

How weather and other factors influence fall leaf color displays

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Economic impact of fall color tourism



VT: 3.6 million visitors, \$460 million (2011); fall season accounts for ¼ of annual tourist spending; fall visits have increased 3-6% every year since 2009



NH: 8.2 million visitors spending \$1.6 billion (2014)
7.5 million visitors, \$1.0 billion (2009)



ME: \$581 million (2013), \$489 million (2009)



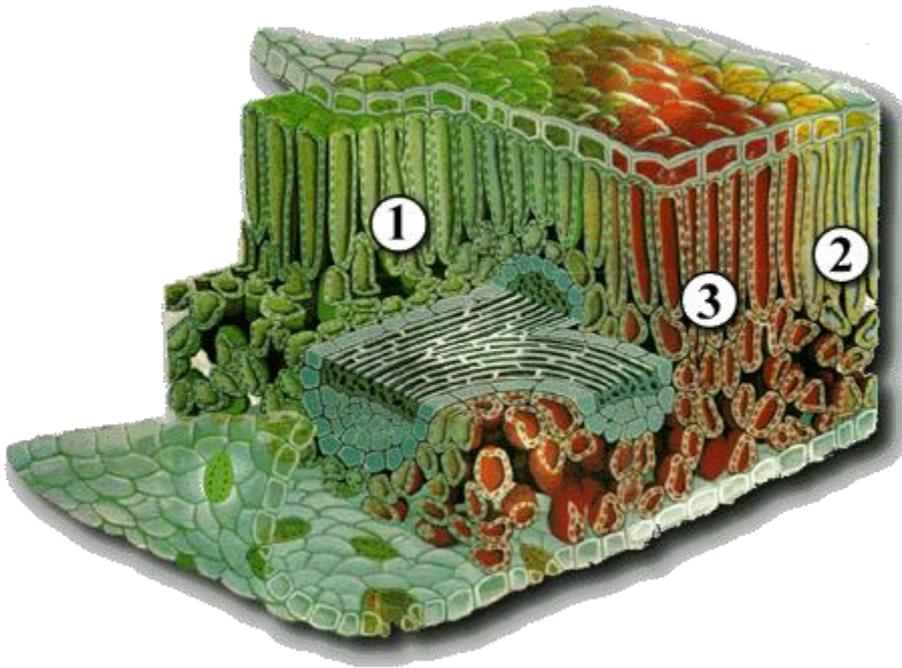
MA: \$2.8 billion (2013), \$2.2 billion (2012)



<http://mashable.com/2014/10/20/fall-foliage-tourism/#3TZAMdUys5qT>



Fall leaf pigments



① **CHLOROPHYLLS** (green):

- captures light energy

② **CAROTENOIDS** (yellow):

- captures light energy
- protective function

③ **ANTHOCYANINS** (red):

- produced following stress exposure
- broad protection

Triggers of foliar color change

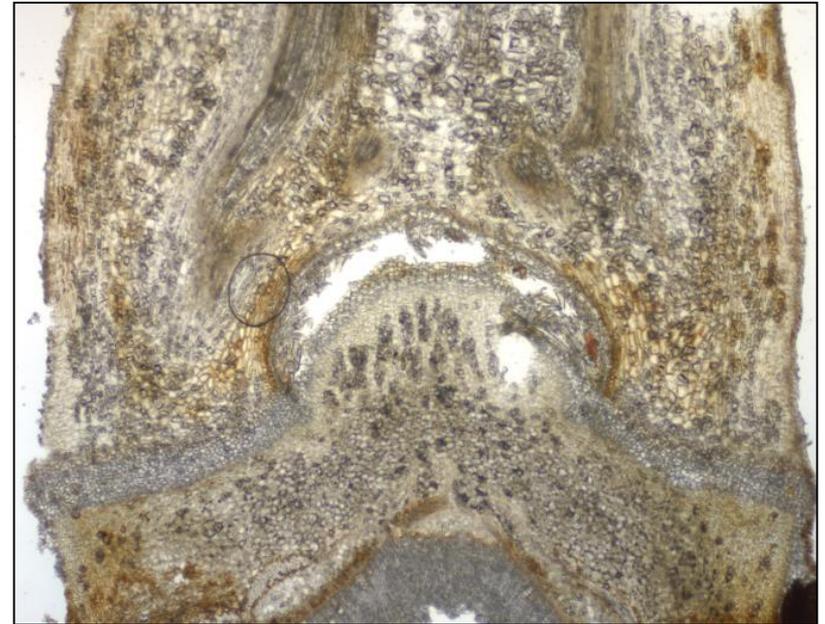
1. Shorter day length:

