Food Crops Program – Pathology

Research Report Form for Performance & Integrated Solutions Trials

Project #: IS00399.22-HI01
Project Title: Control of Leaf Rust in Coffee
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Abstract

Coffee leaf rust (CLR), *Hemileia vastatrix,* is a disease that has severely impacted the major coffee growing areas of the world. The discovery of coffee leaf rust in Hawaiʻi in October of 2020 was devastating news to our growers, threatening the second highest valued crop in the State. The disease quickly spread to all coffee growing areas in Hawaiʻi. Currently, growers can apply copper and biological products, but these are only effective as protectants when rust infections are lower than 5%. Although the fungicide Priaxor® Xemium® had been approved as a Section 18 emergency exemption, there was still an urgent need for true systemic fungicides to provide sustained control of the disease throughout the season and to build a sound IPM program to manage fungicide resistance. An IR-4 field trial was conducted in 2021 to test the efficacy and crop safety of seven fungicide products. The objective of that trial was to meet the data requirements of the registrants. While certain products met the efficacy and crop safety requirements during the trial, a few registrants expressed the need for an extra season of data. Thus, this trial was conducted to generate the additional data required. Five treatments were included in this trial: 1) Untreated Control; 2) Excalia™, inpyrfluxam (2.84 lb ai/gal), treatment rate 4 fl oz/A, registrant Valent; Pyraziflumid 20SC, pyraziflumid (1.84 lb ai/gal), treatment rate 3.2 fl oz/A, registrant Nichino America; 4) Alto® 100SL, cyproconazole (0.83 lb ai/gal), treatment rate 5.5 fl oz/A, registrant Syngenta; 5) Abound®, azoxystrobin (2.08 lb ai/gal), treatment rate 15.5 fl oz/A, registrant Syngenta. The pyraziflumid and inpyrfluxam treatments were repeated from the 2021 trial, while the other two treatments, cyproconazole and azoxystrobin were introduced. Notably, these treatments included the same active ingredients as the combination product (Quadris Xtra) tested in 2021. However, the registrant opted to register the individual active ingredient products instead of the premix product, and as such, sought efficacy and crop safety data on the single active ingredient products.

Field plots were established at a commercial coffee farm in Kona, Hawaii, a major coffee production area in the State. The first spray application was made to all treated plots on 6/30/22 as a preventative spray while disease pressure was low in the field. All treatments were applied with a backpack mistblower in 100 gal/A spray volume. Additional spray applications at the same rates were made to plots at intervals recommended by the registrants.

All fungicide treatments provided excellent control of coffee leaf rust compared to the untreated control. Disease control was maintained in fungicide treated plots for approximately 5 months

following initial spray applications. Visual phytotoxicity ratings did not show any injury to coffee foliage or berries and there was no evidence of plant stunting.

Material & Methods

The trial was conducted at Kona Hills coffee farm in Kona, Hawaiʻi. The field plots were established in a 2-year old field planted with *Coffea arabica var. typica*, the predominant variety grown in Kona. This variety is highly susceptible to coffee leaf rust. The plots were arranged in a randomized complete block design, including 5 treatments with 3 replications for each treatment. Tree spacing within the row was 4 ft and distance between rows was 12 ft. Tree height ranged from 9 to 11 ft. There were 6 trees per plot, and efficacy and crop safety data were collected from the inner 4 trees within each plot. Plots were naturally infected with coffee leaf rust, *Hemeliea vastatrix*. Disease symptoms were detected in the field prior to starting the trial, but disease pressure was very low at this time.

Fresh test substances were supplied by the registrants for use in this trial. The first spray application was made on 6/30/22 using a gasoline powered Solo® backpack mistblower set at full throttle with the nozzle orifice set at 4. All subsequent spray applications were made using a Stihl SR 450 backpack mistblower set at full throttle with the nozzle orifice set at 4. The spray solution was applied evenly to the entire plot on both sides of the row. Spray adjuvants were not added to the tank mixtures. On each spray date, the sprayer was calibrated immediately prior to applications. Application details are listed in Table 1.

