Pigweed Management

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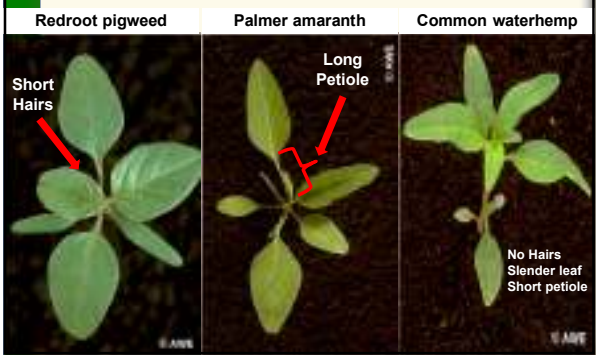
Pigweed Management

Outline

- Identification/Competitiveness
- Genetic Variability
- Herbicide Resistance
- Manage Resistance

Identification



Pigweed Biology

Identification

- Genetic diversity can generate different characteristics in populations

Pigweed Biology

Pigweed Competition

Palmer amaranth
- Height from 6 to 10 ft tall
- Up to 500,000 seed/plant
- Soy yield losses up to 79% at 8 plants/3ft-row

Common waterhemp
- Height from 6 to 9 ft tall
- Up to 2 million seed/plant
- Soy yield losses up to 56% at 8 plants/3ft-row

Redroot pigweed
- Height from 5 to 8 ft tall
- Up to 400,000 seed/plant
- Soy yield losses up to 38% at 8 plants/3ft-row

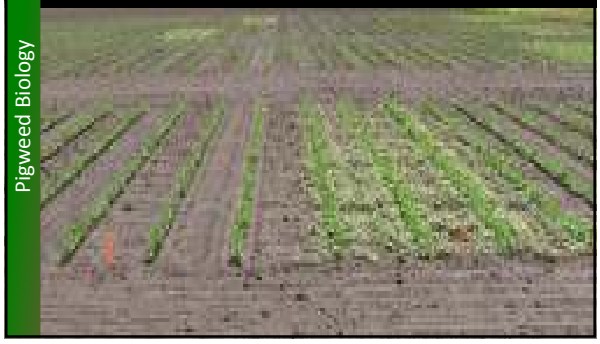
Pigweed Biology

Treatment of Weeds at Proper Size

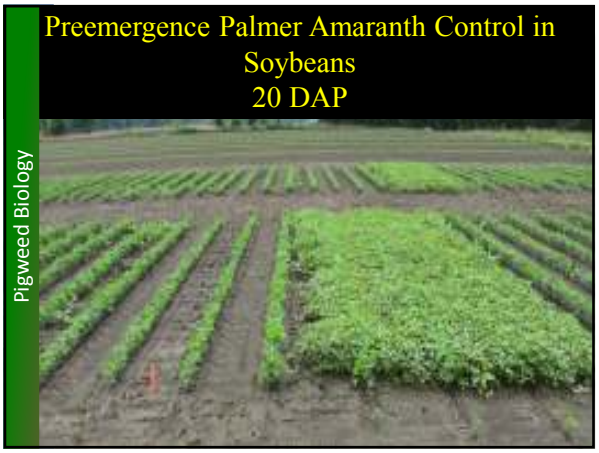
- Rate of Growth when temperatures are in the 80's and 90's
  - Especially true with Palmer amaranth

