

A large, leafy oak tree stands in a grassy field under a clear sky. The tree is the central focus, with its dense canopy filling much of the frame. The ground is a flat, green lawn. The sky is a pale, clear blue.

Oak Leaf Tatters - A Chemical Connection?

A Pilot Study in Spring, 2006

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What is Oak Tatters?



- Abnormal curling of newly emerging leaves
- Occurs only in the Spring
- Has been reported in MN, WI, IL, IN, IA
- Mostly seen on white and bur oaks, but can occur on red oak and hackberry



5/2/06



5/9/06



5/16/06

What happens after Tatters



- White oaks will use stored starch reserves to create a new flush of normal looking leaves.
- Concern is how much reserves do our mature oaks have left??

Tatters does not affect all trees



- Trees within the same species break dormancy at different times
- This explains why neighboring trees can be normal next to tattered trees.
- Occurs on any aged tree; has been reported on urban and rural trees

Eliminating Possible Causes



- We have used on site temperature sensors to rule out frost damage
- No insects or diseases have been found on the leaves
- Wind can tatter leaves, but usually affects mature leaves

University of Illinois Study

- Looked at white oak in 2004
- The objective was to determine if herbicide drift could cause tatters
- Treated trees at three stages with a variety of chemicals
- Swollen bud, leaves unfolding, and leaves expanded
- This study indicated a possible link between tatters and chloroacetamide herbicides when leaves are unfolding

The graphic features the text 'Iowa Facts' in a colorful, multi-colored font. Below it, the population '2.9 M' and four production rankings are listed. The background is a faded image of a large tree in a field, with a black outline of the state of Iowa overlaid on it.

Iowa Facts

Population: 2.9 M

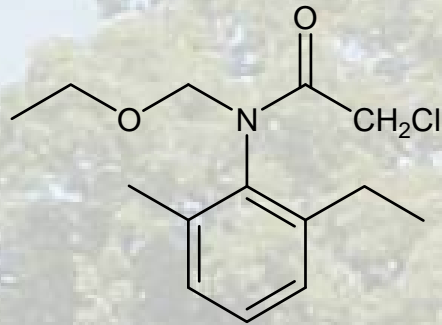
#1 in U.S. Corn Production

#1 in U.S. Soybean Production

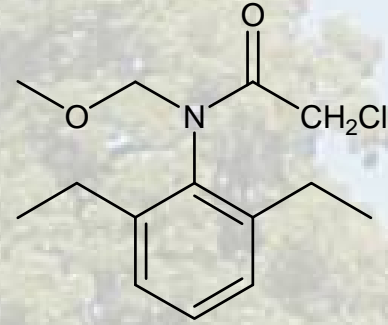
#1 in U.S. Hog Production

#1 in U.S. Egg Production

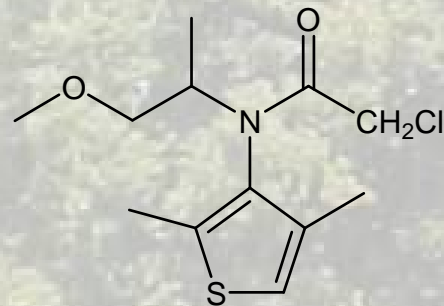
Chloroacetanilide/Chloroacetamide Herbicides



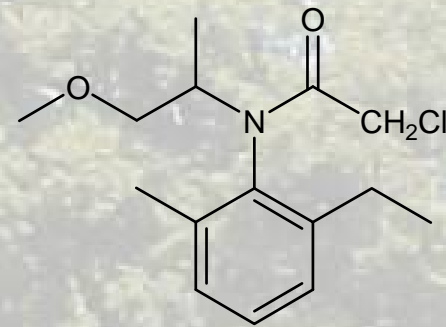
Acetochlor



Alachlor



Dimethenamid



Metolachlor

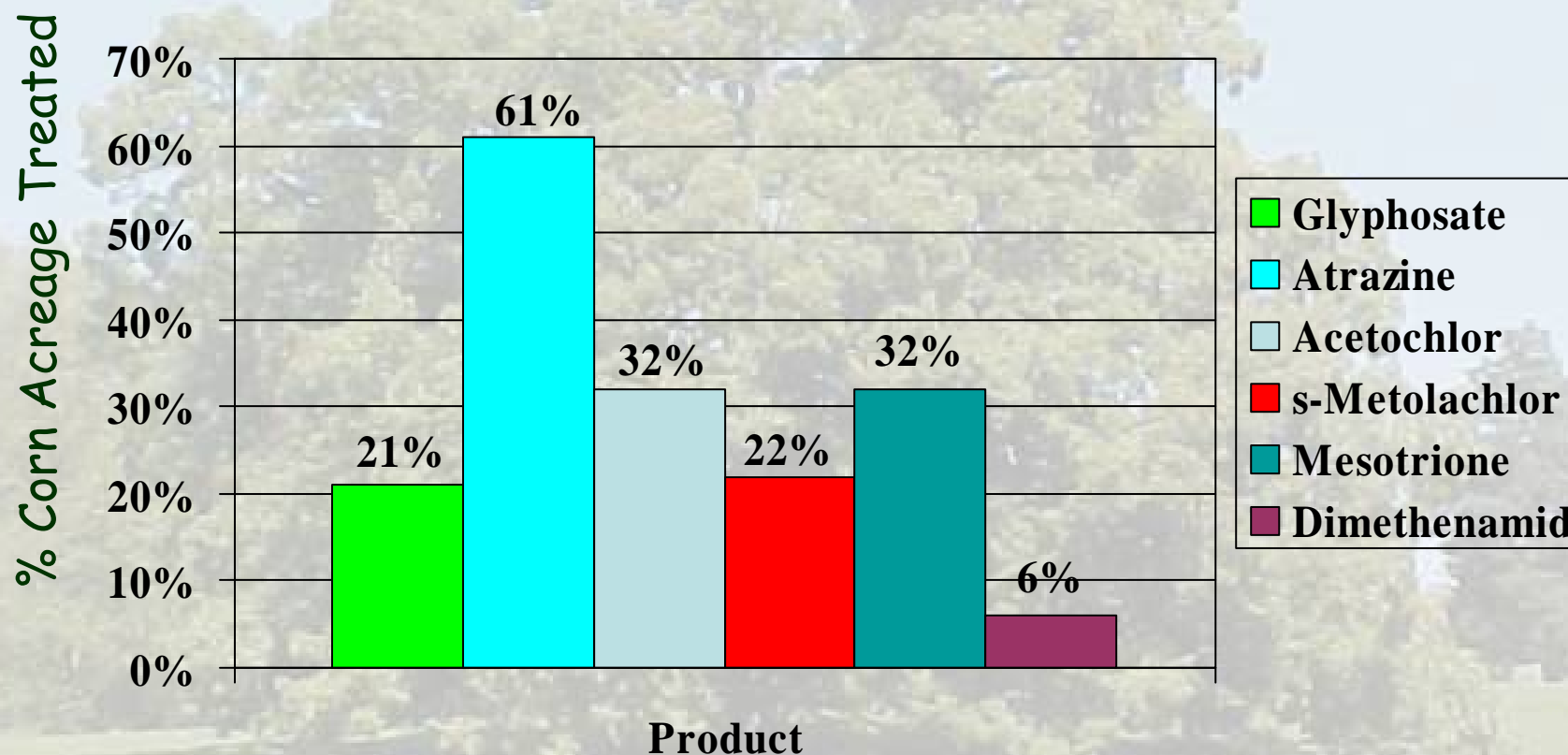
Acetochlor

- Chloracetanilide herbicide for control of grass and broadleaf weeds in corn
- Effective weed control at use rates lower than competitor products...thus considered more "environmentally friendly"
- Conditional registration granted by EPA in 1994
- Conditions attached to registration due to environmental concerns

