

GHT Japan Co., Ltd. & AHT Israel, Ltd.

Amorphous Alloy Heating Ribbons A Disruptive Heating Technology for Greenhouse

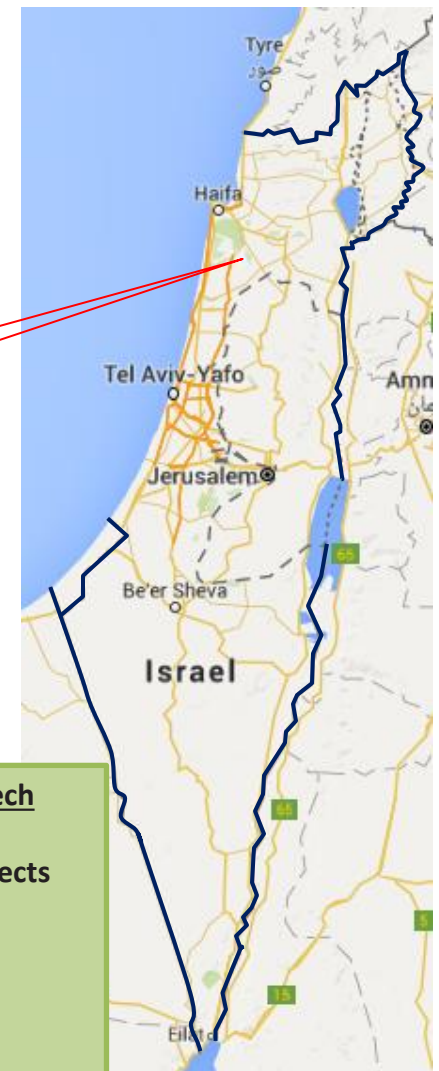
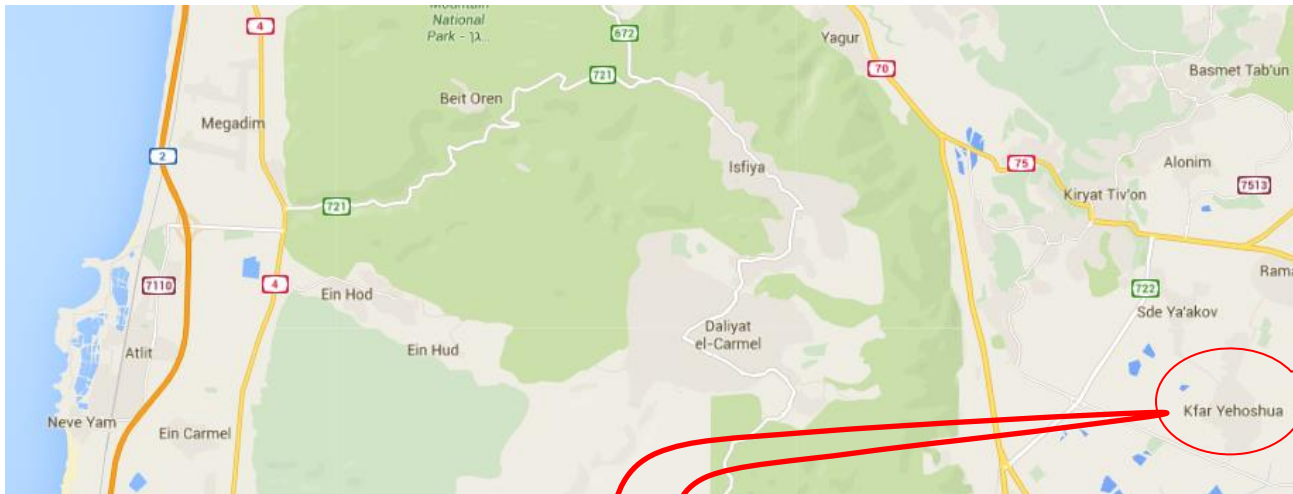
An Experiment Overview

**Remote Farming, IT monitored, Heat Controlled Tunnel type Greenhouse
installed in 'Kfar Yehoshua' – Israel**

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Joined Agriculture Experiment with BF-Agritech Ltd. in Israel



Experiment Venue:
Kfar Yehoshua – Israel

The Objective:
Remote Farming, IT monitored, heat
controlled Tunnel type Greenhouse

**Conducted Joint Experiment with BF-Agritech
Ltd., an Israeli based company that provide:**

1. Advanced IT solutions for Agriculture Projects
2. Vegetable grafting Machines & Accesories
3. Prime quality selction of vegetables
4. Turnkey projects solutions of:
 - Greenhouses
 - Irrigation & Irrigation control
 - Bio Energy for remote farming communities

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Inside the Greenhouse



**High Yield Growth
of Tomato plant**

Vertically stretched cords, enables plants to grow to desired direction and height.

