

# Corn Leaf Blight Epidemics: The New Normal?



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Corn Day at Otesaga Resort Hotel - Cooperstown, NY  
February 11, 2014

# Late-season Northern Corn Leaf Blight Epidemic

Third Year in a Row! Is this the new Normal for New York?



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# Why the Increase in Northern Corn Leaf Blight ?

New races of the fungus?

Greater susceptibility of hybrids?

Favorable weather conditions?

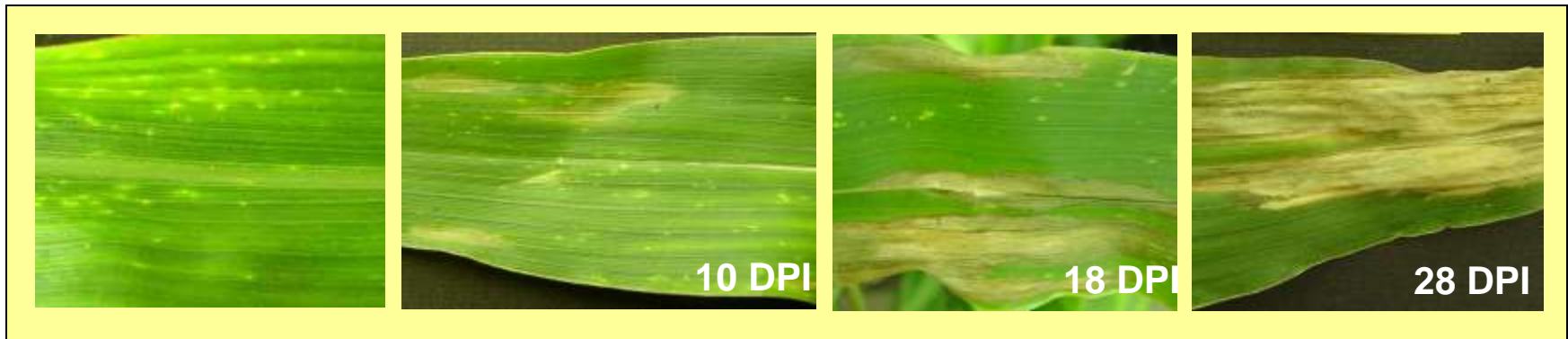
Epidemiological factors?



# Disease development & pathogen development

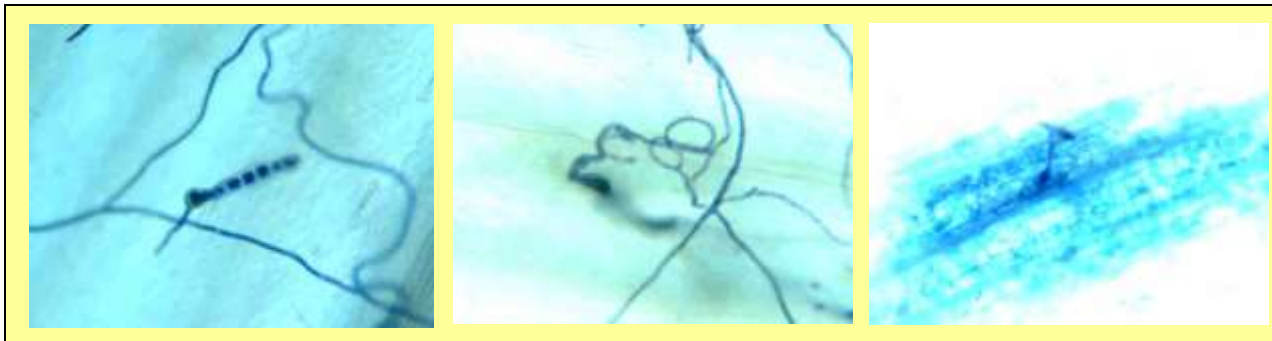
## NLB development:

Infection flecks → wilted lesions → lesions enlarge and coalesce



## *Exserohilum turcicum* development:

Conidia → appressorium → infection peg → inter/intracellular hyphae  
→ hyphae in the xylem



