

Final Report:
Field efficacy testing of off-patent fungicide products for turf diseases.

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Introduction and Objective

Three active ingredients chlorothalonil, iprodione and propiconazole are frequently used to control both brown patch and dollar spot as well as other turf diseases and are no longer patent protected. Therefore, many generic versions of chlorothalonil, iprodione and propiconazole have been introduced to the turfgrass fungicide market. Some of these products contain different formulations, but have the same active ingredients. Pricing varies among those products; however, questions remain regarding the efficacy of these different products in the field. Our central objective was to conduct a comprehensive field efficacy test of generic products containing three active ingredients: the contact fungicide chlorothalonil, and site-specific fungicides iprodione and propiconazole for dollar spot control on fairways at the Joseph Troll Research Facility and Hickory Ridge Country Club, MA for two years (2011 and 2012). In addition, the efficacy of the three fungicide classes was compared within each site to determine the effect of fungicide sensitivity.

Materials and Methods

Field efficacy testing was conducted at the Joseph Troll Turf Research Center (South Deerfield, MA) and Hickory Ridge Golf Club (Hadley, MA). The Joseph Troll Turf Research Center (JTRF) contains a dollar spot population that is sensitive to all active ingredients, whereas the population at Hickory Ridge Golf Club (HRGC) is resistant to benzimidazole (thiophanate-methyl) and insensitive to DMI class fungicides (metconazole, myclobutanil, propiconazole, triadimefon, triticonazole, tebuconazole).

Trials at both locations were conducted on creeping bentgrass/annual bluegrass mixed stands mowed three times per week at fairway height (~ 0.5 inches) for two years, 2011 and 2012. Irrigation was applied as needed to prevent drought stress. Fertilizer was applied as 23-0-20 (0.75 lb N/1,000 ft²) on 26 July 2011 at HRGC. Fertilizer was applied later than expected due to excessive rainfall in May and June, which caused soils to be excessively saturated. Fertilizer was applied as 23-0-20 (0.75 lb N/1,000 ft²) on 8 June 2012 at HRGC. Fertilizer at JTRF was applied as 28-3-10 (1lb N/1,000 ft²) on 13 May 2011. Fertilizer at JTRF was applied as 17-0-17 (1lb N/1,000 ft²) on 17 July 2012. Individual plots measure 3x6 ft (18 ft²) and were separated by a one foot buffer strip on all four sides. Plots were arranged in a randomized complete block design with four replications. Treatments are listed in Table 1 and were applied in the equivalent of 2 gallons of water per 1,000 ft². Treatments containing chlorothalonil were applied on a 14-day application interval. Treatments containing iprodione and propiconazole were applied on a 21-day application interval. Fungicide treatments were applied at a nozzle pressure of 40 psi using a CO₂ pressurized boom sprayer equipped with two XR Teejet 8004VS flat fan nozzles.

Dollar spot severity was visually rated by counting number of dollar spot infection centers once per week. To summarize disease severity over time, the area under the disease

progress curve (AUDPC) was calculated for the number of infection centers at each location using the following formula $\sum[(y_i + y_{i+1})/2](t_{i+1} - t_i)$, where $i = 1, 2, 3, \dots, n-1$ and y_i is the amount of disease (number of infection centers) at the time t_i (days) of the i^{th} rating. AUDPC values were converted into relative control (RC%) percentage with the following formula: [(untreated – fungicide treated)/untreated] x 100 = RC%. Brown patch was not observed during the course of the trial in both 2011 and 2012. All dollar spot assessments, turf quality ratings and RC% were subject to an analysis of variance and means were separated using Fisher's LSD test ($P < 0.05$). Within each location, three active ingredients were analyzed to determine if overall efficacy differed. Formulations within each active ingredient were also compared to determine if control differences existed among formulations. Formulations containing 82.5% chlorothalonil (Ultrax-like versions) were analyzed separately from formulations containing 54% chlorothalonil (Weatherstik-like versions). Relative Control % data were presented on the results because this provides the most concise manner of summarizing results of the study. Individual dollar spot infection center counts for each fungicide formulation at both locations (both years) are shown in the Appendix.

Results and Discussion

Hickory Ridge Golf Club

2011

Dollar spot was first observed on the 25 May, however, due to multiple rain events; initial fungicide applications were not made until 28 May 2011. Untreated plots averaged 15 dollar spot infection centers on 28 May and disease severity was considered moderate within the experimental plot. Due to excessive rain during the in May and June, soil saturation was frequently high and fertilizer application was delayed. These conditions reduced turfgrass growth and led to slow recovery from dollar spot damage. Overall, iprodione provided a significantly higher amount of control than both chlorothalonil formulations and propiconazole (Figure 1). This was somewhat expected since DMI resistance is present at HRGC. Within the same active ingredient, no significant differences in efficacy were detected among formulations of chlorothalonil, iprodione and propiconazole (Table 1). Although some large numerical differences were observed at HRGC, variability among replications within each treatment played a role in the lack of statistical significance among treatments with the four active ingredient categories.

2012

Dollar spot was first observed on the 24 May. Untreated plots averaged 33 dollar spot infection centers on 31 May 2012 (7 days after the first fungicide application) and disease severity was considered moderate within the experimental plot. Overall, iprodione provided a significantly higher amount of control than both chlorothalonil formulations and propiconazole in 2012 (Figure 1). Overall, dollar spot control was also better 2012 over 2011. Improved season long control is likely correlated to earlier fertilization at HRGC, which provided quicker recovery from infection centers that were present during the first application. We also experienced more favorable growing conditions (reduced soil saturation) in 2012 compared to 2011. Additional analysis of fungicide formulations within active ingredient only yielded one statistical difference. On 4 Sept 2012, a significantly higher number of dollar spot infection centers were observed on plots treated with Raven. It should be noted that Raven contained 5.3 infection centers and all other iprodione formulations contained less than 2.0 infection

centers.

Joseph Troll Turf Research Center
2011

Dollar spot was first observed on the 27 May. However, due to multiple rain events, the initial fungicide applications were not made until 1 June. Untreated plots averaged 18 infection centers of dollar spot on 1 June and disease severity was considered moderate within the experimental plot. Overall, turfgrass recovery was quicker at JTRF. Overall, propiconazole provided a significantly higher control than both chlorothalonil formulations and iprodione (Figure 2). Moreover, chlorothalonil (82.5% a.i., Ultrex version) provided significantly higher control than the chlorothalonil (54% a.i., Weatherstik version) and iprodione (Figure 2). Among fungicide formulations, significant differences were detected for chlorothalonil (54% a.i., Ultrex-like version) and iprodione. Chlorothalonil 720 performed significantly worse than all other chlorothalonil (54% a.i.) formulations (Table 3 and Figure 3). Raven performed significantly worse than all other iprodione formulations (Table 2 and Figure 4).

2012

Dollar spot was first observed 5 June and initial applications were made on 6 June. Dollar spot infestation was minimal and favorable conditions subsided after application. Significant differences between fungicide treatments and the untreated were not apparent until 26 June. Overall, propiconazole provided significantly better season long control than chlorothalonil (Figure 2). Chlorothalonil provided significantly better season long control than iprodione (Figure 2). On two rating dates (both 21 days after application), significant dollar spot (25-75 infection centers) was observed in all iprodione formulations. Both rating dates significantly influenced season long control for iprodione, on all other rating dates, control was very good for iprodione formulations (less than 10 infection centers). In contrast to 2011, no differences were observed among fungicide formulations within each active ingredient (Table 2).

Summary

Results show that fungicide sensitivity of the *S. homoeocarpa* population plays a significant role in determining the effectiveness of a given active ingredient. Iprodione was among the most effective active ingredient at HRGC and was one of the least effective at JTRF in both years of the study. Significant differences among fungicide formulations were only observed at JTRF for two active ingredients (chlorothalonil 54% a.i. and iprodione) in 2011 and on one rating date (iprodione) at HRGC in 2012. We did receive a different supply of Raven for the 2012 trial and better control was observed in the 2012 trial. Results indicate that minor differences exist among off-patent fungicides for control of dollar spot.

Figure 1. Relative control % of the three different active ingredients tested at HRGC in 2011 and 2012.

