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MANAGEMENT OF LEAF CURL AND BUD NECROSIS VIRUS DISEASES OF TOMATO

C. RUTH, M. RAJA NAIK, C. H. CHINNABBI, M. RAMAIAH AND K. GOPAL
Department of Plant Pathology,
Dr. YSR Horticultural University, College of Horticulture and Research Institute,
Anantharajupeta – 516105, Kadapa District, Andhra Pradesh, INDIA.
e-mail: ruthbenerjee1@gmail.com

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***Corresponding author**

ABSTRACT
The field experiment was conducted to know the management of Leaf curl and bud necrosis virus diseases of tomato. Seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + Neem seed kernal extract @5% + Spinosad 0.3ml/L is found superior in controlling the viral diseases in tomato. Border crop with Sorghum and yellow sticky traps @ 10 per Ha were also used in controlling the viral diseases in tomato. In this treatment, lowest percent leaf curl disease incidence was recorded 10.72, 12.10, 12.97 at 30, 45 and 60 days after planting. White fly and thrips population were low and recorded 1.18/plant and 0.51/plant respectively after post treatment. Least incidence of Bud necrosis disease incidence was recorded 6.60, 9.93 and 14.88 at 30, 45 and 60 days after planting. The highest yield was recorded 28.92 t/ha. Low Area under disease progress curve (AUDPC) values (843.93), (1042.67) were calculated for selecting the best treatment and the disease incidence was quantified in the management of leaf curl and bud necrosis diseases in tomato respectively. According to AUDPC values, seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + N.S.K.E.@5% + Spinosad 0.3ml/L. along with border crop with Sorghum and yellow sticky traps @ 10 per Ha. was selected as best treatment.

INTRODUCTION

Tomato is an important vegetable crop grown in Kurnool district in Andhra Pradesh. Leaf curl and Bud necrosis virus or Peanut bud necrosis virus are most prevalent causing severe losses to the crop. The basic idea of the research problem is reducing the number of sprayings and use of different mechanical, plant extracts and chemical methods. Leaf curl disease of tomato (*Lycopersicon esculentum* Mill.) caused by Tomato leaf curl geminivirus which is vectored by whitefly *Bemisia tabaci*, is a serious threat to tomato production worldwide (Varma, 1993). The progress of the disease coincides with the build-up of whitefly population. In tomato crop, a loss of 1.26 t in fruit yield per hectare due to infection by Peanut bud necrosis disease caused by peanut or ground nut bud necrosis virus was reported. (Singh and Tripathi, 1991). Ground nut bud necrosis virus in tomato (GBNV-TO), a member of the genus Tospo virus of the family Bunyaviridae, is the most economically important virus of peanut in the Indian subcontinent which is transmitted by melon thrips, *Thrips palmi* in a propagative manner (Reddy *et al*., 1992). GBNV-To disease caused by tospo virus was reported on groundnut as early as 1949 (Reddy *et al*., 1995). The first record of the virus with symptoms similar to that of tospoviruses was seen in the Annual Report of the Indian Agricultural Research Institute in 1949. Tomato spotted wilt virus (TSWV) is one of the most destructive viruses limiting tomato production worldwide (Rosello *et al*., 1995). It was first reported in Australia in 1915. In India, the occurrence of TSWV on tomato (Prasada Rao *et al*., 1980) and several other crop plants, such as pea (Prasada Rao *et al*., 1985), mungbean and urdbean (Amin 1985),cowpea, chilli, and brinjal (Prasada Rao *et al*., 1987) was reported based on the thermal inactivation point, thrips transmission and serological relationship with the virus. In addition, GBNV was reported on soybean (Thakur *et al*., 1996), potato (Akram *et al*., 2004), cotton (Gossypium hirsutum) and sem (Lablab purpureus) (Jain *et al*., 2005). Prasada Rao *et al* (2004) reported that reduction in incidence of Groundnut bud necrosis virus in black gram and increasing in yield (7.3% to 21.26%), when seeds are treated with Imidacloprid @ 2 ml / Kg and one spray (0.25 ml/L) at 30 DAS .Similar works were carried out with integrated approach (Borsha Rani *et al*., 2016). Reducing the thrips and white fly populations using appropriate insecticides can help to reduce the virus spread. There is need to reduce frequent use of insecticides may also lead to development of insecticide resistance in thrips and white fly populations. Hence, strategic planning with cultural practices and botanical agents along with chemicals would offer great scope in the management of virus diseases. So the main objective is to find out effective management of the viral diseases in tomato.

