Evaluating Crop Safety and Weed Control of Pyroxasulfone Applied Post-Emergence in Direct Seeded Fall Brassica Crops

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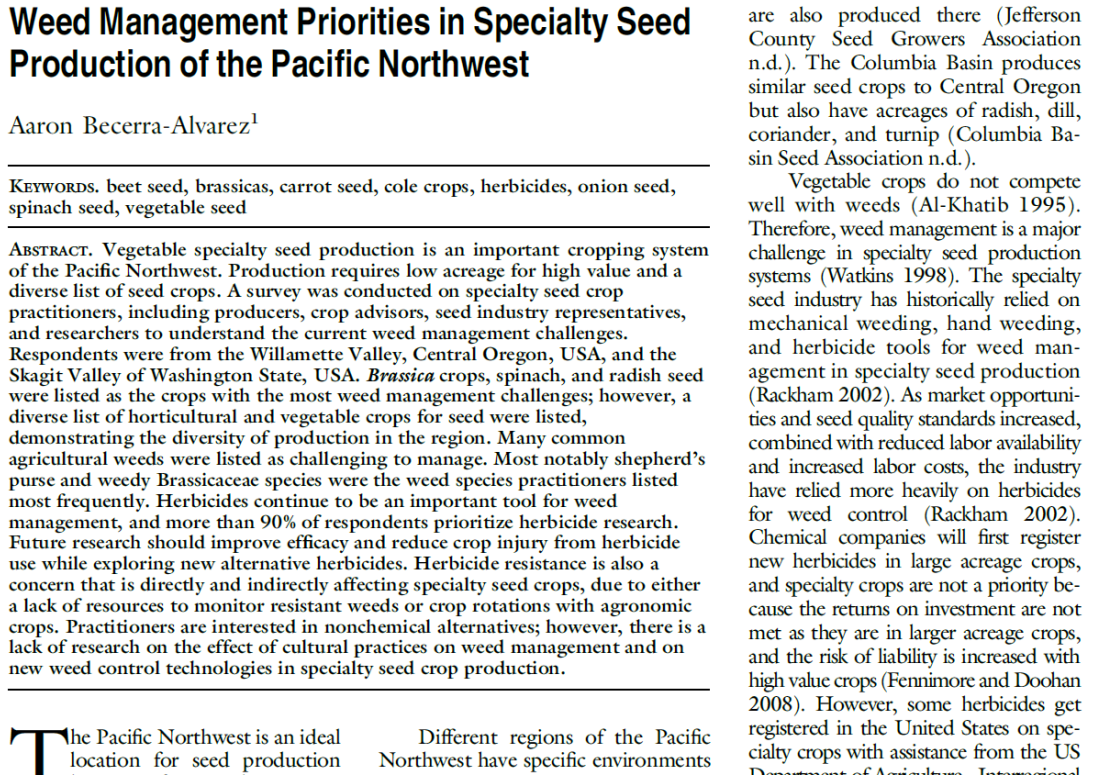
Contents

- Survey of stakeholder needs
- Research needs in specialty seed crops
- Summary of Zidua trial on fall-seeded brassicas
- Future projects in specialty seed crops

Herbicide Research in Specialty Seed Crops

- Compiled survey results and information from field visits
- Mainly Willamette Valley stakeholders but also included some input from Central OR and Western WA



Weed Management Priorities in Specialty Seed Production of the Pacific Northwest

Aaron Becerra-Alvarez[1]

Keywords. beet seed, brassicas, carrot seed, cole crops, herbicides, onion seed, spinach seed, vegetable seed

Abstract. Vegetable specialty seed production is an important cropping system of the Pacific Northwest. Production requires low acreage for high value and a diverse list of seed crops. A survey was conducted on specialty seed crop practitioners, including producers, crop advisors, seed industry representatives, and researchers to understand the current weed management challenges. Respondents were from the Willamette Valley, Central Oregon, USA, and the Skagit Valley of Washington State, USA. *Brassica* crops, spinach, and radish seed were listed as the crops with the most weed management challenges; however, a diverse list of horticultural and vegetable crops for seed were listed, demonstrating the diversity of production in the region. Many common agricultural weeds were listed as challenging to manage. Most notably shepherd's purse and weedy Brassicaceae species were the weed species practitioners listed most frequently. Herbicides continue to be an important tool for weed management, and more than 90% of respondents prioritize herbicide research. Future research should improve efficacy and reduce crop injury from herbicide use while exploring new alternative herbicides. Herbicide resistance is also a concern that is directly and indirectly affecting specialty seed crops, due to either a lack of resources to monitor resistant weeds or crop rotations with agronomic crops. Practitioners are interested in nonchemical alternatives; however, there is a lack of research on the effect of cultural practices on weed management and on new weed control technologies in specialty seed crop production.

