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

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Final report to the Specialty Seed Growers of Western Oregon (SSGWO)

Updates

This report shares the same results from the September 17, 2025, report. The results have been shared with Kumiai Chemistry Industry Co. and are under review by the company. No response to support a SLN label has been provided yet but I got a response it was being reviewed this summer. A second trial was not conducted in 2025 due to limited capacity at time of treatments and no initial response from the company; however, in the 2024-25 season the trial was carried out on three different locations and three crop types which provide robust results. One additional trial in cabbage is being conducted this 2026 in the St. Paul area to develop a two-year dataset for that crop. I was also successful in securing additional funding from USDA IR-4 to evaluate pyroxasulfone and flumioxazin for cabbage grown for seed with the use of this preliminary data. These studies will begin in summer 2027. The pattern uses that will be researched in the studies will include carbon banding pre-emergence and directed spray post-emergence. Our data will also support pyroxasulfone postemergence over the top if registration is successful.

Objectives: The objectives of this study are to evaluate crop safety and weed control efficacy of pyroxasulfone applied post-emergence in direct-seeded fall brassica crops including cabbage, kale, and turnip.

Procedures: The research trials were carried out in an OP cabbage field in Dever-Connor, a lacinato kale field in Brooks, and a turnip field in Sublimity. Zidua treatments at different rates were applied post-emergence over the crop. The treatments are shown in Table 1. Treatment timings were scheduled before rain events. Plot size was 5 ft by 20 ft and arranged in a randomized complete block design. The cabbage field was treated on September 24, 2024, a day after a sweeping A-blade cultivator pass in the rows. The cabbage plants were 4- to 6-leaf stage with still many weeds remaining in the crop row. The kale plants were 5- to 6-leaf stage at treatment timing on October 14, 2024, after the soil was rototilled in between the crop rows. The turnip field was treated on October 25, 2024, when plants were 3-leaf stage. In both the kale and turnip fields, the entire field was already treated with s-metolachlor at planting. The grower treatment in the kale fields also followed with clopyralid post-emergence and simazine post-emergence after the rototiller in the rows. In the turnip field, the grower treatment followed with a clethodim application by 5-leaf stage.

Crop response evaluations were evaluated at 7, 20, 40, and 120 days after treatment (DAT) or 205 DAT in cabbage. Weed control evaluations were evaluated 14, 28, 42, and 120 DAT or 205 DAT in cabbage. The cabbage and kale fields were harvested by hand for rough seed yields sampling 6 ft in the plots of one row. Analysis of data was performed on R (Posit team, 2025). Analysis of variance (ANOVA) and mean separation test with Tukey's HSD at a significance level of $\alpha=0.05$ were performed when appropriate.

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.

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	Cabbage*
Date	September 24, 2024	October 14, 2024	October 25, 2024	November 7, 2026
Crop stage	4-5 leaf stage	5 leaf stage	3 leaf stage	8-9 leaf stage
Treatment	Zidua SC	Zidua SC	Zidua SC	Zidua SC
Application Timing	Postemergence	Postemergence	Postemergence	Postemergence
Start/end time	11:00/12:00	10:00/11:41	10:00/11:00	12:00/1:00
Air temp (F)	75	68	48	58
Rel humidity (%)	57	56	68	66
Wind direction (mph)	4, NE	7, SE	0.2, SE	3, E
Cloud cover (%)	0	0	95	80
Soil moisture	Dry	Dry to moist	Wet	Wet; 55 F soil temp
Plant moisture	Dry	Dry	Moist, dew	Moist, dew
Mix size	1.6 L	1.6 L	1.6 L	1.7 L
GPA	20	20	20	20
Nozzle type	4-XR11002VS	4-8002VS	4-8002VS	4-8002VS
Nozzle spacing and height (in)	20, 20	20, 20	20, 20	20, 20