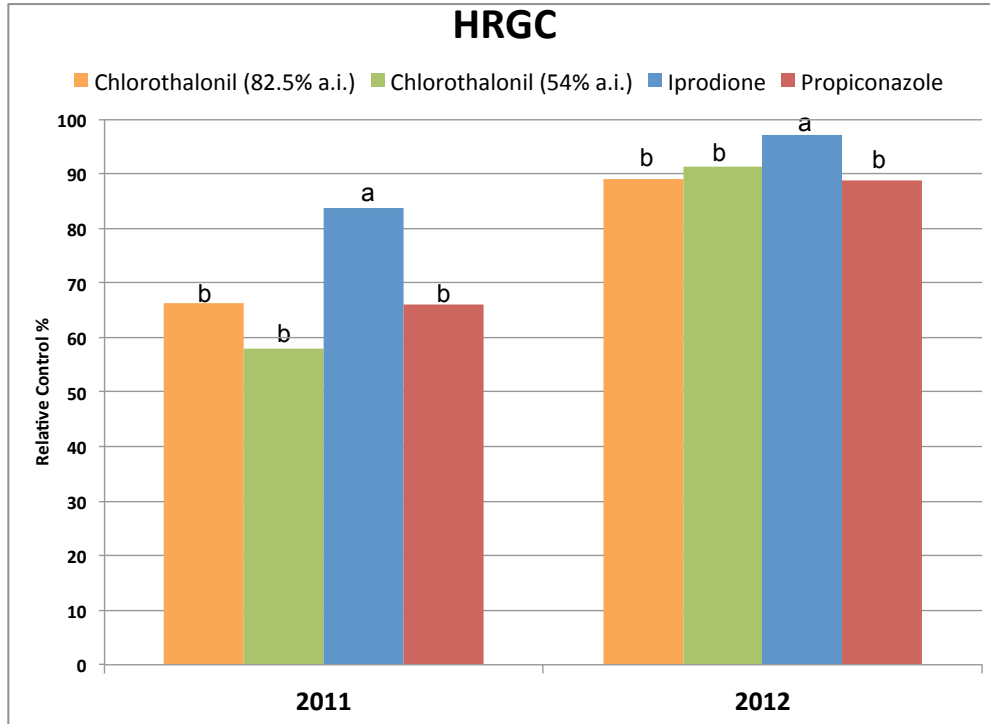


Figure 2. Relative control % of the three different active ingredients tested at JTRF in 2011 and 2012.

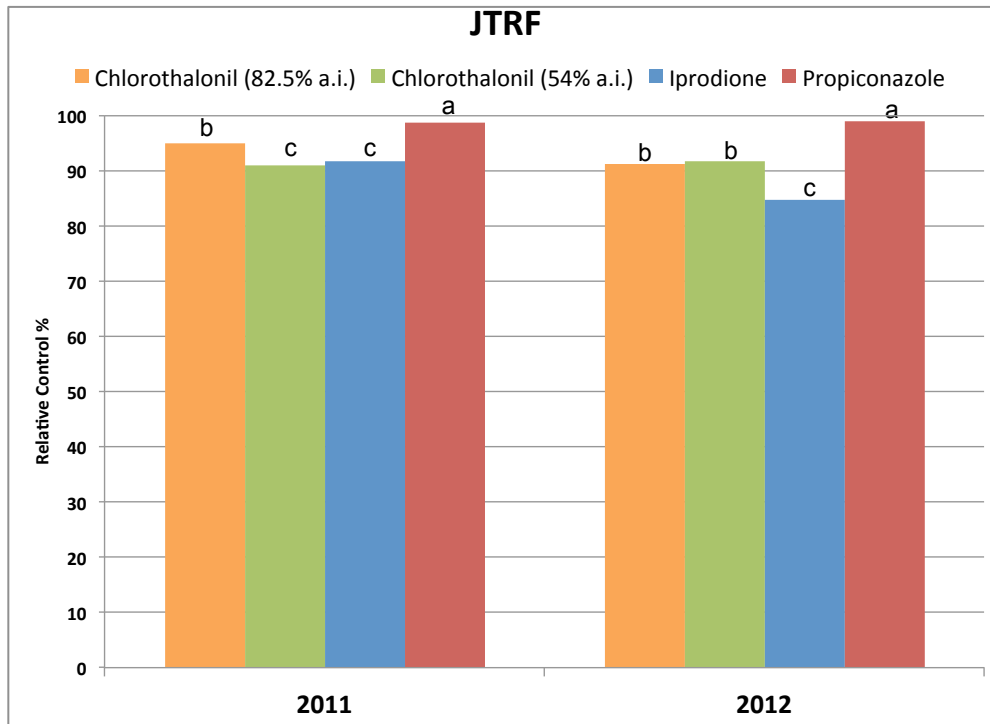


Figure 3. Mean Separation for dollar spot infection centers at JTRF, 2011.

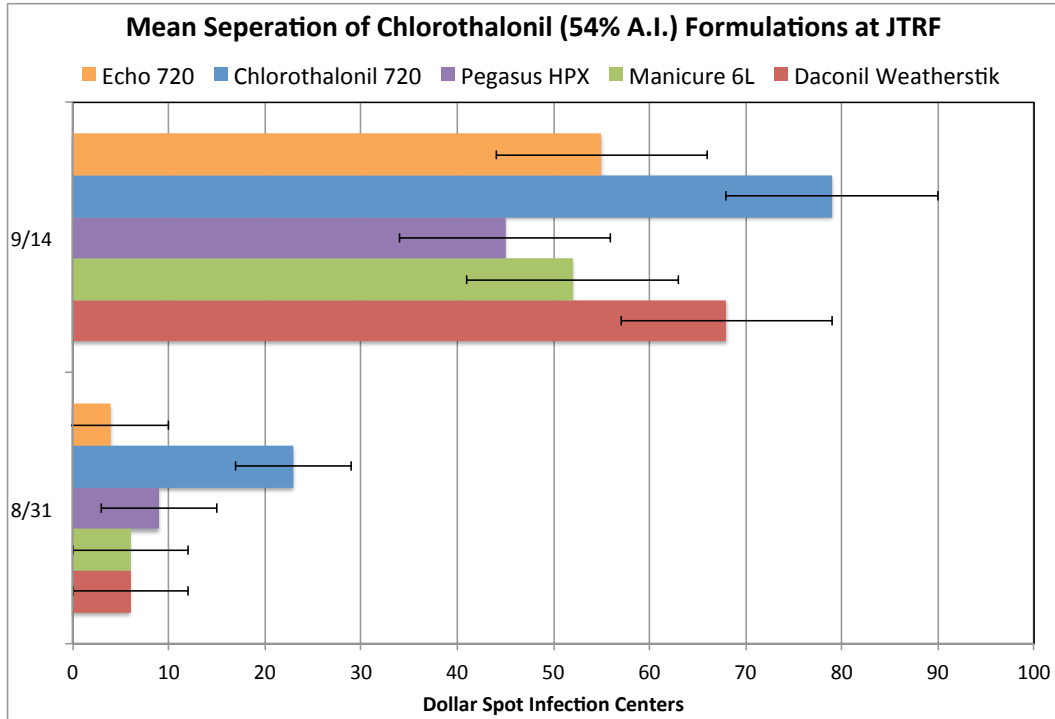


Figure 4. Mean Separation for dollar spot infection centers at JTRF, 2011.

