A Holistic Assessment of the Occurrence of Metolachlor and 2 of its Degradates Across Various Environmental Compartments in 7 Environmental Settings

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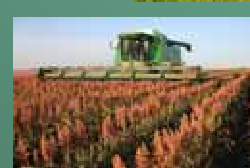
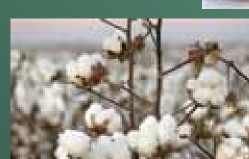
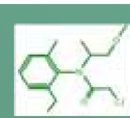
Metolachlor Uses

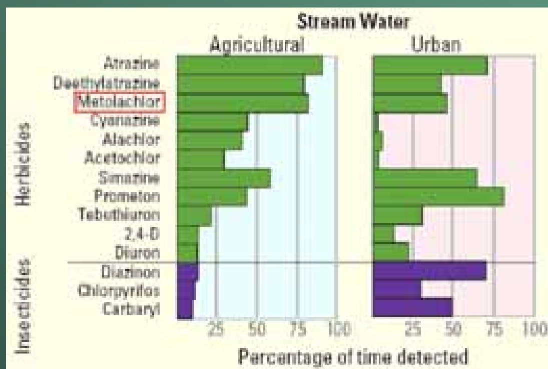
- Pre-emergent herbicide to control broadleaf and annual grassy weeds
- Crops
  - Corn
  - Soybeans
  - Sorghum
  - Cotton
  - Peanuts
  - Sweet Corn
  - Dry Beans
  - Potatoes
  - Green Beans
  - Tomatoes

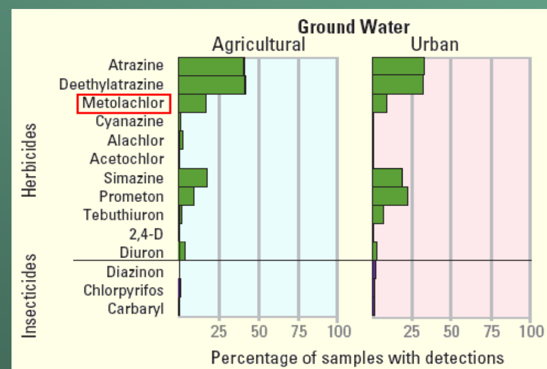




Pesticides in Surface Water and Groundwater







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Purpose of Study

- Present metolachlor detections in 7 agricultural watersheds across the U.S.
- Present estimated mass balance of metolachlor in the environment
- Follow one study area's flowpath from metolachlor application to it's appearance in each of the environmental compartments
- Explain the differences in metolachlor and degradate detections based on the hydrology of each site, and highlight similarities, which are based on the chemical and its travel time in the environment

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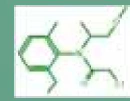
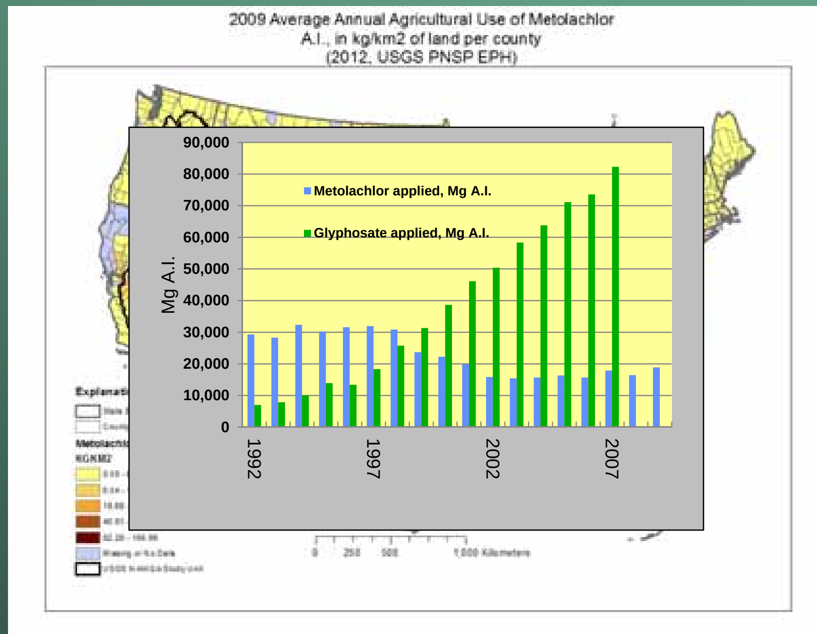
Metolachlor Use in the USA: 2009



