ARY-0452-110 (Xonerate) Alone or Combined with Tenacity to Control *Poa annua* in a Kentucky Bluegrass Fairway

Trial ID: Arysta9-14.WA

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December 22, 2014

A trial was begun in the Spring 2014 and monitored through the Summer 2014 on a Kentucky bluegrass (KBG) fairway infested with *Poa annua* at the Washington State University Palouse Ridge Golf Club (PRGC) in Pullman, WA to determine the effect of ARY-0452-110 alone or combined with Tenacity to control *Poa annua*. Individual treatment plots were 6' x 7' with four replications in a randomized complete-block design. Each treatment was applied 3 times on 2 week intervals: 12 May, 27 May, and 9 June, 2014 at 25 GPA with a bicycle-wheeled CO_2 pressurized (40 psi) sprayer with 11002 flat fan TeeJet nozzles. Weather data was recorded at each application date (Table 1). GPS coordinates for the location: N 46° 44' 29.3", W 117° 08' 22.4", Elev. 2630'. Turfgrass quality was rated beginning 1 week after initial treatment (WAIT), 5/19/14 through 12 WAIT (8/4/14). Turfgrass quality was rated on a scale from 1 to 9, with 9 = excellent. Percentage *P. annua* in the turfgrass stand was estimated in each plot initially (5/12/14), 8 WAIT (7/7/14), and 12 WAIT. Percentage of Kentucky bluegrass (density) in the turfgrass stand was estimated in each plot initially and several times afterward up to 12 WAIT. Percentage open area (no live turfgrass) was estimated 8 and 12 WAIT. Percentage change in *P. annua* and Kentucky bluegrass in the turfgrass stand was calculated based on the initial percentage present on 0 WAIT (5/12/14).

The combination of ARY-0452-110 1.4 or 2.8 fl oz/A + Tenacity 4 fl oz/A + NIS resulted in significant reductions in turfgrass quality beginning 3 WAIT (6/2/14) and lasting up to 12 WAIT compared to the check (Table 2 and Fig. 1). The reduction in turfgrass quality was due primarily to phytotoxicity and eventual death of some of the *P. annua* in the stand (Figs. 7 – 12). *P. annua* dying in the turfgrass stand did result in open depressions which could result in undesirable playing conditions (Figs. 6 and 10 – 15). In addition, some phytotoxicity was noted on the Kentucky bluegrass. However, by 10 and 12 WAIT most treatments showed an increase (although not significantly, except Tenacity 4 fl oz/A) in turfgrass quality compared to the check.

All treatments resulted in a decrease in *P. annua* in the turfgrass stand, compared to the check 10 WAIT (7/21/14) and 12 WAIT (Table 3 and Figs. 2 and 3). The highest percentage change (reduction) in *P. annua* resulted from treatments with ARY-0452-110 1.4 or 2.8 fl oz/A + Tenacity 4 fl oz/A, approximately 50 and 70%, respectively (Fig. 3).

As *P. annua* density decreased in all treatments, except the check, Kentucky bluegrass density increased 8, 10, and 12 WAIT (Table 4 and Fig. 4). Percentage change (increase) in Kentucky

bluegrass density was approximately 30 and 35%, respectively, for the ARY-0452-110 1.4 or 2.8 fl oz/A + Tenacity 4 fl oz/A + NIS treatments 12 WAIT. Figures 13 – 15 show the amount of Kentucky bluegrass in the turfgrass stand, for each treatment, 12 WAIT.

Overall ARY-0452-110 1.4 or 2.8 fl oz/A + Tenacity 4 fl oz/A + NIS applied three times in the Spring at two week intervals resulted in the greatest reduction of *P. annua* and the greatest increase in Kentucky bluegrass in the Kentucky bluegrass fairway by 12 WAIT. However, this came with a reduction in turfgrass quality and playability up to 10 WAIT and occurred during the height of the golf season. Complete *P. annua* control was not achieved, therefore, a multi-year *P. annua* control program would need to be looked at, plus the possibility of overseeding with perennial ryegrass, Kentucky bluegrass, or a mix, to fill in open areas as soon as the residual soil activity of ARY-0452-110 diminishes. A better option may be to use ARY-0452-110 + Tenacity as Fall treatments with the possibility to overseed in the Spring to fill in any open areas.

Table 1. Climatic data at each application.

Application Date	Air temperature (^{o}F)	Soil temperature 2" depth (^{o}F)	Relative humidity (%)
5/12/14	67	56	24
5/27/14	60	65	43
6/11/14	60	58	46

Table 2. The effect of ARY-0452-110 and/or Tenacity on turfgrass quality on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

							Turfgrass quality*								
Treatment	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	App date	1 WAIT 5/19/14	2 WAIT 5/26/14	3 WAIT 6/2/14	4 WAIT 6/9/14	5 WAIT 6/16/14	7 WAIT 6/30/14	8 WAIT 7/7/14	10 WAIT 7/21/14	12 WAIT 8/4/14
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	4.8 a**	4.6 a	4.8 ab	4.8 a	4.6 ab	5.0 ab	5.0 a	4.5 a	4.9 ab
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14									
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14									
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14									
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	4.8 a	4.9 a	5.0 a	4.4 a	4.1 ab	4.0 ab	4.1 ab	5.0 a	5.4 ab
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14									
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14									
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14	4.8 a	4.5 a	4.0 b	4.1 ab	4.1 ab	4.5 ab	4.9 ab	5.4 a	5.8 a
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14									
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14									
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	4.9 a	4.5 a	4.5 ab	3.5 b	3.8 b	3.5 bc	3.9 ab	4.9 a	5.5 ab
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14									
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14									
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14									
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	4.6 a	4.1 a	3.1 c	2.5 c	2.8 c	2.6 c	2.9 c	4.5 a	5.3 ab
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14									
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14									
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14									
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14									
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14									
Untreated Check						0	5.0 a	4.5 a	4.5 ab	4.8 a	4.8 a	5.0 ab	5.1 a	4.4 a	4.5 b

*Turfgrass quality rated 1 to 9, with 9 = excellent.

