Impact of Soil Amendments on the Mobility of Herbicides From Soil into Runoff and Seepage Water

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Introduction

• According to the USEPA, over 441 million kg of conventional pesticides were used in the U.S. Of that total, 77% were used in agricultural applications, and 11% were used for home and garden purposes.

• Approximately 1,200 water body impairments across the U.S. are attributed to pesticides.

• Agricultural activities are frequently conducted in close proximity to lakes, reservoirs, and streams.

• A central hope in all these concerns is the safe use of agrochemicals, development of new soil management practices, and use of mitigation techniques.
Mitigation techniques must be simple, inexpensive, energy conserving, safe and effective for pesticide decomposition and/or removal and erosion control.

Although many factors are responsible for decomposition of pesticides in soils, two are considered the most important: Adsorption & Microbiological activity.
Only 1% reach the plant and 99% reach the soil and leave the application site.

The degree of this pollution problem depends on how close is the water table to the soil surface.
PESTICIDES

What would happen if farmers did not use pesticides?

Supplies of corn, wheat, and soybeans would decrease by 73%.

Objectives

The objectives of this investigation were to:

i) determine the dissipation and half-life ($T_{1/2}$) of metribuzin and DCPA herbicides in soil under three management practices (CM, SS, and NM soil)

ii) monitor herbicides residues in runoff and infiltration water following natural rainfall
Encyclopedia of Environmental Management

Pesticides: Measurement and Mitigation

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Temperature of the inlet 400-1200 F
Amount produced = 75 dry tons/day
More than 11.4 million tons of poultry litter was generated in the U.S.
12% clay – 75% silt – 13% sand
18 plots (22 x 3.7 m each)
10% slop
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KSU Research Farm, Franklin County, Kentucky

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Properties of Humic Substances

**Humic acids** - the fraction of humic substances that is not soluble in water under acidic conditions (pH < 2) but is soluble at higher pH values. They can be extracted from soil by various reagents and which is insoluble in dilute acid. Humic acids are the major extractable component of soil humic substances. They are dark brown to black in color.

**Fulvic acids** - the fraction of humic substances that is soluble in water under all pH conditions. They remains in solution after removal of humic acid by acidification. Fulvic acids are light yellow to yellow-brown in color.

**Humin** - the fraction of humic substances that is not soluble in water at any pH value and in alkali. Humins are black in color.
Humic acids

Model structure of humic acid (Stevenson 1982)

Fulvic acids

Model structure of fulvic acid by Buffle
Chicken Manure  Sewage Sludge  No Mulch
Soil Treatment
0
100
200
300
400
500
600
 Collard
 Kale
Total Yield, lbs acre⁻¹
-1
a
a
b
a
a
b

Soil Treatment

- Chicken Manure
- Sewage Sludge
- No Mulch

Collard
Kale

*Note: Bars with the same letter are not significantly different.*
<table>
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<tr>
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<th>Sewage Sludge Incorporated with Native Soil</th>
<th>Chicken Manure Incorporated with Native Soil</th>
<th>No Mulch Native Soil</th>
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<tbody>
<tr>
<td><strong>Dissipation</strong></td>
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<tr>
<td><strong>Metribuzin</strong></td>
<td><img src="image1.jpg" alt="Image" /></td>
<td><img src="image2.jpg" alt="Image" /></td>
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<tr>
<td>Constant (K)</td>
<td>0.039065</td>
<td>0.028469</td>
<td>0.058519</td>
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<tr>
<td>T$_{1/2}$ Values (days)</td>
<td>17.74 b</td>
<td>24.32 a</td>
<td>11.84 c</td>
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<tr>
<td><strong>DCPA</strong></td>
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<tr>
<td>Constant (K)</td>
<td>0.013283</td>
<td>0.015125</td>
<td>0.026472</td>
</tr>
<tr>
<td>T$_{1/2}$ Values (days)</td>
<td>52.17 a</td>
<td>45.82 b</td>
<td>26.17 b</td>
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</table>
Investigators are not in complete agreement on the behavior of metribuzin in the environment:

Metribuzin is soluble in water and hence *poorly bound* to most soils, giving it a potential for leaching in many soil types (Wauchope et al. 1992).

The mobility of metribuzin is limited in organic soils (Peter and Weber 1985) because metribuzin is *tightly bound* to soils with high clay or organic matter content.

Nicholls et al. (1982) reported little movement (< 10 cm) of metribuzin applied at the surface of a sandy loam soil.
The leaching index (LI) of a pesticide can be calculated using the equation:

$$[LI = (S) \ (T_{1/2}) \ / \ (V_P) \ (K_{OC})]$$

S is the water solubility (mg L$^{-1}$ at 25°C),
$T_{1/2}$ is the half-life of a pesticide in soil (day),
$V_P$ is the vapor pressure (mm Hg at 25°C),
$K_{OC}$ is the organic carbon partition coefficient

$[K_{OC} = K_d / \% \text{ soil organic carbon}]$

**Metribuzin**  
$$[LI = (1050) \ (12) \ / \ (5.8 \times 10^{-7}) \ (96)] = 2.26 \times 10^8$$

**DCPA**  
$$[LI = (0.5) \ (26.17) \ / \ (1.57 \times 10^{-6}) \ (5900)] = 1.41 \times 10^3$$

These LI values indicate the weak leaching of DCPA and the high leaching of metribuzin residues under field conditions.
Conclusion

• Runoff water was reduced by >50% and >75% in soil mixed with SS and CM, respectively.
• Infiltration water was increased by 90% and 245% in SS and CM amended soil, respectively.
• Metribuzin was reduced in runoff by 34% and 44% in SS and CM treatments, respectively.
Conclusion Continued

- DCPA was reduced in runoff by 52% and 63% in SS and CM treatments, respectively.
- Metribuzin was increased in infiltration water by 65% and 148% in SS and CM treatments, respectively.
- DCPA was reduced in infiltration water by 74% and 56% in SS and CM treatments, respectively.

Future plan “trace-elements in soil mixed with SS and CM and metals available to plants”
Acknowledgments

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Thank You

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