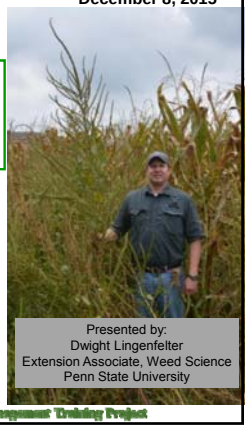
NE SARE PDP Webinar December 8, 2015

Chemical Management of Weeds in Perennial Forages



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New England Forage & Weed ID and Management Training Project

Weeds in forages…

- Compete for light, nutrients, moisture, growing space
- Reduce forage quality, carrying/stocking capacity, and forage intake
- May be eaten by livestock along with the desirable forage grasses and legumes
- Can be poisonous or injurious to livestock
- Can serve as a hosts for insects and pathogens
- Degrade land value
- Can be aesthetically unpleasing

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Weed Problems

- The biggest weed problems in hay and pastures are ***winter annuals***, ***biennials*** and ***perennials***
- Some ***summer annuals*** can cause problems, but mostly at establishment
- Weed identification very important
  - Understand weed lifecycles; influences management options
  - Toxicity issues

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Forage Management IPM

- **Cultural**
  - Use competitive species mixtures (legume-grasses)
  - Maintain optimum soil fertility and pH
  - Harvest hay at proper time and not too frequently
  - Don't overgraze pastures
  - Keep fencerows clean
  - Manage insect and disease pests
- **Mechanical**
  - Mow pastures routinely and at proper time
    - Just before flowering and seedhead formation (<12" tall)
  - Remove weeds by hand when necessary
- **Chemical**
  - Use herbicides when appropriate

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What's Next

Weed control considerations

- Stand establishment or
- Established stands

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Establishment Year-Critical

- Eliminate weeds in prior crop (esp. perennials)
  - take care of brush and herbaceous perennials
  - tillage or herbicides
- Buy certified seed
- Avoid spreading weed seed infested manure
- Costs should be spread over the life of the stand
- Aim for quick establishment (quality seed, firm seedbed) and early growth (seeding timing and soil fertility)
- Consider companion crops (oats, triticale, field pea, etc.)
- Be ready with management tactics
- First 60 days after seeding most important

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Established - Chemical Control

- If weeds become a problem, several herbicide options are available
  - Most forage herbicides are applied postemergence (over-the-top) to existing weed foliage
  - Fewer herbicide options for broadleaf control in legume-grass mixes or grassy weeds in grass-based systems
- Thin or irregular stands do not always thicken once weeds are removed
  - Other weeds can invade open areas
  - Be sure there are sufficient desirable species to justify (alfalfa = 40 to 50 stems or 4 to 5 plants/ft^2)
- Weeds tolerant of herbicides may invade space left by killed species, ultimately creating a more severe weed problem

Weeds Invade

When pastures are overgrazed and forages are eliminated, weeds fill in bare areas and thrive

Evaluate forage stand and weeds

- Evaluate forage stand composition
  - Weeds + bare ground: <30%
    - Herbicide + good management = improved stand
    - Mowing can be incorporated
  - Weeds + bare ground: 30% to 50%
    - Herbicide + over-seeding = improved stand
      - For spring applications, over-seed in fall
      - For summer or fall applications, over-seed in spring
  - Weeds + bare ground: >50%
    - Renovation = improved stand
    - Renovate only as a last resort
    - Know why it needs to be renovated
      - Weedy?, poor fertility?, overgrazing?, wrong pasture grass species?, etc.

FORAGE herbicide choices

Legumes
- Balan
- Eptam
- Buctril
- Butyrac (2,4-DB)
- Chateau
- Metribuzin
- Poast
- Prowl H2O
- Pursuit
- Raptor
- Select
- Velpar
- Sharpen
- Glyphosate for RR alfalfa
- Gramoxone

Grass pasture/hay
- 2,4-D
- Aim
- Dicamba
- Cimarron/metsulfuron
- Crossbow/Garlon
- Stinger
- Milestone/ForeFront
- Sandea/Yukon

What makes these herbicides different?

- Before we get into specifics of these products we will cover some background details
  - Overview of history and current trends of chemical weed control
  - Mode of action and utilities in forages

Herbicide

- *herba* = plant
- *caedere* = kill
- Chemicals that kill plants
- Pesticides used to control weeds
- Crop protection chemical used to kill weedy plants
- Chemical that disrupts the physiology of a plant over a long enough period to kill it or severely reduce it's growth (Zimdahl, 1999)

Evolution of weed control methods in the US since 1920

(Alder et al. 1977; Zimdahl 1999)

Year	Human energy	Animal energy	Mechanical energy	Chemical energy
	% control by year			
1920	40	60	-	-
1947	20	10	70	-
1975	5	-	40	55
1990	<1	-	24	75
2010	<1	-	15	85

Chemical Weed Control (Zimdahl, 1999)

- Herbicides created a major change in the way agriculture is practiced by substituting chemical energy for human and animal energy.
- Herbicides have several benefits and disadvantages that must be considered prior to use.

Benefits and Disadvantages

- **Benefits**
  - Fast, effective, and efficient
  - Relatively consistent
  - Save labor and energy (compared to tillage and hand labor)
  - Reduced and No-tillage possible
  - Control weeds where other techniques are not possible - wet soils, perennials, etc.
- **Disadvantages**
  - Expensive (product, equipment, infrastructure, etc.)
    - Other costs (disposal, pollution, etc.)
  - Toxicity and exposure
  - Environmental concerns –off target movement, water pollution, etc.
  - Discourage diversity
  - Require precision and management
  - Loss of IPM tactics

Requirements for a New Pesticide

- Effective
- User Friendly
- Good Environmental Profile
- Economical
  - 1 in 11,000 succeed - 1965
  - 1 in 50,000 succeed - 1995
  - over $100 million per compound – 1998
  - Cost in 2010 - $200+ million

Source: Bayer, 1998

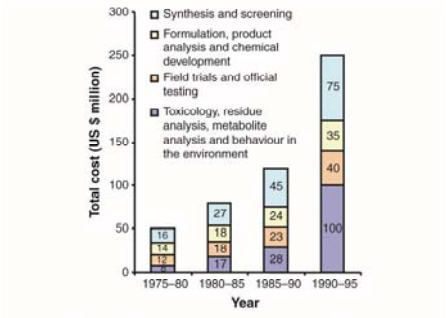


Fig. 2 Cost for the development of a new active ingredient in crop protection between 1975 and 1995. Source: Phillips McDougall (unpubl. report, 2003).

