Effects of Duration of Temperature Perturbations during Flowering on Tomato Fruit

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Background

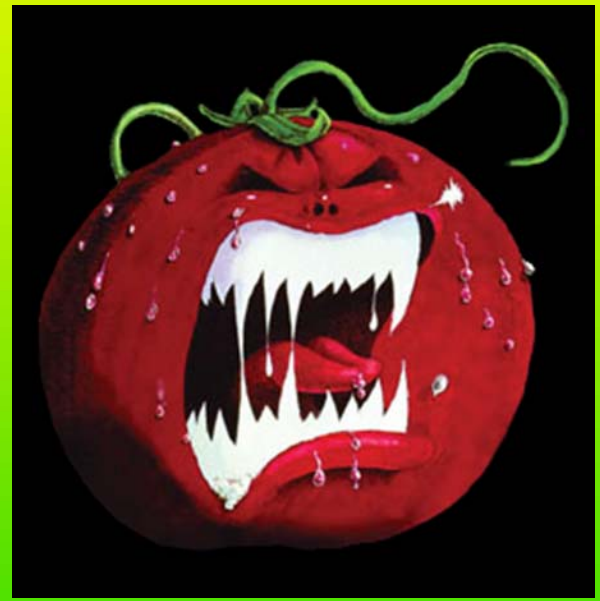
- Food production is necessary for long-duration manned space missions
- Tomato has been selected as an ALSS crop
- While tomato growth and production in controlled environments have been extensively studied, generally environmental conditions are kept constant (optimal)
- For useful plant growth models, perturbation studies are needed in order to better understand plant responses
- Environmental conditions during flowering and fruit set are important

Tomato Production System

- Cultivar ‘Laura’, n = 40
- Media: rockwool, 150 mm (6”) pots with perlite
- Trickle irrigation: every 2 hr during photoperiod
- Top pruning (single cluster)
- Treatment start: 85% of plants had reached 3rd flower anthesis or 3rd fruit set (DAS 44-49)
- Treatment duration: 2, 4, 8, or 14 days (3 Exps)
- Fruit harvesting stages (3-7 fruits per plant):
  - Breaker (25% of surface had red/orange tint)
  - Breaker + 6 days

Environmental Set Points

- **Photoperiod: 16 hrs**
- **CT: 23/18°C, LT: 16/11°C, HT: 30/25°C**
  - **Note LT and HT only during treatment period**
- **PAR: 350-400 µmol/(m²s)**
- **CO_2: 950-1050 µmol/mol**
- **RH: 70-90%**



Equipment (EGC):

- **1 walk-in growth chamber (CT)**
- **4 reach-in growth chambers (2 for LT and 2 for HT)**

Walk-in growth chamber

Moving plants to reach-in growth chambers for LT & HT treatments

Labeling Plants and Fruits

B + 6

DAS 83

Experimental Sequence

Event	Exp. 1	Exp. 2	Exp. 3
Sowing	Jan 18, ’05 (0)	Dec 7, ‘05 (0)	Apr 3, ‘06 (0)
Transplant	Jan 27, ‘05 (9)	Dec 21, ‘05 (14)	Apr 17, ‘06 (14)
Start of Treatment	Mar 3, ’05 (44)	Jan 25, ‘06 (49)	May 22, ’06 (49)
Treatment Duration	14 days	2, 4, or 8 days	2, 4, or 8 days
Final Harvest	May 20, ‘05 (122)	Mar 24, ‘06 (107)	Jul 15, ‘06 (103)
Harvesting Stages	B, B + 6	B	B + 6

Fruit after 14-Day Treatment

LT

CT

HT

DAS 58

Results (I)

Compared to control treatments (Treatment – CT):
Total fruit yield in gram per plant (%)

Harvest Stage, Treatment Duration	LT 16/11°C	HT 30/25°C
B, 14 (days)	19.7 (1.5)	- (BER)
B+6, 14	111.2 (8.0)	- (BER)
B, 2	-35.2 (-3.3)	-84.4 (-8.0)
B, 4	37.5 (3.5)	-480.8 (-45.3)*
B, 8	436.4 (41)*	- (BER)
B+6, 2	-134.5 (-11.5)	-177.2 (-15.2)
B+6, 4	225.2 (19.3)	-567.8 (-48.6)**
B+6, 8	*-168.1 (-14.4)*	- (BER)

*, ** indicates significant at P<0.05, P<0.01, respectively

Results (II)

Compared to control treatments (Treatment – CT):
Number of days to harvest the first three fruits (%)

Harvest Stage, Treatment Duration	LT 16/11°C	HT 30/25°C
B, 14 (days)	5.8 (6.6)**	- (BER)
B+6, 14	5.7 (6.1)**	- (BER)
B, 2	4.3 (5.1)	0.8 (1.0)
B, 4	*-0.5 (-0.6)*	*-3.5 (-4.1)*
B, 8	4.8 (5.6)	- (BER)
B+6, 2	-0.2 (-0.2)	1.3 (1.5)
B+6, 4	1.2 (1.4)	4.1 (4.6)
B+6, 8	1.8 (2.0)	- (BER)

** indicates significant at P<0.01

Results (III)

Compared to control treatments (Treatment – CT):
Dissolved sugars (°Brix) in harvested fruits (%)

Harvest Stage, Treatment Duration	LT 16/11°C	HT 30/25°C
B, 14 (days)	-0.35 (-7.4)	- (BER)
B+6, 14	0.7 (14.6)*	- (BER)
B, 2	0.14 (2.8)	0.0 (0.0)
B, 4	0.0 (0.0)	0.39 (7.8)*
B, 8	0.10 (2.0)	- (BER)
B+6, 2	-0.03 (-0.5)	0.55 (10.0)*
B+6, 4	0.18 (3.3)	0.59 (10.8)*
B+6, 8	0.07 (1.3)	- (BER)

* indicates significant at P<0.05

Results (IV)

Compared to control treatments (Treatment – CT): Lycopene content (mg/L) in harvested fruits (%)

Harvest Stage, Treatment Duration	LT 16/11°C	HT 30/25°C
B, 14 (days)	0.60 (18.9)	- (BER)
B+6, 14	-10.2 (-39.2)***	- (BER)
B, 2	0.33 (41.8)	*1.15 (146)**
B, 4	0.37 (46.8)	-0.01 (-1.3)
B, 8	0.18 (22.8)	- (BER)
B+6, 2	-5.7 (-17.1)	-6.0 (-18.0)
B+6, 4	-7.1 (-21.3)	-5.4 (-16.2)
B+6, 8	-13.3 (-39.8)*	- (BER)

*, *** indicates significant at P<0.05, P<0.001, respectively

Summary

- Temperature perturbations during flowering and fruit set affected tomato fruit growth and development
- Fruit mass, days to harvest, and dissolved sugars (°Brix) were different comparing the LT and HT treatments
- The CT treatment (harvested at B+6), produced the highest lycopene content
- The HT treatment lasting eight or more days consistently resulted in BER
- The differences between the LT and CT treatments were generally small, indicating a potential for some energy savings
- The results are useful for planning scenarios (modeling) for future space missions as well as for earth-bound commercial tomato production

Thank You!!!

Wallace & Gromit: The Curse of the Were-Rabbit, 2005. Aardman Animations.

Questions?