Hudson Valley Research Laboratory

Cornell University

Fire Blight Management in a Changing Climate and Future Research

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Fruit School Hudson Valley & Lake George
Feb 2017

Outline

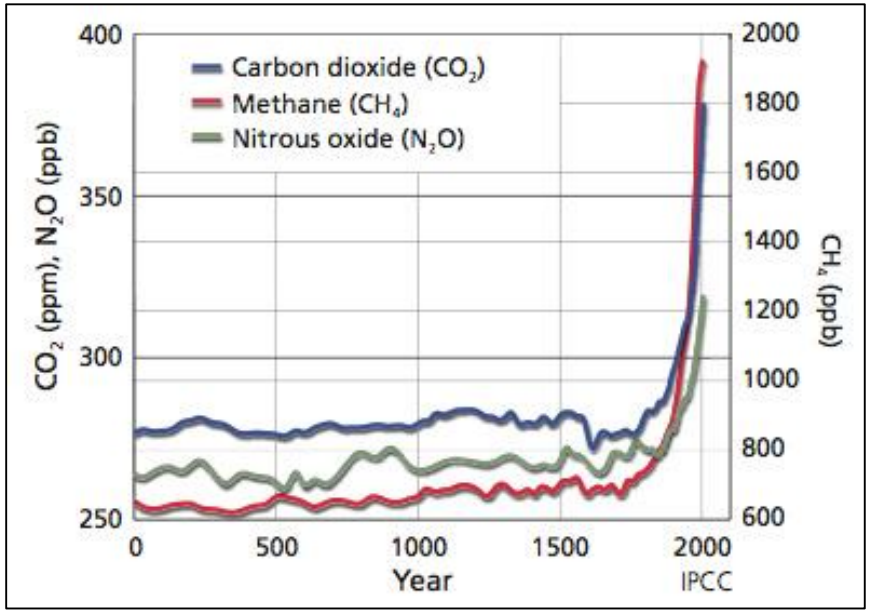
- What is Climate Change?
- Climate Change and Diseases
- Fire Blight Management
- Future Research

Outline

- **What is Climate Change?**
- Climate Change and Disease
- Fire Blight Management
- Future Research

What is Climate Change?

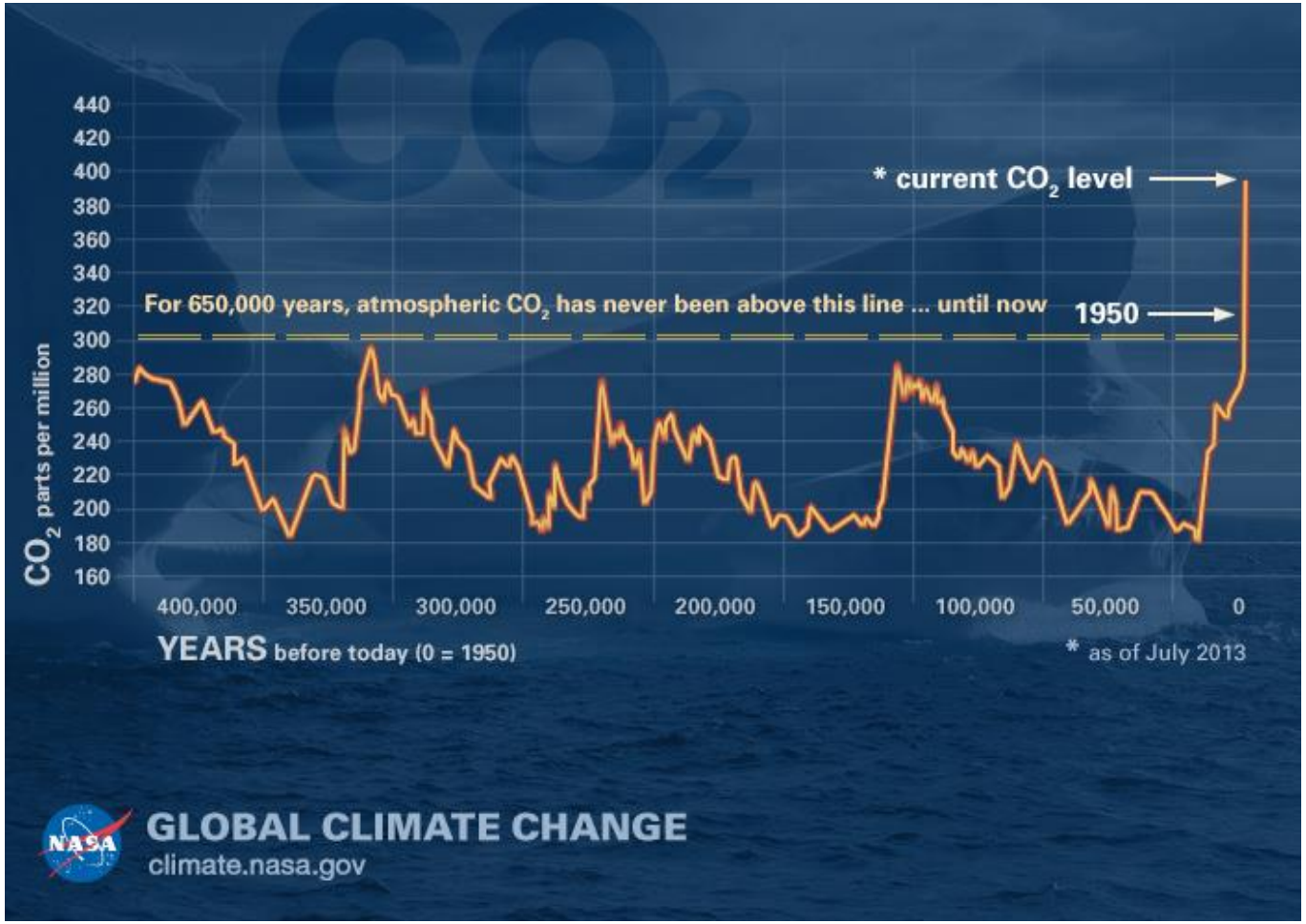
- Increasing average yearly temperatures by 2100 (Cayan et al. 2008):
  - Modeled rise for 4.5ºC
  - Winter minimum rise for 2.4ºC.
- Rise in conc. Of CO_2, CH_4 and VOC-s in air
- CH_4: 20 times the effect than CO_2
- Irregular rainfall, flash floods
- Increased air humidity
- Droughts (El Nino, La Niña), wildfires
- Hot weather in spring,
- More intense hurricanes
- Rising sea levels
- Ocean acidification
- More crop loss