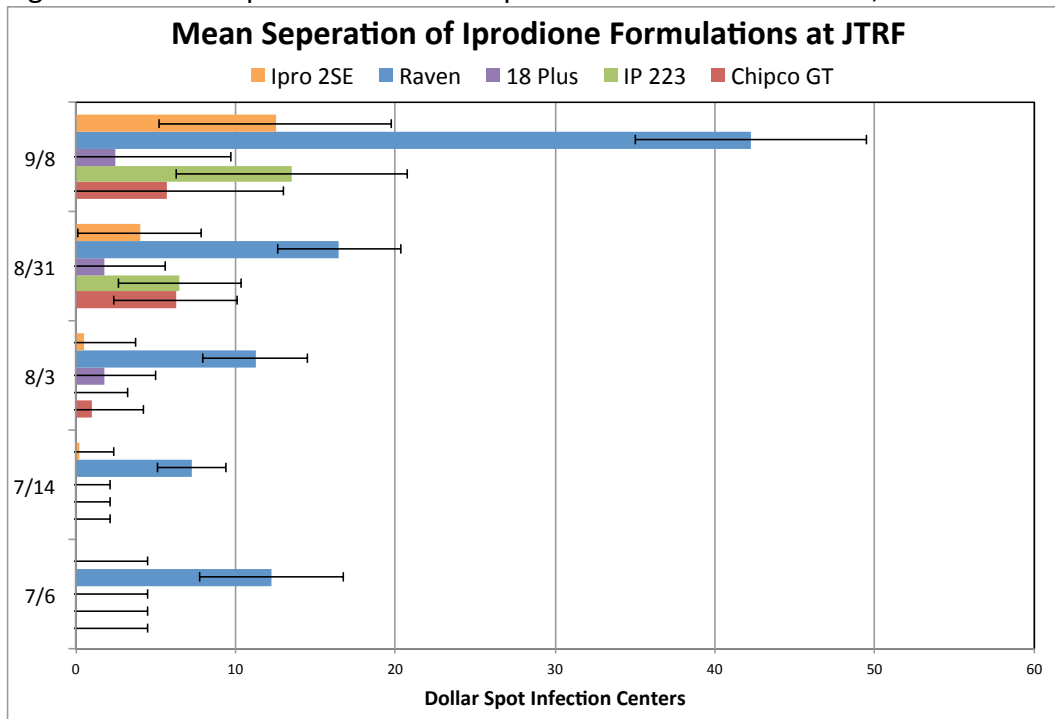


Table 1. Dollar spot relative control % of active ingredients and formulations at HRGC in 2011 and 2012.

Active ingredients Formulations	Company	Interval	Rate ¹	Relative % control of dollar spot	
				2011	2012
Chlorothalonil/82.5% A.I.					
Daconil Ultrex	Syngenta	14 day	3.0	69.8 ²	86.7
CLT 825	Armor Tech	14 day	3.0	54.4	88.1
Manicure Ultra	LESCO	14 day	3.0	70.8	90.7
Pegasus DFX	Phoenix	14 day	3.0	54.7	88.9
Echo Ultimate	SipcamAdvan	14 day	3.0	65.7	87.1
Chloro DF	Quali-Pro	14 day	3.0	82.1	90.1
Treatment <i>P</i> value				0.406	0.9536
Chlorothalonil/54% A.I.					
Daconil Weatherstik	Syngenta	14 day	3.0	43.5	89.2
Manicure 6L	LESCO	14 day	3.0	63.9	93.4
Pegasus HPX	Phoenix	14 day	3.0	65.8	87.1
Chlorothalonil 720	Quali-Pro	14 day	3.0	55.5	90.3
Echo 720	SipcamAdvan	14 day	3.0	61.1	92.3
Treatment <i>P</i> value				0.3540	0.6334
Iprodione					
Chipco GT	Bayer	21 day	4.0	85.4	96.1
IP 223	Armor Tech	21 day	4.0	83.4	96.5
18 Plus	LESCO	21 day	4.0	90.0	96.7
Raven	Phoenix	21 day	4.0	79.3	95.0
Ipro 2SE	Quali-Pro	21 day	4.0	80.3	97.0
Treatment <i>P</i> value				0.3252	0.8535
Propiconazole					
Banner MAXX	Syngenta	21 day	1.0	56.2	88.1
PPZ 143	Armor Tech	21 day	1.0	67.5	87.5
Spectator (38 % A.I.)	LESCO	21 day	0.4	72.7	90.3
Spectator Ultra 1.3	LESCO	21 day	1.0	69.8	81.3
Kestrel	Phoenix	21 day	1.0	62.8	93.5
Propiconazole 14.3	Quali-Pro	21 day	1.0	69.8	89.5
Propensity	SipcamAdvan	21 day	1.0	63.3	91.5
Treatment <i>P</i> value				0.9108	0.3618

¹ Rates are listed as oz/1,000 ft².

² Relative control % is reported as a mean of 4 replications.

Table 2. Dollar spot relative control % of active ingredients and formulations at JTRF in 2011 and 2012.

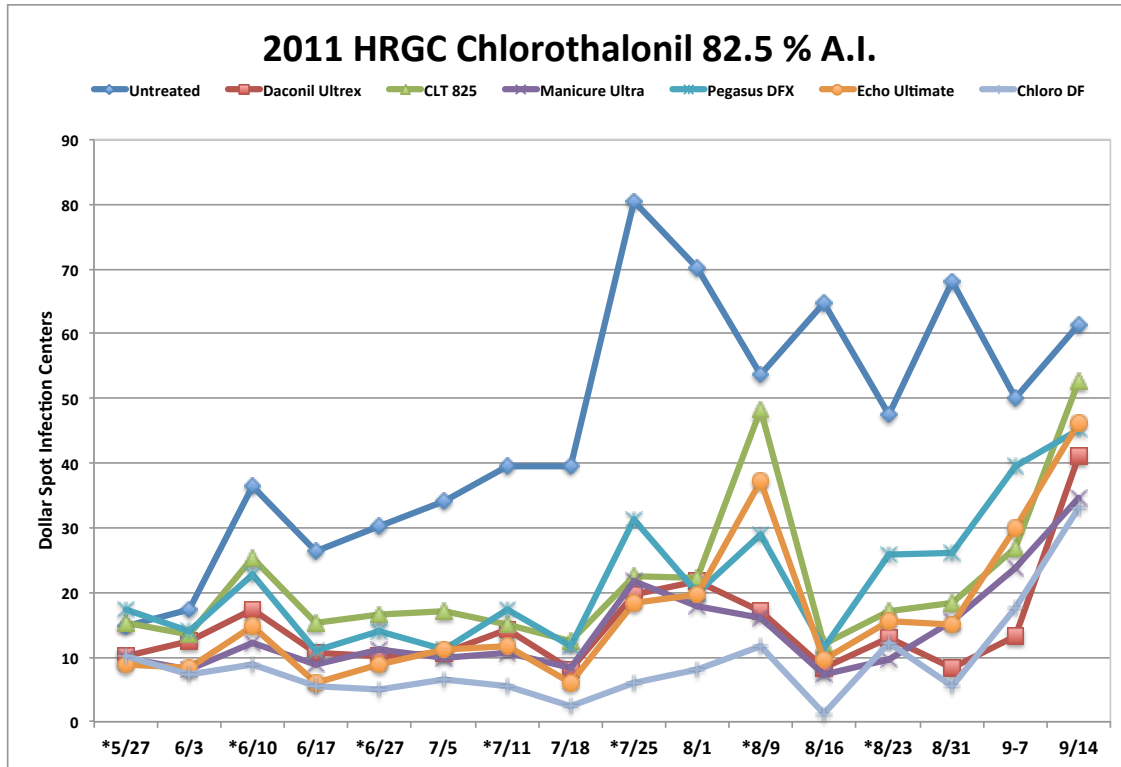
Treatment	Company	Interval	Rate ¹	Relative % control of dollar spot	
				2011	2012
Chlorothalonil/82.5% A.I.					
Daconil Ultrex	Syngenta	14 day	3.0	95.8 ²	95.2
CLT 825	Armor Tech	14 day	3.0	93.8	89.7
Manicure Ultra	LESCO	14 day	3.0	96.2	92.9
Pegasus DFX	Phoenix	14 day	3.0	93.4	86.8
Echo Ultimate	Simcam Agro	14 day	3.0	94.8	88.9
Chloro DF	Quali-Pro	14 day	3.0	95.3	93.1
Treatment <i>P</i> value				0.5108	0.0790
Chlorothalonil/54% A.I.					
Daconil Weatherstik	Syngenta	14 day	3.0	90.7 a ³	92.7
Manicure 6L	LESCO	14 day	3.0	92.2 a	94.9
Pegasus HPX	Phoenix	14 day	3.0	92.9 a	91.3
Chlorothalonil 720	Quali-Pro	14 day	3.0	86.0 b	90.9
Echo 720	Simcam Agro	14 day	3.0	92.9 a	88.1
Treatment <i>P</i> value				0.0210	0.5375
Iprodione					
Chipco GT	Bayer	21 day	4.0	94.5 a	85.8
IP 223	Armor Tech	21 day	4.0	91.6 a	89.3
18 Plus	LESCO	21 day	4.0	96.0 a	81.2
Raven	Phoenix	21 day	4.0	83.3 b	85.5
Ipro 2SE	Quali-Pro	21 day	4.0	93.0 a	81.3
Treatment <i>P</i> value				0.0019	0.1779
Propiconazole					
Banner MAXX	Syngenta	21 day	1.0	99.5	98.1
PPZ 143	Armor Tech	21 day	1.0	98.1	99.0
Spectator (38 % A.I.)	LESCO	21 day	0.4	99.3	99.9
Spectator Ultra 1.3	LESCO	21 day	1.0	98.3	99.6
Kestrel	Phoenix	21 day	1.0	98.4	98.2
Propiconazole 14.3	Quali-Pro	21 day	1.0	98.3	98.5
Propensity	Simcam Agro	21 day	1.0	98.2	98.1
Treatment <i>P</i> value				0.4310	0.0885

¹ Rates are listed as oz/1,000 ft².

