



Management of tomato leaf curl disease through an integrated approach

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Abstract

Tomato leaf curl disease (ToLCD), caused by *begomoviruses* and transmitted by *Bemisia tabaci*, is a major constraint on tomato production. An integrated disease management experiment was conducted at the Agricultural Research Station, Hagari, UAS, Raichur during *rabi* 2025-26 to evaluate insecticidal and immunomodulator based treatment schedules against tomato leaf curl virus (ToLCV) and its vector. The treatments comprised common nursery protection measures followed by foliar application of different insecticides, immunomodulator and neem oil. The results showed that seed treatment with Thiamethoxam 30% FS at 10 ml/kg - Raising seedlings under Nylon net - Nursery spray with Imidacloprid 17.8 SL at 0.5ml/l followed by foliar spray of Flonicamid 17.8 SL (0.3 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT recorded the minimum whitefly population and tomato leaf curl disease incidence, indicating its effectiveness for integrated management of tomato leaf curl disease under field conditions.

Keywords: *Bemisia tabaci*, tomato leaf curl disease, tomatough, neem oil, integrated disease management

Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop and is affected by several viral diseases, among which tomato leaf curl disease (ToLCD) is a major constraint on production. The disease is caused by a *begomovirus* and is transmitted by the whitefly, *Bemisia tabaci*. In South India, tomato leaf curl disease has been reported as an important production constraint, particularly because of the persistence of the vector and availability of alternate hosts (Saikia and Muniyappa, 1989)^[3].

Management of ToLCD is difficult because the disease is closely associated with its insect vector. Reduction of *B. tabaci* populations is therefore an important component of disease management. Earlier studies have demonstrated the effectiveness of insecticidal interventions for reducing whitefly populations and tomato leaf curl disease incidence (Singh and Prajapati, 2014; Sri and Jha, 2018)^[6, 7].

Therefore, the present study was undertaken to evaluate an integrated management approach involving nursery protection, insecticides, an immunomodulator and neem oil for the management of tomato leaf curl disease and its vector under field conditions.

Materials and Methods

1. Experimental site and design

The experiment was conducted at Agricultural Research Station, Hagari, UAS, Raichur, during *rabi* 2025-26. The experiment was laid out in a randomised block design (RBD) with eight treatments, including an untreated control and three replications. Each plot measured 3.15 × 3.0 m, with a spacing of 45 × 60 cm. Border cropping with sorghum was adopted.

2. Treatment details

A common preventive treatment was imposed in the treated plots consisting of thiamethoxam 30% FS @ 10 ml kg⁻¹ seed, raising seedlings under nylon net protection and nursery spraying with imidacloprid 17.8 SL @ 0.5 ml l⁻¹. Subsequently, different systemic insecticides were applied at 15 days after transplanting (DAT), followed by Tomatough at 30 DAT and neem oil at 45 DAT. The details of treatments are mentioned in Table 1.

3. Disease and whitefly population assessment

Disease incidence and whitefly population were recorded before spraying and after the first, second and third sprays at 15, 30 and 45 DAT, respectively. Disease incidence was calculated as the percentage of infected plants in relation to the total number of plants observed in each plot. Whitefly population was recorded from one leaf each of the upper, middle and lower canopy of five randomly selected plants from each plot. Cumulative fruit yield was recorded from successive harvests. Disease incidence was calculated according to Wheeler (1969)^[11].

$$\text{Disease incidence (\%)} = \frac{\text{Number of plants infected}}{\text{Total number of plants observed}} \times 100$$

Result and discussion

1. Effect of integrated disease management on tomato leaf curl disease

The integrated treatments differed significantly in their ability to suppress tomato leaf curl disease. Disease incidence increased progressively with crop growth in all treatments, but the increase was considerably lower in treated plots than in the untreated control (Table 1). After

the third spray, T₇ recorded the minimum disease incidence (28.42%), followed by T₂ (33.02%) and T₆ (35.29%). The untreated control recorded the highest disease incidence (68.35%). T₇ also recorded the highest reduction in disease incidence over the control (58.42%), followed by T₂ (51.69%) and T₆ (48.37%). The maximum fruit yield was recorded in T₇ (468.70 q ha⁻¹), followed by T₂ (419.20 q ha⁻¹) and T₆ (391.80 q ha⁻¹). The untreated control recorded the minimum yield (169.20 q ha⁻¹). Thus, the treatment comprising flonicamid + Tomatough + neem oil, along with the common nursery protection measures, was the most effective treatment and statistically superior in reducing tomato leaf curl disease.