climatecommunication.org

CO_2 conc. Rise

~ 40% CO_2 emitted remains in air -



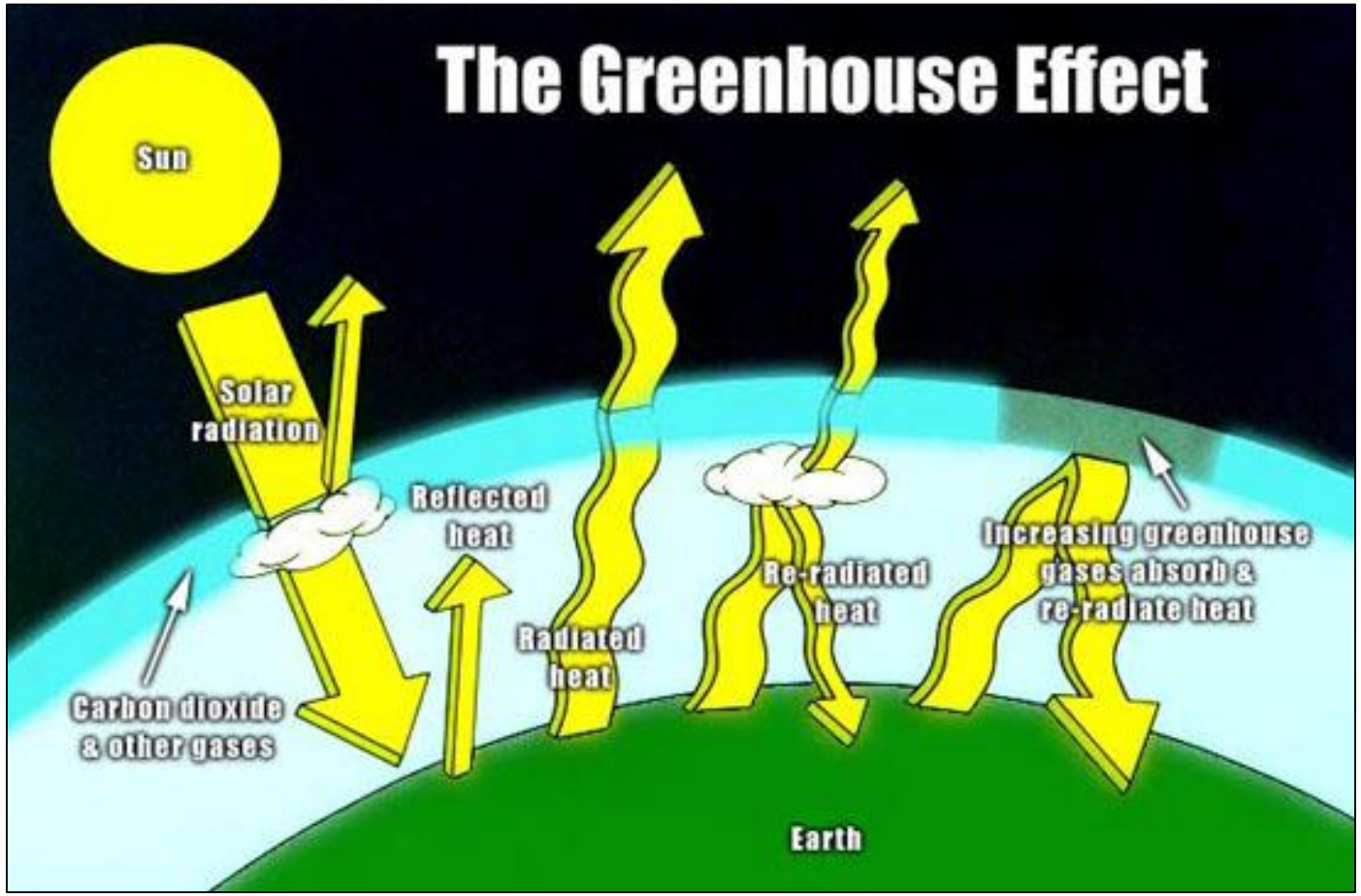
2016: 400 ppm

*Data on CO_2 before 1950's is from air bubbles trapped in oldest ice on Antarctica

Methane Release from Melting Permafrost
- Abraham Lake, Alberta, Canada -

http://yiral.com

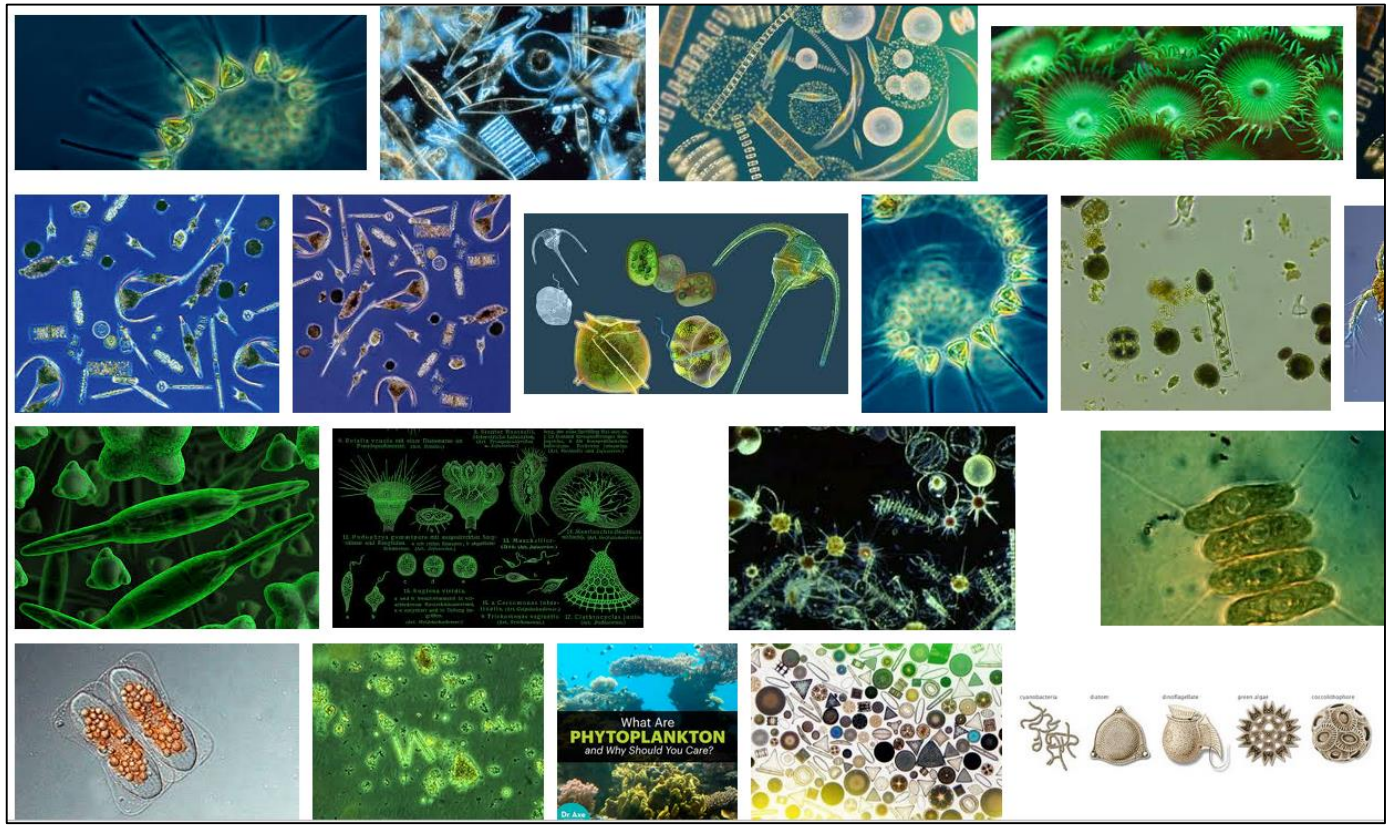
Heat Trapping



http://mrsdlovesscience.com/greenhouse/greenhouse.html

Atmosphere Oxygen Comes from
- Photosynthesis -

- **70% marine plants**
- **28% rainforests**
- **2 % other sources**
- Controls CO_2/O_2 balance
- ~1/2 CO_2 absorbed by seawater, lowers pH
- Reduce CO_3 ion conc, saturation with calcium carbonate
- Acidification impact on plankton debated
- Plankton species dependent
  - Kills some
  - Favors other



