Volunteer buckwheat control in irrigated spring wheat – year two.

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A study initiated in 2016 was repeated in 2017 to evaluate postemergence herbicide control of volunteer buckwheat (*Fagopyrum esculentum* Moench) in irrigated spring wheat. Buckwheat seed contamination in wheat is a concern for exports to Asia because it is considered an allergen risk in some countries, similar to the allergen risk of peanuts in the United States (NRCS bulletin, NB 190-16-8 ECS). Buckwheat is double-cropped or planted as a cover crop in the Columbia Basin irrigated agricultural region. It is normally planted in early summer following harvest of the previous crop and then harvested later in autumn. Buckwheat seed lost at harvest or plowed under with the cover crop can persist in the soil seedbank and become a weed in spring wheat grown the following year contaminating the harvested grain (Figure 1).

Figure 1. Volunteer buckwheat plants flowering in a crop of irrigated spring wheat.

The field site, located in Pasco, WA, was on land being farmed by WSU Franklin County Extension for agricultural research. The plot area had been in potatoes during 2016, therefore buckwheat was not present in the seedbank for the 2017 trial. On March 6, 2017, 48 lb of 'Mancan' buckwheat seed was spread over an 80- by 300-ft area, which resulted in 32 seeds/foot^2. The seed was then incorporated into the top 5 inches of soil with a disk-harrow and then spring-tooth harrowed and rolled with a packer. The field was then seeded on March 6 to 'Expresso' hard-red spring wheat at 184 lb/A using a 42-inch wide double disk drill with 6 openers on 6-inch spacing. Soil temperature averaged 42° F in the top 6 inches. The experimental design was a randomized complete block with four replications per treatment. Each plot consisted of 3 drill passes, each 30 feet long; however, only the center drill pass was used for evaluation. Fertilizer was applied with irrigation and the field site was sprinkler irrigated up until two weeks prior to harvest.

Early postemergence herbicide treatments were applied on April 19 when the majority of the spring wheat had 4 to 5 leaves. Volunteer buckwheat plants ranged from cotyledon to two-leaf stage and averaged 24 plants/m^2. The early treatments were broadcast applied with a CO_2 pressurized backpack sprayer and 10-foot spray boom at 3 mph. Application rate was 15 gpa at 30 psi. Late postemergence herbicide treatments were applied with a tractor-pulled applicator

that simulated center-pivot chemigation. The treatments were applied on May 18 when the majority of spring wheat was in the boot stage with some heads emerging. Volunteer buckwheat seedlings were present in most plots, but flowering plants were abundant only in non-treated check plots. Herbicides were metered into a stream of water on the applicator and into an 11.7-foot spray boom with HH Fulljet nozzles. Volume output was 2700 gpa at 66 psi moving 1 mph to simulate a 0.1-inch irrigation rate. See Table 1 for herbicides and rates of application. Throughout the trial, non-treated check plots were hand-weeded to control all other weeds except volunteer buckwheat.

Table 1. Applications of early and late postemergence (POST) herbicides for control of volunteer buckwheat in irrigated spring wheat.

Trt	Herbicide	Rate (fl oz/a)	Timing[1]	Application method
1	Huskie	13.5	Early POST	Broadcast
	Brox 2EC	32	Late POST	Chemigation
2	Huskie	13.5	Early POST	Broadcast
	Maestro Advanced	25.6	Late POST	Chemigation
3	Huskie	13.5	Early POST	Broadcast
	Starane NXT	27.4	Late POST	Chemigation
4	Huskie	13.5	Early POST	Broadcast
	None	-	-	-
5	GoldSky	16	Early POST	Broadcast
	Brox 2EC	32	Late POST	Chemigation
6	GoldSky	16	Early POST	Broadcast
	Maestro Advanced	25.6	Late POST	Chemigation
7	GoldSky	16	Early POST	Broadcast
	Starane NXT	27.4	Late POST	Chemigation
8	GoldSky	16	Early POST	Broadcast
	None	-	-	-
9	Non-treated check	-	-	-

