Frost Protection By Netafim

Orit Katzir

Before we start

Global climate changes – more areas are exposed to frost events.

Many plants can be damaged or destroyed by temperatures lowering to the freezing point of water, and frost.

Protecting crops from frost can increase the chances of meeting supply schedule.

Frost damage - Avocado. 800 Hectare were damaged in Western Galilee, Israel 2016

Agenda

- **What is Frost?**
- Practices to protect against the frost
- Frost protection using sprinklers
- Factors to consider while choosing a sprinkler frost protection system
- Netafim™ offering for frost protection
- Do’s and Don’ts
- Success story

What is frost?

Frost (***n.***) is the ***coating*** of ***ice*** that may form, in humid air, in cold conditions.

Resulting from ***decreased temperatures on a solid surface***, the ***water-vapor*** contained in the saturated air, ***freezes on the surface***.

- Many plants can be affected or destroyed by temperatures below the freezing point of water, and frost.
- This will vary according to the type of plant tissue or organism exposed to low temperatures.

Frost types

Advection frost:

An advection, or windborne freeze (cold air drift) occurs when a cold air mass moves into an area, bringing freezing temperatures.

No known Solution

Spring (Radiation) frost:

- This is the weather event that causes the greatest damage to fruit trees.
- In this case, frost mitigation is indispensable in certain geographical areas to ensure regular harvest operation in terms of timing/delay, quantity and quality.

Damage to the tree during frost conditions

Physical processes during spring frost:

Dehydrating

- During frost, ice is formed on the outside cells of the plant, while causing them water loss and dehydration.