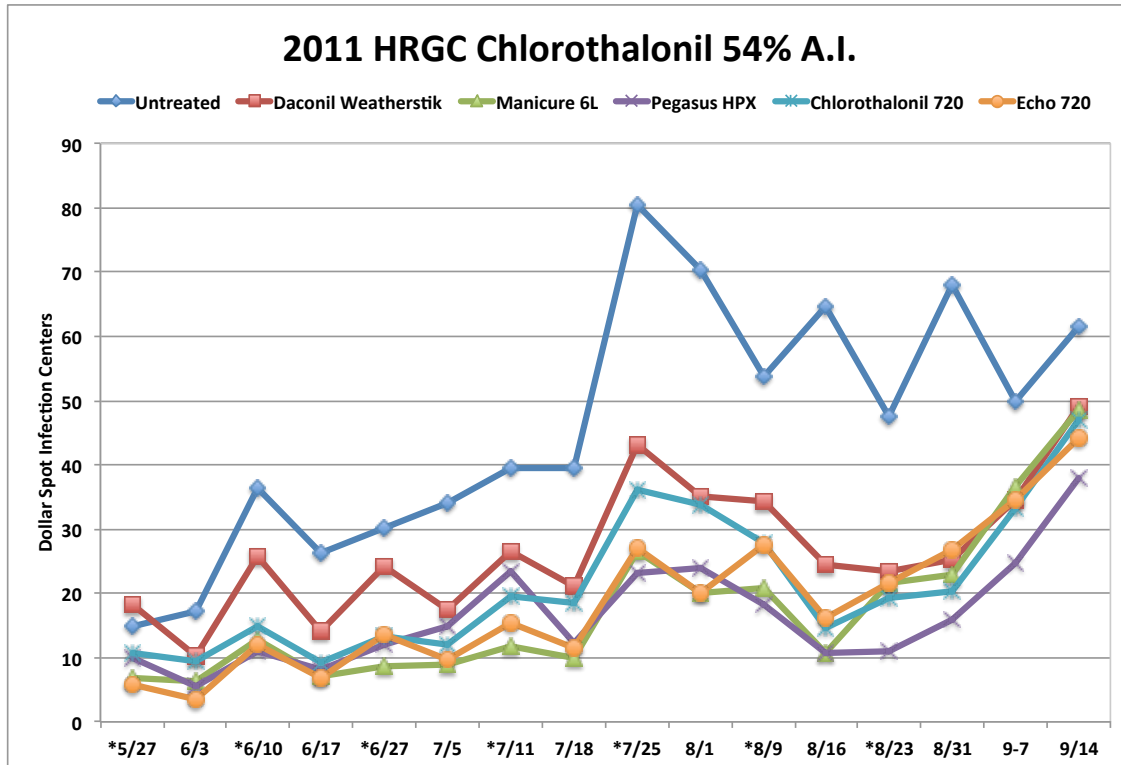
² Relative control % is reported as a mean of 4 replications.

³ Means followed by the same letter are not significantly different according to Fisher's Protected LSD.