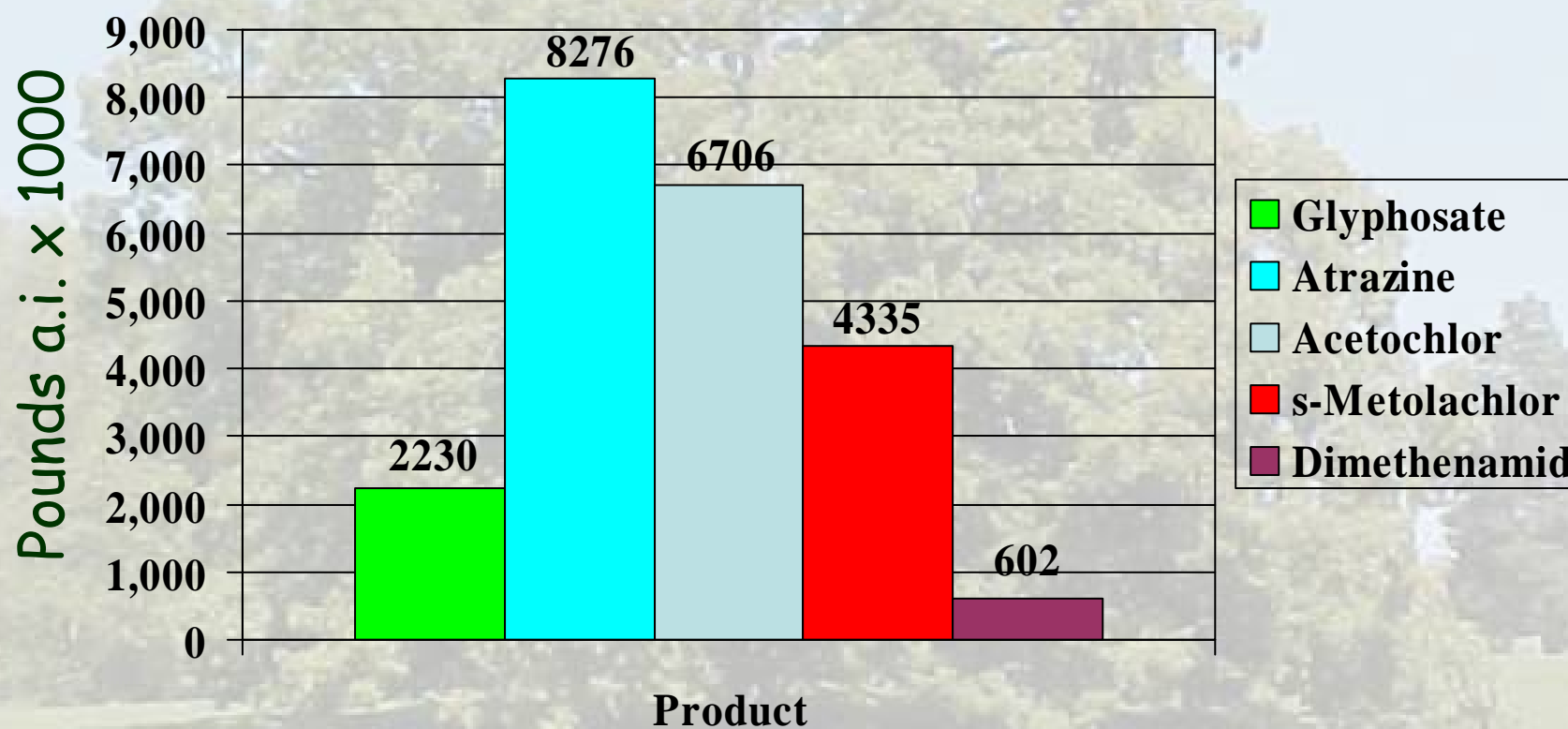
Acetochlor Conditional Registration Agreement

- May not be used on certain coarse soils or when water table is 30 feet or less due to concerns of acetochlor getting into groundwater.
- Extensive water monitoring studies to ensure groundwater not getting contaminated.
- Use of other corn herbicides must decrease by target amounts (alachlor, metolachlor, atrazine, EPTC, butylate, 2,4-D)

