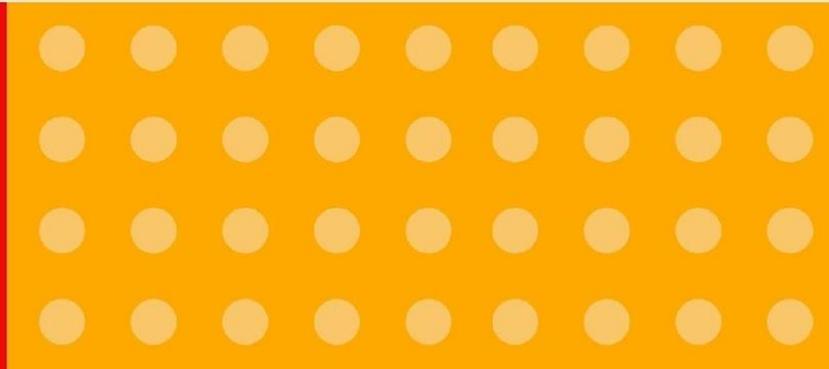
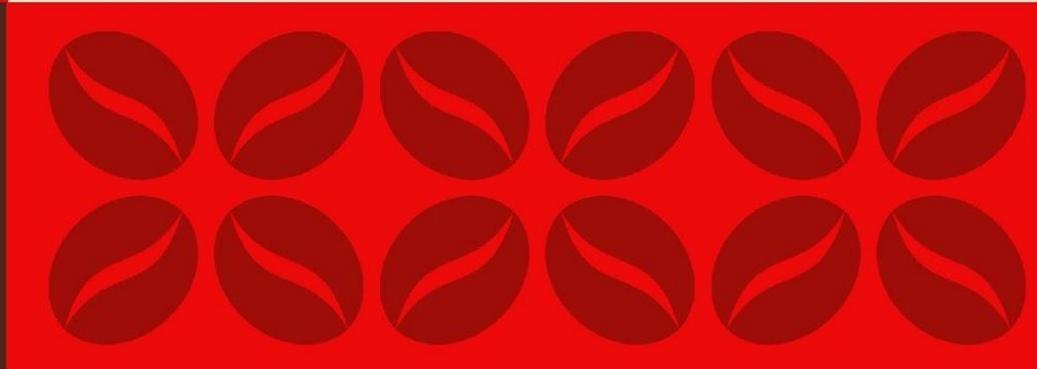




XXVI SIMPOSIO
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- EL SALVADOR -

A central white rectangular area containing a logo on the left and text on the right. The logo is a dark brown hexagon with a white circle inside, depicting a coffee branch with green leaves and a dark brown bean. The text is in a clean, sans-serif font, with 'XXVI' in a larger, bold grey font.



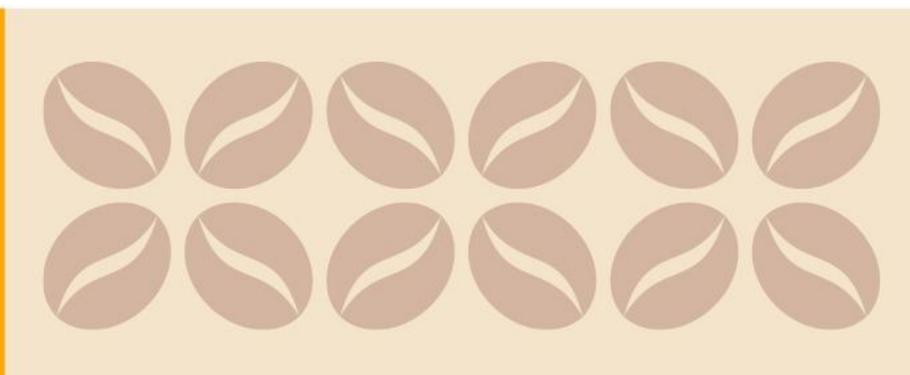
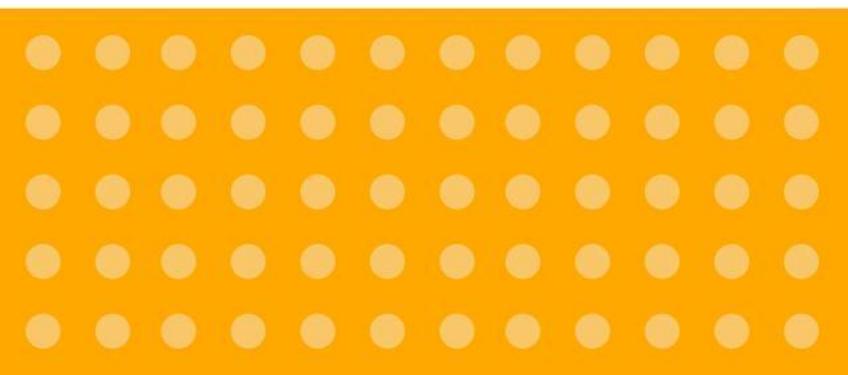
Suppression of Coffee Leaf Rust (*Hemileia vastatrix*) with the use of Terra Vera Technology on Blue Mountain Coffee in Brandon Hill, Jamaica