Off Ground Elevated Bench / Net



Benefits of using Perlite Grow Bags

- Higher yields - more tomatoes then in Rock Wool.
- Perlite growing medium is sterile so there is no seed or bacteria contamination
- High water holding capacity and high capillary attraction
- High aeration ability
- Reusable for multiple growing cycles
- Easily disposed off after use

plant's Individual Irrigating nozzle

Main Irrigating pipe

Perlite Grow Bags – Substrate
For two tomato plants per bag.

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Greenhouse's Wireless Sensing, Monitorint & Recording, IT based System



Radiation Monitoring & Recording

Heating Ribbon's Temperature Sensing & recording



Stem Diameter Sensing & recording



Leaf Temperature Sensing & Recording





AMBIENT HEATING:

Horizontally positioned
Ribbon mounted at 25cm
– 30cm above the Perlite
Grow Bags

SUBSTRATE HEATING:

Ribbon under the Perlite
Grow Bags

Thin Rubber coated
with Aluminum foil





Heating Ribbon under the perlite substrate



Ambient Heating Ribbon @ 25cm above the perlite Substrate

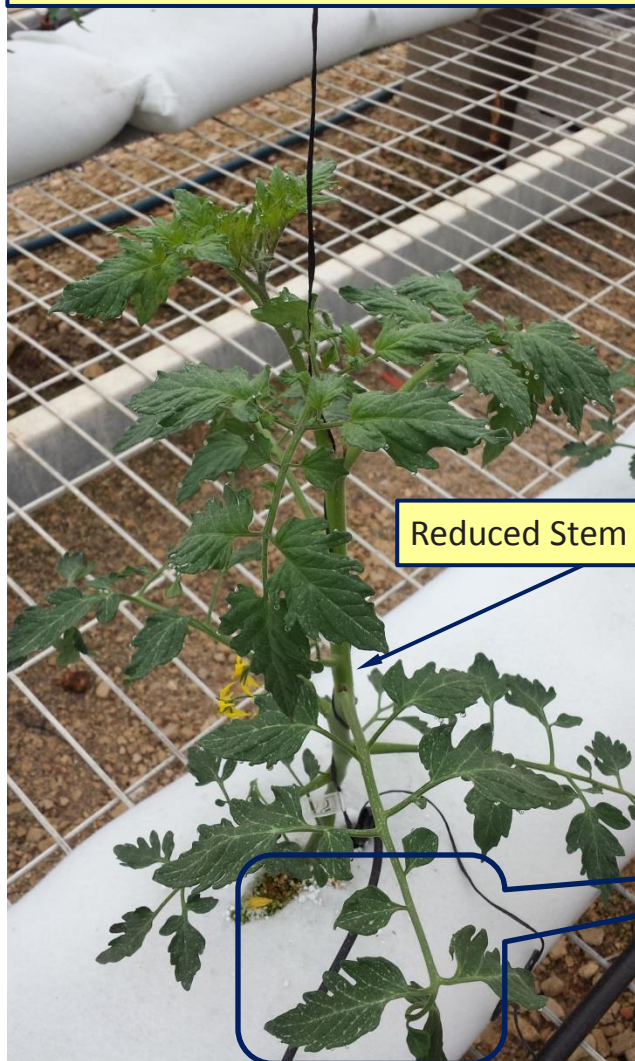
Universal Controller



- Independent Temp. Control System
- Controller for Perlite **Substrate** heating
 - Controller for **Ambient** heating