Preemergence Palmer Amaranth Control in Soybeans
10 DAP

Preemergence Palmer Amaranth Control in Soybeans
14 DAP



Preemergence Palmer Amaranth Control in Soybeans
20 DAP



Cobra at 12.5 oz/A applied 20 DAP

Roundup PowerMax at 32 oz/A

Roundup PowerMax at 32 oz/A

Pigweed Biology

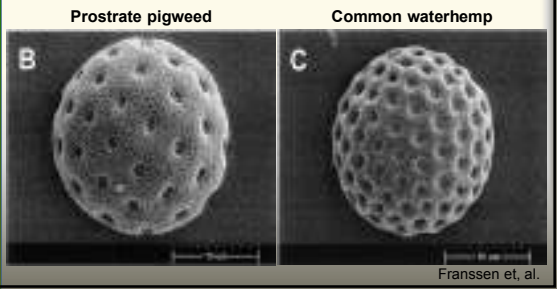
Pigweed Pollination

- Redroot pigweed, smooth pigweed, and prostrate pigweed are monoecious
  - Male and female parts on same plant
- Palmer amaranth and common waterhemp are dioecious plants
  - Male and female parts on separate plants
- Amaranth can cross pollinate between species
  - Potentially transfer resistance genes

Pigweed Biology

Pigweed Pollen Shape

- Pollen shape differences between species
  - Dioecious species generally more apertures



Franssen et, al.

Pigweed Biology

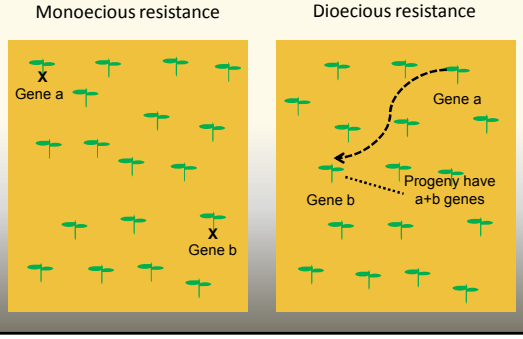
Cultural Practices to Reduce Weed Pressure

- Pollen viability
  - Common waterhemp pollen shown to be viable up to 120h in greenhouse
- Pollen spread
  - Decreased fertilization with greater distances
    - Within 165 ft from pollen source
  - Distances up to a half mile were observed in field studies

Liu et. al, 2012

Pigweed Biology

Pollination and Multi-Gene Resistance



Pigweed Biology

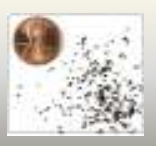
Cultural Practices to Reduce Weed Pressure

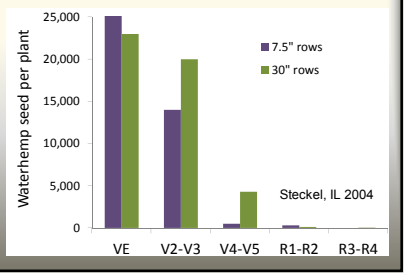
- Crop rotation
  - Crop suppression and use of different herbicide modes of action
- Mechanical
  - Inter-row cultivation
  - Rouging escapes
  - Deep plowing
    - Bury seed
- Crop competitiveness
  - Seeding rates?
  - Narrow row?

Pigweed Biology

Narrow Row Weed Suppression

- Across 6 site years, narrow row soybean suppressed 60% of *Amaranthus* (Bell, AR '15; Schultz, MO '15; Steckel, IL '04)
- Seed suppression across soybean growth stage and row spacing





Pigweed Biology

Iowa State University

What is the Cost of Late Season Waterhemp?

Do the math…

1 plant/15ft of row = 24.4 mil seed/ac

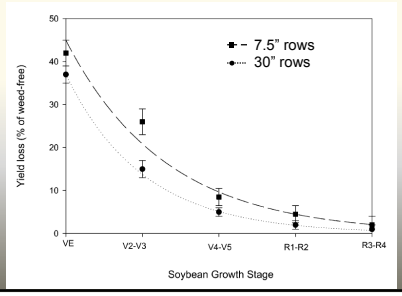
If 60% enter seed bank and 6% emerge = 878,000 plants/ac

