

## Mode of Action: Cell Division Inhibitors

## General properties of the cell division inhibitors

- Inhibit either the root or the shoot growth of emerging seedlings
- usually applied to the soil as PRE or PPI
- little to no translocation of these herbicides
- little to no activity on foliage of established plants
- selective herbicides
- moderately to highly resistant to leaching

From: Monaco, Webster, and Ashlock, 2002

## Herbicide Injury Symptoms

- For root inhibitors: Herbicide family Dinitroaniline (DNA's)
  - grass injury (corn)



<http://missouri.com/crops/corn/images/cornseedling.jpg>

<http://www.kmy.purdue.edu/Extension/Weeds/Herb1nj2/InjuryHerb3.html>

## Herbicide Injury Symptoms

- For root inhibitors: Herbicide family Dinitroaniline (DNA's)
  - broadleaf injury (soybean)



<http://www.secdquest.com/News/releases/2007/graphics/188143.jpg>

<http://www.kmy.gardner.edu/Extension/Weeds/Herb1nj2/InjuryHerb3.html>

## Herbicide Injury Symptoms

- For shoot inhibitors: Herbicide family, Chloroacetamides and Carbamates
  - Grass injury (corn), buggy-whip effect



[http://www.zit.tastate.edu/images/plantpath/corn/seedling/198g\\_2himginfroot](http://www.zit.tastate.edu/images/plantpath/corn/seedling/198g_2himginfroot)

<http://extension.missouri.edu/explore/images/tpm1007seedling08.jpg>

## Herbicide Injury Symptoms

- For shoot inhibitors: Herbicide family, Chloroacetamides and Carbamates
  - broadleaf injury (soybean), drawstring effect



[http://www.aglabs.com/newsletters/images/soybean\\_label04.jpg](http://www.aglabs.com/newsletters/images/soybean_label04.jpg)

<http://extension.missouri.edu/explore/images/tpm1007seedling08.jpg>

## Herbicide groups classified as cell division inhibitors

- Root inhibitors [bind tubulin]
  - Dinitroaniline (DNAs)
- Shoot inhibitors [disorganize microtubules]
  - Chloroacetamide
  - Carbamate

## Herbicide Family: Dinitroaniline

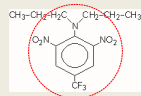
SITE OF ACTION: BIND TUBULIN  
MODE OF ACTION: CELL DIVISION INHIBITOR

## Dinitroanilines (DNA's)

- 2,6-dinitrobenzenamine
  - [2,6-dinitroaniline]
- Characteristic yellow color

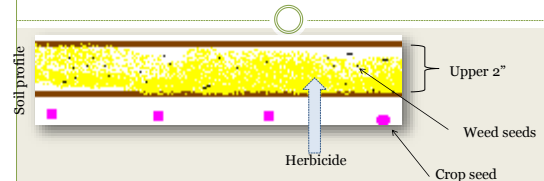


Historically used as yellow dyes



- Insoluble in water, so mainly formulated as EC or G
- Soil persistence generally lasts 8-12 weeks
- Moderate volatility, especially in moist soil
- Must incorporate because degraded by sunlight

## Herbicide Incorporation



- Applied to surface (PRE), and/or mechanically incorporated
- Objectives
  - Place herbicide in position to maximize plant uptake
  - Promote control of emerging seedlings (root uptake)
  - Reduce volatility (incorporation)
  - Reduce \*photodegradation\* (incorporation)

## Other Historical Facts, DNAs

- Historically, some of the most important soil-applied herbicides in the world
- At one time they held 8-10% of total US herbicide sales

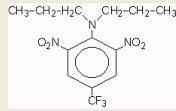
## Biological Properties

- Soil applied and absorbed by weed seedlings during emergence
- Control mainly grass weeds and some small-seeded broadleaf weeds
- DNA-resistant grass plants:
  - green foxtail, 1989
- Very susceptible to photodegradation



## Trifluralin

- Trade name: Treflan (many generics)
- Cost: \$6-8/lb
- Rates: 0.5-2 lb/A
- Time applied:
  - PPI, most common
    - ✦ If incorporating in dry soils, 24 hr delay is acceptable
  - PRE-incorporated, volatility concerns under moist soil conditions



## Weeds Controlled

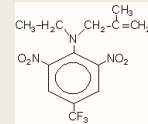
- Most annual grasses and some small seeded broadleaf weeds
- Grass
  - barnyardgrass, E
  - downy brome, F-G
  - green foxtail, E (does not control resistant)
  - yellow foxtail, E
  - wild oat, P-F
- Broadleaf
  - c. lambsquarters, G-E
  - redroot pigweed, E
  - Russian thistle, G
  - wild mustard, P
  - wild buckwheat, P

## Crops Labeled

- Wheat, Barley:
  - Application methods vary depending on crop and season
  - Stand reduction if incorporated too deep
- Soybean, cotton, sunflower, dry bean, safflower, flax, mustard, lentil, legume forage establishment
- Many horticultural crops
- Included in several turf premixes