Courtesy of  
Rebecca Nelson, Cornell

A hemi-biotrophic parasite of corn







*Claymation by Ellie Walsh and Kent Loeffler, Cornell University*

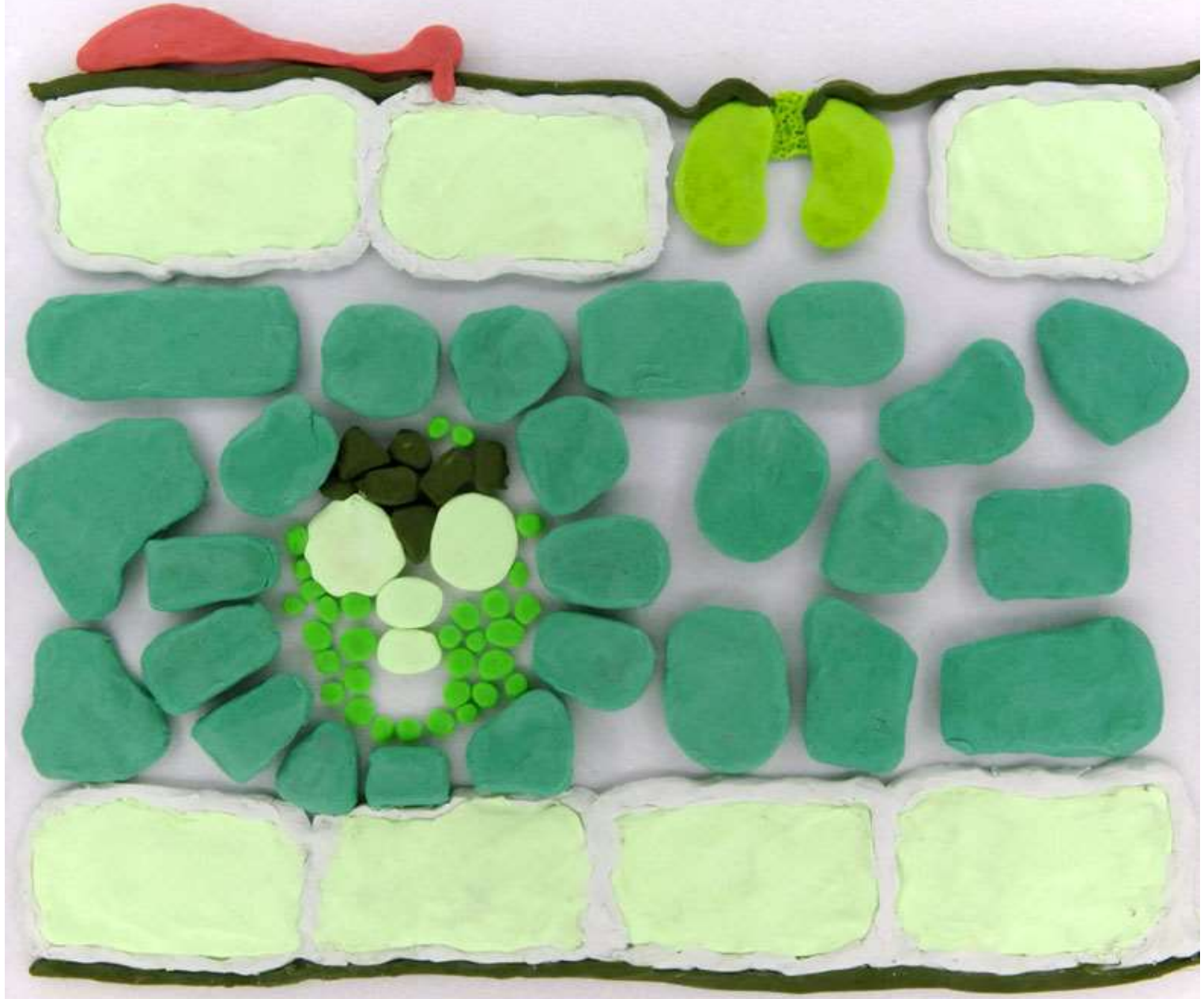




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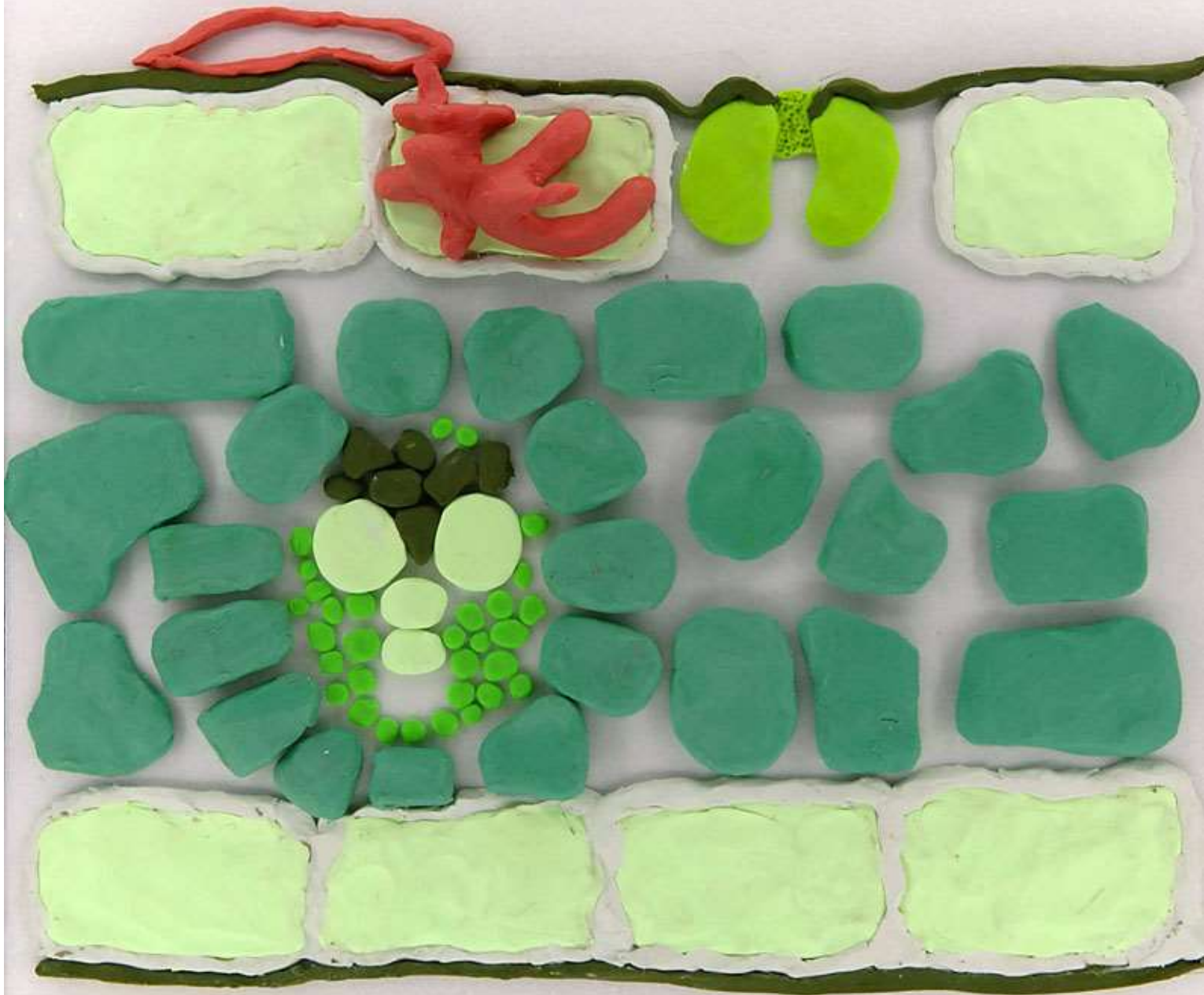




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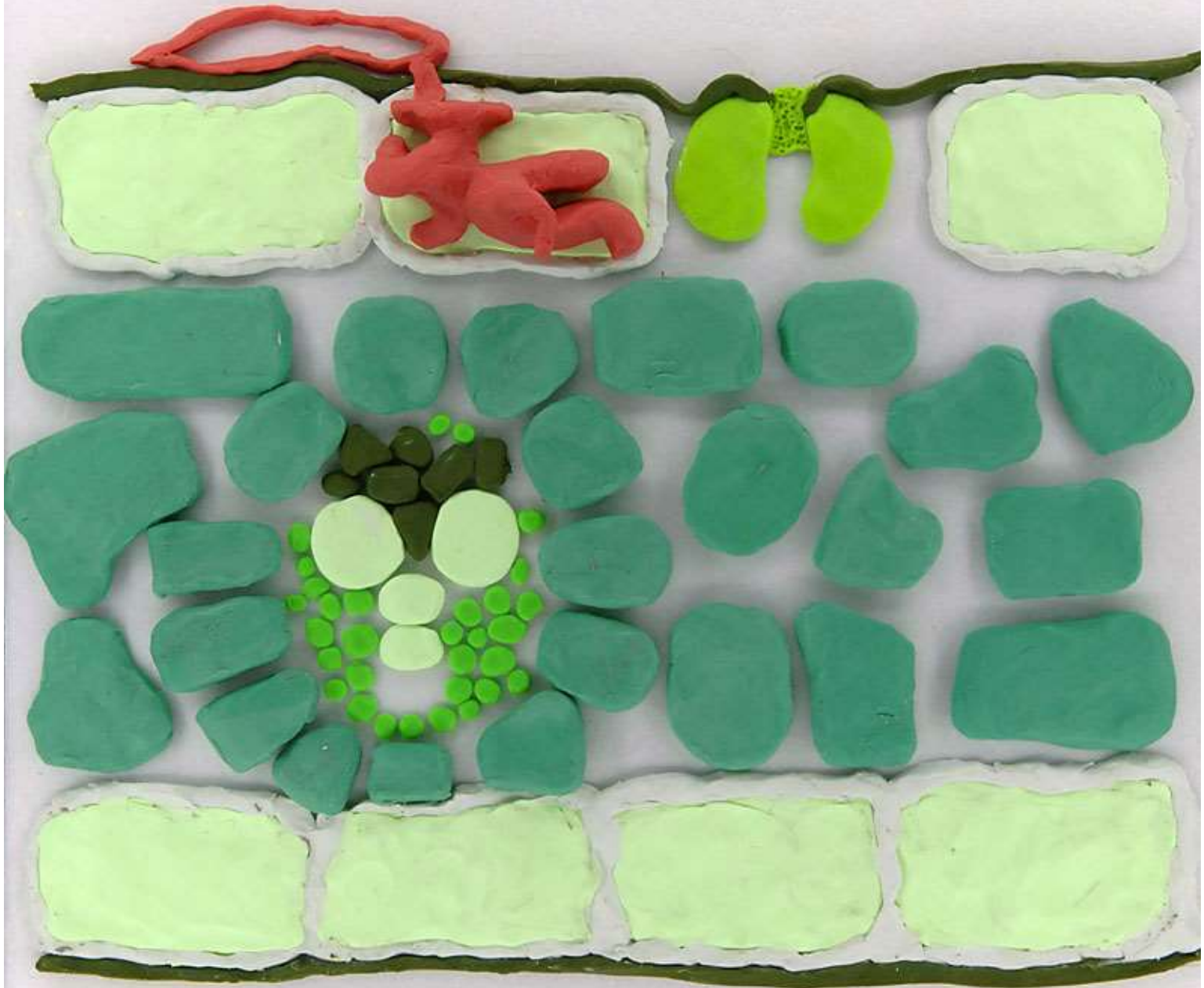




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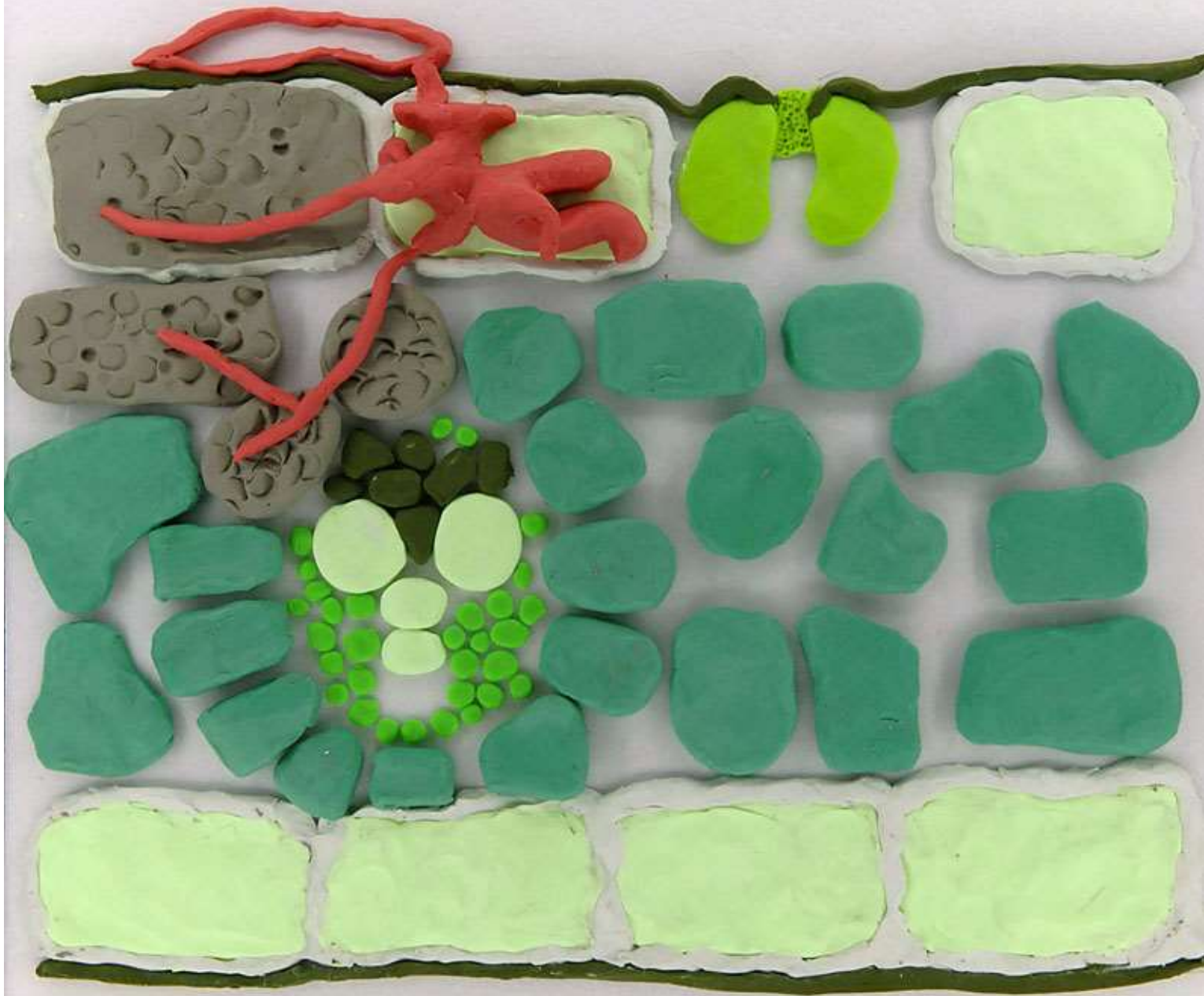