- Iowa
  - Eastern Iowa Basin
- Nebraska
  - Central Nebraska Basin
- Indiana
  - Great, White and Little Miami River Basins
- Mississippi
  - Mississippi Embayment
- California
  - San Joaquin-Tulare Basins
- Washington
  - Central Columbia Plateau- Yakima River Basin
- Maryland
  - Potomac River Basin and Delmarva peninsula



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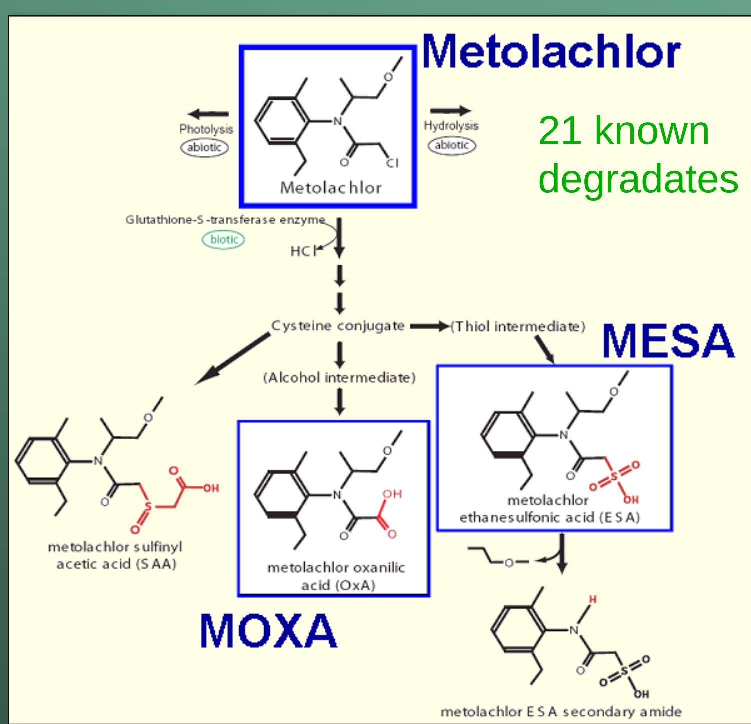
Environmental Degradation of Metolachlor to MESA and MOXA