Google.com

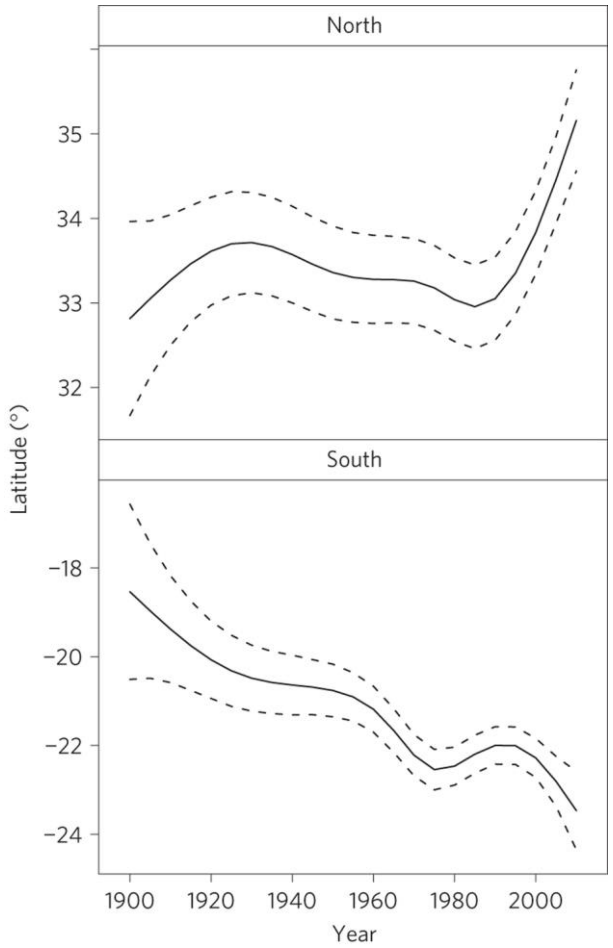
Outline

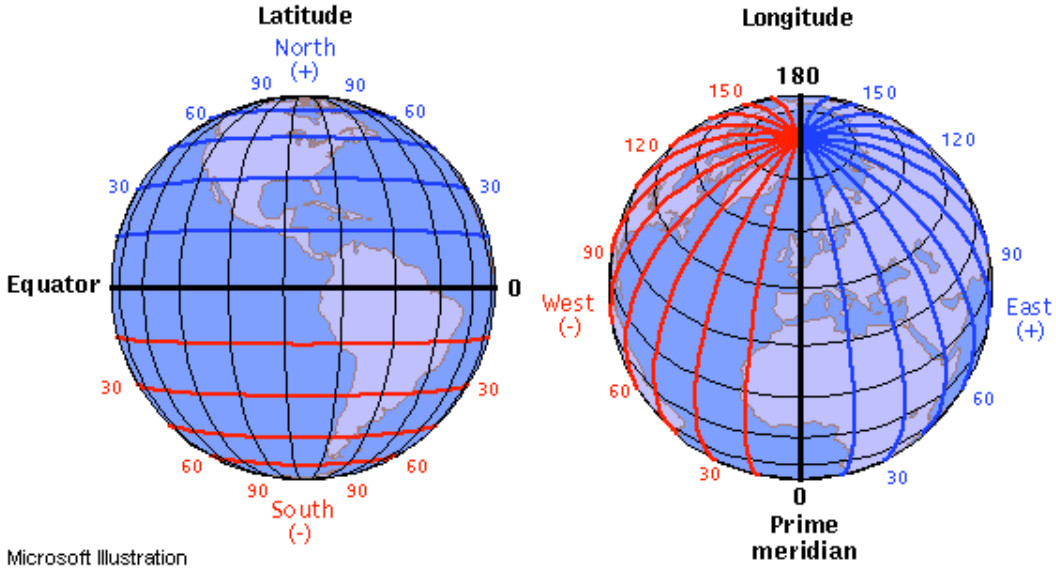
- What is Climate Change?
- **Climate Change and Diseases**
- Fire Blight Management
- Future Research

Climate Change Moves Pests
- Triggers Frequent Outbreaks -

- Bebber et al. 2013, Crop pests and pathogens move polewards in a warming world, *Nature Climate Change*
  - Shift in distribution
    - Moving towards N and S poles
    - Range expansion (global)
  - **Unusual weather patterns**
  - Introduce, spread invasive species
  - ~ 2 miles / yr from 1960
  - Oomycetes and fungi move 3.7-4.3 mi / year
  - Allows living in once unsuitable regions

All Pests from Bebber et al. (2013)



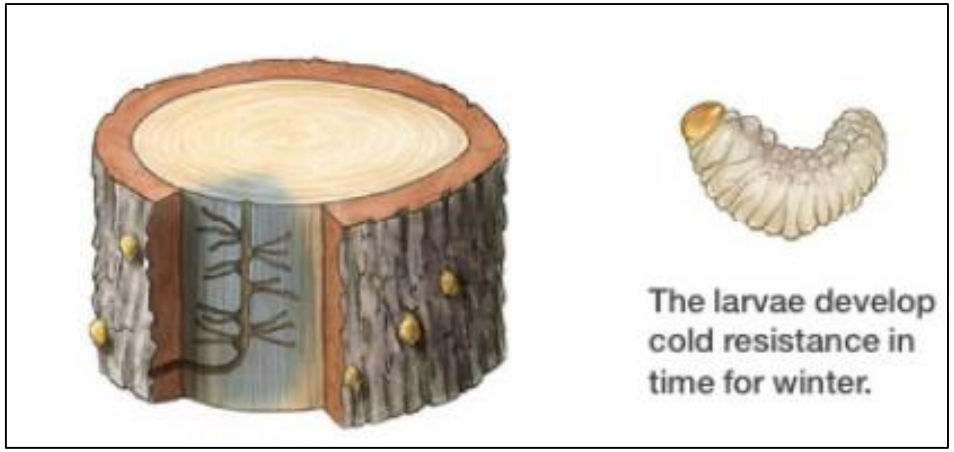


Example: Mountain Pine Beetle & Blue Stain Fungi -

- Warmer winters
- MPB infests more Pacific Northwest
- Spread further north
- To higher altitudes than in the past
- Not too cold anymore
- Fewer trees in south

http://ngm.nationalgeographic.com/2015/04/pine-beetles/epidemic-map

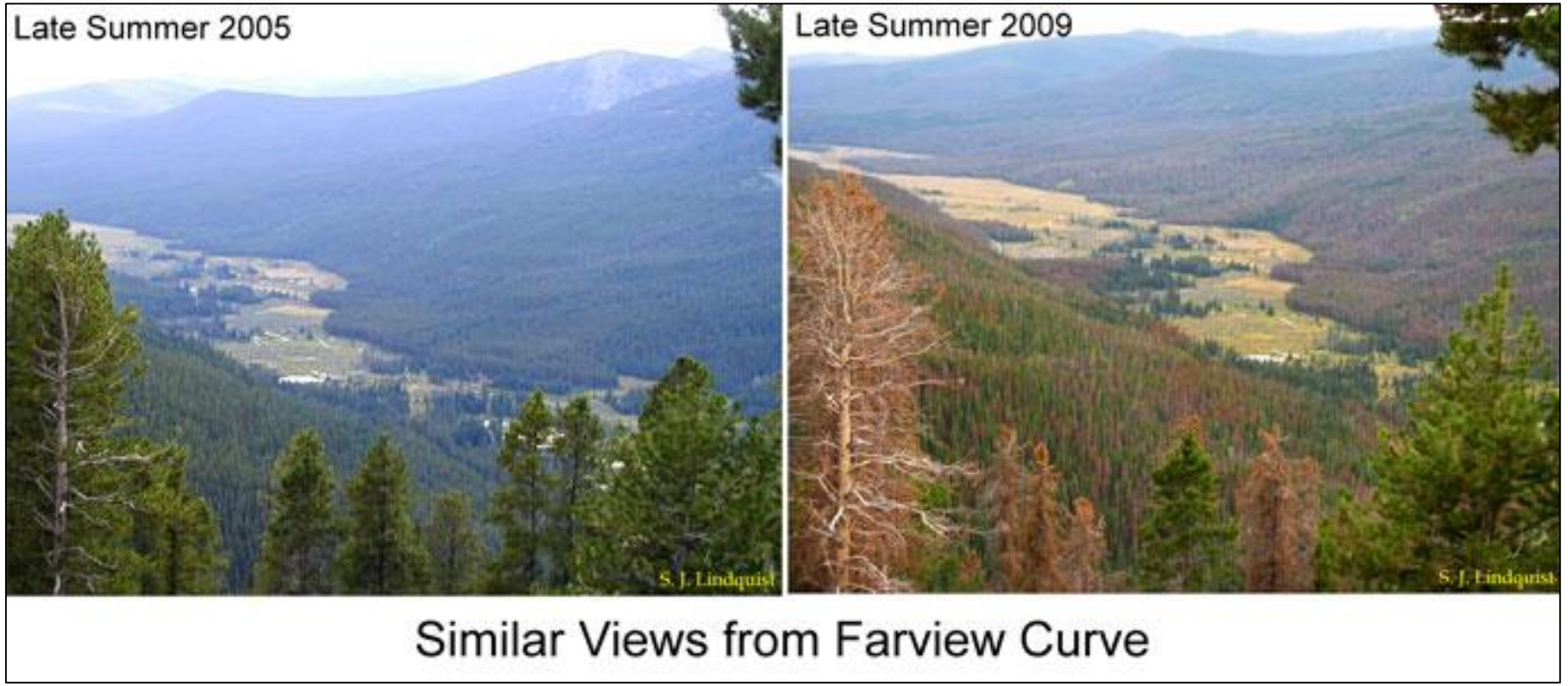
nps.gov



ngm.nationalgeographic.com

Kawuneeche Valley, Colorado

- Photo by S. J. Lindquist at nps.gov -



Mountain Pine Beetle Epidemic (natgeo.com)