**Means within a column followed by the same letter are not significantly different. LSD P = 0.05.

Figure 1. The effect of ARY-0452-110 and/or Tenacity on turfgrass quality on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

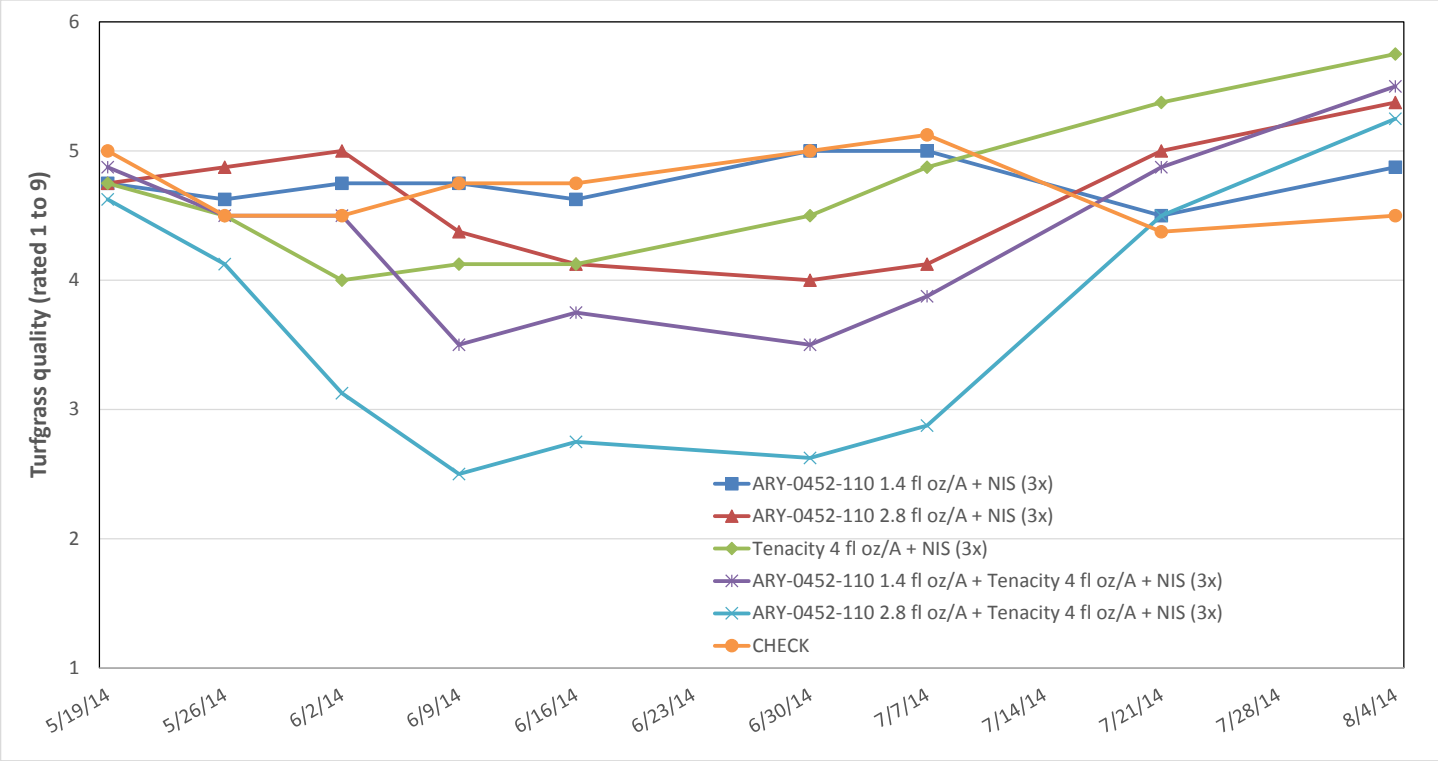

Table 3. The effect of ARY-0452-110 and/or Tenacity on *P. annua* density on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

							***Poa annua* density (% of plot area)**		
Treatment	**Form Conc**	**Form Type**	**Rate**	**Rate Unit**	**Growth Stage**	**App date**	**0 WAIT 5/12/14**	**10 WAIT 7/21/14**	**12 WAIT 8/4/14**
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	53.8 a*	42.0 b	42.0 b
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14			
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14			
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14			
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	42.5 a	28.8 bc	29.0 bcd
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14			
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14			
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14	46.3 a	34.3 bc	35.5 bc
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14			
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14			
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	48.8 a	26.3 cd	25.0 cd
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14			
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14			
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14			
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	47.5 a	14.5 d	14.8 d
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14			
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14			
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14			
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14			
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14			
Untreated Check						0	50.0 a	63.5 a	62.5 a

*Means within a column followed by the same letter are not significantly different. LSD P = 0.05.

Figure 2. The effect of ARY-0452-110 and/or Tenacity on percentage of *P. annua* on a Kentucky bluegrass fairway with *P. annua*. PRGC 14 fairway. Pullman, WA.

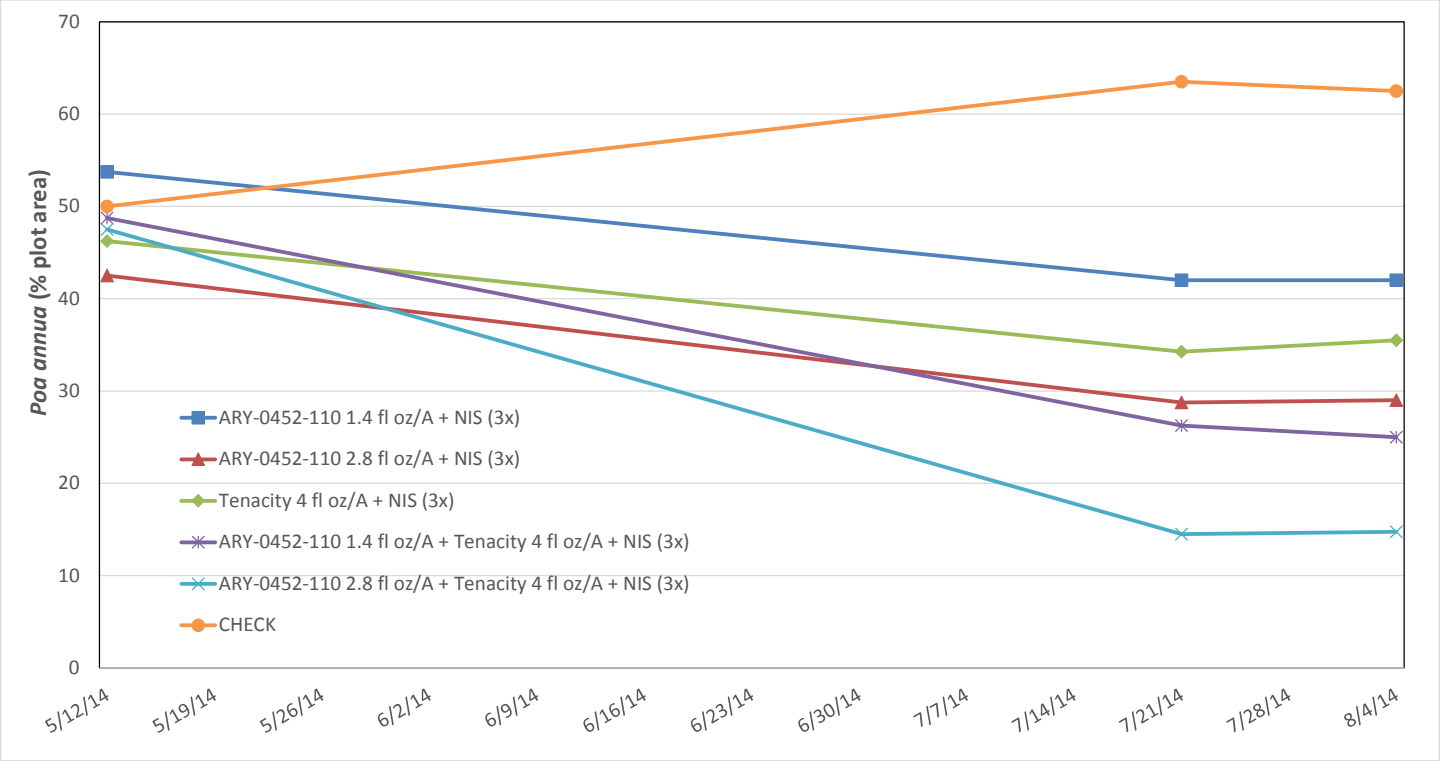

Figure 3. The effect of ARY-0452-110 and/or Tenacity on percentage change of *P. annua* on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