2. Effect of integrated disease management on whitefly population

The treatments significantly influenced whitefly population. The population remained comparatively low in treated plots, whereas a progressive increase was observed in the untreated control (Table 2). After the third spray, T₇ recorded the minimum whitefly population throughout the observation period, reaching 0.25 whiteflies per leaf at 45 DAT, followed by T₂ (0.39) and T₆ (0.46). The untreated control recorded the maximum population (2.20 whiteflies per leaf) at 45 DAT. The minimum whitefly population in T₇ was accompanied by lower disease incidence and higher fruit yield, indicating the importance of effective vector suppression in reducing disease development.

The better performance of the integrated treatments demonstrates the importance of sustained management of *B. tabaci* in reducing tomato leaf curl disease. Since the vector plays a central role in virus transmission, suppression of its population can restrict secondary spread of the virus within the crop. A similar association between effective whitefly suppression and reduced tomato leaf curl disease has been reported by Mane *et al.* (2024) [1]. The superior performance of the flonicamid based treatment may be attributed primarily to its effectiveness against *B. tabaci*. Sadhana *et al.* (2021) [4] reported substantial suppression of whitefly with flonicamid, while Sudha (2018) [9] also reported better

performance of flonicamid against leaf curl-associated disease.

The inclusion of neem oil in the treatment schedule could have provided an additional vector management effect. Sridhar *et al.* (2017) [8] reported improved mortality of *B. tabaci* when neem-based products were used in combination with insecticides. The improved performance of the treatment containing Tomatough may also be associated with its plant defence inducing properties. Seaweed based biostimulants have been reported to improve plant growth, defence and stress tolerance (Shukla *et al.*, 2019) [5], while *Kappaphycus alvarezii* derived formulations have been associated with salicylic acid mediated defence responses (Roy *et al.*, 2022) [2].

The inclusion of nursery protection in the integrated module is also important because early infestation by *B. tabaci* can initiate disease establishment. Protection of seedlings with nylon net in combination with insecticide application has previously been shown to reduce tomato leaf curl disease (Swamy, 2019) [10].

Conclusion

The integrated management approach effectively reduced tomato leaf curl disease and its vector under field conditions. The treatment comprising seed treatment with Thiamethoxam 30% FS at 10 ml/kg - Raising seedlings under Nylon net - Nursery spray with imidacloprid 17.8 SL at 0.5ml/l followed by foliar spray of Flonicamid 17.8 SL (0.3 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT was the most effective treatment, resulting in the minimum disease incidence and whitefly population and the maximum fruit yield. The findings demonstrate the potential of combining early nursery protection, effective vector management, plant defence induction and botanical intervention for integrated management of ToLCD.

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Table 1: Effect of integrated disease management (IDM) against tomato leaf curl virus disease in tomato under field conditions