2005 Iowa Pesticide Use for Corn

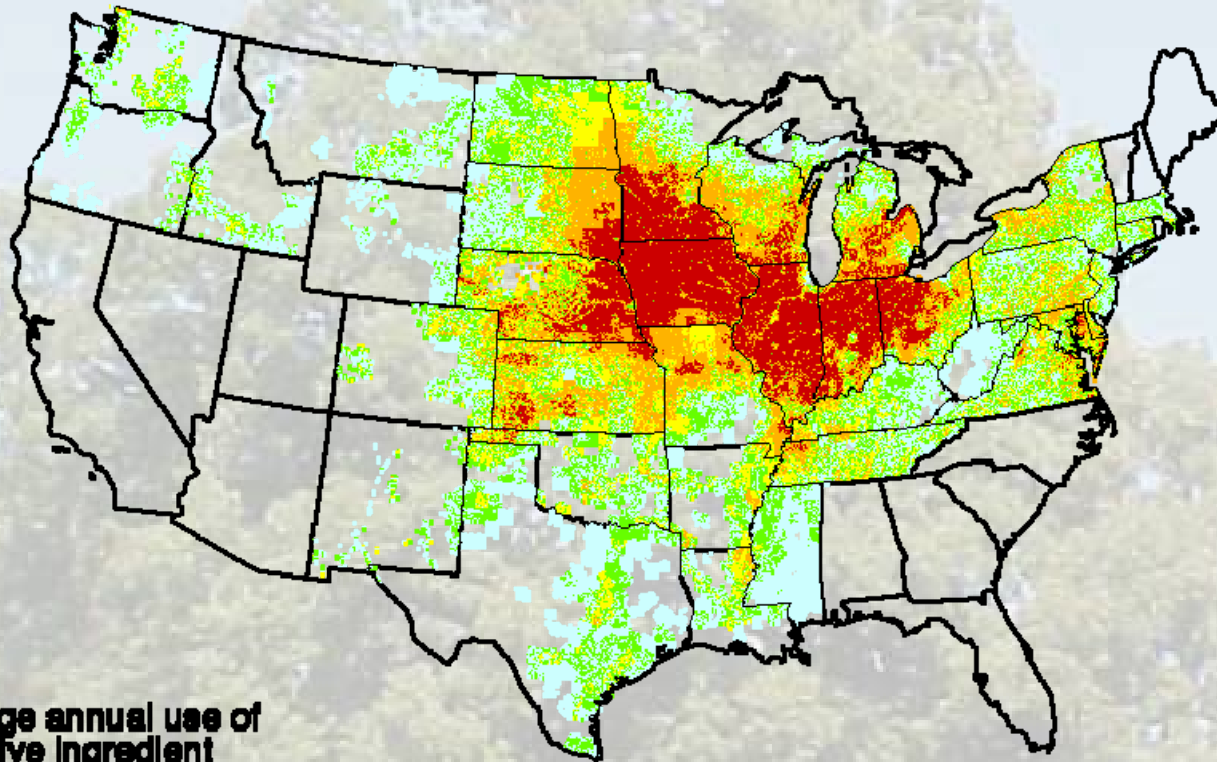


2005 Iowa Pesticide Use for Corn



ACETOCHLOR - herbicide

2002 estimated annual agricultural use

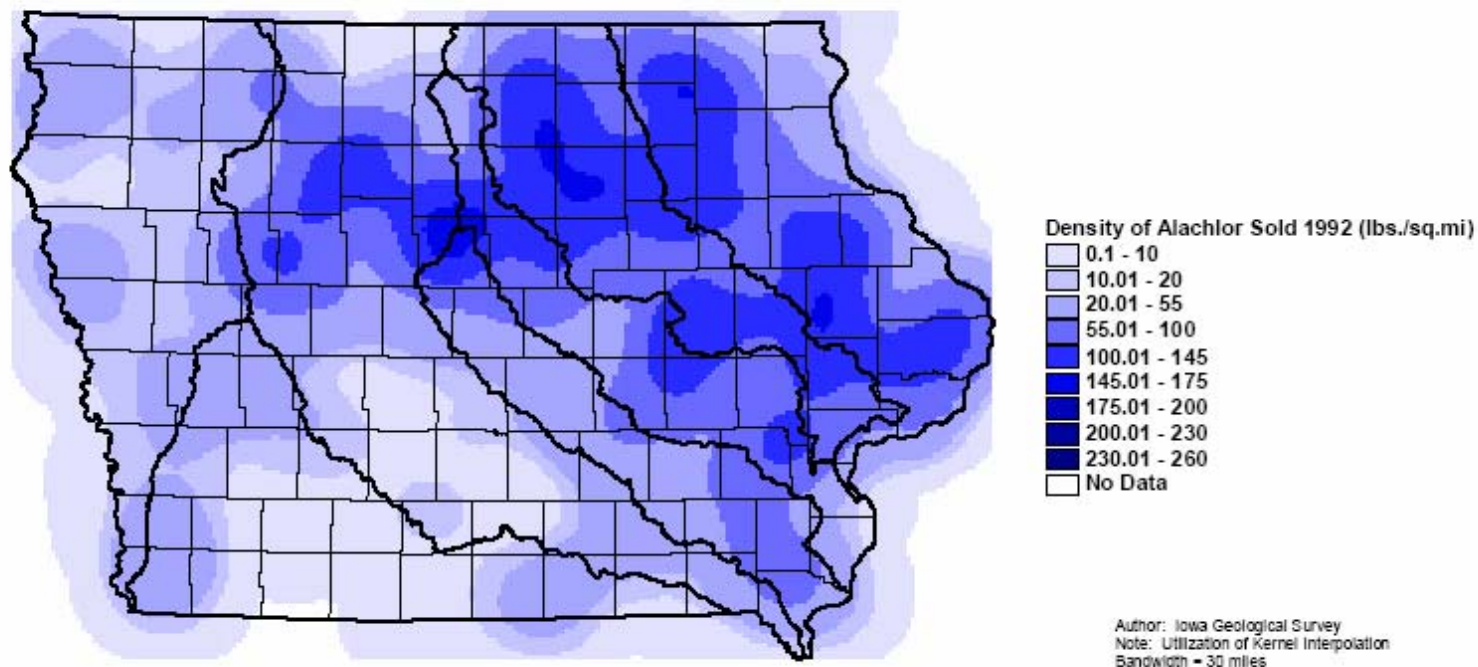


Average annual use of active ingredient (pounds per square mile of agricultural land in county)

- no estimated use
- 0.001 to 0.154
- 0.155 to 0.915
- 0.916 to 4.669
- 4.669 to 21.221
- ≥ 21.222

Crops	Total Pounds Applied	Percent National Use
corn	36140638	100.00

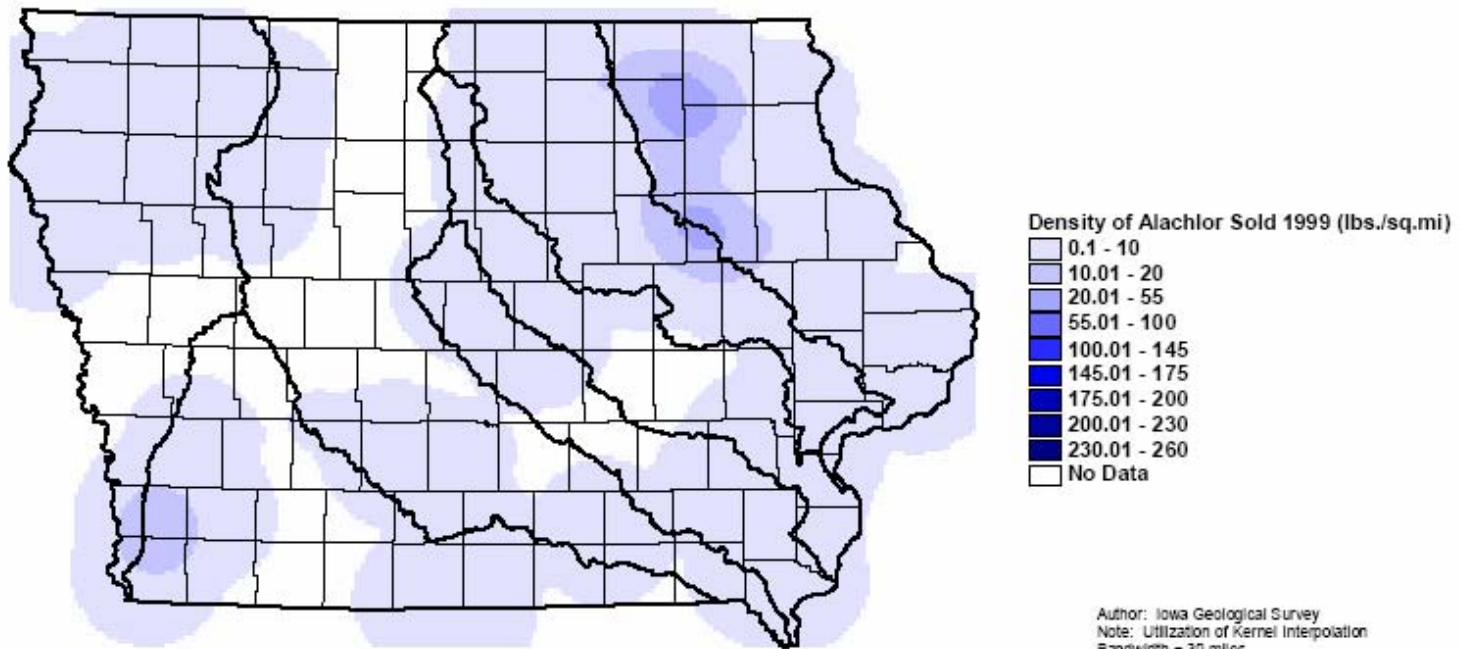
Interpolated Density Surface of Total Alachlor Sales in 1992



100 0 100 200 Miles



Interpolated Density Surface of Total Alachlor Sales in 1999



100 0 100 200 Miles



Routes of Pesticide Exposure

- Spray drift during pesticide application
- Volatilization of chemical after application
- Entrainment of contaminated soil particles
- Rain deposition

Hypothesis:

Oak Tatters is associated with elevated levels of Acetochlor in Leaf Tissue, Rain and/or Air

Based on

- Pesticide in Rain and Air, UHL, 1996-7
- Study done at the University of Illinois
- Onset of condition coinciding with introduction of Acetochlor to the market
- Field observations of proximity to cropping and timing of symptoms

Analytes for Study

- Heavily Used
 - Acetochlor
 - Metolachlor
 - Dimethenamid
- Not Used Extensively
 - Alachlor
 - Butachlor
 - Propachlor

Internal Standard (not sold in US)

- Metazachlor

Design

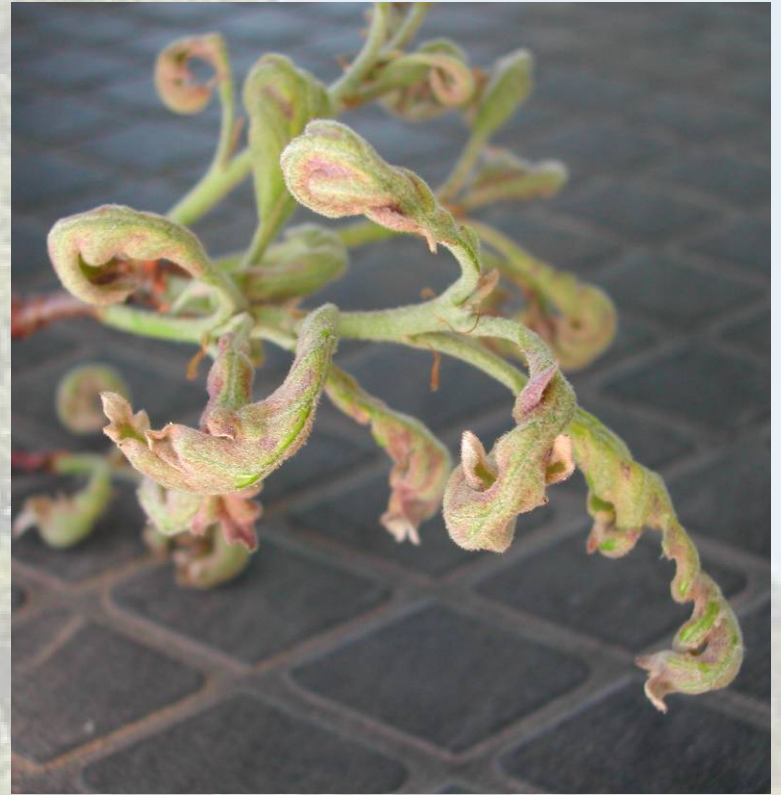
- From April 10 through May 18 in 2006
- Two sites for a variety of proximity to or isolation from cropping
- Collected Leaf, Rain, and Air Samples
 - Leaf - collected by Forestry staff with observations about damage and stage of growth
 - Air - collected on portable personal air samplers
 - Rain - Collected using Teflon funnels into Teflon bottles