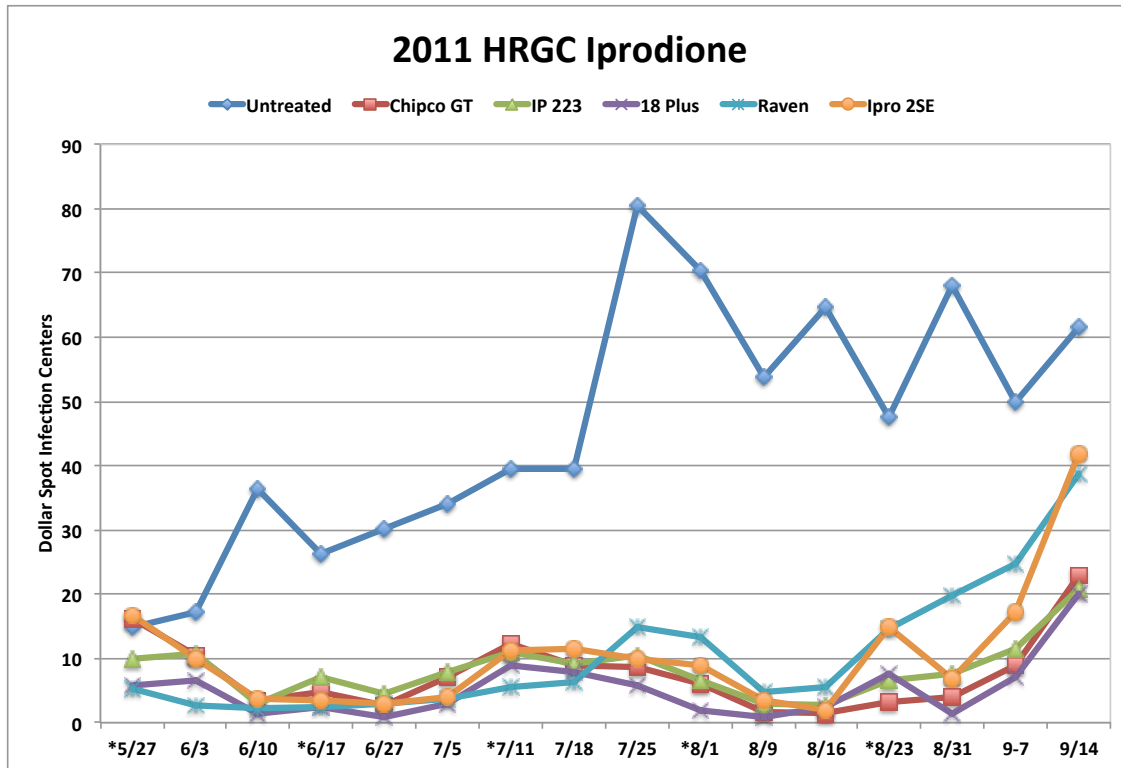
Appendix



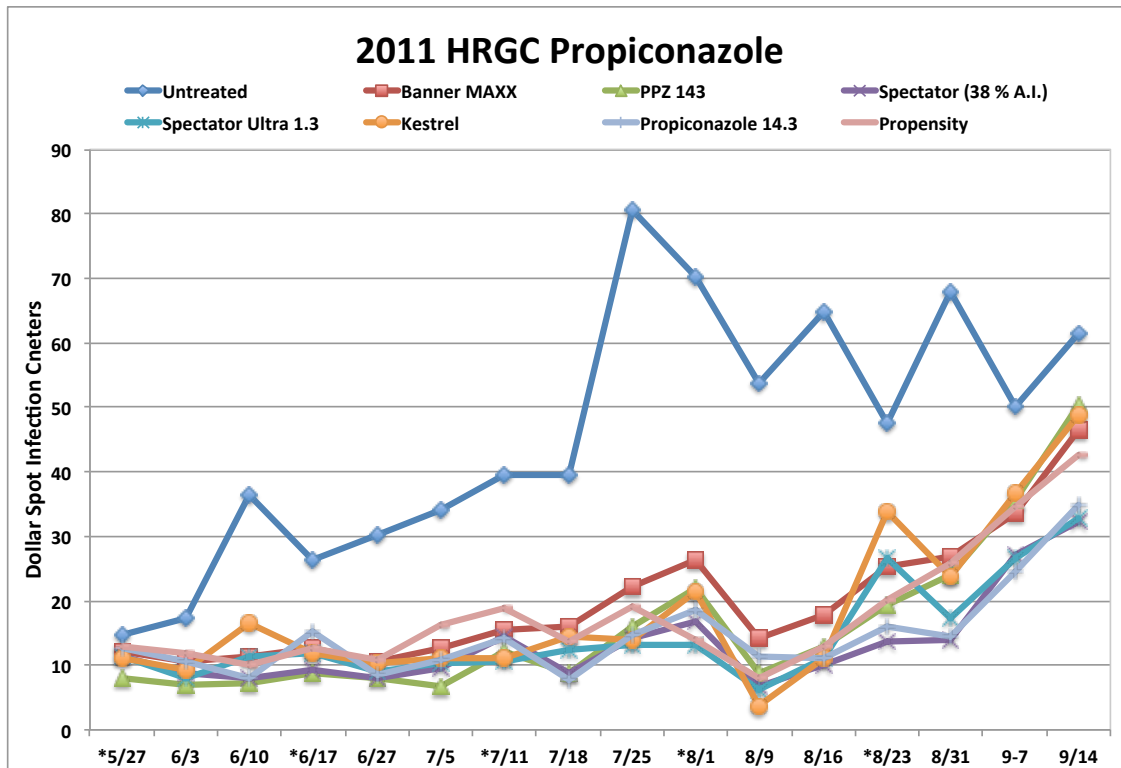
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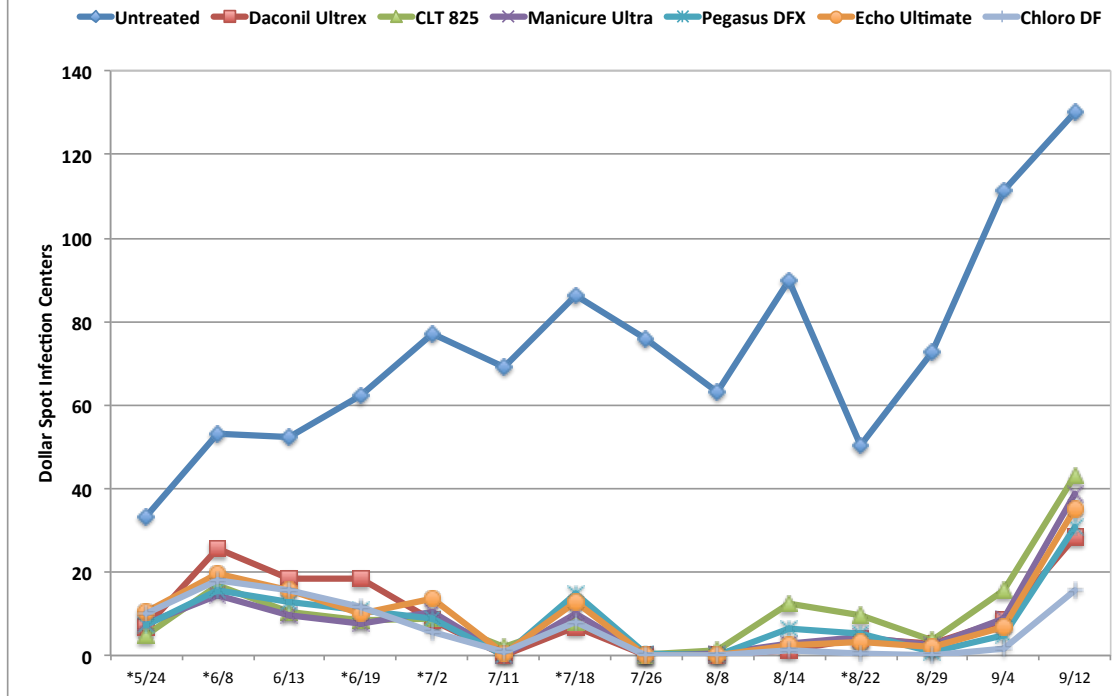


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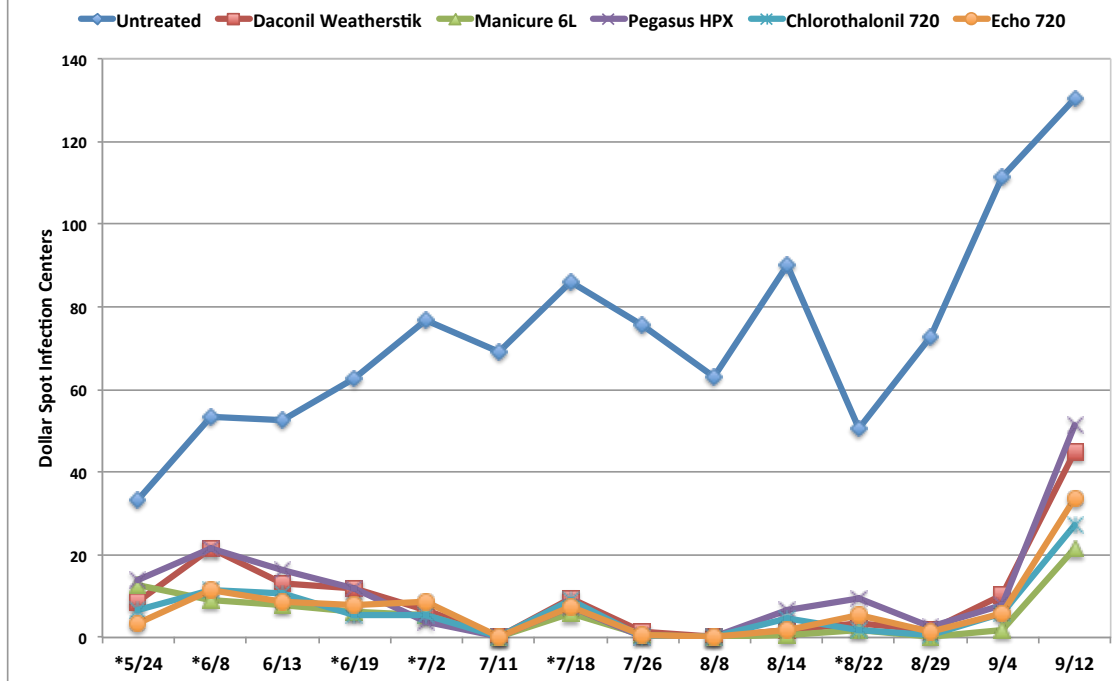
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2012 HRGC Chlorothalonil 82.5% A.I.