If your herbicide program is 95% effective = 1 plant/ft²

Pigweed Biology

Narrow Row Weed Suppression

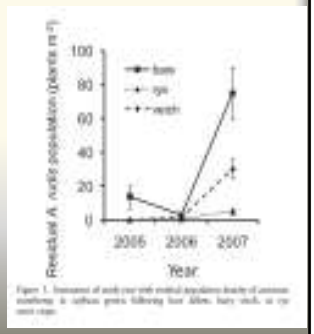
- Yield losses can be reduced with narrow rows when under high weed pressure (Steckel, IL 2004)



Pigweed Biology

Cover crop suppression of weeds

- Cover crops suppress weed emergence
  - Significantly reduced populations and seed production
  - Common waterhemp populations built over time but significantly less in cover crop treatments
    - Can't rely entirely on CC for weed control



Davis, A., 2010, Univ. Ill

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Herbicide Resistance

- Palmer and waterhemp have developed resistance across seven herbicide MOA (Heap 2015)
  - Dinitroaniline (Palmer): Treflan, Prowl
  - Triazine Resistance: Atrazine, Sencor
  - ALS Resistance: numerous Finesse, Pursuit, FirstRate
  - PPO Resistance (Waterhemp): Cobra, Flexstar, Sharpen
  - Glyphosate Resistance: Roundup, Touchdown
  - HPPD Resistance: Callisto, Armazon, Laudis, Balance
  - 2,4-D Resistance (Waterhemp):

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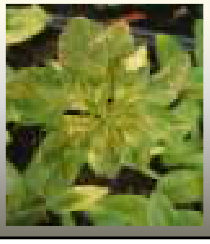
Herbicide Resistance Inheritance

- ALS and triazine resistance in pigweeds complete insensitivity to herbicide
  - Triazine also recently found to be metabolic resistance
- Waterhemp resistance to PPO herbicides is by one gene resistance
  - Resistant plants will show symptoms but won't die
- PPO resistant waterhemp may be common in KS
  - Resistance in KS, IL, MO



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PPO Resistant Waterhemp

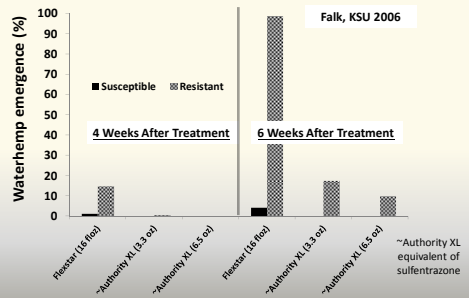
- Although resistant to PPO herbicides postemergence, plants will be susceptible to PPO herbicides applied preemergence
  - Authority, Valor, Reflex, Sharpen

PPO herbicide PRE

PPO herbicide POST

Pigweed Management

PPO Resistant Waterhemp



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Glyphosate Resistance

- The mechanism of glyphosate resistance in pigweed is increased expression of the ESPS enzyme
- Multiple copies of ESPS in individual plants explains varying response to glyphosate within a population

Pigweed Management

Greenhouse Population | Field Population

Pigweed Management

HPPD resistant waterhemp and Palmer amaranth

IA, IL, and NE in corn seed production fields

Kansas in wheat / sorghum rotation

Pigweed Management

Impact/Armezon dose response.

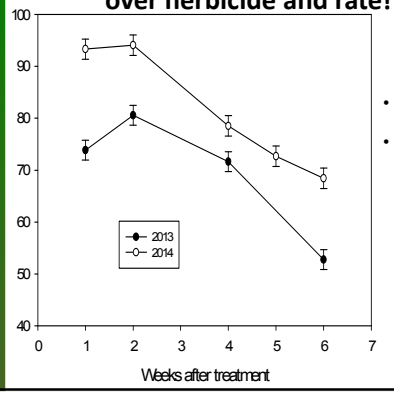
Pigweed Management

HPPD resistant Palmer amaranth control with PRE herbicides, Seward (Thompson, Peterson 2013)

