

## Development of Tenacity 4FL as a Fall renovation program to eliminate *Poa annua* (post-emergence) in Kentucky bluegrass fairways (2013 and 2014 Results)

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A field trial was begun in the Fall 2013 and monitored through mid-July 2014 on a Kentucky bluegrass (KBG) fairway at the Washington State University Palouse Ridge Golf Club (PRGC) in Pullman, WA to determine the effect of Tenacity combined with other herbicides to control *Poa annua* (post-emergence). Individual treatment plots were 6' x 7' with four replications in a randomized complete-block design. Each treatment was applied 3 times on 3 week intervals: 12 Sept., 3 Oct., and 24 Oct. 2013 at 25 GPA with a bicycle-wheeled CO<sub>2</sub> 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' 17", W 117° 07' 56.4", Elev. 2538'. Soil characteristics: 28.8% sand, 52.5% silt, 18.8% clay, pH 6.4, and organic matter 4.9%. Phytotoxicity to KBG and *P. annua* was rated every 1 to 2 weeks up to 8 weeks after initial treatment (WAIT). Phytotoxicity was rated on a scale from 0 to 10, with 0 = no phytotoxicity and 10 = dead turf, rating >2 is considered unacceptable injury. Percentage of and percent change of *P. annua* in the turfgrass stand was estimated on 12 Sept 2013 (initial), 6 WAIT (23 Oct 2013) and every 2 to 4 weeks from 7 May 2014 through 16 Jul 2014. Percentage exposed ground per plot area was rated beginning 21 May 2014 through 16 Jul 2014.

Tenacity 4 fl oz/A + Xonerate 1 oz/A or Prograss 32 fl oz/A + NIS were the only treatments which showed acceptable KBG phytotoxicity up through 8 WAIT (Table 2 and Fig. 1). Tenacity 5 fl oz/A + Trimmit 16 fl oz/A + Turflon 16 fl oz/A + NIS resulted in the highest KBG phytotoxicity 8 WAIT. See Fig. 6 - 11.

However, almost all treatments resulted in phytotoxicity >2 on *P. annua* starting 2 WAIT up to the final rating taken 8 WAIT (Table 3 and Fig. 2). The Tenacity 5 fl oz/A + Xonerate 2 oz/A or Tenacity 4 fl oz/A + Xonerate 1 oz/A + NIS treatments resulted in the highest phytotoxicity on *P. annua* compared to the other treatments. The most common symptoms among all treatments were the *P. annua* leaves yellowing and/or turning light brown (Fig. 5 - 10). However, by 8 WAIT much of the *P. annua* in the Tenacity 4 fl oz/A + Xonerate 1 oz/A + NIS or Tenacity 5 fl oz/A + Xonerate 2 oz/A treatments was actually dying, leaves turning light brown (Fig. 9 and 10). See Fig. 6 - 11 for more Fall 2013 phytotoxicity pictures.

All herbicide treatments resulted in a reduction of *P. annua* in the turfgrass stand 8 WAIT (23 Oct 2013) (Fig. 3 and 4). Tenacity 5 fl oz/A + Xonerate 2 oz/A resulted in the greatest reduction (65%) of *P. annua*. Tenacity 4 fl oz/A + Xonerate 1 oz/A + NIS resulted in a 47% reduction of *P. annua*. Similar reductions in *P. annua* were observed in the Tenacity 5 fl oz/A + Turflon 16 fl oz/A + Trimmit 16 fl oz/A + NIS (44%) and Tenacity 5 fl oz/A + Trimmit 16 fl oz/A + NIS (42%). Tenacity 5 fl oz/A

+ Turflon 16 fl oz/A or Prograss 32 fl oz/A + NIS resulted in 20 to 25% reduction of *P. annua* in the turfgrass stand. However, by early May, Tenacity + Xonerate 1 or 2 oz/A or Prograss 32 fl oz/A treatments result in further reductions of *P. annua* in the turfgrass stand 80 to 95%. Tenacity + Trimmit and/or Turflon resulted in little change in *P. annua* from the Fall 2013 rating. All treatments showed an increase in *P. annua* from May through the final rating on 16 Jul 2014. By 16 Jul 2014 Tenacity + Xonerate 1 or 2 oz/A or Prograss 32 fl oz/A all resulted in approximately 75% reduction in *P. annua* in the turfgrass stand. See Fig. 6 - 23.

All treatments, to some degree, resulted in exposed soil in the Spring (Figure 5). This this appears to result from the death of *P. annua*, which left open exposed areas in the turfgrass stand. Tenacity 5 fl oz/A + Xonerate 2 oz/A or Prograss 32 fl oz/A or Turflon ester 16 fl oz/A resulted in 20 to 35% exposed soil when rated on 7 May 2014. Surprisingly, even though Tenacity 4 fl oz/A + Xonerate 1 oz/A which had 70% reduction in *P. annua* by 7 May 2014 had only 13% exposed soil. However, by 19 Jun 2014, all treatments except Tenacity 5 fl oz + Xonerate 2 oz/A or Prograss 32 fl oz/A had <5% exposed soil. See Fig. 12 -21.

To summarize, by early May 2014 Tenacity 5 fl oz/A + Xonerate 2 oz/A or Prograss 32 fl oz/A or Tenacity 4 fl oz/A + Xonerate 1 oz/A resulted in the greatest reduction of *P. annua* in the stand. Approximately 75% by the end of the study 16 Jul 2014 (Fig. 3 and 4). However, Tenacity 5 fl oz/A + Xonerate 2 oz/A or Prograss 32 fl oz/A resulted in more exposed ground compared to Tenacity 4 fl oz/A + Xonerate 1 oz/A and took longer to heal in. Associated with these treatments, in the Fall of 2013, KBG phytotoxicity was slightly unacceptable and had a high level of *P. annua* phytotoxicity 8 WAIT (Table 2 and 3 and Fig. 1 and 2). In terms of KBG phytotoxicity, only 2 treatments resulted in acceptable levels up to 8 WAIT: Tenacity 5 fl oz + Turflon 16 fl oz/A or Prograss 32 fl oz/A (Table 2 and Fig. 1). These 2 treatments also resulted in the lowest levels of *P. annua* phytotoxicity (Table 3 and Fig. 2), as well as, *P. annua* control in the Fall of 2013 (Fig. 3 and 4). Overall, in terms, of Kentucky bluegrass phytotoxicity in the Fall of 2013, *P. annua* control, and exposed ground in Spring and early Summer 2014, Tenacity 4 fl oz/A + Xonerate 1 oz/A appears to be a better overall treatment. However, no treatment resulted in complete *P. annua* control, therefore a multi-year approach may be needed to achieve total *P. annua* control.

**Table 1. Climate data at each application date.**

Application date	Air temp (F)	Soil temp 2" (F)	RH (%)	Wind Direction/Speed	Weather conditions
9/12/13	<b>84</b>	<b>63</b>	<b>25</b>	<b>East 3-4 mph</b>	<b>Sunny</b>
10/3/13	<b>59</b>	<b>49</b>	<b>31</b>	<b>East 2-3 mph</b>	<b>Sunny</b>
10/23/13	<b>61</b>	<b>50</b>	<b>43</b>	<b>East 5-7 mph</b>	<b>Sunny</b>

Table 2. The effect of various Fall treatments with Tenacity to control *P. annua* on Kentucky bluegrass phytotoxicity. PRGC 17 fairway. Pullman, WA.

Treatment	App. Interval (3 week)	Rate (fl oz or oz/A)	Kentucky bluegrass phytotoxicity				
			2 WAIT	3 WAIT	5 WAIT	6 WAIT	8 WAIT
			9/26/13	10/3/13	10/17/13	10/23/13	11/7/13
Tenacity 4SC + Turflon Ester 2SC + NIS	9/12/13	5 16 0.25% v/v	0.8 b*	1.0 a	1.9 ab	2.4 b	2.6 b
Tenacity 4SC + Turflon Ester 2SC + NIS	10/3/13	5 16 0.25% v/v					
Tenacity 4SC + Turflon Ester 2SC + NIS	10/24/13	5 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + NIS	9/12/13	5 16 0.25% v/v	0.9 b	0.9 a	1.0 bc	2.1 bc	2.1 bc
Tenacity 4SC + Trimmit 2SC + NIS	10/3/13	5 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + NIS	10/24/13	5 16 0.25% v/v					
Tenacity 4SC + Xonerate 70WG + NIS	9/12/13	4 1 oz 0.25% v/v	0.6 bc	0.8 ab	1.1 bc	1.4 bc	1.8 c
Tenacity 4SC + Xonerate 70WG + NIS	10/3/13	4 1 oz 0.25% v/v					
Tenacity 4SC + Xonerate 70WG + NIS	10/24/13	4 1 oz 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	9/12/13	5 16 16 0.25% v/v	1.3 ab	1.3 a	2.4 a	3.6 a	3.5 a
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	10/3/13	5 16 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	10/24/13	5 16 16 0.25% v/v					
Tenacity 4SC + Prograss + NIS	9/12/13	5 32 0.25% v/v	0.0 c	0.5 ab	0.9 cd	1.1 c	1.8 c
Tenacity 4SC + Prograss + NIS	10/3/13	5 32 0.25% v/v					
Tenacity 4SC + Prograss + NIS	10/24/13	5 32 0.25% v/v					
Tenacity 4SC + Xonerate 70WG	9/12/13	5 2 oz	1.6 a	1.1 a	1.4 bc	2.3 b	2.6 b
Tenacity 4SC + Xonerate 70WG	10/3/13	5 2 oz					
Tenacity 4SC + Xonerate 70WG	10/24/13	5 2 oz					
Control		0	0.0 c	0.0 b	0.0 d	0.0 d	0.0 d

\* Means within columns followed by the same letter are not significantly different. LSD  $P = 0.05$ .