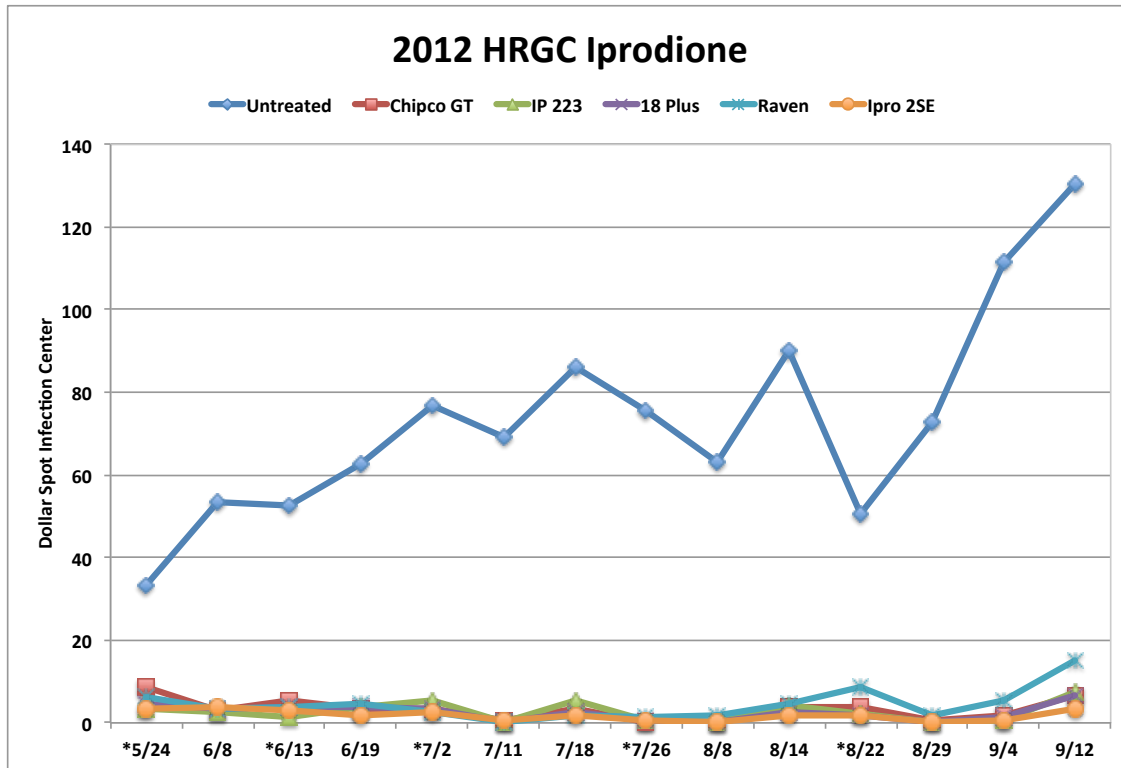


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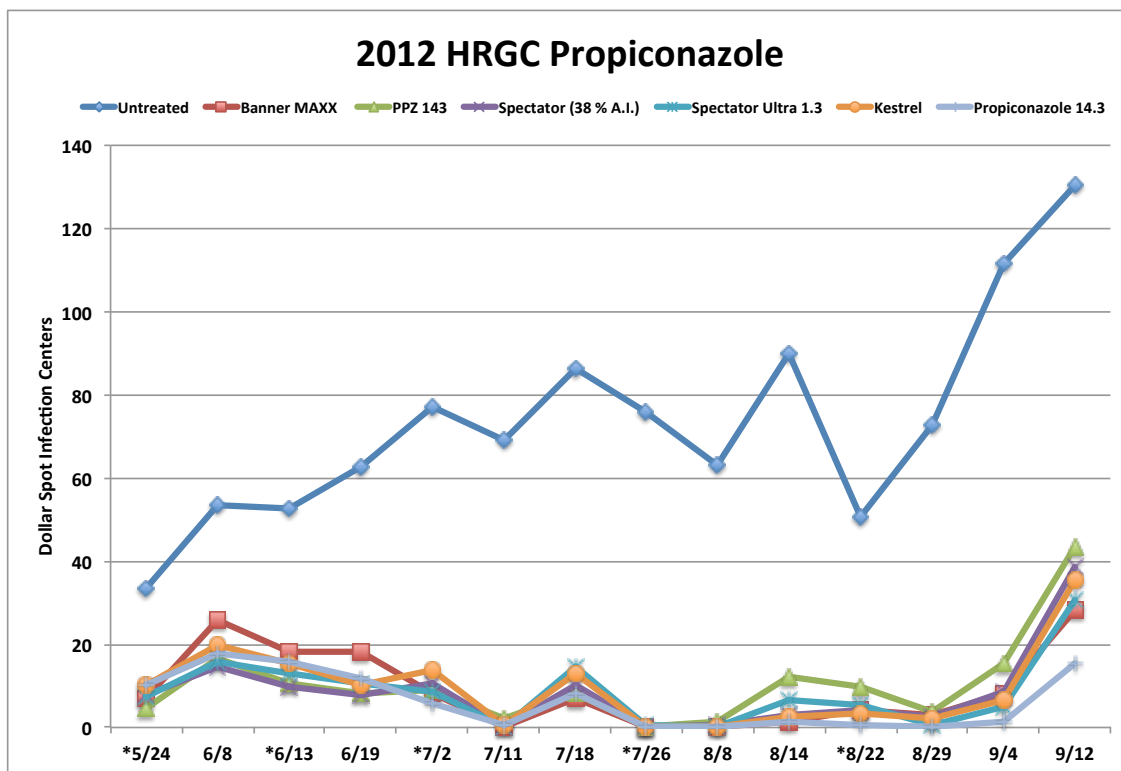
2012 HRGC Chlorothalonil 54 % A.I.



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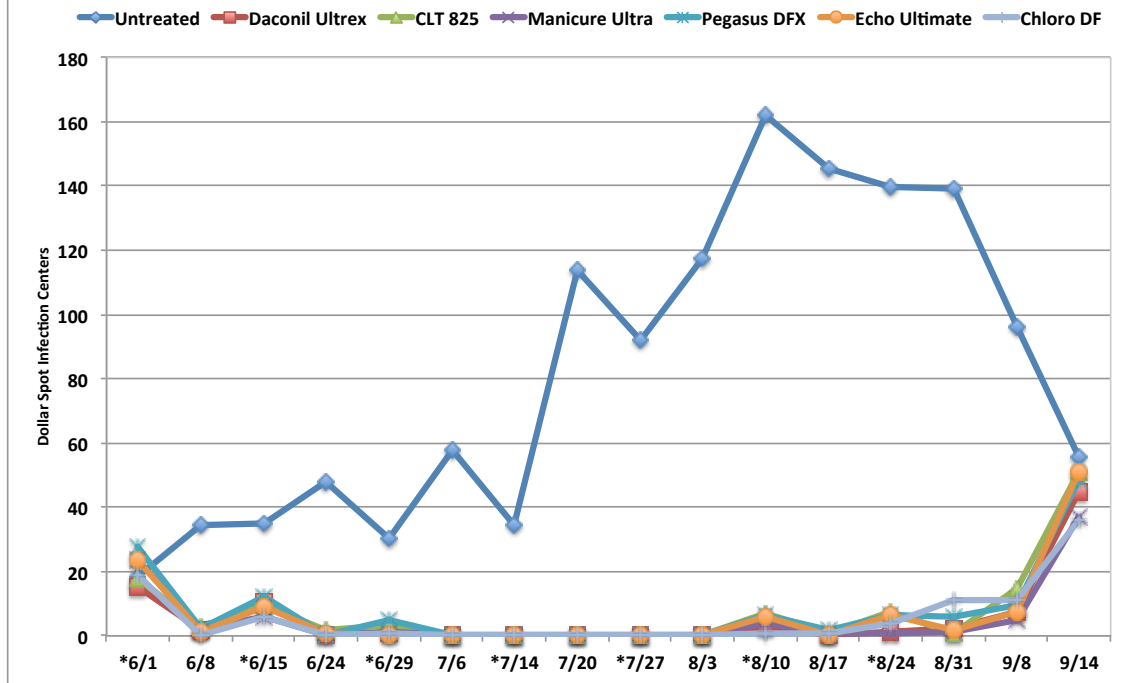


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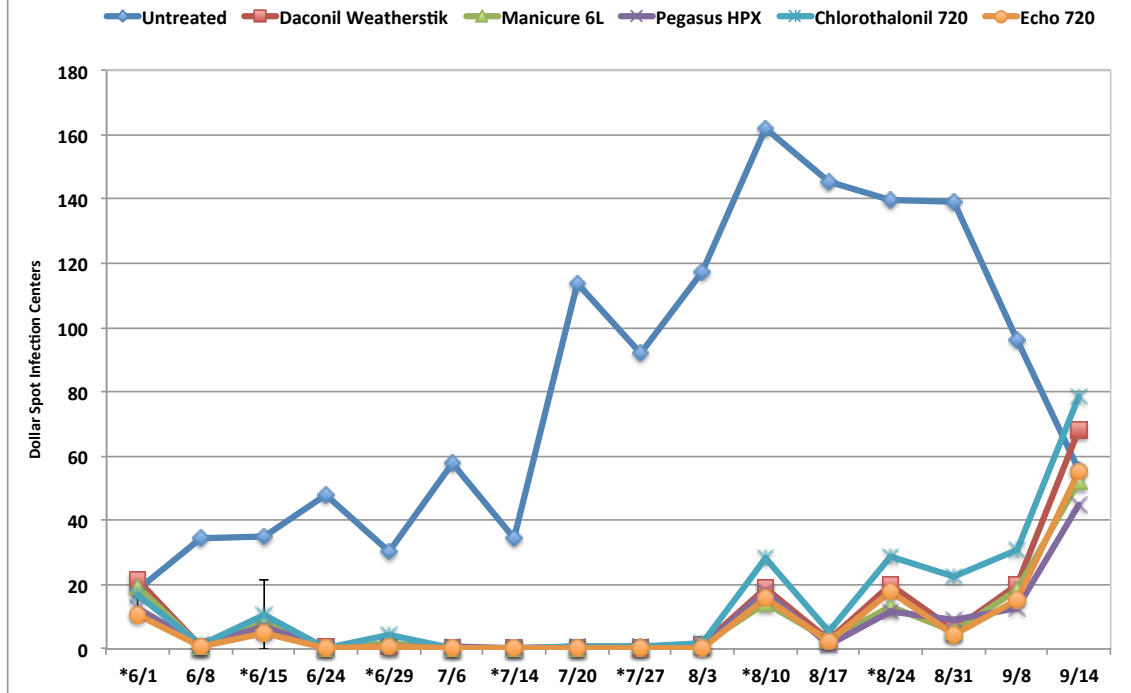
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JTRF 2011 Chlorothalonil 82.5% A.I.