Table 1. Treatment List and Application Method

Trt. No.	Product (EPA Reg. No.)	Product Trade Name	Registrant	Rate	GPA	Application Method	Adjuvant (Product & Rate)	Dates of Application	Crop Growth Stage
1	Untreated	N/A	N/A	N/A	N/A	N/A	NA	N/A	N/A
2	59639-230	Excalia™	Valent	4 fl oz/A	100	foliar mistblower	no adjuvant	6/30/22, 8/15/22, 9/29/22	Flowering, fruiting
3	N/A	Pyraziflumid 20SC	Nichino America	3.2fl oz/A	100	foliar mistblower	no adjuvant	6/30/22, 7/7/22, 7/14/22, 7/22/22	Flowering, fruiting
4	100-1226	Alto® 100 SL	Syngenta	5.5fl oz/A	100	foliar mistblower	no adjuvant	6/30/22, 7/28/22	Flowering, fruiting
5	100-1098	Abound®	Syngenta	15.5fl oz/A	100	foliar mistblower	no adjuvant	6/30/22, 7/7/22, 7/14/22, 7/22/22, 7/28/22	Flowering, fruiting

Disease incidence and severity were evaluated at the start of the trial on 6/23/22 (pre-treatment) and subsequently approximately every 30 days throughout the trial period on 7/20/22, 8/17/22, 9/19/22, 10/10/22, 11/9/22 and 12/20/22. The inner 4 trees in each plot were evaluated. The trees were divided into upper and lower sections. Two (2) randomly selected branches were marked in each section; one branch on each side of the tree (4 tagged branches/tree). The same marked branches were observed for incidence and severity on each evaluation date.

INCIDENCE: On each evaluation date, rust incidence was evaluated by counting the total number of leaves per marked branch and the total number of leaves infected by rust on that branch. Percent rust incidence was calculated by: [no. of infected leaves per branch ÷ total leaves per branch]× 100. The criteria to determine if leaves were infected was the presence of rust pustules on the undersides of the leaf. Leaves with pale yellow spots were not counted as infected.

SEVERITY: Rust severity was evaluated on the whole tree using a pictorial scale adopted from Mora, 2016[1]. On each evaluation date, the inner 4 trees in each plot were compared to the pictorial scale and the percentage of rust severity was estimated by: 0=no rust; 1=3%; 2=10%; 3=30%; 4=60%.

DEFOLIATION: Changes in the total number of leaves per branch over time can serve as an indicative measure of defoliation resulting from CLR infection. Total leaf counts were evaluated to examine defoliation differences between treatments.

CROP SAFETY: Phytotoxicity was evaluated approximately 7 and 14 days after each spray application on 7/7/22, 7/14/22, 7/20/22, 7/28/22, 8/15/22, 9/19/22, 9/29/22, and 10/10/22. The berries and foliage in each plot were evaluated using a 0 to 4 visual rating scale where 0 = no damage; 1 = damage in ≤ 10% of the plot; 2 = damage in 11-25% of the plot; 3 = damage in 26-50% of the plot; 4 = damage in > 50% of the plot. Coffee plants were also evaluated for evidence of stunting.

Yield data was not collected in this study.

[1]Mora, 2016. La roya del cafeto, Hemileia vastatrix. Ficha Tecnica 40. Servicio de Sanidad Vegetal, Inocuidad y Calidad Agroalimentaria, Mexico.

Supplemental Crop Treatments

The coffee plots were managed following normal commercial practices except for applications of copper-based fungicide treatments. Routine crop maintenance records are shown in Table 2. No irrigation was applied. The field was rainfed.