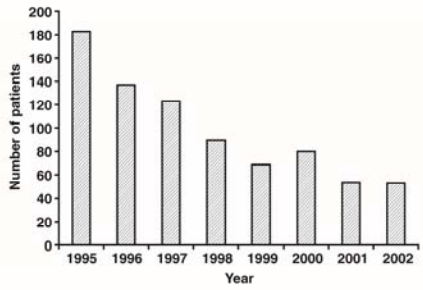


Fig. 1 Number of patents worldwide published between 1995 and 2003 in the area of herbicide research.

Ruegg et al. 2006 - Syngenta

Herbicide Company History – last 50 years

Bayer
Chemagro
Geary Chem.
Baychem
Mobay
Miles
Aventis
Hercules
Boots
BFC
Schering AG
Morton Norwich
NOR-AM
American Hoechst
Roussel Uclaf
Tuco
Fisons
Chipman
Amer. Chem. Paint
AmChem
May & Baker
Rhodia
Mobil
Amchem-Rhor
Union Carbide

BASF
BASF Colors and Chem.
Hooker Chem.
Wyandotte Co.
Occidental
Zoecon
Velsicol
Michigan Co.
Sandoz
Int'l Minerals and Chem.
Amer. Cyanamid
Shell Int'l

Chemtura Corp.
Uniroyal
U.S. Rubber
Naugatuck
Thompson-Hayward
Uniroyal, Inc. Chem.
Div.
Olin-Mathiesen
Duphar

FMC
Food Machinery Corp.
Niagra

Dow AgroSciences
Rohm and Haas
Eli Lilly
Elanco
Murphy Chem.
Dow
Wacker Chemie
Dow-Elanco

Syngenta
Ciba
Geigy
Esso Res. And Eng.
Maag
Ciba-Geigy
Sandoz
Merck Crop Prot.
Zeneca
Victor Chem. Works
Stauffer
ICI
ISK Biosciences

Monsanto
Monsanto Chemical Co.

Dupont
Shell Development

PBI-Gordon
Private Brands, Inc.
Gordon's Chem.

Valent
Calif. Spray Chem Co.
Calif. Chem. Co.
Chevron
PPG Industries
Pittsburgh Plate Glass
Columbia Chem. Co
Southern Alkali Co
Columbia-Southern

Cerexagri
ELF-Atochem N. Amer.
ELF-Aquitaine
Pennsalt
Pennwalt
M&T Chem.

Who's Left?

- 5 to 8 major agronomic manufacturers remain

Bayer CropScience · syngenta · DOW · Dow AgroSciences · BASF · FMC · DUPONT · VALENT · MONSANTO

Current market breakdown

- Approximately 85% of ag chemicals are off-patent (post-patent)
- 60% of these ag chemicals in US are herbicides
- It is estimated that the total generic market is about 25+%
  - Most original brands still dominate, but generics are being accepted and thus growing in market share
- Generic manufacturers can offer a product at a lower cost because they didn't have to pay for the original development and testing that make up most of the $200+ million to bring a new product to market

Name brand vs. Private brand vs. Generic

- **Name brand** = the "original" product
- **Private brand** = essentially identical to the original product but sold as a different tradename
  - Usually manufactured on the same production line as the name brand
  - Similar to a store brand when buying groceries
- **Generic (or post-patent)** = contains the same active ingredient as the original (off-patent) product but manufactured and/or reformulated by a different company
  - Some Generic manufactures make Private Brand for other companies

Common generic/post-patent manufacturers

AgriStar · ADAMA · Loveland · CHEMINOVA · Nufarm · Arysta LifeScience · AMVAC · Gowan · UPI · Drexel · TENKOZ · HELENA · WINFIELD · NovaSource · SipcamAdvan

AND MANY OTHERS…

No New Herbicide Modes of Action

- Over 20 years since a new and unique herbicide mode of action has been discovered
  - Many resources now go into seeds, not chemicals
- Most new products are simply reformulations or pre-mixes of existing active ingredients
  - A lot on new tradenames; can be confusing
- If a new MoA was discovered today, it would take at least 10 years to get to market
- So, we need to use the herbicides we have judiciously

Questions?

- Briefly stop for any questions from the audience...

Herbicide application methods

- Soil applied (preemergence, PRE)
  - Residual chemicals (4-6 weeks control)
  - Preventative approach (before weeds emerge)
  - Activity depends on: clay and organic matter content, pH, rainfall

Herbicide application methods (cont.)

- Foliar applied (postemergence, POST)
  - Controls existing weeds; no to some residual
  - Reactive ("wait and see") approach
  - Activity depends on: weed species, growth stage, climatic conditions

Eight (8-10) major herbicide modes of action

- Seedling growth inhibitors
  - Root (& Shoot) and Shoot
- Pigment inhibitors
- Photosynthesis inhibitors
  - Mobile and Nonmobile
- Plant growth regulators
- Amino acid (protein) biosynthesis inhibitors
- Fatty Acid inhibitors (lipids)
- Cell membrane disrupters
- N-metabolism disrupter

Herbicide Mode of Action

MODE OF ACTION

- **Mode of Action**
  - the sequence of events that leads to plant death or growth interruption
  - 2 phases
    - ** movement to target site*
    - ** interaction at target site*
- **Mechanism of Action**
  - Location at which a herbicide exerts its toxicity at the cellular level
  - more specific

How herbicides work

- Herbicides kill or prevent weeds from growing by interfering with certain plant functions
- Examples: photosynthesis inhibitor, amino acid biosynthesis inhibitor, membrane disrupter, lipid synthesis inhibitor, etc.
- Referred to as "Mode of Action"

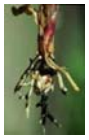
How herbicides work (cont.)