Treatment (PRE applied)	Product/acre	3 WAT	6 WAT
Atrazine	1.5 qt	87	23
Evik DF	1.5 lb	87	23
Callisto	5.4 oz	99	85
Callisto + atrazine	5.4 oz+1.5 qt	100	92
Balance Flexx + atrazine	6 oz + 1.5 qt	100	75
Balance Flx + atz + Zidua	6 oz + 1.5 qt + 4 oz	100	96
Corvus + Atrazine	5.6 + 1.5 qt	98	75
Lumax EZ	2.7 qt	100	93
Lumax EZ + Tricor 75DF	2.7 qt + 7 oz	100	96
Harness Extra 5.6L	2.3 qt	100	72
LSD (0.05)		5	13

Pigweed Management

Palmer amaranth control averaged over herbicide and rate!



- Control declined over time
- Control ratings were higher in 2014 than 2013 due to much cooler weather during and following 2014 application.

Pigweed Management

So What's the Answer?

- Incorporate cultural practices previously mentioned
- Start using a more rigorous preemergence residual herbicide program

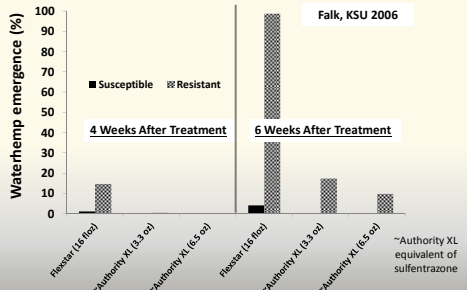
Pigweed Management

Glyphosate Resistant Waterhemp and Palmer Amaranth Control

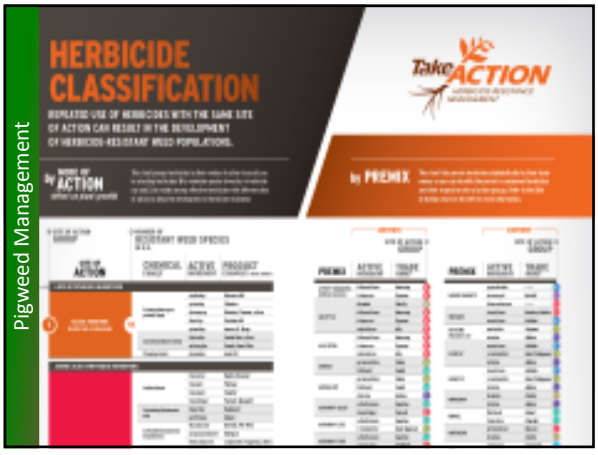
- Utilize an integrated approach incorporating preemergence residual herbicides with different MOA
- Foundation preemergence herbicides
  - Sorghum: Atrazine Premixes, Lexar/Lumax, Verdict
  - Corn: Atrazine/acetamide premixes, Lexar/Lumax, Balance Flexx, Corvus, Verdict, Accuron
  - Soybeans: Prefix, Authority Elite, Trivence, Boundary, Fierce, Optil Pro, Warrant Ultra

