

The Effects of Soil Treatments (Vici Routz GR/SP and Veni GoKlean) on Bacterial Wilt Incidence and Yield in Tomato (EW 815 and EW 834) Production

5th February 2024





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Introduction

Tomato bacterial wilt poses a significant threat to solanaceous crops, particularly during the rainy season. The disease is caused by the bacterium *Ralstonia solanacearum* and is often referred to as "Green wilt" disease due to the retention of green leaves despite wilting symptoms (Jiang *et al.*, 2017). This disease leads to substantial yield and income losses, and controlling it proves challenging (Hertman, 1993; Doan and Nguyen, 2005).

Common control measures against bacterial wilt include implementing good agronomic practices such as selecting resistant varieties, using healthy seeds/seedlings, practicing crop rotation, employing biological control, and adopting integrated management strategies (Elphine and Aley, 1993). However, no universal control measures effectively combat the disease across its wide host range (Cook *et al.*, 1989). Control measures effective in one environment may not be suitable for another, and resistant varieties may not be available in all areas. Presently, biological control of soil-borne diseases using plant growth-promoting rhizobacteria (PGPR) shows promise (Kloepper 1993). Both beneficial *Bacillus* (Guo *et al.*, 2004) and *Pseudomonas* (Vanitha *et al.*, 2009) have been widely utilized in bacterial wilt control. Implementing environmentally friendly biocontrol strategies with bacterial inoculant strains to enhance soil wilt suppressiveness and plant priming capacity holds promise, particularly in endemic pathogen areas (Xue *et al.*, 2013).

Conventional control measures like crop rotation and chemical applications have proven challenging due to the pathogen's variability. Biological control emerges as a promising alternative, with various bacteria and actinomycetes demonstrating efficacy against *R. solanacearum*. Recognizing the necessity for sustainable solutions, this study, conducted in collaboration with the Koppert Foundation, aims to assess the efficacy of Koppert's products, Vici Routz GR/SP and Veni Goklean, in mitigating bacterial wilt and evaluating the impact of tomato varieties on disease incidence and yield.

Objectives

This study aims to investigate the effects of soil treatments on bacterial wilt incidence and yield in tomato production, assess the influence of different bacterial wilt application controls on the incidence and yield of tomatoes, and evaluate the overall return on investment in tomato production.

Materials and Methods

The study was conducted at a tomato plot infected with bacterial wilt in the previous crop at the Centre of Excellence (COE) in Keonjhar, Odisha, throughout the Kharif season, with the date of sowing and transplanting done on 27 June 2023 and 27 July 2023, respectively. The study included two factors: 1) Bacterial Wilt (BW) Control and 2) Tomato Variety. For BW Control, two treatments were considered – C1, involving the application of Soil treatments (Koppert products- Vici Routz GR/SP and Veni Goklean), and C2, representing Farmer Practices (disease management aspects). Tomato varieties included [EW 815](#) (V1), which was evaluated for its fruit quality, firmness, shape, and size, compared to a competitor's variety. The second variety, [EW 834/Ria](#) (V2), is known for its good firmness and high yield potential. The experimental design incorporated a factorial approach within a Randomized



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Complete Block Design (RCBD), with four treatments “(C1V1, C1V2, C2V1, C2V2)” and each treatment replicated thrice. The total experimental area covered 460 m², with individual treatment areas measuring 16.50 m², encompassing a total of 44 plants per treatment and yielding 12 experimental units across three replications. Land preparation and fertilization adhered to the recommendations provided by EWS-KT for optimal crop growth.