Table 2. Crop Maintenance Records

Product Name	A.I.	Rate	GPA	Application Type	Date of Application	Crop Growth Stage
15-15-15 with minors	N-P-K	340 lb/A	N/A	Side-dress	4 times/year starting in Jan. 2022	
Surround® WP	kaolin	3.1 lb/A	25 gal/A	Foliar Airblast (Tank Mix)	7/13/22	Flowering, Fruiting
Seranade® ASO	bacillus subtilis strain QST 713	1 qt./A				
Double Nickel 55™	bacillus amyloliquefaciens strain D747	1 lb/A				
SST 8% Calcium	calcium	16 fl oz/A				
Garlic Barrier AG	garlic juice	4 fl oz/A				
Botanigard® ES	Beauveria bassiana strain GHA	16 fl oz/A				
RoundUp PowerMax	Glyphosate	2% v/v	Not recorded	Backpack spot treatment	7/14/22	Flowering, fruiting
Mad Dog	Glyphosate	2% v/v	Not recorded	Backpack spot treatment	11/2022	Flowering, fruiting

Results

INCIDENCE: On 6/23/22, prior to treatment, the average coffee leaf rust incidence was below 2.5% in all plots, and there were no significant differences between the treatments (Figure 1, Table 3). From 6/23/22 to 11/9/22, rust incidence progressively increased in the untreated plots, exceeding 50%. Meanwhile, rust incidence in the inpyrfluxam, cyproconazole, and azoxystrobin treatments remained below 4%. Between 11/9/22 and 12/20/22, there was a decrease in rust incidence in the untreated plots, as observed in Figure 1. However, this decrease was attributed to significant leaf drop caused by high rust infection, resulting in lower leaf counts. During the same period, rust incidence slightly increased in all treatment plots except inpyrfluxam. By 12/20/22, all treated plots exhibited significantly lower rust incidence compared to the untreated control (Table 3). The inpyrfluxam treated plots consistently maintained rust incidence levels below 2% throughout the entire trial period.

SEVERITY: Coffee leaf rust severity was low throughout the trial period with severity ratings lower in the fungicide treatments compared to the untreated control (Figure 2). Rust severity followed the same trend as incidence, with moderate severity in the untreated plots and low severity in the fungicide treated plots.

DEFOLIATION: In the analysis of temporal leaf counts, untreated branches exhibited a notable overall decrease, suggesting defoliation caused by leaf rust infection. Conversely, in the cyproconazole-treated plots, there was an observed increase in total leaves over time (Figure 2).

CROP SAFETY:
No phytotoxicity was noted in any of the coffee plots throughout the trial period. Coffee trees were healthy, producing new leaves, and fruit load was normal. No stunting was observed in any of the plots.

The fungicides assessed in this study exhibited both high efficacy against coffee leaf rust and ensured the safety of the coffee crop. All products would serve as strong potential candidates for domestic registration on coffee and integration into an IPM program for disease management. Strategic rotation of systemic fungicides with copper and biological products have the potential to provide season long control of coffee leaf rust in well managed coffee orchards.

Figure 1.   Effect of Fungicide Treatments on Mean Percent Incidence of Coffee Leaf Rust