Treatments	Treatment details	Disease incidence (%) *				Reduction over control (%)	Yield (q/ha)
		Before 1st spray	15 DAT	30 DAT	45 DAT		
T1	Seed treatment with Thiamethoxam 30% FS at 10 ml/kg - Raising seedlings under Nylon net - Nursery spray with imidacloprid 17.8 SL at 0.5ml/l	4.07 (11.46)	8.12 (16.47)	21.23 (27.43)	56.45 (48.70)	17.41	235.40
T2	T1 -Foliar spray of Afidopyropen 50 G/L DC (2 ml/l) at 15 DAT -Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	2.89 (9.78)	2.89 (9.78)	8.65 (17.11)	33.02 (35.07)	51.69	419.20
T3	T1- Foliar spray of Diafenthurion 50 WP (1 g/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	3.98 (11.36)	6.00 (14.18)	18.00 (25.11)	44.00 (41.55)	35.63	317.60
T4	T1 - Foliar spray of Tolfenpyrad 15EC (1 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	4.04 (11.40)	6.00 (14.18)	15.02 (22.80)	38.38 (38.28)	43.85	362.80
T5	T1 - Foliar spray of Thiamethoxam WG (0.2 g/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	2.91 (9.83)	6.80 (15.04)	18.73 (25.63)	48.54 (44.17)	28.98	278.40
T6	T1- Foliar spray of Dinotefuron 20 SG (0.2 g/l) at 15 DAT -	2.97	3.95	11.88	35.29	48.37	391.80

	Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	(9.92)	(11.31)	(20.16)	(36.45)		
T7	T1- Foliar spray of Flonicamid 17.8 SL (0.3 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	2.95 (9.89)	2.95 (9.89)	8.84 (17.30)	28.42 (32.22)	58.42	468.70
T8	Untreated control	5.77 (13.89)	15.41 (23.09)	41.37 (40.03)	68.35 (55.86)	---	169.20
	S. Em. $\pm$	0.96	0.85	0.41	0.88	---	9.63
	C. D. at 5%	2.91	2.57	1.24	2.67	---	29.22

*Means of three replications; Values in parenthesis are arc sine transformed values; DAT= Days after transplantin

Table 2: Effect of IDM on whitefly population on tomato under field conditions

Treatments	Treatment details	No. of whiteflies per leaf*			
		Pre count	15 DAT	30 DAT	45 DAT
T ₁	Seed treatment with Thiamethoxam 30% FS at 10 ml/kg - Raising seedlings under Nylon net - Nursery spray with imidacloprid 17.8 SL at 0.5ml/l	0.86 (1.16)	1.04 (1.24)	1.49 (1.41)	1.81 (1.52)
T ₂	T1 -Foliar spray of Afidopyropen 50 G/L DC (2ml/l) at 15 DAT -Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.82 (1.15)	0.75 (1.12)	0.56 (1.03)	0.39 (0.94)
T ₃	T1- Foliar spray of Diafenthurion 50 WP (1 g/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.83 (1.15)	1.07 (1.25)	0.92 (1.20)	0.76 (1.12)
T ₄	T1 - Foliar spray of Tolfenpyrad 15EC (1 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.84 (1.16)	0.88 (1.17)	0.71 (1.10)	0.54 (1.02)
T ₅	T1 - Foliar spray of Thiamethoxam WG (0.2 g/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.85 (1.16)	0.96 (1.21)	0.81 (1.14)	0.65 (1.07)
T ₆	T1- Foliar spray of Dinotefuron 20 SG (0.2 g/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.81 (1.14)	0.79 (1.13)	0.61 (1.05)	0.46 (0.98)
T ₇	T1- Foliar spray of Flonicamid 17.8 SL (0.3 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT	0.80 (1.14)	0.60 (1.05)	0.41 (0.95)	0.25 (0.87)
T ₈	Untreated control	0.87 (1.17)	1.83 (1.52)	2.03 (1.59)	2.20 (1.64)
	S.Em $\pm$	0.0057	0.0085	0.0071	0.0061
	CD at 5%	0.0173	0.0257	0.0216	0.0186

*Means of three replications; Values in parenthesis are square root transformed values; DAT= Days after transplanting



Seed treatment with Thiamethoxam 30% FS at 10 ml/kg - Raising seedlings under Nylon net - Nursery spray with imidacloprid 17.8 SL at 0.5ml/l followed by foliar spray of Flonicamid 17.8 SL (0.3 ml/l) at 15 DAT - Immunomodulator (Tomatough) (4ml/l) at 30 DAT - Neem oil (1500 ppm) (5 ml/l) at 45 DAT



Untreated control plot

Fig 1: IDM of ToLCV disease of tomato under field conditions

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