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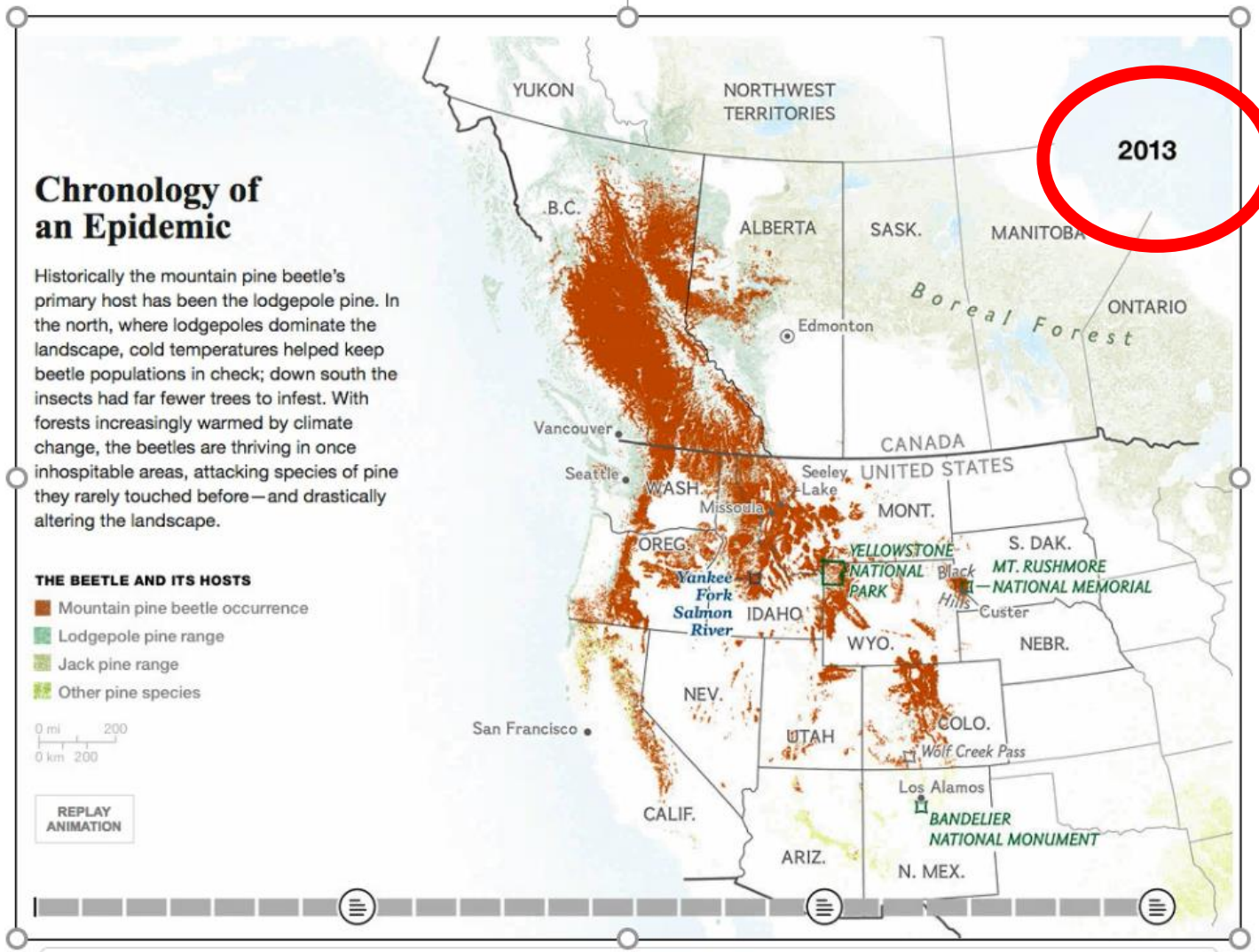

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Example: Fire Blight in Nova Scotia 2014
- Arthur Tropical Storm, Canada -

- Headlines
  - 90% of Nova Scotia orchards (CBC News)
  - Fire blight relief money on the way for Nova Scotia apple, pear growers (CBC News)
  - 75% of an orchard affected
  - >$20 million
  - 45-90,000 trees removed (40-50%, 2-5 yr)
  - Cankers

http://earthobservatory.nasa.gov

http://globalnews.ca

History of Fire Blight in Nova Scotia

- van Der Zwet & Keil (1979), Duyvelshoff (2015) -

- 1950 New Brunswick, Prince Edward Island (not Nova Scotia)
- Late 1966 pear (apple), cankers spotted
- 1980’s - pear limited
- 1984 - orchard removal to FB –pear
- 1985 - Shoot blight of newly planted apple
- 1999 - Many blossom infections observed
- 2005 - Bad season for blossom infection
- 2006 - 2013 - Annual fire blight in ‘pockets’
- 2014 - Trauma blight:
  - Later bloom due to cool March/April = warm bloom
  - 5th June infection, 20 June symptoms

Example: Fire Blight in Switzerland

- Frequency of Epidemics from Pautasso et al. (2012) -

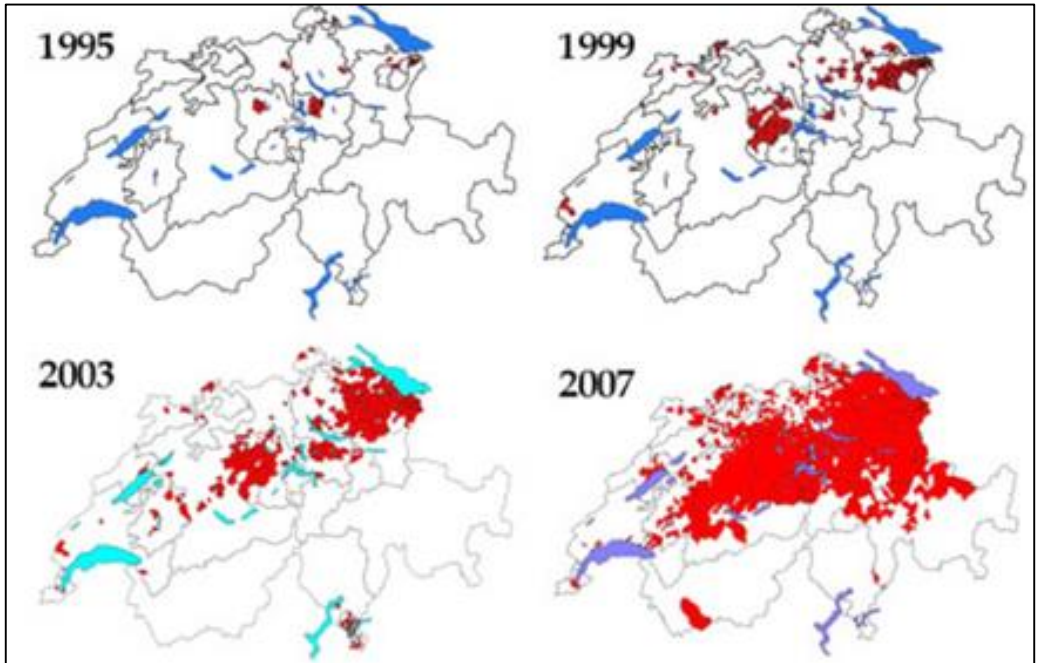


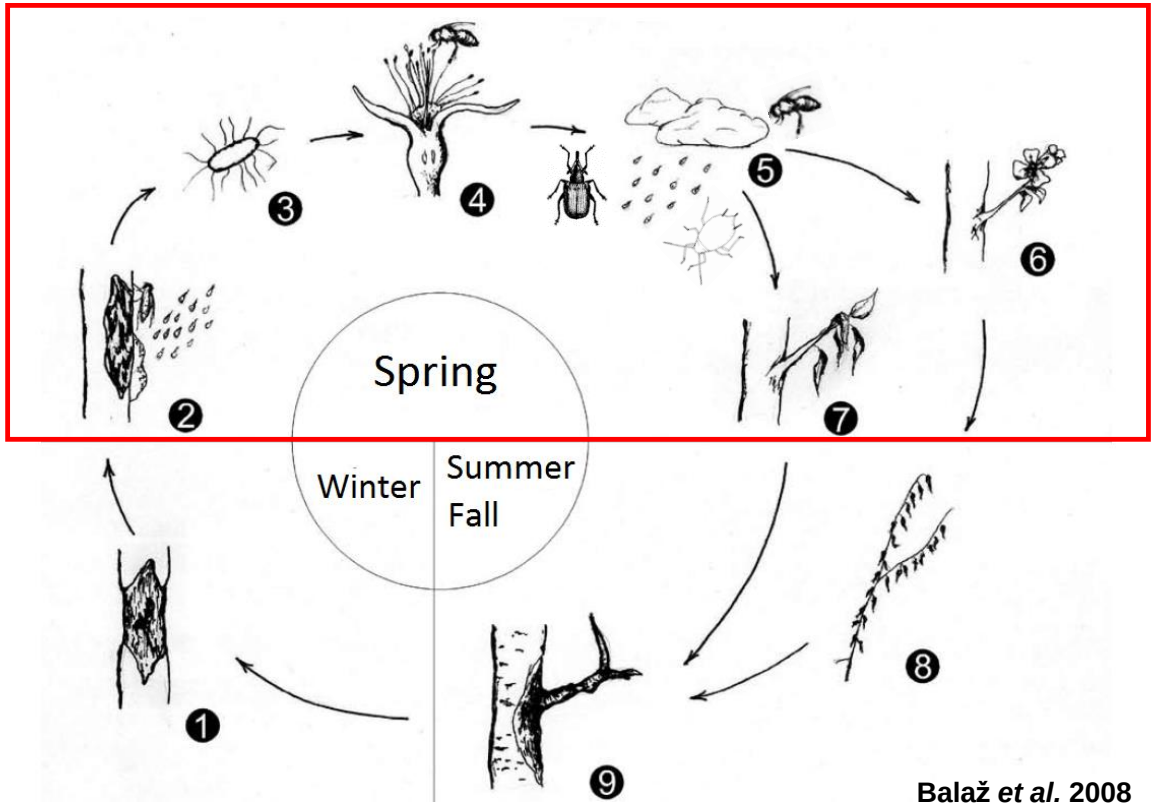
Fig. 2 Development of the fire blight epidemic (due to the bacterium *Erwinia amylovora*) in Switzerland, 1995–2007.

