Renz Weed Science
COLLEGE OF AGRICULTURAL & LIFE SCIENCES
UNIVERSITY OF WISCONSIN–MADISON

Extension
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UW – Madison Weed Science Renz Lab

Evaluation of Kudos + Fungicide and Insecticide Timing on Alfalfa Stand Density in Interseeded Corn – Alfalfa

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Objectives:

1) Determine the impacts of application timing (early vs. late), alfalfa cultivar and agrichemical strategy (combinations of Kudos + Priaxor) using a one-pass application program on alfalfa fall plant density.
2) Determine the best agrichemical strategy (combinations of Kudos + Priaxor + Warrior II) to be adopted late in season to enhance fall alfalfa survival using a one-pass application program.

Summary:

Averaged across treatments, cultivar 55H94 exhibited greater plant densities than cultivar 3240 (Fig.1 and 2-b), which corroborates previous findings from studies conducted in Wisconsin, but no interactions with other factors were observed so subsequent analyses are averaged among alfalfa varieties. Results from our analysis found that all agrichemical strategies applied at the early timing did not improve alfalfa establishment as none of them performed significantly better than the untreated control, resulting in less than 1.0 plant ft^{-2} (Fig. 1-a). Therefore, further analyses focused on the late timing revealed that the addition of fungicide (Priaxor) and insecticide (Warrior II) increased alfalfa survival (Fig. 2-a). However, individual agrichemical strategies still resulted in marginal stands (5.0 plants ft^{-2}). The only exception was Kudos at 16 oz wt acre^{-1} + Priaxor at 4.0 fl oz acre^{-1} which resulted in high alfalfa plant density (above 10.0 plants ft^{-2}). The exceptionally low alfalfa survival rates observed in this study were likely due to the extremely difficult conditions for alfalfa establishment in 2019 (high alfalfa disease, competitive corn, and high potato leaf hopper pressure). Although previous research has suggested Kudos at 26 oz wt acre^{-1} as the standard Kudos rate in this system; we failed to spray Priaxor and Warrior II in this treatment's plots so excluded it from the analysis. These findings indicate that late timing applications should be adopted in a one-pass application

program where Kudos at ≥ 16 oz wt acre^{-1} is partnered with fungicide and insecticide. As 2019 was a challenging establishment year, the late timing treatments will be repeated in 2020.

Experimental Design and Treatments Information:

This experiment was conducted near Arlington, WI (43°18' N, 89°20' W) on a Plano silt loam (fine-silty, mixed, superactive, mesic Typic Argiudoll). Following fertilization with 200 pounds of N per acre and ample P and K, corn at 36,200 seeds per acre was planted on May 13, 2019. Two alfalfa varieties were sown at 16 pounds per acre one day after planting corn (May 14, 2019). Corn was planted using a 30 inches between-row spacing and four rows of alfalfa were interseeded between corn rows. The experiment was set up as a randomized complete block design with four replicates. Plots were 5 feet wide by 20 feet long (100 square feet). Treatments were the combinations of two alfalfa cultivars (3240 and 55H94), two application timings (early and late), and several agrichemical strategies (different combinations of Kudos + Priaxor + Warrior II). Untreated controls were also included for each alfalfa cultivar. Treatments application information are listed in Table 1 and a list with all treatments is listed in Table 2.

Table 1. Treatment's application information.

Date: July 3rd, 2019, 12 – 2pm	
Equipment: Single-nozzle boom calibrated to deliver 20 gallons per acre	
Nozzles: One (1) Flat Tip XR Teejet XR11005VS	
Boom PSI: 40 PSI	
Weather Station:	**KWIARLIN2**
Temperature:	82°F
Wind Speed and Direction:	4mph SE
Relative Humidity:	74%
Previous Rain Event Within 48 Hours:	07.02.19 – 0.41 inches
When ≥ 0.25 inches of precipitation occurred after treatment:	07.04.19 – 0.94 inches

Table 2. Treatment list with details.

