المـركـز الوطنـي لأبحـاث وتطوير الزراعة المستدامة
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Effect of lowered temperatures on sweet pepper cultivation in an Air Conditioning cooled greenhouse

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Background

In an air conditioning cooled greenhouse substantial lower temperatures can be realized than in pad&fan greenhouses. However, growing at lower temperatures is more expensive in terms of electricity consumption for cooling. Therefore, growing at lower temperatures need to provide clear benefits in terms improved production or quality.

In order to study this trade off, two of the High-tech compartments have been planted with various types of sweet pepper. The growing strategy (side shoot pruning, irrigation, CO2 dosing, screening and dehumidification) was equal for both compartments, but the temperature in H3 was on average 2 degrees below the temperature in H1, which was operated as usual. Usual means here that the temperatures were similar to the pepper growing cycles in previous years in Estidamah.

Objective

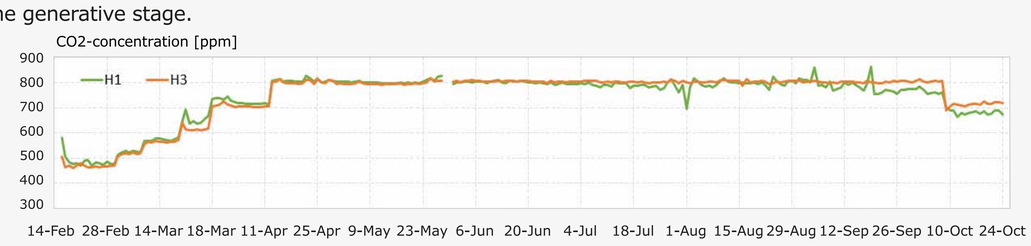
- Evaluation of the trade-off between energy costs for cooling and improved production of a number of varieties of sweet pepper.
- In the same experiment the effect of plant density was evaluated.

Methods

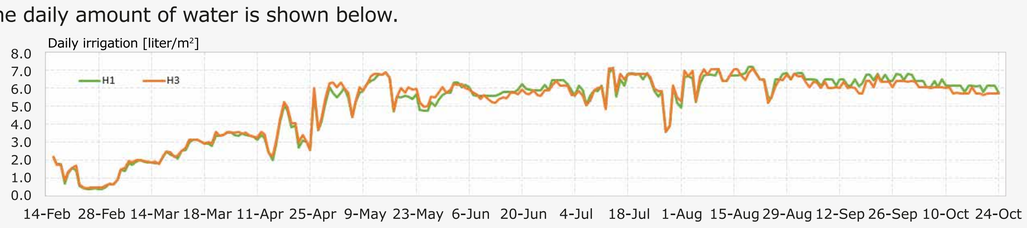
- The air conditioning cooled compartments of Estidamah consist of 400 m² compartments that accommodate 11 plant rows. The two side rows are left out of consideration which leaves 9 rows that can be used to compare variety and density treatments.
- In both compartments the following lay-out was applied.
  In general the productivity difference between colored and green peppers is levelled by the higher price of colored peppers.

Row nr	Variety	Pl. density [#/m²]	colour	pl/slab
1	TORMES	2.68	Yellow	3
2	Makaw	1.88	Green	3
3	FICKA F1	1.88	Yellow	3
4	CEBRAIL F1	1.88	Red	3
5	MOZART F1	1.88	Orange	3
6	Makaw	2.50	Green	4
7	CEBRAIL F1	2.50	Red	4
8	FICKA F1	2.50	Yellow	4
9	MOZART F1	2.38	Orange	4
10	Sunstone F1 (NUN 54104)	1.88	Yellow	3
11	Cassiano F1 (NUN 50170)	2.68	Red	3

- The main varieties Makaw, Ficka, Cebrail and Mozart were placed in two rows, but with different density. The yellow variety Sunstone was only placed with the low plant density.
  The seeds were propagated in the designated propagation area and transplanted to H1 and H3 on February 2022 ,16.
- Three weeks after transplanting, all plants were provided with three wires to support the main shoot, a side shoot and a secondary side shoot. The number of stems ended therefore on three times the number of plants, being 5.64 and 7.50 stems/m².
- Side shoots from these three stems were pruned after the first node of the shoot, while keeping the associated leaves and potential fruit. This pruning strategy is typical for high wire sweet pepper growing, aiming at high quality fruits.
- As air conditioning cooled greenhouses are highly sealed, the inside CO2 concentration can be increased at relatively low costs. Therefore, the CO2 concentration was controlled at 800 ppm when the crop reached the generative stage.