- The specific site the herbicide affects is referred to as "Site or Mechanism of Action"
- Examples: Photosystem II, ALS enzyme, ACCase enzyme, EPSP enzyme, etc.
- For example – glyphosate binds with EPSP synthase and inhibits the biosynthesis of three aromatic amino acids

Why understand how herbicides work?

- Herbicide groups have similar properties
  - Environmental and toxicity characteristics
  - Chemical properties – water sol., vapor pressure, dissipation/degradation pathways
  - Herbicide activity
    - Know what group of weeds are killed and rate structure
  - Help with application techniques – soil vs. foliar
  - Injury symptomology
- Manage herbicide use to help prevent herbicide resistant weeds

Specific symptoms and MOA



- Plants display specific symptoms depending on herbicide class
- Examples of symptoms:
  - Twisting, bending, cupping
  - Bleaching, yellowing, "burning", necrosis
  - Stunted roots or shoots
- Location on plant plus timing and "speed" of symptoms are important

Herbicide Hierarchy – general to specific

- Mode of action – Plant growth regulator, photosynthesis, amino acid biosynthesis, etc.
  - Site of action – unknown, PS II, ALS, EPSP, etc.
    - Chemical family – Phenoxy, Triazine, Imidazolinone, etc.
      - Active ingredient (common name) – 2,4-D, atrazine, imazethapyr, etc.
        - Tradename – Weedar, Aatrex, Pursuit, etc.

FORAGE herbicide modes of action

Seedling growth inhib.
- Balan
- Eptam
- Prowl H2O

Photosynthesis inhib.
- Metribuzin
- Velpar
- Buctril

Amino acid synthesis inhib.
- Pursuit
- Raptor
- Cimarron/metsulfuron
- Sandea
- Glyphosate

Lipid synthesis inhib.
- Poast
- Select

Cell membrane disrupters
- Chateau
- Aim
- Sharpen
- Gramoxone

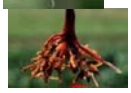
Plant growth regulators
- 2,4-D
- Dicamba
- Crossbow/Garlon
- Stinger
- Milestone/ForeFront

Herbicide Class/MOA					
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
	Seedling Root Growth Inhibitors				
3	Microtubule Inhibitors	6	Benzamide	pronamide	Kerb
			Dinitroaniline	ethalfluralin	Curbit, Sonalan
				oryzalin	Surflan
				pendimethalin	Pendulum, Prowl, others
				prodiamine	Barricade
				trifluralin	Treflan, others
			Phthalic acid	DCPA	Dacthal
			Pyridazine	dithiopyr	Dimension
	Seedling Shoot Growth Inhibitors				
8	Lipid Synthesis Inhibitors (not ACCase)	5	Phosphorodithioate	bensulide	Prefar
			Thiocarbamate	butylate	Sutan+
				cycloate	Ro-Neet
				EPTC	Eptam, Eradicane
15	Long-chain Fatty Acid Inhibitors	1	Acetamide	napropamide	Devrinol
			Chloroacetamide	acetochlor	Breakfree, Degree, Harness Topnotch, Warrant, others
				alachlor	Intro, Micro-Tech
				dimethenamid	Outlook
				metolachlor	Dual, Cinch, others
			Oxyacetamide	flufenacet	Define
			Pyrazole	pyroxasulfone	Zidua
16	Specific Site Unknown	0	Benzofurane	ethofumesate	Nortron

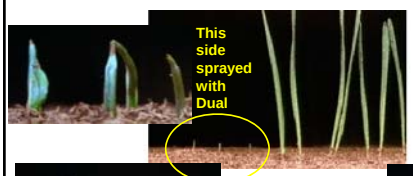
Seedling growth inhibitors

- Herbicide applied to soil before weeds germinate
- Controls small seeded annual grasses and broadleaves
  - 3-6 weeks residual activity
- Require rainfall or incorporation to activate
- How they work:
  - Root/shoot inhibitors
    - Microtuble inhibitors (mitosis) or inhibit cell wall biosynthesis
    - Root development is inhibited; causes clubby roots & stunted plants
  - Shoot inhibitors
    - Inhibits shoot growth by affecting cell growth and division; multiple sites affected
    - Stunted shoots; poor emergence; leaves don't unfurl

Seedling growth inhibitors (root/shoot)



Seedling growth inhibitors (shoot)



Herbicide Class/MOA					
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
	Photosynthesis Inhibitors				
5	Photosystem II Inhibitors (mobile) different binding than 6 and 7	26	Phenylcarbamate	phenmedipham	Spin-Aid
			Triazine	atrazine	Atrazine
				prometon	Pramitol
				simazine	Princep
			Triazinone	hexazinone	Velpar
				metribuzin	Glory, Metribuzin, TriCor
			Uracil	terbacil	Sinbar
6	Photosystem II inhibitors (non-mobile) different binding than 5 and 7	1	Benzothiadiazole	bentazon	Basagran
			Nitrile	bromoxynil	Buctril
7	Photosystem II inhibitors (mobile) different binding than 5 and 6	11	Urea	diuron	Direx, Karmex
				linuron	Linex, Lorox
				tebuthiuron	Spike

Photosynthesis inhibitors

- Primarily annual broadleaf, some grass control
- Generally applied to soil, but can be sprayed directly on foliage
- Four to five week residual control or longer depending on rate
  - Herbicides applied to soil penetrate the root and move throughout the plant
  - Watch rotational crops, some have long residuals
- How they work:
  - Herbicide blocks the photosynthesis process so light can't be used to produce sugars; plant starves
  - **Oldest leaves turn yellow first**, with veins remaining green; plant eventually dies

Typical PSI symptoms

- **Marginal necrosis**
- Oldest leaves first
- **Interveinal chlorosis**
  - **Green veins**

