MODE OF ACTION:

Amino Acid Synthesis Inhibitors

Sites of action:

- **Acerolactate Synthase Inhibitors** ([ALS] group 2)
  - Inhibit formation of branch chain amino acids (valine, leucine, isoleucine)
  - Herbicide families:
    - Imidazolinone: IMIs
    - Sulfonyleurea: SUs
    - Triazolopyrimidine: TPs
    - Sulfonlamino carbonyl-triazolinone: SACTs
- **EPSP Synthase Inhibitor** ([glyphosate] group 9)
  - Inhibit formation of aromatic amino acids (phenylalanine, tyrosine, tryptophan)
- **Glutamine synthetase inhibitor** ([glufosinate] group 10)
  - Inhibits glutamine synthetase enzyme, which converts glutamate + ammonia to glutamine

Why are amino acids important?

Herbicide injury symptoms

- **General symptoms**:
  - slow to develop (1-2 wk), stunting or slowing of plant growth
  - chlorosis
  - slow death
- **ALS inhibitors**
  - Broadleaf plants
  - Grass plants
- **EPSP Synthase**
  - nonselective
- **Glutamine Synthetase, exception to AA symptomology**
  - nonselective
  - exception to general symptomology
Glyphosate injury

Herbicide family: Sulfonylurea (SUs)

 Mode of action: Amino acid synthesis inhibitor
 Site of action: Acetolactate synthase (ALS)

General characteristics: SUs

- **Chemical and physical properties**
  
  
  - **Insoluble in water:** Sold as WDGs

- **Historical:** Introduced by the DuPont Co. in the 1980s
  
  - **Noted for their efficacy at low rates and selectivity**
  
  - **Example:** Chlorsulfuron safe in wheat in soil concentrations up to 100 ppb
  
  
  - Sugarbeet is injured at 0.1 ppb
  
  
  - 1000 X difference!

- **Slight changes in the basic chemical structure can have great effects on the selectivity of these herbicides from one crop to another!**
  
  - **SELECTIVITY due to differential metabolism**

- **Control of many broadleaf and grass weeds**
  
  - Selectivity varies greatly from herbicide to herbicide
  
  - All applied POST, some have PRE activity

- **Some crops are very susceptible**

- **Need nonionic surfactant (NIS) for activity**

- **SUs + organophosphate insecticides may be synergistic and increase crop injury**

SU resistant weeds

- **Kochia 1987**
  
  - Wild Mustard 1999
  
  - Marshelder 2003

Check out other resistant biotypes
- WCG page 98
Concept: Soil persistence

- Herbicide carryover, WCG p. 102-105
- Definition:
  - The length of time a herbicide remains in the soil. Refers to either the effective life (biological activity) or total soil residence time.
  - Herbicide half-life is a chemical property indicating persistence.
- Why is soil persistence important?
  - Residues may remain to provide control.
  - Residues may carry over and affect susceptible crops.
  - Residues may contaminate edible portions of crops and the water supply.


Soil residual

- Some ALS inhibitor herbicides have soil persistence and are described in the ND WCG as:
  - SR = Short residual, no concerns for next year’s crop.
  - LR = Long residual, can persist up to 3 years.
  - VLR = Very long residual, can persist more than 3 years.
- Some may persist longer if used improperly:
  - **CHECK THE LABEL**
  - Know your soil type and pH.
    - Generally speaking, higher pH means less degradation and more availability of SUs, since they are broken down in acidic soils.

Chlorsulfuron VLR

- Trade name: Glean (crop), Telar (noncrop).
- Cost: $33/oz
- Time applied: POST and translocated (some PRE).
- Weeds controlled (best if less than 2 in tall):
  - Wild mustard – E
  - Kochia – E (except ALS resistant)
  - Composite family – G-E
- Crops labeled:
  - Wheat, barley, and oats
  - 2-leaf to prior to boot.

Metsulfuron LR

- Trade name: Ally (crop), Escort (non-crop).
- Cost: $11.50/oz – $15.50/oz.
- Rates: 0.03 – 1.2 oz/A.
- Time applied: POST and translocated.
  - 2-leaf – prior to boot-stage.
- Weeds controlled:
  - Kochia, mustard spp., and perennial sowthistle.
  - 2,4-D or MCPA improves broadleaf weed control and crop safety.

