



Synchronizing Chemical Rotation and Crop Rotation

Frank L. Young – USDA-ARS
Pullman, WA



Agenda

- Benefits of crop rotation
- Benefits of chemical rotation
- Synchronization



Benefits of Crop Rotation

- Pest management
- Interrupts life cycle of weeds
- Increased yield
- Increased markets
- Sustainability



Integrated Pest Management (1985 – 1994)

- Tillage – conservation, conventional
- WML – min, mod, max
- Crop rotation
 - WW, SB, SP
 - WW, WW, SW



Benefit of Crop Rotation



Prophetic Statements

“Agriculture is a controversy with weeds.”

“Monoculture cropping – facilitates weeds; low species richness.”



“No pest dictates what crops or cropping system choices you use like weeds.”

Benefits of Herbicide Rotations

- Improve weed control.
- Delay / prevents weed resistance from occurring.



Herbicide Rotation Bulletin *

Guide for Herbicide Rotation in the Pacific Northwest

To avoid selecting for herbicide-resistant weeds, do not use herbicides from the same color group more than once within three years. Rather, rotate to a different group every year of the production system.

Herbicide group number and site of action	Herbicide chemical family	Herbicide common name	Herbicide trade names	Resistant weeds in the PNW	States with resistant weeds		
Group 1 Acetyl CoA carboxylase (ACCase) inhibitors	cyclohexanediones	clethodim	Select Max, Envoy, several others	Italian ryegrass Downy brome	ID, WA		
		sethoxydim	Poast, several others	Italian ryegrass Downy brome	ID, WA OR		
		tralkoxydim	Achieve	Italian ryegrass	ID, WA		
	aryloxyphenoxypropanoates	clodinafop	Discover NG	Italian ryegrass Wild oat	ID, WA ID		
		diclofop	Hoelon	Wild oat Italian ryegrass	ID, OR, WA ID, OR, WA		
		fenoxaprop	Puma, others	Wild oat	ID, OR		
		fluzifop	Fusilade DX	Downy brome	OR		
		quizalofop	Assure II, Targa	Italian ryegrass Downy brome	ID, WA OR		
	phenylpyrazoline	pinoxaden	Axial	Italian ryegrass	ID, OR, WA		
	Group 2 Acetolactate synthase (ALS) inhibitors	imidazolinones	imazamox	Raptor, Beyond, Clearmax (Beyond + MCPA)	Downy brome Spiny sowthistle	OR WA	
			imazapic	Plateau, others			
			imazapyr	Arsenal, Chopper, several others			
			imazethapyr	Pursuit, others	Prickly lettuce Kochia Spiny sowthistle Black mustard Mayweed chamomile	ID ID ID ID ID	
sulfonyleureas		chlorsulfuron	Glean, Telar	Prickly lettuce Kochia Russian thistle Italian ryegrass Mayweed chamomile Smallseed falseflax	ID, OR, WA ID, OR, WA ID, OR, WA OR ID, WA OR		
				halosulfuron	Sandea, others		
				mesosulfuron	Osprey	Italian ryegrass	ID, WA
				mesosulfuron/propoxycarbazone	Olympus Flex		