- Initiates development of abscission layer
- Slows replacement of chlorophyll

Result: fading of green (chlorophyll not replaced) and unmasking of yellow (carotenoids which were always present)

2. Stress exposure:

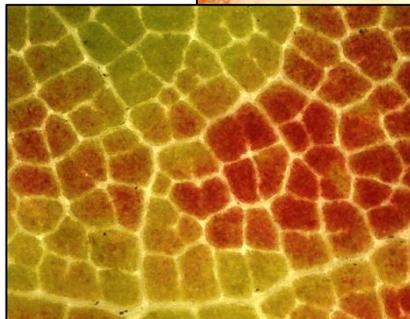
- Facilitates formation of abscission layer
- Increases breakdown of chlorophyll
- Triggers anthocyanin production



Anthocyanins

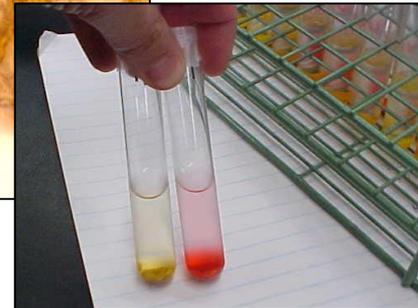
Stress-induced:

Drought
Ozone
UV radiation
Wounding
Pathogens
Insect attack
Nutrient deficiencies
Low temperatures



Protective function:

Photoprotection
Antioxidant activity
Osmotic activity
Drought protection
Cold tolerance



Experimental evidence of mechanism



Stress (e.g., N deficiency) associated with leaf sugar buildups



Sugar buildups signal a decline in leaf function / early senescence



Biochemical trigger of anthocyanin production



Experimentally manipulated via girdling, etc.

Schaberg et al. 2003, Murakami et al. 2008, Schaberg et al. 2008



Experimentally-induced production of anthocyanin

- Low temperatures slow phloem sugar transport
- Trapping sugars in leaves
- Triggering anthocyanin production



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NOTE

Experimental branch cooling increases foliar sugar and anthocyanin concentrations in sugar maple at the end of the growing season