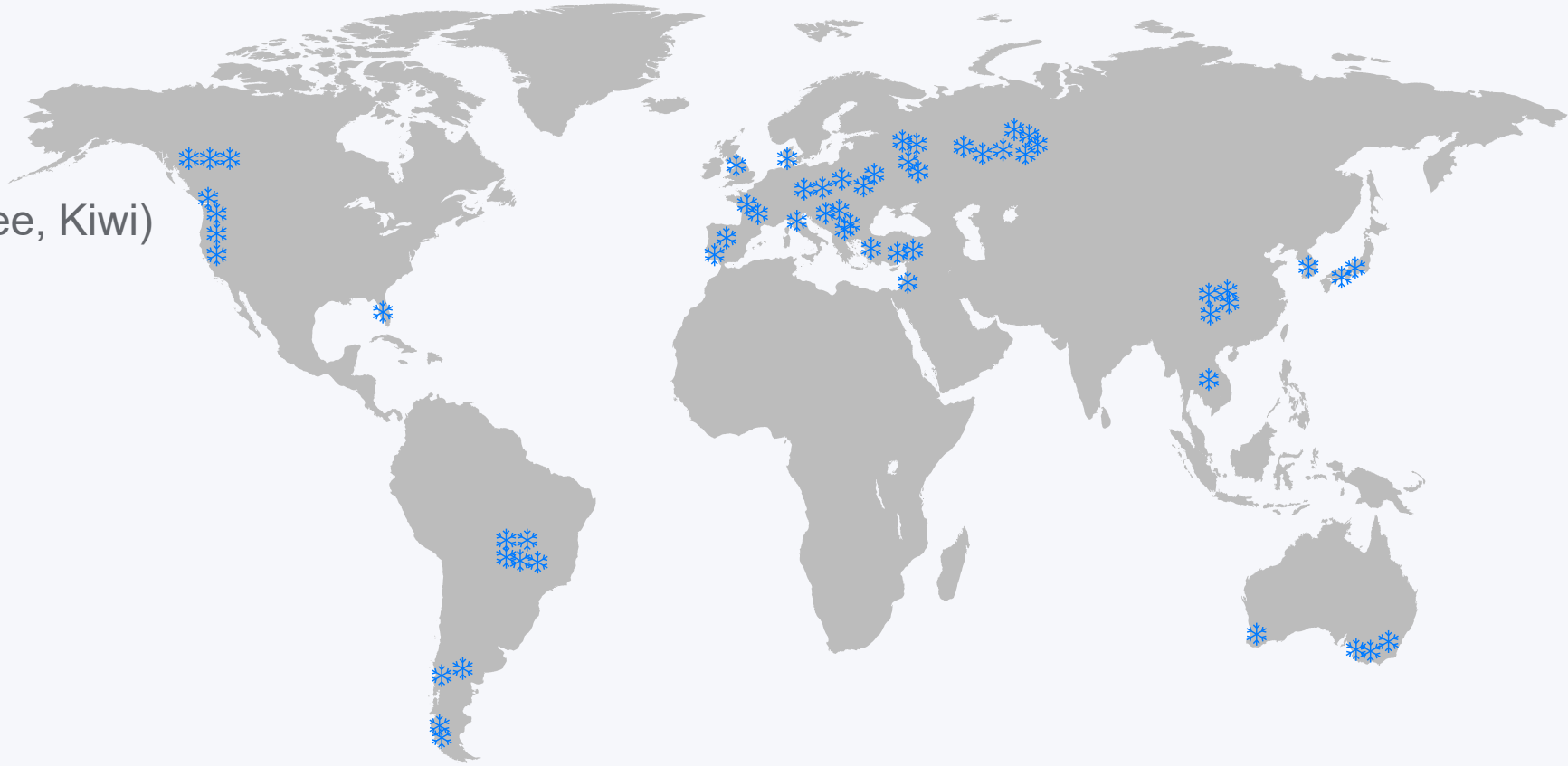
Morning oxidation

- Oxidation of the plant cell, caused by sun radiation (the morning after frost event)

Damage to the tree during frost conditions

Types of trees that typically suffer from frost damage:

- Deciduous (Apple, Pear)
- Sub tropic (Mango, Lychee, Kiwi)
- Greens (Avocado)
- Vineyard
- Berries



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Practices to protect against frost

Common practices for frost protection:

Heaters

Big Fans

Thermal Nets

Water Sprinklers

Practices to protect against frost

Heaters
Suck and warm cold air

Cold air suction
Raise cold air to 60m height

Practices to protect against frost

Big Fans

Generate air movement

Practices to protect against frost

Thermal Nets

- Reduce heat loss due to irradiation
- Create shading for the morning after the frost.

Practices to protect against frost

Water sprinklers

Frost protection methods - Comparison

Method	Advantages	Disadvantages	Comments
Heaters	• Relatively low installation costs • Tolerates a certain delay • Direct radiation to plants located around heaters	• Between 75%-85% of heat is lost • High energy consumption • Fuel oil is expensive • Less effective if no inversion exists • Lighting of high heat makes them lose efficacy • Contributes to greenhouse effect – use is forbidden in some parts of the world	• Free-standing or pipeline
Windmills	• Installation cost similar to heaters • Works fairly well when used with other methods such as heaters or over-tree sprinkling	• High energy consumption	• Mixes warm air near the top of inversion down to crop height
Helicopter	• It may prove very effective as it can be adapted to the height of inversion and moved to “cold points”	• Expensive to operate • Helicopter availability • Ineffective under little or no inversion	• Blows warm air from near the top of inversion down to crop height
Water sprinklers	• Lower operational costs than heaters • Same system can be used for conventional irrigation	• Relatively high installation costs • Risk of damage to crop with inadequate precipitation rate • Tree branches may break • Waterlog risk	• Plant parts protected by heat of fusion • Irrigation must continue until complete melting • Backup power source essential

Main advantages of frost protection by water

- Targets specific zones
- Ease of operation
- Lower capex
- Lower opex
- Suitable for multiple applications

How much water is required? Common knowledge: 3 mm/h

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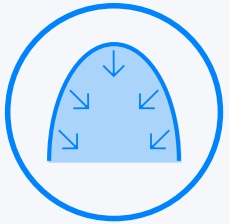
How over-canopy sprinklers can mitigate frost damage?

Three physical processes occur:



1 Heat Radiation & Conduction:

a. **Energy is transferred to the air.** Water temperature is higher than air temperature. As water cools down, it transfers energy to the surrounding air and warms it.

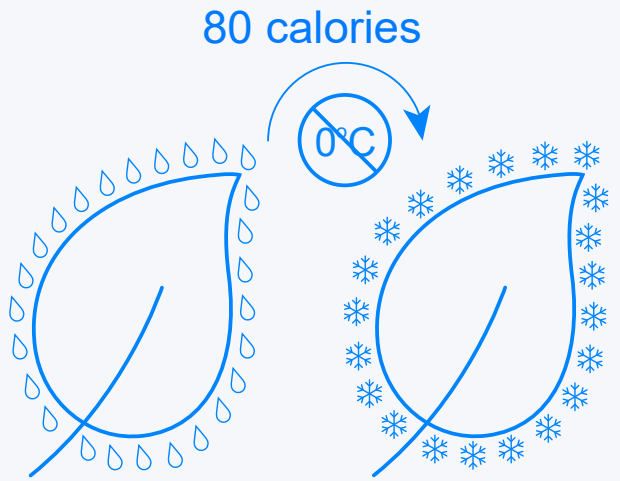
b. **Energy is transferred to the plant itself.** Water temperature is higher than plant temperature, with the sprayed water creating a temperature gradient between the water and plant. This makes the energy from the increased water temperature move to the decreased plant temperature.