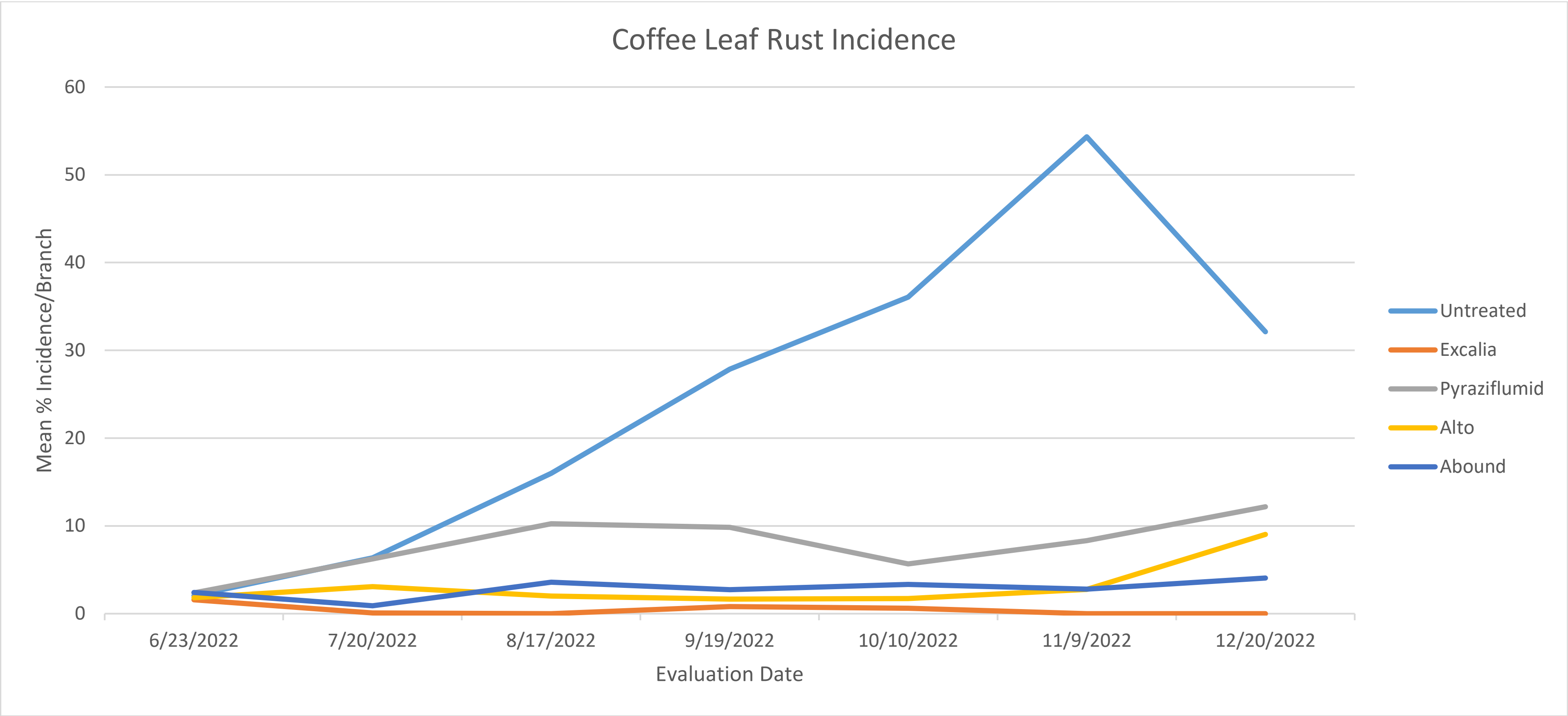
