2011: Weed Control and Crop Tolerance with 2,4-D in the Southeast & MidSouth

First patent on 2,4-D in 1944

Culpepper (UGA) and Steckel (UT)

Dallas Peterson
KSU

Murphy, Mccullough, Prostko, Sosnoskie
UGA

York, Mitchem
NCSU
2,4-D and the NCWSS

1944 – First meeting of NCWCC

- Kephart – Chemical Weed Killers After the War
  - “some of the so-called hormone chemicals are amazingly injurious to plants in almost unbelievably small concentration”

1948 – Over 90% of the 334 abstracts in the NCWCC Research Report addressed weed control and crop tolerance to 2,4-D

(Small grains, corn, sorghum, flax, soybeans, sugarbeets, asparagus, lima beans, onions, potatoes, table beets, strawberries, raspberries, clover, trees, brush, pasture)
## 2,4-D and the Southern Weed Conference

<table>
<thead>
<tr>
<th>Year</th>
<th>Conference</th>
<th>Number of talks with 2,4-D in title*</th>
<th>Total number of talks</th>
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<tr>
<td>1948</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Annual SWC</td>
<td>5</td>
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<td>1949</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Annual SWC</td>
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<td>1955</td>
<td>8&lt;sup&gt;th&lt;/sup&gt; Annual SWC</td>
<td>5</td>
<td>79</td>
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</table>

*Doesn’t include talks that describe ‘effects of herbicides on growth and cytological processes’ or ‘crop response to vapor drift’ or ‘pre-emergence weed control in corn’ or other topics which could refer to experiments with 2,4-D.
2,4-D – Early scientific literature

- Web of Science® search 1945-1955
- 196 articles in which 2,4-D was the topic, including:
  - 2,4-D INJURY TO COTTON FROM AIRPLANE DUSTING OF RICE
    - (1948)
    - PHYTOPATHOLOGY 38: 638-644
  - THE VOLATILITY OF SEVERAL SALTS AND ESTERS OF 2,4-D AS DETERMINED BY THE RESPONSE OF TOMATO, BEAN, AND COTTON PLANTS
    - (1949)
    - PROCEEDINGS OF THE AMERICAN SOCIETY FOR HORTICULTURAL SCIENCE 53: 281-290
  - 2,4-D HERBICIDES POSE THREAT TO COTTON AND OTHER SUSCEPTIBLE CROPS
    - (1953)
    - SCIENCE 118: 782-783
1948 Congressional Hearings about 2,4-D Drift to Cotton

Last year the rice people down in Texas and other Southern States picked it up and when the rice was well out of the ground they began applying 2,4-D dust from airplanes to the rice fields. The first time the laymen heard of it, they heard that there had been a sudden blight to the cotton crops in two of the counties in my district. It so happened that the cotton farmers in that area are among the best we have. They are the descendants of the old Czech and Scandinavian pioneers. They are extremely thrifty, and they farm their own places. We knew immediately that the blight must have been something strange and unforeseeable.
The purpose of the resolution under consideration is to sensibly regulate the use of 2, 4-D and to prevent another disaster such as we had in Texas last year. In approaching it, you ought to know something about the chemical itself. It may be a liquid, but it is most effective in the form of a dust. The dust is an extremely light product. It drifts with the slightest breeze. If you put it in a hopper, or a spray gun or any ordinary means of distributing it, it is so fine that it will go through a crack or a leaky nozzle that water will not go through. Then it has a particular stick-to-itness. Once you use it in a hopper, you cannot clean it all out even under high pressure from a hose. Steam will not clean it out. No ordinary method of cleaning the hopper will get it out entirely. Sometimes they have had it in a hopper which was later used for an insecticide. Although they thought all 2, 4-D had been cleaned out, enough remained to injure potatoes or tomatoes or some other broad-leaved plant on which the bug killer was used.
1948 Congressional Hearings about 2,4-D Drift to Cotton

kinds of dust, and under what atmospheric conditions. It was clear that a very important factor was the height at which the plane was operating from the ground, because we had heard, although I cannot confirm this, that a plane operating over in Louisiana had discharged some 2, 4-D, more or less by accident, I guess, at a high elevation, perhaps several thousand feet, and that that material had drifted for many more miles even than we have been told today. One report says 35 or 40 miles. That has not been confirmed, but we have it on fairly good authority.
1948 Congressional Hearings about 2,4-D Drift to Cotton

HERBICIDES CAN INCREASE FOOD PRODUCTION IN 1948

Statement by C. J. Willard, professor of agronomy, the Ohio State University; president, North Central Weed Control Conference, semiannual meeting of the Agricultural Insecticide and Fungicide Association, Statler Hotel, Washington, D.C., February 20, 1948

The three great groups of enemies of the crop producer are weeds, insects, and plant diseases. Any estimate of the total losses from these three groups of pests shows that weeds cause more loss than either of the others, but we have heard little of weed control compared to insect and disease control, because hitherto we have had no really satisfactory methods of weed control.