Treatment Nº	Alfalfa variety	Kudos[1] (oz wt A^{-1})	Priaxor[2] (fl oz A^{-1})	Warrior II[3] (fl oz A^{-1})	Timing
1	3420	Untreated	Untreated	Untreated	Untreated
2	55H94	Untreated	Untreated	Untreated	Untreated
3	3420	0	4.0	0	Early
4	3420	8.0	0	0	Early
5	3420	8.0	4.0	0	Early
6	3420	16.0	0	0	Early
7	3420	16.0	4.0	0	Early
8	55H94	0	4.0	0	Early
9	55H94	8.0	0	0	Early
10	55H94	8.0	4.0	0	Early
11	55H94	16.0	0	0	Early
12	55H94	16.0	4.0	0	Early
13	3420	0	4.0	0	Late
14	3420	0	4.0	1.0	Late
15	3420	8.0	0	0	Late
16	3420	8.0	4.0	0	Late
17	3420	8.0	4.0	1.0	Late
18	3420	16.0	0	0	Late
19	3420	16.0	4.0	0	Late
20	3420	16.0	4.0	1.0	Late
21	3420	26.0	4.0	1.0	Late
22	55H94	0	4.0	0	Late
23	55H94	0	4.0	1.0	Late
24	55H94	8.0	0	0	Late
25	55H94	8.0	4.0	0	Late
26	55H94	8.0	4.0	1.0	Late
27	55H94	16.0	0	0	Late
28	55H94	16.0	4.0	0	Late
29	55H94	16.0	4.0	1.0	Late
30	55H94	26.0	4.0	1.0	Late

[1]prohexadione-calcium; [2]pyraclostrobin+fluxapyroxad; [3]lambda-cyhalothrin+benzisothiazolin

Statistical Analysis

Statistical analyses were performed using the open-source statistical software R 3.6.1 (R Core Team 2014). Mixed-effects models were fit to the data using the package "lme4" and function "lmer" in R. In addition, data was analyzed in two steps due to the unbalanced treatment's structure between early and late timing treatments. First, application timing (early vs. late), alfalfa cultivar, agrichemical strategy (combinations of Kudos + Priaxor) and their interaction were considered fixed effects. The second part of the analysis investigated only treatment's effects applied late in the season. The statistical model included Kudos rate, pest strategy (Kudos only, Kudos + Priaxor or Kudos + Priaxor + Warrior II), alfalfa cultivar and their interaction as fixed effects. Block was considered a random effect on both steps of the analyzes. Differences were declared when $P < 0.05$. Mean separation was based on Tukey's HSD test using the "*emmeans*" package and function in R. Data was square root transformed to satisfy the assumptions of analysis of variance, but nontransformed means were reported.

Results

Results from the first part of the statistical analysis detected a significant application timing x agrichemical strategy interaction ($p<0.001$); therefore, the effects of each agrichemical strategy were presented by application timing (Fig. 1-a). All agrichemical strategies applied at the early timing failed to enhance alfalfa's survival as none of them resulted in significantly greater alfalfa plant densities as compared to the control. Additionally, none of the early timing agrichemical strategies resulted in alfalfa plant densities above the marginal threshold (5.0 plants ft^{-2}). An overall increase in treatment's effectiveness was observed with the late timing application; however, most agrichemical strategies still resulted in low alfalfa stands (Fig. 1-a). The only exception was Kudos at 16 oz wt $acre^{-1}$ + Priaxor at 4.0 fl oz $acre^{-1}$ which resulted in optimal alfalfa plant density (above 10.0 plants ft^{-2}). Furthermore, a significant effect of alfalfa cultivar was also detected ($p<0.01$). Averaged across application timings and agrichemical strategies, cultivar 55H94 exhibited greater plant densities than the cultivar 3240 (2.1 vs 1.4 plats ft^{-2}) (Fig.1-b).

Results from the analysis focused on the late timing revealed a significant Kudos rate x pest strategy interaction ($p<0.001$); therefore, the effects of kudos rate (0, 8, 16 oz wt $acre^{-1}$ plus untreated) were presented by pest strategy (Kudos only, Kudos + Priaxor and Kudos + Priaxor + Warrior II) (Fig. 2-a). For Kudos only treatments, there were no benefits of increasing Kudos rates as all rates resulted in very low alfalfa plant densities (<1.0 plants ft^{-2}) and were not statistically different than the control. Alfalfa plant density increased as we increased Kudos rates when partnered with Priaxor at 4.0 fl oz $acre^{-1}$; however, only the highest rate of Kudos (16 oz wt $acre^{-1}$) resulted in optimal alfalfa stand (10.4 plants ft^{-2}). Finally, a significant effect of alfalfa cultivar was also detected ($p<0.01$). Averaged across application timings and agrichemical strategies, cultivar 55H94 exhibited greater plant densities than the cultivar 3240 (4.03 vs 3.1 plants ft^{-2}) (Fig.2-b).

Table 3. Alfalfa plant density mean and standard error (± SE) for each treatment.