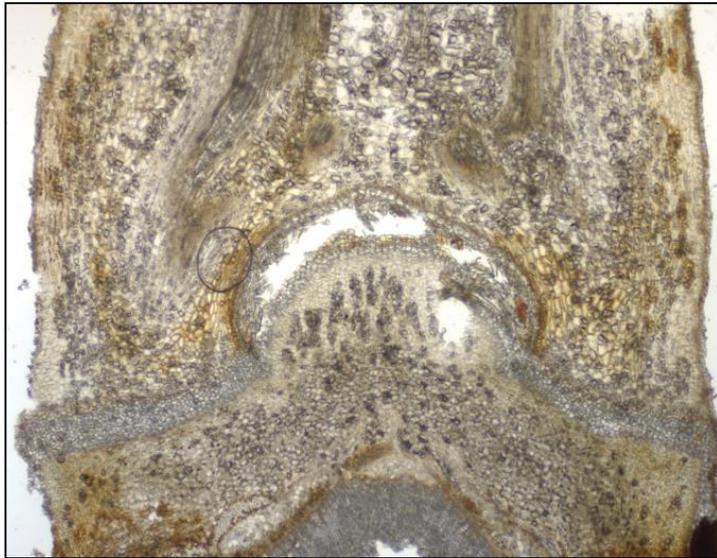
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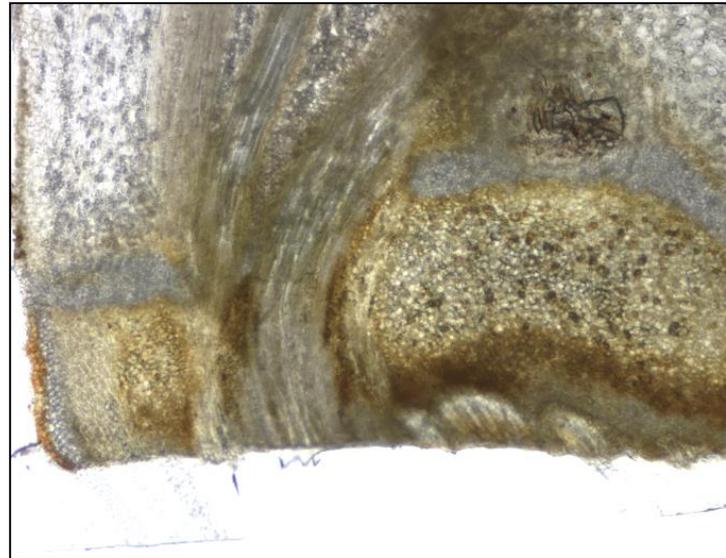
Why spend energy to make red?

Evidence suggests anthocyanins prolong retention of leaves allowing for resorption of carbohydrates and nutrients (N) back into stems (Schaberg et al. 2008)

YELLOW LEAF



GREEN and RED LEAVES



Species variation in red pigmentation

Birch, aspen, beech, etc. – revealing of YELLOW

Sugar/red maple, white ash, red/white oak, staghorn sumac, etc. – **production** of RED

Species mix across landscape important for fall color diversity!



Variability of color expression

1. An integration of species mix
2. Pattern of stress exposure
 - localized stress (pathogen/insect) - small scale expression
 - weather phenomena (drought/low temperature) - large scale expression
3. Stress intensity
 - moderate drought – triggers anthocyanin production
 - severe drought – leaf desiccation and rapid leaf excision



Fall 2017 – dry and warm

Where are the colorful leaves? Vermont foliage experts promise it's coming

Dan D'Ambrosio, Free Press Staff Writer Published 7:22 p.m. ET Oct. 6, 2017

WEATHER EXPLAINERS

Warmth in the East, Snow in the West Is Bad News for Leaf Peepers

By Linda Lam · October 04 2017 06:30 PM EDT · weather.com

The color is out there, if you search hard enough

Joel Banner Baird, Free Press Staff Writer Published 5:48 p.m. ET Oct. 16, 2017 | Updated 6:11 p.m. ET Oct. 16, 2017

Business Brisk, Fall Colors Late

Posted date: Monday, October 9th, 2017 In: News, Photo Slider, Top Story No Comments