The Pacific Northwest is an ideal location for seed production

Different regions of the Pacific Northwest have specific environments

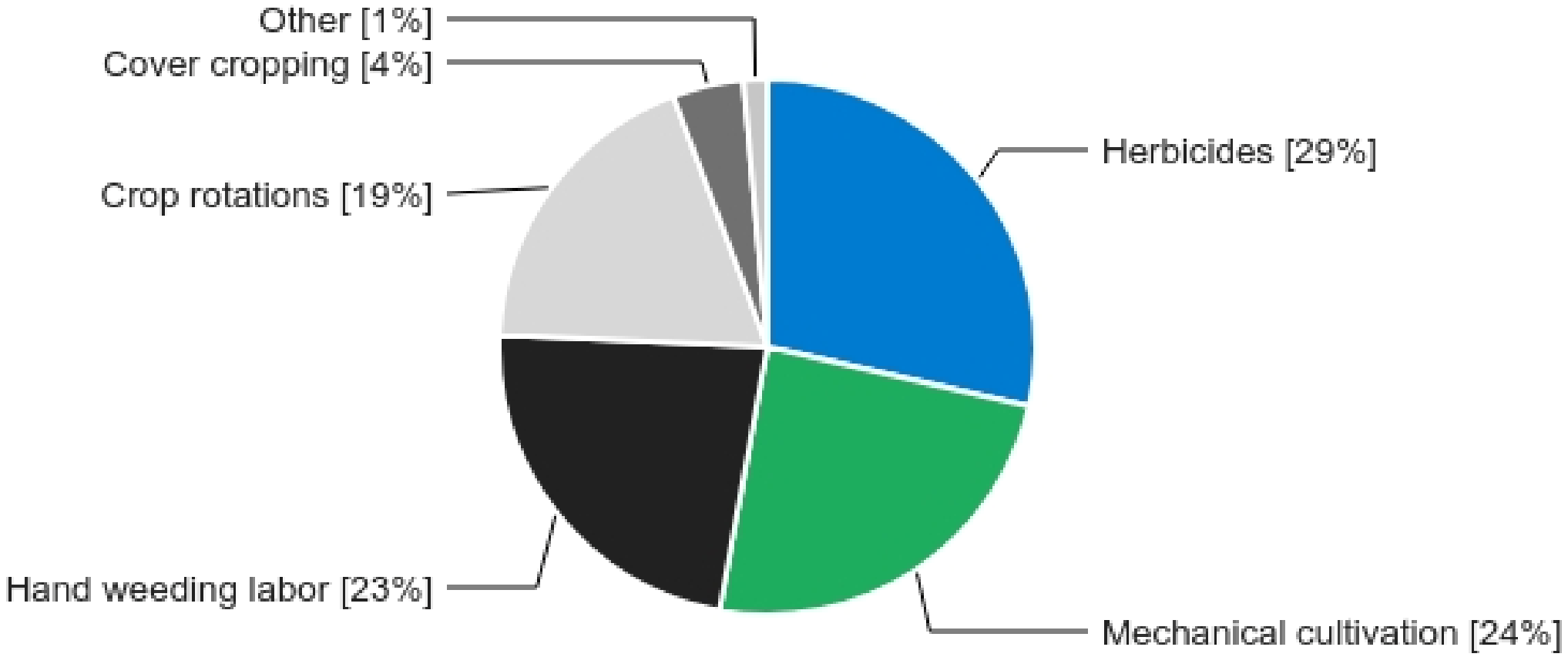
are also produced there (Jefferson County Seed Growers Association n.d.). The Columbia Basin produces similar seed crops to Central Oregon but also have acreages of radish, dill, coriander, and turnip (Columbia Basin Seed Association n.d.).