How over-crop sprinklers can mitigate frost damage?

2 Latent Heat

Latent heat, is heat that is either absorbed or given off during material phase change.

Water is spread and turns into ice, e.g. change its phase from liquid to solid. During this phase change, 80 calories per gram of water are given off with no change in the temperature of water.



How over-crop sprinklers can mitigate the frost damage?

3 Ice barrier

A mixture of ice and water exposed to a temperature below the freezing point will remain at 0°C until all water is frozen.

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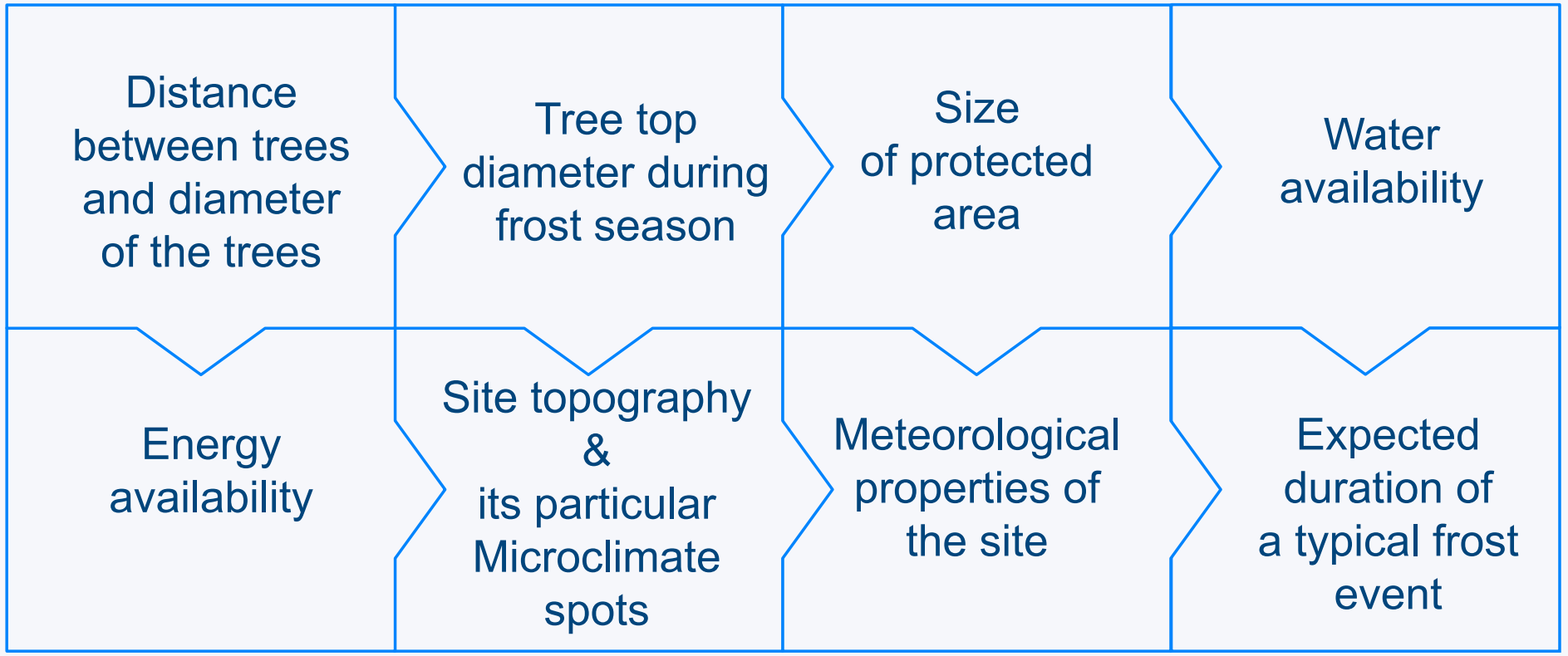
Important factors to consider while choosing a frost protection system



Choosing the right system is important but only a properly operating system will help protect against frost

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Netafim™ offering for frost protection