MOXA: metolachlor oxanilic acid

MESA: metolachlor ethane-sulfonic acid

Primary degradate pathway: **biotic**



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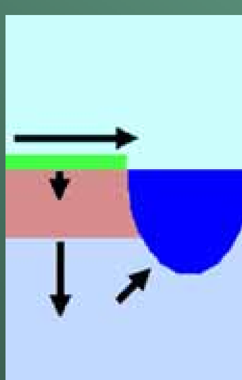
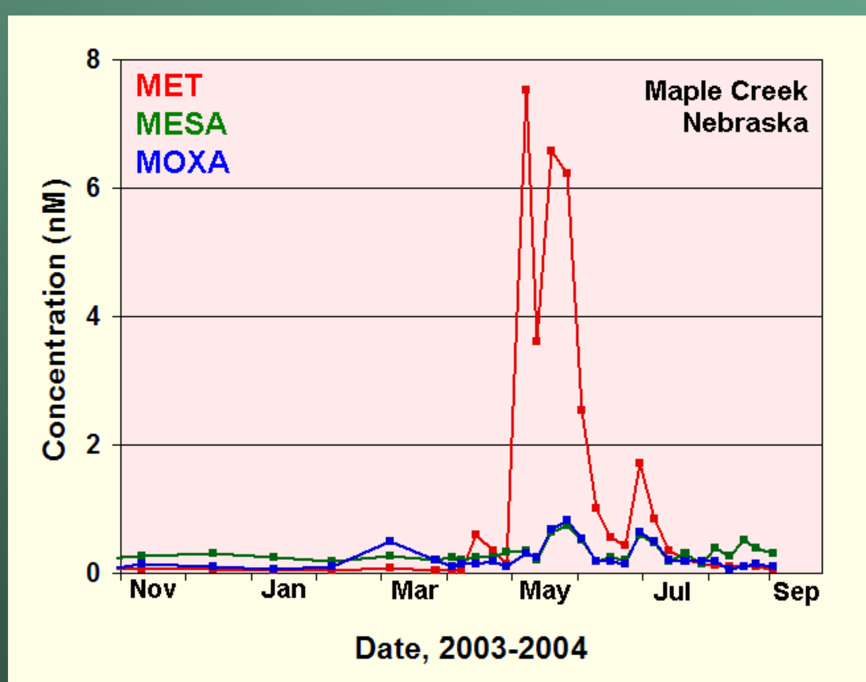
Estimated Values from the Best Fit of Environmental Observations

	Soil half-life (days)	
Metolachlor	10 (15-190)	
MESA	70 (---)	
MOXA	50 (---)	

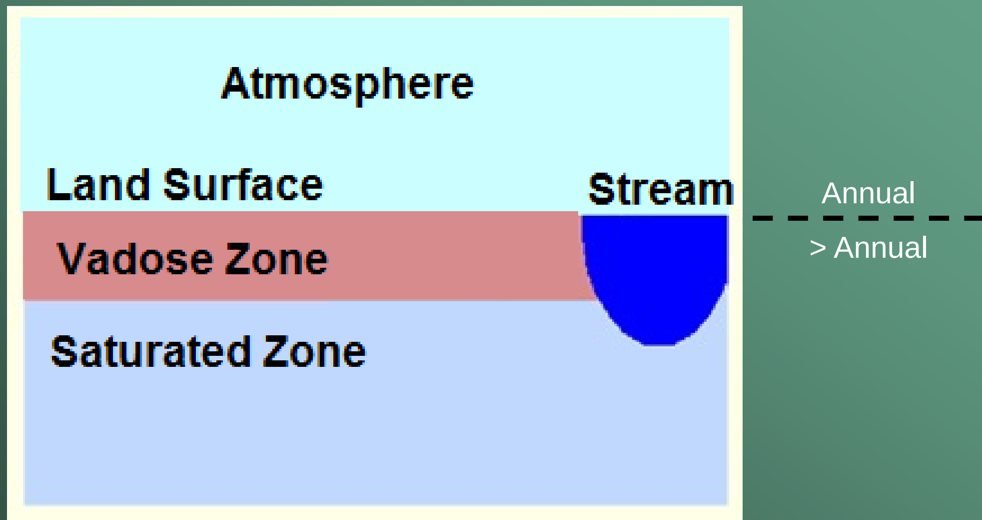
Typical Seasonal Trend in Agricultural Streams





Fate and Movement of Metolachlor in the Environment

General “Mass Balance” of Metolachlor (Parent)



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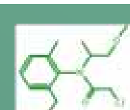
Use and Median [Metolachlor] (µg/L)



State	Use	Rain	OV	TD	SW	VZ	GW/SW	GW
NE	28							
MD	67							
CA	3							
IN	64							
WA	1							
MS	19							
IA	25							

Use (kg/km^2) relative compared to Washington study site. (WA: 2 kg/km2; MD: 134 kg/km^2)