[1] Early POST herbicides were broadcast applied April 19 when the spring wheat had 4 to 5 leaves. Huskie was applied with ammonium sulfate at 1 lb/A. GoldSky was applied with a non-ionic surfactant at 0.5% v/v. Treatments were applied with a hand-held 10-ft spray boom. Volunteer buckwheat ranged from cotyledon to 2 leaves and averaged 12 plants/m^2. Late POST herbicides were applied through chemigation on May 18 when the majority of spring wheat was at boot stage, but some were beginning to head. Spray adjuvants were not added to the chemigation treatments. Volunteer plants ranged from cotyledon to older injured plants from early the POST treatments. Density was light and varied by efficacy of early POST treatments.

Herbicide efficacy was rated visually as percent control compared with the non-treated plots. Early postemergence (POST) treatments were rated 2 and 4 weeks after treatment (WAT) on May 3 and 18, respectively. Late POST chemigation treatments were rated 2 WAT on June 1. In addition, flowering buckwheat plants were counted at 2 and 4 WAT for both the early and late

POST applications, with the last census occurring at harvest on July 13. Plots were harvested with a Wintersteiger® plot combine and the grain from each center 3.5- by 30-foot drill pass was bagged, weighed, and then hand-screened to determine number of buckwheat seeds per kg of wheat. Sub-samples were oven dried at 60°F for 72 hours to determine grain moisture content. Crop yield was converted to bu/A and reported on a 12% moisture basis.

Early POST applications of Huskie® were more effective than GoldSky® in controlling early establishing volunteer buckwheat plants (Table 2). Huskie control was near 100% at 2 and 4 WAT, whereas, GoldSky control was only near 70% at 2 WAT but increased to 85% at 4 WAT. Buckwheat plants treated with Huskie displayed significant burn-down injury by 2 WAT, but Goldsky treated plants were only curled and yellowed at 4 WAT. Late POST chemigation treatments were at or near 100% effective in maintaining control 2 WAT (Table 2). Plots only treated with early POST applications of Huskie and GoldSky had slightly lower control by the final rating.

Table 2. Visual control ratings of volunteer buckwheat plants following early and late postemergence (POST) herbicide applications in irrigated spring wheat.

			Buckwheat Control[3]		
Trt	Early[1]	Late[2]	Early POST 2 WAT	Early POST 4 WAT	Late POST 2 WAT
	(spray)	(chemigation)	---------- (%) ----------		
1	Huskie	Brox 2EC	100 a	100 a	100 a
2	Huskie	Maestro Advanced	99 a	100 a	100 a
3	Huskie	Starane NXT	99 a	100 a	100 a
4	Huskie	None	100 a	100 a	96 b
5	GoldSky	Brox 2EC	69 b	85 b	99 ab
6	GoldSky	Maestro Advanced	69 b	85 b	100 a
7	GoldSky	Starane NXT	68 b	85 b	100 a
8	GoldSky	None	70 b	85 b	90 c
9	None	None	0 -	0 -	0 -

[1] Early treatments were evaluated May 3 and May 18, 2 and 4 weeks (WAT) after broadcast applications, respectively. See Table 1 for application rates.

[2] Late treatments were evaluated on June 1, 2 weeks after chemigation treatments (WAT). See Table 1 for application rates.

[3] Injury symptoms ranged from slight epinasty and curling on leaves to complete death. Means in each category followed by the same letter are statistically identical at $p \leq 0.05$. The non-treated check (Trt=9) is not included in the statistical comparison.