Vegetable crops do not compete well with weeds (Al-Khatib 1995). Therefore, weed management is a major challenge in specialty seed production systems (Watkins 1998). The specialty seed industry has historically relied on mechanical weeding, hand weeding, and herbicide tools for weed management in specialty seed production (Rackham 2002). As market opportunities and seed quality standards increased, combined with reduced labor availability and increased labor costs, the industry have relied more heavily on herbicides for weed control (Rackham 2002). Chemical companies will first register new herbicides in large acreage crops, and specialty crops are not a priority because the returns on investment are not met as they are in larger acreage crops, and the risk of liability is increased with high value crops (Fennimore and Doohan 2008). However, some herbicides get registered in the United States on specialty crops with assistance from the US

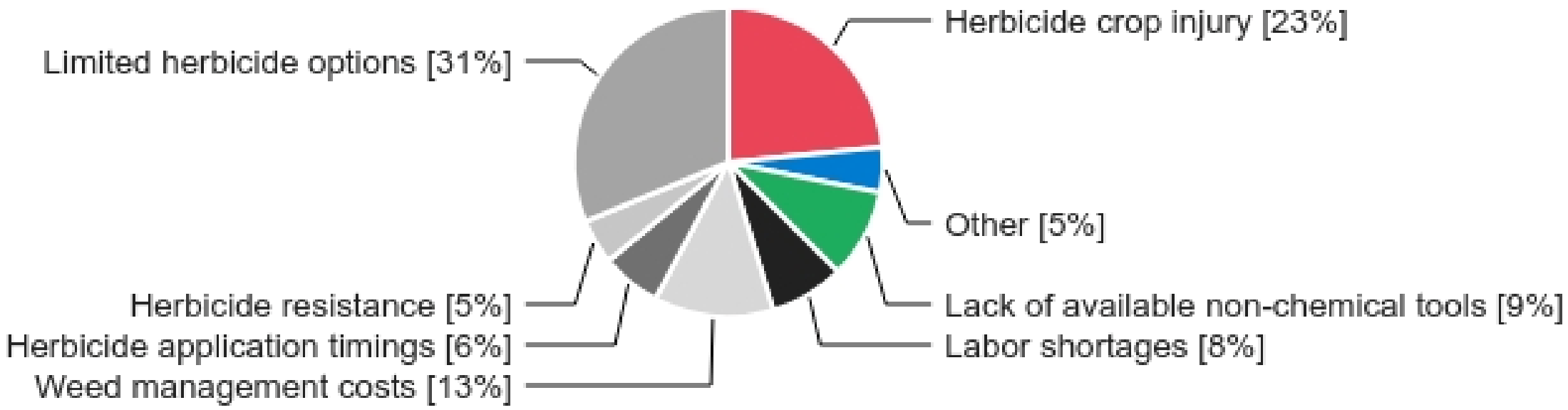
HortTechnology, *35*(5), 719-723.

Most common crops grown for seed

Crop	Scientific name
Brassicas[ii]	Various *Brassica oleracea* L., *B. rapa* L., *B. napus* L., and *B. juncea*
Spinach	*Spinacia oleracea* L.
Radish[iii]	*Raphanus sativus* L.
Beets	*Beta vulgaris* L.
Cucurbits	Various Cucurbitaceae species
Bunching onions	*Allium fistulosum* L.
Flower seed[iv]	Various species
Carrot	*Daucus carota* L.
Cover crop seed[v]	Various species
Onion	*Allium cepa* L.
Clover	*Trifolium* spp.
Meadowfoam	*Limnanthes alba* Benth.
Lettuce	*Lactuca sativa* L.
Parsley	*Petroselinum crispum* L.
Peas	*Pisum sativum* L.