MATERIALS AND METHODS

The field experiment was carried out during kharif 2009, 2010, 2011, 2012 and 2013 at Horticultural Research Station, Mahanandi, Kurnool dt., Andhra Pradesh**. It** was conducted in randomized block design with a spacing of 60x45 cm with 15 treatments. Local popular tomato hybrid, NP-5005 was grown. General agronomical practices were followed for

management of the crop. Thrips population counts were taken from 5 leaves per plant (Top-2, middle-2, bottom-1) from each treatment at before and after spray. White fly population also recorded and disease incidence was recorded starting from 30 DAP, 45 DAP, 60 DAP. The treatments were imposed in nursery and main field of tomato crop.) Area under disease progress curves (AUDPC) were calculated to differentiate and select the best treatment, the disease incidence was quantified by using the following formula.

$$AUDPC = \sum_{i-1}^{k} 1/2(Si + Si - 1)d$$

where Si = disease incidence at the end of the week i

K = The number of successive evaluations of disease

d = Interval between two evaluations

Treatments adopted:

T_1 : Nursery raising under nylon net

$T_{2:}$ Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed

T_3 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray @ 1g/L in nursery stage

T_4 : Seed treatment with Imidacloprid (Gaucho @ 5g / Kg seed + N.S.K.E.@ 5% spray in nursery stage

T_5 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Root dip with chloripyriphos @ 2ml/L

T_6 : Root dip alone with chloripyriphos @ 2ml/L

T_7 : Seed treatment with Imidacloprid (Gaucho @ 5g / Kg seed + Acephate spray 1g/L

T_8 : Seed treatment with Imidacloprid (Gaucho @ 5g / Kg seed + N.S.K.E.@5%

T_9 : Seed treatment with Imidacloprid Gaucho) @ 5g / Kg seed + Spinosad spray @ 0.3 ml/L

T_{10} : Seed treatment with Imidacloprid (Gaucho @ 5g / Kg seed + N.S.K.E.@5% + Spinosad 0.3 ml/L

T_{11}: Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E + Acephate 1g/L

T_{12} : N.S.K.E @5% alone (2sprays)

T_{13} : Acephate @0.1% alone (2sprays)

T_{14} : Spinosad@0.03% alone (2sprays)

T_{15} :Control.

*T_5 to T_{14} – combination with Barrier crop Sorghum and yellow sticky trap @ 10/ Ha

*T_7 to T_{15} – spray in main field.

RESULTS AND DISCUSSION

Pooled data from 2009 to 2012

Among 15 treatments, seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + N.S.K.E.@5% + Spinosad 0.3ml/L along with border crop Sorghum and yellow sticky traps @ 10/ha is found be superior in controlling the viral diseases in tomato. In this treatment, lowest percent leaf curl disease incidence was recorded 10.72, 12.10, 12.97 at 30, 45 and 60 days after planting, followed by seed treatment with Imidacloprid (Goucho) @ 5 g/kg + NSKE 5% + Acephate 1g/L (12.03, 13.17, 21.92) and seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed + Spinosad 0.3ml/L (13.60, 15.06 and 16.89) at 30, 45 and 60 days after planting (Table-1). White fly and thrips population were low and recorded 1.18/plant and 0.51/plant respectively after spray in the treatment,

Table 1: Management of Leaf curl disease of Tomato

Treatment details	30 DAP	45 DAP	60 DAP	AUDPC	Pooled Yield data(t/ha)
T_1 :Nursery raising under nylon net	16.62	17.08	18.34	1776.9	19.1
$T_{2:}$ Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed	22.65	24.03	26.76	1949.9	18.82
T_3 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray @ 1g/L in nursery stage	21.11	22.35	24.09	1872.3	19.97
T_4 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E. @ 5% spray in nursery stage	21.23	22.84	24.61	1782.5	19.49
T_5 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Root dip with chloripyriphos @ 2ml/L	21.43	24.26	25.75	1949.7	19.93
T_6 : Root dip alone with chloripyriphos @ 2ml/L	26.32	29.31	31.08	2259.54	17.55
T_7 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray 1g/L	14.32	17.03	18.92	1396.37	24.9
T8 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E.@5%	17.07	18.09	19.27	1442.97	22.24
T_9 : Seed treatment with Imidacloprid Gaucho) @ 5g / Kg seed + Spinosad spray @ 5%	13.6	15.06	16.89	1180.59	25.22
T10 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E.@5%+ Spinosad 0.3ml/L	10.72	12.1	12.97	843.93	28.92
T_{11}: Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E + Acephate 1g/L	12.03	13.17	21.92	993.58	25.9
T_{12} : N.S.K.E @5% alone (2sprays)	21.7	22.99	24.99	2013.06	21.97
T_{13} : Acephate @0.1% alone (2sprays)	20.76	22.37	23.81	2002.02	18.26
T_{14} : Spinosad@0.03% alone (2sprays)	20.84	20.93	23.29	1901.57	24.59
T_{15} :Control.	32.8	35.55	37.15	3074.68	14.47
CD @5%	1.68	1.47	1.55		
CV %	2.26	1.98	2.09		