The crop management schedule outlined specific practices for Bacterial wilt disease, distinguishing between Soil Treatments (Koppert Products) and Farmer Practices. Soil Treatments (Koppert Products), Vici Routz and Veni Goklean, were applied at specified intervals with recommended rates during key stages of crop development (Table 1)

1. Vici Routz GR and Vici Routz SP (*Bacillus megaterium*) are natural products for soil application, which contain Phosphobacteria, soil probiotics and prebiotics that act as bio primer that stimulates the crop growth and root system, nutrient uptake, drought tolerance, disease resistance which results in healthy crop and higher yield.
2. VENI GOKLEAN contains 100 ppm colloidal silver and 100 ppm colloidal copper encapsulated by a bio-polymer and suspended in water. Useful for pre-sowing soil disinfection. Disinfection of Fungi, Bacteria, and Viruses on plants and post-harvesting. It helps extend the shelf life of the produce, due to its disinfection property.

Table 1. Application schedule for Soil Treatments (Koppert Products)

Activities	Bacterial wilt control	Application rate	Remarks
1) Basal application - Land preparation	Veni GoKlean	Mixed 2 ml Veni GoKlean in 1 litre of water, drenched 2 litre solution to 1 m ² bedding area.	
2) 8 DAT	Veni GoKlean	Mixed 2 ml Veni GoKlean in 1 litre of water, drenched 70 ml solution per plant (0.375 m ²) to the root zone	Drenched to the root zone.
3) 11 DAT	Veni GoKlean	Mixed 2 ml Veni GoKlean in 1 litre of water, drenched 70 ml solution per plant (0.375 m ²) to the root zone	Drenched to the root zone.
4) 18 DAT	Vici Routz GR	Applied to the bed at the rate 8 g/ bed (5.5 m ²)	Compost mixed with Vici Routz GR granules to increase the quantity and uniform application.



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5) 23 DAT	Vici Routz SP	Mixed 250g in 200 litre of water, drenched 20 ml solution per plant (0.375 m ²) to the root zone	
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Farmer Practices included lime application during land preparation and subsequent periodic copper-based fungicide and antibiotics drenching at various stages of plant growth (Table 2). Other disease incidences were controlled by KT recommendation for all the treatments.

Table 2. Application schedule for Farmer Practices Treatment.

Activities	Bacterial wilt control	Application rate	Remarks
Land preparation	Lime	100 kg per Acre	
1 week after transplanting	Drenched Copper	2 g per 1 Litre, drenched 30 ml/ plant (0.375 m ²)	
14 DAT	Copper + Streptocycline	2 g per Litre of water + 2 g per 15 Litre of water	
21 DAT	Metalaxyl 4% and Mancozeb 64%	2 g per Litre of water	Applied Ridomil Gold®
28 DAT	Copper + Streptocycline	2 ml per Litre of water + 2 g per 15 Litre of water	
35 DAT	Azoxystrobin 18.2% + Difenoconazole 11.4% SC	1 ml per Litre of water	Applied Amistar Top®
42 DAT	Metalaxyl M	2 g per Litre of water	
49 DAT	Copper	2 g per Litre of water	
56 DAT	Copper	2 g per Litre of water	

Data collection focused on assessing bacterial wilt incidence weekly, starting one week after transplanting, by counting completely wilted plants. Disease severity was documented using a rating scale 0-5 (Winstead and Kelman,1952), and the Disease Index (DI%) was calculated for each plot. Marketable yields per treatment were recorded.

For more information on the experiment, here is the link to the [Protocol](#).