Misc. injured crops from triazine carryover

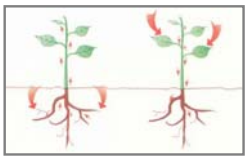
Triazine injury on cucurbit

Herbicide Class/MOA

WSSA Group	Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
Amino Acid Synthesis Inhibitors					
			Imidazolinone	imazamox	Beyond, Raptor
				imazapic	Plateau
				imazapyr	Arsenal
				imazethapyr	Pursuit
				pyrithiobac	Staple
			Pyrimidinylthio-benzoic acid	flucarbazone	Everest, Pre-Pare
			Sulfonylaminocarb-onyltriazolinone	propoxycarb-azone	Olympus
				thiencarbazone	component of Capreno, Corvus
			Sulfonylurea	chlorimuron	Classic
				chlorsulfuron	Glean
				foramsulfuron	Option
				halosulfuron	Permit, Sandea
				mazosulfuron	League
				sidosulfuron	Autumn
				mesosulfuron	Osprey
				metsulfuron	Cimarron, others
				nicosulfuron	Accent Q
				primisulfuron	Beacon
				prosulfuron	Peak
				rimsulfuron	Matrix, Resolve
				sulfosulfuron	Maverick
				thifensulfuron	Harmony
				tribenuron	Express
				triflusulfuron	UpBeet
			Triazolopyrimidine	cloransulam	FirstRate
				flumetsulam	Python
				pyroxsulam	PowerFlex
9	EPSP Synthase inhibitor (5-enolpyruvyl-shikimate-3-phosphate)	15	Organophosphorus	glyphosate	Roundup, Touchdown, others

Amino acid (protein) biosynthesis inhibitors

- Two different types *or sites of action*
  - ALS enzyme inhibitors
  - EPSP enzyme inhibitors
- Each has a different ways of killing susceptible plants

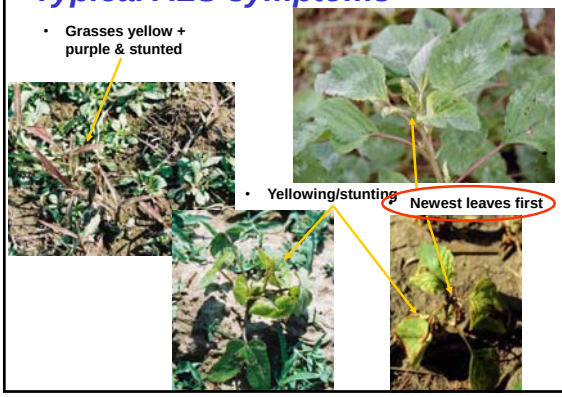


ALS-inhibitors

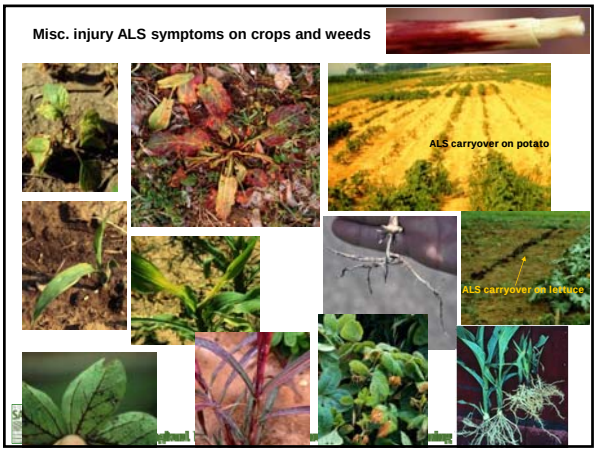
- Soil and foliar applied depending on product
- Mostly broadleaves controlled; some grasses and nutsedge depending on product
- Some have long residuals; watch rotation crops
- How they work:
  - Kills plants by blocking key amino acid enzymes, thus stopping protein building; plant slowly dies (7-10 days)
  - Symptoms include: stunted, yellow, dead growing point, purple veins, roots malformed (bottle-brush)
  - Systemic activity; **young leaves affected first**

Typical ALS symptoms

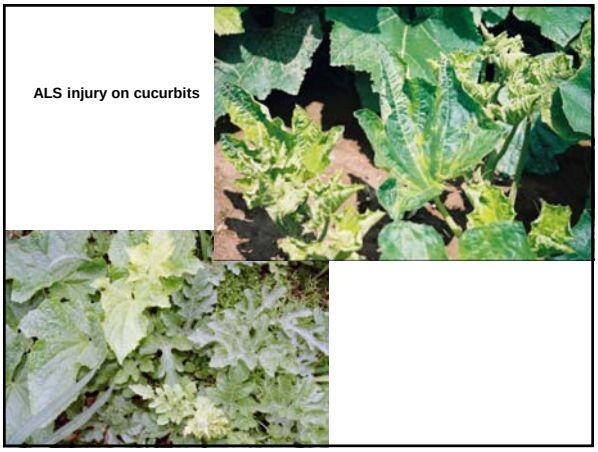
- Grasses yellow + purple & stunted
- Yellowing/stunting
- Newest leaves first



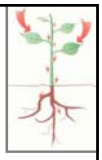
Misc. injury ALS symptoms on crops and weeds



ALS injury on cucurbits



EPSP-inhibitor



- Applied to foliage (has no soil activity)
- Nonselective; good on most broadleaves and esp. grasses
  - *Roundup Ready crops are resistant to glyphosate*
- Good translocation to root system
- Symptoms:
  - Normal function of enzyme is blocked, inhibiting protein building
  - Systemic activity; *young leaves affected first*
  - Symptoms include: newest growth turns yellow/reddish; plant slowly browns and dies
  - Slow acting (5-7 days for symptoms to appear)

Typical EPSP symptoms

- Yellowing/stunting
- Newest leaves first

EPSP inhibitor

Herbicide Class/MOA					
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
	Lipid Synthesis Inhibitors				
1	ACCase Inhibitors (acetyl CoA carboxylase)	15	Aryloxyphenoxy-propionate (fops)	clodofop	Hoelon
				fenoxaprop	Puma, Tacoma
				fluazifop	Fusilade
				quizalofop	Assure II, Targa
			Cyclohexanedione (dims)	clethodim	Select Max
				sethoxydim	Poast
			Phenylpyrazolin	pinoxaden	Axial XL