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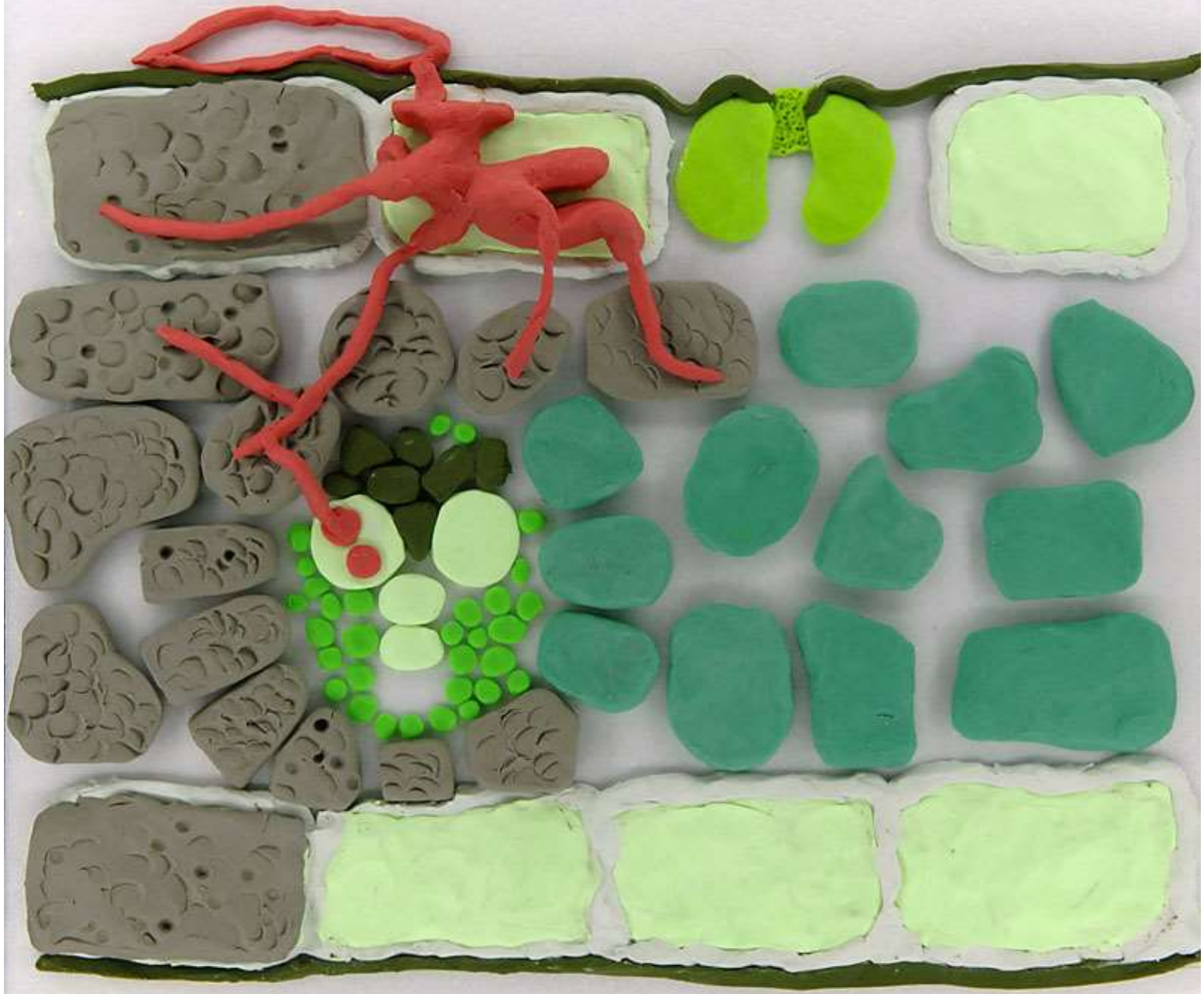




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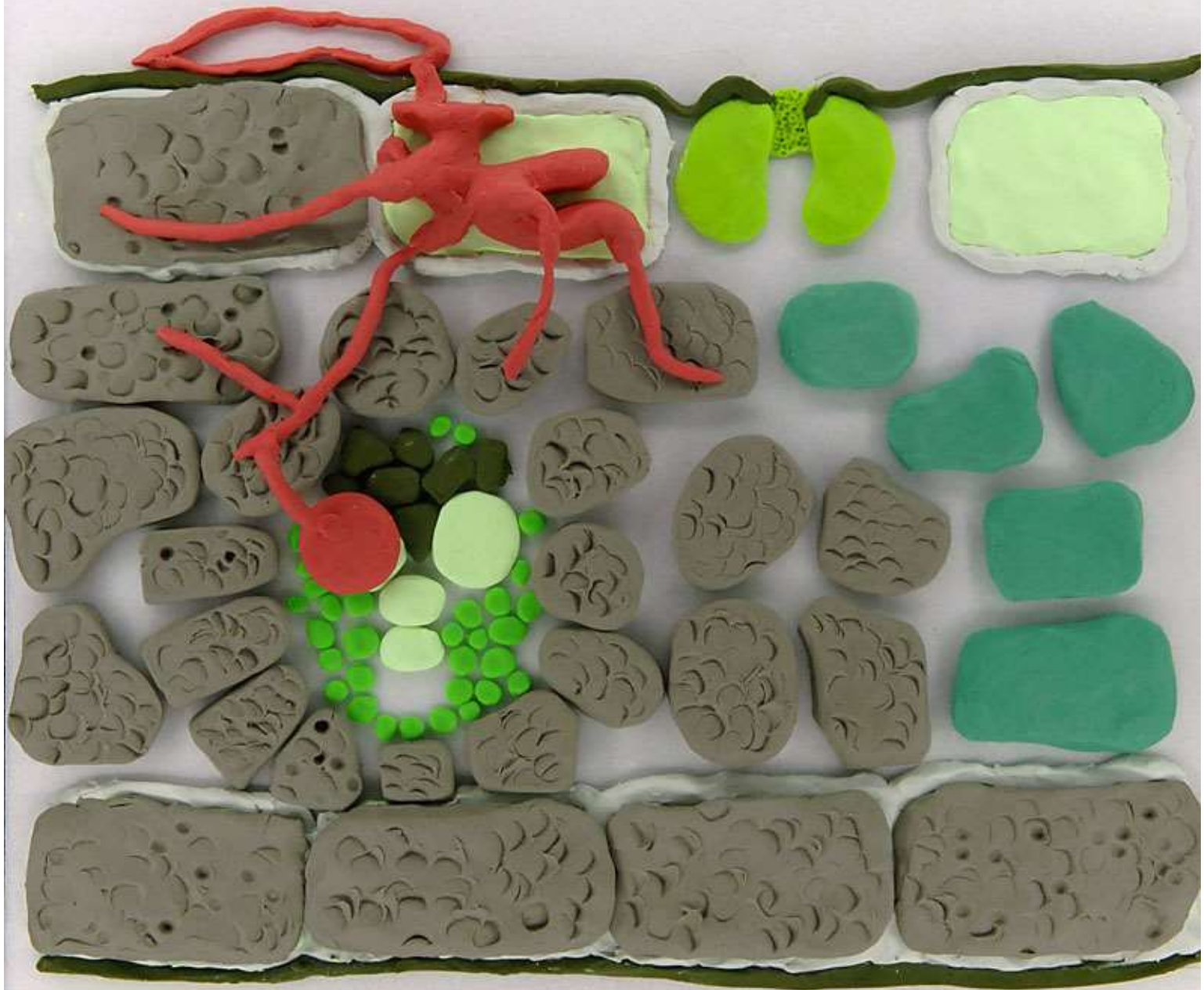






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# Races of *Exserohilum turcicum*, the northern leaf blight fungus

Occurs in:	Fungal Race:	Resistance gene in hybrid:			
		<i>Ht 1</i>	<i>Ht 2</i>	<i>Ht 3</i>	<i>Ht N</i>
Predominant in US / NYS	0	R	R	R	R
Increasing in US / NYS	1	<b>S</b>	R	R	R
?	2	R	S	R	R
?	1,2	<b>S</b>	<b>S</b>	R	R
?	2,3	R	<b>S</b>	<b>S</b>	R
Mexico	2,3,N	R	<b>S</b>	<b>S</b>	<b>S</b>

- *Ht1* still being used by many seed companies; some stacking *Ht1* and *HtN*
- Some also selecting for general resistance / tolerance (additive, minor genes)