In the early years of this century, we had a beginning, in a few isolated cases, of chemical weed control in growing crops. The methods were clumsy and expensive for the most part, and their use did not expand. Sodium chlorate, introduced about 1920 and still the best general herbicide, is little more than a surgical operation to eliminate weeds that have defied other methods of control. Crop production was discontinued while chlorate was used. More and better chemical herbicides were introduced during the 1930's, but in general they were limited to a few special crops and conditions.

It was not until the announcement in 1944 of the organic growth-regulator-type herbicides, of which 2,4-D is the present outstanding example, that we began to hope for anything like general application of chemical weed control to all, or many, crops.
2,4-D Products

- Hundreds of Products on the Market
- Multiple formulations:
  - Esters
  - Amines and Salts
  - Acid
- Liquid and Dry products
- Labels vary by formulation and product
# 2,4-D Labeled Uses

<table>
<thead>
<tr>
<th>Crops</th>
<th>Rangeland, Fallow, and Noncrop Uses</th>
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</thead>
<tbody>
<tr>
<td>Corn</td>
<td>Pasture and Rangeland</td>
</tr>
<tr>
<td>Small grains</td>
<td>Fallow, No-Till Burndown</td>
</tr>
<tr>
<td>Sorghum</td>
<td>Turf</td>
</tr>
<tr>
<td>Rice</td>
<td>Forestry</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>Christmas Trees</td>
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<tr>
<td>Grass for Seed</td>
<td>Rights of Way</td>
</tr>
<tr>
<td>Fruit and Nut Trees</td>
<td>Aquatic</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Ditchbanks</td>
</tr>
</tbody>
</table>
Total 2,4-D Usage on an Area-Weighted Basis

Legend
2,4-D Use (lbs/sq mile)
- 0.0
- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 25.0
- 25.1 - 80.0

<table>
<thead>
<tr>
<th>Crops</th>
<th>Non Crop</th>
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</thead>
<tbody>
<tr>
<td>Corn: 5-15%</td>
<td>Pasture &amp; Rangeland 20%</td>
</tr>
<tr>
<td>Small grains: 35%</td>
<td>Burndown 10-20%</td>
</tr>
<tr>
<td>Sorghum: 5-10%</td>
<td>Turf 25%</td>
</tr>
<tr>
<td>Orchards: 40-50%</td>
<td>Rights of Way 20%</td>
</tr>
<tr>
<td>Vegetables: &lt;1%</td>
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Estimates of Usage SE & MidS
Small Grains in the SE & MidS

2,4-D best option

Radish/Mustard Control
2,4-D Use in Small Grains

• Formulations: mostly esters
• Rates: 0.5 to 0.75 lb ae/acre
• Timing: Postemergence fully tillered
• Species: Wild radish
Timing Effect on Small Grains
2,4-D commonly used in orchards in SE and MidS

**Apple:** do not spray w/n 14 d bloom; avoid contact of tree.

**Pecan:** do not spray in 60 d of harvest; avoid contact of tree.

**Peach:** applications before bud break; no contact of tree.

Amine formulation only. Often up to 1 lb ae when alone in grass strip. Often mixed with glyphosate at 0.5 lb to improve control of morningglory, primrose, radish next in herbicide strip. Will become more important with GR horseweed.
Peaches = winter annual broadleaf weeds growing between strips as part of an integrated approach to control cat-facing insects. Also leaves grass groundcover to prevent erosion and facilitate equipment movement.

2,4-D commonly used in Peaches
2,4-D and Forage Grasses SE and MidS

• The beginning of selective weed control in grass pastures and hay fields.

• Effective for control of:
  – Thistles (bull and musk)       - Buttercup sp.
  – Common Ragweed       - Bitter sneezeweed
  – Cutleaf eveningprimrose - Wooly croton
  – Dandelion              - Plantain sp.
  – Horseweed             - Spiny amaranth
Positive attributes

- Grasses are highly tolerant
  - Seedling grasses @ 4-5 If stage

- Low in cost, usually the first choice of farmers

- Short soil persistence (avg. half-life = 10 d)
  - does not interfere with rotations with other crops
  - In southern U.S. grasses and legumes may be reseeded 1 to 2 months after application
2,4-D and Forage Grasses SE and MidS

• Positive attributes (cont.)
  – MOA of 2,4-D is needed as part of herbicide-resistant weed prevention strategies
    • Sulfonylurea herbicide use is increasing in forage grasses, particularly bermudagrass

  – A common tank-mixture partner with other herbicides (i.e. lower cost, increase control spectrum.
    • Dicamba, clopyralid, triclopyr, picloram, aminopyralid, metsulfuron (Cimarron Max)
2,4-D and Forage Grasses SE and MidS

• Grazing and Haying Restrictions compatible with animal production systems
  – Grazing Restrictions – may vary by label
    • 7 d lactating dairy cattle
    • 0 d beef cattle, horses, others
  – Hay Restrictions
    • 7 to 30 d all livestock species
  – Slaughter – remove animal from 2,4-D treated pasture 3 d before slaughter
2,4-D Turf

Phenoxy Herbicide
- Disrupts cell division, cell enlargement, protein synthesis and hormonal balance.
- Beneficial chemistry in rotation with sulfonylureas and triazines to manage weed resistance in turfgrass.