Pigweed Management

PPO Resistant Waterhemp



Pigweed Management

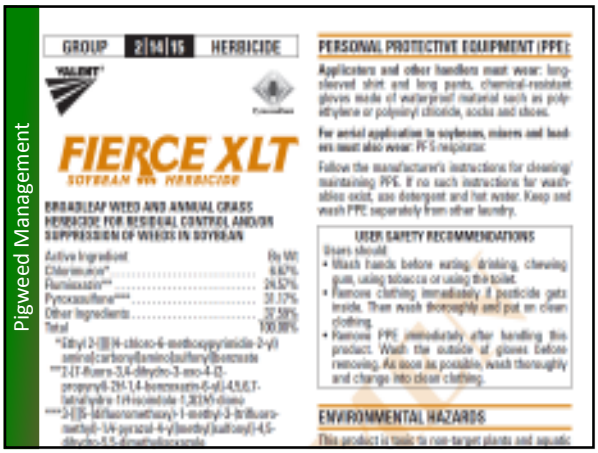


Pigweed Management

WSSA Site of Action Classification

- Number system assigned to different Herbicide Sites of Action
  1. ACCase inhibitors: Assure, Select, Poast, Fusion, etc
  2. ALS inhibitors: Sulfonylureas, Imidazoliones, etc
  4. Auxin receptors: 2,4-D, dicamba, Tordon, etc
  5. Photosystem II inhibitors: atrazine, metribuzin, etc
  9. EPSP inhibitor: glyphosate
  10. Glutamine Synthetase inhibitor: Liberty
  14. PPO inhibitors: Valor, Spartan, Sharpen, Cobra, Cadet, etc
  15. Long Chain Fatty Acid Inhibitors: Dual, Harness, Outlook, Zidua, etc
  27. HPPD inhibitors: Balance, Callisto, Laudis, Armezon, Huskie, etc

Pigweed Management


GROUP 2 | 14 | 15 HERBICIDE

FIERCE XLT

SOYBEAN HERBICIDE

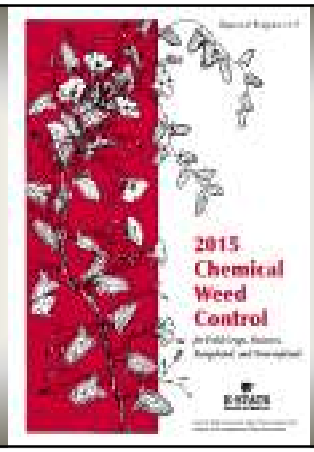
BROADLEAF WEED AND ANNUAL GRASS HERBICIDE FOR RESIDUAL CONTROL AND/OR SUPPRESSION OF WEEDS IN SOYBEAN

PERSONAL PROTECTIVE EQUIPMENT (PPE):

USER SAFETY RECOMMENDATIONS

ENVIRONMENTAL HAZARDS

Pigweed Management



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Herbicide Site of Action Designation

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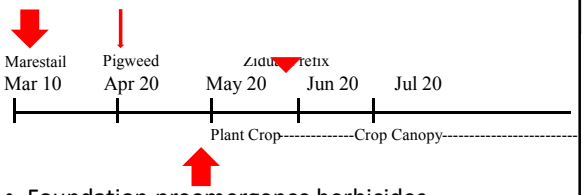
Soybean Weed Control Calendar



- Foundation preemergence herbicides
  (No more than 1 to 2 weeks preplant)
  - Soybeans: Authority, Valor, Fierce, Trivence, Prefix, Dual, Verdict, Zidua, Prowl

Pigweed Management

Soybean Pre Herbicide Solubility

Dual	Authority	Sencor	Reflex
30d*	32d	45d	100d

water soluble: active with less rainfall

less water soluble: active with rain

Prowl	Treflan	Valor	Zidua
25d	23d	15d	25d

* Approximate half life of herbicide according to the 2014 Herbicide Handbook

Pigweed Management

Preemergence Residual Herbicides Critical for Weed Control in Crops

- 3 major processes govern herbicide fate in soil
  - Chemical (adsorption, acid hydrolysis)
  - Physical (leaching, volatility, photo degradation)
  - Microbial degradation
- Longevity and fate of herbicide is dependent on
  - Clay content, pH, organic matter, soil moisture, microbial population

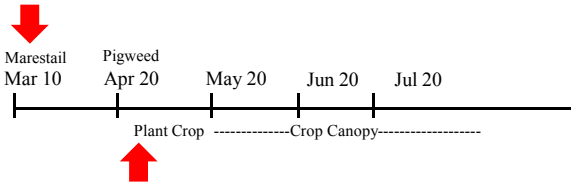
All these factors influence availability and phytotoxicity of residual herbicides