Results and Discussion



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The assessment of bacterial wilt incidence and severity at different time points (28, 45, 58, and 73 days after transplanting (DAT)) revealed dynamic trends across various treatments (Table 1). No significant differences were observed except at 73 DAT. In the initial stages (28, 45, and 58 DAT), all treatments exhibited low incidence rates. As time progressed, significant differences emerged in bacterial wilt control among the varieties. At 73 DAT, the variety EW 834 under Farmer Practices showed the highest incidence and severity, with notable interactions between bacterial wilt control and variety. Comparing the two varieties, EW 815 and EW 834, under Farmer Practices, EW 815 displayed lower bacterial incidence. However, the application of soil treatments was effective in controlling bacterial incidence in both varieties. The presence of colloidal silver and colloidal copper in Veni Goklean resulted in effective disinfection of bacterial wilt pathogens in the soil. Following this, the application of Vici Routz GR and SP to the soil led to the colonization of beneficial microorganisms around the root zone, increasing tomato plant tolerance/resistance to bacterial wilt. Colloidal copper and silver have broad antimicrobial activity against both Gram-negative and Gram-positive bacteria (Assar and Hamuoda, 2010; Ermini and Voliani, 2021). It has been reported that colloidal silver can significantly reduce the duration and severity of many bacterial infections (Tran *et al.*, 2017). Additionally, the study showed that the soil treatment reduced disease incidence and severity compared to traditional farmer practices. Comparing the varieties in terms of bacterial wilt severity and incidence, EW 815 consistently showed lower incidence rates under Farmer Practices, while EW 834 had the highest incidence at 73 DAT. The application of soil treatments effectively controlled bacterial wilt in both varieties.

Table 1. a) Disease incidence was calculated as the percentage of plants that have completely wilted. b) Disease severity was scored at 28, 45, 58 and 73 days after transplanting on a scale of 1-6 where 1 = no symptoms, 2 = 1 leaf partially wilted, 3 = 2-3 leaves wilted, 4 = all except the top 2 or 3 leaves wilted, 5 = all leaves wilted, and 6 = dead.

Bacterial wilt control	Variety	Disease incidence (1-6)				Disease severity (%)			
		28 DAT	45 DAT	58 DAT	73 DAT	28 DAT	45 DAT	58 DAT	73 DAT
Soil Treatments	EW815	1.0	1.0	1.3	1.9 B	0.0	0.0	4.8	17.9 B
	EW834	1.0	1.0	1.2	2.0 B	0.0	0.0	3.6	19.1 B
Farmer Practice	EW815	1.0	1.8	2.3	2.3 B	0.0	15.5	26.2	26.2 B
	EW834	2.1	3.3	3.9	4.8 A	22.6	47.6	58.4	75.0 A
Variety (V)		ns	ns	ns	**	ns	ns	ns	**
Bacterial wilt control (W)		ns	ns	ns	**	ns	ns	ns	**
V*W		ns	ns	ns	**	ns	ns	ns	**



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Figure 2. Variety EW 815 at 58 DAT a) In Soil Treatments (Left) b) In Farmers practice (Right)



Figure 3. Variety EW 834 at 58 DAT a) In Soil Treatments (Left) b) In Farmer practices (Right).

The data presented in Table 3 shows the yield of tomato production in 500 m² under different bacterial wilt control methods. Two categories of bacterial wilt control are compared: "Soil Treatments" and "Farmer Practices".

Table 3. Yield of tomato production with Soil Treatments and Farmer Practices in 500 m².

Bacterial Wilt Control	Yield (Tons)		
	EW 815	EW 834	Mean
Soil Treatments	2.26	2.91	2.58A
Farmer Practices	1.45	1.26	1.35B
Mean	1.84	2.09	
F-test ($P < 0.05$)			
Bacterial Wilt Control (B)		*	
Variety (V)		ns	
B x V		ns	
LSD _{0.05} (B)		0.6468	

The results indicate no interaction between bacterial wilt control and variety, but significant yield variations were observed between soil treatments and Farmer Practices for



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bacterial wilt control. For the soil treatments, the yield was higher, with 2.91 tons/500m² for the EW 834 variety and 2.26 tons/500m² for the EW 815 variety, representing a 131% increase compared to Farmer Practices for the EW 834 variety and a 56% increase for the EW 815 variety. This may be due to the use of Vici Routz GR and Vici Routz SP, which have Phosphobacteria that help in the colonization of beneficial microorganisms, better uptake of nutrients, water, and resistant to diseases resulting in roots and plant growth leading to an increase in yield. Plant growth, total and marketable yield increased by the application of biofertilizer containing *Bacillus megaterium var. phosphaticum* and yield increased with increasing doses (Oztekin *et al.*, 2016). In contrast, the yield under Farmer Practices was considerably lower, with 1.26 tons for the EW 834 variety and 1.45 tons for the EW 815 variety. This yield study reveals that the application of soil treatments significantly enhances yields compared to traditional Farmer Practices, indicating a positive interaction between disease control and increased yield. Saha and Das, 2012 revealed that there is a loss in yield of 0.75 to 0.77 t/ ha for every 1% increase in disease severity.