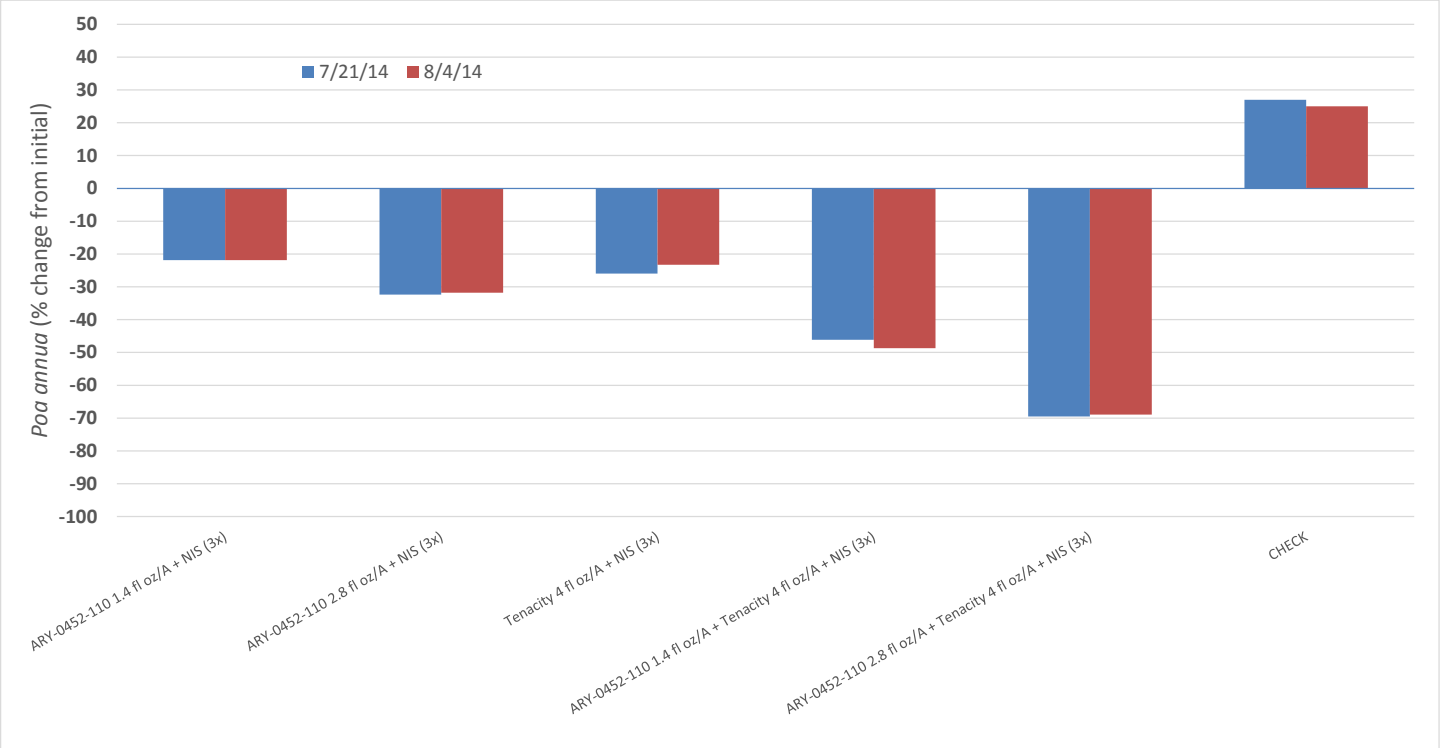

Table 4. The effect of ARY-0452-110 and/or Tenacity on Kentucky bluegrass density on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

							Kentucky bluegrass density (% of plot area)			
Treatment	Form Conc	Form Type	Rate	Rate Unit	Growth Stage	App date	0 WAIT 5/12/14	8 WAIT 7/7/14	10 WAIT 7/21/14	12 WAIT 8/4/14
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	46.3 a*	55.0 a	55.0 b	56.3 b
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14				
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14				
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14				
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	58.8 a	58.8 a	65.0 ab	68.8 ab
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14				
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14				
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14	53.8 a	56.3 a	63.8 ab	63.8 ab
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14				
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14				
ARY-0452-110 +	4	SC	1.4	fl oz/a	POSPOS	5/12/14	51.3 a	55.0 a	65.0 ab	71.3 ab
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14				
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	5/27/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14				
ARY-0452-110 +	4	SC	1.4	fl oz/a	+ 14 d	6/9/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14				
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	POSPOS	5/12/14	52.5 a	57.5 a	72.5 a	78.3 a
Tenacity +	4	SC	4	fl oz/a	POSPOS	5/12/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	POSPOS	5/12/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	5/27/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	5/27/14				
Nonionic Surfactant fb	100	SL	0.25	% v/v	+ 14 d	5/27/14				
ARY-0452-110 +	4	SC	2.8	fl oz/a	+ 14 d	6/9/14				
Tenacity +	4	SC	4	fl oz/a	+ 14 d	6/9/14				
Nonionic Surfactant	100	SL	0.25	% v/v	+ 14 d	6/9/14				
Untreated Check						0	50.0 a	30.0 b	33.5 c	36.0 c

*Means within a column followed by the same letter are not significantly different. LSD P = 0.05.