Treatment Nº	Alfalfa variety	Kudos[1] (oz wt A^{-1})	Priaxor[2] (fl oz A^{-1})	Warrior II[3] (fl oz A^{-1})	Timing	Alfalfa stand (plants ft^{-2})
1	3420	Untreated	Untreated	Untreated	Untreated	0.0
2	55H94	Untreated	Untreated	Untreated	Untreated	0.4 (± 0.28)
3	3420	0	4.0	0	Early	0.2 (± 0.15)
4	3420	8.0	0	0	Early	0
5	3420	8.0	4.0	0	Early	0.2 (± 0.1)
6	3420	16.0	0	0	Early	0.1 (± 0.1)
7	3420	16.0	4.0	0	Early	0.8 (± 0.57)
8	55H94	0	4.0	0	Early	0.8 (± 0.43)
9	55H94	8.0	0	0	Early	1.3 (± 0.97)
10	55H94	8.0	4.0	0	Early	0.2 (± 0.19)
11	55H94	16.0	0	0	Early	1.2 (± 0.68)
12	55H94	16.0	4.0	0	Early	1.9 (± 1.11)
13	3420	0	4.0	0	Late	2.0 (± 0.57)
14	3420	0	4.0	1.0	Late	4.6 (± 1.47)
15	3420	8.0	0	0	Late	0.2 (± 0.15)
16	3420	8.0	4.0	0	Late	3.6 (± 1.08)
17	3420	8.0	4.0	1.0	Late	0.8 (± 0.61)
18	3420	16.0	0	0	Late	0.1 (± 0.1)
19	3420	16.0	4.0	0	Late	9.6 (± 1.07)
20	3420	16.0	4.0	1.0	Late	5.5 (± 0.62)
21	3420	26.0	4.0	1.0	Late	0.0 (± 0.5)
22	55H94	0	4.0	0	Late	2.5 (± 1.12)
23	55H94	0	4.0	1.0	Late	7.3 (± 1.85)
24	55H94	8.0	0	0	Late	1.5 (± 0.78)
25	55H94	8.0	4.0	0	Late	2.8 (± 1.02)
26	55H94	8.0	4.0	1.0	Late	1.6 (± 0.34)
27	55H94	16.0	0	0	Late	0.7 (± 0.52)
28	55H94	16.0	4.0	0	Late	11.2 (± 0.9)
29	55H94	16.0	4.0	1.0	Late	9.5 (± 1.23)
30	55H94	26.0	4.0	1.0	Late	1.5 (± 0.83)

[1]prohexadione-calcium; [2]pyraclostrobin+fluxapyroxad; [3]lambda-cyhalothrin+benzisothiazolin

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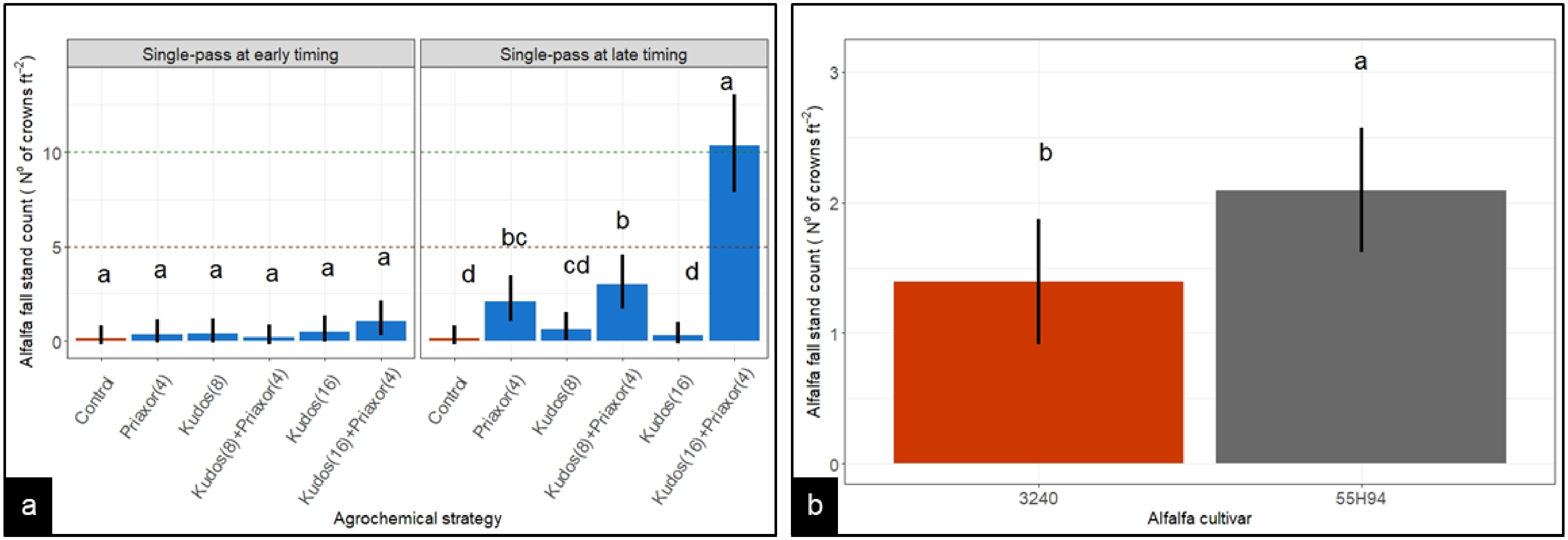