Figure 1. The effect of various Fall treatments with Tenacity to control *P. annua* on Kentucky bluegrass phytotoxicity. PRGC 17 fairway. Pullman, WA.

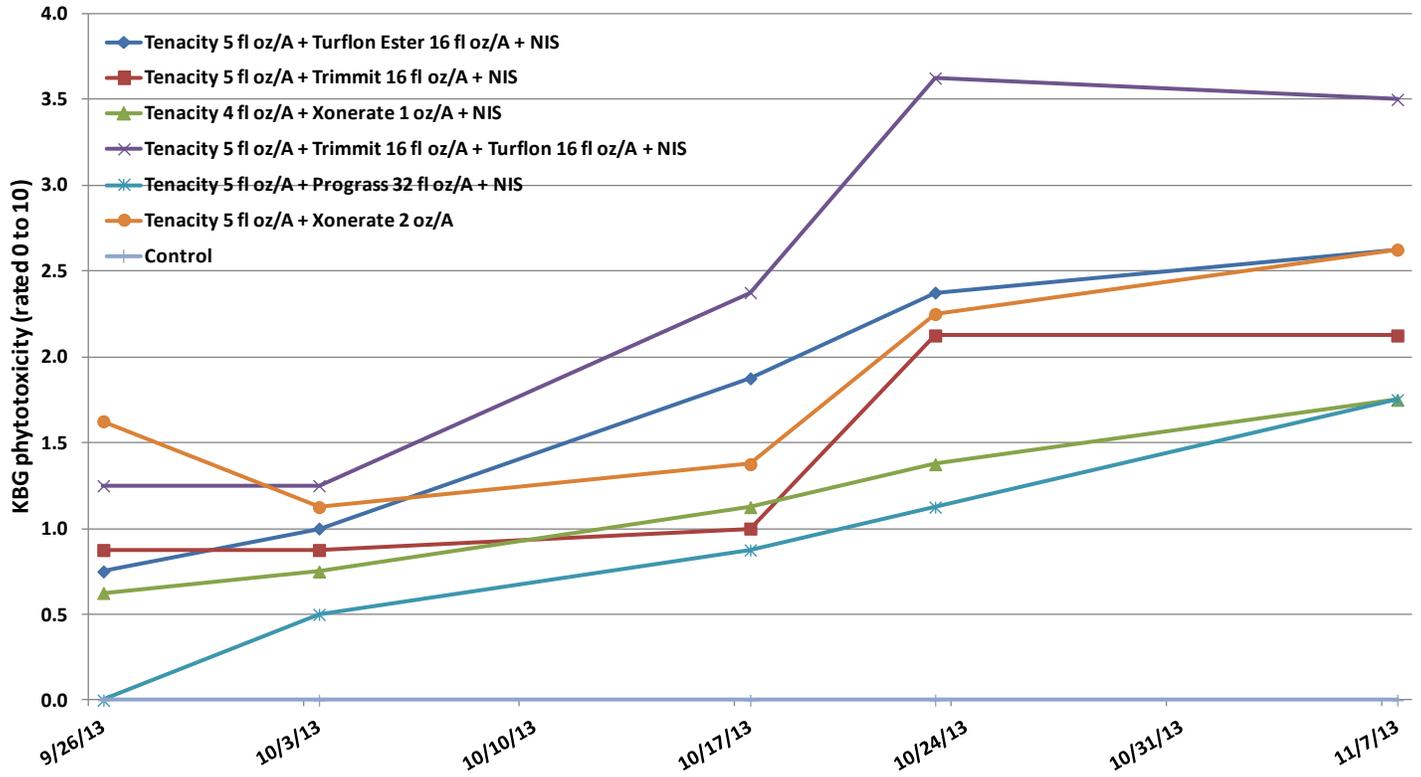


Table 3. The effect of various Fall treatments with Tenacity to control *P. annua* on *P. annua* phytotoxicity. PRGC 17 fairway. Pullman, WA.

Treatment	App. Interval (3 week)	Rate (fl oz or oz/A)	<i>Poa annua</i> phytotoxicity				
			2 WAIT	3 WAIT	5 WAIT	6 WAIT	8 WAIT
			9/26/13	10/3/13	10/17/13	10/23/13	11/7/13
Tenacity 4SC + Turflon Ester 2SC + NIS	9/12/13	5 16 0.25% v/v	1.5 ab*	3.9 ab	3.9 bc	4.0 bc	4.8 d
Tenacity 4SC + Turflon Ester 2SC + NIS	10/3/13	5 16 0.25% v/v					
Tenacity 4SC + Turflon Ester 2SC + NIS	10/24/13	5 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + NIS	9/12/13	5 16 0.25% v/v	2.5 a	5.1 a	5.3 ab	5.6 ab	6.3 c
Tenacity 4SC + Trimmit 2SC + NIS	10/3/13	5 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + NIS	10/24/13	5 16 0.25% v/v					
Tenacity 4SC + Xonerate 70WG + NIS	9/12/13	4 1 oz 0.25% v/v	2.0 ab	2.3 b	3.6 c	5.3 ab	7.5 ab
Tenacity 4SC + Xonerate 70WG + NIS	10/3/13	4 1 oz 0.25% v/v					
Tenacity 4SC + Xonerate 70WG + NIS	10/24/13	4 1 oz 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	9/12/13	5 16 16 0.25% v/v	2.0 ab	5.4 a	6.8 a	6.8 a	7.1 bc
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	10/3/13	5 16 16 0.25% v/v					
Tenacity 4SC + Trimmit 2SC + Turflon Ester 2SC + NIS	10/24/13	5 16 16 0.25% v/v					
Tenacity 4SC + Prograss + NIS	9/12/13	5 32 0.25% v/v	1.0 bc	2.3 b	2.9 c	3.4 c	5.1 d
Tenacity 4SC + Prograss + NIS	10/3/13	5 32 0.25% v/v					
Tenacity 4SC + Prograss + NIS	10/24/13	5 32 0.25% v/v					
Tenacity 4SC + Xonerate 70WG	9/12/13	5 2 oz	2.9 a	4.0 a	5.3 ab	6.8 a	8.4 a
Tenacity 4SC + Xonerate 70WG	10/3/13	5 2 oz					
Tenacity 4SC + Xonerate 70WG	10/24/13	5 2 oz					
Control		0	0.0 c	0.0 c	0.0 d	0.0 d	0.0 e

\* Means within columns followed by the same letter are not significantly different. LSD  $P = 0.05$ .

Figure 2. The effect of various Fall treatments with Tenacity to control *P. annua* on *P. annua* phytotoxicity. PRGC 17 fairway. Pullman, WA.