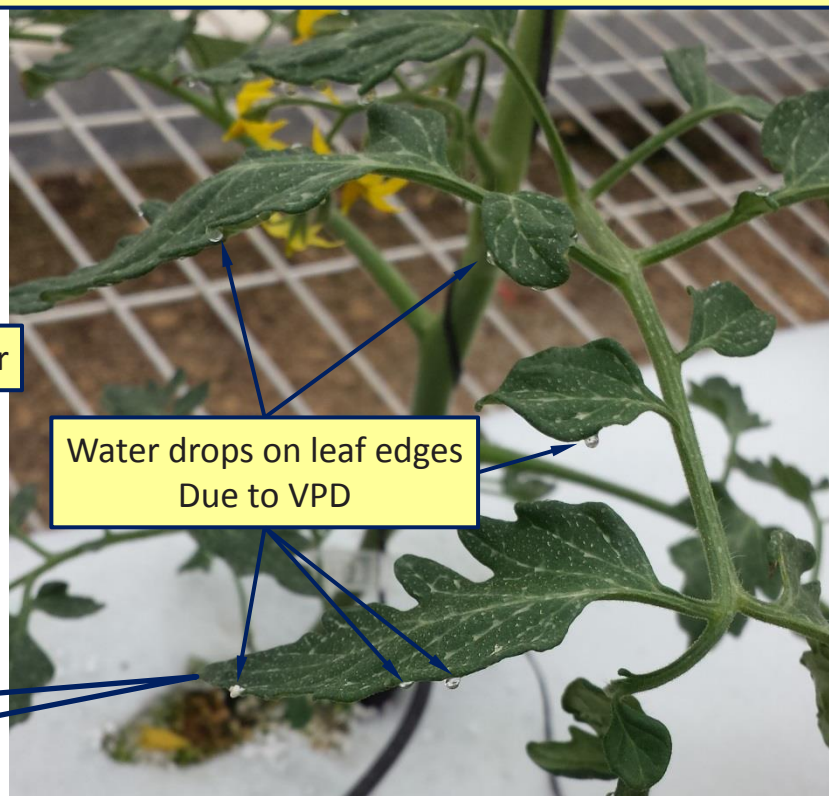


Unheated section inside the greenhouse



Reduced Stem Diameter

Lower ambient temperature causes leaves start a process of perspiring on their edges due to increased VPD*. Plants cope with changing humidity by adjusting the stomata on the leaves. Stomata open wider as VPD decreases (high RH) and they begin to close as VPD increases (low RH). Stomata begin to close in response to low RH to prevent excessive water loss and eventually wilting but this closure also affects the rate of photosynthesis because CO₂ is absorbed through the stomata openings. Consistently low RH will often cause very slow growth or even stunting. Humidity therefore indirectly affects the rate of photosynthesis so at higher humidity levels the stomata are open allowing CO₂ to be absorbed.