Herbicide group number and site of action	Herbicide chemical family	Herbicide common name	Herbicide trade names	Resistant weeds in the PNW	States with resistant weeds	
Group 5 Photosystem II inhibitors (groups 5, 6, and 7 have the same site but different binding behavior)	triazines	atrazine	AAtrax, others	Common lambsquarters Pigweed spp. Common groundsel Annual bluegrass Kochia	ID, OR, WA ID OR, WA OR ID	
		simazine	Princep, Simazine	Common groundsel	WA	
		as-triazines	hexazinone	Velpar, others	Shepherd's purse	OR
	uracils	metribuzin	Sencor, others	Shepherd's purse	OR	
				Redroot pigweed	ID	
		terbacil	Sinbar	Common groundsel Pigweed spp. Common lambsquarters	OR OR, WA OR	
Group 6 Photosystem II inhibitors (see group 5)	benzothiadiazoles	bentazon	Basagran			
	nitriles	bromoxynil	Buctril, Bronate (contains MCPA), several others	Common groundsel	OR	
Group 7 Photosystem II inhibitors (see group 5)	ureas	diuron	Karmex, Direx, others	Common lambsquarters Annual bluegrass	OR OR	
				linuron	Lorox, Linex	
				tebuthiuron	Spike, others	
Group 8 Lipid synthesis inhibitors but not ACCase inhibitors	thiocarbamates	cycloate	Ro-Neet			
			EPTC	Eptam, Imperium (Imperium is not registered in OR)		
			EPTC + safener	Eradicane		
Group 9	glycines	glyphosate	Roundup, several	Italian ryegrass	OR	

* Source: www.cals.uidaho.edu/edComm/pdf/pnw/pnw0437.pdf

Herbicide Rotation Restrictions

Rotation Restrictions (months):	Maverick	Powerflex	Olympus	Osprey	Everest
Active Ingredient:	Sulfosulfuron	Pyroxsulam	Propoxy-carbazine	Mesosulfuron	Flucarbazone
Canola	22	9?	22	9	9
Peas			12	3	11
Lentil			18	3	24

