



Temperature Effects on Ethylene Sensitivity

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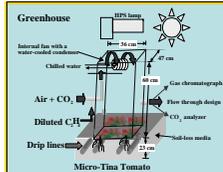


Tim Steve Bruce

Abstract

Ethylene is an endogenously synthesized plant hormone that dissipates quickly in rural field conditions, seldom exceeding 1 to 5 nmol mol^{-1} (1-5 ppb), but which can accumulate to 10-100 times that in controlled environments. The best known effects of ethylene are its impacts on leaf senescence and fruit ripening, however, ethylene influences growth and development throughout the life cycle. To identify how temperature influences ethylene-sensitivity from the early developmental stage of flowering through harvest, we examined ethylene-temperature interactions in Micro-Tina tomatoes at 0, 20, and 40 ppb C_2H_4 and 22 and 28 °C in a greenhouse. At 22 °C, the 20 and 40 ppb red fruit yields were 50 and 11% of the control. At 28°C, yields were 33 and 5% of the control. Red fruit yield at 22 °C was 2.1, 3.7, and 6.6 (0, 20, and 40 ppb) times greater than at 28 °C. Vegetative growth was only slightly inhibited by ethylene. Ethylene-sensitivity of tomato at anthesis increased with increasing temperature.

Materials and Methods



- Micro-Tina tomatoes were grown in our 12-chamber, flow-through greenhouse system
- Natural sunlight and high pressure sodium lamps provided a PPF of 34-41 $\text{mol per m}^2\text{-day}$
- For each 0.2 m^2 chamber:
 - Air was supplied at 40 L per min
 - Water-cooled heat exchangers and computer-controlled electric heaters maintained temperature to within +/- 0.2 °C of the setpoint
 - CO_2 was supplemented at 1200 ppm
- Ethylene was supplied independently to each chamber at 0, 20, or 40 ppb and monitored once per hour with our gas chromatograph to insure consistency

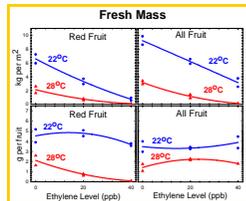
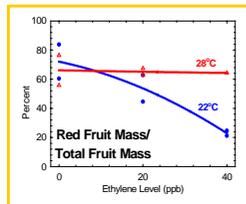
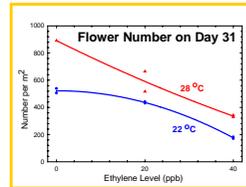


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Effect on Flowering and Fruit Set

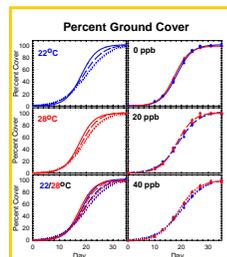
Increasing C_2H_4 concentration inhibited flower development



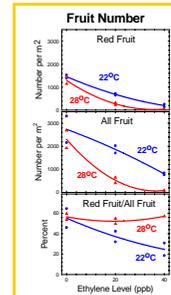
Fresh mass and Harvest Index declined steadily with increasing C_2H_4 concentration at both 22 and 28°C

Effect on Vegetative Development

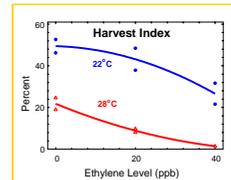
C_2H_4 had only a small effect on canopy closure at 40 ppb



Increasing C_2H_4 concentration and temperature inhibited fruit set



Exogenous C_2H_4 increased the ratio of mature fruit to all fruit but surprisingly did not hasten fruit ripening

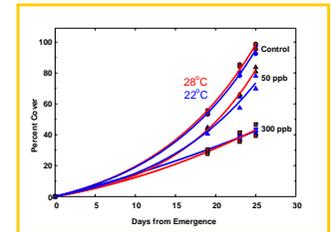


Effect of High C_2H_4 Concentrations



Control 50 ppb C_2H_4 300 ppb C_2H_4

300 ppb C_2H_4 inhibited canopy closure and 50 and 300 ppb inhibited flowering



Temperature did not interact with C_2H_4 -sensitivity in canopy closure at levels up to 300 ppb

Environmental Control in Flow-through Systems

Biomass (kg dry mass per chamber)	Potential C_2H_4 Production Rate (nmol per kg-s)	Air Flow Needed to Keep Output Concentration at 5 ppb (L per min)
0.2	1.00	60
0.2	0.10	6

Conclusions

Micro-Tina tomato is extremely sensitive to ethylene during anthesis, but sensitivity appears less pronounced before or after anthesis even at higher concentrations

Cooler temperatures increased fruit yields especially at elevated ethylene concentrations

Ample ventilation at the time of anthesis is needed to reduce ethylene-induced problems in controlled environments

References

- Klassen, S., and B. Bugbee (2002) Sensitivity of Wheat and Rice to Low Levels of Atmospheric Ethylene. *Crop Science* 746-753.
- Campbell, W.F., F.B. Salisbury, B. Bugbee, S. Klassen, et al. (2001) Comparative floral development of Mini-grown and ethylene-treated earth-grown Super Dwarf wheat. *J. of Plant Physiology* 1051-1060.
- Klassen, S., B. Bugbee, and W.F. Campbell (1999) Effects of low ethylene levels on USU-Apogee and Super Dwarf wheat. Proceedings of the International Conference on Environmental Systems (ICES), July 12-15, SAE Paper # 1999-01-2025.