Figure 4. The effect of ARY-0452-110 and/or Tenacity on Kentucky bluegrass density on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

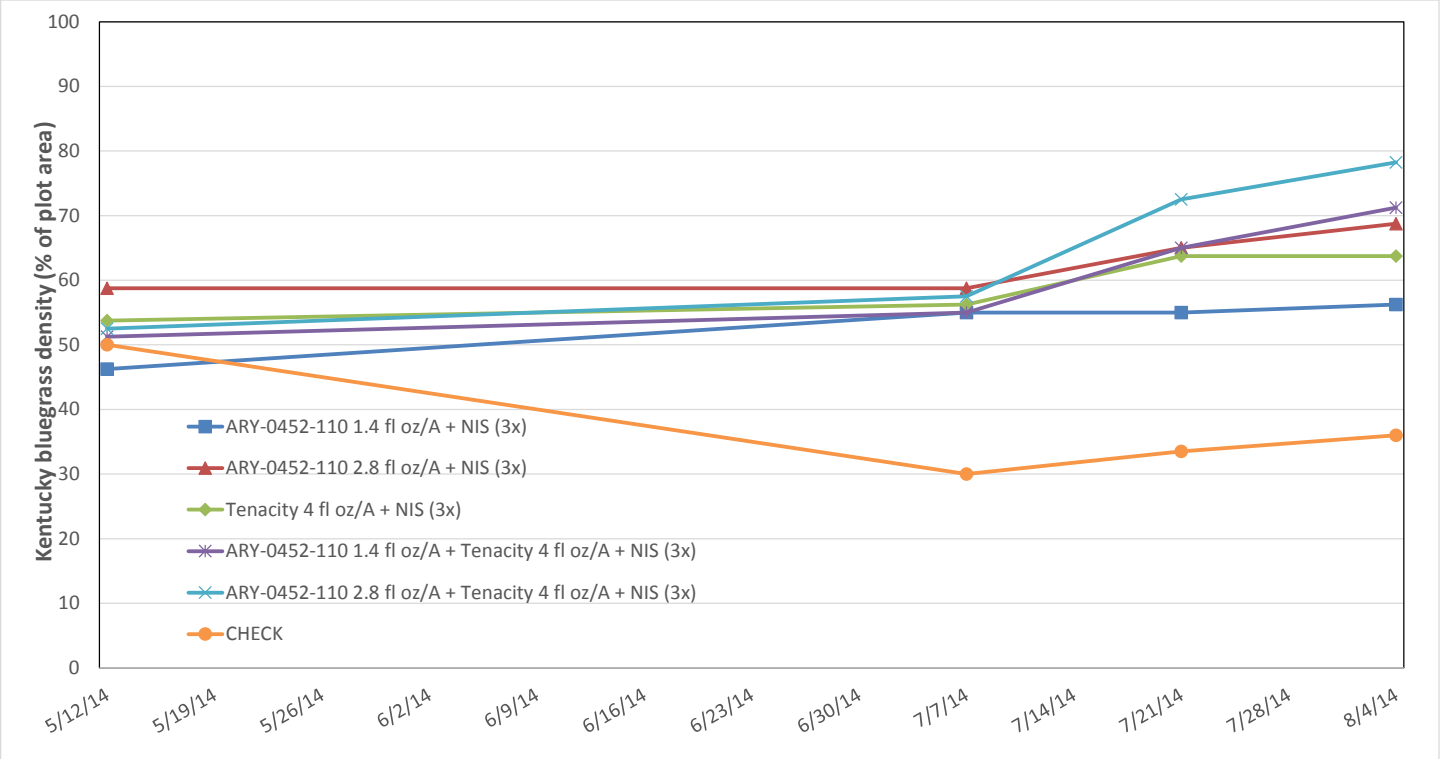

Figure 5. The effect of ARY-0452-110 and/or Tenacity on percentage change in Kentucky bluegrass density on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

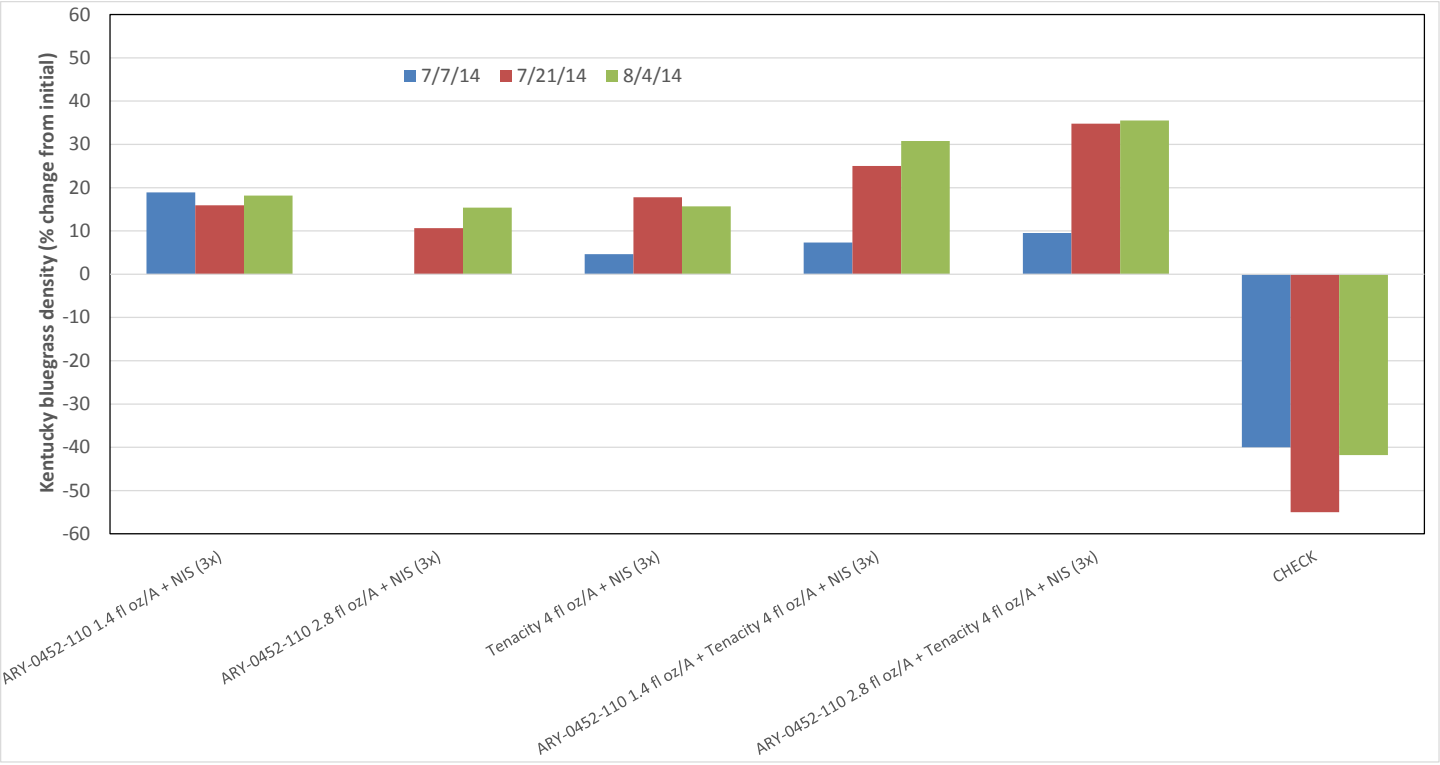

Figure 6. The effect of ARY-0452-110 and/or Tenacity on percentage of open area (no live turfgrass) on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