Other comments:

- Sold in premixes:
  - E.g., Finesse® or Cimarron Plus®
  - Chlorsulfuron + metsulfuron
  - Other generic combos as well (Chism).
  - Do not apply within 22 mo of last treatment of either chlorsulfuron or metsulfuron.
  - Degrades slowly in high pH soils (7.5-7.9).
  - Do not apply to soils with a pH over 7.9.
  - Crops vary in susceptibility.
  - Original herbicide that selected for ALS-resistant Kochia.

Crops labeled:

- Wheat.
- Barley.
- Small grain preharvest (burndown faster than other SUs).
- CRP (rates generally higher).
- No grazing restrictions.
Thifensulfuron SR

- **Trade name:** Harmony SG
- **Several generics**
- **Premixes with tribenuron, Affinity and several generics**
- **Cost:** up to $80/oz, premixes $8 to 15/oz
- **Rates:** 0.06 – 0.7 oz/A (0.3 – 0.7 oz/A*)
- **Label rates vary widely on formulation type and use**
- **Time applied:** POST and translocated

Weeds controlled

- **kochia, F-G**
- **common lambsquarters, G**
- **redroot pigweed, E**
- **Pennsylvania smartweed, G-E**
- **wild mustard, P *G-E (not winter annual mustard spp.)**
- **wild buckwheat, P *E**
- **Common ragweed, N *G**
- **Nightshades, N**

Crops labeled

- **Soybean (NO OIL-based adjuvants!)**
  - at fully expanded first trifoliolate to 60 d preharvest
- **Tolerance is due to metabolism (deesterification)**
- **Small grains**
  - 2-leaf to prior to flag-leaf emergence
  - HRS wheat
  - Durum wheat
  - Barley
  - Oat

Tribenuron SR

- **Trade name:** Express SG, generics
- **Premixes available with thifensulfuron**
- **Cost:** $44/oz
- **Rate:** 0.13-0.33/A
- **Time applied:** POST and translocated

Weeds controlled

- **mustard spp., E (even winter annual mustards)**
- **kochia, E**
- **Russian thistle, E**
- **marshelder, E**
- **Canada thistle, G (suppression)**
  - advantage over thifensulfuron

Crops labeled

- **Small grains, 2-leaf to prior to flag-leaf emergence**
  - HRS wheat
  - Durum wheat
  - Winter wheat
  - Barley
- **Express Sun sunflower (0.13-0.25 oz/A)**
  - Early POST (EPOST) 2-leaf to prior to bud formation
**Nicosulfuron LR**

- **Trade name:** Accent Q
- **Premixed with rimsulfuron such as in Steadfast Q**
- **Cost:** $40/oz
- **Rates:** 0.35-0.5 oz/A
- **Time applied:** POST and translocated

**Weeds controlled**

- wild oat, E
- green foxtail, E
- yellow foxtail, F-G
- quackgrass, G-E
- barnyardgrass, E
- vol cereals, G-E
- mustard spp., E
- red root pigweed, E
- common lambsquarters, P

**Crops labeled**

- corn
- popcorn
- sweet corn

- Grass selectivity in corn!

**Other comments:** Nicosulfuron

- COC required for improved activity
- herbicide persistence: follow label for rotation restrictions
- For onion, potato, and sugarbeet 18 months and 28 inches of rain in ND
- Broadleaf weed control improved with tank-mix partners
- OP insecticides may cause synergism and increase injury to corn

**Sulfozulfuron VLR**

- **Trade name:** Maverick, Outrider
- **Cost:** $24.00/oz
- **Rate:** 0.25-0.5 oz/A
- **Time applied:** PRE and POST
- **Weeds controlled:** Bromus spp., mustard spp., wild oat, and quackgrass (POST)

- Labeled for use in corn

- other grass control ratings: ND WCG p. 13

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**Foramsulfuron LR**

- **Trade name:** Option
- **Sold with isoxadifen safener**
- **Cost:** $30.00/oz
- **Rate:** 0.53-0.61 oz/A
- **Time applied:** Post and translocated