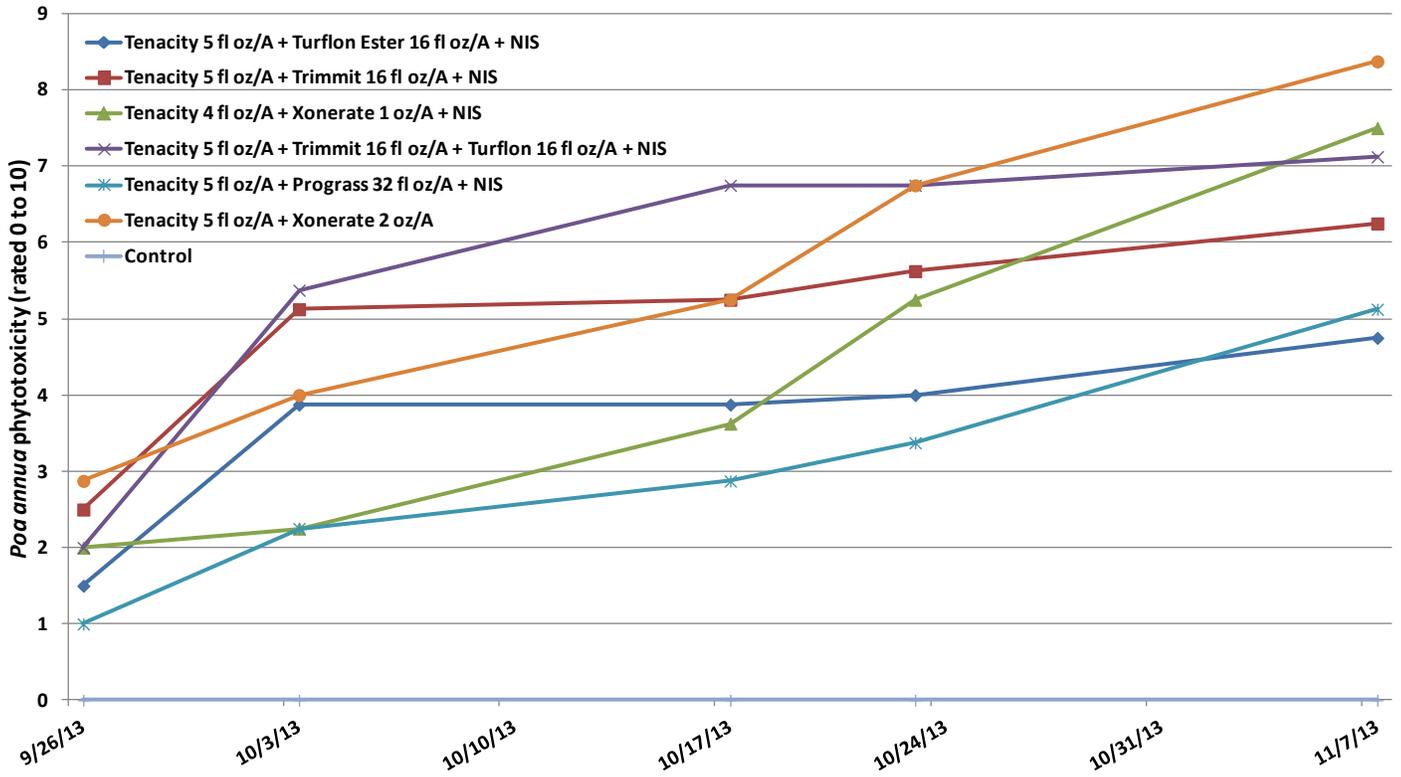


Figure 3. The effect of various Fall treatments with Tenacity to control *P. annua* on percentage of *P. annua* in the turfgrass stand. PRGC 17 fairway. Pullman, WA.

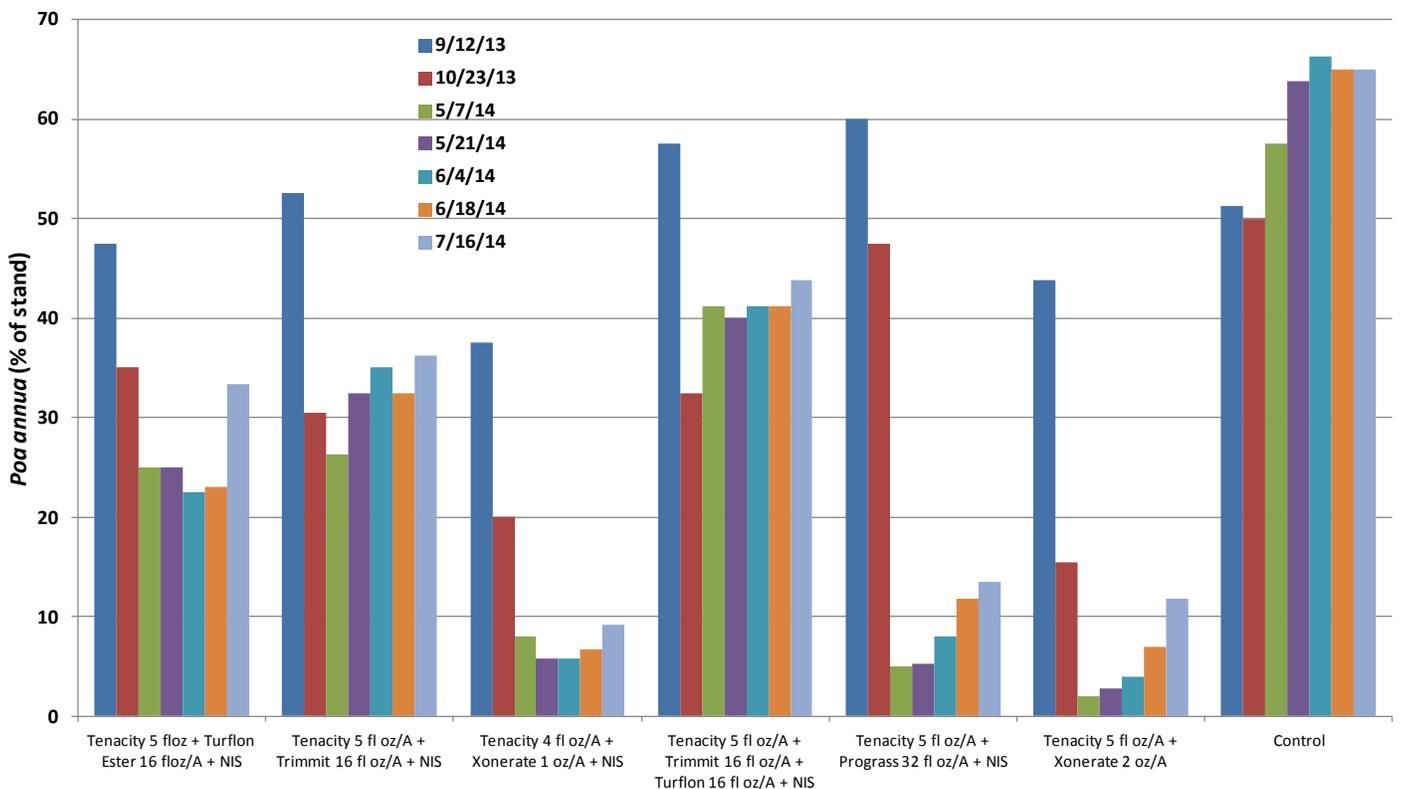


Figure 4. The effect of various Fall treatments with Tenacity to control *P. annua* on percent change of *P. annua* in the turfgrass stand. PRGC 17 fairway. Pullman, WA.

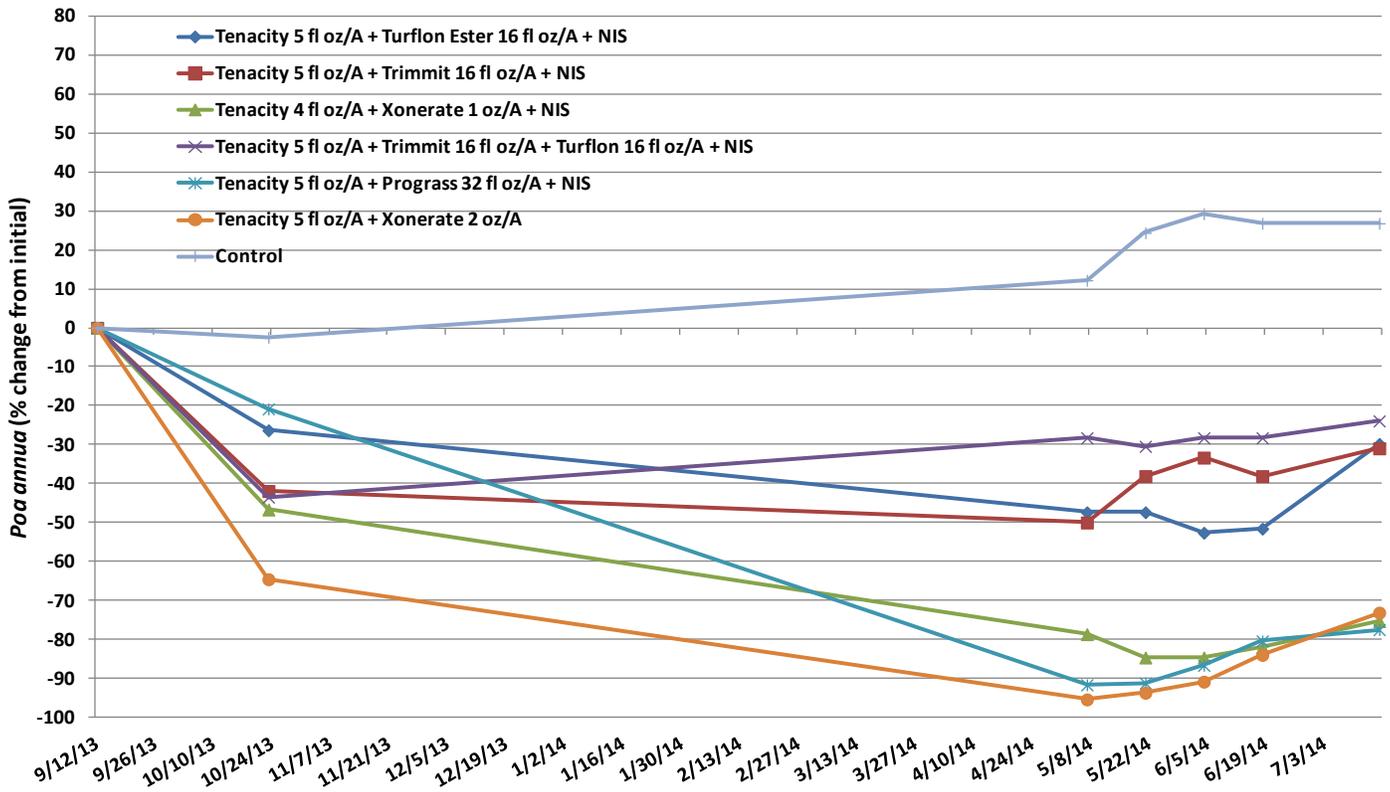


Figure 5. The effect of various Fall treatments with Tenacity to control *P. annua* on percent exposed ground in the Spring and early Summer in the turfgrass stand. PRGC 17 fairway. Pullman, WA.