Outline

- What is Climate Change?
- Climate Change and Diseases
- **Fire Blight Management**
- Future Research

Fire Blight is Risk of Production

- Life Cycle -



Balaž *et al.* 2008

Diagnose – Know Your Enemy
- Actively Oozing Cankers -

http://www.omafra.gov.on.ca

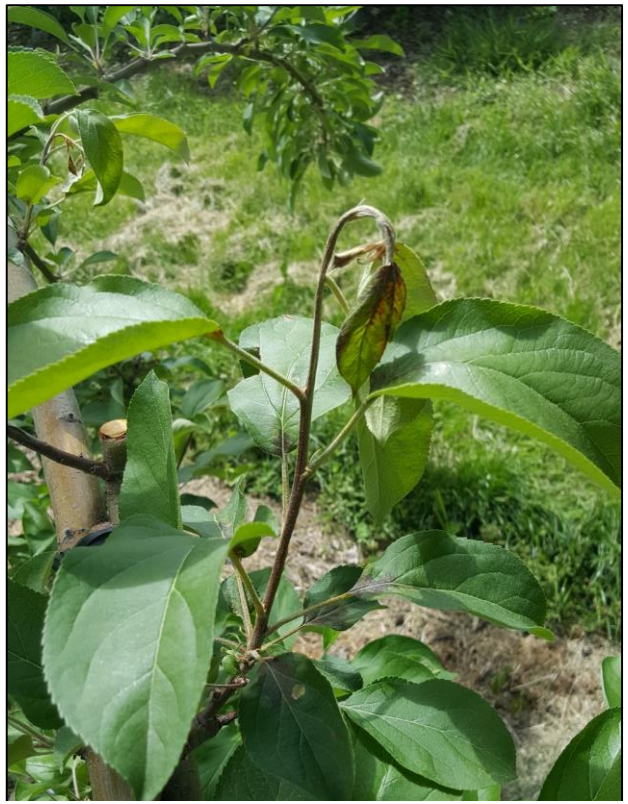
Flowers

- Ooze –

Shoots & Fruitlets

- Ooze -

Shoot Blight



Fire Blight Cankers

Determinate	Indeterminate

Worst Cases

- Trauma, Rootstock Blight -

Photo by Mark Longstroth

Photo by Michael A. Ellis

Shift to High Density = Low Fire Blight Tolerance

- Dwarf trees, Susceptible Rootstocks -

- Tall/super spindle (~1000 - 1500 /A)
- Susceptible varieties:
  Mutsu, Fuji, Gala, Gingergold, Honeycrisp, Idared, Jonathan, Lady Apple, Monroe, Paulared, Rome, SweeTango, NY-1, NY-2
- Susceptible rootstocks:
  M.9, M.26
- Trees < 6-8 yr old.

Weather Triggers Infection
- Issues 2016 -

- Late cv-s: still in bloom
- Early cv-s: rat-tail flowers; young shoots
- Extremely conducive conditions in NE NY:
  - Bloom end
  - No terminal bud set
  - Shoot growth
  - Hot: high 80-90’s
  - Few short rain/dew events
  - Hail storms
  - Disease history
  - Bacteria increase number rapidly in flowers
  - May 27, predicted extreme risks & rain on 29 & 30

NEWA – Summary
- Forecasted-

Fire Blight Risk Predictions for Peru

Blossom blight predictions using the Cougarblight model begin at first blossom open.

First blossom open date: 5/7/2016

First blossom open date above is estimated *based on degree day accumulations. Infection cannot occur without open blossoms. If the predicted bloom date is incorrect,* ***enter the actual date for blocks of interest*** *and the model will calculate the protection period during bloom more accurately. If bloom in your orchard has not yet occurred, continue to check Cougarblight daily and monitor your bloom. If bloom in your orchard has not yet occurred, enter a future bloom date, up to five days into the future, to gauge fire blight risk potential.*

Orchard Blight History: Fire blight occurred in your neighborhood last year.

The orchard blight history above is the NEWA default. Select the actual blight history for your orchard and the model will recalculate recommendations.

Blossom Blight Summary - Cougarblight

	Past	Past	Current	Blossom Blight 5-Day Forecast (Forecast Details)				
Date	May 18	May 19	May 20	May 21	May 22	May 23	May 24	May 25
4-day DH	15	33	140	311	407	599	743	866
Risk Level	Low	Low	Low	High	High	Extreme	Extreme	Extreme
Wetness Events								
Rain Amount	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.05
Rain Prob (%) Night|Day			-|-	-|-	-|-	-|-	-|-	-|-
Dew	Yes	Yes	Yes	No	No	Yes	No	Yes
Leaf Wetness (hours)	0	1	0					

NA - data not available

Cougarblight Charts

Download Time: 5/20/2016 23:00

Fire Blight Risk Predictions for Chazy

Blossom blight predictions using the Cougarblight model begin at first blossom open.

First blossom open date: 5/10/2016

First blossom open date above is estimated *based on degree day accumulations. Infection cannot occur without open blossoms. If the predicted bloom date is incorrect,* ***enter the actual date for blocks of interest*** *and the model will calculate the protection period during bloom more accurately. If bloom in your orchard has not yet occurred, continue to check Cougarblight daily and monitor your bloom. If bloom in your orchard has not yet occurred, enter a future bloom date, up to five days into the future, to gauge fire blight risk potential.*

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	Past	Past	Current	Blossom Blight 5-Day Forecast (Forecast Details)				
Date	May 18	May 19	May 20	May 21	May 22	May 23	May 24	May 25
4-day DH	10	51	180	342	436	602	745	863
Risk Level	Low	Low	Caution	High	High	Extreme	Extreme	Extreme
Wetness Events								
Rain Amount	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.05
Rain Prob (%) Night|Day			-|-	-|-	-|-	-|-	-|-	-|-
Dew	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Leaf Wetness (hours)	0	2	0					

NA - data not available

Cougarblight Charts

Download Time: 5/20/2016 23:00

NEWA – Summary
- Infection Happened on May 29 & 30 -

Fire Blight Risk Predictions for Peru

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Blossom Blight Summary - Cougarblight

	Past	Past	Current	Blossom Blight 5-Day Forecast (Forecast Details)				
Date	May 27	May 28	May 29	May 30	May 31	Jun 1	Jun 2	Jun 3
4-day DH	1142	1358	1315	1527	1385	1101	1106	1017
Risk Level	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Wetness Events								
Rain Amount	0.00	0.00	0.51	0.16	0.00	0.00	0.07	0.02
Rain Prob (%) Night|Day			-|-	-|-	-|-	-|-	-|-	-|-
Dew	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Leaf Wetness (hours)	0	0	9					

NA - data not available

Cougarblight Charts

Download Time: 5/29/2016 23:00

Fire Blight Risk Predictions for Chazy

Blossom blight predictions using the Cougarblight model begin at first blossom open.