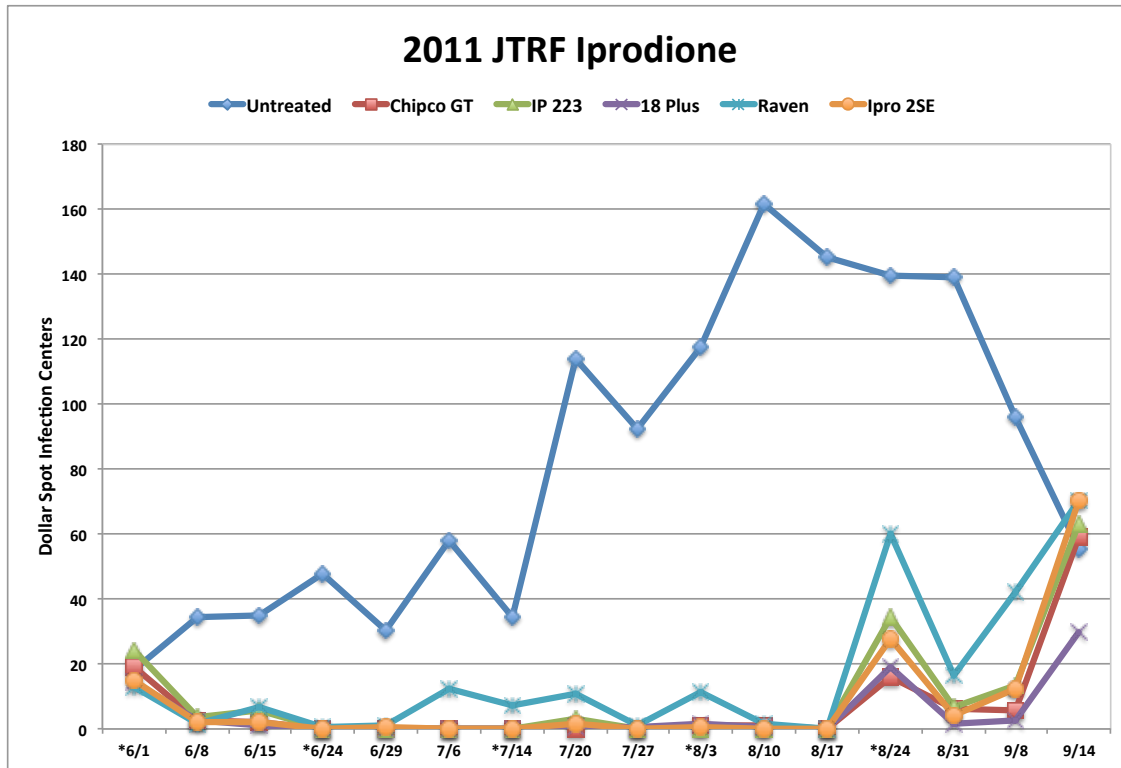


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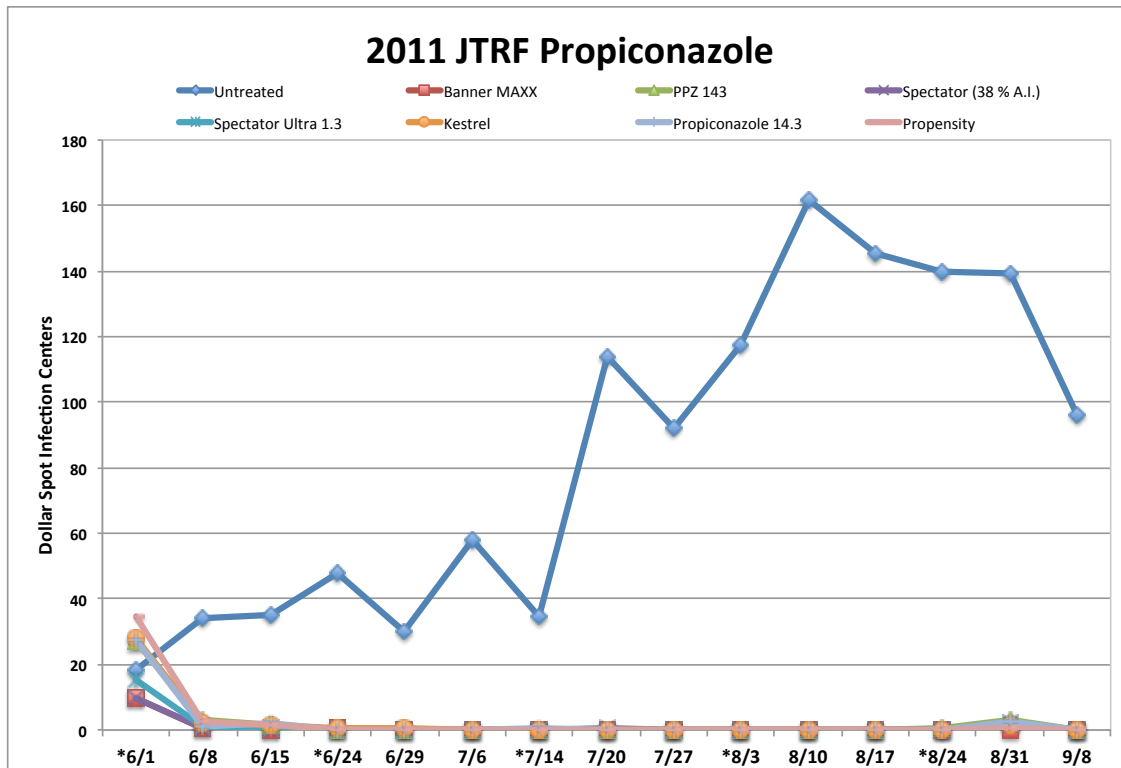
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* = application date.