# Genetic diversity of corn for susceptibility to northern leaf blight



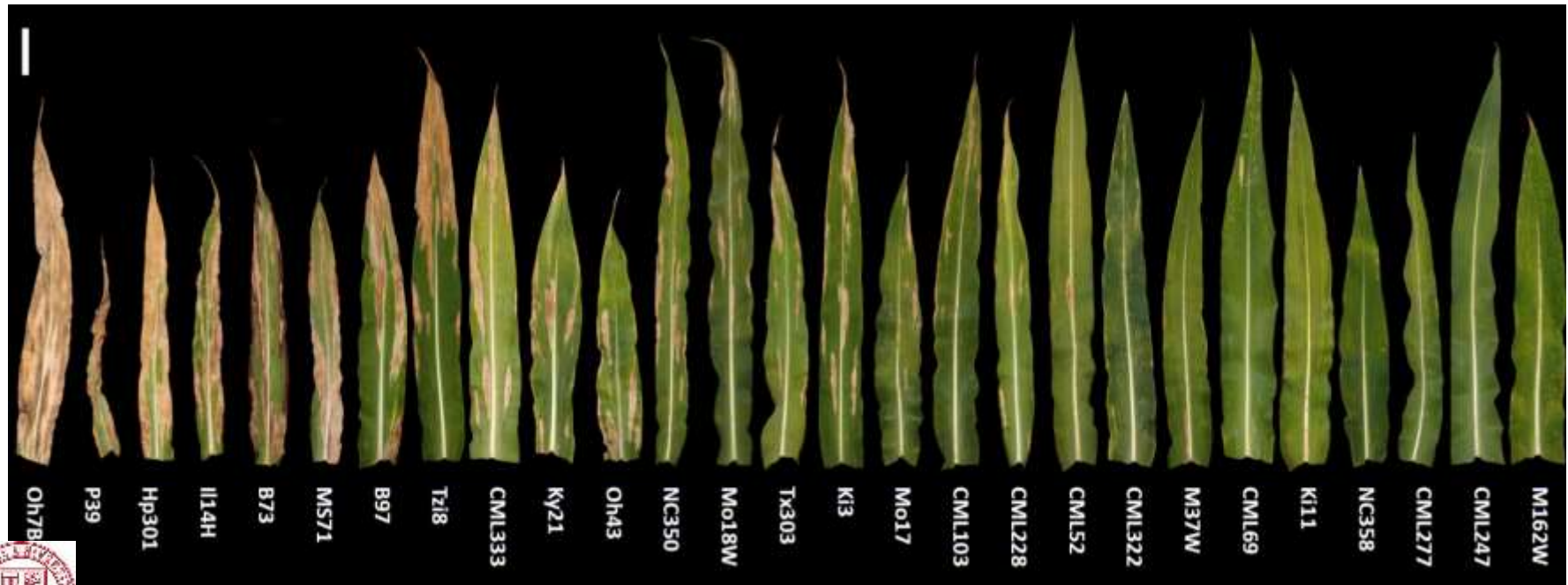
Susc.



R gene Resist.



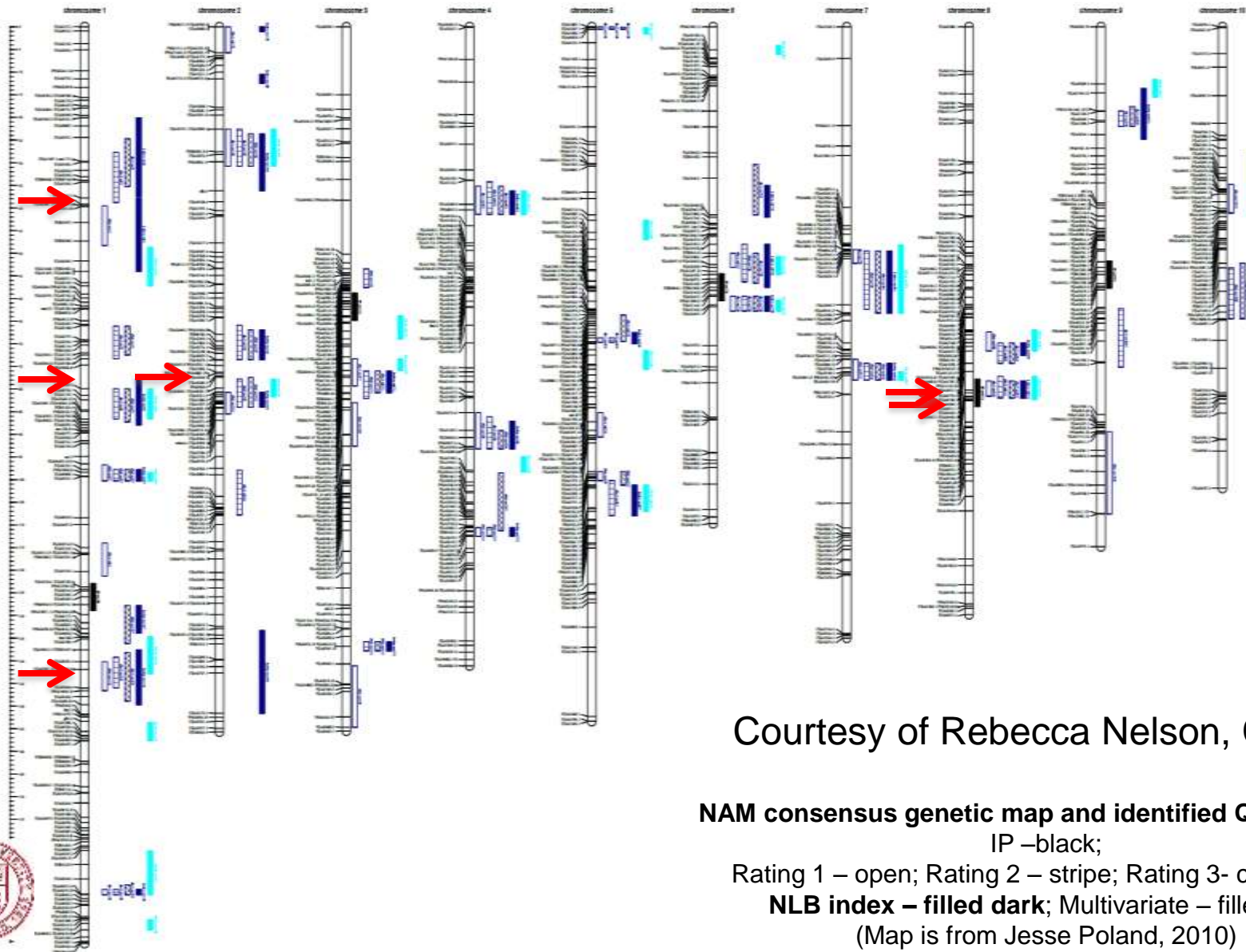
Continuous distribution of quantitative resistance



Courtesy of Rebecca Nelson, Cornell University



# Linkage Map of Corn Chromosomes Showing Loci for Quantitative Resistance to Northern Leaf Blight



Courtesy of Rebecca Nelson, Cornell

**NAM consensus genetic map and identified QTL for NLB.**  
IP –black;  
Rating 1 – open; Rating 2 – stripe; Rating 3- checkered;  
**NLB index – filled dark**; Multivariate – filled light  
(Map is from Jesse Poland, 2010)



# Hybrid resistance to specific pathogens as described by seed companies

'1 Best' Scale	Relative descriptions	'9 Best' Scale
1	Highly resistant	9
2		8
3	Resistant	7
4		6
5	Moderately resistant	5
6		4
7	Susceptible	3
8		2
9	Highly susceptible	1





# Hybrid resistance to northern leaf blight

Moderately Resistant

Susceptible



Photo courtesy of Chris Daum

Leaf blights during grain fill can reduce yield ...



and can predispose to later root/stalk rots





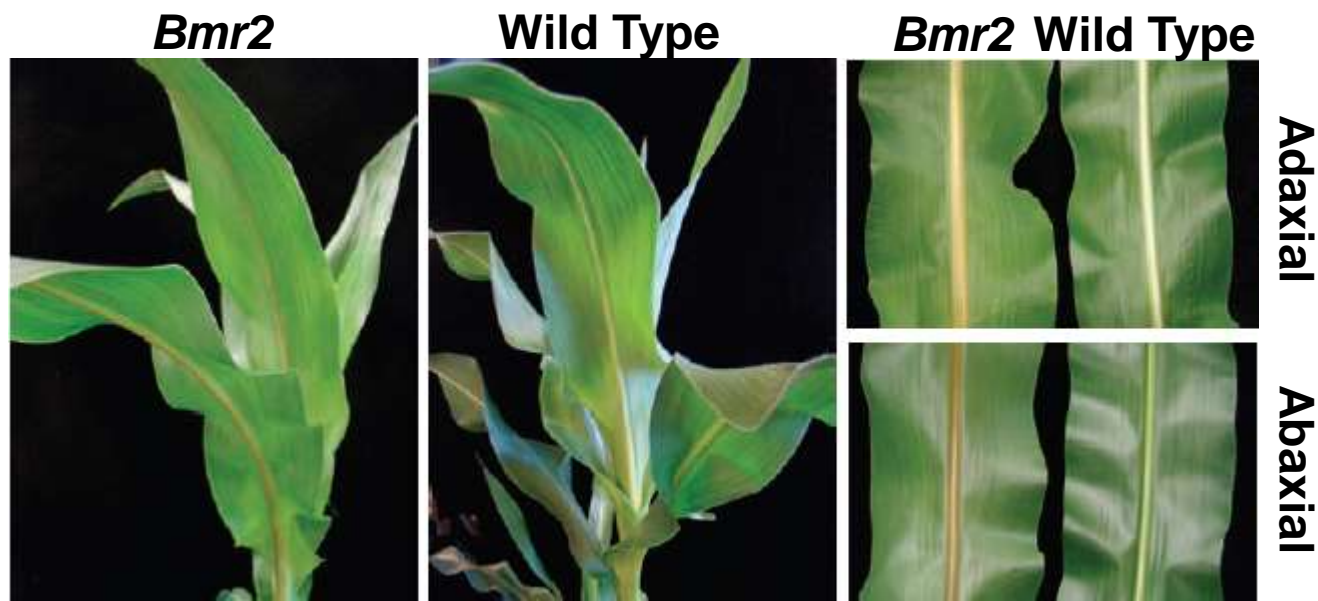
# Severe Northern Leaf Blight and Lodging In BMR Corn (Cayuga Co., 2013)