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Introduction



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- Cultivation occurs mainly in Jamaica Blue Mountain (JBM) and High Mountain regions.
- Discovered in 1986 in Clarendon Jamaica.
- Identified as Race II of Coffee Leaf Rust (CLR) by 1989.
- Spraying of hazardous chemicals and culling plants.
- 2012 outbreak and by 2013 CLR infected 25%-30% of JBM region.

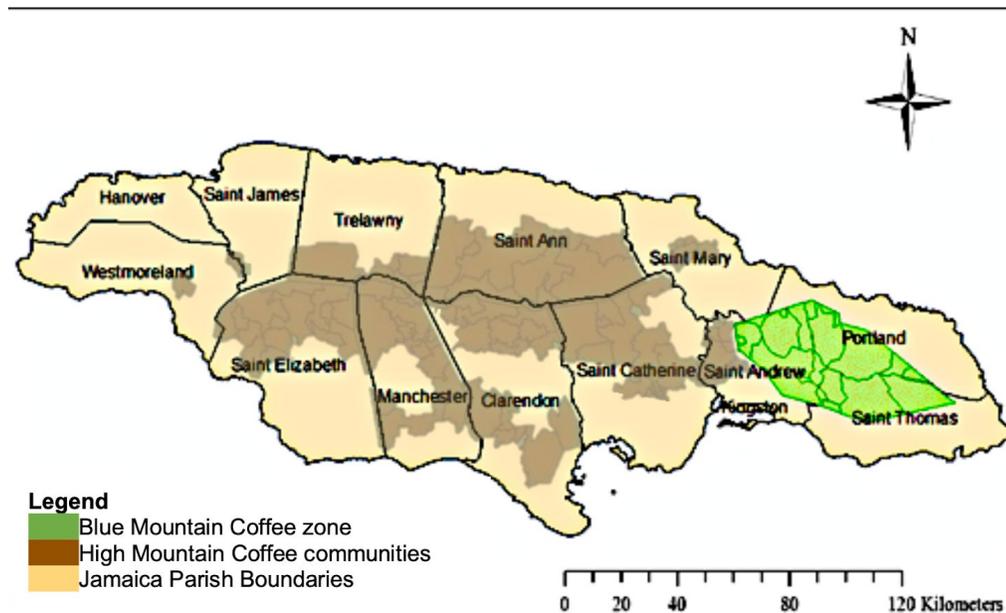


Figure 1: Illustration of coffee growing communities in Jamaica. The Jamaica Blue Mountain (JBM) coffee region is highlighted in green and High Mountain coffee communities are shown in brown (Birthwright 2020, 5)[Brown High Mountain communities is an image layover from Birthwright and

Objectives



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1. Assess the incidence and severity of Coffee Leaf Rust.
2. Identify and confirm the Coffee Leaf Rust species.
3. To assess the potential usage of Terra Vera technology, in suppressing and reducing the incidence of Coffee Leaf Rust (*Hemileia vastatrix*).