Sites

- ICS - "Iowa City Site"
 - Southwest of West Branch, IA
 - Open wooded area surrounded by Fields
- WPH - "White Pine Hollow"
 - White Pine Hollow Forest Preserve
 - Heavily wooded
 - Relatively isolated

Leaf Samples

- Collected by Forestry Personnel
- Noted Damage to Correlate to Analytical Results
- Extracted by routine UHL methods
- Analyzed by LC/MS/MS



Leaf Samples

- Some leaves protected by pollination bags
 - Prevented access by rain and air
 - Prevented damage



Air Samples

- For 24 hours
 - On 1 min., off 2 min.
 - 3 L/min while on
 - 1400 Liters of air
- PUF media
- Extracted at UHL
- Analyzed by LC/MS/MS



Rain Samples

- Collected with Teflon funnel into Teflon Bottle
 - Included wet and dry precipitate
 - Separate rain gauge to measure amount of rain
- No extraction, only filtering
- Analyzed by LC/MS/MS



What is LC/MS/MS

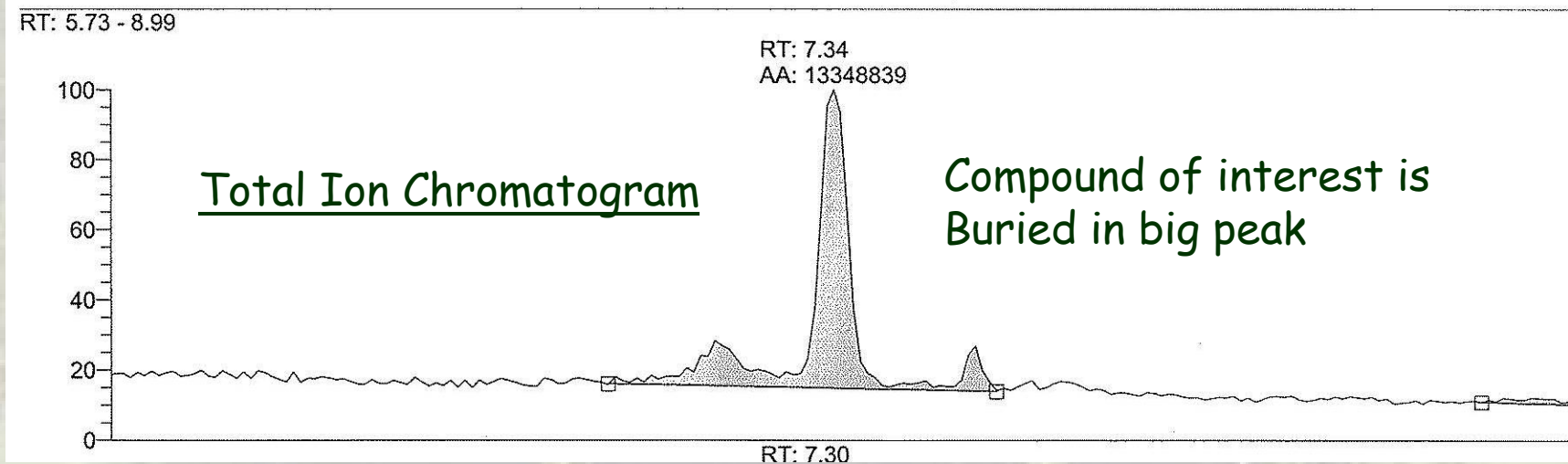


What is LC/MS/MS

- Separate your compounds on Liquid Chromatograph (LC)
- Ionize all the compounds present
- Look for the ion with the specific mass that hopefully indicates your compound
- Smash that ion into smaller bits that even better indicate your compound

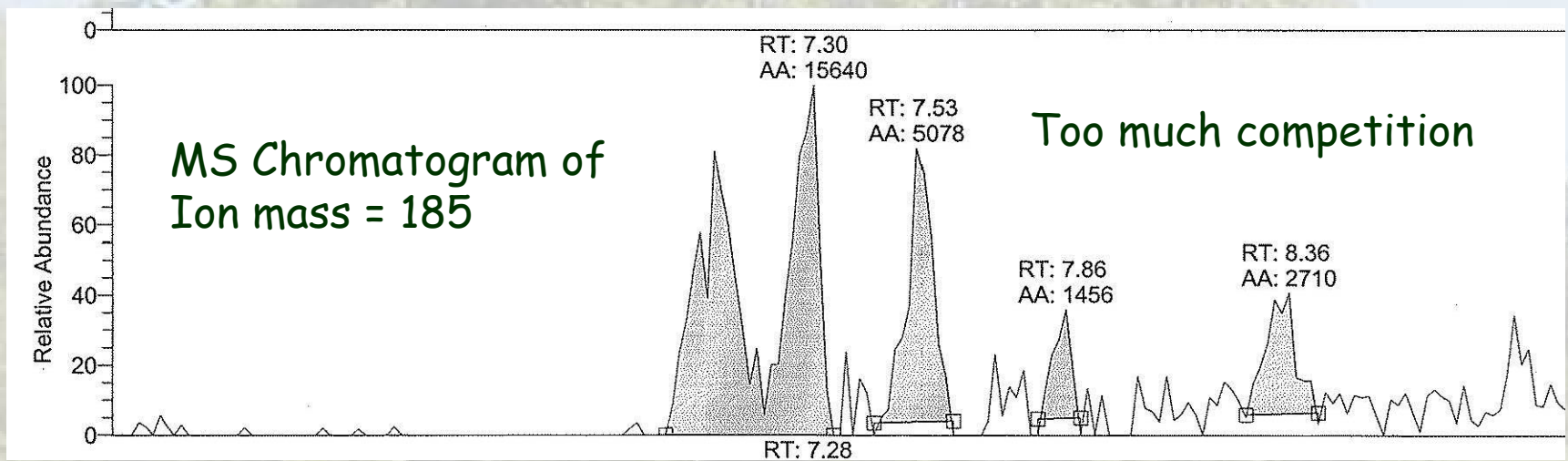
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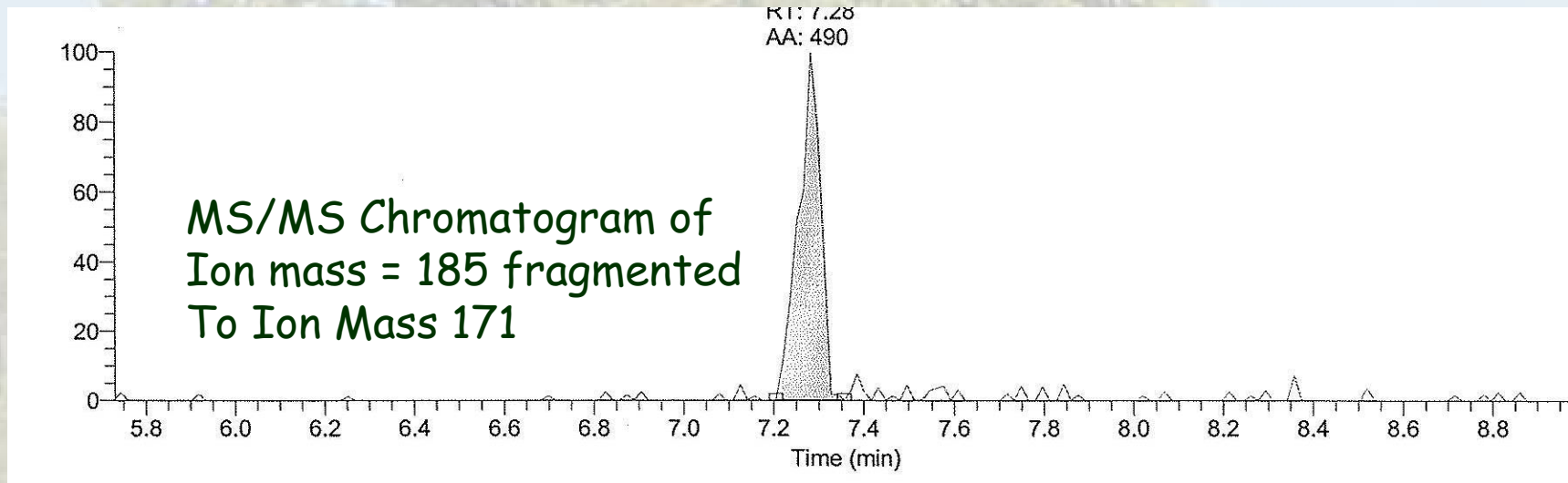
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What is LC/MS/MS

