Rush skeletonweed control in winter wheat following CRP takeout

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Rush skeletonweed is a deep-rooted perennial species that has become well established on thousands of acres across eastern Washington while the land was out of wheat production in the Conservation Reserve Program (CRP). Recent changes to the CRP have resulted in many acres coming back into production and most often without prior skeletonweed control. Uncontrolled skeletonweed in the fallow phase of the rotation reduces seed-zone moisture and leaves inadequate soil moisture for germination of winter wheat in the fall. Areas where wheat fails to emerge are either late-seeded after fall rains replenish soil moisture or are left blank. In either case, crop yield is reduced. Herbicide control in the crop phase is one part of an overall strategy to reduce or eradicate skeletonweed from these production areas.

We applied five different synthetic auxin herbicides to rush skeletonweed infested winter wheat on November 12, 2015 as the wheat was tillering and again prior to stem jointing on March 17, 2016, at a field site near LaCrosse, WA. The land had been in CRP until October 2013 and the first post-CRP crop was harvested in 2014. In 2015, the field was in summer fallow and was seeded to 'ORCF-102' winter wheat at 60 lb/A on September 11 with a John Deere HZ616 grain drill. The field had been fertilized prior to seeding with 80 lb nitrogen, 10 lb sulfur, and 10 lb chloride per acre. At both treatment dates, herbicides were applied with a CO_2 pressurized backpack sprayer and 10-ft spray boom delivering 15 gal/A spray volume. Boom pressure was 25 psi and ground speed was 3 mph. Experimental design was a randomized complete block with four replicated blocks and a factorial arrangement of herbicides and timing. Plot dimension was 10 by 35 feet.

Rush skeletonweed density was highly variable across the plot site. The infestation was patchy and non-uniform and difficult to objectively assess for herbicide efficacy on a plant population basis. Therefore, two 1-meter quadrats per plot were flagged on April 6, 2016 and all skeletonweed plants, dead or alive, were counted to establish baseline initial densities to follow until crop harvest. Plants that had been killed by the fall applications were still visible and were included in the count. Skeletonweed densities were recounted in all quadrats on June 2 when the wheat was in the soft-dough stage and again on July 20 at crop harvest.

Additionally, herbicide control/injury of skeletonweed was evaluated visually on a whole-plot basis as a percent of the non-treated check plots. Visual ratings on March 8, 2016 evaluated fall-applied herbicides and were taken prior to the spring-applied treatments. March 31 ratings evaluated control two weeks following spring applications as well as the fall applications. Follow-up ratings were made on June 2 and July 20.

The plots were harvested on July 20 with a Kincaid plot combine. All grain samples were analyzed for moisture with a Foss grain analyzer. Wheat yield was converted to bu/A and reported on a 12% moisture basis.

Milestone® and Stinger® applied either in the fall or spring were most effective at reducing skeletonweed density. Both herbicides reduced original densities to less than one plant/m^2 by the June 2 census (Table 1). Although, we reported fall-applied Milestone and Stinger treatments averaging 6.9 and 4.8 plants/m^2 at the April 6 census, most of these plants were dead and were included to represented the initial density in November when treatments were applied (data not shown). In contrast, DPX-MAT28-128, was only effective in reducing skeletonweed density when applied in spring with a 56% reduction by July 20. Currently, Milestone and DPX-MAT28-128 are not labeled in wheat and appropriate rates and timing have not yet been established. Each has herbicidal activity similar to clopyralid, the active ingredient in Stinger, which is labeled in wheat. Both Clarity® and 2,4-D LV6 are also synthetic auxin herbicides, but Clarity was not effective at reducing skeletonweed density at either application date. In contrast, 2,4-D LV6 did reduce plant numbers by 64% when applied in the fall, and 55% when applied in the spring (Table 1).

Skeletonweed visual control ratings on March 8 were variable and were confounded by winter injury symptoms observed on the rosettes. The majority of plants in the Milestone and Stinger plots were completely dead and thus clearly controlled (Table 2); however, it was difficult to assess efficacy of the other three herbicides. By March 31, clear differences were observed in the fall-treated plots between dead plants and live rosettes that were recovering from winter stress and producing new leaves. Milestone and Stinger control were each around 90% while DPX-MAT28-128 and 2,4-D LV6 only showed 10 and 15% control, respectively (Table 2). For the spring-applied treatments, the March 31 ratings were two weeks following spring applications and very few herbicide injury symptoms could be detected.

Herbicide control was visually greatest by the June 2 rating and approached 100% for fall-applied Milestone and Stinger and Stinger applied in the spring, while control for the other herbicides only averaged 37 to 53% (Table 2). By this time, skeletonweed had begun to bolt in the non-treated check plots and in a few of the herbicide-treated plots (data not shown). By the July 20 harvest census, flowers were observed on a few skeletonweed plants, primarily in the non-treated check plots. At this census, fall-applied Milestone and Stinger had maintained nearly the same level of control observed at the June 2 census (Table 2); however, control in the spring-applied plots averaged only 76 and 78%, respectively, and was not different from the 66% control by 2,4-D LV6. This reduction in control rating was due to the presence of bolting stems originating from rosettes that previously appeared nearly or completely dead (data not shown).