**Weeds controlled:** Grass weed spectrum the same as nicosulfuron, except control of yellow foxtail (E) and some broadleaf species is improved

- Labeled for use in Corn

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1/21/2019
Crops labeled
- Winter wheat
- HRS wheat
- Certain grass turf and roadsides

Other comments
- Requires a NIS + tank pH between 6-8
- Up to 22 month soil residual; crop rotation restrictions
  - Recommended only for use in continuous wheat due to rotation restrictions

Triflusulfuron SR
- Trade name: UpBeet
- Cost: $40/oz
- Rates: 0.13 – 0.25 oz/A
- Time applied: POST
  (weeds cotyl – 2-leaf)

NDSU Micro-rate program
- Weed control in sugarbeet (WCG p. 44, 87 (M8))
  - Triflusulfuron is generally sprayed with a herbicide tank-mix with multiple herbicides
    - triflusulfuron + desmedipham + phenmedipham + ethofumesate + clethodim + MSO
    - Include clethodim for grass control
    - Applications begin when weeds are just emerging
    - MSO increases weed control with low rates
    - Applications are made 3 or more times at 5 to 7 day intervals as needed

Weeds controlled via micro-rate
- Primarily targets broadleaf weeds
  - Wild buckwheat: F-G
  - Kochia: E (not ALS res)
  - Common Lambsquarters: G-E
  - Wild mustard: E
  - Nightshades: G
  - Redroot pigweed: G-E
  - Canada Thistle: F-G
  - Lanceleaf sage: P-F

Rimsulfuron: LR
- Trade name: Matrix
- Cost: $73/oz
- Rate: 0.25 – 0.38 oz/A
  - Up to 1 oz/A in tree crops
- Time applied: PRE (after hilling and before potato emergence) or POST (before potato is 14” tall)
- Crops labeled: Potato (citrus, stone, pome fruits; tree nuts; grape; tomato)
- Weeds controlled: Eastern black nightshade (G), hairy nightshade (F), black nightshade (N)

Halosulfuron: LR
- Trade name: Permit, Sandea, others
- Persistence longest at pH=7 (also true for rimsulfuron)
  - Acid hydrolysis below pH 7
  - Uncommon base hydrolysis above pH 7
- Controls c. sunflower, c. cocklebur, c. ragweed, mustard spp., and Venice mallow
- PRE or POST
- Crops labeled: corn, sorghum, rice, sugarcane, cotton, and dry bean
Herbicide family: Imidazolinone (IMIs)

Mode of action: Amino acid synthesis inhibitors
Site of action: Acetolactate synthase (ALS)

Importance of Structure Shape

- **Synthesis produces meta- and para-isomers**
  - meta-isomer: controls wild oat, weak on wild mustard
  - para-isomer: controls wild mustard, weak on wild oat
  - formulated as the methyl ester in a 3:2 ratio of the para- and meta-isomers (same formula, different compounds)

Weeds controlled

- green foxtail, G
- yellow foxtail, F-G
- common cocklebur, E
- kochia, E (except ALS resistant)
- lancelleaf sage, E
- mustard family, E
- nightshade family, E
- pigweed family, E
- common ragweed, P
- Canada thistle, N

IMI soil persistence (ND WCG p.102)

- **Major difference from SUs**
  - SUs are broken down by acid hydrolysis
    - Occurs most readily in soil pHs < 6.8
    - At soil pH > 7 SUs are (-) charged, and do not bind with (-) charged soil
      - SUs persist much longer
      - Are very available for plant uptake
      - Minimally affected by soil moisture, texture, OM, or microbes
  - In contrast, IMIs are:
    - degraded microbially, soil pH > 6.5, warm temps
    - strongly adsorbed to organic matter (OM) in dry soils
    - displaced from OM in moist soils

Imazethapyr LR

- **Trade name:** Pursuit
- **Cost:** $16-18/oz
- **Rate:** 0.5-0.75 oz/A (RRV), 1 oz/A most of US
  - 0.5 oz/A rate is for drybean and pea to avoid injury
- **Time applied:** PPI, PRE, or POST; translocates

Weeds controlled

- Avoid treating plants in bloom
- soybean
- dry bean
- field pea, chickpea, lentil
  - for legumes apply from 1<sup>st</sup> trifoliate to pre-bloom
- Clearfield<sup>®</sup> corn (imi-resistant)
  - Sold in a premix called “Lightning” (imazethapyr + imazapyr)