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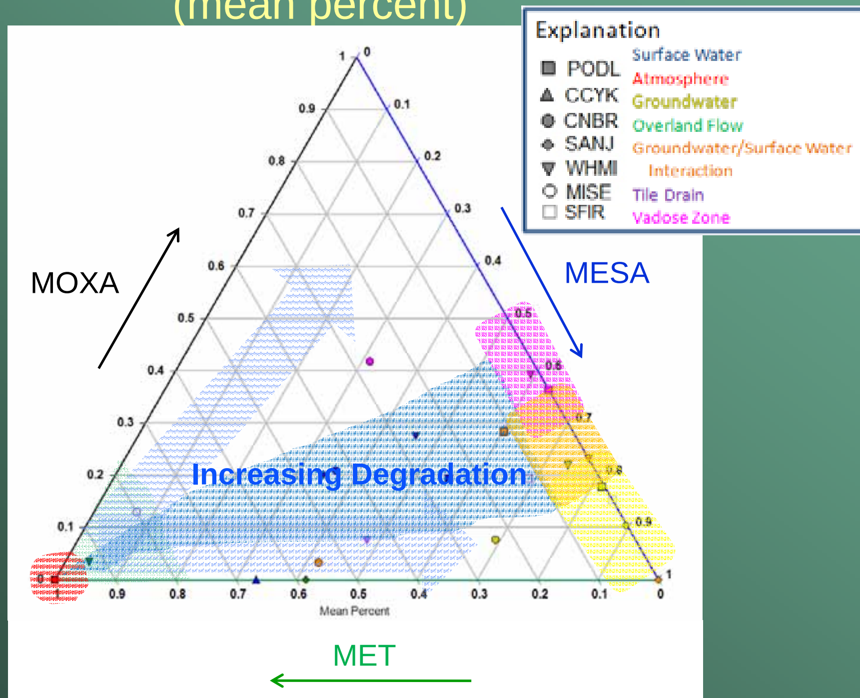
Summary of Findings
Parent and degradate distributions (mean percent)

