**MODE OF ACTION: LIPID SYNTHESIS INHIBITORS**

Site of Action #1: Acetyl-CoA carboxylase enzyme (ACC-ase) membrane lipids

Site of Action #8 (15): Very Long Chain Fatty Acid (VLCFA) elongases elongation of carbon chains for waxes

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**ACCase injury symptoms**

- Injury takes 7-14 days (grasses only)
- newer leaf tissue will be yellow (chlorotic) or brown (necrotic)
- Leaves in whorl easily removed with a “tug”
- ACCase resistant grass plants do occur
- Limited soil activity

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**ACCase structural families**

- Cyclohexanediones
  - DIMs
- Aryloxyphenoxypropionate
  - FOPs
- Phenylpyrazolin
  - DEN

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**HERBICIDE FAMILY: CYCLOHEXANEDIONE (dim)**

Site of Action: Acetyl-CoA carboxylase enzyme (ACC-ase) SOA #1

Mode of Action: Lipid synthesis inhibitors

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**Sethoxydim**

- Trade name: Poast
- Cost: $67/lb
- Rate: 0.1-0.3 lb/A
- Time applied: POST and translocated
  - The first POST grass herbicide
- Weeds controlled: annual and perennial grasses
  - quackgrass, F
  - downy brome, P-G
  - All other WCG ratings, E or G-E

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**Clethodim**

- Trade name: Select, generics
- Cost: $33-100/lb
- 0.05-0.1 lb/A
- Time applied: POST
- Weeds controlled: annual and perennial grasses, generally does a better job than sethoxydim
  - All WCG ratings, E
  - quackgrass, G-E
  - downy brome, P-E
Other comments, Seth and Clet

- Crops labeled
  - many (see label)
  - selects for grasses in broadleaf crops
- Use of oil concentrate increases efficacy
  - MSO is best but PO sufficient
  - Sethoxydim is degraded by UV light, MSO gives more rapid absorption = less sun time
- Antagonism with broadleaf herbicides
  - apply one day before, or 5d after broadleaf herbicide

ACC-ase resistant weeds do occur

- wild oat, 1991
- green foxtail, 2010

Fenoxaprop

- Trade name: Parity/Tacoma
- Cost: $165-190/lb
- Rates: 0.04-0.08 lb/A
- Time applied: POST

Weeds controlled

- Annual grasses
  - green foxtail, E (0.04 lb/A)
  - vol. corn, E (0.04 lb/A)
  - wild proso millet, E (0.05 lb/A)
  - yellow foxtail, E (0.05 lb/A)
  - wild oat, E (0.08 lb/A)
  - barnyardgrass, E (0.08 lb/A)
  - downy brome, N
  - quackgrass, N

Crops labeled

- Selects for many weedy grasses in grass crops!
  - Just fenoxaprop: HRS wheat (must include a auxin-type herbicide for broadleaves)
    - Application timing: emergence to 60 d prior to harvest
      - auxin-type herbicide antagonized fenoxaprop providing safety.
    - Application timing: Emergence to 4-leaf stage
  - Rice: fenoxaprop is called Whip 360, barnyardgrass control
  - Turfgrass: fenoxaprop + an oil adjuvant, called Acclaim Extra
    - controls large crabgrass and smooth crabgrass
    - may briefly stunt Kentucky bluegrass, but plants will quickly outgrow injury symptoms
Other comments

- Protection against injury by fenoxaprop must be provided
  - Antagonism only works in HRS wheat
  - Parity/Tacoma® include the safener mefenpyr

- What does the safener do?
  - Reduces crop injury without reducing weed control
  - How?
    - by enhancing metabolism in crops, but not as much in susceptible weeds

Enhanced metabolism by safeners

- fenoxaprop ethyl
- fenoxaprop acid
- further metabolism faster in crops than weeds

Clodinafop

- Trade name: Discover NG
- Cost: $290/lb
- Rate: 0.05-0.06 lb/A
- Time applied: POST

Weeds controlled

- wild oat, E (0.05 lb/A)
- barnyardgrass, E (0.05 lb/A)
- green foxtail, E (0.06 lb/A)
- yellow foxtail, G-E (0.06 lb/A)
- quackgrass, P (0.06 lb/A)

Crops labeled

- 2-leaf to prior to boot
  - HRS wheat
  - durum

- OTHER COMMENTS
  - packaged with its own adjuvant
  - sold with a safener, cloquintacet-mexyl
  - not as prone to antagonism as fenoxaprop

Summary: clodinafop and fenoxaprop

- Both herbicides control grass weeds in grass crops
- Generally speaking:
  - Fenoxaprop is considered better on foxtails
  - Clodinafop is considered better on wild oat
  - It’s newer – but not newest