Sprinklers above canopy

Full coverage

MegaNet™

GyroNet™ Turbo

Localized

GyroNet™
Local/full coverage

SuperNet™
Local/full coverage

High efficiency

Pulsar™ with GyroNet™

Pulsar™ with StripNet™

Full coverage with MegaNet™

Example: **Apple**

- Tree plantation: 3mX4m
- Top tree diameter: 3 meter
- Total trees per hectare = 833 (10,000/(3*4))

Full coverage with MegaNet:

- MegaNet 450 L/h
- 12mX12m, 2.5 bar
- **Average precipitation rate: 3.1 mm/h**
- **Total flow required per hectare: 31.25 m^3/h**
- **CU=87%**

Netafim™ offering for frost protection

Sprinklers above canopy

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High efficiency

Pulsar™ with GyroNet™

Pulsar™ with StripNet™

Localized irrigation with over-crop sprinklers

- Targets the crop only
- Provides efficient frost mitigation down to -5.5°C, with a 3 mm/h (applied locally)
- Saves over 30% water compared to full coverage
- Reduces energy consumption

Localized with SuperNet™

Example: **Apple**

- Tree plantation: 3mX4m
- Top tree diameter: 3 meter
- Tree to area: 7.06 m²
- Total trees per hectare = 833 (10,000/(3*4))

Localized with SuperNet:

- SuperNet SR 27 L/h OR GyroNet SR 27
- One emitter per tree
- Total emitters per hectare: 833
- **Average precipitation rate: 3.86 mm/h**
- **Total flow required per hectare: 22.5 m³/h**

SuperNet™
- Total or localized coverage
- Flow regulation
- Insect-proof

GyroNet™
- Total or localized coverage
- Relatively low working pressure
- Insect-proof

Netafim™ offering for frost protection

Sprinklers above canopy

Full coverage

MegaNet™

GyroNet™ Turbo

Localized

GyroNet™
Local/full coverage

SuperNet™
Local/full coverage

High efficiency

Pulsar™ with GyroNet™

Pulsar™ with StripNet™

High efficiency coverage with Pulsar™

Example: **Apple**

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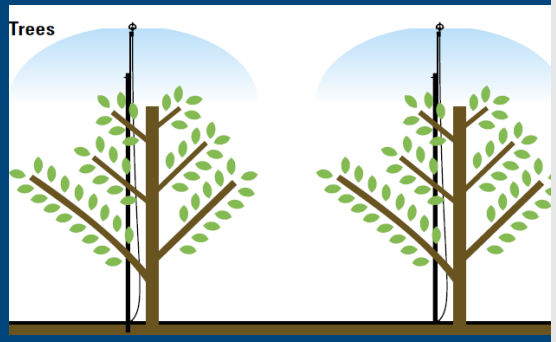
- Total trees per hectare = 833 (10,000/(3*4))



Example: **Apple**

- Pulsar™ 20 + Gyronet™ SSR head
- one emitter per tree
- Total emitters per hectare: 833
- **Average precipitation rate: 2.86 mm/h**
- **Total flow required per hectare: 16.67 m³/h**

Pulsar + GyroNet:

- Flow rate: 8, 12, 15, 20, 25 l/h
- Pressure required – 2.5bar at the AD valve inlet

Solutions comparison - summary table

Example: **Apple**

- Tree plantation: 3mX4m
- Top tree diameter: 3 meter
- Tree to area: 7.06 m²
- Total trees per hectare = 833 (10,000/(3*4))

GyroNet™ vs Full coverage	Pulsar™ vs Localized
27%	**26%**
Less water and less energy	Less water and less energy

	Full coverage	Localize	High Efficiency coverage
Emitter	MegaNet™ 24D 450 l/h	SuperNet™ SR 27 l/h	Pulsar™ 20 + GyroNet™ SSR head
Spacing	12*12 m	One emitter per tree	One emitter per tree
Calculated precipitation rate (mm/h)	3.13	3.86	2.86
Total emitters per hectare (units)	69	833	833
Total flow per hectare (m^3/h)	**31.25**	**22.50**	**16.67**
Main pipe needed diameter (estimated)	12”	10”	8”

Localized irrigation with over-canopy sprinklers

Pulsar™ with StripNet™:

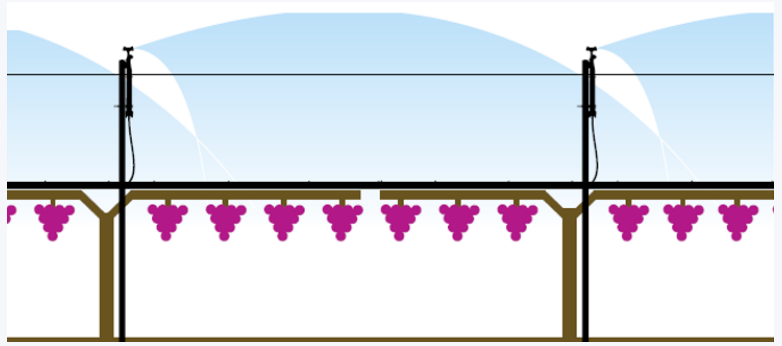
- Flow rate: 12, 15, 20 l/h
- Pressure required – 2.5bar at the AD valve inlet

2 options are available:

1. StripNet™ with 1 active nozzle per 50cm-width. Installation at up to 5 meters between heads

2. StripNet™ with 2 active nozzles per 70cm-width. Installation at up to 5 meters between heads

Pulsar™ with StripNet™
- Flow regulation
- Strip area protection
- Highly efficient water consumption



Localized high efficiency – Pulsar™ with StripNet ™ 2 nozzles

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DO'S & DON'TS

- **Complete system installation** before the frost season begins.
- **Check the system shortly before** an expected frost event.
- **Don't delegate** frost mitigation to someone else
- **Be prepared. Every second counts**
- **Open the system ON-TIME** (2.5°C)
- **Ensure water is applied continuously**
- **Don't shut down the system too early.**

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Success story – Ravid, Israel

Site description

Mango

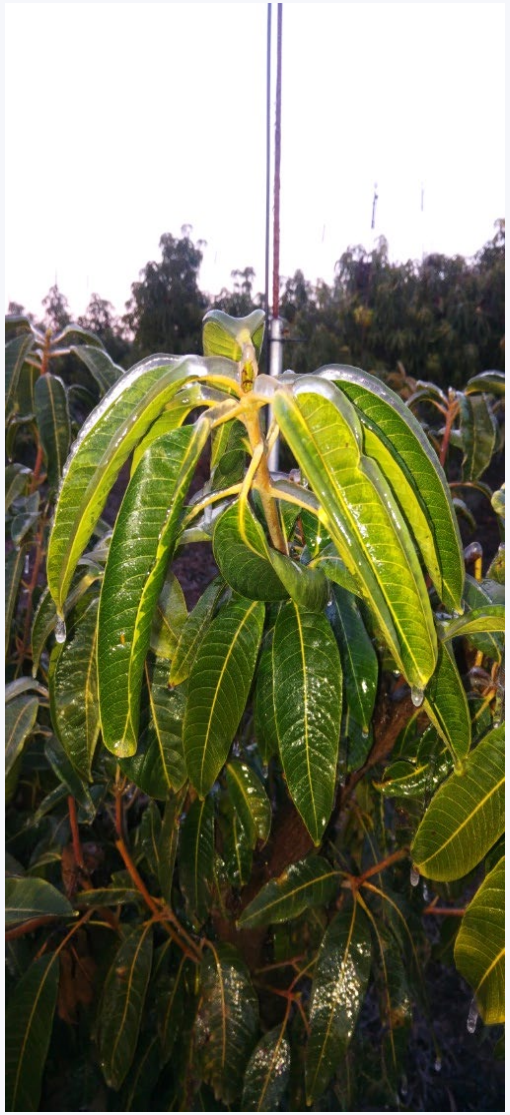
Mature trees.
5 hectare

Distance between trees:	Top tree diameter:
3mX5m	3m

Required application rate:	In this case the correct configuration is:
3 mm/h	Pulsar™ 20 l/h with GyroNet™ SRD head.

Frost event

The frost event occurred on 28/January/2016. It started ~ 23:00 and lasted until 07:00.
Minimum temperature in field during the frost event: -3.0°C.
The farmer started the system at 20:00 before the frost begun, and continued watering until 11:00 after the ice was melted.



Success story – Ravid, Israel

Voice of the customer

Before Netafim Pulsar offering:

The farmer decided to uproot the 80 hectare site.

The site has suffered from 3 frost events over the past 10 years.

After Netafim Pulsar offering:

Farmer agreed to try the Pulsar since it offers full tree coverage with low irrigation rate.

Results

- Yield of 50 tons per hectare for the trees that got full protection.
- The yield was identical to the yield from trees not exposed to the frost event.
- The Mango trees of a neighbor farm were not protected, and strongly damaged by that Frost Event.

Following the success, the location has become very popular for other farmers, researchers and insurance companies.

Today Netafim Israel are doing their utmost to install additional 20 sites with frost protection using Pulsar™


NETAFIM™
Thank You