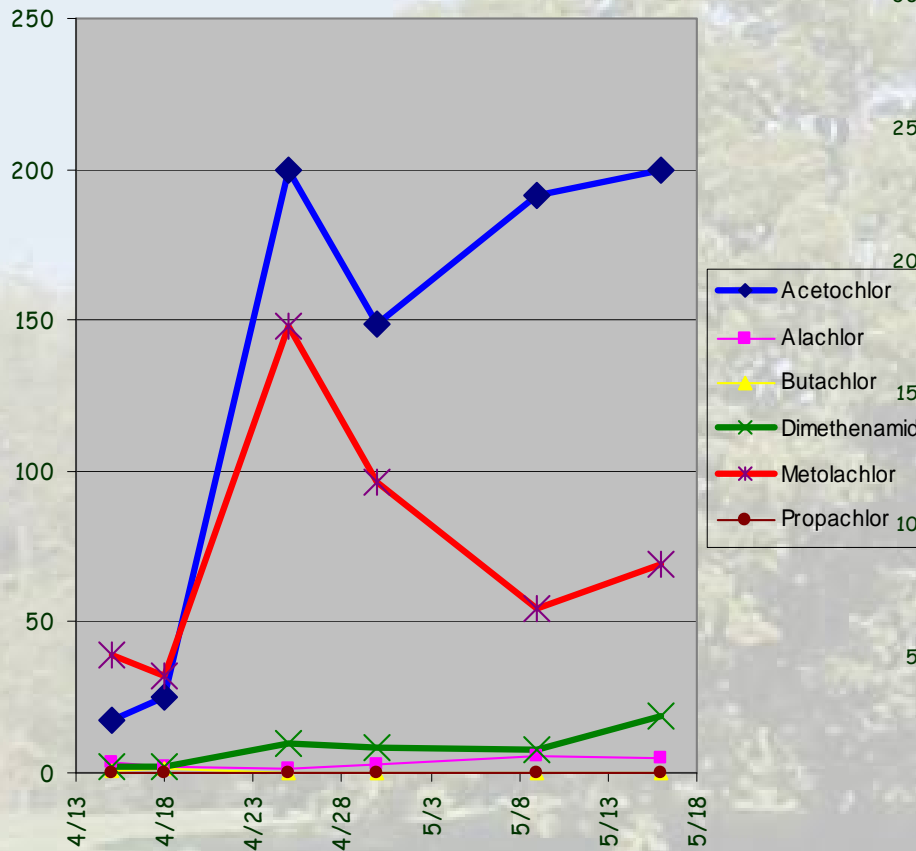
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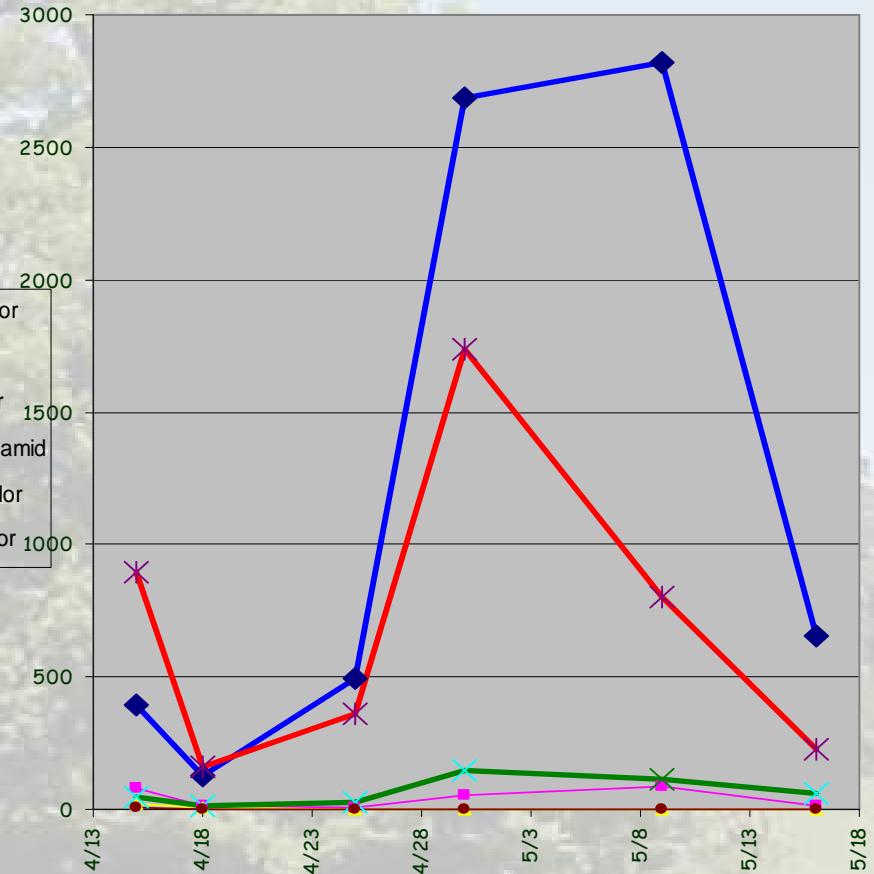
Sensitive and Specific

Rain Results at ICS

Concentration in Rain at ICS (ng/L)

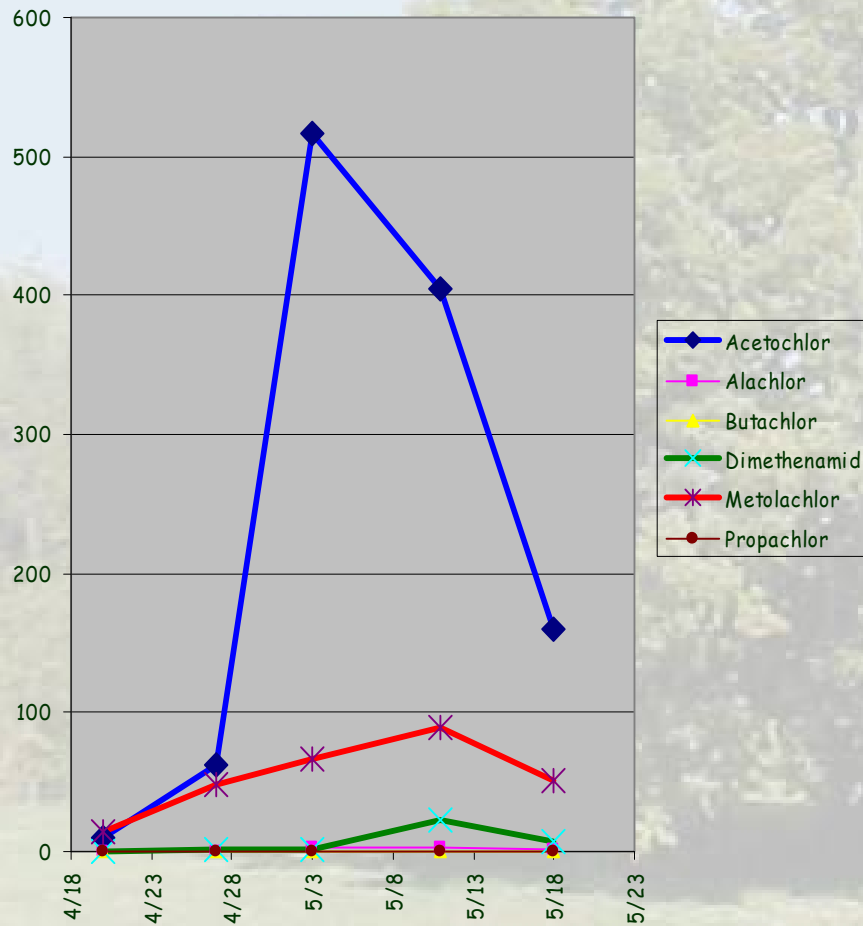


Amt. per Sq. Inch Falling at ICS (pg)