- Some consultants will recommend mixing the two at reduced rates to pick up both groups of weeds
**Fluazifop-P**
- Trade name: Fusilade DX
- Cost: $68/lb
- Rate: 0.09-0.19 lb/A
- Time applied POST

**Weeds controlled**
- Annual and perennial grass weeds
  - vol. corn, G
  - wild proso millet, G
  - green foxtail, G-E
  - yellow foxtail, G-E
  - quackgrass, G (suppression)
  - wild oat, E
  - downy brome, F-G

**Crops labeled**
- Used in dicot crops
  - soybean
  - cotton
  - fallow/non-crop
  - ornamentals
  - some tree fruit and nut crops
  - onion (monocot)

**Quizalofop-P**
- Trade name: Assure II
- Cost: $123/lb
- Rate: 0.03 to 0.07 lb/A
- Time applied: POST

**Weeds controlled**
- Annual and perennial grass weeds
  - vol. corn, G
  - wild proso millet, G
  - green foxtail, E
  - yellow foxtail, F-G
  - quackgrass, G-E (suppression)
  - wild oat, G
  - downy brome, P-E

**Crops labeled**
- Soybean
- dry bean
- lentil
- field pea
- sugarbeet
- canola
- Non-crop areas
  - excellent product for establishment of wild-flowers
Other comments: fluazifop-p and quizalofop-p
- ACC-ase herbicides in general are antagonized by broadleaf herbicides
  - Antagonism occurs on the leaf surface (decreased absorption)
  - Antagonism occurs internally with auxin herbicides (decreased translocation)
    - apply one day before or five days after broadleaf herbicide
- Absorption is relatively quick compared with cyclohexandiones
- Use petroleum oil concentrate (POC) instead of MSO

HERBICIDE GROUP: PHENYLPYRAZOLINE (den)

Site of Action: ACC-ase Inhibitor
SOA #1
Mode of Action: Lipid Synthesis Inhibitor

Pinoxaden
Trade name: Axial XL
Cost: $314/lb
Rates: 0.05 lb/A
Time applied: POST

Weeds controlled
- Many annual grasses
  - 1- to 6-leaf stage, prior to emergence of 4th tiller
    - wild oat, E
    - Persian darnel, E
  - 1- to 5-leaf stage, prior to emergence of 3rd tiller
    - green foxtail, E
    - yellow foxtail, G-E
    - barnyardgrass, G-E

Crops labeled
- crop stage for safe application:
  - 2-leaf to prior to boot

- HRS wheat
  - but not durum

- Barley

Other comments
- Newest of the grass control products in grass crops
- Formulated with Adigor adjuvant
- Can be tank-mixed with most broadleaf herbicides
- Commercial premix with fluroxypyr
  - Axial Star
- Excellent crop safety
- Minimal rotation restrictions
  - HRS wheat, durum, barley: 0 days
  - 4 months most others
HERBICIDE GROUP: CARBAMOTHIOATES (FORMERLY THIOCARBAMATES)

Site of action: Very Long Chain Fatty Acid Inhibitors
SOA #8 - Elongation of carbon chains
Mode of Action: Lipid synthesis inhibitor

General Characteristics
- Derivatives of Carbamic Acid
- Most carbamothioates are volatile (high vapor pressure), especially in moist soil
- Short soil persistence (3-6 weeks)
  - microbial metabolism enhanced by familiarity
- Insoluble in water, but formulated as ECs

Biological Properties
- **PPI** or PRE
  - Some kill only grasses, some grasses and broadleaf weeds
    - Use declined with increasing reduced/no-till
    - Use reconsidered with res. grasses
- Readily absorbed by roots, shoots, and foliage
  - generally translocated after absorption to the shoots, which is where they inhibit development

EPTC
- **Trade name:** Eptam
- **Cost:** $7/lb
- **Rates:** 2-6 lb/A
- **Time applied:** PPI (very volatile)

Eptam 20-G Granules

Weeds controlled
- Most annual grass and some broadleaf weeds
  - green foxtail, E
  - yellow foxtail, E
  - quackgrass, F-G
  - vol. cereals, G-E
  - wild oat, G-E
  - wild buckwheat, F
  - c. lambsquarters, F
  - nightshades, F
  - pigweeds, G
  - common ragweed, F
  - wild mustard, P
  - Canada thistle, N

Crops labeled
- sugarbeet (spring: 2-3 lbs/A; fall: 3.5-4.4 lbs/A)
- potato
- sunflower
- dry bean
- safflower
- alfalfa
Other comments