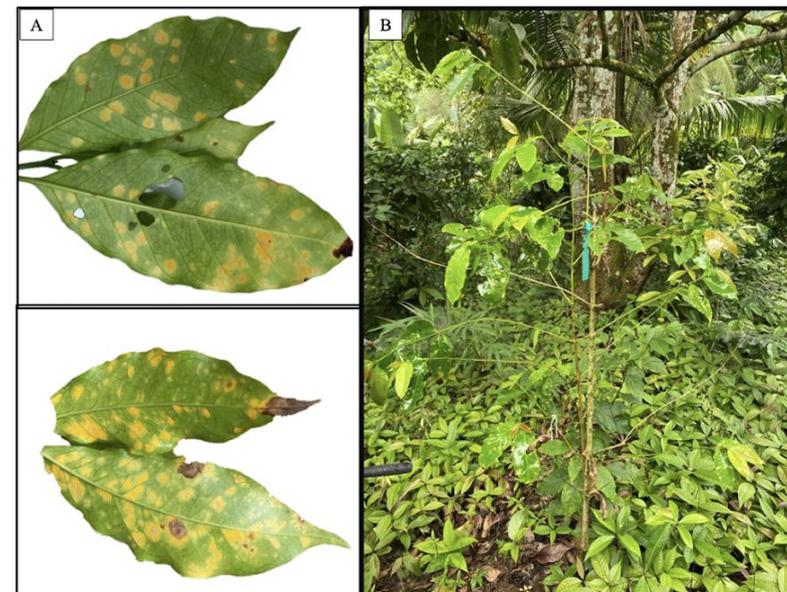


Figure 2: Symptoms of CLR disease presenting (A) spores and lesions on coffee leaves and (B) severe defoliation of coffee tree, in Brandon Hill, Jamaica. Images by Jed Goodridge from small holder coffee farm in Brandon Hill Jamaica.

Methodology



1. **Study site** –An estimated 174 coffee farmers settled in the Brandon Hill district.
2. **Establishment of research plot-** A preliminary survey was done to determine a suitable study site, with incidence of CLR and no recent usage of fungicides.
3. **Experimental design-** Sixty (60) coffee plants were assessed for incidence of CLR over a 9 week period.
 - Four experimental conditions;
 - I. 2:1 solution of reverse osmosis (RO) water to Terra Vera (TV).
 - II. 3:1 solution of RO water to TV.
 - III. RO water.
 - IV. No-application.
 - Consisted of plants with a range of disease severities (Level 0 - Level 7) as determined using standard area diagram disease severity chart



Level 0 (0.0 %)	 0.0 %	 0.0 %	 0.0 %
Level 1 (0.1 - 0.99 %)	 0.2 %	 0.5 %	 0.9 %
Level 2 (1.0 - 2.0 %)	 1.2%	 1.6%	 1.9%
Level 3 (2.01 - 4.0 %)	 2.1%	 3.2%	 3.9%
Level 4 (4.01 - 8.0 %)	 4.5%	 6.1%	 7.9%
Level 5 (8.01 - 16.0 %)	 8.4%	 13.3%	 15.4%
Level 6 (16.01 - 20.0 %)	 17.0%	 17.8%	 19.1%
Level 7 (20.01 - 50.0 %)	 23.4%	 33.0%	 50.9%

Figure 3: Standard area diagram constructed with color photographs to aid in estimating the severity of coffee leaf rust (*Hemileia vastatrix*) in conilon coffee (*Coffea canephora*). The numbers represent the percentage of diseased leaf area containing uredospores/urediniospores of the pathogen, disregarding the light- yellow halo around the lesions. (Belan et al.

- 4. Preparation of stock solution-** A precursor concentrate, and RO water was connected to the Terra Vera electrolysis unit, to produce and collect the TV stock solution.
- 5. Application of TV and RO water-** The abaxial and adaxial surfaces of leaves, were sprayed with either the RO water or a Terra Vera concentration (2:1 or 3:1).
- 6. Laboratory identification-** The Sellotape mount technique and Lactophenol Cotton Blue (LCB) was used to prepare the spores.
- 7. Data collection-** The severity of disease for each plant was estimated weekly. The average (mean, mode, median) and relative changes in severity levels were calculated.
- 8. Statistical analysis** - The Kruskal Wallis and Mann-Whitney tests. In all cases, significant differences were defined as those with $P < 0.05$.