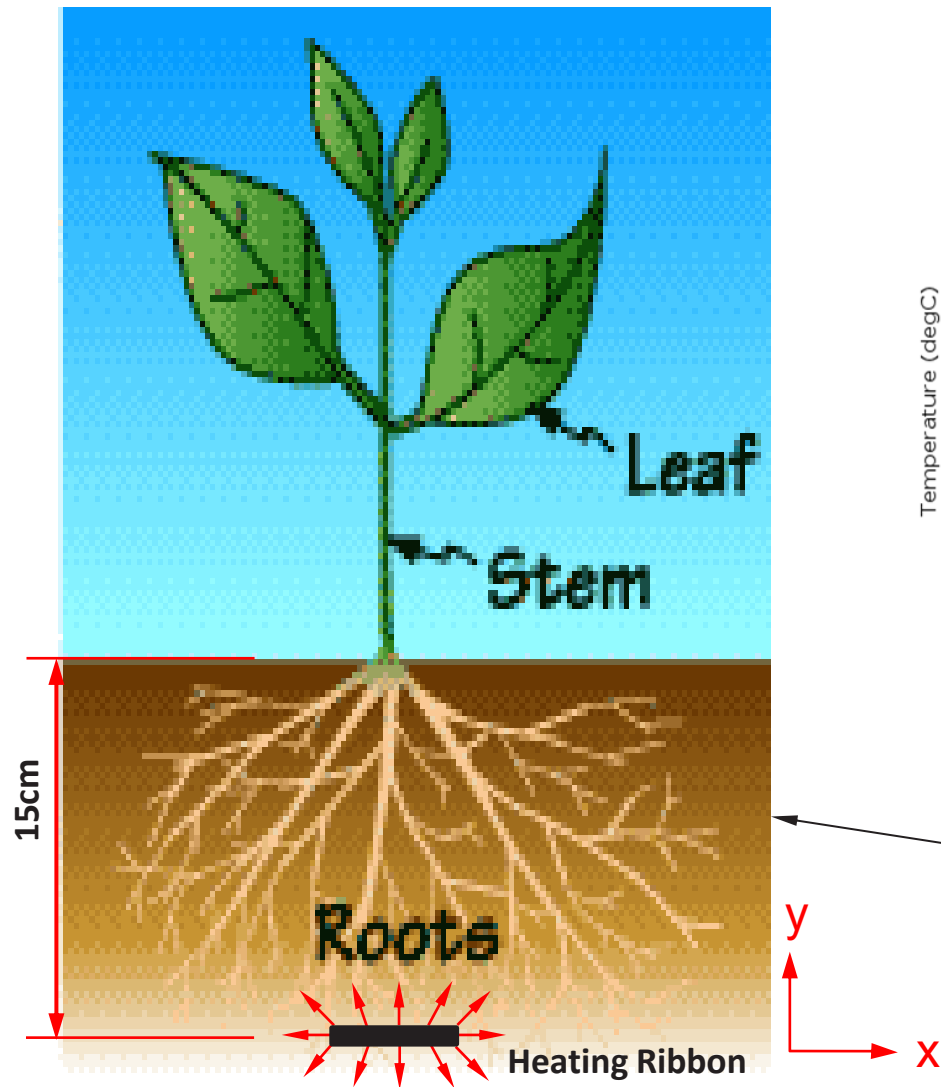


Water drops on leaf edges
Due to VPD

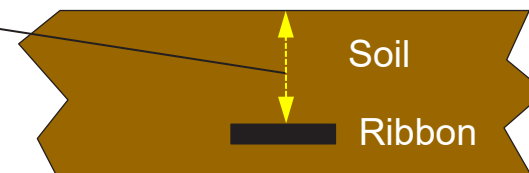
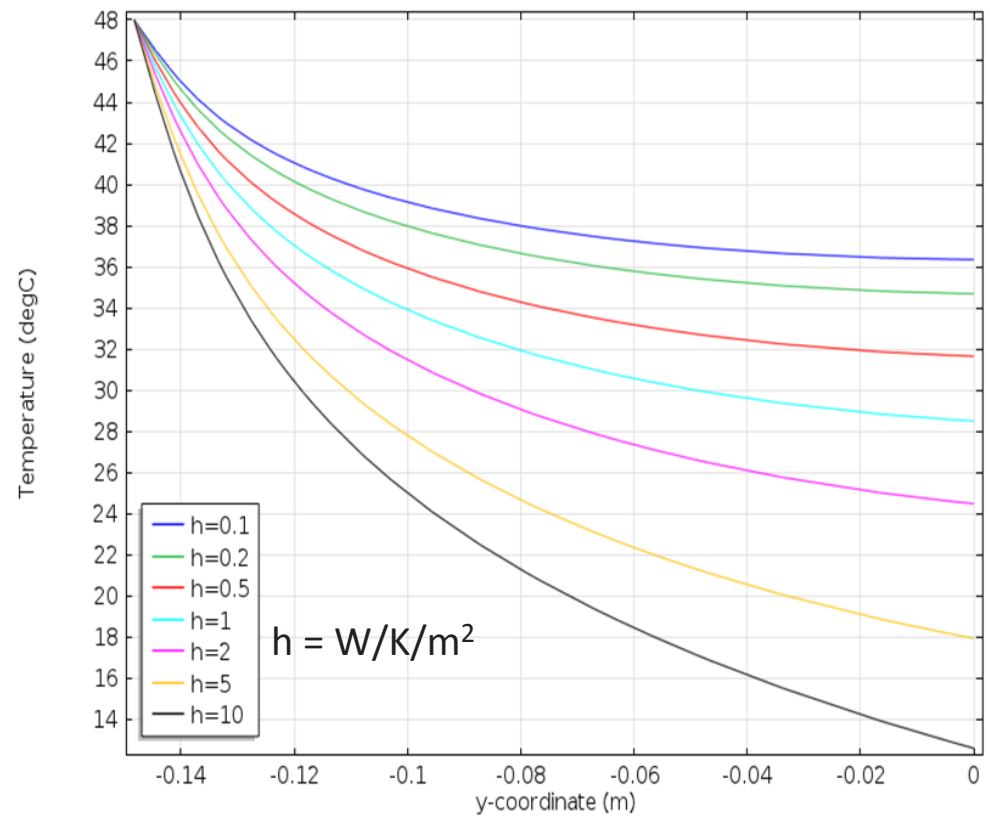
(*) VPD = Vapor Pressure Deficit