The cost analysis presented in Table 4 indicates comparable expenses between tomato production using the soil treatments and traditional Farmer Practices in a 500 m² area. Both methods exhibit similar costs for various farm inputs and labor activities. The total cost is calculated by summing up the costs of farm inputs and labor. The total costs for the soil treatments are 319.41 USD per 500 m² for both EW 815 and EW 834 varieties. For Farmer Practices, the total costs are slightly higher at 362.46 USD per 500 m² for both varieties. The primary reason for the observed difference in total cost is due to the high expenses associated with chemical fungicides used and the labors for bacterial wilt control in the Farmer Practices method.

Table 4. Inputs and Labour costs of tomato production with the soil treatments and Farmer Practices in 500 m².

Item/Activities	Soil Treatments	Farmer Practices
Farm inputs	USD/ 500 m²	
Land preparation	13.0	13.0
Seedling production	11.1	11.1
Trellis	134.2	134.2
Insecticides	12.0	12.0
Plastic mulch	28.0	28.0
Fertilizer application	25.8	25.8
Fungicides (Bacterial wilt control)	13.8	20.9
Labor cost	81.43	117.43
Total	319.41	362.46



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The findings from Table 5 present data on the return on investment (ROI) in tomato production, comparing the use of the soil treatments and traditional farmer practices across two varieties - EW 815 and EW 834. The soil treatment yielded a positive return of 75.22% and 125.62% for EW815 and EW 834 respectively. Conversely, Farmer Practices led to negative returns for both varieties, with -0.93% for EW 815 and -13.91% for EW 834. These ROI figures highlight the financial challenges associated with Farmer Practices, such as the use of chemical fungicides and antibiotics, which can result in significant losses for farmers. While the soil treatment provided higher returns, choosing the right variety is also crucial for achieving better yields and returns.

Table 5. Return on investment in tomato production with the soil treatments and Farmer Practices.


Bacterial wilt control	Varieties	Cost of investment	Net income	Net Profit	The return of investment
		(USD/ 500 m ²)			%
Soil Treatments	EW 815	319.41	559.67	240.3	75.22
	EW 834	319.41	720.63	401.2	125.62
Farmer Practice	EW 815	362.46	359.08	-3.4	-0.93
	EW 834	362.46	312.03	-50.4	-13.91

Conclusion and Recommendation

This study was primarily conducted to determine the role of Soil Treatments (Koppert Products) in influencing bacterial wilt incidence and yield in tomato production. The study also demonstrated a reduction in the disease incidence and severity of bacterial wilt, as well as a significant increase in tomato yield with the application of soil treatments, highlighting their role in enhancing productivity.

The decrease in bacterial wilt disease incidence and severity alongside the increase in yield underscores the significance of Soil Treatment in vegetable production, aiding in the mitigation of biotic stress conditions and enhancing agricultural outcomes. Moreover, the return on investment (ROI) highlights the economic advantages of adopting soil treatments, offering clear financial benefits for farmers considering more sustainable and profitable approaches in tomato production.

These findings are important for farmers, showing that using innovative solutions like soil treatments might help crops withstand disease better, leading to higher yields and income. However, it's essential to continue researching and monitoring to ensure the long-term sustainability of these methods. Conducting multiple trials is essential for accurately analyzing

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yields across different tomato varieties. Moreover, measuring the levels of bacterial wilt pathogens in the soil before and after experiments is crucial for evaluating the effectiveness of soil treatments, and this aspect should be included in future trials.

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