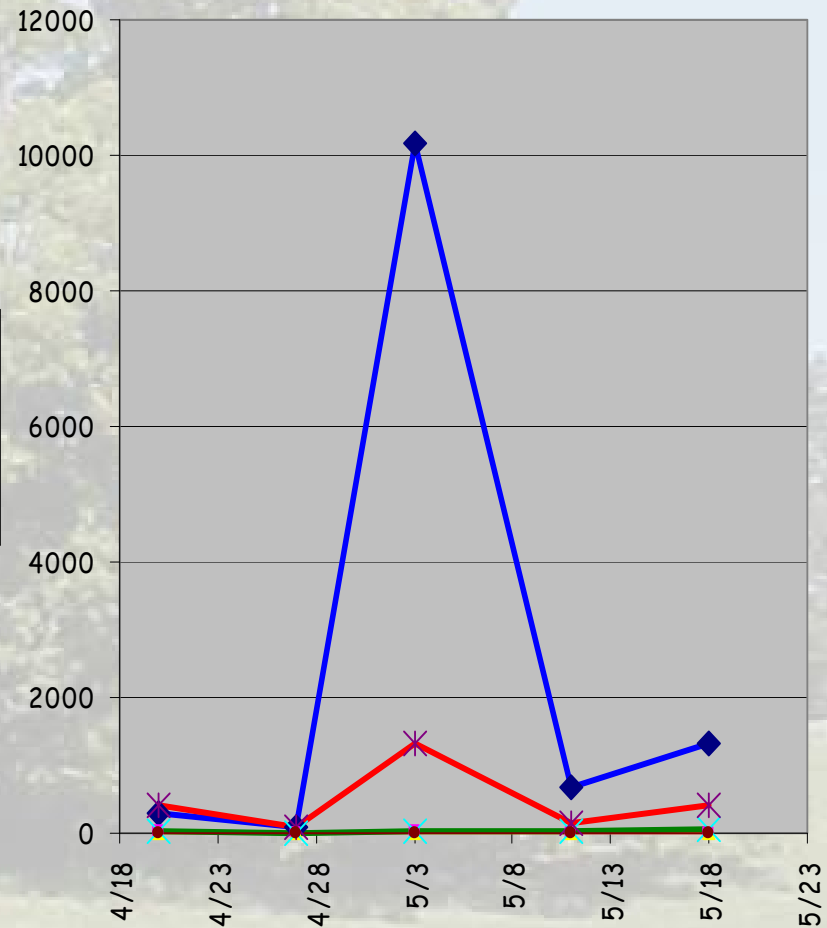


Rain results at WPH

Concentration in Rain at WPH (ng/L)

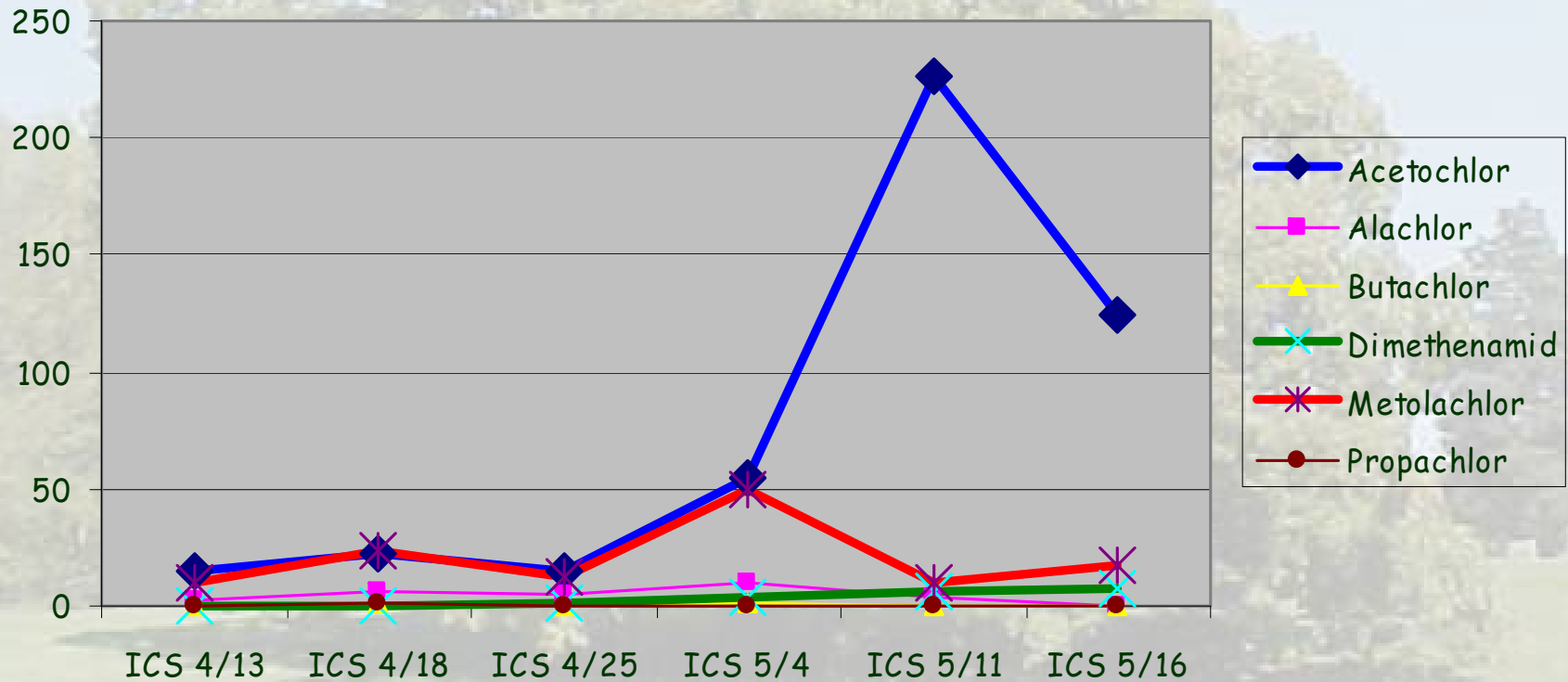


Amt. per Sq. Inch Falling at ICS (pg)