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Experiment Part – II
Field Growing (Lettuce) with
Heating System Embedded in Soil

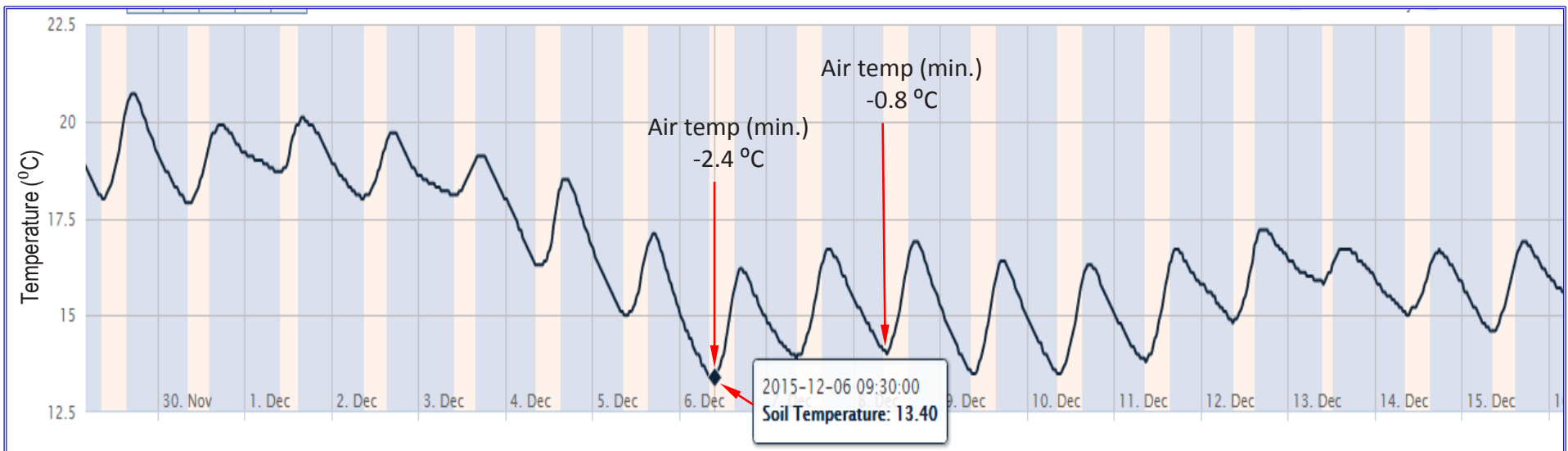
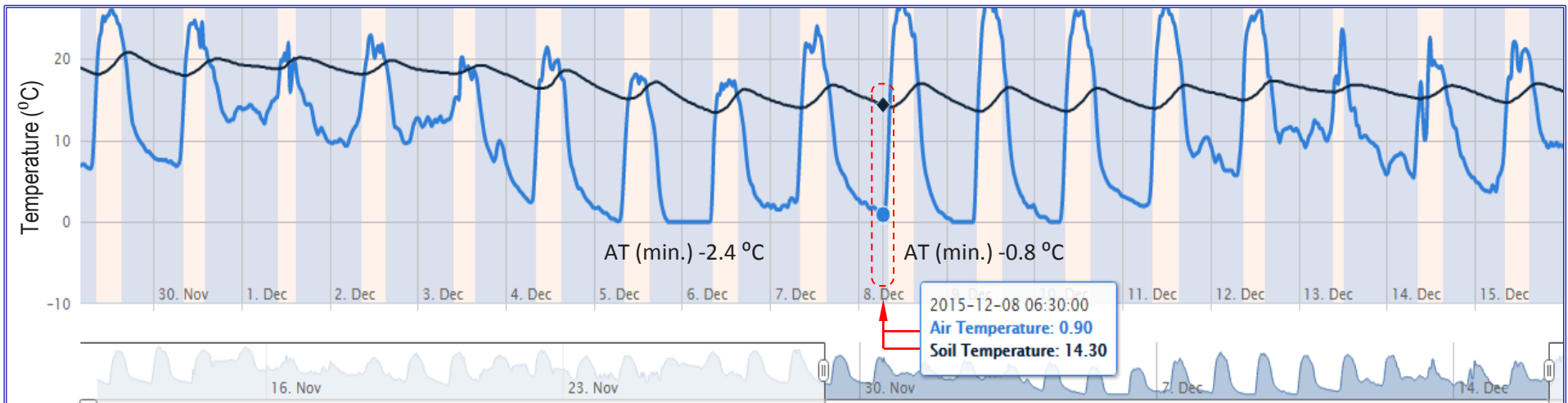