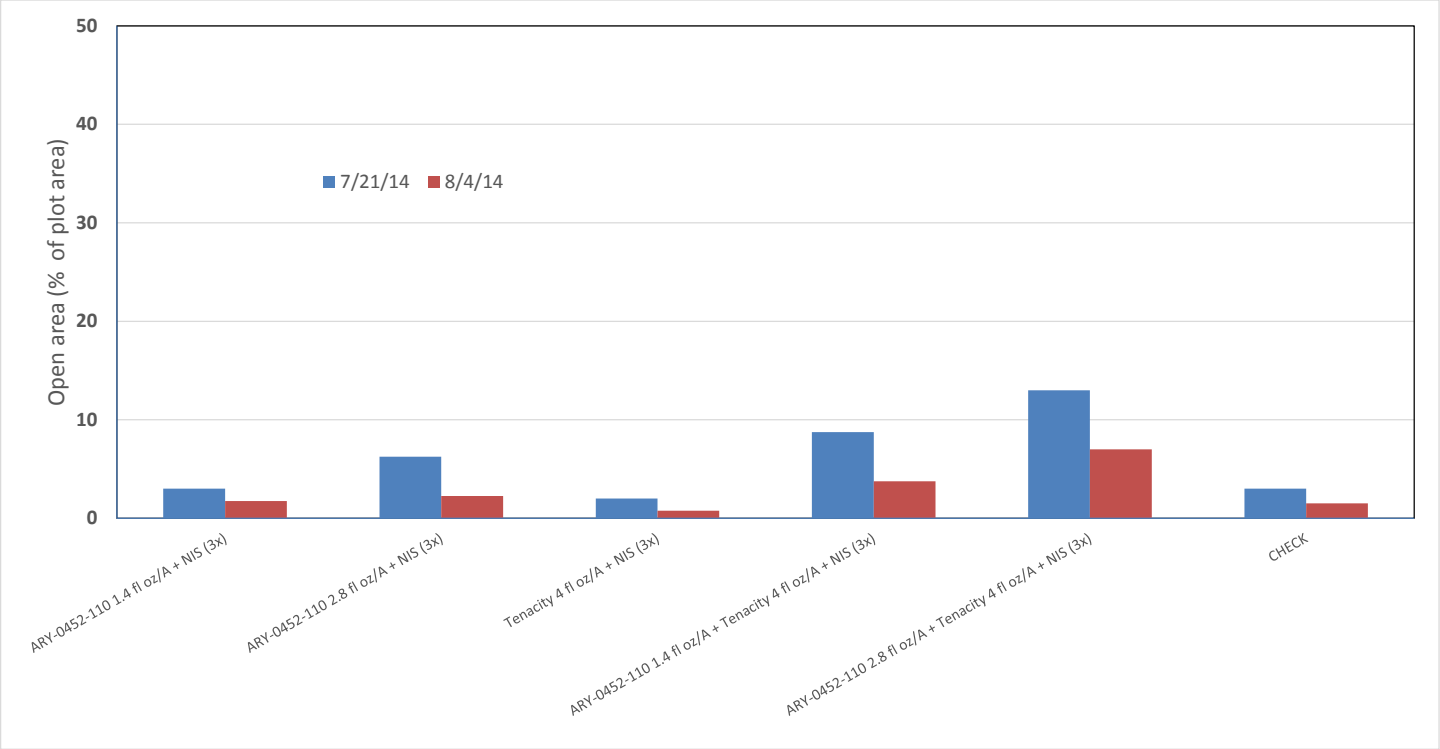

Figure 7. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

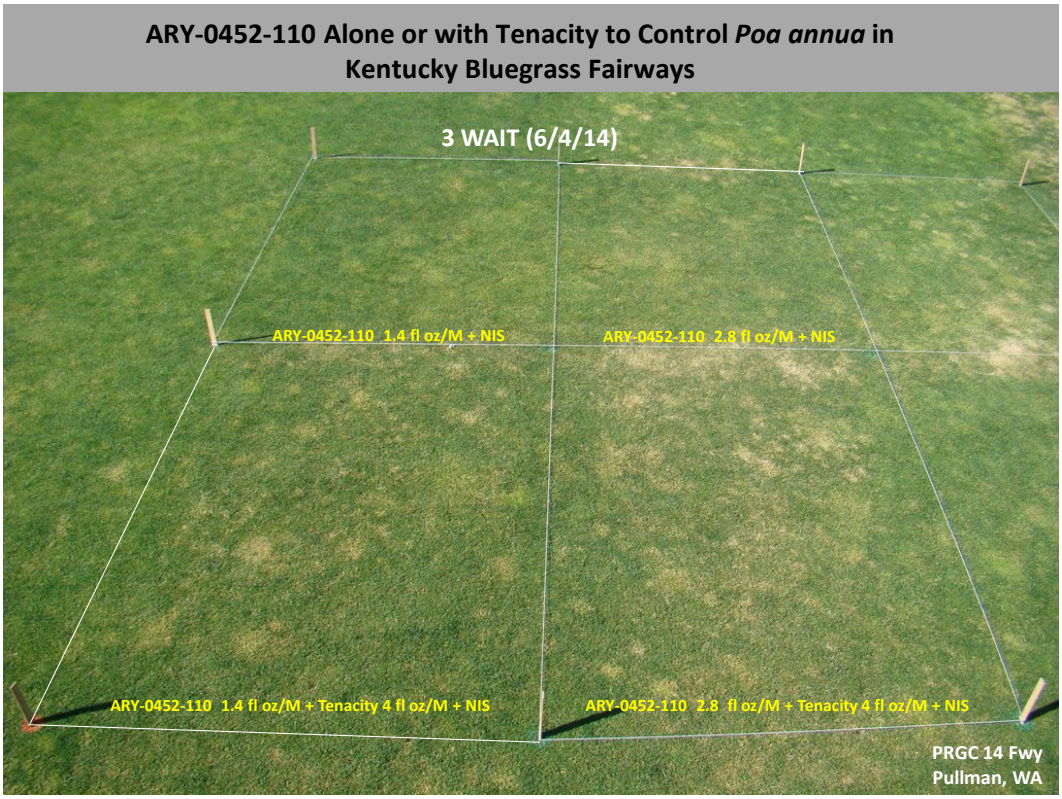

Figure 8. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

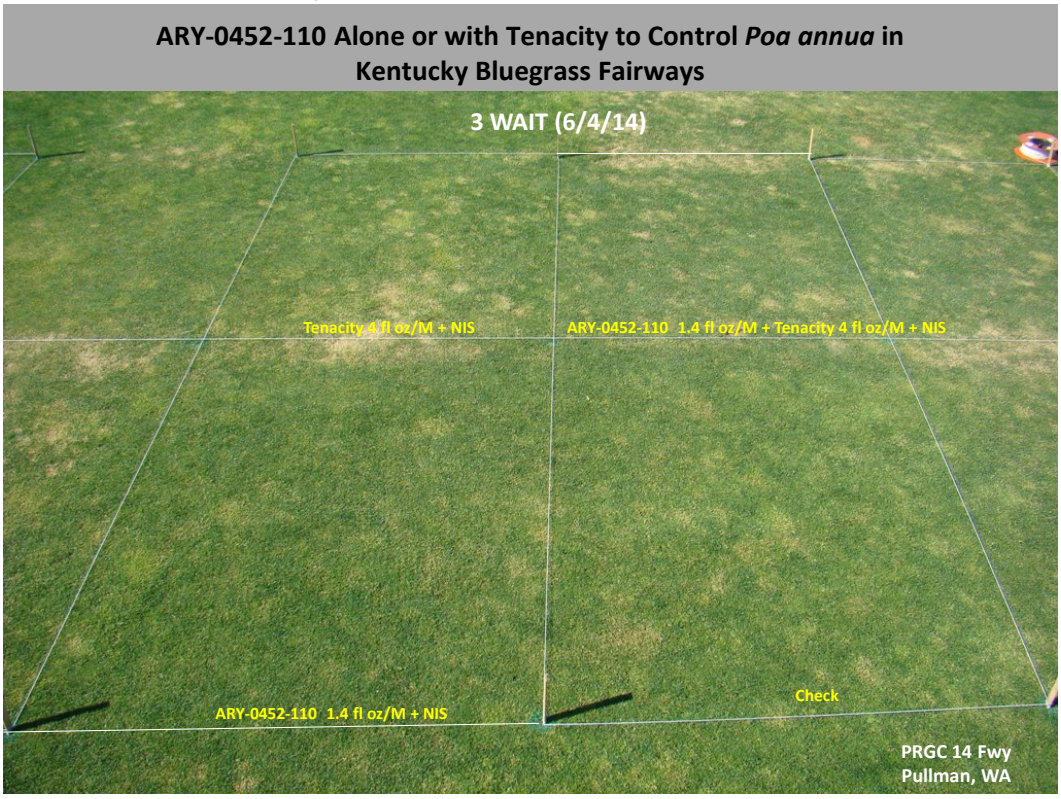