First blossom open date: 5/10/2016

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Blossom Blight Summary - Cougarblight

	Past	Past	Current	Blossom Blight 5-Day Forecast (Forecast Details)				
Date	May 27	May 28	May 29	May 30	May 31	Jun 1	Jun 2	Jun 3
4-day DH	1095	1289	1241	1462	1293	1044	1072	958
Risk Level	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme	Extreme
Wetness Events								
Rain Amount	0.00	0.00	0.38	0.12	0.00	0.00	0.09	0.02
Rain Prob (%) Night|Day			-|-	-|-	-|-	-|-	-|-	-|-
Dew	No	Yes	Yes	No	No	Yes	Yes	No
Leaf Wetness (hours)	1	0	11					

NA - data not available

Cougarblight Charts

Download Time: 5/29/2016 23:00

Dave Rosenberger's run of Maryblyt 7.1

- Unusually hot and humid -

Maryblyt 7 (modified)

File Edit Options Help

Save Print Copy Paste Save Screen as Image View Graph

Inputs **Data Entry Mode**

Date	Phenology	Max Temp (F)	Min Temp (F)	Wetness (in)	Trauma	Spray	Notes	Avg Temp (F)	EIP	BHWTR	BBS
5/15/2016	B	51.4	39.5	0.03				45.4	-	+ - + - M	-
5/16/2016	B	54.9	37.1	0.02				46.0	-	+ - + - M	-
5/17/2016	B	64.8	33.6	0.00				49.2	-	+ - - - L	-
5/18/2016	B	60.9	39.9	0.00				50.4	-	+ - - - L	-
5/19/2016	B	65.1	45.1	0.00				55.1	-	+ - - - L	-
5/20/2016	B	71.6	42.7	0.00				57.2	17	+ - - - L	-
5/21/2016	B	74.4	47.0	0.00				60.7	46	+ - - + M	-
5/22/2016	B	79.0	55.3	0.01				67.2	106	+ + + + I	-
5/23/2016	B	76.8	49.8	0.00				63.3	148	+ + - + H	9 a
5/24/2016	B	82.6	52.1	0.00				67.4	205	+ + - + H	21 a
5/25/2016	B	80.8	54.9	0.00				67.8	244	+ + - + H	34 a
5/26/2016	B	74.9	54.3	0.00				64.6	222	+ + - + H	43 a
5/27/2016	B	90.0	60.1	0.00				75.0	238	+ + - + H	63 a
5/28/2016	B	83.4	67.8	0.00				75.6	298	+ + - + H	83 a
5/29/2016	B	83.8	61.8	0.51				72.8	362	+ + + + I	100 a
5/30/2016	B	84.5	66.4	0.02				75.4	356	+ + + + I	20 b
5/31/2016	B	80.2	61.3	0.00				70.8	306	+ + - + H	35 b
6/1/2016	B	75.1	57.9	0.00				66.5	248	+ + - + H	46 b
6/2/2016	B	74.9	59.7	0.03				67.3	166	+ + + + I	58 b
6/3/2016	B	83.0	63.0	0.00				73.0	188	+ + - + H	76 b
6/4/2016	B	76.1	58.0	0.00				67.0	193	+ + - + H	87 b
6/5/2016	B	67.1	55.8	1.46				61.4	153	+ + + + I	94 b
6/6/2016	B	75.9	59.9	0.00				67.9	103	+ + + + I	106 b
6/7/2016	B	70.4	53.9	0.01				62.2	120	+ + + + I	93 c

Dave Rosenberger: High RH?

- Models are not perfect -

Peru station					
		LW	rain	RH	
5/30/16 9:00	70.9	7	0	96	
5/30/16 8:00	67.9	60	0	98	
5/30/16 7:00	66.4	60	0	98	
5/30/16 6:00	66.6	60	0.01	98	
5/30/16 5:00	66.5	60	0	98	
5/30/16 4:00	66.6	60	0.01	99	
5/30/16 3:00	66.6	60	0	98	
5/30/16 2:00	66.5	60	0	98	
5/30/16 1:00	66.8	60	0	98	
5/30/16 0:00	66.9	60	0	98	
5/29/16 23:00	67.7	60	0.02	98	
5/29/16 22:00	68.5	56	0.01	98	
5/29/16 21:00	69.5	53	0	96	
5/29/16 20:00	69	60	0	98	
5/29/16 19:00	69.7	60	0.15	98	
5/29/16 18:00	70.7	60	0.05	98	
5/29/16 17:00	71.2	60	0.07	98	
5/29/16 16:00	70.4	60	0.01	98	
5/29/16 15:00	72.3	26	0.2	94	

Fire Blight Management
- Chemical Control -

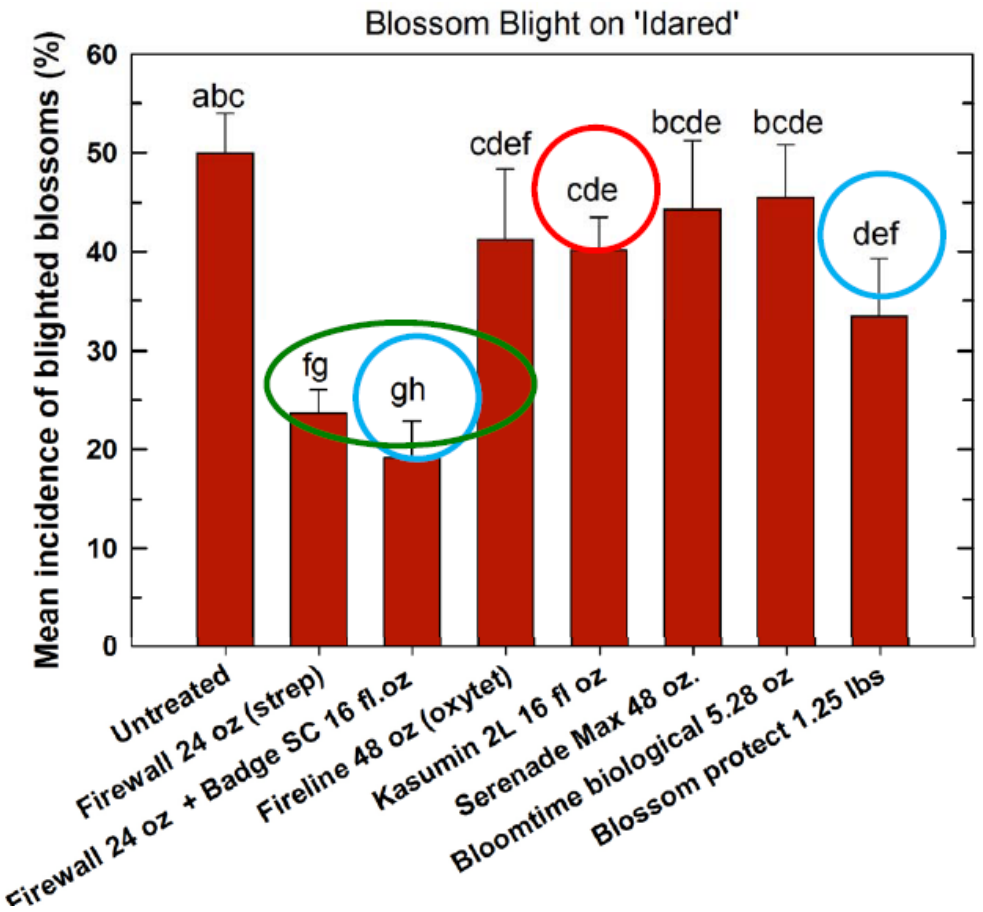
- **Use prediction models**
  - Cougarblight, Maryblyt (NEWA), RIMpro
  - Orchard history

- **Timing**
  - Dormancy (Silver tip – 1/2 inch Green)
    - Copper (oil + Bordeaux 8-10-10, Champ, Cuprofix, Kocide, Badge 3.5-7.0 pts or lb / A)
    - Late dormant: lower rate Badge SC/X2 @ 1-1.5 pts / A OR 1-1.25 lb / A
  - Tight Cluster
    - Badge SC/X2 @ 1-1.5 pts / A OR 1-1.25 lb / A (AVOID SLOW DRYING)
  - Pink
    - Badge SC/X2 @ 1-1.5 pts / A OR 1-1.25 lb / A (AVOID SLOW DRYING)
    - Double Nickel 55/LC @ 0.5-1 lb / A OR 1-2 qt / A
  - Bloom (first to last open flower):
    - Streptomycin (Firewall, Agri-Mycin) 24 oz/A, 12 oz / A + 1 pt Regulaid / 100 gal
    - Kasugamycin (Kasumin 2L) 64 fl oz/100 gal
    - Oxytetracycline (Fireline, Mycoshield) 3 lb / A
    - Double Nickel 55/LC @ 0.5-1 lb / A OR 1-2 qt / A
    - Cueva Fungicide Concentrate @ 2-3 qt / A (AVOID SLOW DRYING)
    - Badge SC/X2 @ 1-1.5 pts / A OR 1-1.25 lb / A (AVOID SLOW DRYING)
    - Apogee @ 6 - 12 oz / 100 gal
    - Serenade ASO 2-6 qt / A