Pigweed Management

Preemergence weed control (3 WAP) at Manhattan (Peterson and Thompson 2014)

Herbicide	Rate	Paam	Vele	Ilmg
		----------(%)----------		
Fierce	3 oz	100	100	70
Sonic	3 oz	92	70	70
Sonic	6 oz	96	88	88
Surveil (Valor+FirstRate)	2.4 oz	100	100	78
Trivence	8 oz	100	100	75
Prefix	2 pt	98	20	30
Boundary	2 pt	100	80	13
LSD (5%)				

Sorghum Weed Control Calendar



- Fall / Late Winter Burndown
  - Glyphosate + Atrazine + Dicamba / 2,4-D
- Foundation preemergence herbicides
  - Chloroacetamide + Atrazine, Verdict, Lumax EZ
- Postemergence
  - Huskie + Atrazine or Clarity + Atrazine

Pigweed Management

Sorghum or Corn Pre Herbicide Solubility

Dual	Stinger	Python	Callisto
30d*	40d	60d	10d

water soluble: active with less rainfall

less water soluble: active with rain

Zidua	Balance	Atrazine
25d	2d	150d

++ metabolite has herbicide activity so soil residual longer than you think

* Approximate half life of herbicide according to the 2014 Herbicide Handbook

Pigweed Management

Weed control in sorghum, Manhattan (Thompson and Peterson 2014)

Treatment	Timing	Rate	Palmer	VELE	Yield
		Prod. / acre	% control		Bu/a
Lumax EZ	Pre	2.7 qt	99	100	110
Huskie+atrazine	POST	13oz + 1 pt	84	100	100
H+A+2,4-D LV4	POST	13+1+4 oz	89	100	88
H+A+Starane Ultra	POST	13+1+6.4 oz	93	100	105
H+A+Clarity	POST	13+1+4 oz	90	100	108
Starane NXT+Atra	POST	14 fl oz+1pt	77	87	76
Dual II Magnum/ Huskie+atrazine	Pre POST	1.3 pt 13+1 pt	100	100	105
Dual II Magnum/ Clarity+Atrazine	Pre POST	1.3 pt/ 8 oz+ 1 pt	89	85	105
Dual II Magnum/ Aim EC+Atrazine	Pre POST	1.3 pt/ 0.5 oz+1 pt	97	94	103
LSD (0.05)			8	4	16

Pigweed Management

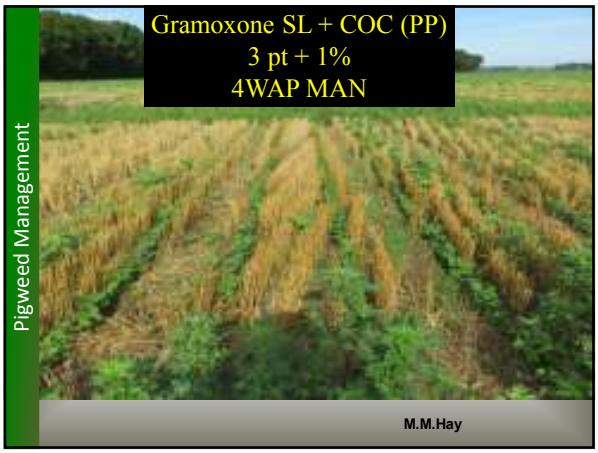
Glyphosate Resistant Waterhemp and Palmer Amaranth Control