Total = MET + MESA + MOXA

Fractional Percent of Total Metolachlor for: MET MESA MOXA



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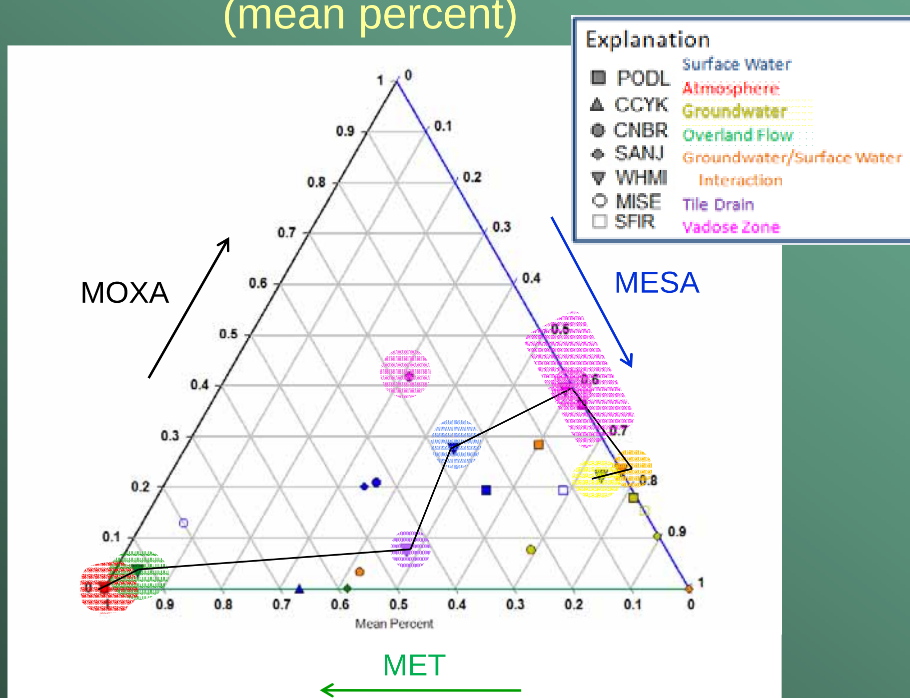
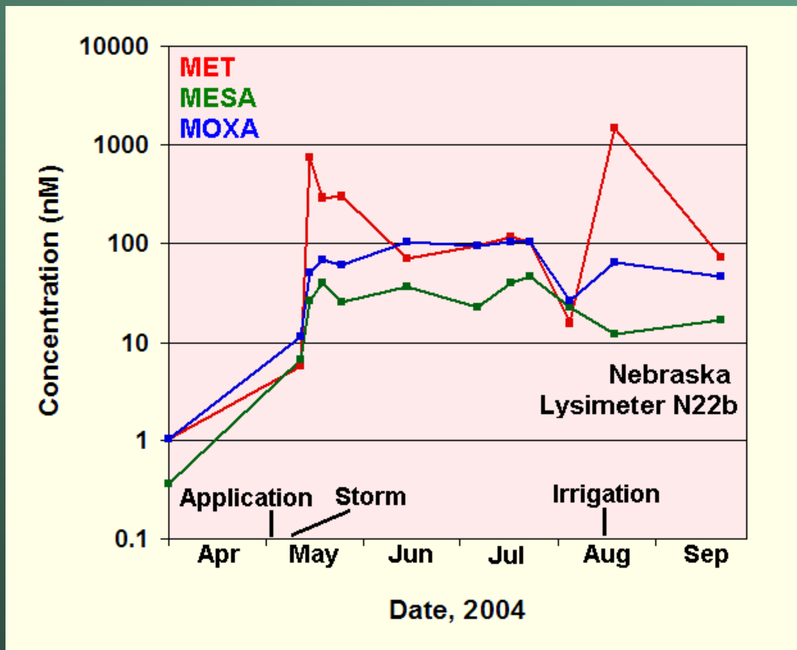
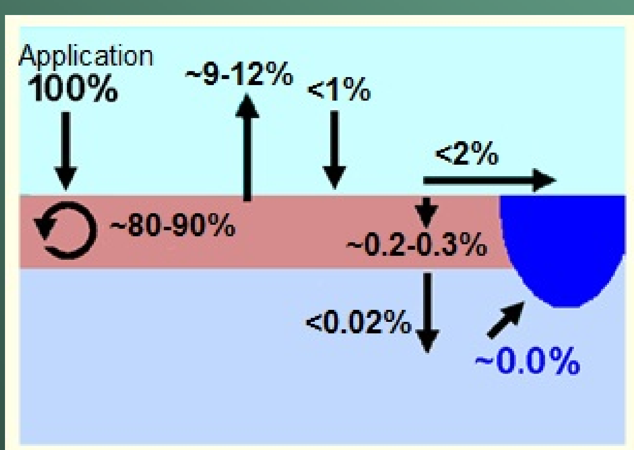