*Treated but no results have been shared on this report

Results and Discussion

Cabbage response to Zidua post-emergence

Cabbage field plot images after Zidua post emergence applications



Nontreated control 28 DAT



Zidua 0.75 floz/A 28 DAT



Zidua SC 1 fl oz/A 28 DAT



Zidua SC 2 fl oz/A 28 DAT



Zidua SC 4 fl oz/A 28 DAT



Nontreated 42 DAT





Zidua 0.75 floz/A 42 DAT





Zidua SC 1 fl oz/A 42 DAT





Zidua SC 2 fl oz/A 42 DAT





Zidua SC 4 fl oz/A 42 DAT





Nontreated control 205 DAT, interrow control





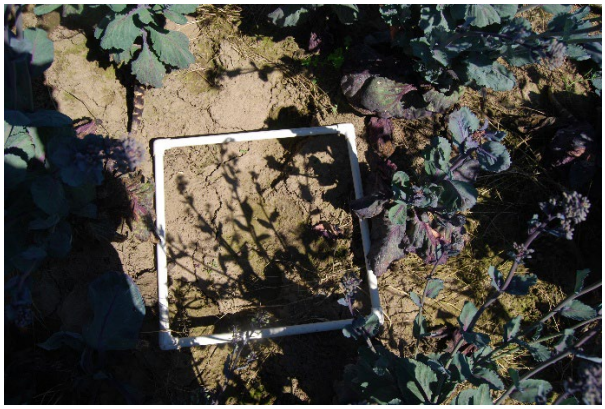
Zidua SC 0.75 fl oz/A 205 DAT




Zidua SC 1 fl oz/A 205 DAT




Zidua SC 2 fl oz/A 205 DAT

Zidua SC 4 fl oz/A 205 DAT

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.

Early on minimal foliage burn spots were observed at higher rates but plants recovered and appeared normal by the following weeks (Table 3). There was some stunting observed by 20 DAT and 40 DAT; however, it was across all plants and may have been caused by the weed pressure in the crop row and not the herbicide applications. No differences across treatments were observed. No differences in plant height across treatments were observed at 40 DAT, recording 40 to 46 cm (p=0.27). No difference in flowering time was observed. The cabbage was safe after post-emergence application of Zidua.

Weed control in cabbage field from Zidua post-emergence

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.

The dominant weed in the cabbage field was shepherd's purse in the fall; however, some annual ryegrass, nightshades, and fluvellin were also present. Weed control in the inter-row was only significant across ratings ($p<0.001$) and not rates ($p=0.103$) or ratings and ratings combined ($p=0.47$). Treatments were only different to the nontreated and presented here for reference (Table 4). At this location, different Zidua rates did not improve or reduce control, and control was adequate throughout the season. Only by 42 DAT was weed control reduced (Table 4). By 205 DAT, the previous fall weeds went through their life cycle and new spring weeds emerged. This explains the observed increase in control (Table 4).

By the beginning of spring, new weeds like swine cress, pineapple weed, and mallow emerged. A new flush of shepherd's purse also appeared to emerge; however, it was less amount than in fall. No differences were observed across treatments on visual control (Table 4). There was variation in the data among replications, and it was unclear how well Zidua treatments-controlled weeds into spring. 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).

Kale response to Zidua post-emergence

Kale field plot images after Zidua post emergence applications



Nontreated 14 DAT





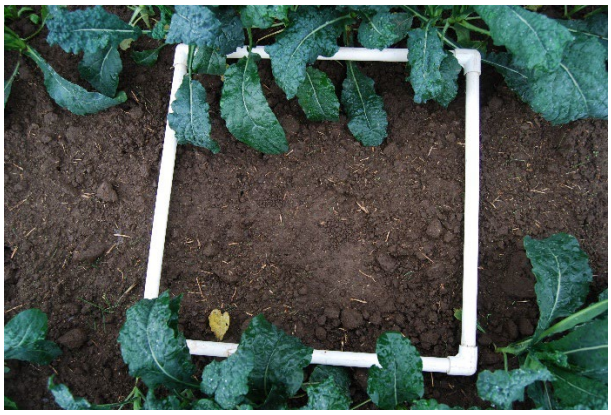
Zidua SC 0.75 fl oz/A 14 DAT




Zidua SC 1 fl oz/A 14 DAT




Zidua SC 2 fl oz/A 14 DAT

Zidua SC 4 fl oz/A 14 DAT





Nontreated control 120 DAT





Zidua SC 0.75 fl oz/A 120 DAT





Zidua SC 1 fl oz/A 120 DAT





Zidua SC 2 fl oz/A 120 DAT





Zidua SC 4 fl oz/A 120 DAT



Standard POST simazine

Minimal to no injury was observed in kale plants after the post-emergence Zidua application. Plant height at 20 DAT was 34 to 37 cm across all treatments ($p=0.15$). General phytotoxicity was observed from 2% to 5% across all treatments ($p=0.84$). Most noticeably, stunting was common and chlorotic lower leaves by 120 DAT. Visual injury collected increased from 2% in 7 DAT to 9% at 120 DAT ($p<0.001$). These symptoms were likely caused by cold temperatures and normal senescence because the nontreated showed symptoms too. At harvest, the plant dry biomass from a 6 ft sample within the crop row of each plot averaged 820 to 1,050 g/6ft row across all treatments ($p=0.34$). The rough seed yield from each plot averaged 465 to 639 lbs/A across all treatments ($p=0.53$). No treatment differences in crop response were observed.