Vertical Temperature From Ribbon to Surface (degC), $T_{amb} = -2.5\text{ C}$



$$T_{ribbon} = 48^{\circ}\text{C}$$

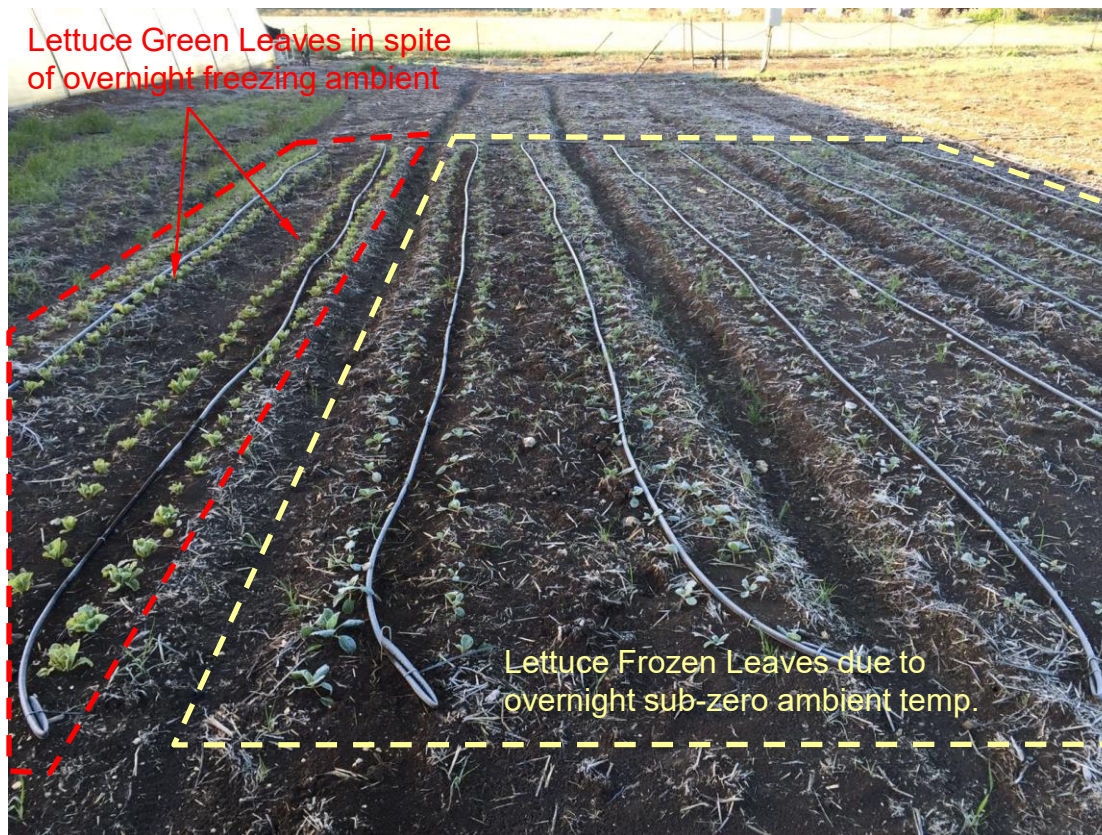
Air and soil temperature comparison. Soil temperature sensor embedded at 15-18 cm depth



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Outdoors Greens (Lettuce) growing



Clear evidence that embedded heating system saved the lettuce from freezing as well as prevented the water from getting frozen inside the irrigation pipes.