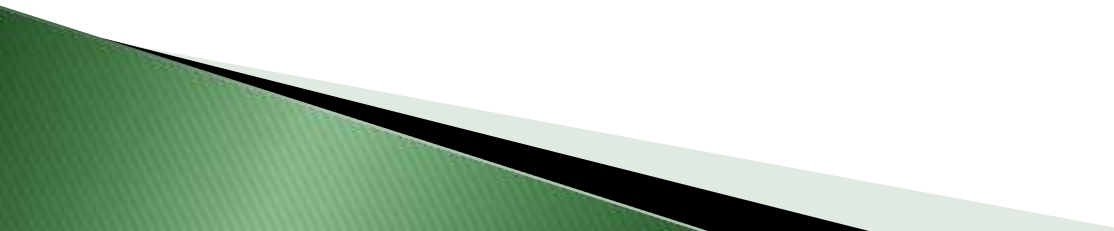


Herbicide Resistant Weeds

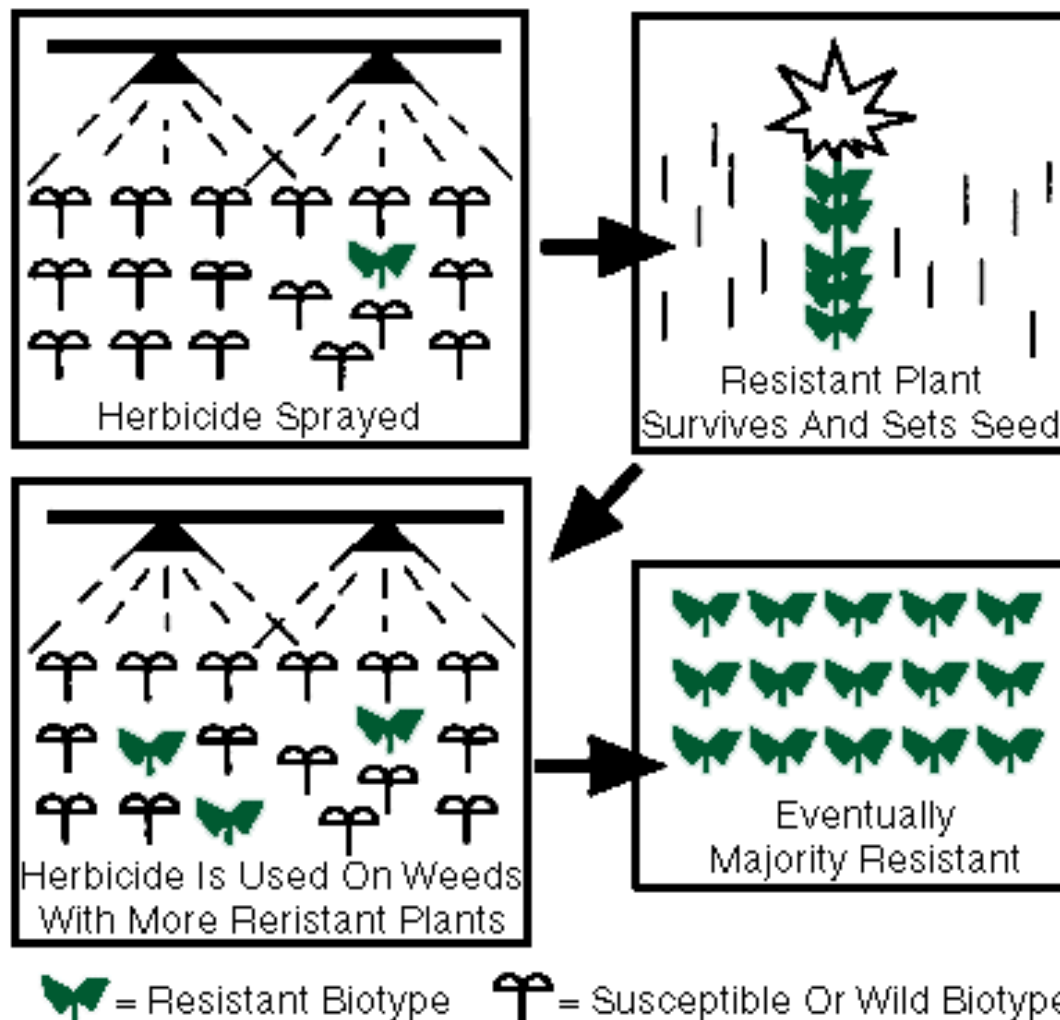
- > 211 weed species resistant to one or more herbicides (74 in US)
- 9 WA, 14 ID, 16 OR
- 9 weeds resistant to glyphosate (Roundup)



Herbicide Resistance

- Inherited ability of a plant to survive and reproduce following a herbicide dose to which the original population was susceptible.
 - Monoculture cropping systems.
 - Same herbicide, same field, same weed.
- 

Herbicide Selection Pressure



Source: J.L. Gunsolus. *Herbicide Resistant Weeds*. 1998.
North Central Region Extension Publication 468.

Preventing Herbicide Resistant Weeds

- **Herbicide rotation**
- Short – residual herbicide
- **Crop Rotation**
- Cultivation
- Accurate record keeping
- Clean Seed
- Integrated weed management



Winter Wheat / Summer Fallow Rotation



Winter Annual Grass Control

- Jointed goatgrass (*Aegilops cylindrica*)
- Downy brome (*Bromus tectorum*)
- Feral ryegrass (*Secale cereale*)



What Are You Using?

Wheat – Downy Brome

Herbicide	Group
Hoelon	1
Sencor	5
Olympus	2
Maverick	2



Benefits of Canola

- Improved weed control.
- Improved wheat yield.
- Improved soil quality.
- Improved sustainability.