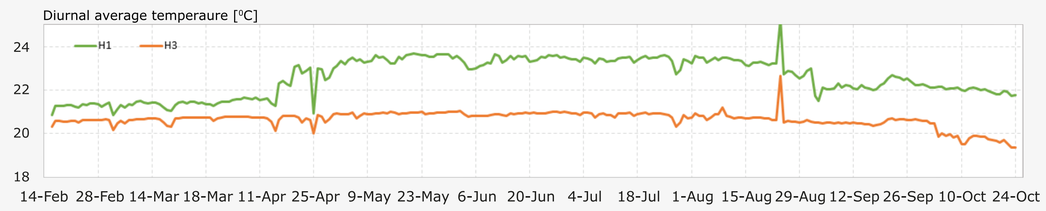


- Watering was controlled as normal in Estidamah, meaning that the water (with dissolved fertilizers) is provided in shots of about 200 cc per m² and that the number of shots is based on the accumulated radiation. In summer this will result in about 30 irrigation shots per day.
  The daily amount of water is shown below.

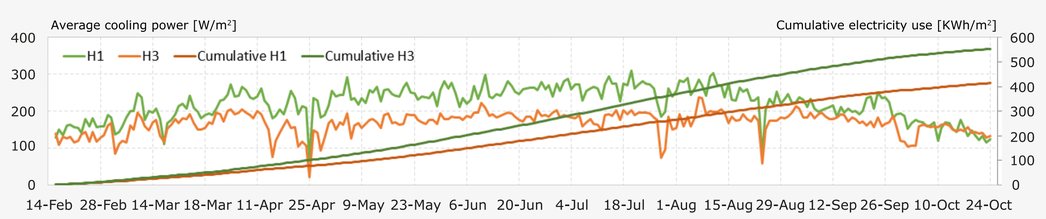


Results

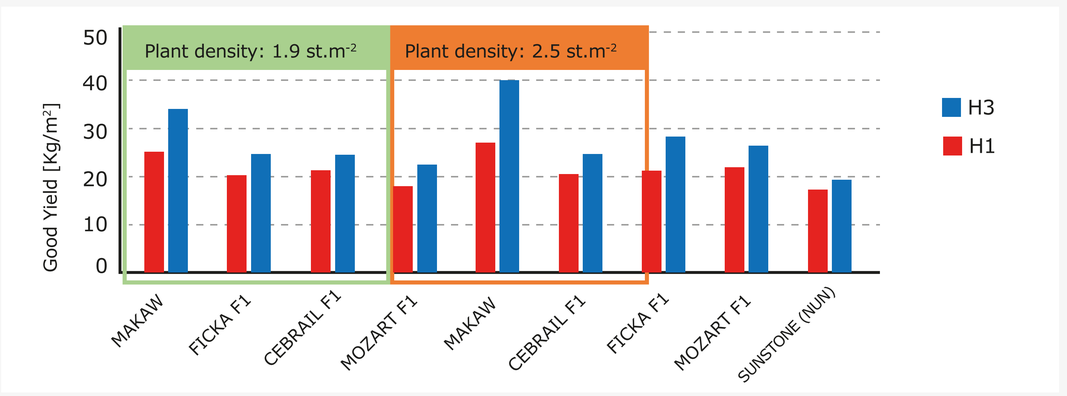
The graph below shows the diurnal average temperatures in H1 and H3



As both compartments are cooled by air conditioning, keeping these temperatures in the harsh weather conditions of Riyadh requires quite some cooling. The graph below shows the daily amount of cooling and the cumulative electricity consumed by the chiller.



As can be seen from the graph, realizing the lower temperature in H3 required 160 kWh additional electricity per m² during this cultivation of almost one year. Compared to the reference compartment, this is %40 more. The experiment showed the following results in terms of marketable product for the 5 varieties as a total sum of the production period.



The compartment with the lower temperature (H3) clearly showed a higher production than the reference compartment. The experiment also shows that using a higher stem density works better than the lower stem density, although it should be noted that a higher number of stems will increase the labor demand. The production levels of the colored varieties were quite similar. The green pepper variety showed, as always, a notably higher production.

In general the productivity difference between colored and green peppers is levelled by the higher price of colored peppers.

Conclusion

- Lowering the temperature in an AC-cooled closed greenhouse resulted in a higher yield (%27 more)
- The colder compartment H3 used %40 more electricity (162 kWh/ m²) for cooling than compartment H1.
- The energy-use efficiency of the lower temperature greenhouse is therefore lower than the standard greenhouse. For the standard temperature compartment the grand average over all varieties and treatment shows an electricity consumption of 18.7 kWh/kg, compared to 20.7 kWh/kg for the low temperature greenhouse.
- However, under current market conditions %27 additional peppers has more value than the costs of %40 more electricity consumed, so growing at lower temperature pays out.
- A plant density of 2.5 plants per m² gave a higher yield than a density of 1.9 plants per m².
- Different varieties showed different total production, but the temperature-effect could be seen in every variety.
- The green pepper variety (Makaw) showed the highest production (up to 40 kg/m². From the colored peppers, Ficka (a red pepper) produced best, with 28 kg/(m² yr) .

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