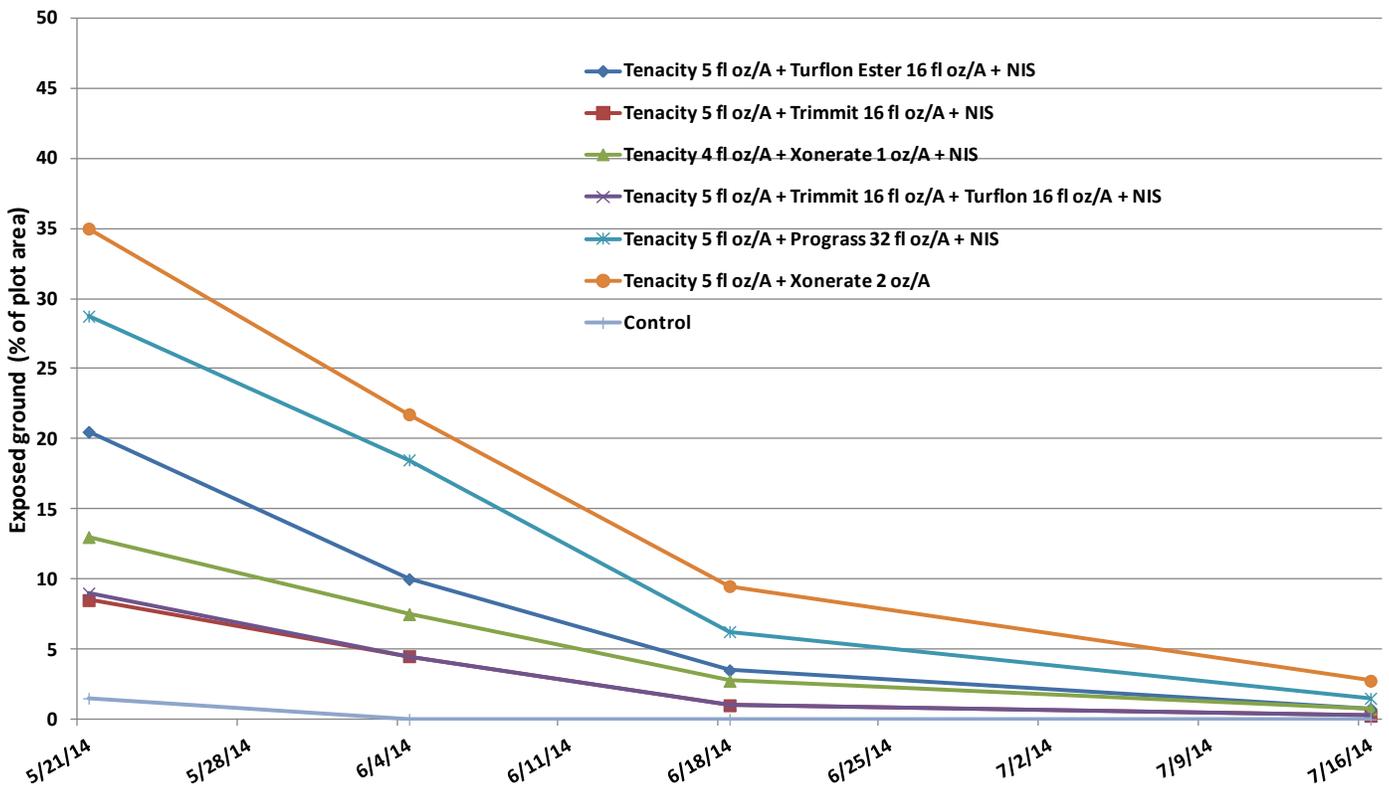


Figure 6. The effect of various Fall treatments with Tenacity to control *P. annua* 2 WAIT. PRGC 17 fairway. Pullman, WA.

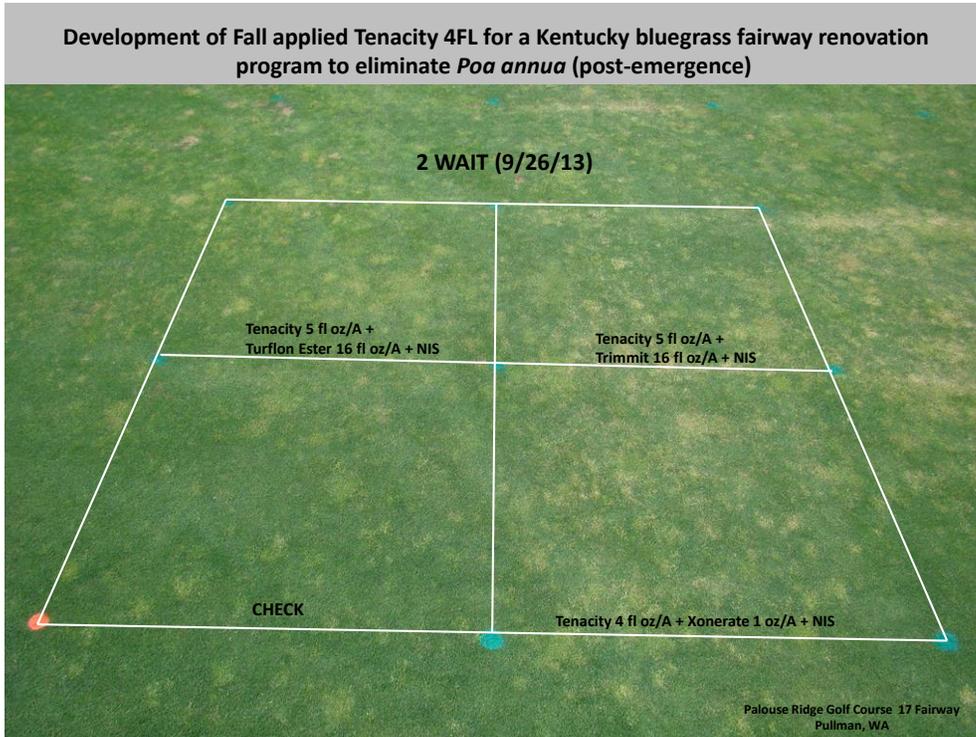


Figure 7. The effect of various Fall treatments with Tenacity to control *P. annua* 2 WAIT. PRGC 17 fairway. Pullman, WA.

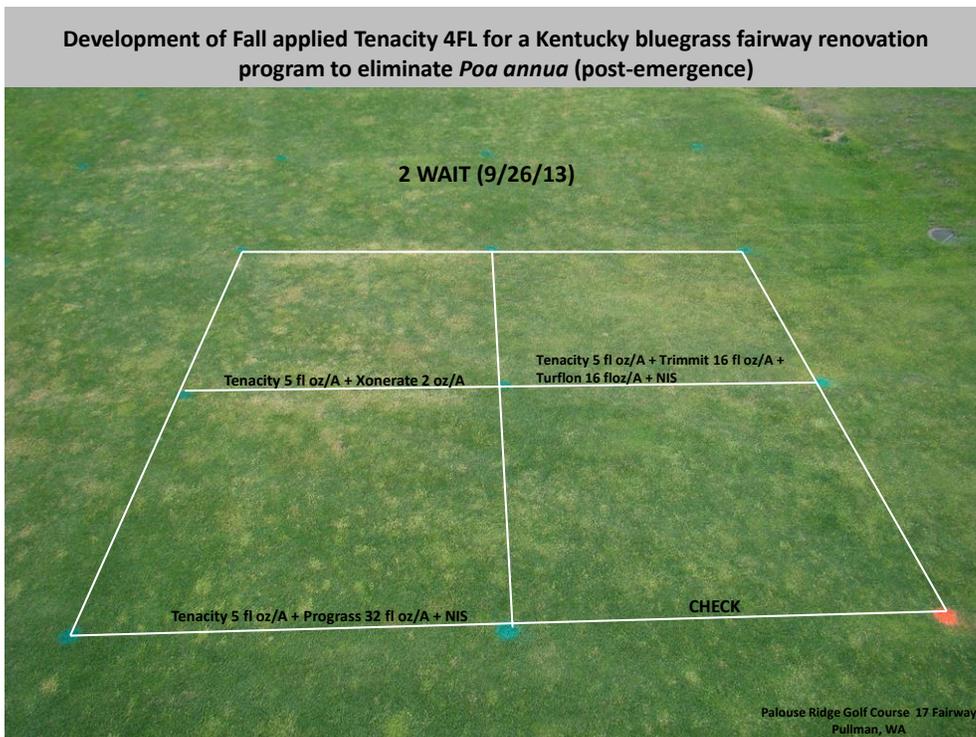


Figure 8. The effect of various Fall treatments with Tenacity to control *P. annua* 5 WAIT. PRGC 17 fairway. Pullman, WA.