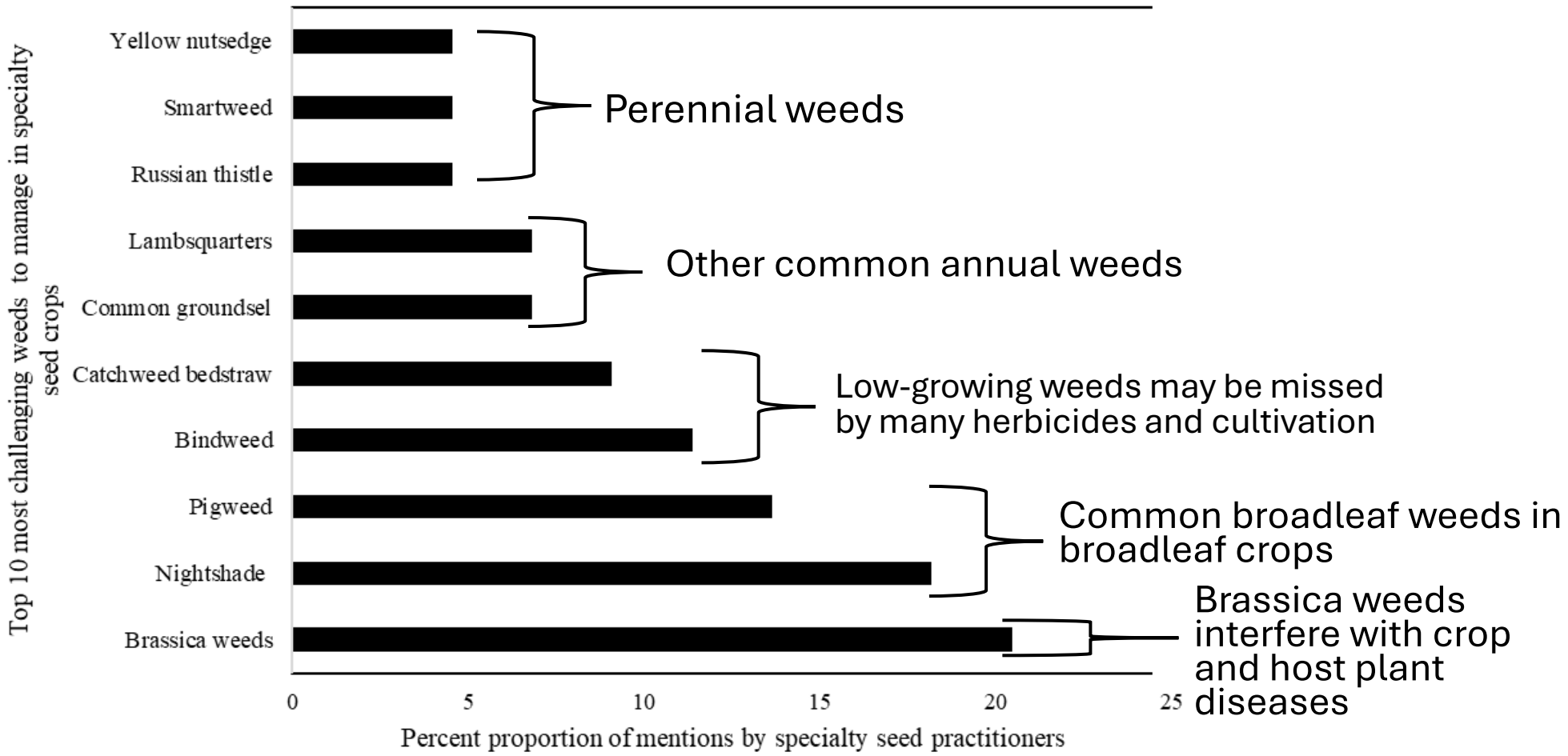


What tools do you use for weed management?



What are the weed management challenges you face?

Most challenging weeds to manage



Brassica weeds

- Shepherd’s purse
- Wild mustard
- Affecting Brassica crops

Cabbage field infested with Shepherd’s purse

- Wild radish in kale

- Brassica weeds can host plant diseases
  - Black rot
  - Alternaria
  - Clubroot
  - Etc.

Figure 3. Black leg on a broccoli stem (l) and the base of a kale plant (r).
Photos by Cindy Ocamb (OSU Department of Botany and Plant Pathology)

Nightshades

- Solanaceae family
  - Hairy nightshade
  - Black nightshade

Pigweeds

- Amaranthus family
  - Redroot pigweed
  - Powell pigweed
  - Other Amaranthus?

