Banana frost protection by thermal nets in Israel

Jordan Valley
Banana Experimental Station

Navot Galpaz
Winter temperatures in the Jordan Valley, Israel

Banana cultivation areas, Israel

- Western Galilee (600 hectares)
- Coastal plain (1200 hectares)

Monthly minimum temperatures, Jordan Valley, Israel, 1995-2018

Temperature (°C)

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December
Frost-event frequencies and daily minimum winter temperatures in the Jordan Valley, Israel

- From 1961-2015, 19 winters with frost events were recorded in the Jordan Valley, Israel.
- Sequence of four winters with frost events from 2013/14-2016/17.

Increase in the frequencies of frost events due to climate change?
Plantations affected by a frost event (January 2016)

Estimated economic loss: $15M

Jordan Valley, first year

Jordan Valley, third crop cycle
Strategies tested for banana frost protection in Israel

- Overhead water-sprinkling
- Fog machines
- Active air heating
- Air turbulence by wind machines and helicopters
- Thermal nets
Thermal nets (Aluminet type)

- Aluminized polyethylene nets.
- Block and reflect IR radiation emitted by plants and the ground to the sky during radiation frost.
- Elevate net house air temperatures by up to 8 °C.
- Mitigate the radiation damage to the photosynthetic system that occurs on a sunny day following a frosty night.
- Shading levels: 20%-80%.
Experimental design (Western Galilee site)

- One replicate per net, replicate area: 0.1 hectare.
- Tested nets: 30%, 40% and 50% shading level thermal nets (Aluminet type) and Cristal Leno 10% shading level net (control).
- Planting date: August 2015.
- To avoid shading damage and protect the nets, the thermal nets were set up as a thermal screen under the commonly used Cristal Leno 10% shading net only in the winter months (December through March).
Visual frost damage under the various nets

Sub-zero temperatures recorded in the experimental plot in January 2016

Cristal Leno 10% (control)  Aluminet 30%
Aluminet 50%  Aluminet 40%
Plant height and bunch weight with the different nets - first crop cycle

Yield:    Aluminet 50% net - 83.6 ton/hectare
          Cristal Leno 10% net - 68 ton/hectare

Aluminet 50% selected for further evaluation
Experimental design (Jordan Valley site)

- Four replicates per net, replicate area: 0.1 hectare.
- Tested nets: Aluminet 50% and Cristal Leno 10% (control).
- Planting date: August 2016.
- Thermal net was set up as a thermal screen during the winter months only.

Aluminet 50%  Cristal Leno 10%

courtesy
Ram Hachmon
Sub-zero temperatures in the Jordan Valley (grass height, 29.1.17-4.2.17)
Visual frost damage under the different nets

Cristal Leno 10%

Aluminet 50%

Before (31.1.17)

After (28.2.17)
Plant height and bunch weight with the different nets - first crop cycle

**Plant height**
- Cristal Leno 10%: 307 cm
- Aluminet 50%: 323 cm

**Bunch weight**
- Cristal Leno 10%: 30.6 kg
- Aluminet 50%: 34.1 kg

**Yield:**
- Aluminet 50% net - 102.3 ton/hectare
- Cristal Leno 10% net - 96.2 ton/hectare
Improved growth vigor and early flowering under the thermal nets (second crop cycle, Western Galilee)

Flowering date distribution

Cristal Leno 10% Aluminet 30% Aluminet 40% Aluminet 50%
Air, ground, leaf temperatures and shading levels under the different nets (Jordan Valley site)

**Air and ground temperatures (1.2.17-3.2.17)**

- **Aluminet 50% ground**
- **Cristal Leno 10% ground**
- **Aluminet 50% air**
- **Cristal Leno 10% air**

**Leaf temperature (2.2.17)**

- **Cristal Leno 10%**
- **Aluminet 50%**

**Shading levels-winter 2016/17**

- **Aluminet 50%**
- **Cristal Leno 10%**
Photosynthetic system performance in the short and long terms (Jordan Valley site)

Photosynthetic rate

- Crystal Leno 10%
- Aluminet 50%

2/2/2017

- Crystal Leno 10%
- Aluminet 50%

4/4/2017

Photosystem II quantum yield

- Crystal Leno 10%
- Aluminet 50%

2/2/2017

- Crystal Leno 10%
- Aluminet 50%

4/4/2017

Stomatal conductance

- Crystal Leno 10%
- Aluminet 50%

2/2/2017

- Crystal Leno 10%
- Aluminet 50%

4/4/2017
Summary

• Incremental frost protection was observed for banana with the various thermal nets differing in shading level. the higher the shading level-the better the protection.

• Plants protected by the thermal nets were stronger, flowered earlier, their bunches were heavier and no negative effects observed.

• Protection is presumably achieved by a combination of elevated leaf and ground temperatures and shading protection of the photosynthetic system.

• Open questions: Chilling protection? Economical value?
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