- Often fall applied after Oct 15
  - cool soil temperature (<45°F), reduces microbial degradation
- Very volatile so must be incorporated immediately
- 3-6 weeks soil persistence
  - with cool soil temps this window carries over to the next spring

Accelerated degradation (aka conditioning)

- Soil microbial population becomes enriched due to extensive use of the herbicide
- Degradation may occur so rapidly that the period of weed control is inadequate
- Extenders – chemicals added to inhibit microorganisms
  - Eptam contains EPTC
  - Eradicane included EPTC plus safener
  - Eradicane Extra was EPTC, safener, and microbicide

Cycloate

- Trade name: Ro-Neet
- Cost: $30/lb
- Rates: 3-4 lb/A
- Time applied: PPI (volatile)
- Weeds controlled:
  - annual grasses, G-E
  - nightshades and pigweeds, F-G
- Crops labeled: sugarbeet, table beet, spinach
  - safer on sugarbeet than EPTC

EPTC and Cycloate [WCG p. 87]

- EPTC may cause sugarbeet stand reduction in coarse, low OM soils
- Cycloate causes less sugarbeet injury on coarse, low OM soils
- EPTC gives better weed control than cycloate on fine textured, high OM soils during dry conditions
- Cycloate gives better weed control when spring rains are adequate
- Adjust rates based on soil type!

Triallate

- Trade name: Far-Go (4EC or 10G)
  - pre-mix of triallate and trifluralin called Buckle
- Cost: $14/lb
- Rates: 1-1.5 lb/A
- Time applied: PPI or PRE-incorporated

Wild oat controlled

- unique because most wild oat herbicides are POST

Crops labeled

- winter wheat, HRS wheat, durum, barley, field pea chick pea, lentil, and sugarbeet
Other comments

- Fall application typically provides better wild oat control (10%)
  - minimizes losses by volatility and microbial degradation
- Volatile, incorporate immediately after application
  - much less volatile than EPTC
- Selectivity based on differences in wheat and wild oat emergence types
  - Wheat = elongating coleoptile
    - growing point at seed for 2-3 wks, absorption does not occur
  - wild oat = elongating coleoptile and first internode
    - growing point close to surface, absorption occurs in herbicide band

Spring treatment
- seed wheat first deep, then incorporate triallate shallow
  - like the previous picture

Fall treatment
- seed wheat shallower to minimize seed exposure to herbicide already in the soil profile

Relative effectiveness
- Granules most effective in fall
- liquid most effective in spring

General Characteristics

- Chloroacetamide chemical and physical properties
  - Derivatives of acid amide
  - Acetanilide subgroup
  - Persistence in soils generally 6 to 10 wks
    - reason, along with weed control, for being a very widely utilized herbicide group
  - Moderate solubility in water
    - ground water concerns

Biological properties

- PRE herbicides
  - absorbed by roots (mainly dicots)
  - absorbed by shoots (mainly monocots)
- Control many annual grasses and broadleaf weeds
- Site/Mechanism of action: VLCFA inhibitors
- Selectivity appears to be based on the rate of metabolism… tolerant plants metabolize the chloracetamides faster than susceptible plants

Herbicide injury symptoms

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

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

Weeds controlled

- most annual grasses and some broadleaf weeds
  - foxtails, G-E
  - Wild Oat, P-F
  - common lambsquarters, G-E
  - nightshades, G-E
  - pigweeds, G-E
  - wild mustard, F
  - yellow nutsedge, "controlled"

Metolachlor

- Trade name: Dual Magnum, Dual II Magnum
- Cost: $13-15/lb
- Rates: 1.25-1.9 lb/A
- Time applied: PRE

Acetochlor

- Trade name: Harness, Surpass, Warrant, generics
- Cost: $11-15/lb
- Rates: 1.1-2.0 lb/A
- Time applied: PRE or PPI

Crops labeled

- corn
- cotton, sorghum, soybean (Warrant)

Other comments

- Sold with a safener to prevent injury to corn
- Works well on high clay and high OM soils; label claims activated with 0.25 inch rainfall
  - Increasing OM and clay, typically hold herbicides better
- Frequently premixed (atrazine, dicamba, others...)

Weeds controlled

- Most annual grass and some broadleaf weeds
  - foxtails, G-E
  - wild oat, P-F
  - pigweeds, G
Crops labeled
- Corn, horseradish, dry bean, field pea, peanut, potato, pumpkin, rhubarb, safflower, sugarbeet, sunflower, sorghum, soybean, tomato

Other comments
- Tightly bound to high clay and high OM soils