- Palmer amaranth
  - Established in Eastern OR, and Idaho
  - Also observed in WA on roadsides, 2024
- Waterhemp
  - Observed in Eastern OR and Idaho

Palmer amaranth

Waterhemp

Low-growing weeds

- Low-growing weeds may be missed by many herbicides and cultivation
  - Catchweed (*Galium aparine*)
  - Bindweed (*Convolvulus arvensis*)
  - Sharppoint fluvellin (*Kickxia elatine*)
    - Mentioned in the survey only once but is a unique weed of our region
    - Also challenging in grass seed fields

Specialty seed crop research needs

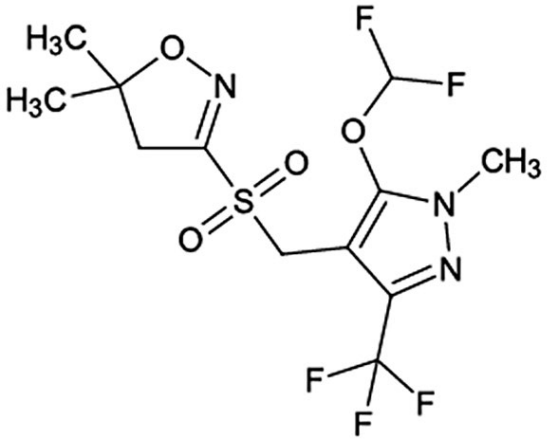
1. Evaluate new herbicides
2. Characterizing herbicide crop injury
    a. Develop data to improve herbicide labeling of specialty seed crops and for future reference
3. Herbicide interactions with mechanical and cultural practices
    a. Help address increasing costs
    b. Improve IPM efforts
4. Documenting herbicide-resistant weeds and finding alternative control methods

Specialty seed crop research needs

6. Evaluate new technologies in weed control for our production systems
7. Help educate incoming specialty seed practitioners

Pyroxasulfone

- Exploring new herbicides in brassicas
- Zidua (Pyroxasulfone)
  - Group 15 MOA (very long chain fatty acid inhibitor)
  - Chemical family: Isoxazolines
  - Controls grasses and some broadleaf weeds
  - Absorbed by emerging shoots and roots
    - Used as pre-emergence weeds only
  - Terrestrial field dissipation half-life of 16 to 26 d.



pyroxasulfone

Pyroxasulfone

- SSGWO report “Vegetable Crop Tolerance to PRE and POST Herbicides” showed different crop responses across brassicas with pyroxasulfone applied PRE

Different crop response to pyroxasulfone PRE direct-seeded, 2018

Crop	Rate	%Emergence	Phyto (1-10)	%Growth rating
Arugula	0.75 oz/A	93	2	23
Broccoli	0.75 oz/A	0	10	0
Indian mustard	0.75 oz/A	90	3.3	10
Kale	0.75 oz/A	5	5	2
Red radish	0.75 oz/A	97	2	58
Rutabaga	0.75 oz/A	20	3	3

Fall seeded brassica response to Zidua applied POST

- Crop safety and weed control of Zidua (pyroxasulfone) applied POST in fall-seeded brassicas
  - Longer residual and good control of grasses and some broadleaf weeds
- Field trial in 2024 to 2025
  - Cabbage
  - Kale
  - Turnip

- Applied after cultivation in the interrow in cabbage and kale field not in turnip field

Table 1. Treatment list evaluating Zidua SC (pyroxasulfone) in directed seeded fall brassicas

	Treatment	Rate	Timing	Crop stage
1	Nontreated	-	-	
2	Handweeded check	-	POST	After 3-leaf
3	Zidua SC	0.75 fl oz/A	POST	After 3-leaf
4	Zidua SC	1 fl oz/A	POST	After 3-leaf
5	Zidua SC	2 fl oz/A	POST	After 3-leaf
6	Zidua SC (2X)	4 fl oz/A	POST	After 3-leaf
7	Grower treatment	Varies	-	-

Grower standards will differ across the field sites. Crops: cabbage, kale, and turnip. POST, postemergence.