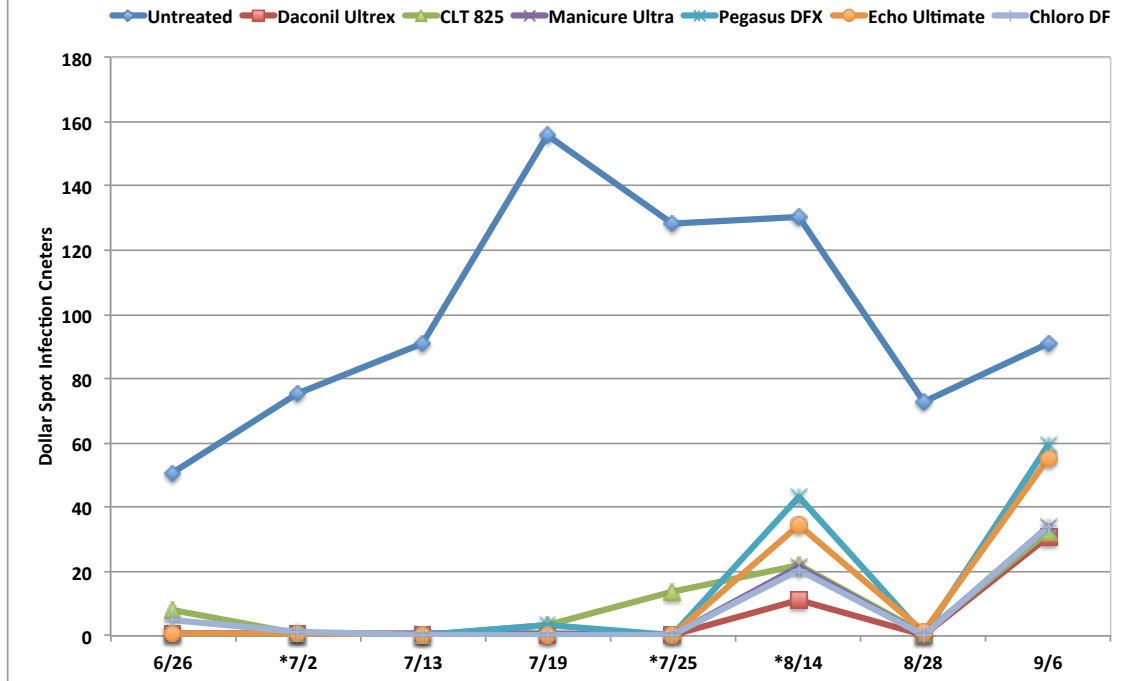


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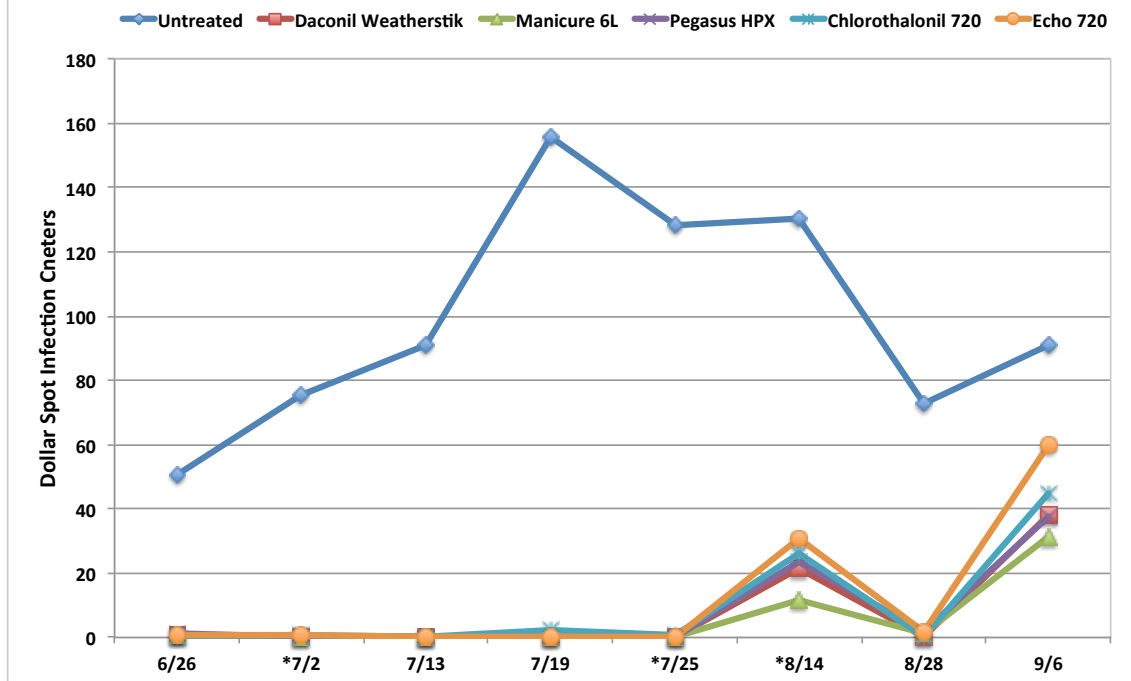
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2012 JTRF Chlorothalonil 82.5% A.I.

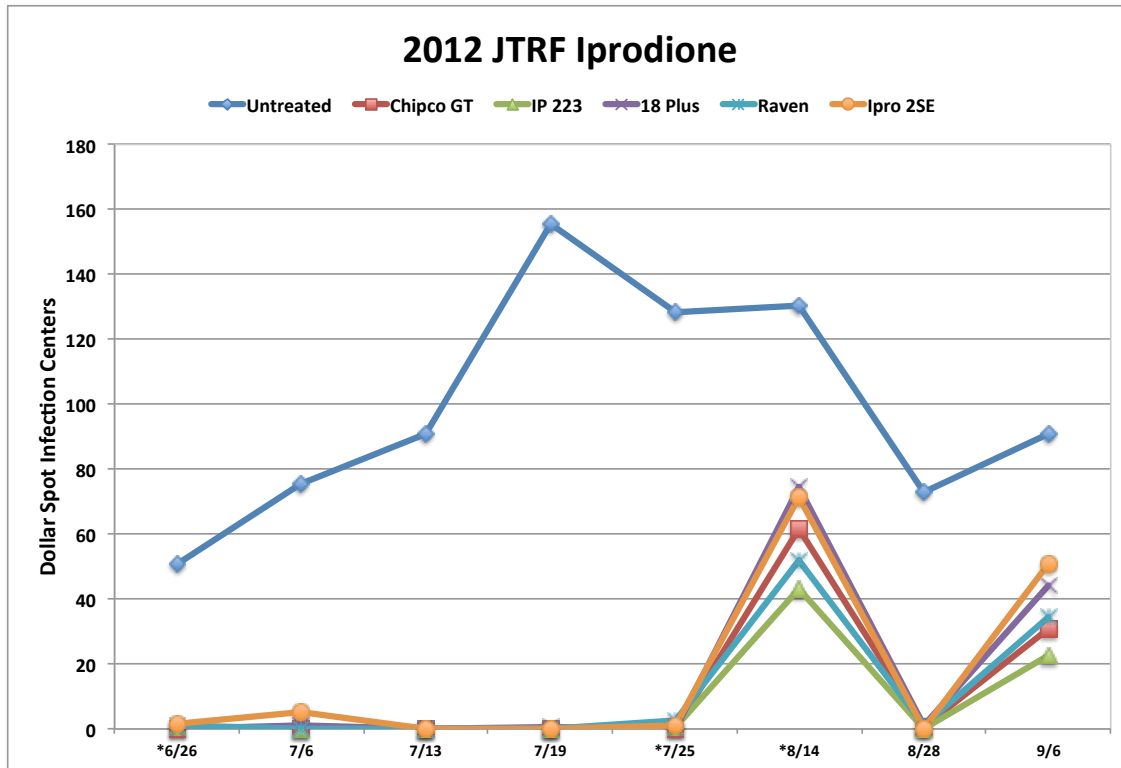


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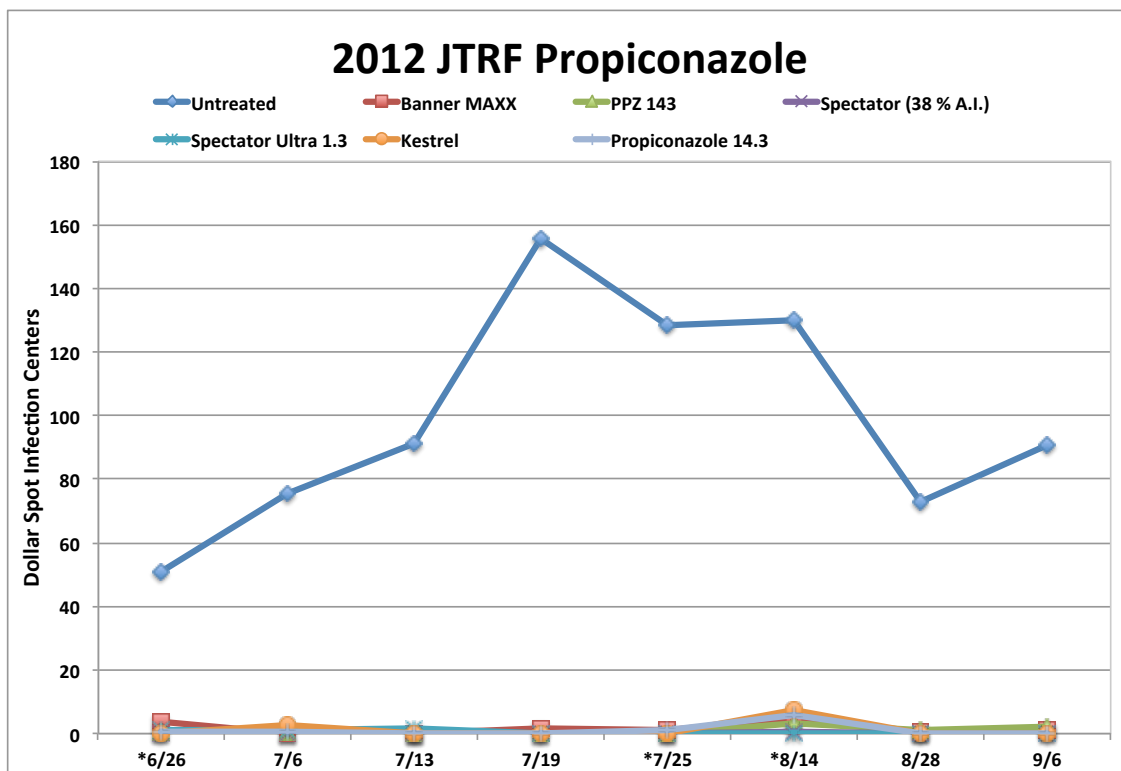
2012 JTRF Chlorothalonil 54% A.i.



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