Fire Blight Management – Year Dependent
- Chemical Control -

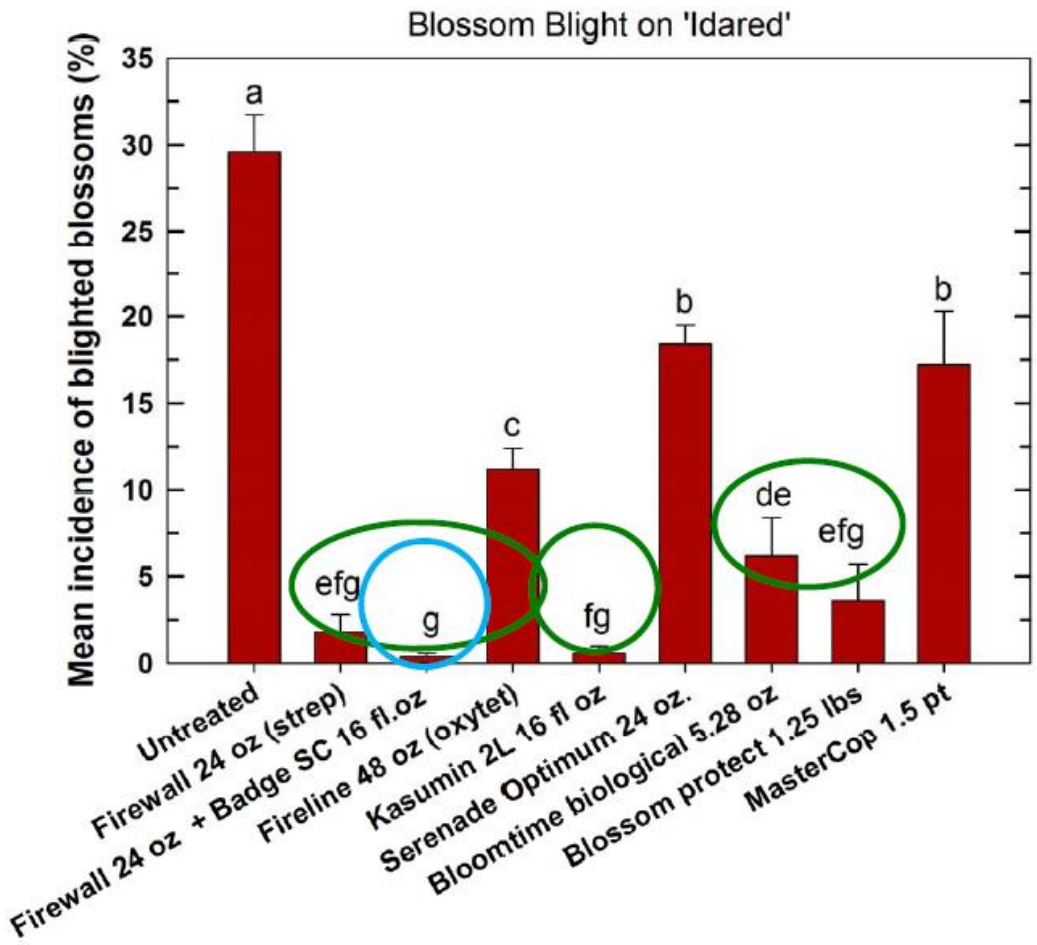
- Timing
  - Petal Fall
    - Streptomycin (Firewall, Agri-Mycin) 24 oz/A, 12 oz / A + 1 pt Regulaid / 100 gal
    - Kasugamycin (Kasumin 2L) 64 fl oz/100 gal
    - Oxytetracycline (FireLine, Mycoshield) 3 lb / A
    - Double Nickel 55/LC @ 0.5-1 lb / A OR 1-2 qt / A
    - Cueva Fungicide Concentrate @ 2-3 qt / A (AVOID SLOW DRYING)
    - Badge SC/X2 @ 1-1.5 pts / A OR 1-1.25 lb / A (AVOID SLOW DRYING)
    - Apogee @ 6 - 12 oz / 100 gal
  - Summer
    - Apogee @ 6 - 12 oz / 100 gal
    - Streptomycin (Firewall, Agri-Mycin) 24 oz / A, 12 oz / A + 1 pt Regulaid / 100 gal
    - Cueva Fungicide Concentrate @ 2-3 qt / A (AVOID SLOW DRYING)
    - Double Nickel 55/LC @ 0.5-1 lb / A or 1-2 qt / A
  - Use biologicals in rotation program with streptomycin