© Judy Kolkman

# Many Brown Midrib Hybrids are Highly Susceptible

- Reduced lignin content and altered lignin composition
  - Increased digestibility...
  - Forage crop → easier for cows to digest
- **Very susceptible – also easier for fungi to digest?**

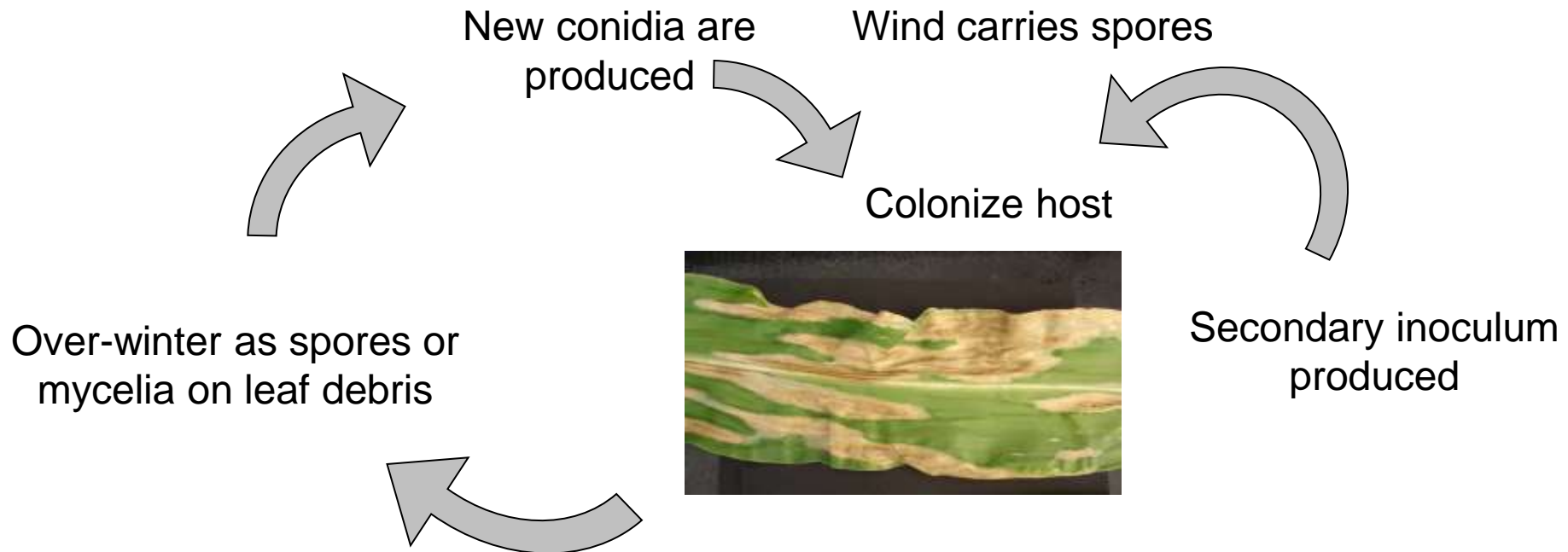


- Tang, H. M. (2011). The brown midrib 2 ( *bm2* ) gene of maize encodes methylenetetrahydrofolate reductase, 2.





# Disease Cycle of Northern Leaf Blight



# Spores can be splashed from within-field corn debris or arrive on winds from long-distances



© G. G. Bergstrom



Gray leaf spot continues in endemic locations and is gradually making inroads in new locations



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# Gray Leaf Spot Lesions on Corn Leaves



A slow-developing necrotrophic parasite of corn







*Claymation by Ellie Walsh and Kent Loeffler, Cornell University*



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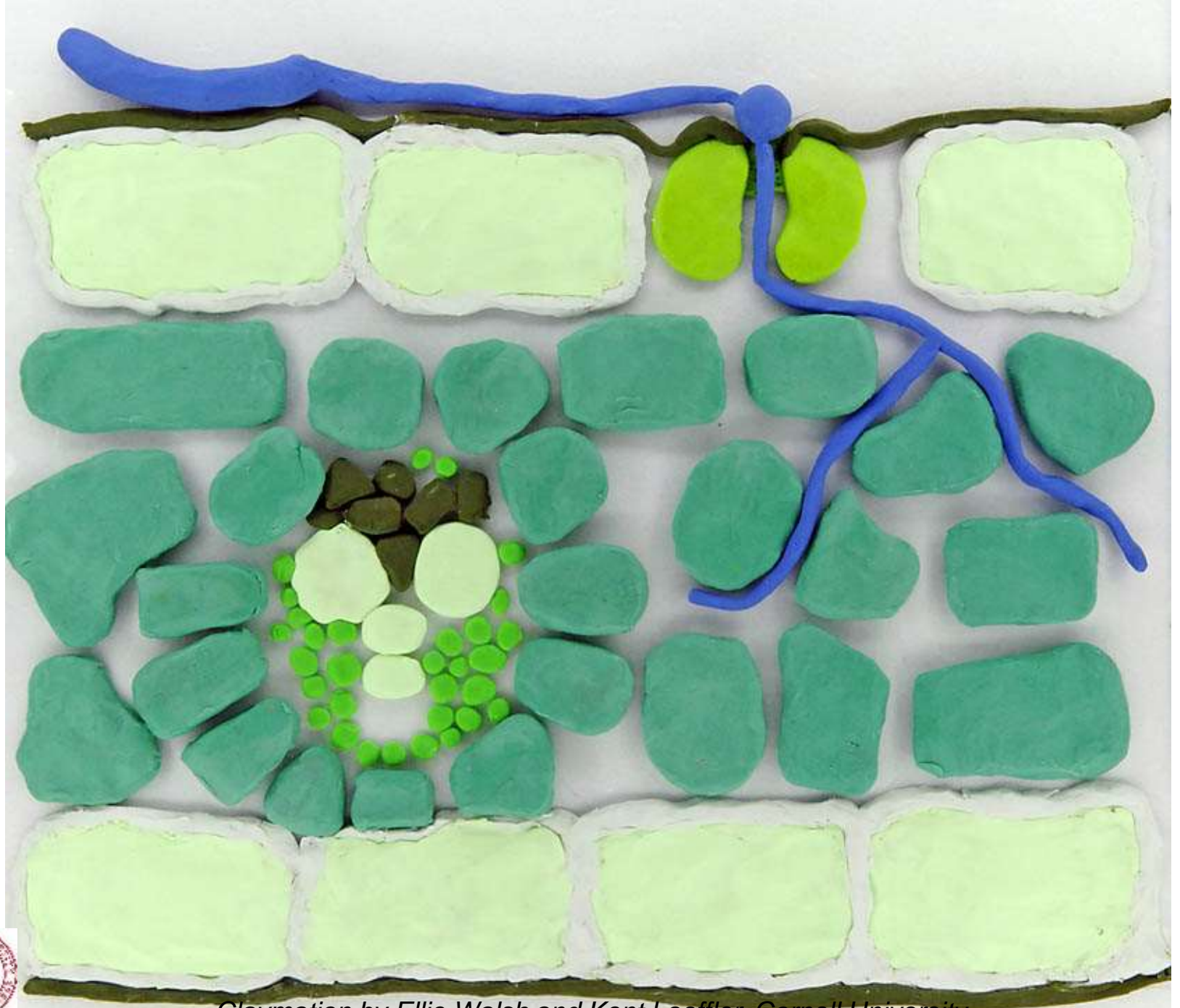


