Advances in Aerial Herbicide Application for Drift Mitigation

2014 Aquatic Weed Control Short Course
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Topics for Discussion

- Factors affecting drift potential
- Application of solids
- Aerial spraying, deposition efficiency
- Aircraft and equipment selection
- Effect of spray additives
- Environmental factors affecting drift potential and herbicide performance
Factors Affecting Drift Potential

- **Application parameters**, especially droplet size and spraying technique (nozzle selection, booms, aircraft, etc.)
- **Weather effects**, especially wind speed and direction, height of inversion layer
- **Tank mix effects**, product formulations, surfactants, emulsifiers, drift control agents
- **Research** by the Spray Drift Task Force and others provides some useful information for minimizing drift
Fixed-Wing Application
Helicopter Spraying
## Rotor Vs. Fixed Wing

<table>
<thead>
<tr>
<th>HELICOPTER</th>
<th>FIXED WING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote Landing</td>
<td>Greater Payload</td>
</tr>
<tr>
<td>Maneuverable</td>
<td>Lower Costs</td>
</tr>
<tr>
<td>Slow Air Speed</td>
<td>More Potential for Off-Site Movement</td>
</tr>
<tr>
<td>Used in Sensitive areas</td>
<td>Not Permitted with Some Herbicides</td>
</tr>
</tbody>
</table>
Solids: Iso-Lair Bucket
Aerial Application of Solids

- Modified seeders and fertilizer spreaders are used to broadcast herbicide granules
- More difficult to control rate per acre and uniformity across the swath than sprays
- Carrier evaporation is not a concern
- Fines or dust in product formulations increase potential for off-site movement
- To avoid streaks or drift, do not apply when winds are gusty or exceed 5 mph
Small Droplets Give Good Coverage on the Leaf Surface

<table>
<thead>
<tr>
<th>Droplet Diameter (Microns)</th>
<th>Droplets on Leaf (Per Sq. Inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>92,250</td>
</tr>
<tr>
<td>100</td>
<td>11,750</td>
</tr>
<tr>
<td>200</td>
<td>1,425</td>
</tr>
<tr>
<td>400</td>
<td>180</td>
</tr>
<tr>
<td>800</td>
<td>22</td>
</tr>
</tbody>
</table>

Akesson and Yates, 1987, WSSA
Small Droplets Drift!!!

<table>
<thead>
<tr>
<th>Droplet Diameter (Microns)</th>
<th>Wind 1 mph</th>
<th>Wind 5 mph</th>
<th>Wind 10 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1.5 miles</td>
<td>7.5 miles</td>
<td>14.5 miles</td>
</tr>
<tr>
<td>100</td>
<td>75 feet</td>
<td>375 feet</td>
<td>750 feet</td>
</tr>
<tr>
<td>300</td>
<td>8 feet</td>
<td>42 feet</td>
<td>83 feet</td>
</tr>
<tr>
<td>600</td>
<td>2 feet</td>
<td>11 feet</td>
<td>21 feet</td>
</tr>
<tr>
<td>800</td>
<td>1 foot</td>
<td>6 feet</td>
<td>12 feet</td>
</tr>
</tbody>
</table>

Hansen, 1965; see Akesson and Yates, 1987, WSSA
## Evaporation Rate & Droplet Size

20 ft, 1 mph Wind, 25°C, 55%RH

<table>
<thead>
<tr>
<th>Droplet Diameter (Microns)</th>
<th>Droplet Disappears (Fall Distance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>--</td>
</tr>
<tr>
<td>150</td>
<td>15 ft</td>
</tr>
<tr>
<td>120</td>
<td>7 ft</td>
</tr>
<tr>
<td>100</td>
<td>3.5 ft</td>
</tr>
<tr>
<td>80</td>
<td>2 ft</td>
</tr>
</tbody>
</table>

Akesson and Yates, 1987, WSSA
Application Parameters Affecting Droplet Size Spectrum

- Orifice size and type of nozzle
- Nozzle discharge angle
- Pressure at the nozzle
- Application height
- Droplet shear, turbulence, airspeed
- Evaporative losses while airborne
Nozzle Selection

- Flat fans, disc-cores, cone nozzles can produce fairly coarse sprays by VMD if operated at low pressures and low nozzle angles.

- Solid stream nozzles can produce even coarser sprays by VMD if operated at medium pressures.

- *All of these also tend to produce some “fines”*

- Multiple-orifice solid stream nozzles such as TVB and Accu-Flo tend to produce very coarse sprays and few “fines” if operated optimally.
Aerial Spray Equipment

- **CONVENTIONAL**
  - Simplex(R) Boom
  - Warnell(R) Boom
  - Teejet(R) Disc-Core Nozzles
  - Raindrop(R) Nozzles

- **CONTROLLED DROPLET**
  - Microfoil(R) Boom
  - Thru-Valve(R) Boom
  - Microfoil(R) Nozzles
  - TVB(R) Nozzles
  - Accu-Flo(R) Nozzles
Microfoil® Boom
Thru-Valve Boom & Nozzle (TVB)
TVB 0.045 Pattern
TVB 0.028 Pattern
Accu-Flo Nozzle
Comparison of the percentage of fines with various nozzles spraying water

% < 153 um

Nozzle Type

- CP helicopter
- D10-46
- CP deflector 30
- CP solid stream
- Accu-Flo 0.016

Minogue 2004, FVMC
Boom Length

- Shorter boom lengths can greatly reduce drift, for rotary and fixed wing aircraft
- For fixed-wing aircraft, the greatest benefit is obtained when booms are <65% of wing length
- Will not necessarily decrease swath width sufficiently to require significantly more flight passes
GPS: Global Positioning Systems

- Documents path of the aircraft
- Delineates treatment area
- Very useful to determine airspeed to ensure correct calibration of spray volume and herbicide rates per acre.
- Can be integrated with injection systems to control delivery rate.
AG-NAV GPS

- Direction to Swath
- Cross-Track
- Direction to Intercept

Large Nav-Bar - External

Medium Nav-Bar - Internal
AG-Flow Flow-Control

Controls output volume based on ground speed
Application Practices: Swath Adjustment

- Most applicators already practice swath adjustment, a practice which can have a very large effect on reducing drift.
- Offset varies by wind speed and droplet size.
- Fly the pattern.
Tank Mix Effects

- Tank mix selection can have a large effect on droplet size from some nozzle types.
- Avoid the use of excessive non-ionic surfactant where possible (especially polyethoxylates).
- Emulsion adjuvants such as emulsified seed oils and organosilicones can reduce “fines”.
- “Drift Control” Polymers tend to increase VMD, but often also increase % “fines”, and may be affected by pumping and tank mix partners; not suitable with some nozzle types.
Herbicide/ Modified Seed Oil Tank Mixes

Minogue and Dexter, 2002, BASF Research Rpt. 2002-02
Polyethoxylate surfactants increase fines.

Percentage of Droplets < 153 microns

Minogue and Dexter, 2002, BASF Research Rpt. 2002-02
Meteorological Effects

- Wind speed and direction are key parameters affecting drift.
- Temperature and relative humidity can affect evaporation rates, so may also be important.
- Air stability important- most labels recommend not spraying under local surface temperature inversion condition.
Conclusions

- Select nozzle type to avoid fine droplets
- Carefully consider application methods and conditions
- Avoid great release heights
- Avoid high wind speeds
- Use short boom lengths and good application practices
- Avoid excessive (NIS) surfactant
- Use emulsion carrier to reduce fines