Buckwheat plants emerged with crop and were flowering in the non-treated check plots at each census. Flowering plant density at the 2 WAT early POST census averaged 14.3 plants/m^2 (Table 3). Early POST Huskie applications were more effective at inhibiting flower production than GoldSky. At 2 WAT, Huskie treated plants were dead and incapable of flowering. In contrast, GoldSky treated plots had up to 1.0 flowering plants/m^2 (Table 3). By the early POST 4 WAT,

no flowering plants were found in any of the treated plots. Flowering was controlled until harvest in all plots receiving both an early and a late application. Plots with only an early POST treatment had a few flowering plants by the last census (Table 3); however, differences were not found between any of the treatments except when compared with the non-treated check.

Table 3. Density of flowering volunteer buckwheat plants following early and late postemergence (POST) herbicide applications to irrigated spring wheat.

			Flowering Buckwheat Plants[3]			
Trt	Early[1]	Late[2]	Early POST 2 WAT	Early POST 4 WAT	Late POST 2 WAT	Late POST 4 WAT
	(spray)	(chemigation)	---------- (flowering plants/m^2) ----------			
1	Huskie	Brox 2EC	0 c	0 b	0 b	0 b
2	Huskie	Maestro Advanced	0 c	0 b	0 b	0 b
3	Huskie	Starane NXT	0 c	0 b	0 b	0 b
4	Huskie	None	0 c	0 b	0.07 b	0.13 b
5	GoldSky	Brox 2EC	0.8 b	0 b	0 b	0 b
6	GoldSky	Maestro Advanced	0.9 b	0 b	0 b	0 b
7	GoldSky	Starane NXT	1 b	0 b	0 b	0 b
8	GoldSky	None	0.7 b	0 b	0.03 b	0.06 b
9	None	None	14.3 a	29.2 b	26.5 a	12.5 a

[1] Early POST treatments were evaluated May 3 and May 18, 2 and 4 weeks after broadcast treatments (WAT), respectively. See Table 1 for application rates.
[2] Late POST treatments were evaluated on June 1 and June 13, 2 and 4 weeks after treatments (WAT), respectively. See Table 1 for application rates.
[3] Means in each category followed by the same letter are statistically identical at $p \leq 0.05$.

Low numbers of buckwheat plants in treated plots resulted in low numbers of buckwheat seeds per harvest sample. The non-treated plots average 142 seeds/kg of wheat but all treated plots had buckwheat seed densities less than 0.1 seeds/kg and were not different from zero (Table 4). Wheat yields were variable across the plots with averages ranging between 71 and 91 bu/A; however, yield differences between treatments were not significant at $p \leq 0.05$.

In this trial, good control of volunteer buckwheat was seen with all treatments; however, some evidence suggested that both early and late POST applications were needed to keep buckwheat from flowering and producing seed later on in the trial as the wheat crop ripened. Applications of Huskie were very effective in quickly controlling early emerging buckwheat plants while GoldSky was slower acting. There were no differences in efficacy between the chemigation treatments, which may have been partly due to low buckwheat presence following the initial early emergence. Very few seedlings were observed after the initial flushes (data not shown). Buckwheat contamination was only abundant in wheat harvested from the non-treated plots (Figure 2.) This study will be repeated in 2018 to verify results from 2016 and 2017.

Table 4. Volunteer buckwheat seed contamination in irrigated spring wheat following early and late postemergence (POST) herbicide applications.

Trt[1]	Early POST	Late POST	Buckwheat Contamination in Spring Wheat[2]
	(spray)	(chemigation)	(buckwheat seeds/kg wheat)
1	Huskie	Brox 2EC	0 b
2	Huskie	Maestro Advanced	0 b
3	Huskie	Starane NXT	0 b
4	Huskie	None	<0.1 b
5	GoldSky	Brox 2EC	<0.1 b
6	GoldSky	Maestro Advanced	<0.1 b
7	GoldSky	Starane NXT	0 b
8	GoldSky	None	0 b
9	None	None	142 a

[1] See Table 1 for application rates.
[2] Means in each category followed by the same letter are statistically identical at $p \leq 0.05$.

Figure 2. Volunteer buckwheat seed contamination in spring wheat.