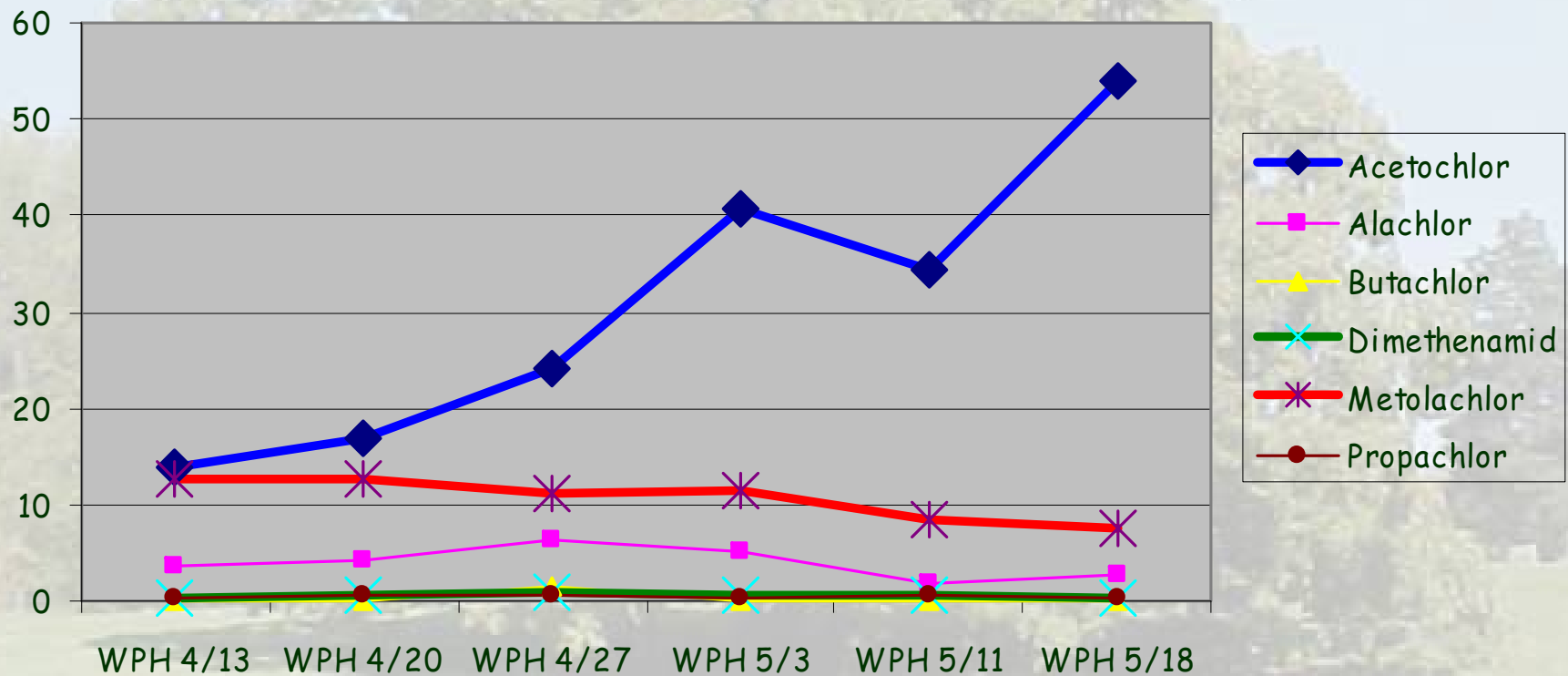
Air results at ICS

Concentrations in Air at ICS (ng/m³)



Air Results at WPH

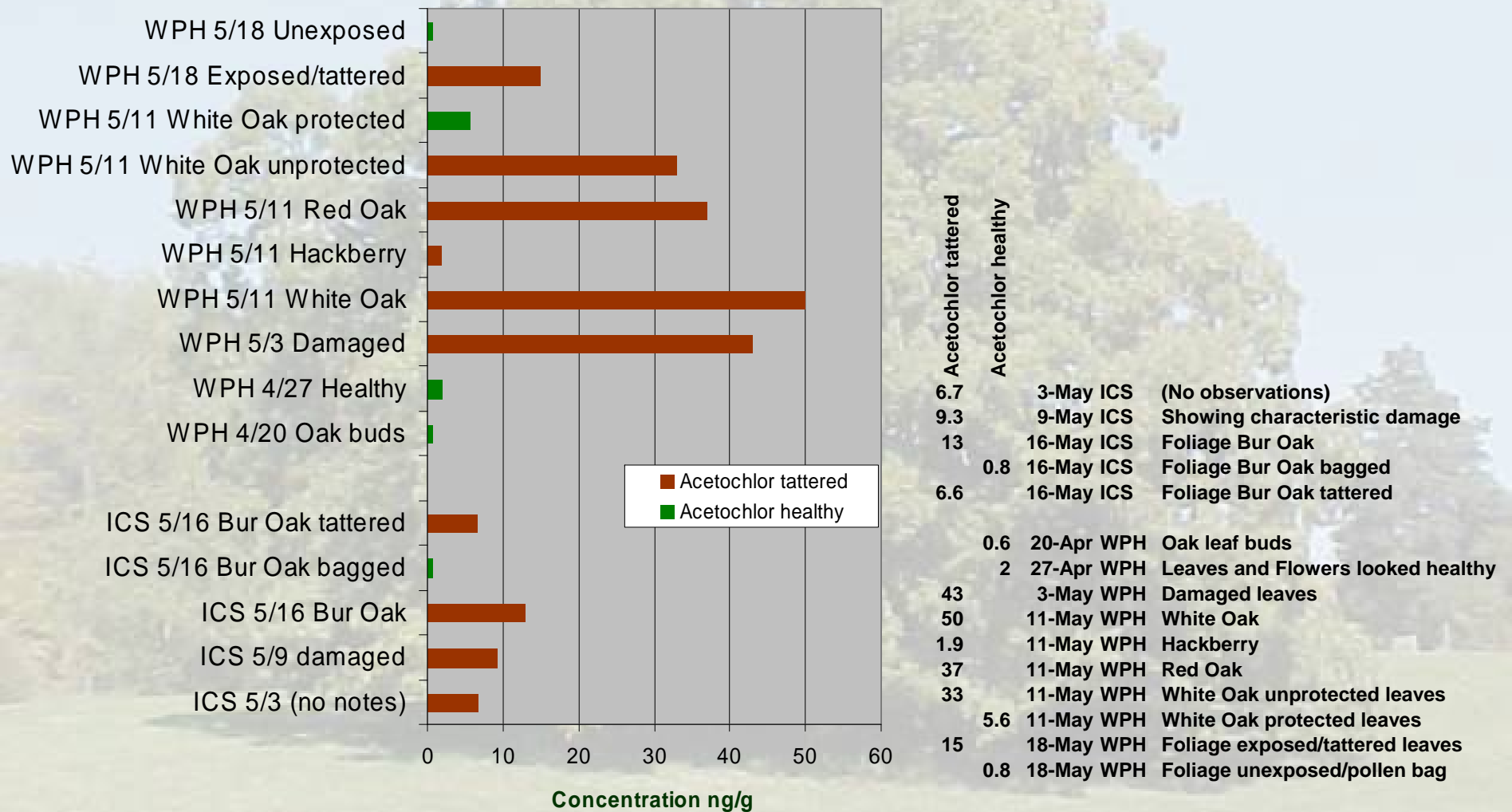
Concentrations in Air at WPH (ng/m³)