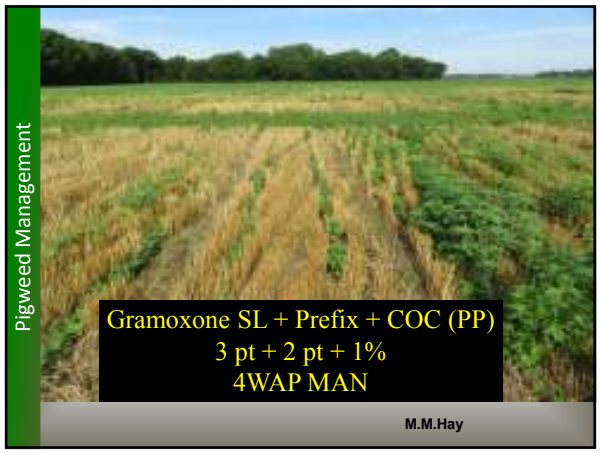
- Utilize an integrated approach incorporating postemergence and residual herbicides with different MOA
- Postemergence herbicide options
  - Sorghum – Huskie, atrazine, dicamba, 2,4-D
  - Corn – Callisto, Laudis, Capreno, Impact, Armezon, Status, 2,4-D, Glyphosate
  - Soybean – Flexstar, Cobra, Ultra Blazer, Glyphosate
- Burndown options for wheat fallow and DC Soybean?

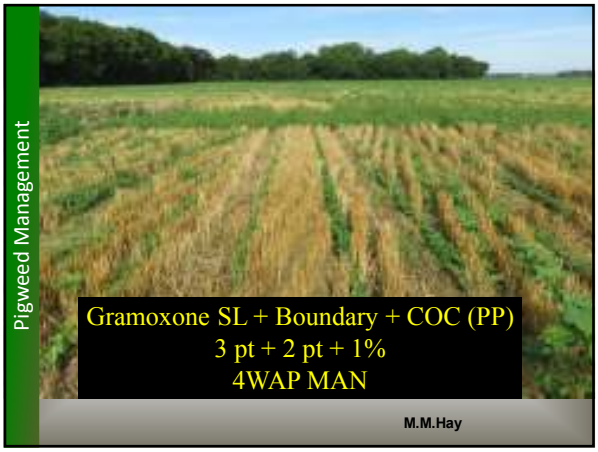
Pigweed Management

Palmer amaranth control in double crop wheat with preplant treatments (Hay, Peterson, and Shoup, 2015)

Herbicide	Rate	Palmer amaranth Control 7/8	7/24	8/22
	(per acre)		(%)	
Zidua (March 30 in wheat)	2 oz	5	0	0
Gramoxone + COC	3 pt	95	60	45
Prefix + COC	2 pt	75	70	60
Graxomone + Prefix +COC	3 pt + 2 pt	99	95	90
Gramoxone + Trivence + COC	3 pt + 8 oz	99	99	97
Gramoxone + Anthem + COC	3 pt + 8 oz	99	95	85
LSD (5%)		13	14	14







Pigweed Management

Future for Weed Management

- Genetically modified crops
  - Liberty-Link crops (currently available)
  - 2,4-D resistant corn, cotton, and soybean (Dow)
  - Dicamba resistant soybean and cotton (Monsanto)
  - Isoxaflutole-resistant soybeans (Bayer & Syngenta)

Pigweed Management

Preemergence in Liberty Link soybeans at Manhattanin 2014 (Peterson and Thompson)

Herbicide	Rate	Paam	Vele	Ilmg
		----------(%)----------		
Liberty (P)	36 oz	67	98	93
Liberty/Liberty (EP/P)	29/29 oz	97	100	100
Valor/Liberty (PRE/P)	3/29 oz	100	100	97
Fierce/Liberty (PRE/P)	3.5/29 oz	100	100	97
Authority XL/Liberty (PRE/P)	6/29 oz	100	100	100
Authority Max/Liberty (PRE/P)	7/29 oz	100	100	100
LSD (5%)		3	2	6

Pigweed Management

Summary

- Amaranthus species are a major challenge for all producers,
  - More of a "watch-out" for no-till producers where tillage isn't used
- Competitiveness of pigweeds can have a negative impact on yield
- Currently there is resistance to 7 different herbicide MOA in amaranth species
- Proper management against resistance is important to keep our technology relevant

Pigweed Management

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