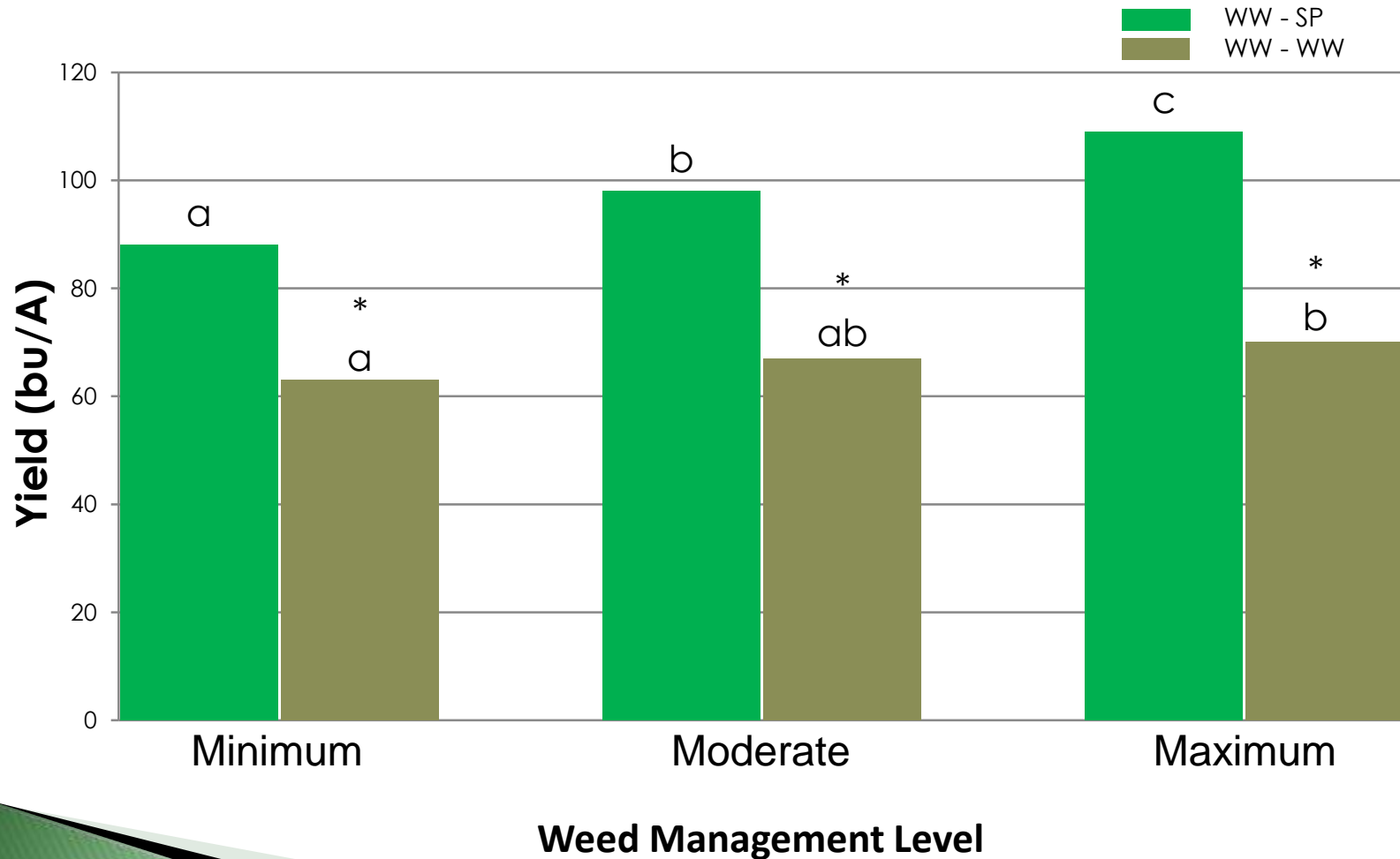
Grass Herbicides for Winter Canola

Effect of grass herbicides on feral rye control, biomass, seed heads, and winter canola yield.

Herbicide	Control	Rye Biomass	Heads	Yield
	%	lbs/A	no yd ⁻²	lbs/A
Untreated	0	3,920	255	1,165
Assure II ①	74	823	3	1,635
Select Max ①	64	1,597	40	1,680
Roundup ⑨	99	290	0	1,730



IPM Study – Winter Wheat Yield



Benefit of Crop & Chemical Rotation



A landscape photograph featuring a vast field of bright yellow flowers in the foreground, a dark, rocky hillside in the middle ground, and a blue sky with light clouds in the background. A wooden fence post is visible on the right side of the frame. The word "Questions?" is overlaid in large, bold, yellow text in the center of the image.

Questions?