Weed control in kale field from Zidua post-emergence

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	Grower treatment		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.

Table 6. Grass and broadleaf weed control after post-emergence applications of Zidua SC (pyroxasulfone) at different rates in direct-seeded kale in western Oregon.

	Treatment	Product rate	Timing	Grass weed control		Broadleaf control across ratings
				14 DAT	120 DAT	
					%	
1	Nontreated	-		0 b	0 b	-
2	Handweeded check	-	POST	100 a	76 a	-
3	Zidua SC	0.75 fl oz/A	POST	73 a	30 b	39 c
4	Zidua SC	1 fl oz/A	POST	85 a	89 a	70 abc
5	Zidua SC	2 fl oz/A	POST	96 a	95 a	90 a
6	Zidua SC (2X)	4 fl oz/A	POST	94 a	98 a	80 ab
7	Grower treatment		POST	80 a	80 a	42 bc

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.

The dominant weeds observed at this site included annual ryegrass and shepherd's purse. The total weed control was effective and reduced weed densities compared to the nontreated (Table 5). Control of grass weeds was most effective at rates over 1 floz/A (Table 6). Broadleaf weed control was only significant across Zidua rates (p=0.0007) and rating timing (p=0.001), but no interaction effect was observed (p=0.11). The application rates of 2 floz/A and over improved control of broadleaf weeds compared to the 0.75 floz/A application rate (Table 6). It is not surprising grass weeds were more easily controlled since Zidua is more effective on grass than broadleaves.

Turnip response to Zidua post-emergence

Turnip field plot images after Zidua post emergence applications



Nontreated 40 DAT (both left and right), little to now weeds present




Zidua SC 0.75 fl oz/A 40 DAT




Zidua SC 1 fl oz/A 40 DAT




Zidua SC 2 fl oz/A 40 DAT




Zidua SC 4 fl oz/A 40 DAT




Nontreated 120 DAT




Zidua SC 0.75 fl oz/A 120 DAT




Zidua SC 1 fl oz/A 120 DAT




Zidua SC 2 fl oz/A 120 DAT



Zidua SC 4 fl oz/A 120 DAT

Visual injury on turnip was observed early on only up to 4% by the 4 floz/A rate which was greater than the grower standard plots but like all other herbicide treatments. By 120 DAT, visual injury as chlorosis and necrosis of leaves increased but across all treatments. The injury was most likely normal leaf senescence or some disease pressure on the plants. Additional crop response data was not collected at this site.

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.

Weed control in turnip field from Zidua post-emergence

Weed pressure was low at this site. The dominant weeds at this site included annual ryegrass, and volunteer clover while some small shepherd's purse, lambsquarter, and wild carrot under the crop canopy were also recorded. There were no differences observed in total weed control (p=0.85), grass weed control (p=0.34), and broadleaf control (p=0.54). All values were from

80% to 90% control (data not shown). Weed density data was also no different among treatments and values were 3 to 10 in grass counts/ft2 and 1 to 3 in broadleaf counts/ft2. The images demonstrate the low weed population and the few weeds that were present were all relatively small and never got larger than the turnip plants.

Conclusion

Minimal to no visual crop injury was observed in any of the crops after Zidua post emergence applications at 0.75 floz/A to 4 floz/A rates. Zidua is safe as post-emergence in direct-seeded cabbage, kale, and turnip. Weed populations and pressure varied across trial locations; however, weed control appeared adequate to excellent with Zidua. No single treatment of Zidua outperformed the grower treatments but results were similar. A mixture of herbicides with Zidua may be necessary to achieve greater shepherd's purse control where pressure is high. Most noticeably in the kale field, Zidua did not control broadleaves as well as it controlled grasses.

S-metolachlor was used as preemergence in the kale and turnip fields and is the same mode of action group as Zidua. While using similar modes of action within one crop is not recommended for resistance management, these two herbicides do have different control spectrums and different crop responses. Zidua is safe as a post emergence on brassicas like cabbage, kale, and turnip as demonstrated here. Zidua can complement herbicide programs for extended residual soil activity after crop establishment into winter and/or spring.

This data supports use on cabbage and demonstrates safety in kale and turnip when applied post-emergence. The registrants have been informed of our interest in this use of Zidua. A positive response has not been received by Kumiai Chemistry Industry Co. and is still under review by the company.