Application details

Table 2. Treatment applications of Zidua SC (pyroxasulfone) postemergence on cabbage, kale and turnip grown for seed in western Oregon 2024 to 2025.			
Crop	Cabbage	Kale	Turnip
Date	September 24, 2024	October 14, 2024	October 25, 2024
Crop stage	4-5 leaf stage	5 leaf stage	3 leaf stage
Treatment	Zidua SC	Zidua SC	Zidua SC
Application Timing	Postemergence	Postemergence	Postemergence
Start/end time	11:00/12:00 am	10:00/11:41 am	10:00/11:00 am
Air temp (F)	75	68	48
Rel humidity (%)	57	56	68
Wind direction (mph)	4, NE	7, SE	0.2, SE
Cloud cover (%)	0	0	95
Soil moisture	Dry	Dry to moist	Wet
Plant moisture	Dry	Dry	Moist, dew
Mix size	1.6 L	1.6 L	1.6 L
GPA	20	20	20
Nozzle type	4-XR11002VS	4-8002VS	4-8002VS
Nozzle spacing and height (in)	20, 20	20, 20	20, 20

- OP
- The crop row was weedy at application and remained weedy
- Applied after cultivation in the row

Cabbage

Table 3. Direct-seeded cabbage response after post-emergence applications of Zidua SC (pyroxasulfone) at different rates in western Oregon.

	Treatment	Product rate	Timing	Necrosis	Total injury	Necrosis	Total injury
				7 DAT		20 DAT	
				%			
1	Nontreated	-		0 b	0 b	0 a	0 a
2	Handweeded check	-	POST	0 b	0 b	0 a	0 a
3	Zidua SC	0.75 fl oz/A	POST	0 b	0 b	0 a	4 a
4	Zidua SC	1 fl oz/A	POST	2 ab	2 ab	0 a	4 a
5	Zidua SC	2 fl oz/A	POST	3 ab	3 ab	0 a	3 a
6	Zidua SC (2X)	4 fl oz/A	POST	4 a	4 a	0 a	2 a

Means with the same letter within each column do not differ with Tukey's HSD at significance level of α=0.05.

Cabbage

- Zidua SC 1 fl oz/A 42 DAT and 205 DAT

Zidua SC 1 fl oz/A 42 DAT

Zidua SC 1 fl oz/A 205 DAT

Cabbage

- 1, 2, and 4 fl oz did have control on emerging shepherd's purse to some degree
  - Some control of emerging spring weeds like swine cress, pineapple weed, and mallow
- The weed counts at 205 DAT did not account for weed size and it is noted that the weeds in the nontreated were larger weeds and the weeds in the treated plots were new emergences which could account for why we see numerically higher counts in the high rate

Table 4. Weed control in the inter-row after post-emergence applications of Zidua SC (pyroxasulfone) at different rates in direct-seeded cabbage in western Oregon.

	Treatment	Product rate	Timing	Weed control				Weed density		
				14 DAT	28 DAT	42 DAT	205 DAT	14 DAT	42 DAT	205 DAT
				%				count/ft^2		
1	Nontreated	-		0 b	0 b	0 b	0 b	8 a	5 ab	12 a
2	Handweeded check	-	POST	75 a	43 ab	82 a	100 a	12 ab	6 a	4 ab
3	Zidua SC	0.75 fl oz/A	POST	85 a	94 a	77 a	81 a	6 ab	3 ab	9 a
4	Zidua SC	1 fl oz/A	POST	94 a	98 a	81 a	81 a	1 bc	2 ab	12 a
5	Zidua SC	2 fl oz/A	POST	94 a	98 a	75 a	91 a	0 c	0 b	5 ab
6	Zidua SC (2X)	4 fl oz/A	POST	100 a	100 a	75 a	99 a	0 c	0 b	16 a

Weed density data log-transformed and back transformed for presentation.

Means with the same letter within each column do not differ with Tukey's HSD at significance level of α=0.05.

Kale

- Lacinato kale
- Zidua worked the best in this scenario
  - Applied after tillage with an interrow rototiller
- Minimal crop injury observed
  - 9% injury (stunting) observed at 120 DAT observed across treatments, unclear if it was environmental factor or herbicide
  - Recorded no differences in plant height measurements across treatments

