Herbicide Activity/Fate in Furrow Irrigation and Late-Season Weed Control

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Herbicide Fate in Soil

- Herbicide fate involves all interactions possible with components of soil
- Goal is to get residual activity for weed control but not for prolonged persistence
- All can play key role simultaneously
- 3 processes that occur in soil with relation to herbicide fate:
  - Chemical
  - Physical
  - Microbial

Chemical Soil Processes

- Adsorption: herbicide ions held onto soil particles by electrical attraction (iron filings or lint)
  - Leads to unavailability to plants and microbes (passive state)
  - Occurs on clay and humus fractions
  - Stronger on dry soils (readily displaced by water on clay)
  - Humus (OM) major player in adsorption in most soils (not readily displaced by water due to high CEC)
  - pH effects
    - >anionic herbicides in acid soils
    - >cationic herbicides in alkaline soils
    - little to no effect on nonionic herbicides

Chemical Soil Processes

- Ion exchange: competing ions lead to adsorption and release of herbicides into solution
- Photochemical degredation: sunlight UV energy causes alteration of herbicide molecule ie. breaking bonds (incorporation)
- Chemical rxns: oxidation-reduction, hydrolysis, formation of water insoluble salts, formation of chemical complexes
- Absorption by plants and microbes

Physical Soil Processes

- Leaching: movement of herbicide as influenced by water flow
  - Can occur in any direction (downward most common)
  - Good (herbicide incorporation, enhanced plant interception)
  - Bad (crop injury, reduced weed control, groundwater contamination, increased volatility)
  - Affected by:
    - Soil texture and permeability (> course sandy soils; restricted with hard-pan)
    - Water volume (> as volume moving past given point increases)
    - Water solubility of herbicide (generally > with increased solubility but insoluble herbicides can leach as suspended particles in soil solution)
    - Adsorption is most critical factor (can move with soil colloid)

Physical Soil Processes

- Volatility: going from liquid to gas (high vapor pressure)
  - Can occur more rapidly in moist soils and high temps
  - Negative effects (reduced herbicide concentration and movement of vapors)
  - Reduced by soil incorporation and formulation changes

- Vapor drift: movement of vapors in air

Microbial Soil Processes

- Most important degradation means for herbicides
  - Driven by enzyme action (use herbicide as carbon source)
  - Fungi, Bacteria, Actinomycetes (present or mutate)
  - Favored by:
    - Moisture (50-100% FC)
    - Good aeration
    - Mild temps (80-90 F)
    - pH (6.5-8; more fungi at lower pH)
    - Herbicide application increases population after initial lag phase

Herbicidal Properties and Fate

- Chemical properties can affect herbicide adsorption
  - Sorption potential to clay and OM most often expressed as K_{oc} (K_d, K_f) (Pendimethalin=17,200 mL/g avg., diuron=480 mL/g Paraquat=1,000,000 mL/g)
  - Water solubility (0.25 mg/L;42 mg/L; 620,000 mg/L)
  - Degredation rate (photodegradation, microbial, hydrolysis etc)
  - Ability of pH to change ionic characteristics of herbicide (SU and IMI restrictions at high pH)

Irrigation Effects on Herbicides

- Triggered at 2” deficit level
  - 0.25” water use per day in summer
  - Multiple irrigations depending on soil type and capacity
  - Have potential to move herbicide down and laterally (slow rate???) especially in lighter soils (low OM and CEC)
    - Water readily displaces herbicides on clay particles
    - May get some movement on soil particles
    - Most labels call for rainfall or irrigation of 0.5 to 1” for activation (2” with irrigation)
    - May be moving herbicide out of weed seed zone
    - Providing good conditions for microbe activity

Irrigation Effects on Herbicides

- Successful late-season control in irrigated cotton
  - Good crop management allowing benefits of shading
  - Good nutrient and pH management
  - Minimal soil disturbance
  - OT applications of glyphosate or graminicides