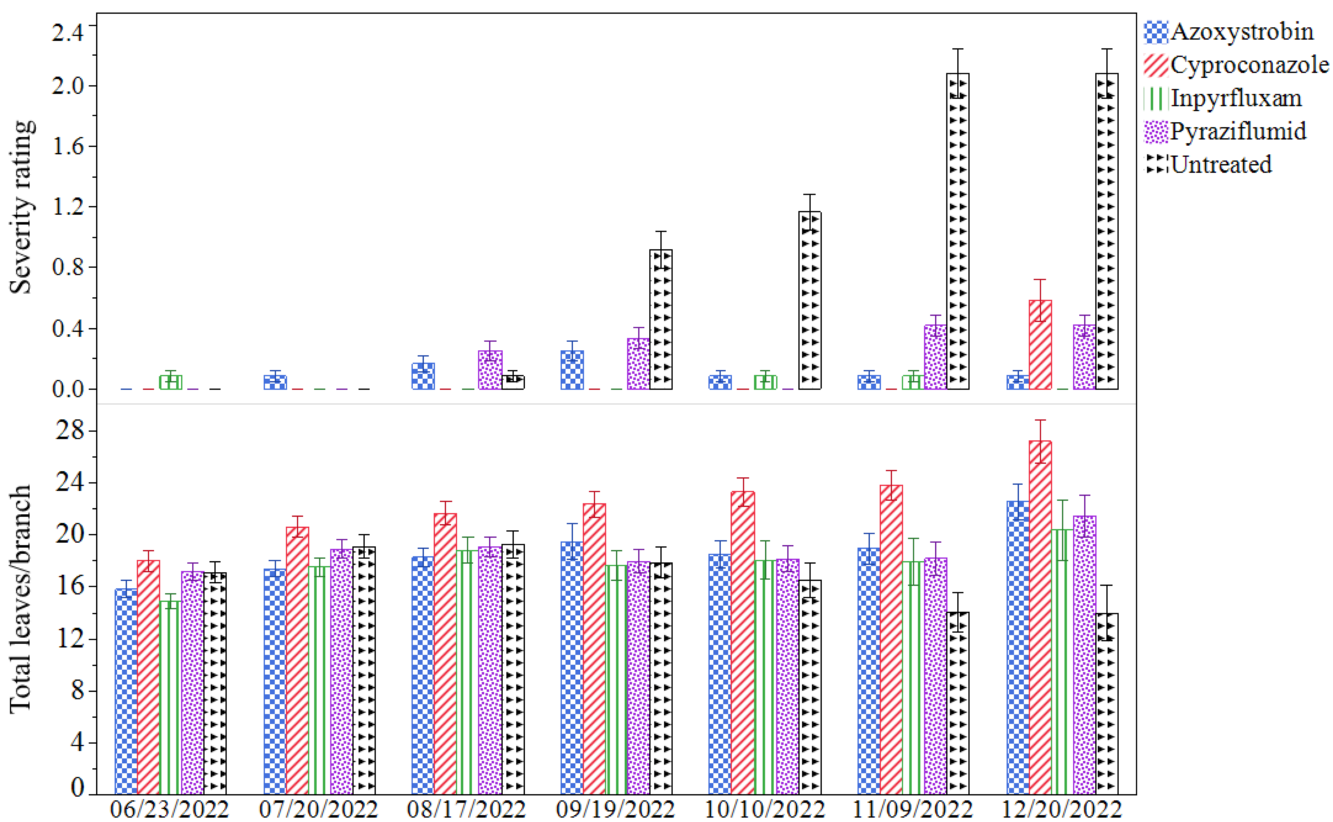