Results

Coffee Leaf Rust *Hemileia vastatrix*

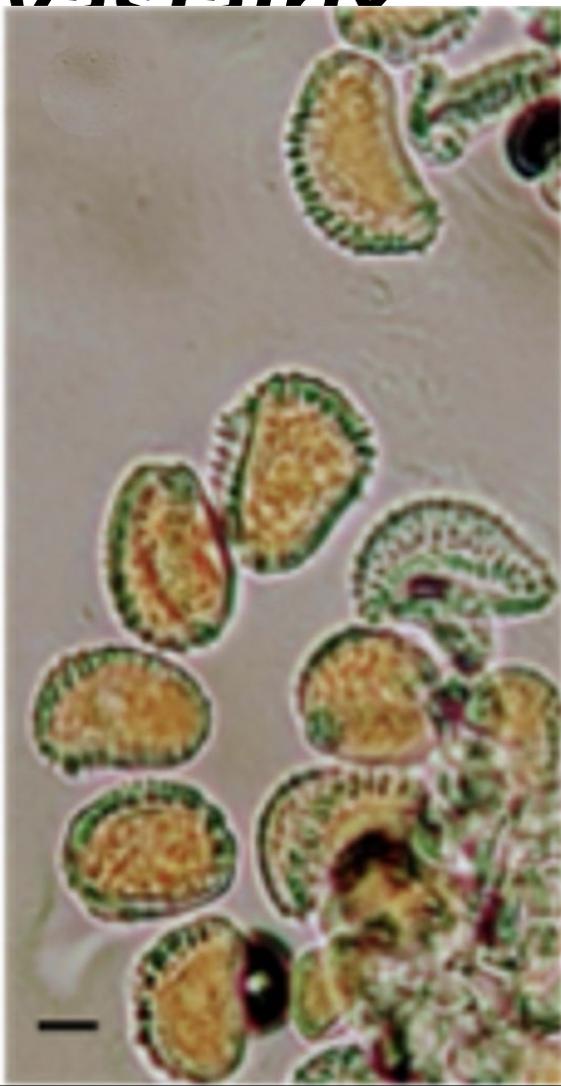


Figure 4: Characteristic uredospores/urediniospores sampled from a coffee plant in Brandon Hill, Jamaica (bar = 10 mm)

Disease Severity



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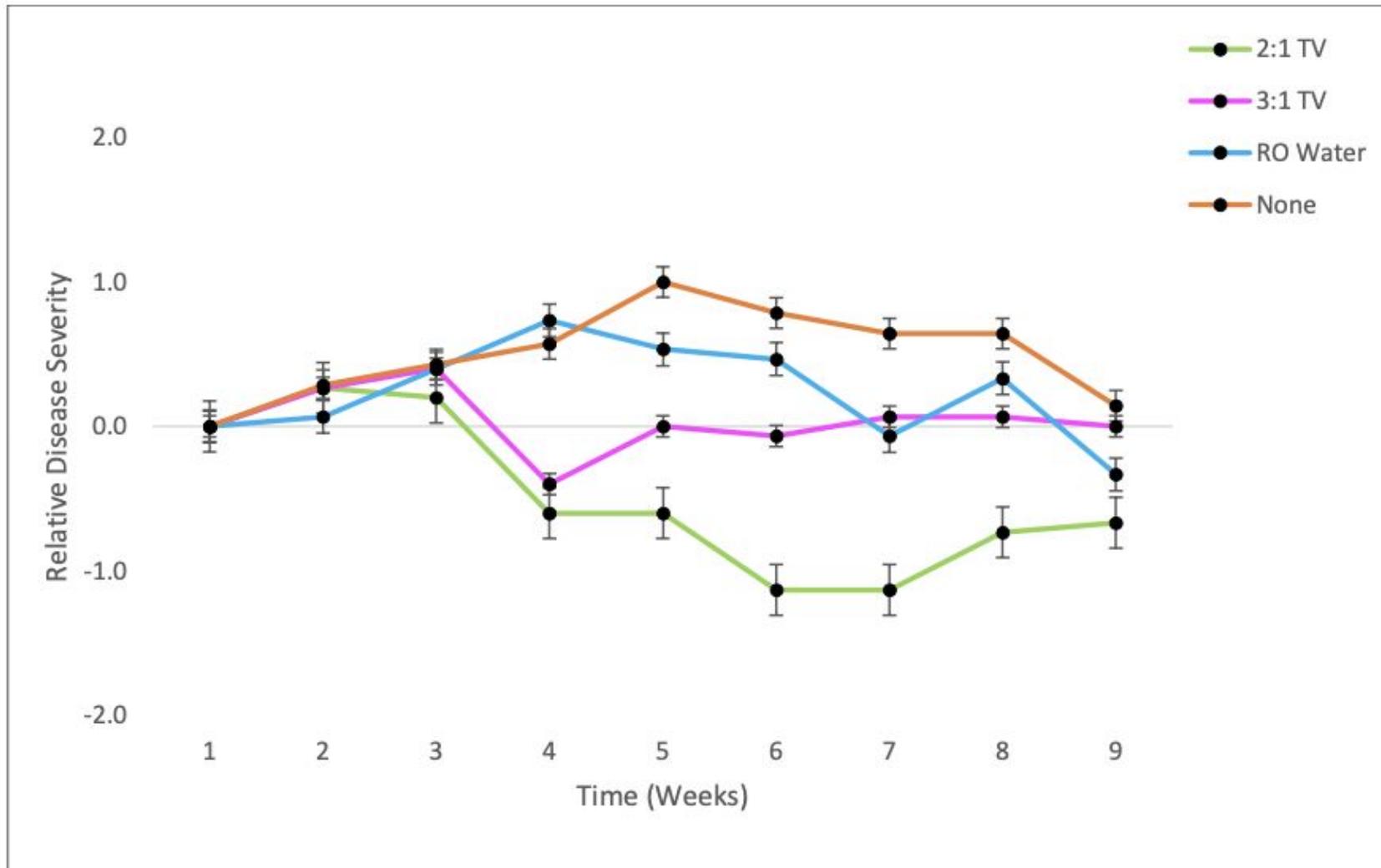