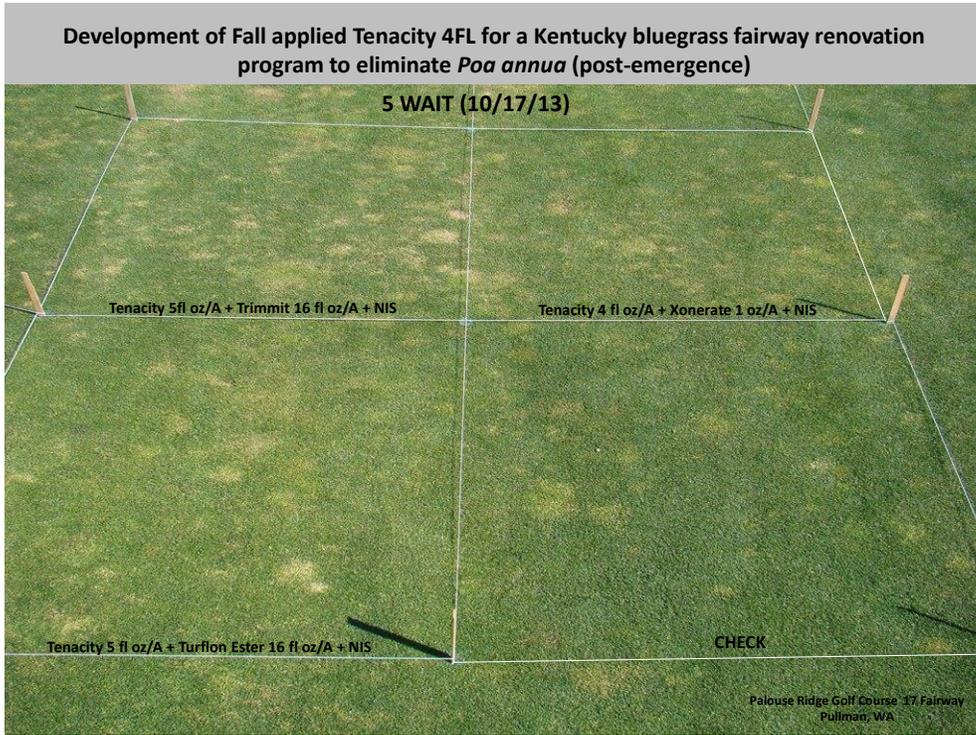


Figure 9. The effect of various Fall treatments with Tenacity to control *P. annua* 5 WAIT. PRGC 17 fairway. Pullman, WA.

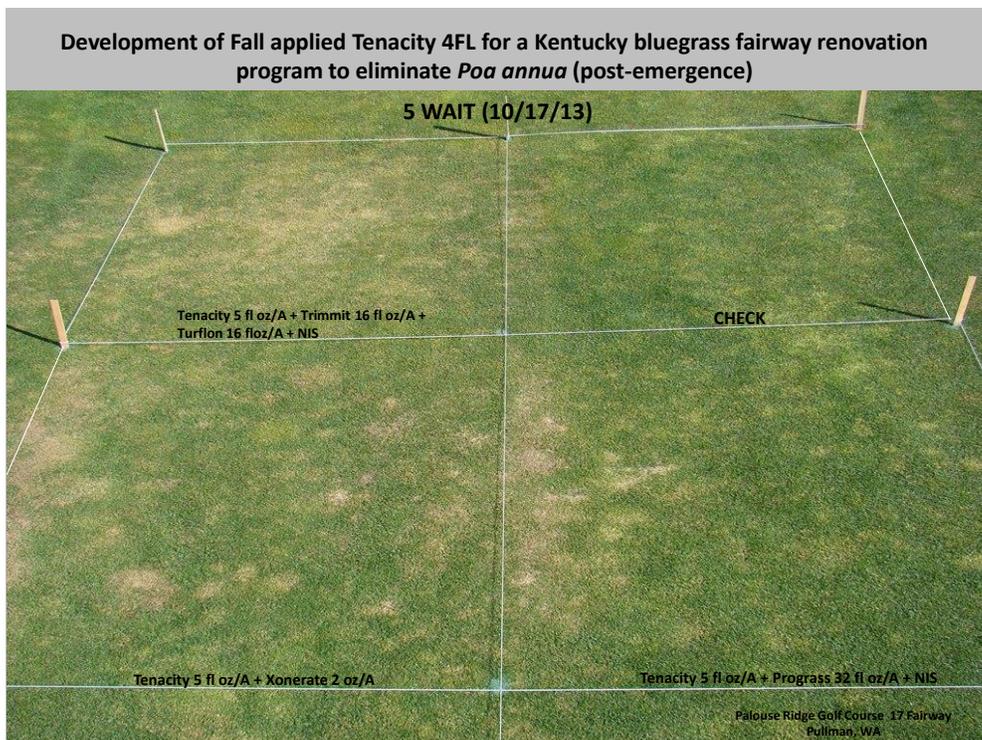


Figure 10. The effect of various Fall treatments with Tenacity to control *P. annua* 8 WAIT. PRGC 17 fairway. Pullman, WA.

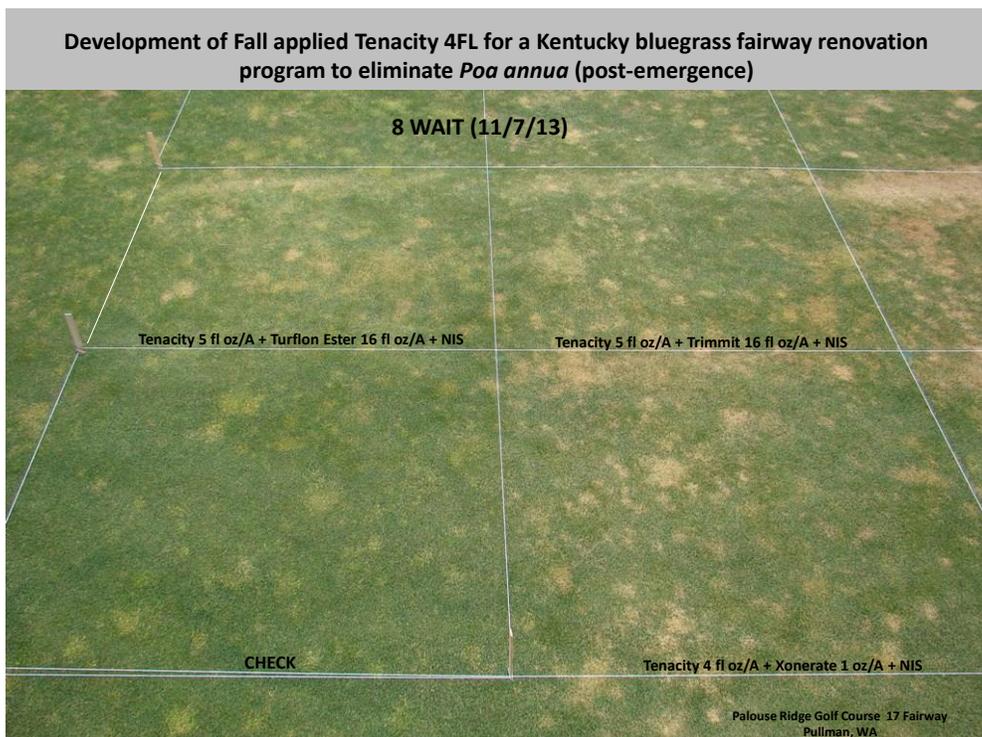


Figure 11. The effect of various Fall treatments with Tenacity to control *P. annua* 8 WAIT. PRGC 17 fairway. Pullman, WA.

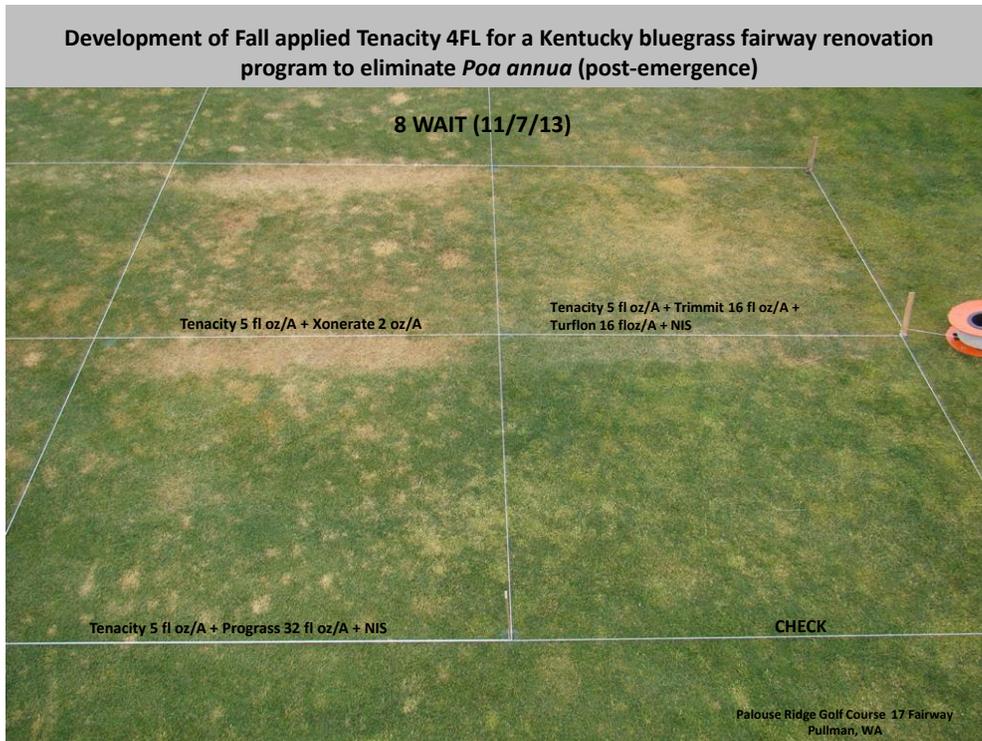


Figure 12. The effect of various Fall treatments with Tenacity to control *P. annua* 7 May 2014. PRGC 17 fairway. Pullman, WA.