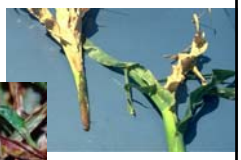
Fatty acid inhibitors

- Applied to foliage
- Controls annual/perennial **grasses only** (esp. warm-season spp.); no broadleaf or sedge activity
- How they work:
  - Affects ACCase-enzyme involved in fatty acid/lipid formation in the shoot of grasses
  - Plants become stunted and yellow/brown; **death of growing point occurs first (easily pulls from whorl)**
  - Slow acting (5-10 days)

Typical fatty acid inhibitor symptoms

- *Affects grasses only*
- Shoot decays and easily pulls from whorl
- Yellowing/stunting on new growth

Fatty acid inhibitors



Herbicide Class/MOA					
WSSA Group[1]	Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
	Cell Membrane Disrupters				
14	PPO Inhibitors (protoporphyrinogen oxidase)	2	Aryl triazolinone	carfentrazone	Aim
				fluthiacet	Cadet
				sulfentrazone	Authority, Spartan
			Diphenyl ether	acifluorfen	Ultra Blazer
				fomesafen	Reflex
				lactofen	Cobra, Phoenix
				oxyfluorfen	Goal
			N-phenylphthalimide	flumiclorac	Resource
				flumioxazin	Chateau, Valor
			Oxadiazole	oxadiazon	Ronstar
			Pyrimidinedione	saflufenacil	Kixor, Sharpen
22	Photosystem I Electron Diverter	5	Bipyridylium	diquat	Reglone
				paraquat	Gramoxone

Contact herbicides

- Cell membrane disrupters
- Photosynthesis inhibitors – nonmobile
- N-metabolism disrupter

- These are "rapid-acting"; causing quick cell membrane destruction
- Act only at sight of contact; these herbicides do not translocate within plant
- Symptom development is hastened by bright sunlight and high humidity

Cell membrane disrupters

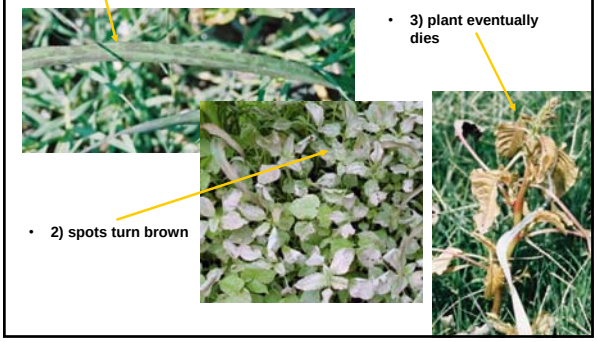
- Foliar applied: Gramoxone (paraquat); Aim (carfentrazone); Sharpen (saflufenacil)
- Soil applied: Chateau (flumioxazin)

- Mostly broadleaf control, few grasses
  - Gramoxone is broadspectrum; the others are selective
- Good spray coverage and sunlight necessary
- Temporary crop injury may occur

- How they work:
  - Interfere with certain processes and form highly active radicals which breakdown cell membranes and stop cells from manufacturing energy
    - Gramoxone – activated by photosystem I
    - The others – PPO or Protox enzyme
  - Water-soaked spots where herbicide contacts leaf, rapid wilting, "burning", leaf speckling, browning, wilting and then death within a few days

Typical "contact" symptoms

- 1) water-soaked spots
- *Kills only at site of droplet*
- 3) plant eventually dies
- 2) spots turn brown

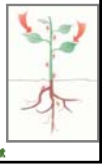


Foliar, contact/PPO herbicide spray injury on crops

WSSA Group	Herbicide Class/MOA: Site of Action	No. Resistant in U.S.	Family	Active Ingredient	Trade Name
	Growth Regulators				
4	Auxin receptors (synthetic auxins)	8	Benzoic acid	dicamba	Banvel, Clarity
				aminopyralid	Milestone
				clopyralid	Stinger
			Carboxylic acid	fluroxypyr	Starane, Vista
				picloram	Tordon
				quinclorac	Facet
				triclopyr	Garlon, Remedy
			Phenoxy	2-4-D	various
				2,4-DB	Butyrac, various
				MCPA	various
19	Auxin transport inhibitor	0	Semicarbazone	diflufenzopyr	component of Status

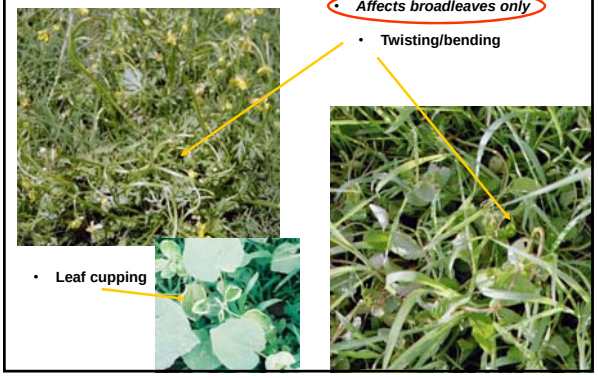
Plant growth regulators (PGRs)

- Applied directly to foliage (postemergence)
- Good on most annual/perennial broadleaves only
- How it works:
  - Affect growth in newest stems and leaves by disrupting protein building and normal cell division (multiple sites affected)
  - Stems twisted, bent, malformed, leaf cupping/crinkling, brittle stems, leaf-roll, others
  - Initial effects evident within hours of application
  - "Grows itself to death"
  - Systemic – moves throughout the plant



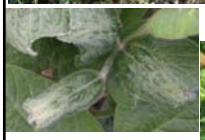
Typical PGR symptoms

- *Affects broadleaves only*
- Twisting/bending
- Leaf cupping

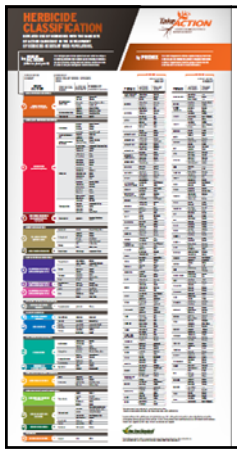


More PGR symptoms




www.takeactiononweeds.com



Questions?