Table 3. Effect of Fungicide Treatments on Coffee Leaf Rust Incidence

	Mean % Incidence/Branch						
	6/23/22	7/20/22	8/17/22	9/19/22	10/10/22	11/9/22	12/20/22
Untreated	2.06 a	6.35 a	16.00 a	27.86 a	36.07 a	54.33 a	32.12 a
Excalia	1.58 a	0.09 b	0.0 c	0.82 c	0.63 b	0.0 b	0.0 c
Pyraziflumid	2.37 a	6.23 a	10.24 ab	9.85 b	5.67 b	8.31 b	12.18 b
Alto	1.81 a	3.07 ab	2.00 c	1.66 bc	1.73 b	2.76 b	9.03 bc
Abound	2.43 a	0.90 b	3.60 bc	2.74 bc	3.33 b	2.81 b	4.06 bc

Means within the same column with the same letter are not significantly different, Tukey's Studentized range test α=0.05 (SAS v. 9.4).

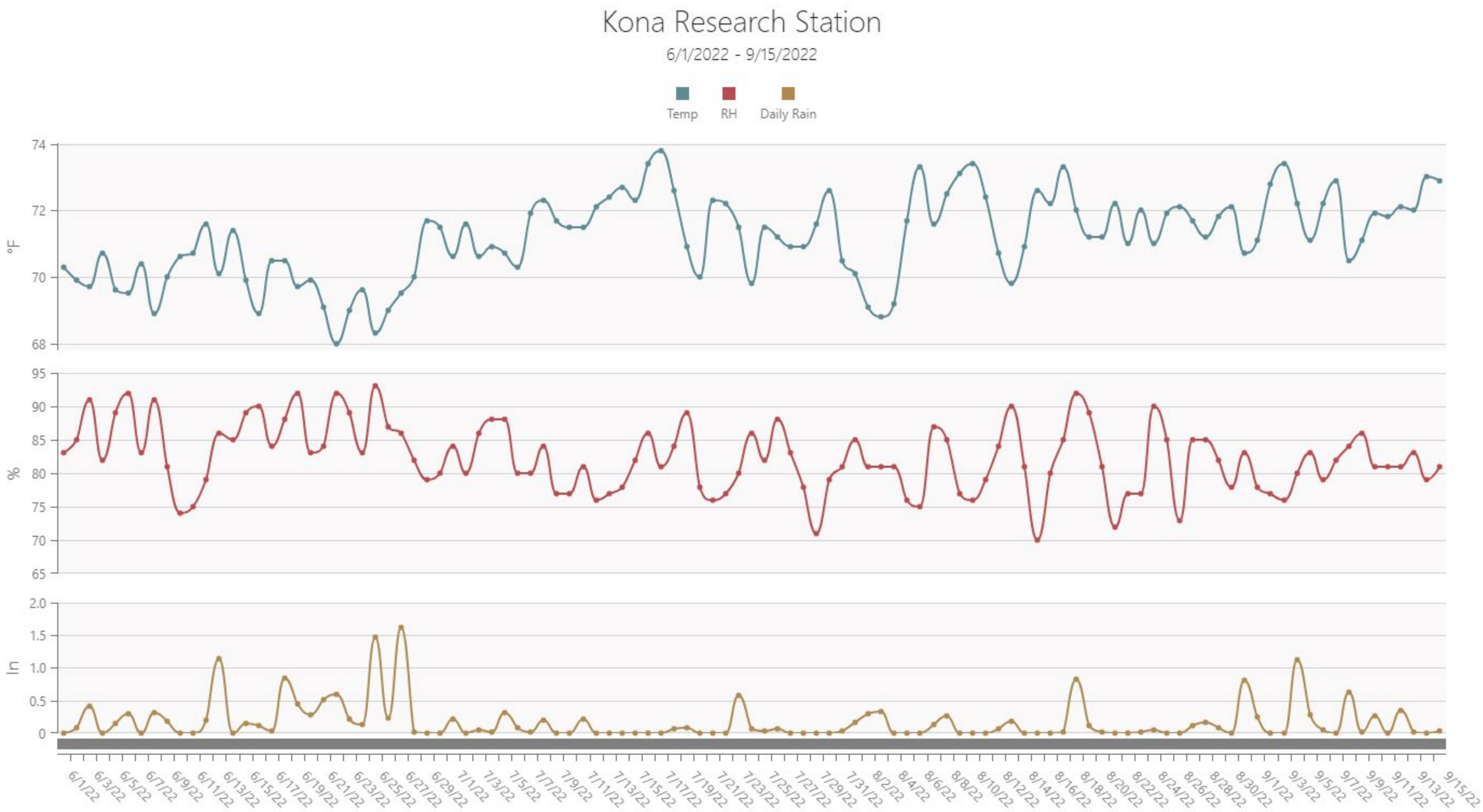
Figure2. Effect of Fungicide Treatments on Coffee Leaf Rust Severity and Defoliation



Raw Data

See attached file: Raw Data 2022 Report.xlsx

Environmental Conditions during the Trial



Environmental Conditions during the Trial (cont.)