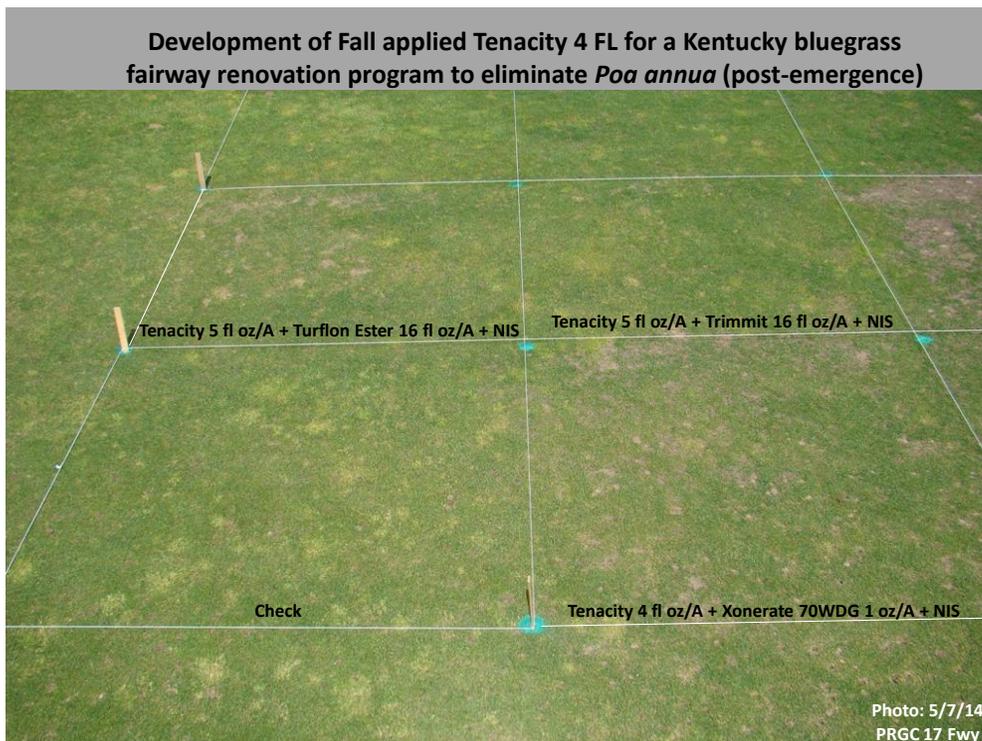


Figure 13. The effect of various Fall treatments with Tenacity to control *P. annua* 7 May 2014. PRGC 17 fairway. Pullman, WA.

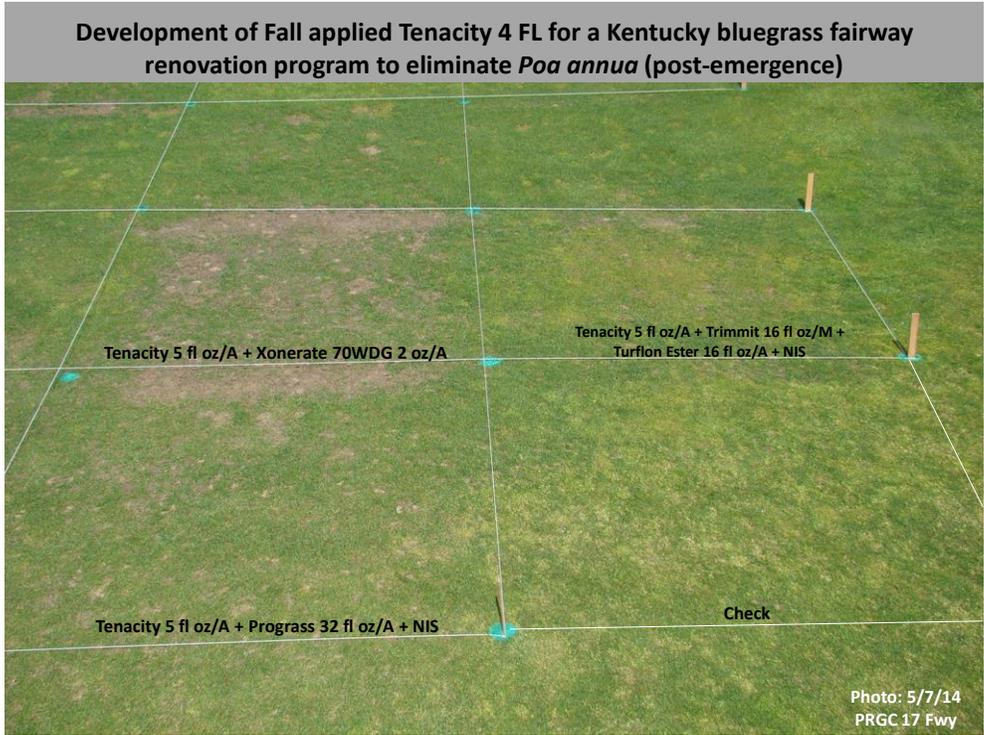


Figure 14. The effect of various Fall treatments with Tenacity to control *P. annua* 7 May 2014. PRGC 17 fairway. Pullman, WA.

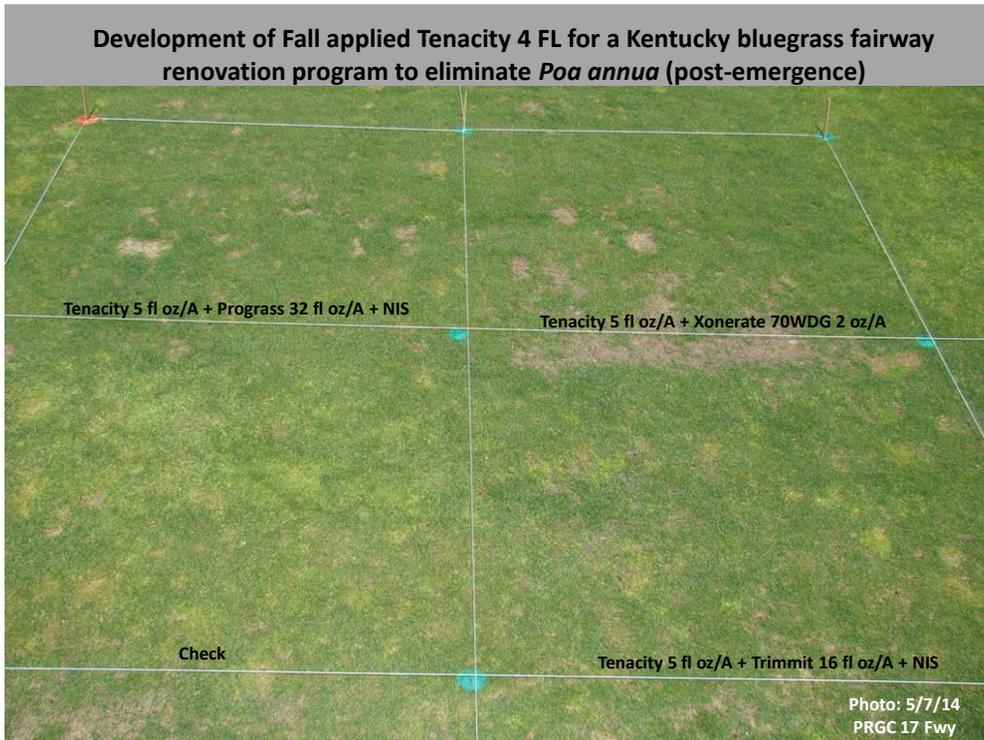


Figure 15. The effect of various Fall treatments with Tenacity to control *P. annua* 7 May 2014. PRGC 17 fairway. Pullman, WA.

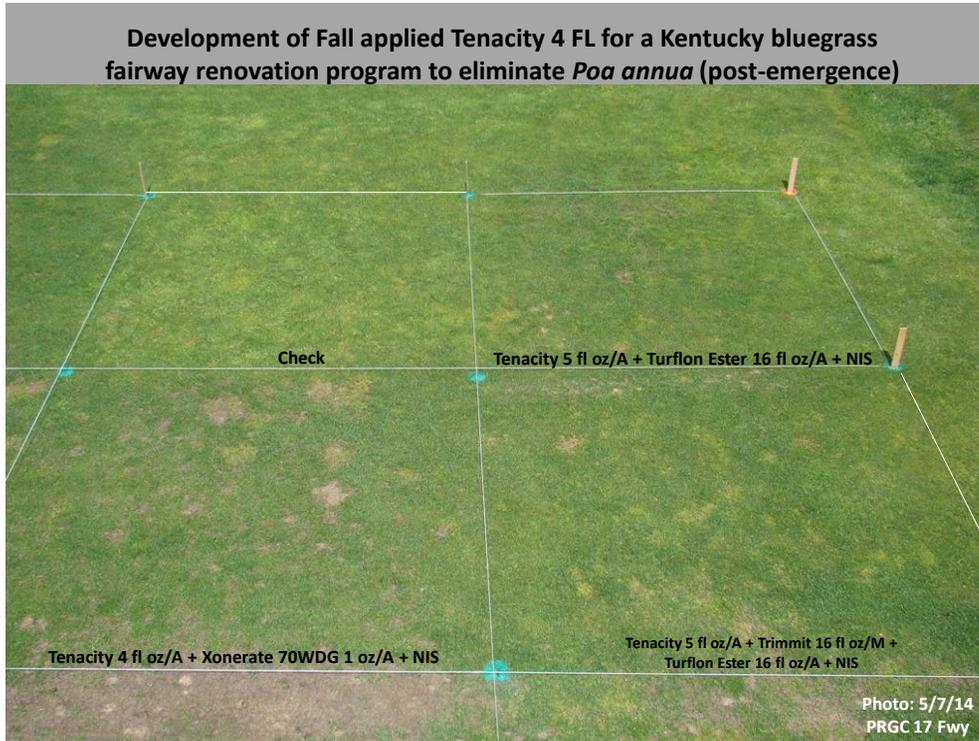


Figure 16. The effect of various Fall treatments with Tenacity to control *P. annua* 4 Jun 2014. PRGC 17 fairway. Pullman, WA.