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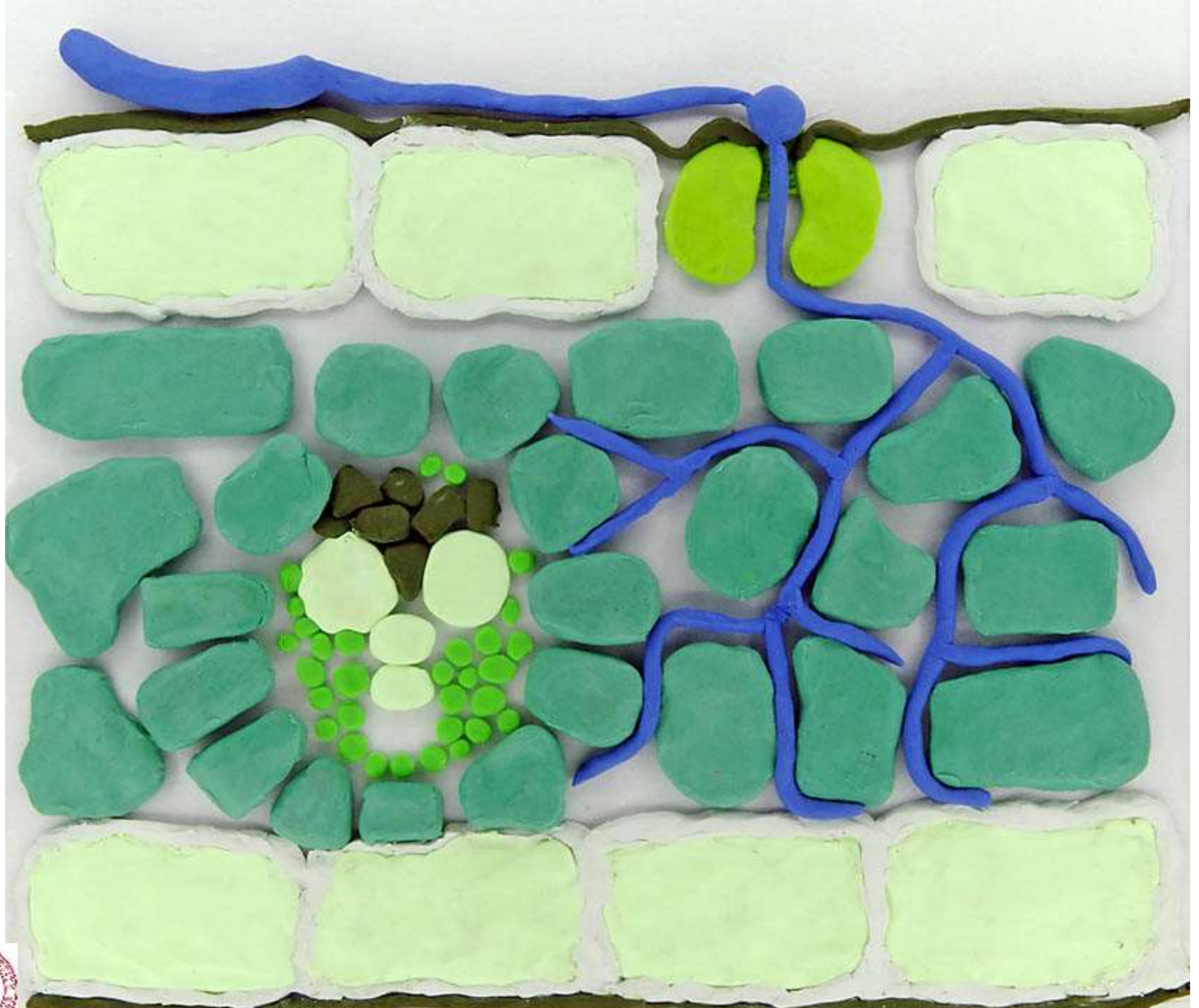


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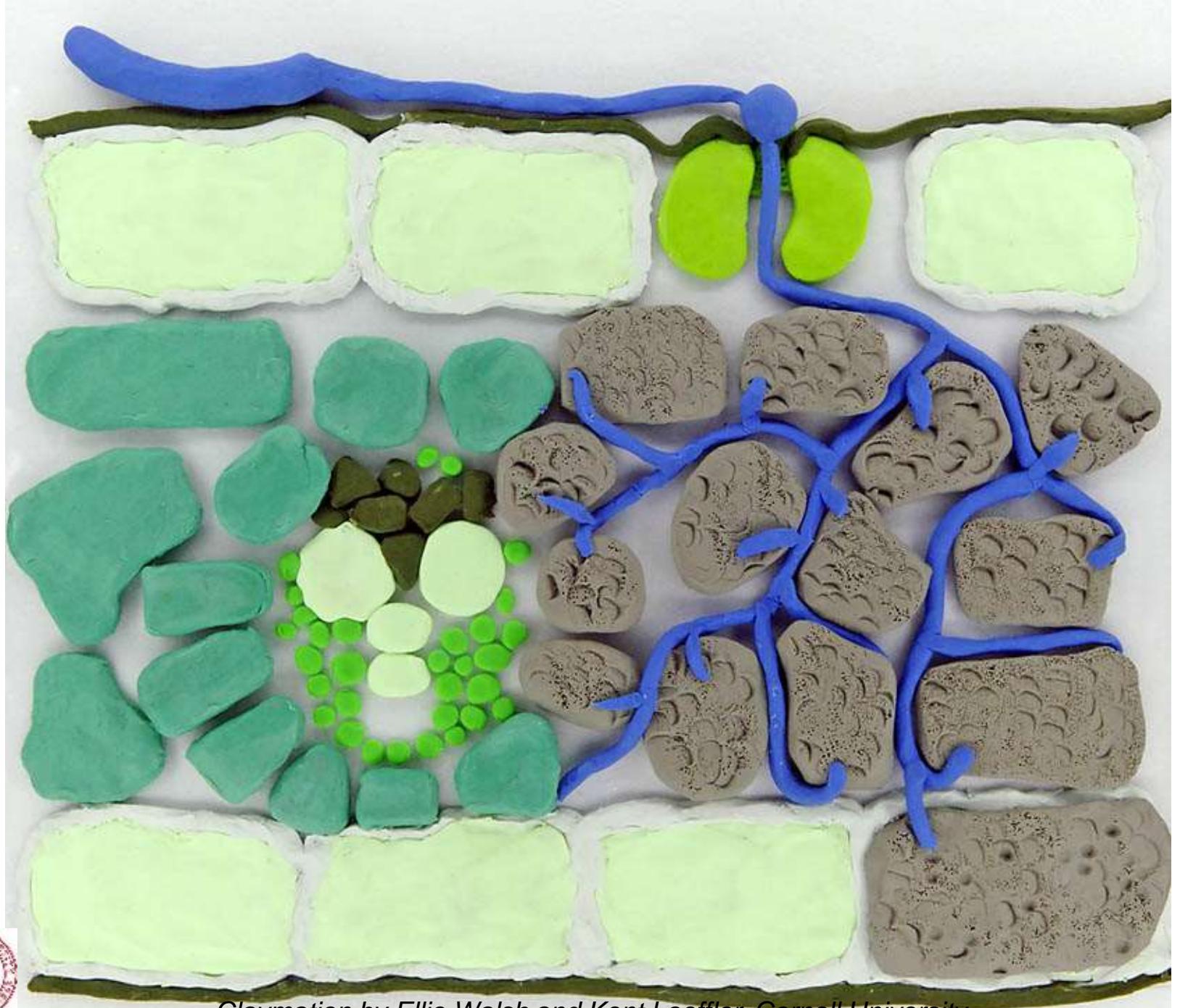
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# High Risk Environments for Gray Leaf Spot



- Past history of GLS
- Continuous corn
- Corn stubble in field (reduced tillage)
- Valley microenvironment
  - Susceptible hybrid
  - Disease develops early
- Progress to mid canopy by tassel/silk



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# Hybrid resistance to gray leaf spot

Six on the Pioneer 9-1 scale  
'moderately resistant'

Four on the Pioneer 9-1 scale  
'moderately susceptible'

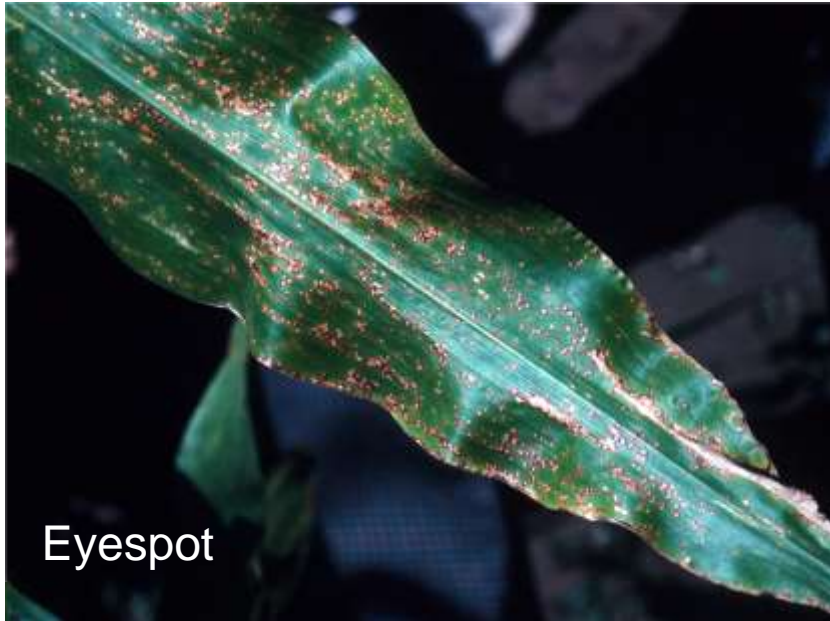
A 30-40 bu/A  
yield differential in a  
moderately severe  
GLS environment



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# Other fungal leaf blights in New York