Crops labeled

- Soybean
- dry bean
- field pea, chickpea, lentil
  - for legumes apply from 1<sup>st</sup> trifoliate to pre-bloom
- Clearfield<sup>®</sup> corn (imi-resistant)
  - Sold in a premix called “Lightning” (imazethapyr + imazapyr)
Other comments

- Apply with an adjuvant and liquid nitrogen
  - best is MSO + 28% ammonium nitrate
- Soil residual affects crop rotation
  - do not plant sugarbeet, canola, or carrot for 40 months after application
  - could be longer in acidic soils (Southern Minn)
- Drift concerns to susceptible crops like sugarbeet and mustards
- ALS resistance occurs
  - kochia, some nightshade, tall waterhemp, Powell amaranth

Imazamox LR

- Trade name: Raptor, Beyond
- Cost: $34/oz
- Rate: 0.25-0.5 oz/A
- Time applied: POST

![Raptor herbicide](image)

Crops labeled

- alfalfa
- dry bean
- field pea
- soybean
- Clearfield varieties
  - canola
  - sunflower
  - wheat
  - lentil

Weeds controlled

- nightshade family, E
- mustard family, E
- redroot pigweed, E
- common sunflower, E
- kochia, E²
- many annual grasses, F-E
- common ragweed, P
- biennial wormwood, P
- Canada thistle, N-P

Clearfield® Production System

Protecting crops and the environment

Using the Clearfield Production System farmers can protect crops such as corn, wheat or rice from weeds for the entire growing season. This is accomplished through the use of toxic herbicides with a crop that is tolerant to these herbicides. The seeds are obtained using traditional breeding methods and not using genetic engineering. Herbicides act when it’s too late for the weeds to compete, with a crop that is tolerant to the herbicides.

Clearfield® Production System is competitive in the market for herbicide-tolerant systems - one of the fastest growing segments in the agriculture market.

"obtained using traditional breeding methods and not using genetic engineering"

Other comments

- Shorter residual than imazethapyr; but crop restrictions remain
  - for 18 months do not plant barley, canola, crambe, flax, potato, safflower, and sugarbeet
- More effective on grasses than imazethapyr
- Apply with 28% UAN plus NIS or oil adjuvant
- ALS resistance occurs
- Be aware of drift

Imazapic VLR

- Trade name: Plateau, Cadre
- Cost: $4.70/oz
- Rate: 1-3 oz/A
- Time applied: PRE and POST

Weeds controlled

- Some annual weeds
  - common cocklebur, buffalobur, downy brome (wa), yellow starthistle
- Some perennial weeds
  - leafy spurge, quackgrass, Russian knapweed, and johnsongrass
  - Leafy spurge control was better with the addition of a biocontrol agent,
    and repeated applications were necessary (2 oz/A) for complete control
  - suppressed non-native Kentucky bluegrass in Neb.

Crops labeled

- Pastures
- CRP
- rangeland
- noncrop areas
- native prairie restoration
- wild flower establishment
- peanut

Other comments

- The 3 oz/A rate can be used for long residual bare ground control
  - Use under pavement is mentioned on the label
  - MSO is required
- RESTRICTED SALE HERBICIDE
- Cadre issue

Imazapic improves leafy spurge control with picloram and 2,4-D

Imazapyr VLR

- Trade name: Arsenal Powerline
- Cost: $2.25/lb
- Crops labeled:
  - pasture
  - rangeland
  - noncrop areas
- Option for cattail control

Imidazolinone summary

- Developed in the 1980s
- Generally provide excellent control of annual grasses and some broadleaf weeds
- Used in both cropland and noncrop situations
- Susceptible plants
  - chlorotic growing point 2-4 days after application
  - at 7-10 days after application the whole plant will appear chlorotic
  - plant eventually dies.
- Have soil residual depending on pH, OM, & moisture

http://www.des.ucdavis.edu/faculty/Springborn/Yellow_star_thistle.jpg
http://www.mda.state.mn.us/protecting/conservation/practices/grass2.ashx?w=300&h=420&as=1
http://www.ag.ndsu.edu/pubs/plantsci/rowcrops/mode-15.jpg
Herbicide family: Triazolopyrimidine (TPS) -1993