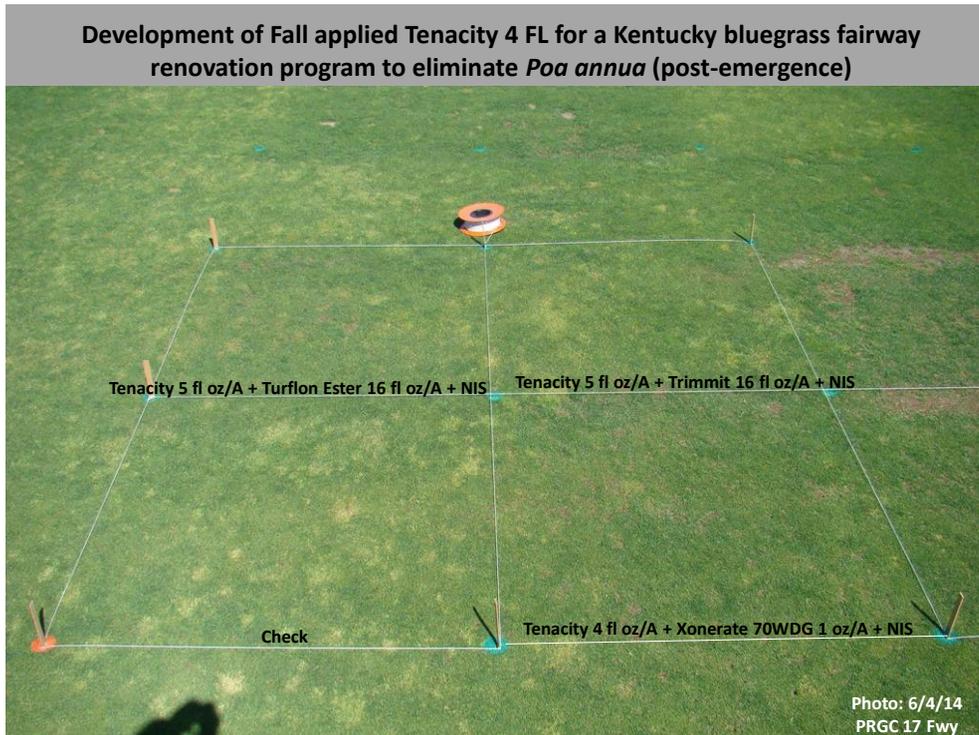


Figure 17. The effect of various Fall treatments with Tenacity to control *P. annua* 4 Jun 2014. PRGC 17 fairway. Pullman, WA.

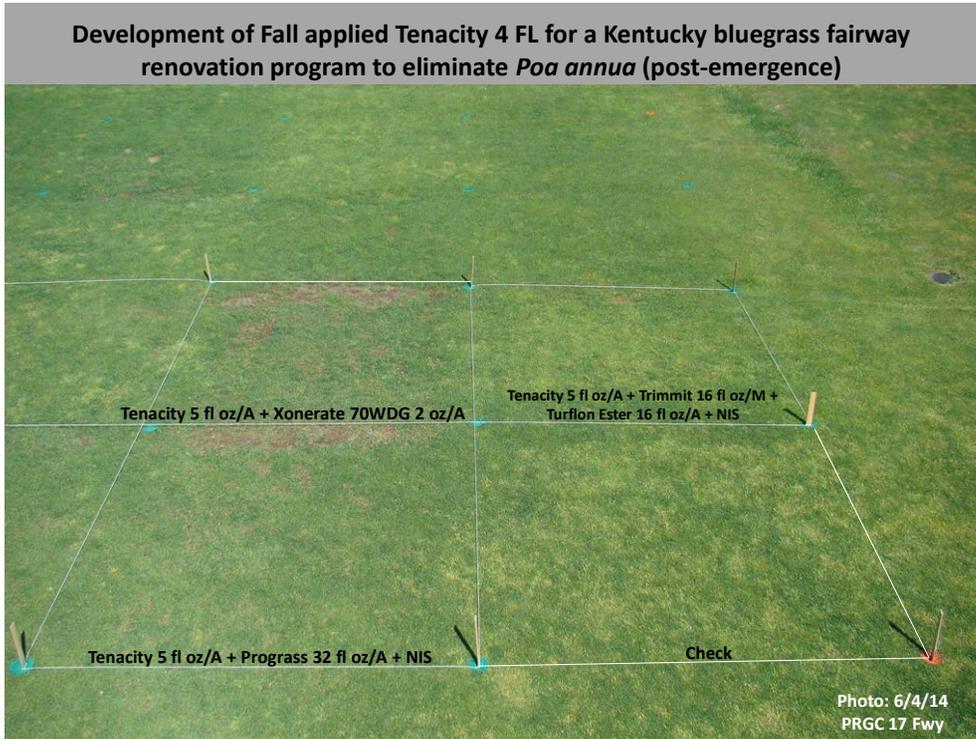


Figure 18. The effect of various Fall treatments with Tenacity to control *P. annua* 4 Jun 2014. PRGC 17 fairway. Pullman, WA.

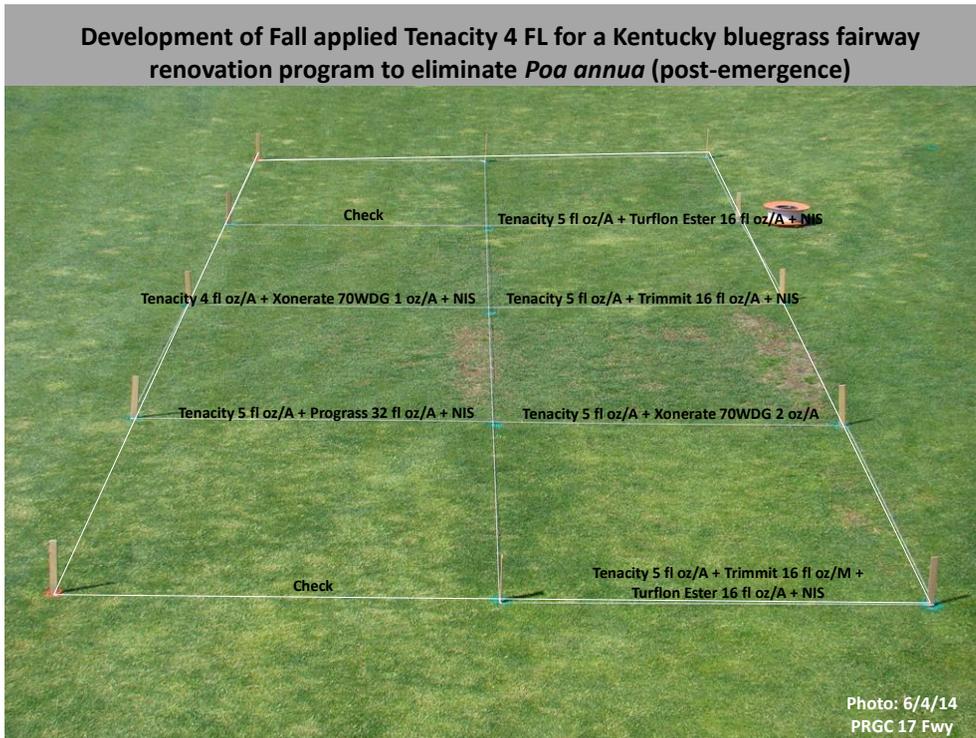


Figure 19. The effect of various Fall treatments with Tenacity to control *P. annua* 19 Jun 2014. PRGC 17 fairway. Pullman, WA.