- Briefly stop for any questions from the audience...

Legume FORAGE herbicide choices

- Balan
- Eptam
- Buctril
- Butyrac (2,4-DB)
- Chateau
- Metribuzin (Sencor)
- Poast
- Prowl H2O
- Pursuit
- Raptor
- Select
- Velpar
- Glyphosate for RR alfalfa

Apply to actively growing alfalfa and weeds

- **Butyrac 200 2E** – 2,4-DB (several) – mustards, lambsquarters, pigweed, ragweed, etc. ($14/A)
- **Pursuit 2S/70DG** – imazethapyr (BASF) –Thunder – chickweed, mustards, pigweed, small annual grasses, etc. ($14/A)
- **Raptor 1S** – imazamox (BASF) - chickweed, mustards, lambsquarters, pigweed, medium size annual grasses, etc. ($18.75/A)
- **Select** – clethodim (Valent) – Arrow, Intensity, Section, Shadow, Volunteer, etc. – annual and perennial grasses ($6.25/A)

Herbicides for alfalfa-grass mixtures

- Seedling - None??
- Established
  - Pursuit, metribuzin, and glyphosate (spot)

Raptor vs. Pursuit – grass control

Grassy weeds	Raptor	Pursuit
Barnyardgrass	8	8
Crabgrass	7	7
Fall panicum	**8+**	8
Foxtails	**8+**	**8+**
Johnsongrass (seedling)	**8+**	**9**
Johnsongrass (rhizome)	7	7
Quackgrass	N	6
Shattercane	**8+**	**9**
Volunteer corn	8	6
Wirestem muhly	N	N
Yellow nutsedge	6	7

Raptor vs. Pursuit – broadleaf control

Broadleaf weeds	Raptor	Pursuit
Burcucumber	6	6
Cocklebur	**9**	**9**
Jimsonweed	8	8
Lambsquarters (inc. TR)	**8+**	7
Annual morningglory	7	7+
E. Black nightshade	8	8
Pigweed (inc. TR)	**9**	**9**
Common ragweed	8	7
Giant ragweed	8	6
Smartweed	8	**8+**
Velvetleaf	**9**	**9**

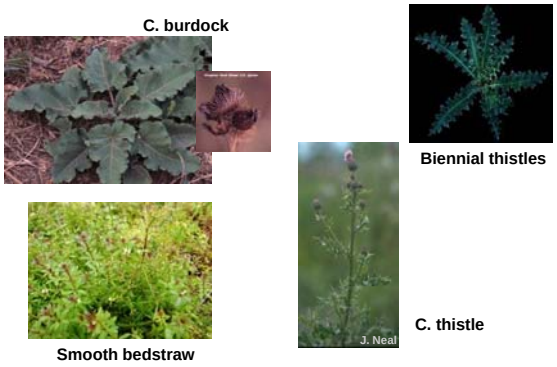
Apply to dormant alfalfa and weeds

- **Chateau 51WDG** – flumioxazin (Valent) – chickweed, henbit, etc. ($14/A)
- **Gramoxone 2S** – paraquat (Syngenta) – Firestorm, Parazone, Quik-Quat, etc. – winter annuals ($8/A)
- **Metribuzin 75DF/4L** – metribuzin (several) – Dimetric, Glory, Metri, TriCor, etc. – winter annuals ($6.50/A)
- **Prowl H2O 3.8CS** – pendimethalin (BASF) – winter and summer annuals ($15/A)
- **Velpar 2L/90DF** – hexazinone (Dupont) – winter annuals and dandelion ($27/A)

Roundup Ready alfalfa

- Genuity Roundup Ready alfalfa available for forage planting – Jan. 27, 2011 approval (not sprouts or seed production)
- Benefits: good weed control, wide harvest intervals, greater potential for no-till,other
- Challenges: alfalfa-grass mixtures, concern for resistant weeds, more expensive seed

Weeds of Grass Pasture and Hay



Herbicides labeled for grass hay and pasture

- Older
  - Glyphosate - nonselective spot treatment
  - Crossbow (triclopyr + 2,4-D) - annual and perennial broadleaves
  - Banvel (dicamba) - annual and perennial broadleaves
  - Stinger (clopyralid) - annual and perennial broadleaves
  - 2,4-D - annual and perennial broadleaves
- Newer
  - Cimmaron/Ally (metsulfuron) - annual and perennial broadleaves
  - Curtail (clopyralid+2,4-D) – annual and perennial broadleaves
  - Overdrive (dicamba), Yukon - broadleaves
- Newest
  - Forefront HL (Milestone+2,4-D): broadleaves **(Watch hay/manure restrictions)**
  - Facet – some grass control
  - Aim, Sharpen – annual broadleaves

Most of these products can kill legumes!

Common Herbicides for Grass Pastures

	Avg. herbicide cost/acre
• 2,4-D	<$5
• Banvel/Clarity (dicamba)	<$10
• Cimarron Plus (metsulfuron + chlorsulfuron)	$15
• Crossbow (triclopyr + 2,4-D)	$25-30
• ForeFront HL (aminopyralid + 2,4-D)	$15
• Roundup/glyphosate products	$5-10
– Spot treatments or renovation	
• Facet (quinclorac)	≈$25 (25 fl oz)

***The avg. cost does not represent the use of spray additives or application costs**
****Generic alternatives are available for some of these herbicides**

Selected Generic alternatives for grass hay/pasture

Active ingredient(s)	Tradename	Manufacturer	Alternative to:
Clopyralid	Spur	Albaugh/Agri-Star	Stinger
Metsulfuron-methyl	Accurate Ciramet Metsulfuron 60EG AG Plotter PureStand Romestol	Cheminova AgSurf Arysta LifeScience Rotam North Amer. NuFarm Rotam North Amer.	Cimarron 60DF (DuPont no longer sells the single ai product for pastures)
Metsulfuron-methyl + chlorsulfuron	Chisum	Cheminova	Cimarron Plus
Triclopyr + 2,4-D	Candor Crossroad	NuFarm Albaugh/Agri-Star	Crossbow