Observations from a Focused Recharge Area



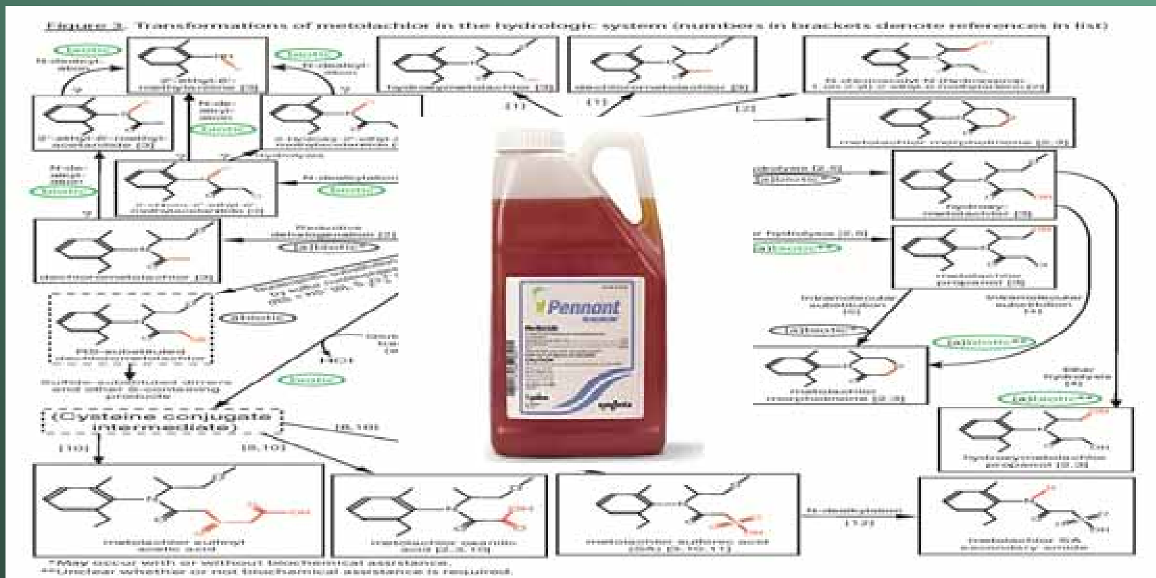
Through July, MESA + MOXA accounts for about 20% of the loss of Metolachlor.

Fate and Movement of Metolachlor in the Environment: Conclusions



- Use of metolachlor results in its movement throughout the environment
- Similarities and differences can be explained by the differing characteristics of the study areas.
- Trends in the mass movement of metolachlor allow for estimation of its movement within each environmental compartment

Questions or Comments?



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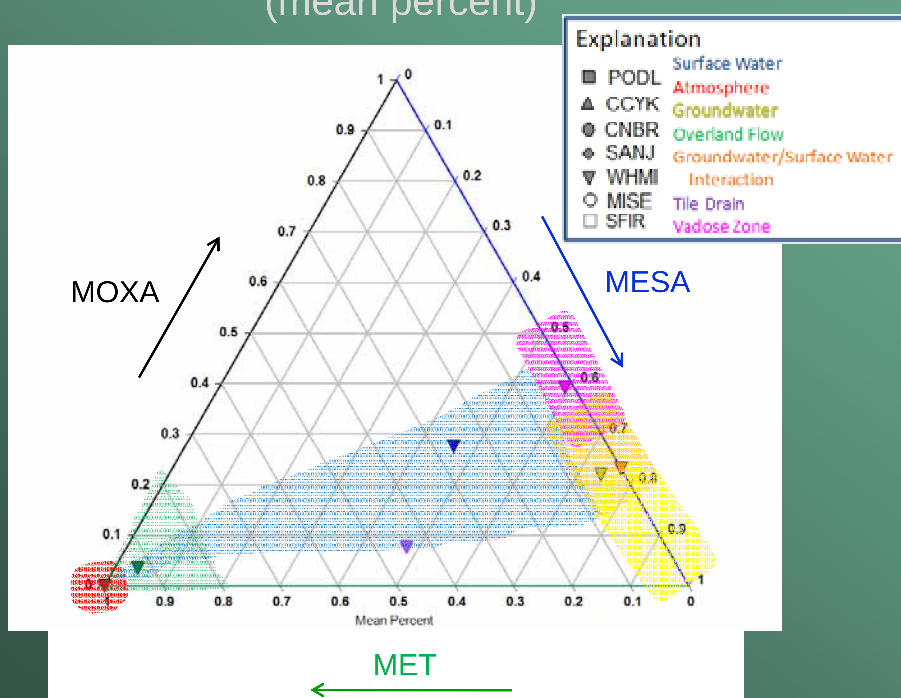