Figure 9. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

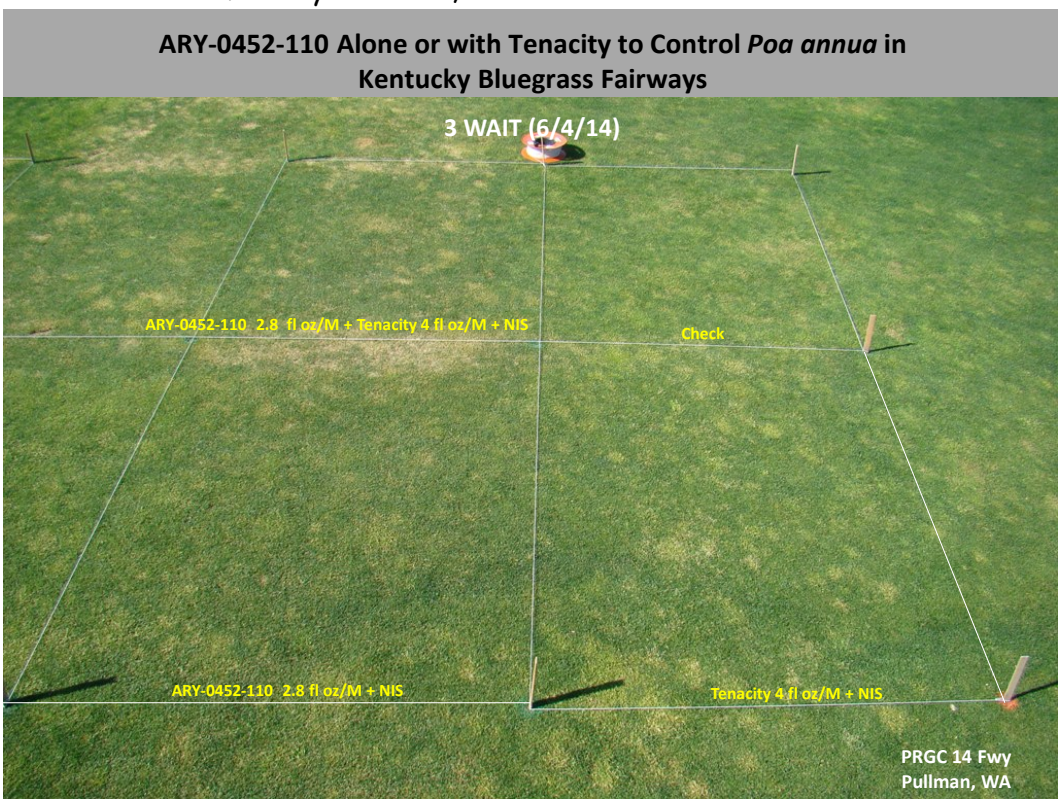

Figure 10. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

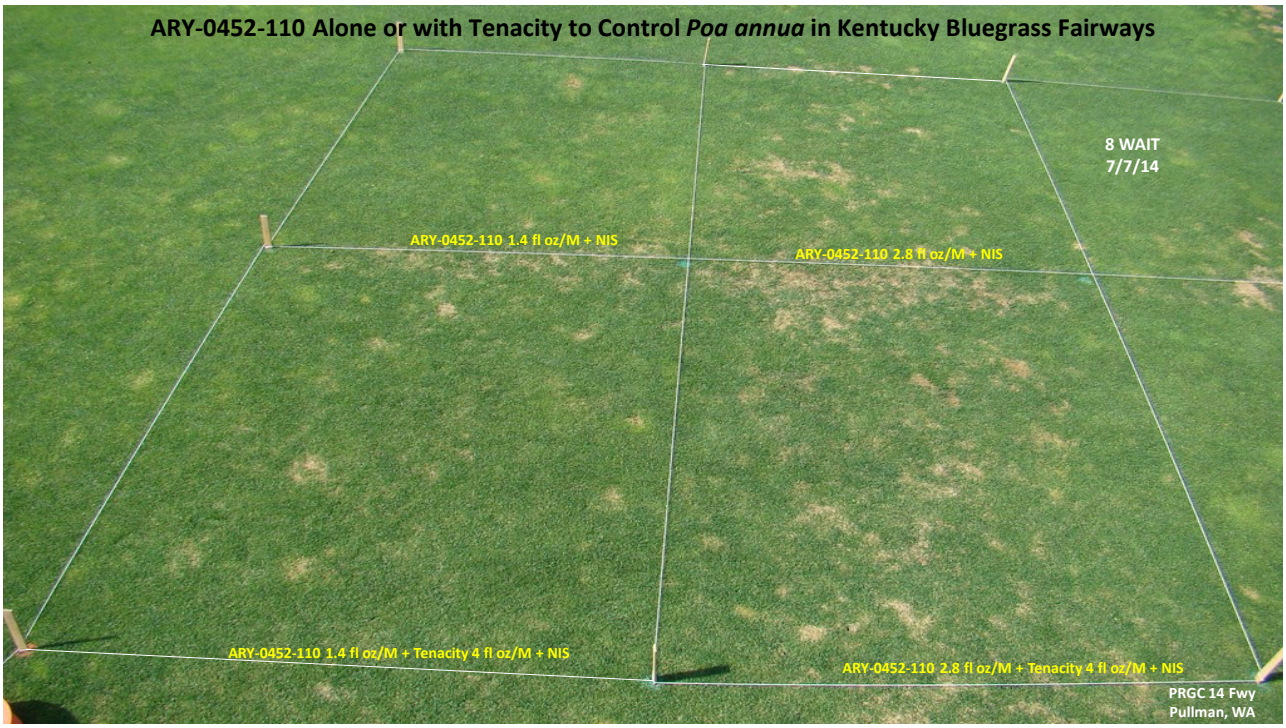

Figure 11. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