Eyespot



Anthrachnose

© G.C. Bergstrom



Common rust

© G.C. Bergstrom



Northern leaf spot

© Alex Wright





# Goss's bacterial leaf blight

Necrotic lesions with water-soaked appearance



Courtesy of Dr. Kiersten Wise

# Goss's bacterial leaf blight

Dark 'freckling' in leaves is diagnostic of disease

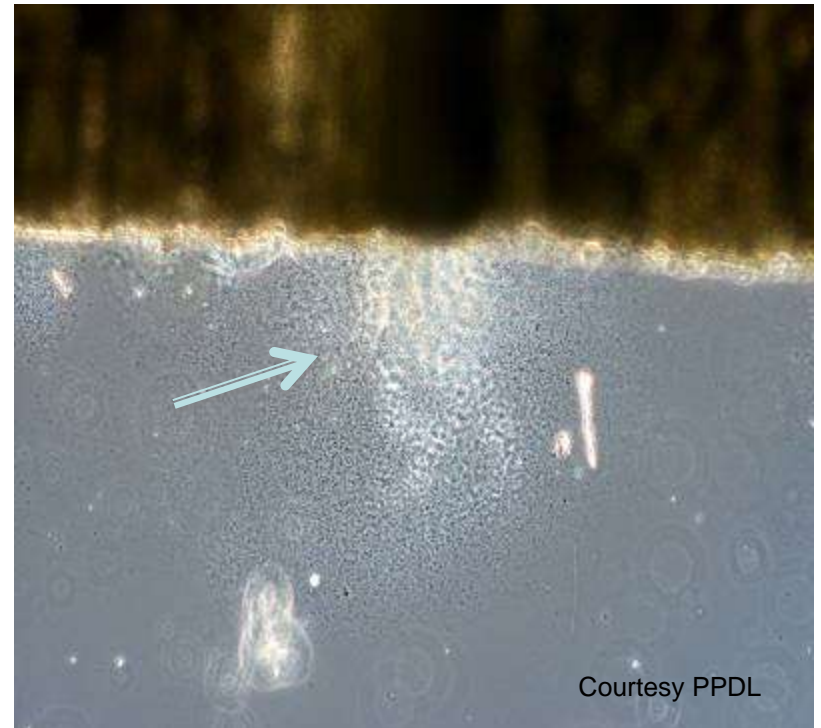


Courtesy of Dr. Kiersten Wise



# Diagnosis of Goss's wilt

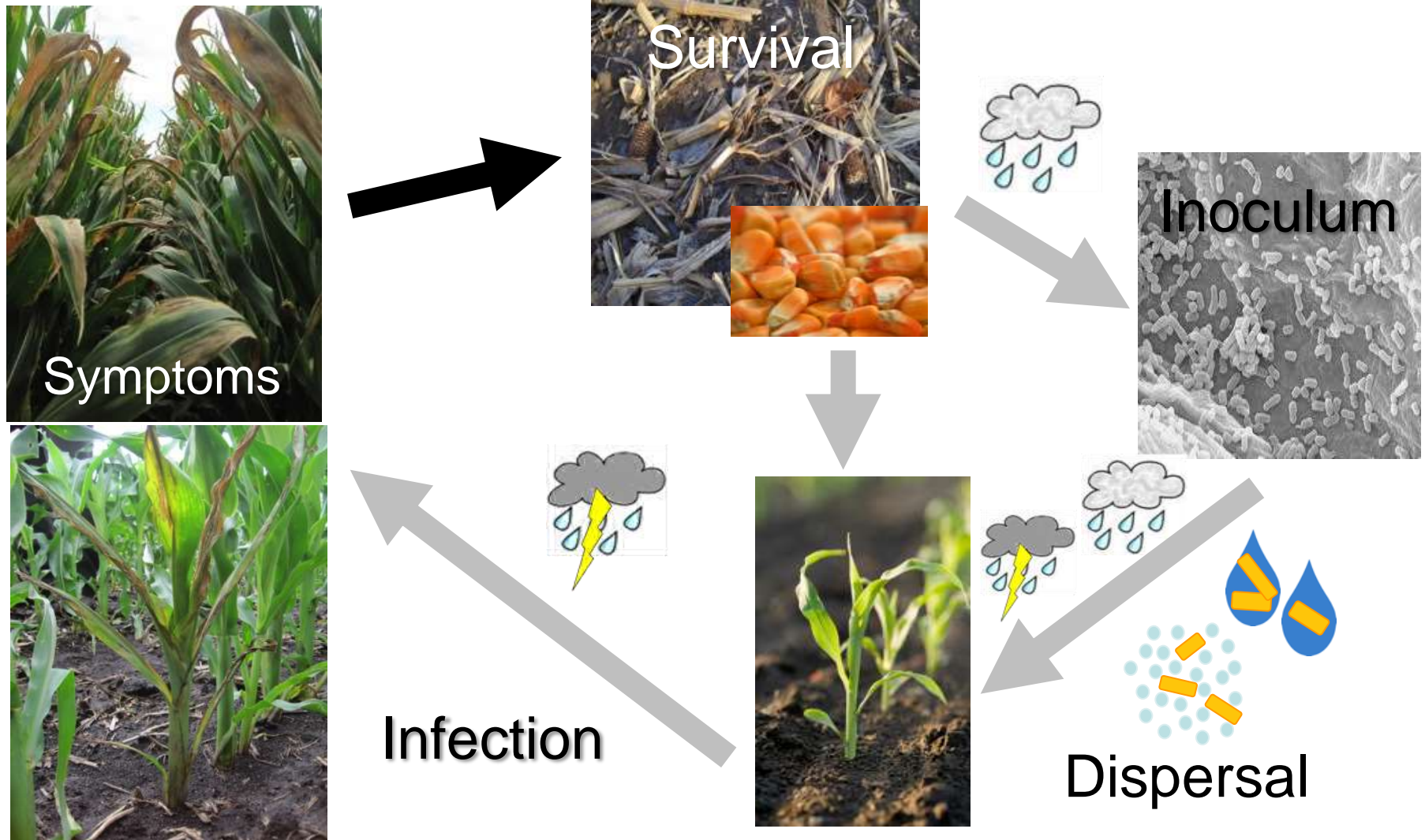
- Microscopic observation
- Bacterial streaming
- Only can confirm that it is a bacterial disease
  - Could be Stewart's wilt
- Immunostrip (Agdia) test for *Clavibacter* species



100x Magnification



# Goss's wilt and leaf blight disease cycle





# Seed transmission at Ames, Iowa 2013

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Alison Robertson, Charlie Block, Lisa Shepherd,  
Jeff Sernett, and Gladys Mbofung

# Low probability of seed transmission

Total plants/acre = 30,000

Transmission rate = 0.00005

% Seed infection	Potential no. infected plants/acre	1 plant per X acres
1.0	0.15	6.67
1.5	0.23	4.44
7.5	1.13	0.89
27.0	4.05	0.25



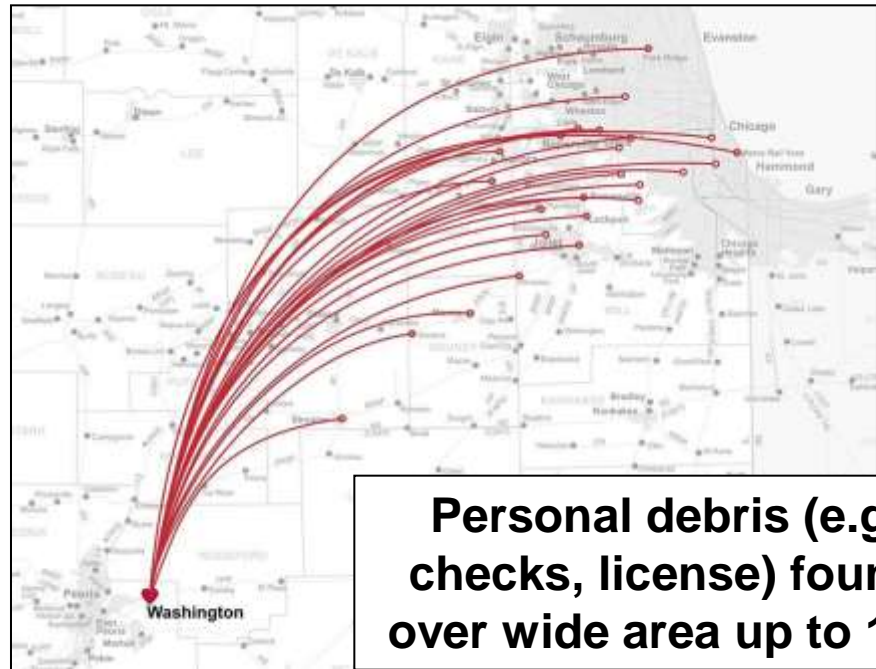
Alison Robertson, Charlie Block, Lisa Shepherd,  
Jeff Sernett, and Gladys Mbofung