Figure 1. a) Fall stand density of alfalfa interseeded into silage corn in response to agrichemical strategies applied early and late in the season using a single-pass application program. Data are averaged across alfalfa varieties and means with unlike letters differ based on Tukey's HSD test (P<0.05). **b)** Fall stand density of alfalfa interseeded into silage corn in response to alfalfa cultivar. Data are averaged across agrichemical strategies and application timing. Means with unlike letters differ based on Tukey's HSD test (P<0.05).

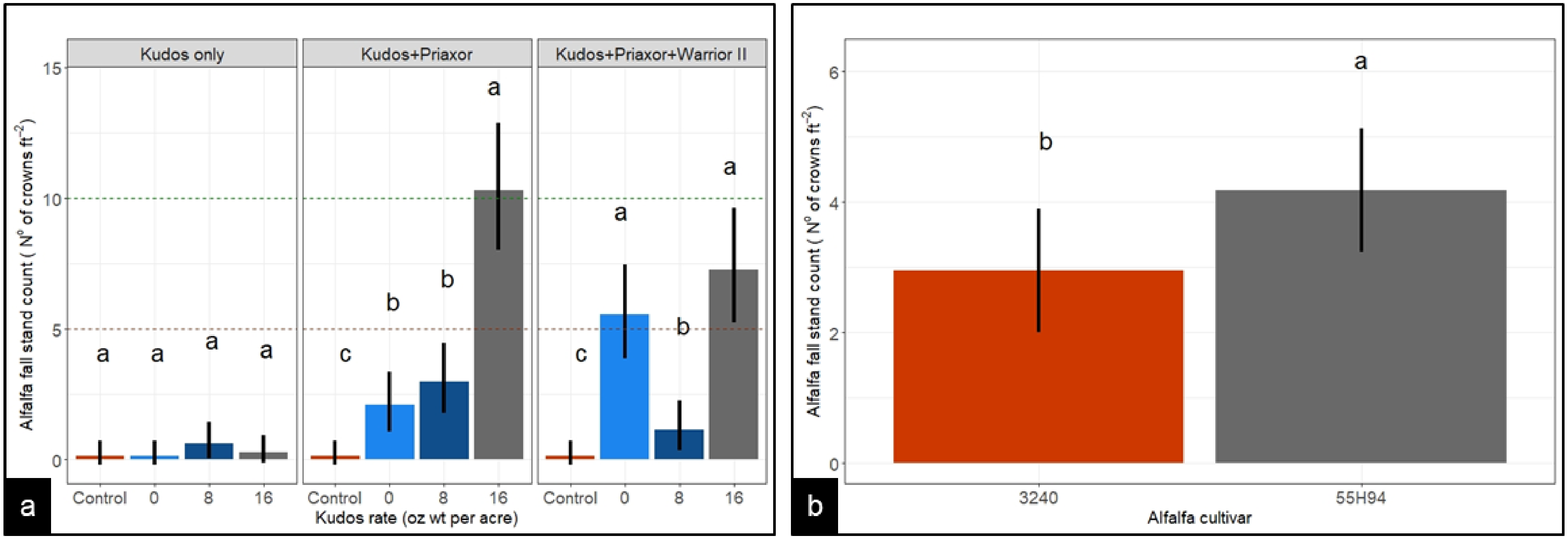

Figure 2. a) Fall stand density of alfalfa interseeded into silage corn in response to Kudos rates and pest strategy (Kudos only, Kudos + Priaxor (4.0 fl oz acre^{-1}) or Kudos + Priaxor (4.0 fl oz acre^{-1}) + Warrior II (1.0 fl oz acre^{-1}) applied late in the season using a single-pass application program. Data are averaged across alfalfa varieties and means with unlike letters differ based on Tukey's HSD test ($P<0.05$). **b)** Fall stand density of alfalfa interseeded into silage corn in response to alfalfa cultivar. Data are averaged across Kudos rates and pest strategy. Means with unlike letters differ based on Tukey's HSD test ($P<0.05$).