Figure 5: Average relative change in CLR disease severity levels for all four experimental conditions,

2:1 TV Treatment

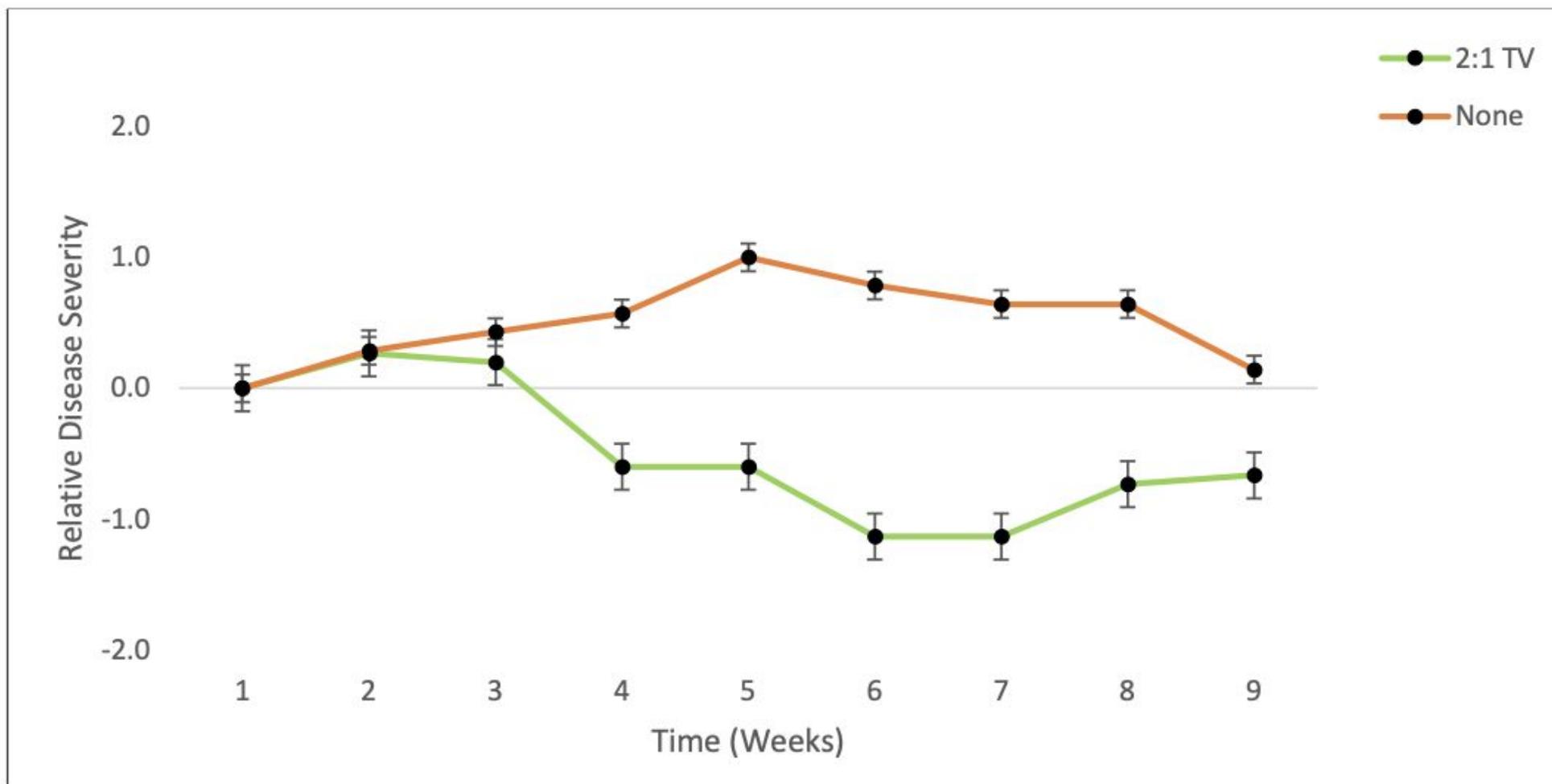


Figure 6: Comparison of average relative change in CLR diseases severity levels for 2:1 TV treatment and no-application study conditions.