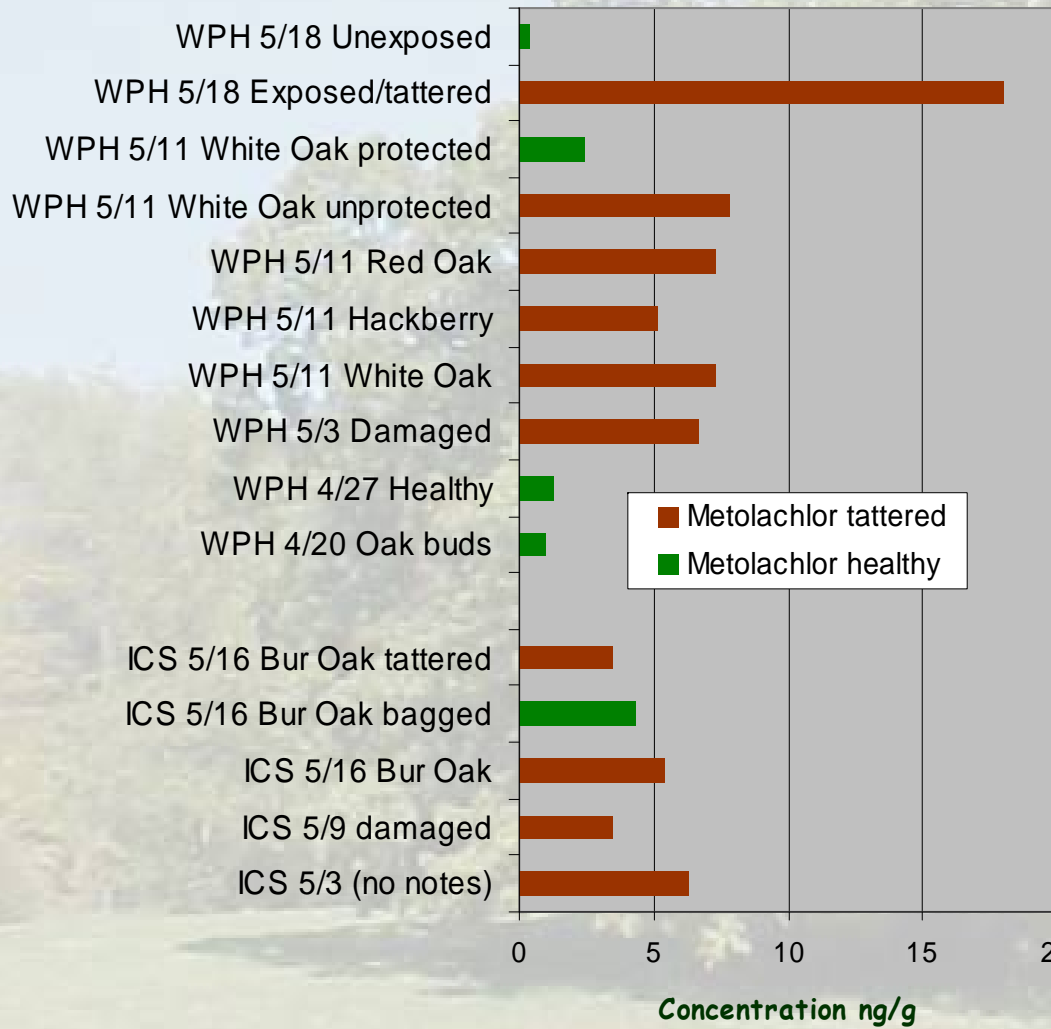
Leaf Results

3-May	ICS	(No observations)
9-May	ICS	Showing characteristic damage
16-May	ICS	Foliage Bur Oak
16-May	ICS	Foliage Bur Oak bagged
16-May	ICS	Foliage Bur Oak tattered
20-Apr	WPH	Oak leaf buds
27-Apr	WPH	Leaves and Flowers looked healthy
3-May	WPH	Damaged leaves
11-May	WPH	White Oak
11-May	WPH	Hackberry
11-May	WPH	Red Oak
11-May	WPH	White Oak unprotected leaves
11-May	WPH	White Oak protected leaves
18-May	WPH	Foliage exposed/tattered leaves
18-May	WPH	Foliage unexposed/pollen bag

Leaf Results - Acetochlor

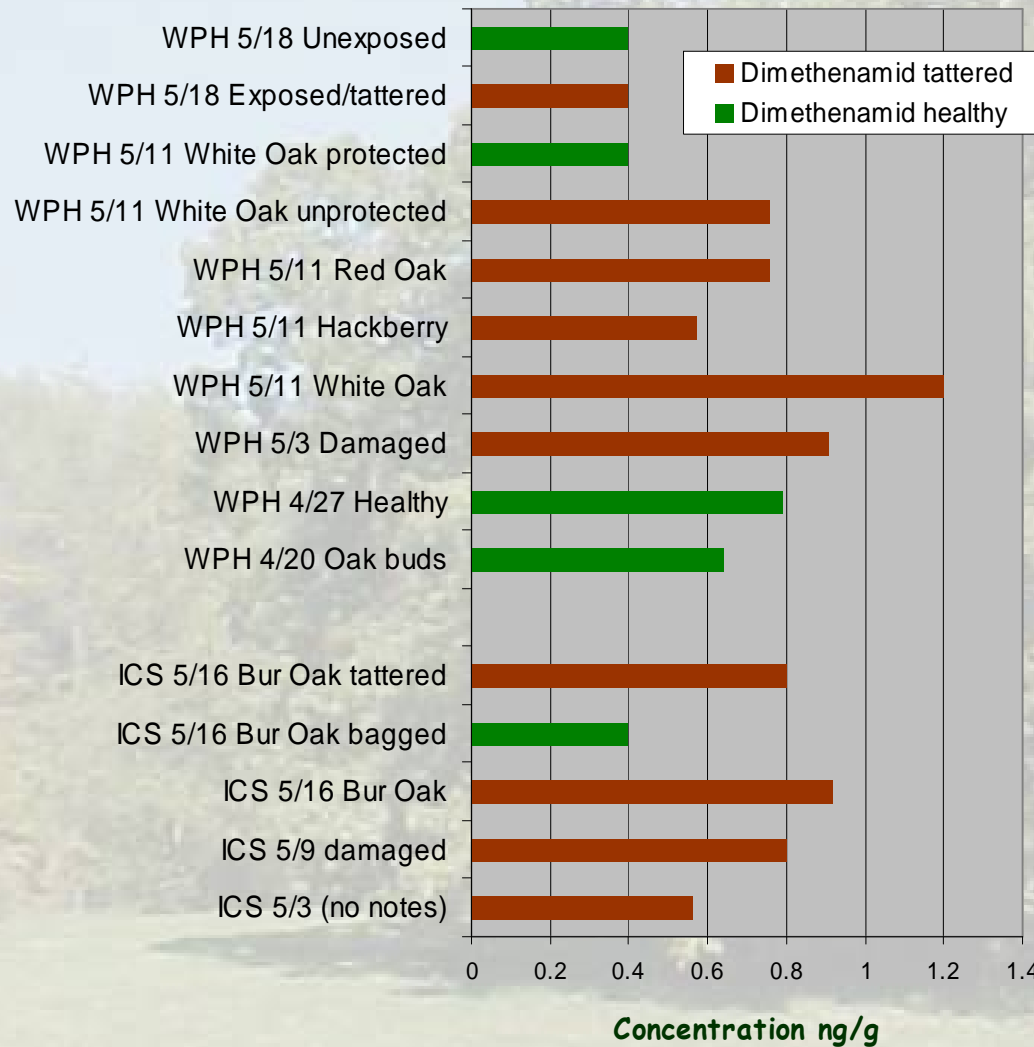


Leaf Results - Metolachlor



Concentration (ng/g)	Sample	Notes
6.3	3-May ICS	(No observations)
3.5	9-May ICS	Showing characteristic damage
5.4	16-May ICS	Foliage Bur Oak
4.3	16-May ICS	Foliage Bur Oak bagged
3.5	16-May ICS	Foliage Bur Oak tattered
1	20-Apr WPH	Oak leaf buds
1.3	27-Apr WPH	Leaves and Flowers looked healthy
6.7	3-May WPH	Damaged leaves
7.3	11-May WPH	White Oak
5.2	11-May WPH	Hackberry
7.3	11-May WPH	Red Oak
7.8	11-May WPH	White Oak unprotected leaves
2.4	11-May WPH	White Oak protected leaves
18	18-May WPH	Foliage exposed/tattered leaves
0.4	18-May WPH	Foliage unexposed/pollen bag

Leaf Results - Dimethenamid



Concentration (ng/g)	Sample	Notes
6.3	3-May ICS	(No observations)
3.5	9-May ICS	Showing characteristic damage
5.4	16-May ICS	Foliage Bur Oak
4.3	16-May ICS	Foliage Bur Oak bagged
3.5	16-May ICS	Foliage Bur Oak tattered
1	20-Apr WPH	Oak leaf buds
1.3	27-Apr WPH	Leaves and Flowers looked healthy
6.7	3-May WPH	Damaged leaves
7.3	11-May WPH	White Oak
5.2	11-May WPH	Hackberry
7.3	11-May WPH	Red Oak
7.8	11-May WPH	White Oak unprotected leaves
2.4	11-May WPH	White Oak protected leaves
18	18-May WPH	Foliage exposed/tattered leaves
0.4	18-May WPH	Foliage unexposed/pollen bag

Future Work

- This study and others show a very strong correlation between oak leaf tatters and exposure to chloroacetanilide herbicides.
- More work is needed to better understand factors that contribute to this effect and what can be done to minimize tatters.
- Source of funding needed to continue this work. Most funding is directed towards impact of chemical exposure to human health.

Acknowledgements

- Mark Vitosh - District Forester
- Bob Hibbs - District Forester
- Bruce Blair - District Forester
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