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Study Unit Description Table

	Maryland	Indiana	Nebraska	California	Washington	Mississippi	Iowa
Drainage Basin	Morgan Creek Basin	Sugar Creek Basin	Maple Creek Basin	Lower Merced River Basin	Granger Drain Basin	Bogue Phalia Basin	South Fork Iowa River Basin
Intermediate stream	-	Sugar Creek	Mapel Creek	Lower Merced River Basin	Granger Drain	Bogue Phalia	South Fork Iowa River
Subbasin area (km^2)	-	240	955	831	160	1250	570
Mean annual discharge (m^3/s)	-	2.9	2.27	19.4	34.4	21.3	0.5
Percent agriculture (%)	-	75	95	55	52	>80	>95
Small stream	Morgan Creek	Leary-Weber Ditch	Un-named	Mustang Creek	DR2	-	-
Subbasin area (km^2)	31	7.2	1.5	17.5	5.5	-	-
Mean annual discharge (m^3/s)	0.31, Continuous	0.9, Intermittent	~0.001, Intermittent	~0.01, Intermittent	4.93, Continuous	-	-
Percent agriculture (%)	74	97	97	90	89	-	-
Primary crops[+]	Corn, soybeans, small grain (60%) Pasture, hay (13%) Nursery, orchard (1.5%) Animal operations (0.3%)	Corn (50%) Soybeans (50%)	Corn (50%) Soybeans (50%)	Almonds (45%) Vineyards (12%) Corn, grain (16%)	Corn, grain (42%) Grapes, juice (17%) Pasture (11%)	Corn (%) Soybeans (%) Rice (%) Cotton (%)	Corn (%) Soybeans (%)
Average annual precipitation (cm)	112	100	72.3	33	17.6	137	83
Climate	Humid-subtropical	Moderate	Humid-continental	Arid to semi-arid	Hot, dry summers; cold winters	Moderate	Moderate
Irrigation Source	Intrabasin ground wtaer	None	Deep ground water	Deep ground water and interbasin canal	Interbasin canal	Intrabasin ground water	Intrabasin ground water
Irrigated agriculture (%)	10	0	30	>95	>95	-	-
Irrigation method	Center pivot	None	Center Pivot	Sprinkler, drip	Rill, sprinkler, drip	Pipe, center pivot, flood	
Water capacity	-	High	-	-	High	Low to moderately high	High
Soil permeability	Moderate	Moderate to low	Low	High to moderate	Moderate to low	Low	Moderate to low
Soil type	Coarse sand and fine silt loam	Silt loam with clay	eolian sand, silt, fine-grained loess	Silt loam, sandy loam, hardpan	Eolian sand, loess, lake sediment	Silt loam, clayey silts	Till with sand and gravel
Artificially enhanced soil drainage?	No	Yes	No	No	Yes	Yes	Yes
Tillage	Conservative, no-till	Tillage is practiced	-	-	-	Some tillage	-
Local ground-water system	Intermediate:-	Intermediate: In some locations	Intermediate: Yes	Intermediate: Yes	Intermediate: Yes	Intermediate: Yes	Intermediate: Yes
connectioin to regional ground-water system	Small: Yes	Small: Yes	Small: No	Small: No	Small: Yes	Small:-	Small:-

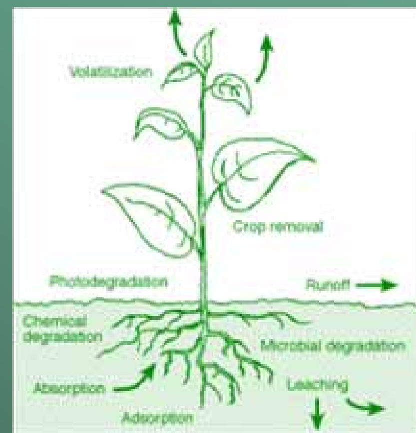
[+]Percentages are based on total agricultural land in the intermediate subbasin, except for Maryland
Modified from Capel et al., 2008