3:1 TV Treatment

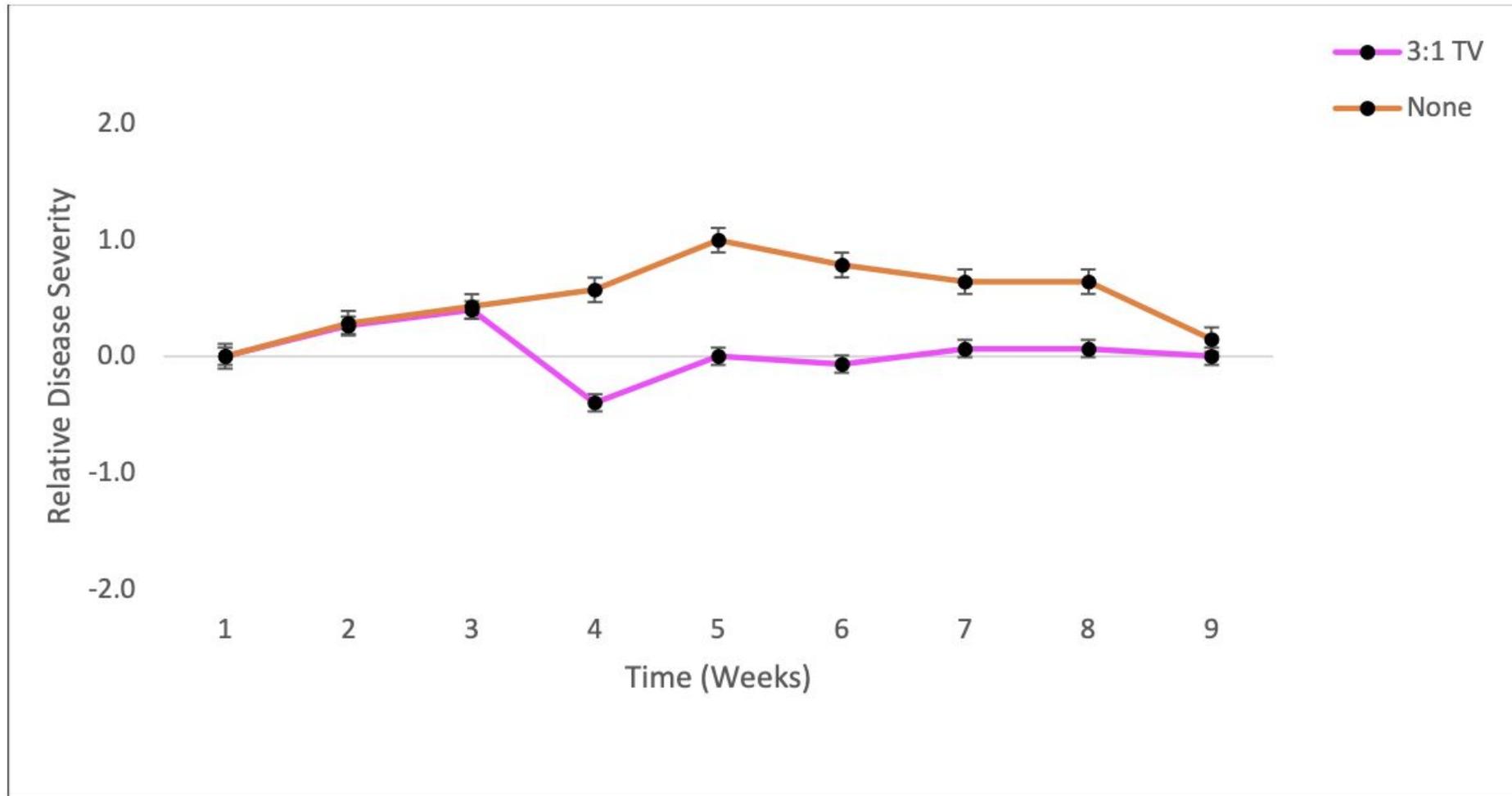


Figure 7: Comparison of average relative change in CLR disease severity levels for 3:1 TV treatment and no –application study conditions.

Control Conditions: RO water (negative control) and No-application (blank control)