Effect of Herbicides on Selected Pasture Weeds

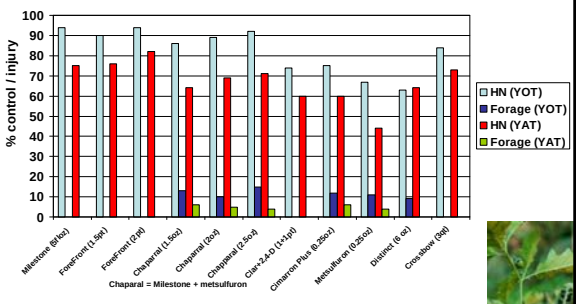
Weed	2,4-D	Clarity (dicamba)	2,4-D + Clarity	Cimarron Plus	Crossbow	ForeFront	Roundup (spot)
Milkweed	6	8	**8+**	N	7+	6	7+
Poison hemlock	7	8	**9**	N	**9**	7	**9**
Pokeweed	7	7	7		**9**	8	8
E. Black nightshade	7+	**8+**	8	8	**8+**	**9**	**9**
Horsenettle	7	8	**8+**	6	**8+**	**9**	8
Jimsonweed	8	**9+**	**9+**	**9+**	**9**	8	**9**
Buttercup	**8+**	8	**9**	**9+**	**9**	**9**	**9**
Lambsquarters	**9**	**9+**	**9+**	**9+**	**9+**	**9**	**9**
Pigweed	**9**	**9**	**9+**	**9+**	**9**	8	**9**
Ragweed	**9**	**9**	**9+**	7	**9+**	**9**	**9+**
White snakeroot	8	**9**	**9**	N	**9**	8	8
Plantain species	**9**	8	**9+**	**9**	**9**	7+	**9**
Smooth bedstraw	7	N	7	N	**8+**	**9**	**9**
Canada thistle	8	8	**8+**	**8+**	8	**9+**	8
Multiflora rose	6	6	7+	**8+**	**8+**	7+	8

***Weed control ratings: 10 = 95-100%, 9 = 85-95%, 8 = 75-85%, 7 = 65-75, 6 = 55-65%, N = no control**

Target: Horsenettle

Horsenettle control and forage injury

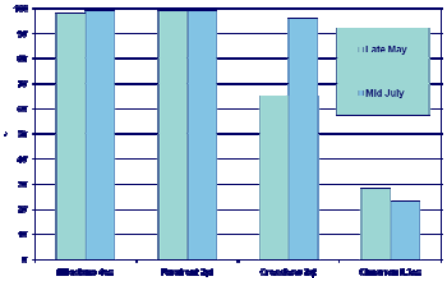
(year of treatment (YOT) and year after treatment (YAT))



Sprayed 7/20/09, rated 9/3/09 and 8/10/10

Smooth bedstraw

Effect of herbicides and spring and summer application timings on smooth bedstraw control in Pennsylvania in 2006.
(Late season ratings.)



Multiflora rose management

- Long-term effort with combined tactics
- Watch for new seedlings/infestations
- Mechanical options
  - Repeated mowing
  - Excavation – backhoe, bulldozer, shovel
- Biological control
  - Goats – 8-10/A for 4 years; include in pasture with other livestock
  - Rose rosette disease – slowly moving into area – other biocontrols?
- Chemical control
  - Several effective herbicides - generally applied around flowering

Multiflora rose – Chemical control

- Pasture

– 2,4-D	6
– Cimarron/metsulf.	8+
– Clarity/Banvel	6-8
– Crossbow	8+
– ForeFront	7+
– Glyphosate	8
– Spike	8

6 = 55-65%
7 = 65-75%
8 = 75-85%
9 = 85-95%

GRASS Forage – labeled

- ***Facet L 1.5L*** **(BASF)**
  - **Active ingredient: quinclorac (same as Paramount)**
  - **Specialty product – currently, only herbicide labeled that controls annual grasses in cool-season grass pasture/hay and CRP**
    - **Established bromegrass, Kentucky bluegrass, tall fescue, orchardgrass, ryegrass; (timothy not on label)**
    - **Also labeled for switchgrass and other warm season grasses**
  - **Typical use rate: 22 – 32 fl oz/A plus adjuvants; apply POST**
  - **Effective on "small" annual weeds and selected perennials**
  - **Will injure/kill clover, alfalfa, other legumes**
  - **7 day haying restriction; but no grazing restriction**

Weeds - Foxtails, large crabgrass, barnyardgrass, lambsquarters, ragweed, velvetleaf, annual morningglory, dandelion, field/hedge bindweed

Facet L herbicide

***Prowl H2O is coming soon for use in grass pasture/hay...**

Top Choices

- Bedstraw – late June/early July
  - Forefront HL, Crossbow
- Biennial thistles – bull, musk, plumeless – late fall/early spring
  - Forefront HL, Stinger/clopyralid, 2,4-D+Banvel
- Canada thistle – bud to bloom or fall
  - Forefront HL, Stinger/clopyralid, 2,4-D+Banvel
- Horsenettle – bud to bloom
  - ForeFront HL, Crossbow, Banvel
- Multiflora rose – bloom or fall
  - Cimarron Plus, Crossbow
- Spiny pigweed - seedlings
  - Cimarron Plus or Metsulfuron
- Annual grasses
  - Facet

ForeFront HL: Watch hay/manure restrictions

Reasons why weeds <u>are not</u> controlled in pastures*

KY ANR agent survey (Nov 2007)

- 73% Do not want to kill clover
- 60% Herbicides too expensive
- 18% Why spray if cows eat weeds
- 16% Land topography (steep terrain, etc.)
- 13% Mowing too expensive
- 11% Concern with grazing restrictions
- 11% Poor / Low management
- 9% Weeds are not a problem
- 7% Spray equipment limitations

Univ. of Kentucky survey

*** Each survey participant listed top 2 reasons**

Grass + Clover Issues

- "Get over the clover…"
- Most people use this as a reason not to spray
- Is the small amount of clover really an impediment to good weed control?
  - Was it actually planted or is it some short 'wild' type?
- Control weeds; overseed clover if necessary
  - Most white clover seed is inexpensive and at low seeding rates; frost seed