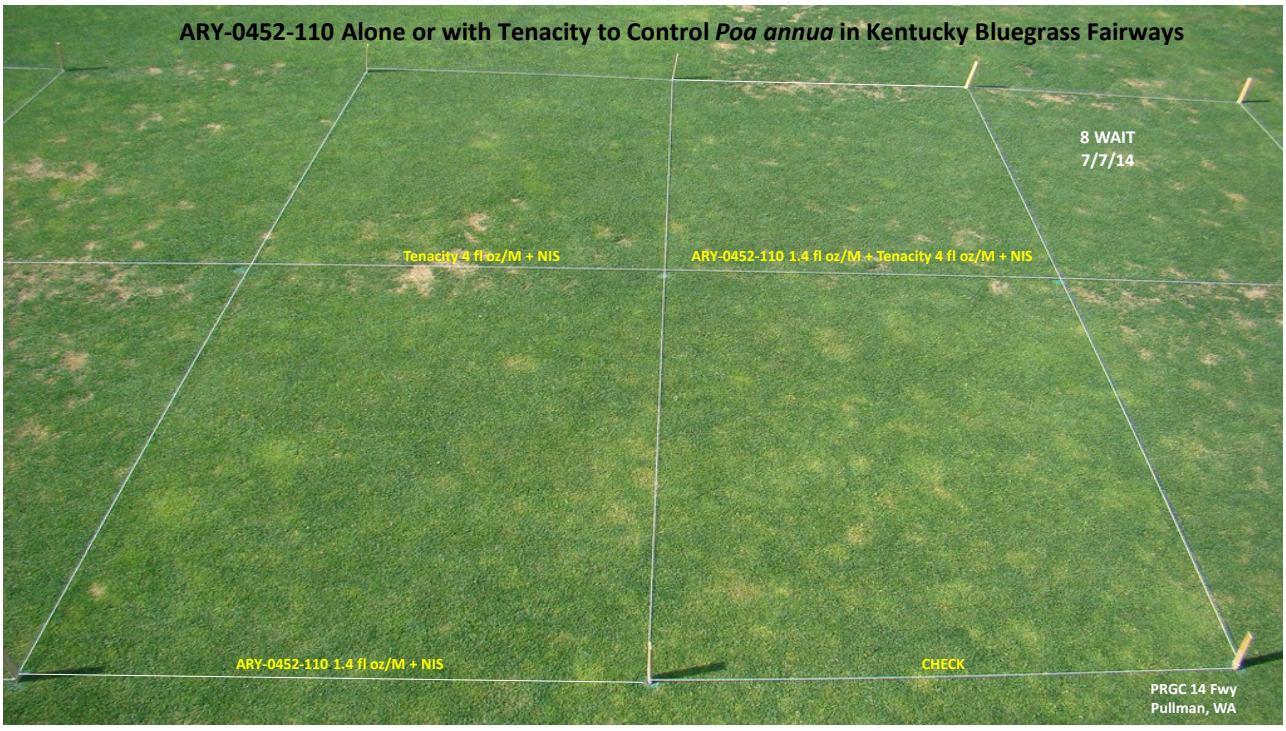

Figure 12. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

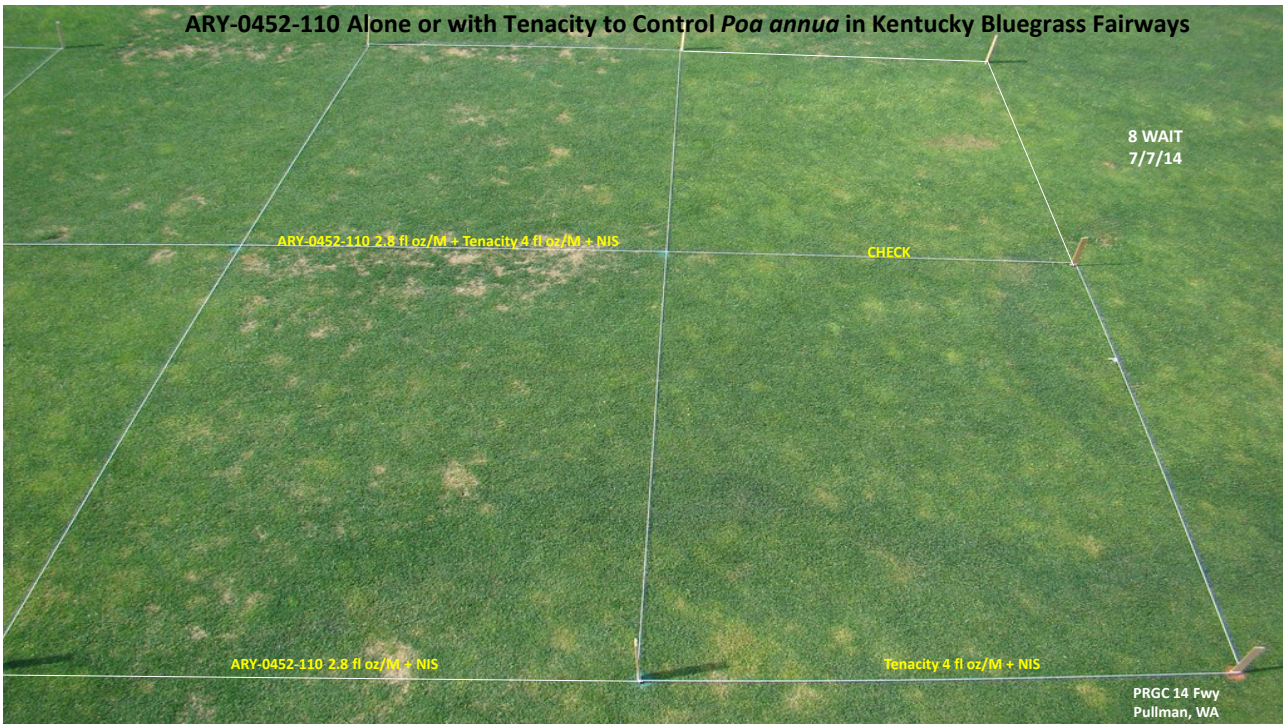

Figure 13. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

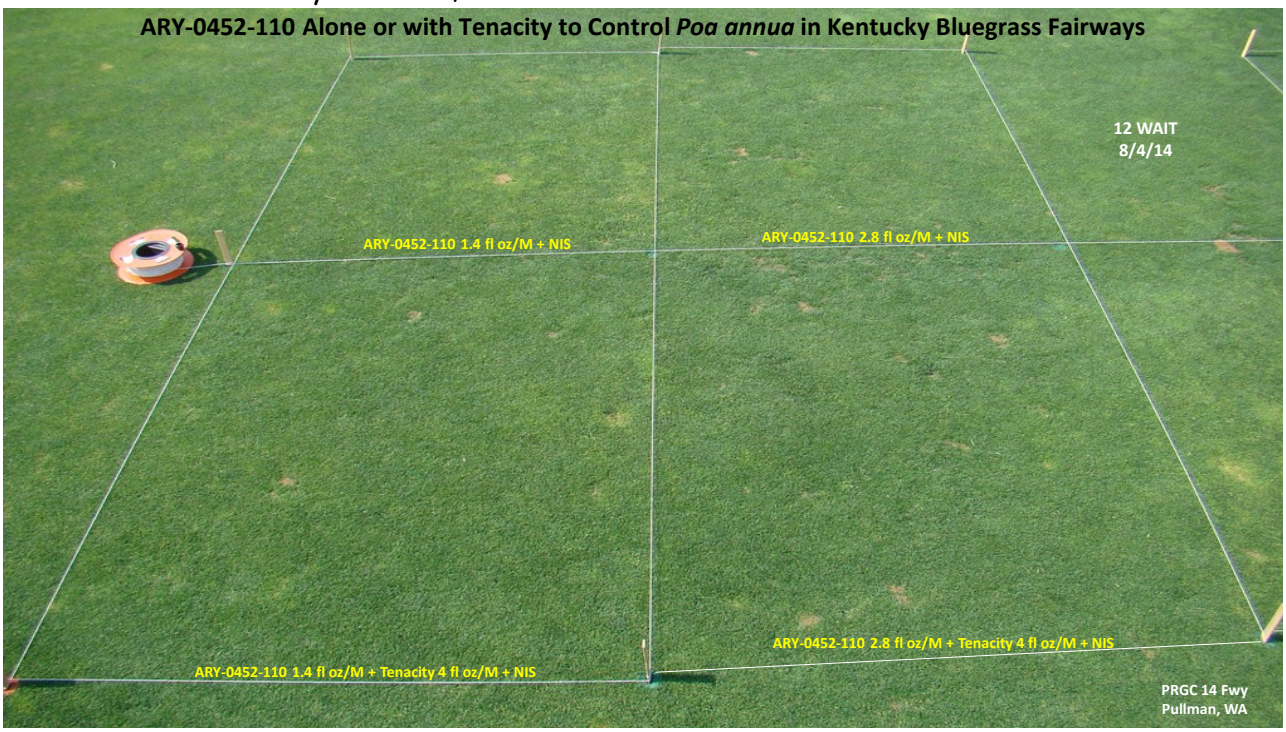