# Distance movement by windborne corn debris



Courtesy of J. Pataky, Monsanto



# Management of Goss's wilt

- Genetic resistance!
- Crop rotation
- Tillage
- Control weed hosts





# What is the latest on foliar fungicides in corn?

Management of  
fungal foliar diseases



Non-disease  
'plant health' effects





# 2013 Regional Corn Fungicide Summary Corn Disease Working Group

Members of CDWG  
Summarized by Kiersten Wise



# 2013 data

State/Province	Submitter	# of comparisons	Application timings
Arkansas	Travis Faske	14	R1
Illinois	Carl Bradley	72	VT/R1
Indiana	Kiersten Wise	45	V5, VT/R1, V5 + VT
Kansas	Doug Jardine	34	V5 through VT + 14
Kentucky	Paul Vincelli	12	V6 through VT
Louisiana	Clayton Hollier	7	VT
Michigan	Martin Chilvers	18	V5, VT/R1, V5 + VT
Nebraska	Tamra Jackson-Ziems	8	VT/R1
North Dakota	Mike Ostlie	54	In-furrow to VT
Ohio	Pierce Paul	39	V4/V5 through R1, V6 + VT
Ontario	Albert Tenuta	62	V5/V6, R1, V5 + VT
Tennessee	Heather Young-Kelly	54	V6, through VT/R1, V6 + VT
Wisconsin	Damon Smith	23	V6, V8, VT/R1
Total		442	

# Break-even scenarios for corn

Corn price (\$/bu)	Application cost (\$/A)						
	\$12	\$16	\$20	\$24	\$28	\$32	\$36
\$3.00	4.0	5.3	6.7	8.0	9.3	10.7	12.0
\$4.00	3.0	4.0	5.0	6.0	7.0	8.0	9.0
\$5.00	2.4	3.2	4.0	4.8	5.6	6.4	7.2
\$6.00	2.0	2.7	3.3	4.0	4.7	5.3	6.0
\$7.00	1.8	2.3	2.9	3.4	4.0	4.6	5.1
\$8.00	1.5	2.0	2.5	3.0	3.5	4.0	4.5
\$9.00	1.3	1.8	2.2	2.7	3.1	3.6	4.0
\$10.00	1.2	1.6	2.0	2.4	2.8	3.2	3.6



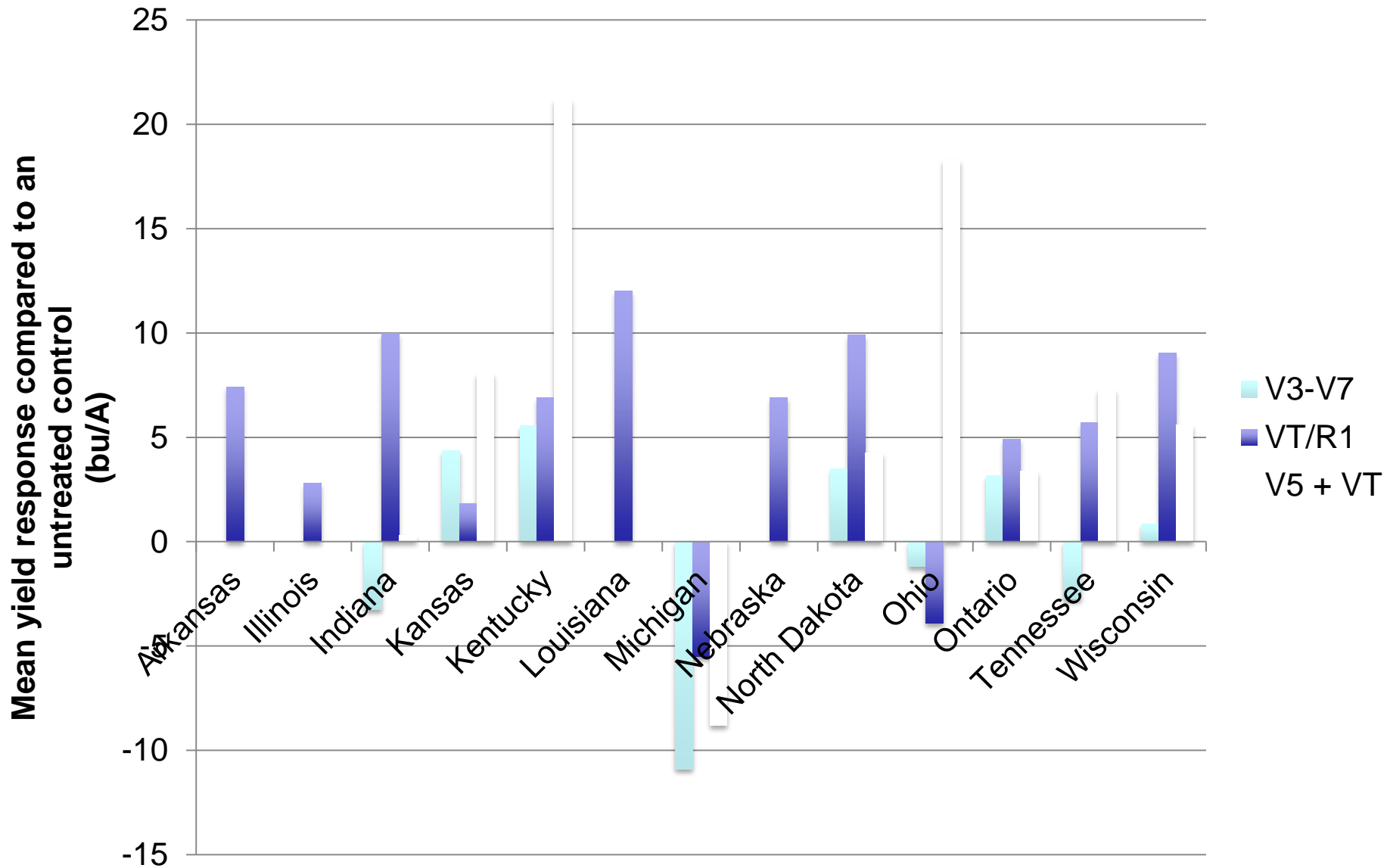
# 2013 Regional Corn Fungicide Summary

## Data from 12 states and Ontario, Canada

Timing of application	# of fungicides tested	# of observations	Mean yield response compared to non-treated control (bu/A)*
V3-V7	17	97	0.1
VT/R1	14	286	4.5
V5 + VT/R1	11	42	3.7

\*Mean calculated over all fungicides compared in individual state trials

# Effect of fungicide applications on yield by location 2013





# What about influence of final disease levels?

- Compared VT/R1 observations of states that submitted rating data
  - Across all fungicides
- Less than 5% disease rated on non-treated control:  
**+4.28 bu/A**
- More than 5% disease rated on non-treated control:  
**+6.15 bu/A**



# Impact of Foliar Fungicides on Corn (U.S. Data)\*

<b>Disease severity of untreated (%)</b>	<b>Mean yield response (bu/A)</b>	<b>Total treatments</b>
< 5	1.5	347
> 5	9.6	266

\*Wise, K. and Mueller, D. 2011. Are Fungicides No Longer Just For Fungi? An Analysis of Foliar Fungicide Use in Corn. APSnet Features. doi:10.1094/APSnetFeature-2011-0531

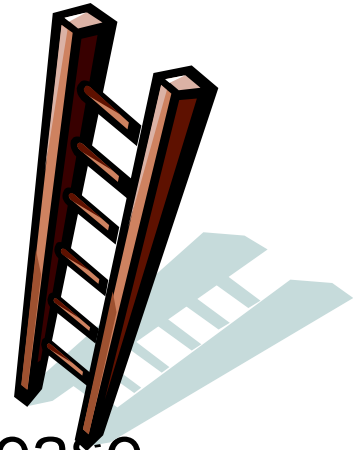


# Mean yield response compared to non-treated control in bu/A over time

	<b>2010</b> <b>N = 160</b>	<b>2011</b> <b>N = 57</b>	<b>2012</b> <b>N = 343</b>	<b>2013</b> <b>N = 425</b>
V5	3.4	2.1	-1.1	0.1
VT-R2	4.5	0.4	4.9	4.4
V5 + VT/R1	7.4	4.5	3.0	3.7

# When does an application pay?

- Fungicides are most profitable in corn when a combination of factors are present:
  - Hybrids susceptible to foliar disease
  - Continuous corn
  - No-till or reduced tillage systems
  - Late-planted corn
  - Irrigation
  - Weather conditions are favorable for disease development
  - **Disease develops**





# Replicated fungicide strip plots



At least 3 replicates of paired strip plots



Disease assessment at R1 & R5



# Information on corn foliar diseases and foliar fungicides














[www.fieldcrops.org](http://www.fieldcrops.org)





# Relative efficacy of foliar fungicides against diseases

Based on observations of U.S. Corn Disease Working Group of University pathologists

	Northern Lf Blight	Gray Lf Spot	Anthr. Lf Blight	Eyespot	Common Rust	Aerial app in NYS	Days to Harvest
	G	E	VG	VG-E	E	Yes	7
 	VG	E	?	E	E	Yes*	7
  	G	G	NL	E	VG	Yes	30
	VG	?	?	?	?	Yes	14
	VG	E	VG	E	VG-E	Yes	30
	VG	E	VG	VG-E	VG-E	Yes	30
	VG	E	?	E	E	Yes*	20
	VG	E	VG	E	E	No	30

G = good    VG = very good    E = excellent    NL = not labeled    ? = limited data



\* Except within 100 feet of aquatic habitats

# Integrated Management of Fungal Leaf Blights:

**Disease Identification** (essential); **Rotation** (whenever possible);  
**Resistant Hybrids** (disease-specific); **Foliar Fungicides** (when  
there is disease risk); **Tillage** (if necessary)



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# Questions and Discussion



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