## Ethalfuralin

- Trade name: Sonalan
- Cost: \$15/lb
- Rate: 0.6-2.25 lb/A
- Time applied:
  - PPI
  - PRE-incorporated



## Weeds Controlled

- Grasses and some broadleaf weeds
- Weed control spectrum similar to trifluralin, but does better on the goosefoots and provides a little nightshade control (WCG)
- Soil persistence is slightly less than trifluralin. Waiting 48 hrs to incorporate is acceptable – **but not recommended**

## Crops Labeled

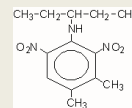
- Legumes: soybean, dry beans, field pea, chick pea/garbanzo bean, peanut
- Mustards: canola, crambe
- Non-legume: safflower, sunflower

### Other Comments: Trifluralin and Ethalfluralin

- Residue can affect sugarbeets and some grass crops the year after treatment
- Be aware of resistant **green** foxtail!

### Pendimethalin

- Trade name: Prowl (3.3 EC), Prowl H2O (ACS)
- Cost: \$12-14/lb
- Rates: 1-1.5 lb/A
- Time applied: PRE or PPI
  - Less volatile
  - If surface applied (PRE), 1" rain provides incorporation
  - Much less photodegradation



### Weeds Controlled

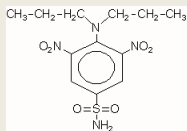
- Most annual grasses and some annual broadleaf weeds (incorporation enhances efficacy)
  - wild oat, F
  - green foxtail, E (not resistant)
  - yellow foxtail, E
  - common lambsquarters, G-E
  - redroot pigweed, E
  - Russian thistle, G
  - wild mustard, P
  - nightshade family, N

### Crops Labeled

- Corn
  - Legumes
  - Sunflower
  - Vegetable (hort crops)
  - Tree crops
  - Established lawn and turf
  - Ornamentals
- } Often impregnated on fertilizer

### Oryzalin

- Trade name: Surflan
- Cost: \$25/lb
- Rates: 2-4 lb/A
- Time applied: PRE
  - non-volatile
- Weed control spectrum similar to pendimethalin



### Crops Labeled

- container grown and outdoor ornamentals
- fruit crops, vineyards, nut crops
- industrial turf and right of way



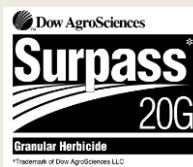
## Herbicide family: Chloroacetamides

SITE OF ACTION: NOT WELL UNDERSTOOD,  
DISORGANIZE MICROTUBULES  
MODE OF ACTION: CELL DIVISION INHIBITOR

## Introduced Under VLCFA Inhibitors

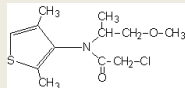
- Acetochlor
- Alachlor
- Metolachlor

 Dual II Magnum®



## Dimethenamid-P

- Trade name: Outlook, generics
- Cost: \$30/lb
- Rates: 0.5-0.8 lb/A
- Time applied: PPI, PRE, EPOST



**Outlook**®  
herbicide

**BASF**  
The Chemical Company

## Weeds Controlled

- Some annual grass and a few broadleaf weeds
  - foxtails, G-E
  - vol. cereals, G
  - wild oat, P
  - nightshades, F-G
  - pigweeds, G-E
  - goosefoots, P-F
  - wild mustard, P-F

## Crops Labeled

- Legumes
  - dry bean, peanut, soybean
- Grasses
  - Corn, Sorghum
- High Value
  - Sugarbeet (post 2-leaf to 8-leaf stage), compatible tank-mix
  - Onion

## Other comments

- Popular pre-mix partner by BASF
- Rates have been reduced by 40% due to improved manufacturing of the active isomer
  - Less total herbicide applied to the environment, but similar to better weed control results
- Soil persistence is generally inconsequential for next years crop in ND

## Herbicide family: Isoxazoline

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## Pyroxasulfone

- Trade name: Zidua
- Premixes:
  - FMC – Anthem (with fluthiacet)
  - Valent – Fierce (with flumioxazin)
- Cost: \$170/lb
- Rates: 0.05-0.21 lb/A
- Time applied: shallow PPI, PRE, EPOST
  - Introduction of delayed PRE timing



## Weeds Controlled

- Some annual grass and a few broadleaf weeds
  - foxtails, G-E
  - vol. cereals, N
  - wild oat, F-G
  - barnyardgrass, E
  - nightshades, F-G
  - pigweeds, G
  - goosefoots, P
  - wild mustard, P

## Crops Labeled

- Zidua
  - corn
  - cotton
  - soybean
  - wheat
- Anthem
  - corn
  - soybean
- Fierce
  - orchards
  - vineyards
  - fallow



## Herbicide group: Carbamates

**SITE OF ACTION: NOT WELL UNDERSTOOD,  
DISORGANIZE MICROTUBULES  
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