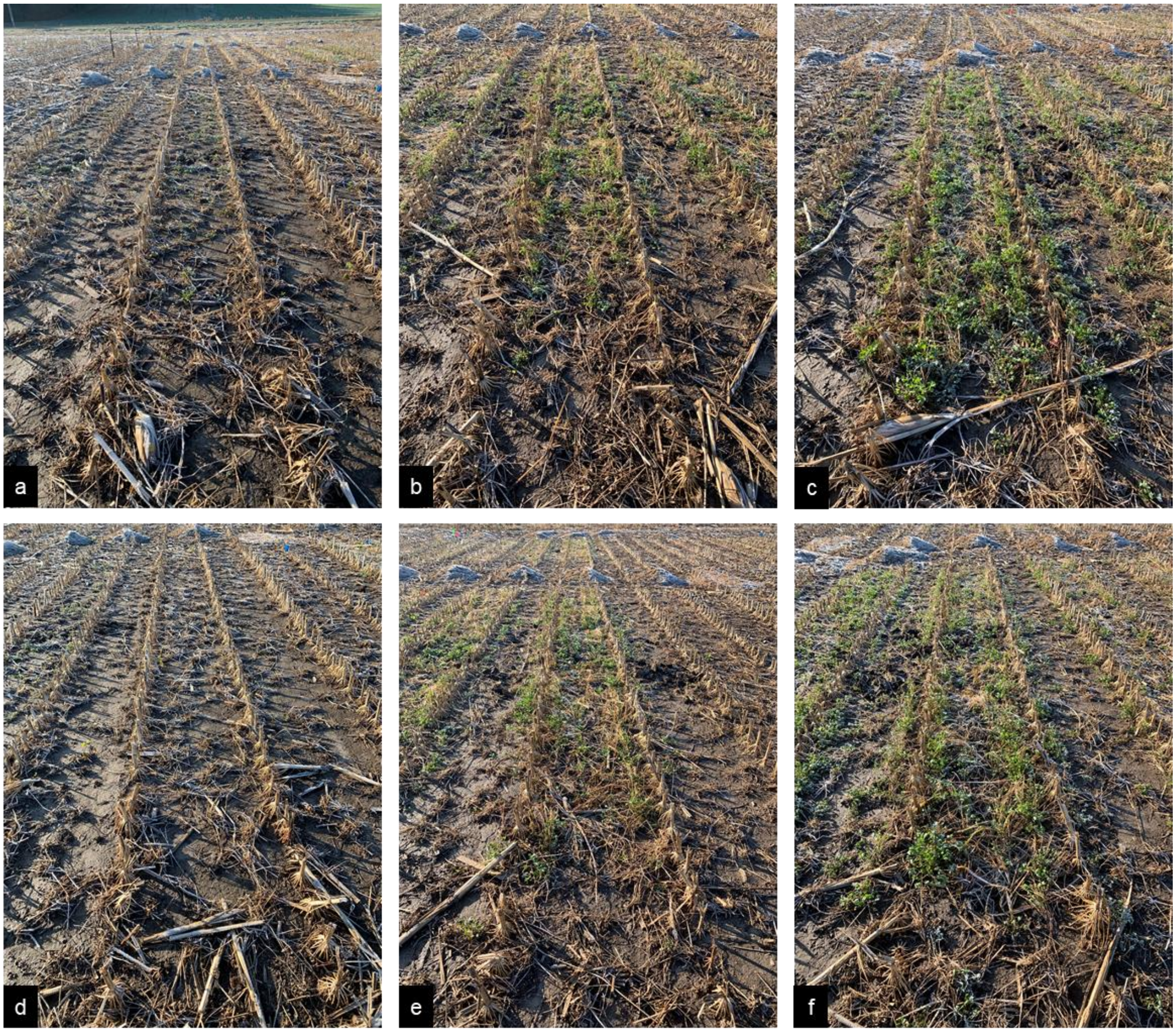

Figure 3. Cultivar 3240 (a-c): a) Early timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A); **b)** Late timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A); **c)** Late timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A) + Warrior II (1.0 fl oz/A). **Cultivar 55H94 (d-f): d)** Early timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A); **e)** Late timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A); **f)** Late timing Kudos (16 oz wt/A) + Priaxor (4.0 fl oz/A) + Warrior II (1.0 fl oz/A).