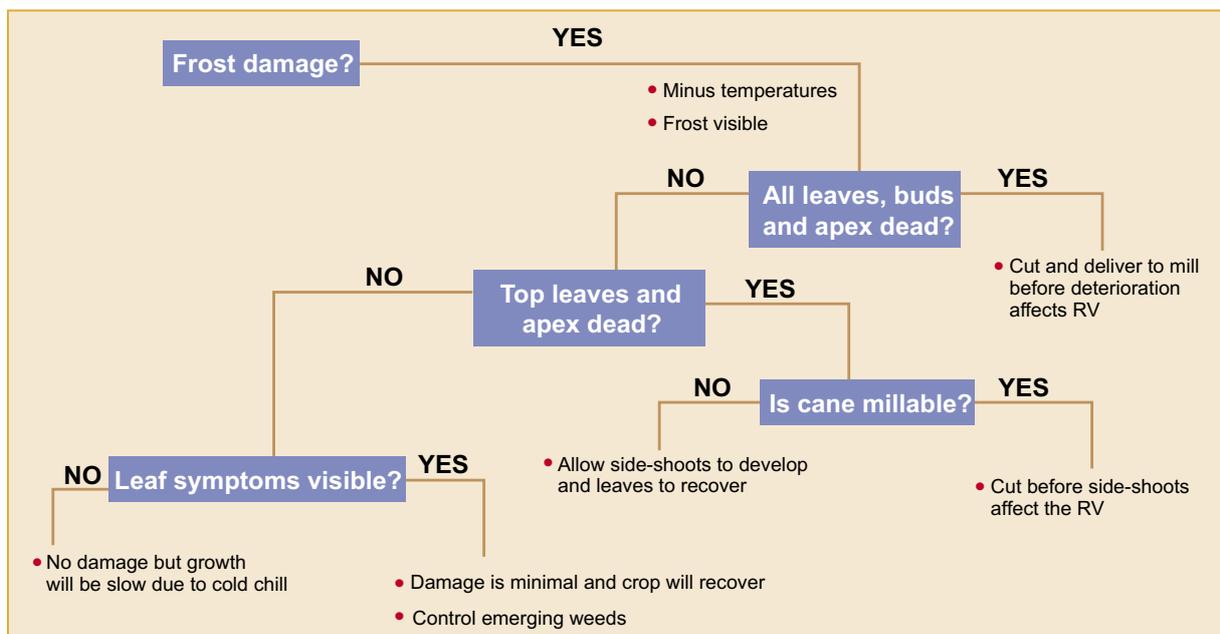
Strategies to minimise the effect of frost

If cane is to be grown in a frost-prone area, management and growing conditions should be optimised. Avoid poorly drained, shallow or nutrient deficient

soils. Supplementary irrigation is strongly recommended where available. The objective is to stimulate rapid growth and produce tall cane that can be harvested profitably each winter. The following steps should be considered:

- In areas with a high risk, the cane should be planted in late summer (March). This young cane will recover rapidly from frost damage, and then has a whole year to grow and mature. Supplementary irrigation is recommended to encourage rapid growth.
- Use quick growing (N31), early maturing (N16, N37) or cold tolerant (N21) varieties.
- Harvest the plant crop at about 16 months, and the following ratoons at about 12 months in mid to late winter.
- Two crops of moderate to severely frosted cane at 12 months will out-yield one 24-month old crop in tons RV per hectare. However, the extra costs of weeding and fertilising twice as often as in the 2 year old crop must be considered.
- Never plant in frost-prone areas from October through to mid-February, so that frosting and subsequent loss of unmillable cane is avoided.
- Research conducted up to now has shown that chemicals offer no protection against frost damage.

DECISION TREE



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