Wheat yield was variable across the study site due to poor emergence following the September 2015 seeding. This resulted from inadequate soil moisture in the seed zone likely caused by a combination of low rainfall in 2015 and moisture depletion by skeletonweed in the denser patches. Rosette density in the non-treated check plots ranged from 1.4 to 89 plants/m^2 at the beginning of the trial in November 2015. At harvest the low-density plot yielded 89 bu/A and the high-density plot yielded 75 bu/A. In spite of stand variability, differences were seen in wheat yield in relation to the herbicide treatments. Plots treated with Milestone, Stinger, and Clarity averaged the highest yields in both the fall and spring applications and were not different from the fall-applied non-treated check (Table 2). In contrast, DPX-MAT28-128 and 2,4-D LV6 plots were the lowest yielding fall-applied treatments averaging 76 bu/A, each. These two herbicides also resulted in the lowest yields for the spring-applied treatments. The 2,4-D LV6 treatment averaged 76 bu/A, and the DPX-MAT28-128 applied in the spring caused kernel abortion and blank heads resulting in a wheat yield of only 48 bu/A (Table 2.)

In this trial, fall applications of Milestone or Stinger substantially controlled rush skeletonweed in the crop phase of the rotation without reducing grain yield. The experimental DPX-MAT28-128 and 2,4-D LV6 did not control skeletonweed well and appeared to reduce yield. Clarity did not lower yield, but also did not control skeletonweed.

Table 1. Rush skeletonweed density over time in relation to each individual treatment following fall and spring applications to winter wheat.

Treatments[1]	Rate	Rush skeletonweed census dates[2]		
		April 6	June 2	July 20
	(oz/A)	(plants/m²)		
Fall-applied herbicides				
Non-treated	-	9.6 a	9.3 a	7.9 a
Milestone	0.6	6.9 a	0.1 b	1.0 b
Stinger	8.0	4.8 a	0.1 b	0.3 b
DPX-MAT28-128	1.7	4.4 a	3.1 a	2.6 a
Clarity	4.0	5.5 a	4.4 a	4.4 a
2,4-D LV6	8.7	8.3 a	4.6 b	3.0 b
Spring-applied herbicides				
Untreated	-	8.8 a	8.5 a	9.0 a
Milestone	0.6	6.5 a	0.6 b	1.3 b
Stinger	8.0	4.8 a	0.0 b	0.5 b
DPX-MAT28-128	1.7	9.4 a	4.0 b	4.1 b
Clarity	4.0	4.6 a	3.3 a	3.4 a
2,4-D LV6	8.7	13.0 a	10.1 b	5.8 c

[1]All herbicide applications included a non-ionic surfactant (R-11) at 0.25% v/v rate. Fall treatments were applied on November 12, 2015; spring treatments were applied on March 17, 2016. DPX-MAT28-128 is an experimental product containing the synthetic auxin aminocyclopyrachlor as the active ingredient.

[2]Counts on April 6, 2016 represent initial density present at the fall application and included all plants, dead or alive, in two 1-meter permanent quadrats per plot. Counts on subsequent dates are of living plants, only. Numbers (LSMeans) in each row followed by the same letter are not different at $p \leq 0.05$ and measure change in density for each treatment over the course of the trial.

Table 2. Visually rated control of rush skeletonweed, and wheat grain yield in relation to herbicide applications in winter wheat.[1]

Treatments[2]	Rate	Visual control ratings[3] March 8	March 31	June 2	July 20	Wheat yield
	(oz/A)	-------(% of non-treated check)-------				(bu/A)
Fall-applied herbicides						
Non-treated	-	0 -	0 -	0 -	0 -	84 ab
Milestone	0.6	83 a	88 a	98 a	89 a	90 a
Stinger	8.0	87 a	92 a	98 a	96 a	87 a
DPX-MAT28-128	1.7	50 a	10 c	40 b	47 b	76 b
Clarity	4.0	63 a	58 b	37 b	45 b	92 a
2,4-D LV6	8.7	42 a	15 c	48 b	37 b	76 b
Spring-applied herbicides						
Non-treated	-	0 -	0 -	0 -	0 -	79 bc
Milestone	0.6	0 -	6 a	94 a	76 a	87 ab
Stinger	8.0	0 -	10 a	100 a	78 a	90 a
DPX-MAT28-128	1.7	0 -	3 a	53 b	35 b	48 d
Clarity	4.0	0 -	5 a	50 b	32 b	83 a-c
2,4-D LV6	8.7	0 -	5 a	53 b	66 a	76 c

[1]Numbers (LSMeans) in each column followed by the same letter are not different at $p \leq 0.05$.

[2]All herbicide applications included a non-ionic surfactant (R-11) at 0.25% v/v rate. Fall treatments were applied on November 12, 2015; spring treatments were applied on March 17, 2016. DPX-MAT28-128 is an experimental product containing the synthetic auxin aminocyclopyrachlor as the active ingredient.

[3]March 8 ratings were prior to spring applications; March 31 ratings were 2 weeks following spring applications; June 2 ratings were at wheat soft dough stage; July 20 ratings were made just prior to harvest.

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