Turfgrass Use
- Most major warm and cool-season turf species.
- St. Augustinegrass, centipedegrass, and bentgrass golf greens may be sensitive to applications.

Weeds Controlled
- Excellent postemergence activity on annual and perennial broadleaf weeds.
Phenoxy overdose on St. Augustinegrass
2,4-D

**Common Uses**
- Lawns, golf courses, sports fields, and sod farms
- 2,4-D; 2,4-DB, and 2,4-DP used in turfgrass

**Herbicide Combinations**
- 2,4-D is most commonly used in prepackaged formulated mixture products for turf weed control.
- Examples of tank-mix partners: dicamba, MCPP, fluroxypyr, clopyralid, triclopyr, sulfentrazone, quinclorac.
Escalade at 3 pt/acre (2,4-D + dicamba + fluroxypyr)
4 WAT 2009, UGA

Photo: P. McCullough
2,4-D in Corn
Controlling GR Horseweed in RR Corn

Height Guidelines for 2,4-D:

- **Burndown**
  - 1 to 2 pts/ A 7 to 14 DBP
  - Do not apply on coarse soils

- **Applied PRE (Plant deep as practical)**
  - 8 oz/ A, Do not apply on coarse soils

- **Post (Spike to 8”)**
  - 8 oz/ A (if corn is growing rapidly)
  - Should only be sprayed if hybrid is tolerant
Corn Injury with 2,4-D
2,4-D For Burndown
2,4-D in Fallow and Burndown

- Formulations: amine or ester
- Rates: 0.125 to 1 lb ae/acre
- Timing: Crop and formulation dependent
- Weeds: annual and perennial broadleaf weeds

Historical perspective:
- Limited use in early years because of tillage systems
- Common tank-mix partner with glyphosate in 1970’s, 80’s, and 90’s to minimize cost of treatment
- Now it’s a common tank-mix to improve control of problematic weeds
Primrose was driver of 2,4-D use because of its tolerance to glyphosate and it is present in every field.

Radish to a small degree.
Glyphosate + 2,4-D  Untreated

Primrose 6-9”, prebloom

42 days after treatment

% control

1 pt/A 0.75 pt/A 0.5 pt/A 0.25 pt/A
Will it grow back???
Horseweed Control
March 30th Application

- Roundup WM 22 oz + Clarity 8 oz
- Ignite 32 oz + Clarity 8 oz
- Ignite 32 oz + Clarity 4 oz
- Ignite 32 oz + 2,4-D 32 oz
- Gramoxone Max 32 oz + Clarity 8 oz
- Roundup WM 22 oz
- Ignite 32 oz
- Gramoxone Max 32 oz

LSD = 13

% Control 40 DAT
2,4-D vs Clarity for Horseweed

There appears to be no difference in horseweed control between the two 2,4-D salts.

In our data 2,4-D showed similar horseweed control to Clarity.

In the field 2,4-D has not been as consistent.
Edgecombe Co., NC 2008
8 weeks after burndown

Untreated                          Roundup only                          Roundup + Valor

Roundup + Valor + Clarity       Roundup + Valor + 2,4-D
2,4-D at Planting

Ignite
Spray Drift and Tank Contamination

- Spray drift and tank contamination has been an ongoing issue with the use of 2,4-D since its introduction.
- Improved formulations and application techniques have lessened the problem over time, but still room for improvement.
Arkansas 2,4-D Application Restriction

- Applies to North West AR Counties
  - 2,4-D can be applied up to April 15
    - No 2,4-D can be sprayed for any reason after this date
  - Exemptions can be applied for:
    - Quite a bit of paper work
    - Representative from AR plant board as well as land owner must be present at time of application
    - Rarely occurs
FLorida 2,4-D Application Restriction
(FL’s Organo-Auxin Herbicide Rule No. 5E-2.033)

- No high volatile forms
  - Except for use as PGR on citrus

- Other forms
  - Can be used if follow specific guidelines
  - Ex. 4 mph crosswind = 1/8 mile
  - Ex. 4 mph upwind = 5 feet
  - Ex. 4 mph downwind = ¼ mile
2,4-D Uses - Summary

- 2,4-D has been and continues to be a widely used herbicide.
- 2,4-D is a very versatile herbicide used in a wide variety of crops and situations.
- 2,4-D is a valuable tank-mix partner with other herbicides for broad-spectrum, cost-effective weed control.
- 2,4-D is a useful herbicide to help manage herbicide resistant weeds.
Questions or Comments?