Site of action: Acetolactate synthase inhibitors

Mode of action: Amino acid synthesis inhibitor

- Breakdown very similarly to IMIs in the soil

Cloransulam LR

- Trade name: FirstRate
- Cost: $55/oz
- Rate: 0.25-0.63 oz/A
- Time applied: Early preplant, PRE, POST
  - Up to 50% flowering (POST)

- Labeled for use in Soybean

- Breakdown very similarly to IMIs in the soil

Weeds controlled

- Provides excellent control of some annual composite weeds (up to 4 inches tall)
  - common cocklebur
  - horseweed
  - marshelder
  - common ragweed
  - sunflower
- But poor control of biennial wormwood
- wild mustard, G-E
- annual smartweeds, E

Other comments

- applied with a NIS + UAN or oil adjuvant
- usually applied with another herbicide for broad-spectrum control
- Crop rotation restrictions
  - shortest soil residual on high pH soils
  - microbially degraded at moderate pHs
  - rapid base hydrolysis in high pHs (3 day half-life)
  - 18 months for potato
  - 30 months for sugarbeet and sunflower

Flumetsulam LR

- Trade name: Python
- Cost: $19.40/oz
- Rate: 0.64-1.06 oz/A
- Time applied: PPI, PRE, POST

- Crops labeled: Soybean, Corn
- May carry over more than one cropping season
- Weeds controlled: Many broadleaf weeds
  - mustard, kochia (not ALS), pigweeds, goosefoots
Other comments

- Often applied with another herbicide for broad-spectrum control
  - Soybean – just flumetsulam
  - Corn – flumetsulam
    - flumetsulam + clopyralid (Hornet)
    - flumetsulam + acetochlor + clopyralid (SureStart or Tripleflex)

- Crop rotation restrictions
- Some resistant weeds

Florasulam SR

- Trade name: only in premixes
  - Orion – florasulam + MCPA
  - GoldSky – florasulam + pyroxsulam + fluroxypyr
  - Quelex – florasulam + halaxifin

- Cost: varies
- Rates: varies
- Time applied: POST and translocated

Pyroxsulam SR

- Trade name: TeamMate, PowerFlex
- Cost: $50-78/oz
- Rates: 0.21-0.26 oz/A
- Premix
  - GoldSky – pyroxsulam + florasulam + fluroxypyr
  - PerfectMatch – pyroxsulam + clopyralid + fluroxypyr
- Time applied: POST and translocated

Weeds controlled with GoldSky

- downy brome: F-E
- green foxtail: F
- yellow foxtail: G
- wild oat: G-E
- buckwheat family: G-E
- goosefoot family: G-E
- mustard family: E
- nightshade family: G
- pigweed family: G-E
- Canada thistle: P-F

Flucarbazone SR to LR

- Trade name: Everest also Pre-Pare as 70WDG
  - newer formulation Everest 2.0 or Sierra includes a safener
  - Even newer Everest 3.0 better shelflife and easier mixing
- Cost: $35-47/oz
- Rates: 0.21-0.42 oz/A
- Time applied: POST and translocated

Herbicide family: Sulfonylaminocarbonyltriazoloionone (SACT)

Site of action: Acetolactate synthase inhibitors

Mode of action: Amino acid synthesis inhibitor
Weeds controlled

- downy brome: F-E
  - E: fall application to small plants
  - F: spring application to larger plants
- green foxtail: E
- yellow foxtail: P-G
- wild oat: G-E*
- mustard family: E
- redroot pigweed: G-E
- common lambsquarters: P
- Canada thistle: N

Crops labeled

- HRS wheat
- winter wheat
- NOT barley

Some crop rotation restrictions apply

- Oat: 18 months
- Edible legumes: 24 months

Propoxycarbazone VLR

- Trade name: Olympus
- Cost: $21.50/oz
- Rates: 0.28-0.42 oz/A
- Time applied: POST

Premix as Rimfire Max with mesosulfuron
- Weeds controlled: quackgrass, downy brome, Japanese brome, foxtail barley, mustard family
- Crops: HRS wheat, triticale