Kale

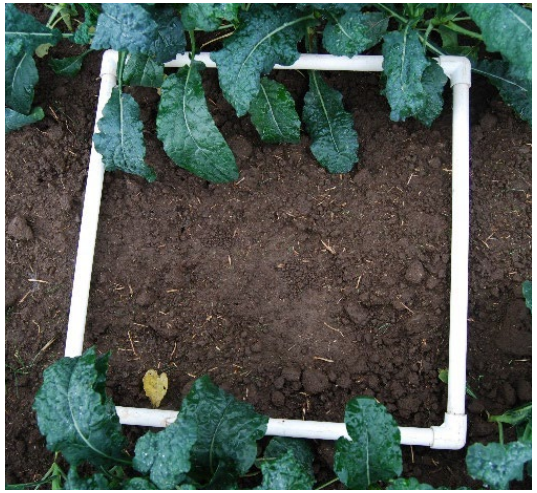
- Images14 DAT

NTC

Zidua 0.75 floz/A

Zidua 1 floz/A

Zidua 2 floz/A



Zidua 4 floz/A

NTC

Table 5. Weed control after post-emergence applications of Zidua SC (pyroxasulfone) at different rates in direct-seeded kale in western Oregon.

	Treatment	Product rate	Timing	Total weed control		Weed density	
				14 DAT	120 DAT	14 DAT	120 DAT
				%		count/ft^2	
1	Nontreated	-		0 c	0 c	27 ab	53 a
2	Handweeded check	-	POST	-	-	33 ab	20 bc
3	Zidua SC	0.75 fl oz/A	POST	65 ab	27 b	18 ab	40 ab
4	Zidua SC	1 fl oz/A	POST	84 a	81 a	16 ab	15 c
5	Zidua SC	2 fl oz/A	POST	89 a	93 a	13 b	10 c
6	Zidua SC (2X)	4 fl oz/A	POST	64 ab	94 a	8 b	5 c
7	Simazine		POST	56 ab	86 a	12 b	10 c

All plots received s-metolachlor at planting; the grower standard consisted of simazine post.

Means with the same letter within each column do not differ with Tukey's HSD at significance level of α=0.05.

Kale

- 120 DAT
- Grasses and broadleaves
- Better control of grasses

Zidua 0.75 floz/A

Zidua 1 floz/A

Zidua 2 floz/A

Zidua 4 floz/A

Turnip

- In this field we knew there was Poast resistant ryegrass, and it was being rotated with turnip for a year
- Few weeds present

NTC

Zidua 1 floz/A

Zidua 2 floz/A

Turnip

- Images 40 DAT
- No differences across treatments in crop injury and weed control

Turnip

- Weed control was 80% to 90%
- Weed density data was no different among treatments and values were 3 to 10 in grass counts/ft2 and 1 to 3 in broadleaf counts/ft2
- The few weeds that were present were all relatively small and never got larger than the turnip plants

Table 6. Weed control after post-emergence applications of Zidua SC (pyroxasulfone) at different rates in direct-seeded fall turnip in western Oregon.

	Treatment	Product rate	Timing	Total injury		
				7 DAT	20 DAT	120 DAT
					%	
1	Nontreated	-		0 b	0 b	0 b
2	Handweeded check	-	POST	0 b	0 b	0 b
3	Zidua SC	0.75 fl oz/A	POST	1 ab	2 a	15 a
4	Zidua SC	1 fl oz/A	POST	1 ab	0 ab	15 a
5	Zidua SC	2 fl oz/A	POST	2 a	1 ab	12 a
6	Zidua SC (2X)	4 fl oz/A	POST	4 a	1 ab	30 a
7	Grower treatment		POST	0 b	0 b	23 a

All plots received s-metolachlor at planting; the grower standard consisted of clethodim post emergence.

Means with the same letter within each column do not differ with Tukey's HSD at significance level of α=0.05.

NTC

Zidua 1 floz

Zidua 2 floz

Zidua 2 floz

Summary of field trials

- Minimal to no visual crop injury was observed in any of the crops after Zidua post emergence applications at 0.75 floz/A up to 4 floz/A rates
- Zidua is safer as a post-emergence on brassicas like cabbage, kale, and turnip as demonstrated here, than when applied pre-emergence and could complement herbicide programs for extended residual soil activity
- A mixture of herbicides with Zidua or follow ups may be necessary to achieve greater shepherd's purse control where pressure is high or already emerged weeds
- I have not heard back from registrant if this is of interest but continue evaluating maybe spring seeded brassicas also

New research for 2026

- Alternative preemergence herbicides in spinach seed
  - Dual Magnum and Nortron mixtures
  - Metamitron (Goltix 700 SC)
- Goltix 700 SC response to table beets
  - Also add swiss chard
  - Any others?
- Herbicide screening on brassica crops
- Evaluating new technologies for weed control

Thank you

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