Grass + white clover

NC State Univ.

	grass weeds to permit pasture reseeding				at time of treatment. Add 1 qt of a nonionic surfactant per 100 gal of water. Check label for grazing restrictions.
Pastures LADINO CLOVER, ORCHARDGRASS, FESCUE, and other grasses	Curly dock, ragweed, bittersweet, pigweed, dandelion, and other broadleaf weeds	2,4-D amine, MOA 4 (various brands) 4 SL	1 to 2 pt	0.5 to 1	Spray when weeds are 4 to 6 in. tall and before heading. Clover may be stunted and growth retarded 3 to 6 weeks. Use lower rate in warm, wet weather. For wild garlic, apply late February or early March. Repeat for 3 year. *Do not* graze dairy animals on treated areas within 7 days after application. Remove meat animals from treated areas for 3 days before slaughter. Withdrawal is not necessary if more than 2 weeks have elapsed since treatment. Do not cut treated grass for hay within 30 days after application.
	Wild garlic	2,4-D amine, MOA 4 (various brands) 4 SL	1 qt	1	

(Tenn. also has amine and LV4 in their Guide)

2009 Louisiana Suggested Weed Management Guide

PASTURE and FORAGES

Active Ingredient and Rate	Formulated Product and Rate	Weeds Controlled	Remarks and Precautions
PERMANENT PASTURES WITH WHITE OR LADINO CLOVER: 2,4-D amine @ 0.75-1.0 lb/A	2,4-D Amine @ 1.5-2.0 pt/A Apply in 10-20 GPA by ground or 2 -5 GPA by air	Dock, plantain, bull thistle, buttercup, other winter or spring growing broadleaf weeds. Bitterweed, fleabane, ragweed, marsh elder, goatweed, pigweed and many other summer growing broadleaf weeds	Apply when weeds are small in Oct. and Nov. and/or Feb. and March. May be sprayed in the summer and early fall if no 2,4-D susceptible plants are nearby. Fall spraying of dock is most effective. A second application may be required for complete kill at these rates. Do not apply 2,4-D if temperature is below 65° F. Some injury can be expected to established white or ladino clover. Do not apply 2,4-D in fall prior to seeding clover. Spray these weeds in the spring if cotton or other phenoxy susceptible crops are not nearby. Use the higher rate for fall spraying of more mature weeds.
2,4-D amine @ 1.0-2.0 lb/A	2,4-D Amine @ 1.0 - 2.0 qt/A Apply in 10-20 GPA by ground or 2 -5 GPA by air	Cypressweed, dog fennel, common mullein, jimsonweed	Apply when weeds are small, usually from April to June, but can be applied all summer and into early fall. Rates in excess of 1.0 lb Amine or 0.5 lb LVE 2,4-D will kill or severely injure clover. Lower rates of 2,4-D will control these weeds in seedling stage but higher rates required for more mature weeds.

Ropewick/wiper applications

Follow Herbicide Grazing and Haying Restrictions

(taken from PSU Agronomy Guide)

Herbicide	Type of Animal	Interval between Application and Grazing	Interval between Application and Green Harvest	Interval between Application and Haying	Comments
2,4-D amine or	Lactating dairy	7 days	—	30 days	Remove meat animals from treated area 3 days before slaughter. 2,4-D labels vary; see specific label of product used
2,4-D LVE	Other livestock	0	—	30 days	
Arm (carfentrazone)	All	0	0	0	Slaughter restrictions are not mentioned on label
Chaparral (aminopyralid + metsulfuron)	All	0	—	0	No slaughter restrictions
Cimarron Plus (metsulfuron + chlorsulfuron)	All	0	0	0	Be cautious of crop rotation restrictions; see label for details
Clarity/Banvel (dicamba)	Lactating dairy	7 days if < 1 pt 21 days if 1–2 pt 40 days if 2–4 pt	—	37 days if < 1 pt 51 days if 1–2 pt 70 days if 2–4 pt	Remove meat animals from treated areas 30 days prior to slaughter
	Other livestock	0	—	0	
Crossbow (2,4-D + triclopyr)	Lactating dairy	Do not graze until next season	—	14 days	Remove meat animals from treated areas or dried hay 3 days prior to slaughter
	Other livestock	0	—	14 days	
Facet L (quinclorac)	All	0	—	7 days	No slaughter restrictions on the label
GrazonNext HL (amino-	All	0	—	?	Do not transfer grazing animals for 3 days from treated areas to areas with Milestone-sensitive

Owning your own sprayer: basic considerations

- Do you have the time to spray your own ground?
- How much land do you actively farm?
- What crops will it be used in and will it be used for various types of pesticides (i.e., herbicides, insecticides, fungicides, etc.) and liquid fertilizers?
- When will the application timings occur during the growing season (e.g., burndown, preemergence, in-crop, etc.)?
- How busy are you with other things when the applications need to occur?
- Do you have someone that can be dedicated when necessary to this task?
- Consider any potential conflicts with other farming operations during busy times of the year
- Nozzles that are typically used for applying herbicides generally are not the best choice when applying fungicides, insecticides, and/or liquid fertilizers
- Understanding of chemicals to apply based on the target pests; how to maintain, calibrate and operate the sprayer, mix in the correct order, and apply at the correct volume and speed
- You will likely need applicator insurance in case anything happens or in particular if you decide that you might want to hire yourself out to others.

Size of spray rig and other factors

- 3-point hitch; pull-behind; or self-propelled?
- Boom width
- Tractor size
- Labor and time
- Insurance
- Repairs and maintenance
- Fuel, taxes, bank interest, etc.

Weed Management with Herbicides

- More than just spraying some herbicides on a field
  - Correct weed ID; scouting is very important
  - Resistant weeds
  - Proper herbicide selection and rates
  - Modes of action
  - Generic products
  - Application timing
  - Necessary adjuvants
  - Sprayer calibration
  - Nozzle selection
  - Droplet sizes
  - Drift control
  - Rotational crops and cover crops
  - Personal protection (PPE)
  - Others…

Thank You!

Any QUESTIONS?