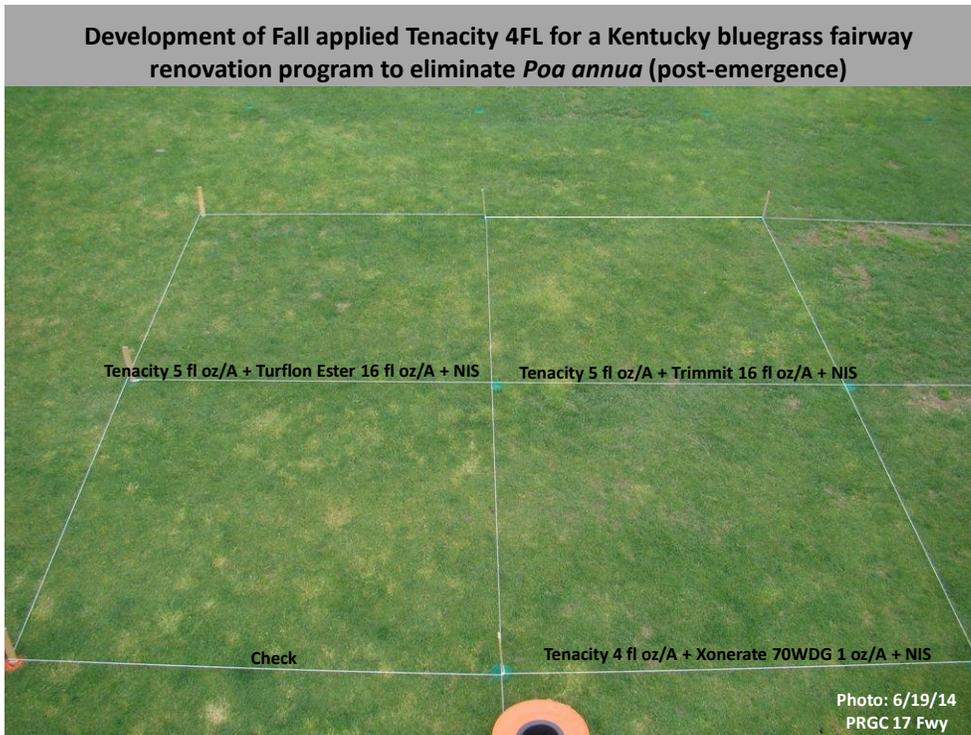


Figure 20. The effect of various Fall treatments with Tenacity to control *P. annua* 19 Jun 2014. PRGC 17 fairway. Pullman, WA.

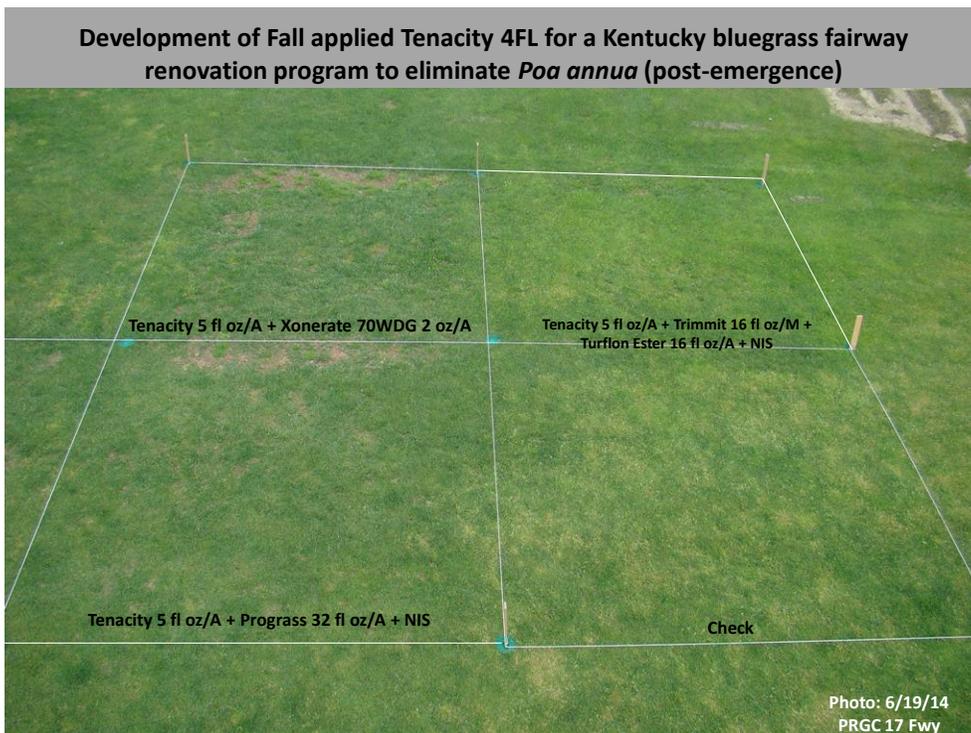


Figure 21. The effect of various Fall treatments with Tenacity to control *P. annua* 19 Jun 2014. PRGC 17 fairway. Pullman, WA.

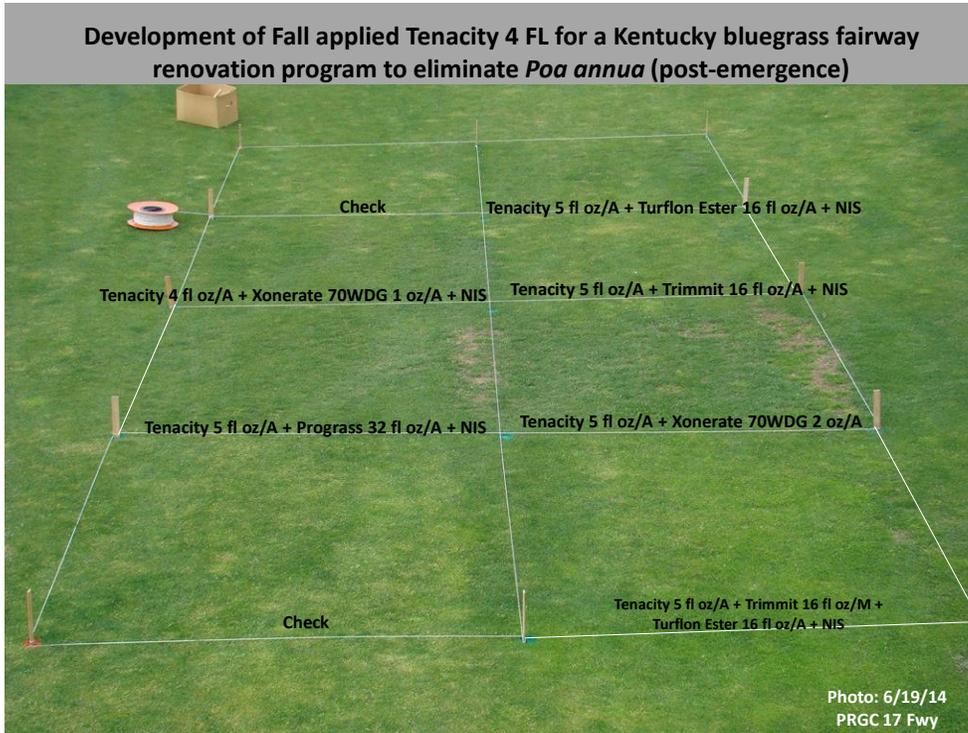


Figure 22. The effect of various Fall treatments with Tenacity to control *P. annua* 15 Jul 2014. PRGC 17 fairway. Pullman, WA.

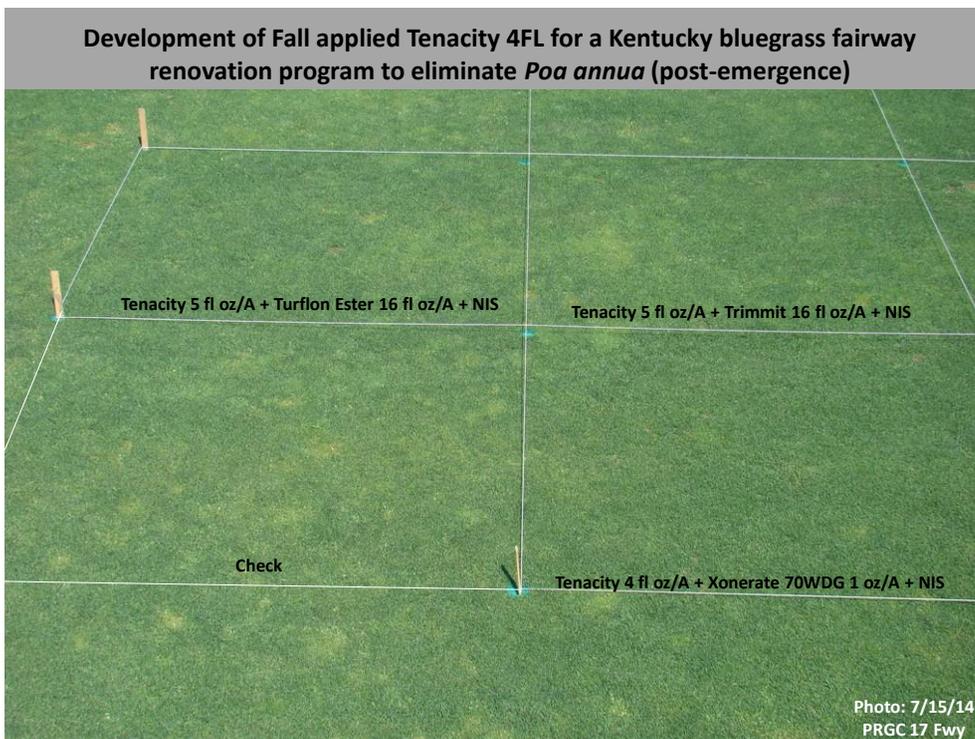


Figure 23. The effect of various Fall treatments with Tenacity to control *P. annua* 15 Jul 2014. PRGC 17 fairway. Pullman, WA.