Figure 14. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.

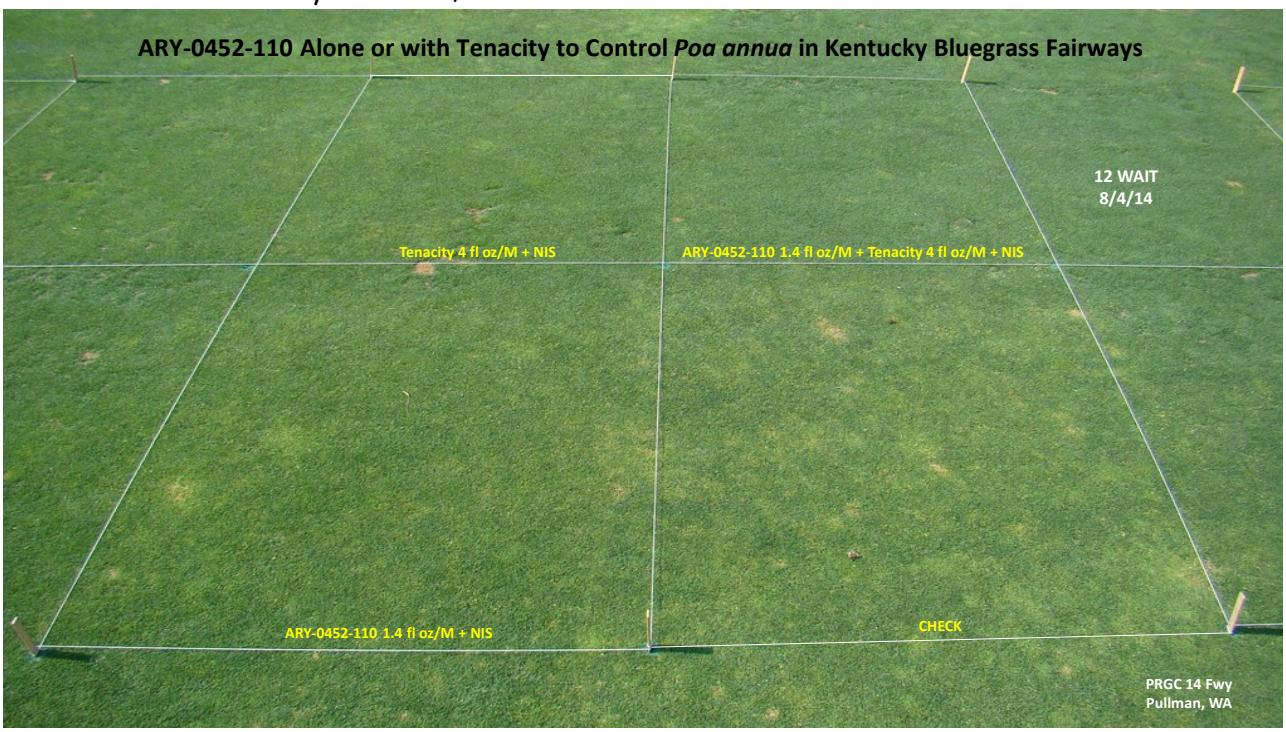

Figure 15. The effect ARY-0452-110 and/or Tenacity on a Kentucky bluegrass fairway infested with *P. annua*. PRGC 14 fairway. Pullman, WA.