Thiencarbazone SR

- Trade name: Varro
- Cost: $204/oz
- Rates: 0.072 (wheat) to 0.21 (corn) oz/A
- Time applied: POST and translocated

- Weeds controlled: wild oat, foxtails, barnyardgrass, small downy brome

Herbicide Family:
Amino acid derivative

Site of Action: EPSP Synthase Inhibitors
Mode of Action: Amino Acid Inhibitors

Glyphosate

- Released by Monsanto in 1971

\[ \text{Glycine} \quad \text{phosphonomethylglycine} \]
Glyphosate

- Trade name: Many
- Cost (RU Powermax): $5.60/lb
- Rate:
  - 0.36-0.75 lb/A annually in past
  - Current recommendation varies by crop 0.56-1.5 lb/A
  - 1-3 lb/A perennials
- Time applied: POST and translocated

Weeds controlled

- Non-selective, so... most
  - good on annuals
  - better on grasses than broadleaves
- Transgenic cropping systems
  - Insert resistant enzyme
  - Expression varied by DNA location
  - Selected events very safe to crop
  - Some markets reject “Frankenfoods”

Glyphosate Formulations

- ipa (the best form)
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
- k+ (many are this, cheaper)
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
- dam
  - H\(_2\)N\(^+\) - \(\begin{array}{c}O\end{array}\)-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
- acid
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
- tms (original Touchdown)
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH
  - HO-\(\begin{array}{c}C\end{array}\)-CH\(_2\)-NH-CH\(_2\)-PO\(_2\)-OH

Crops labeled

- Preplant or prior to crop emergence
  - most agronomic and horticultural crops
- Chemical fallow
  - weaker on broadleaves so add in:
    - gly + dicamba or gly + 2,4-D
  - DO NOT TANK MIX AMINES! Buy premix!
  - antagonism of salts
- Preharvest (green weeds, crop)
  - Home, garden, turf
  - use caution!
  - Use what for selective broadleaf control!

Other comments

- Readily translocated in the phloem
- Inactivated by soil, immediately
- Generally low volatility
- Some causes of poor weed control
  - wheel tracks
  - dust on leaves or in spray water
  - high water volume
  - formation of insoluble glyphosate salts
  - inadequate surfactant
  - resistant weeds

Selective sprayers

- Recirculating sprayer
- Roller applicator
- Wick applicator
Herbicide Family: Organophosphorus

Site of Action: Glutamine Synthetase Inhibitors

Mode of Action: Amino Acid Inhibitors

Weeds controlled

- Non-selective, most annual and some perennial broadleaf and grass weeds
- G-E on most weeds in the weed guide EXCEPT:
  - horseweed, F
  - quackgrass, P
  - Canada thistle, P
  - common lambsquarters, F-G at best
- Gets the annuals, burns of the top growth of the perennials
- Better control of smaller weeds
- Very dependent on hot, sunny weather for control
- What about grass control?

Crops labeled

- LibertyLink® (herbicide resistant crops)
  - canola
  - corn
  - soybean
- Transgenic
  - metabolism gene

Other comments

- Apply with AMS at 3 lb/A, proposed label change to 1.5 lb/A
- Best activity
  - High humidity
  - Full sunlight, apply between dawn and 3 pm for best control
- No practical soil residual, 7 day half-life, rapidly degraded by microbes
- Highly water soluble
  - requires 4 hr rain-free period
- Why does it kill? Inhibits glutamine synthetase
  - Inhibits production of all AA
  - Ammonia toxicity

Glufosinate

Herbicide family: None generally accepted, (sometimes called a phosphorylated amino acid or amino acid derivative)

Trade name: Liberty 280

Cost: $36/lb

Rate: 0.4-0.58-0.72 lb/A, canola-corn-soybean

Time applied: POST, very limited translocation

Non-selective, most annual and some perennial broadleaf and grass weeds

G-E on most weeds in the weed guide EXCEPT:

- horseweed, F
- quackgrass, P
- Canada thistle, P
- common lambsquarters, F-G at best

Gets the annuals, burns of the top growth of the perennials

Better control of smaller weeds

Very dependent on hot, sunny weather for control

What about grass control?