Efficacy Trials by Kerik Cox 2012
- High Pressure -



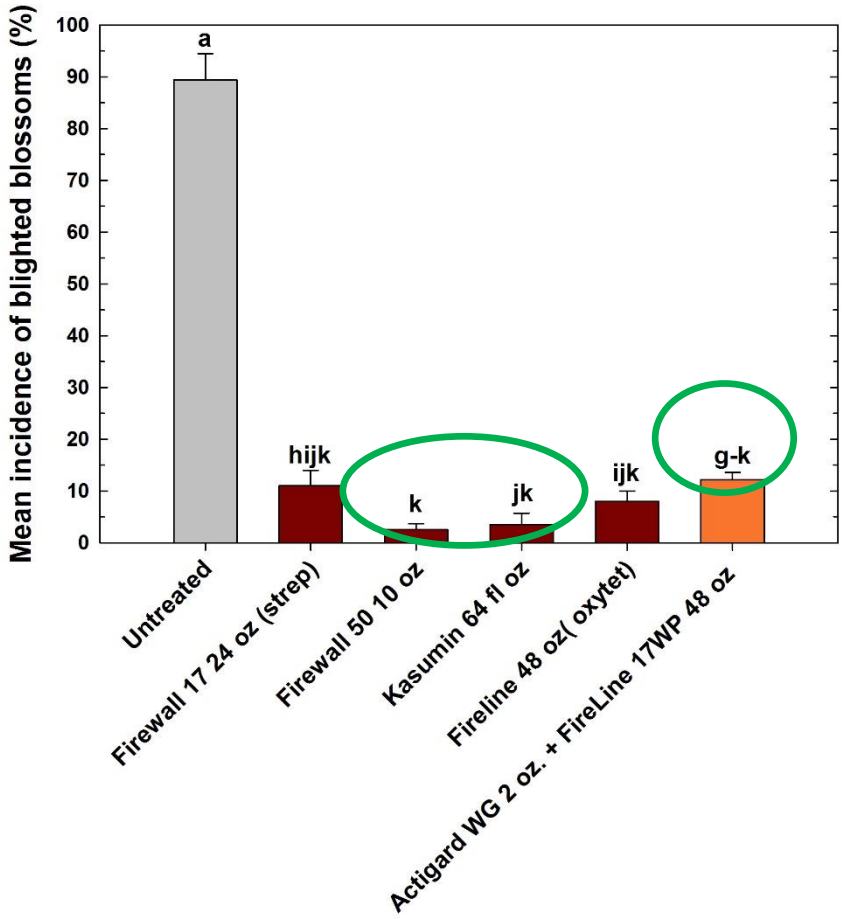
Efficacy Trials by Kerik Cox 2013

- Low Pressure -



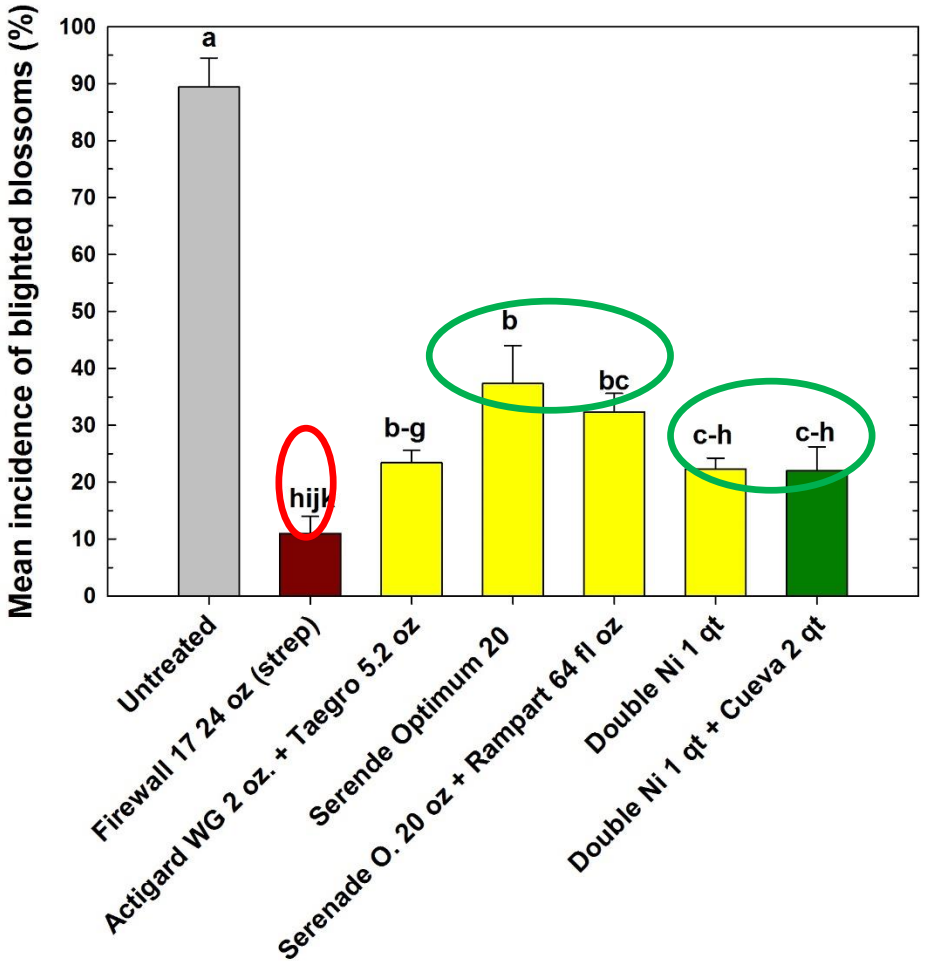
Efficacy Trials by Kerik Cox 2015

- Antibiotics -



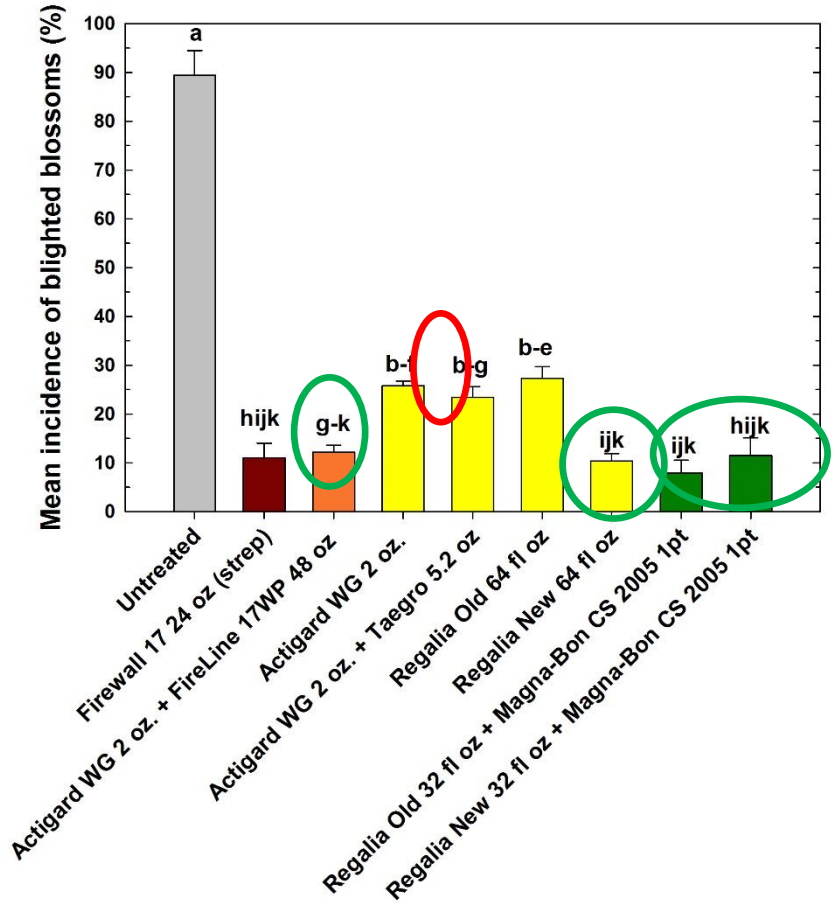
Efficacy Trials by Kerik Cox 2015

- Biologicals -



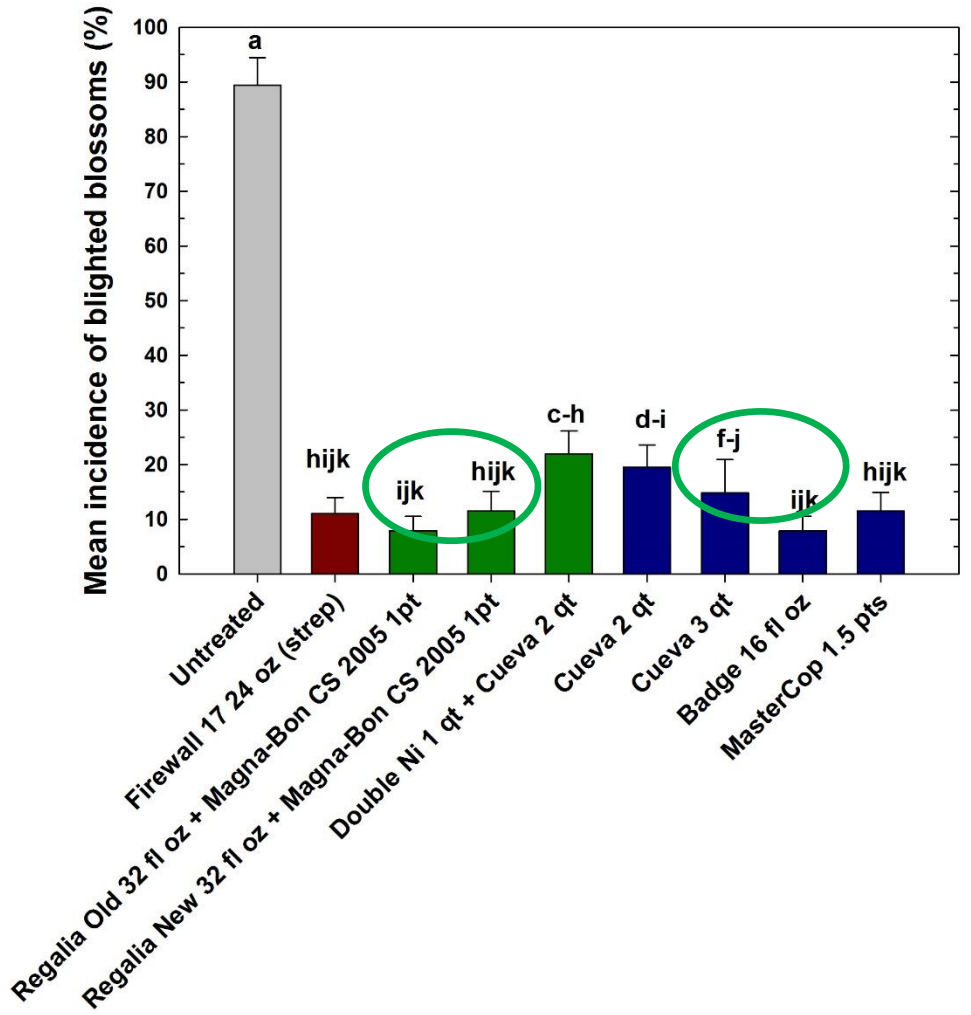
Efficacy Trials by Kerik Cox 2015

- SAR -



Efficacy Trials by Kerik Cox 2015

- Copper -



Outline

- What is Climate Change?
- Climate Change and Diseases
- Fire Blight Management
- **Future Research**

Fire Blight Management
- Research -

- Canker studies
  - Copper (2)
  - Species & cultivar effect
  - Tree drought stress
  - Overwintering

- Why?
  - Can we eradicate *Ea* in cankers?
  - Survival?
  - Can winter extinction happen?
  - Improve prediction models
  - Some cankers stay
  - No post-infection spray options
  - Reduce inoculum

Thank you!

- blogs.cornell.edu/acimoviclab/

Fire Blight in Champlain Valley 2016 (II) – Management Options in 2016 & 2017
September 12, 2016

Fire Blight in Champlain Valley 2016 (I) – History
August 26, 2016

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