

Temperature Effects on Plants



Feb 22 and 25

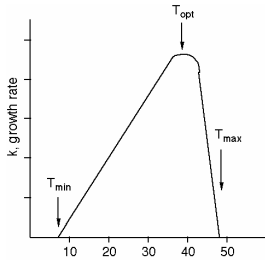
The effects of temperature are important for several reasons:

1. Extremes may damage plants
2. The rate of many biochemical and physical processes is temperature dependent

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Growing Season Temperatures

Every species has a minimum, maximum and optimal temperatures = Cardinal Temperatures



This is not just a plant science term!

Applies to other organisms.

Applies to processes (pollen germination)

Varies during development (seedling may be more susceptible to stress than mature plant)

Varies depending on tissue (floral buds may be especially susceptible to damage from extremes)

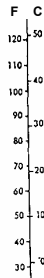
Varies depending on environmental factors – as relative humidity increases tolerance to high temperatures changes as ability to dissipate heat changes.

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What are these values....

Minimum Cardinal Temperature-
for growth – 5-6°C for most species
for survival – Chilling sensitive plants (0-7°C)
Semi-hardy species (-9 to -2°C)
Hardy plants (<0°C)

Maximum Cardinal Temperature-
for growth – 32-36°C
for survival – For temperate crops ~35°C, tropicals tolerate 54°C



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OPTIMUM TEMPERATURE

Depends on species and factors such as their place of origin or selection.

Cool-season plants: T_{opt} 18-24°C

- 1) In Southern U.S. grow as fall-winter crops.
- 2) In Northern U.S.: grow in late spring, summer, early fall

Warm season plants: T_{opt} 24-32°C

- 1) In Southern U.S. grow in late spring and summer, early fall
- 2) In Northern U.S. grow in summer, but for some warm season crops the growing season may be too short for optimal yield.

WHAT DETERMINES CARDINAL TEMPERATURES?

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Cardinal temperature for the germination of some important crops (Bierhizzen, 1973)

S.No	Plant	Cardinal temperature °C		
		Minimum	Optimum	Maximum
1	Rice	10-12	30-32	36-38
2	Sorghum	8-10	32-35	40
3	Maize	8-10	32-35	40-44
4	Wheat	3-4.5	25	30-32
5	Barley	3-4.5	20	38-40
6	Sugarbeat	4-5	25	28-30
7	Tobacco	13-14	28	35
8	Carrot	4-5	8	25
9	Pumpkin	12	32-34	40
10	Peas	4-5	25	28-3
11	Oats	4-5	30	36
12	Lentils			
In General				
	Cool season crops	0-15	25-31	31-37
	Hot season crops	15-18	31-37	44-50

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Some plants have a narrow cardinal temperature range and this is a major problem as climates change.

Agriculture can be affected
-- currants in Tasmania

Old-growth plant species may also be impacted
-- certain trees may not tolerate the changes

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Air Temperature and Growth

Temperature affects photosynthesis, respiration, hormone production and many processes

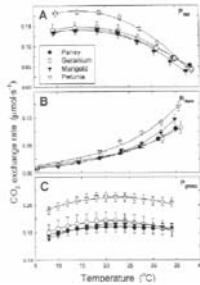
Temperature affects the kinetics of nutrient uptake and product movement.

Since dry weight accumulation is dependent upon CO₂ fixation, the amount of CO₂ exchange is a useful predictor of plant growth.

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HYPOTHESIS: Temperature influences CO₂ exchange.

EXPERIMENT: (JASHS 128:100) Four bedding plants (pansy, geranium, marigold and petunia) are tested for CO₂ exchange at various temperatures.



RESULTS:

C. Gross photosynthesis: Does not change much between 8-35°C

B. Respiration: increases exponentially with temperature.

A. Net Photosynthesis: No significant variability between 8-20°C, then decreases rapidly due to an increase in respiration

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Daily carbon gain measured in plants grown at different temperatures

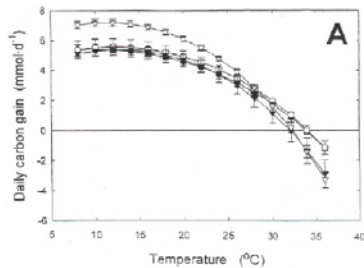
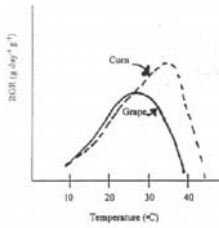


Fig. 3. The effect of short-term changes in air temperature on (A) the daily carbon gain (DCG), a measure of plant growth rate.

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RGR– (relative growth rate) normalizes growth rate to account for existing size.



Why is corn growing better at elevated temperatures?
As air temperature increases the dissolved CO₂/O₂ ratio decreases.

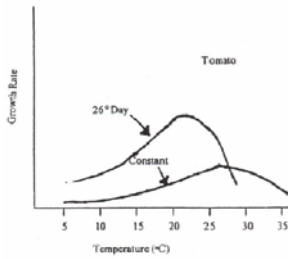
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HYPOTHESIS: Fluctuating day/night temperatures result in increased growth relative to constant temperatures.

EXPERIMENT: grow tomatoes in constant temperatures and at a varying night temperature with a 26°C day.

RESULTS:

1. The best constant temperature is 26°C
2. Plants experiencing a night temperature between 20-23°C with a 26°C day grow best.
3. Plants grow at a higher rate when a 26°C day is coupled to a cool night (5-20°C)– when there is a diurnal fluctuation.
4. Plants do not grow well when grown in a 26°C day and a warmer night.



Good test questions– what are your interpretations of these data?
What is the problem with this figure? Something is not quite right!

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THERMOPERIODISM

Growth and development controlled by oscillation of day and night temperature.

In general, optimal growth occurs when day temperatures are 5-12°C greater than night temperatures (when all temps aren't too hot or cold).

Why?

1. increased CO₂ assimilation at higher day temperatures
2. decreased CO₂ loss at lower night temperatures
3. increased carbohydrates available for growth

Thermoperiodic effects are not always observed. Tropicals sometimes grow best at constant temperatures.

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