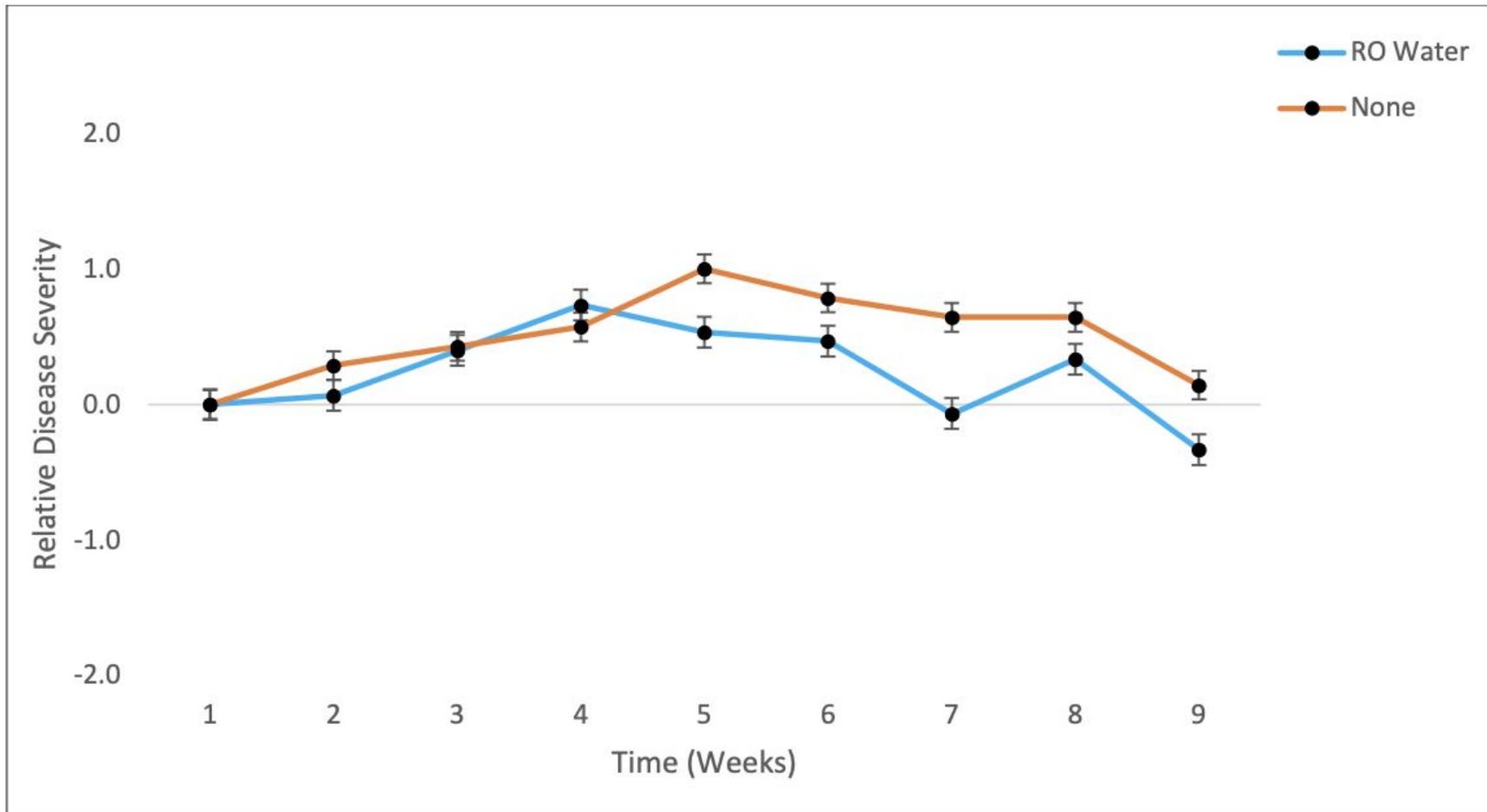


Figure 8: Comparison of average relative change in CLR disease severity levels for RO water and no-application study conditions.

Photographed Examples of CLR Disease Severity Levels Initial and after Applications from each Treatment.

Initial	After	
<i>Level 4</i>	<i>Treatment: 2:1 TV</i>	<i>Level 2</i>
		
<i>Level 4</i>	<i>Treatment: 3:1 TV</i>	<i>Level 4</i>
		
<i>Level 5</i>	<i>Treatment: RO water</i>	<i>Level 6</i>
		
<i>Level 3</i>	<i>Treatment: No treatment</i>	<i>Level 7</i>
		

Table 1: Displaying coffee leaves' abaxial surfaces showing CLR disease severity level initial and after TV applications from each treatment. Images by Jed Goodridge from small holder coffee farm in Brandon Hill Jamaica.

Comparative cost of Terra Vera with Traditional Treatment

TERRA VERA					TILT				
Inputs	Unit	Number	Unit cost (\$J)	Total (\$J)	Inputs	Unit	Number	Unit cost (\$J)	Total (\$J)
Percussor amino acid salt RMD	Kg	7	16607.14	116250.00	Concentrated bottle of Tilt	L	1	13656.27	13,656.27
RO H ₂ O for dissolving RMD	Gal	5	70.00	350.00	Tilt standard dilution	Gal	42	325.15	13,656.27
RO H ₂ O for electrolysis	Gal	5	70.00	350.00	NA	NA	NA	NA	NA
Concentrated TV chemisty	Gal	60	1949.17	116950.00	NA	NA	NA	NA	NA
RO H ₂ O for 2:1 dilution	Gal	5	70.00	350.00	NA	NA	NA	NA	NA
Option 1 STATEMENTS					Option 2 STATEMENTS				
Concentrated TV for application	Gal	14	1949.17	27288.38	Diluted Tilt for application	Gal	42	325.15	13,656.27
Labour to spray	Manday	1	5000.00	5000.00	Labour to spray	Manday	1	5000.00	5000.00
Cost of Terra Vera + labour	Acre	1	34248.38	34248.38	Cost of Tilt + labour	Acre	1	18656.27	18,656.27