Abstract

- The widely used herbicide, metolachlor, is one of the most frequently detected pesticides in surface water and groundwater throughout the United States in both agricultural and urban settings. Metolachlor has also been detected in rain and in the unsaturated zone. The U.S. Geological Survey conducted a study to assess the controlling factors in the transport and fate of metolachlor and its degradates across seven watersheds in California, Indiana, Iowa, Maryland, Mississippi, Nebraska, and Washington during 1997-2007. The occurrence of metolachlor and two degradates (metolachlor ethane-sulfonic acid and metolachlor oxanilic acid) was examined in several environmental compartments within these environmental settings; groundwater, surface water, overland flow, subsurface drains, the unsaturated zone, and the atmosphere. Within these environmental compartments, the occurrence of metolachlor and its degradates primarily is affected by a number of factors including use, management, environmental setting, and physical and chemical properties of metolachlor and its degradates. The fate of metolachlor can be generalized by the environmental compartments. The majority (90%) of metolachlor is taken up by plants, degraded in the soil, or is trapped in/adsorbed to soil. About 10% of the applied metolachlor is volatilized into the atmosphere, and about 0.3% returns by rainfall. Some (0.4%) metolachlor is transported to surface water, while an equal amount (0.4%) is infiltrated into the unsaturated zone and may move downward into groundwater. Generally, groundwater stores less than 0.02% and does not serve as a metolachlor source to receiving surface waters.

Concerns : Pesticides in the Environment

- Where does it go? / How far does it travel?
- Does it degrade?
- At what concentration is it detected?
- Does it reach drinking water?
- Does it affect animals?
- Does it harm ecosystems?
- How can we prevent offsite movement?



Fate of pesticides in the environment.
University of MO Extension

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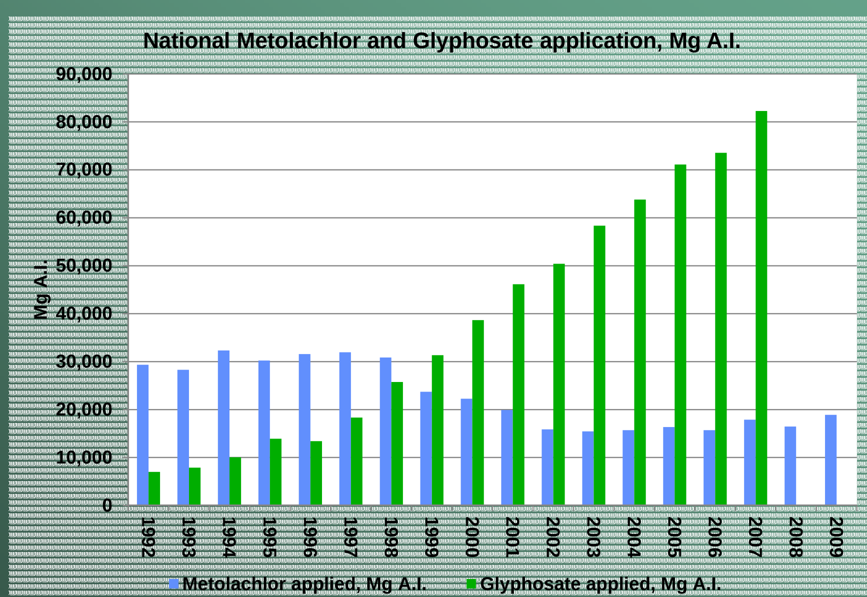
Metolachlor and Glyphosate Use

- GM Crops replaced some metolachlor acreage
- Reformulation of S-metolachlor decreased needed usage by ~35%



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