Outdoors

Despite high hopes, hot weather dulls fall foliage season across New England

By Wilson Ring, The Associated Press · October 8, 2017 1:19 pm

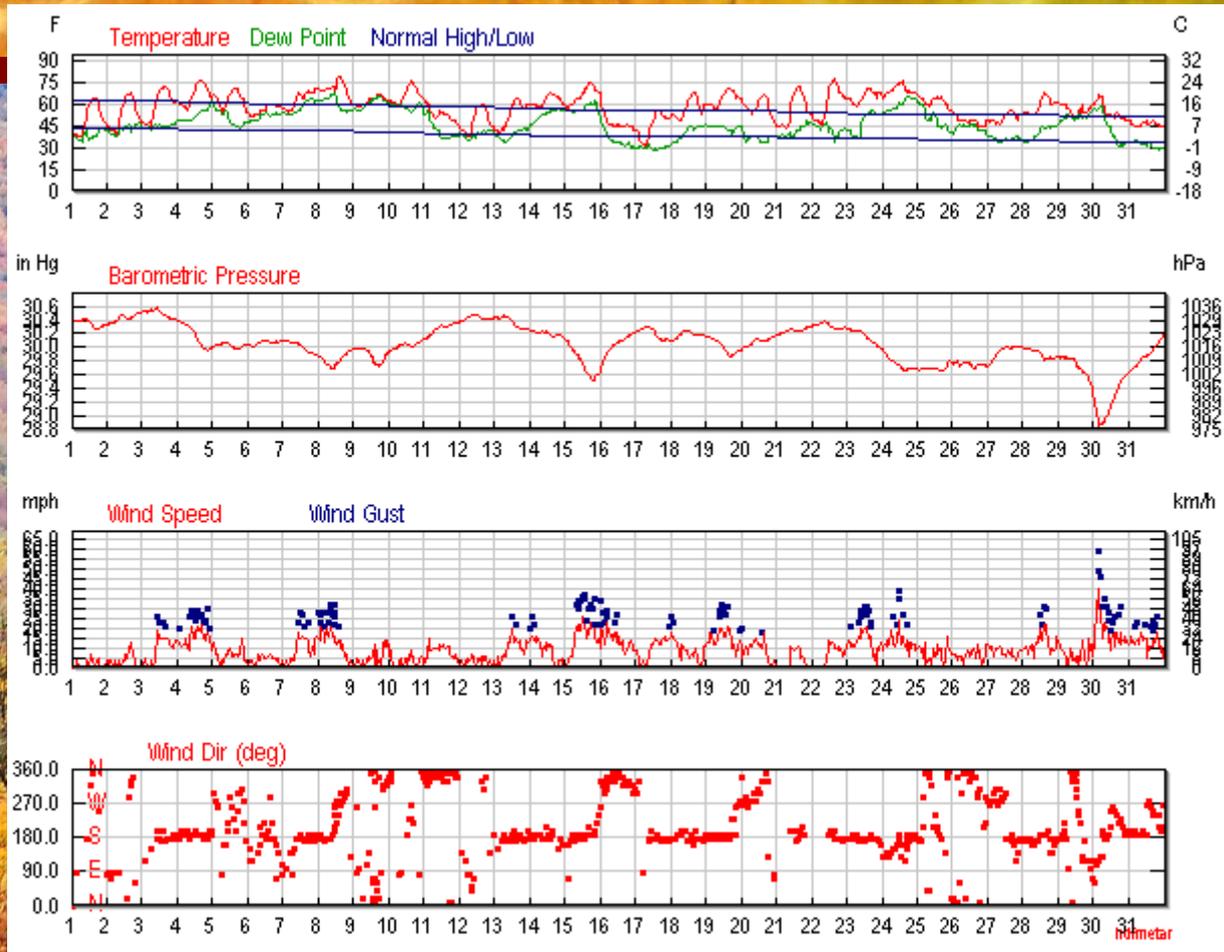
Updated: October 9, 2017 8:58 am

boston.com NEWS WEATHER SPORTS CULTURE TRAVEL

Why New England's peak fall foliage is a little later than usual



Fall 2017 – third warmest on record



https://www.wunderground.com/history/airport/KBTW/2017/10/7/MonthlyHistory.html?req_city=&req_stat_e=&req_state=&reqdb.zip=&reqdb.magic=&reqdb.wmo=



What does this all mean?



Without widespread cold, leaves remain green longer, develop red later



Delayed senescence not a bad thing – lengthens timeframe for foliar carbon capture



Delayed senescence does not necessitate poor color!



Continued warmer/variable temperature – color patterns less predictable - may require greater attention to weather nuances



Questions?