Footnote:Std sprayer capcity	Gal	4	NA	NA	Footnote:Std sprayer capcity	Gal	4	NA	NA
Footnote: Sprayer filled of 2:1 TV solution			\$140.00 + \$1,949.17	2089.17	Footnote: Sprayer filled of Tilt solution			4 Gal x \$325.15	1300.60
Footnote:Acre uses 28 Gal RO water for 2:1 TV			28 gal x \$70	1960.00					
Footnote: Initial investment in the Terra Vera Brawndo TM system				5,425,000					

Table 2: Comparative cost assessment of using Terra Vera verses traditional treatment for the suppression of coffee leaf rust in Jamaica.



Conclusion

- The use of TV technology as an anti-fungal agent against CLR may prove as an effective alternative CLR control in coffee production.
- A significant (< 0.05) difference between experimental conditions was observed from the data generated from CLR assessments over the nine-week period in JBM region of Brandon Hill.



- The stronger concentration of 2:1 TV demonstrated the greatest reduction in CLR relative average severity levels.
- The reduction observed from the 3:1 TV were not as sustained as the reduction observed from 2:1 TV.
- The farmers would require further assistance inclusive of but not limited to,
 - I. Financial assistance.
 - II. Improved extension services.
 - III. Forecasting systems (CLR and climate) to ensure correct timing of application and concentration of TV.
- Further investigations are warranted to determine the most adequate application practices in accordance with the local agroecological factors and epidemiology.



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TERRA  VERA