Table2 : Management of Bud necrosis percent disease of Tomato

Treatment details	30 DAP	45 DAP	60 DAP	AUDPC	Pooled Yield data(t/ha)
T_1 :Nursery raising under nylon net	12.19	15.32	18.36	1880.0	18.86
$T_{2:}$ Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed	18.90	21.19	22.74	1851.86	18.35
T_3 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray @ 1g/L in nursery stage	16.38	18.35	21.91	1728.38	18.98
T_4 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E. @ 5% spray in nursery stage	18.11	20.36	23.56	1847.15	18.61
T_5 : Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Root dip with chloripyriphos @ 2ml/L	19.15	20.97	23.19	1884.32	18.95
T_6 : Root dip alone with chloripyriphos @ 2ml/L	20.21	23.67	25.34	2240.64	17.00

Table3: Whitefly and Thrips population in the management of viral disease of Tomato (Four years pooled data from 2009-10 to 2012-13)

	Treatment	White fly Population		Thrips population	
		Pre treatment (Before spray)	Post treatment (After spray)	Pre treatment (Before spray)	Post treatment (After spray)
T_1	Nursery raising under nylon net	2.04	2.02	1.71	1.87
T_2	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed	3.84	3.26	1.23	1.22
T_3	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray @ 1g/L in nursery stage	2.84	3.08	2.32	2.16
T_4	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed +N.S.K.E.@ 5% in nursery stage	1.87	1.69	0.94	0.92
T_5	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Root dip with chloripyriphos @ 2ml/L	2.81	2.21	1.32	1.23
T_6	Root dip alone with chloripyriphos @ 2ml/L	3.64	2.92	2	2.05
T_7	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + Acephate spray g/L	3.77	3.83	1.83	1.42
T_8	Seed treatment with Imidacloprid (Gaucho) @ 5g/Kg seed + N.S.K.E.@ 5%	3.74	2.23	2.1	1.76
T_9	Seed treatment with Imidacloprid Gaucho) @ 5g/Kg seed + Spinosad spray @ 0.3m/L	4.07	3.09	1.68	1.41
T_{10}	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed + N.S.K.E @ 5% + Spinosad 0.3ml/L	2.75	1.18	1.34	0.51
T_{11}	Seed treatment with Imidacloprid (Gaucho) @ 5g / Kg seed +N.S.K.E + Acephate 1g/L	3	1.49	1.18	0.91
T_{12}	N.S.K.E @5% alone (2sprays)	2.61	2.16	2.26	1.28
T_{13}	Acephate @0.1% alone (2sprays)	3.06	2.33	1.69	1.24
T_{14}	Spinosad@0.03% alone (2sprays)	2.31	1.69	2.27	1.62
T_{15}	Control.	4.76	4.57	2.96	2.79
	CD @ 5%	0.53	0.61	0.32	

seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + N.S.K.E.@5% + Spinosad 0.3ml/L(Table-3). Least incidence of Bud necrosis disease incidence was recorded 6.60, 9.93 and 14.88 at 30, 45 and 60 days after planting, in the treatment, seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + N.S.K.E.@5% + Spinosad 0.3ml/L followed by seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + NSKE 5% + Spinosad 0.3ml/L (9.62, 12.38. 14.88) (Table-2). Low Area under disease progress curve (AUDPC) values (843.93), (1042.67) were calculated in the management of leaf curl and bud necrosis diseases in tomato respectively. The highest yield was recorded (28.92 t/ha) in the treatment, seed treatment with Imidacloprid (Goucho) @ 5 g/kg seed. + N.S.K.E.@5% + Spinosad 0.3ml/L.

Savarni Tripathi and Anupam Varma(2002) reported that the use of polythene bags to cover tomato plants (PC) and polythene sheets as mulch were found most effective in reducing the disease incidence and promoting the growth and yield of tomato plants as compared to other treatments. Thiribhuvanamalai *et al*. (2013) revealed that, in US 618 tomato hybrid foliar spray with Imidacloprid (0.0375%) 7 th and 30 th DAT; *Pseudomonas fluorescens* (Pf-1) (2%) + butter milk (0.3%) on 15,30 and 45 DAT recorded minimum incidence of 0.9 per cent peanut bud necrosis compared to the untreated control (21.0 per cent incidence). The population of whitefly varies from year to year and place to place (Varma, 1984). The incidence of leaf curl disease was correlated with the whitefly population (Saikia and Muniyappa, 1989)

Coupled with the seed treatment, vector control with pesticide and neem seed kernel extract spray 3-4 strips of sorghum as barrier crop all around the tomato field as barrier crop and the seed sown after seed treatment with imidacloprid @ 5 g / kg seed and spray with spinosad @0.3 m/L was found to be the best management practice against bud necrosis and leaf curl viral diseases.

Imidacloprid was ideally suited for seed treatment because of

its excellent systemic activity. Studies conducted on *F. fusca* (Burries *et al.,* 1995; Graham, 1999) and *T.tabaci* (E1-Hamady and Shloa, 1999) showed that imidacloprid (Gaucho 480) seed treatment significantly reduced both adult and immature thrips and gave high levels of long term control (Allen *et al.,* 1998, 2000; Cook *et al*., 1998). Neverthless, Santos and Santos (1999) reported that imidacloprid seed treatment was not effective against cotton thrips.

Imidacloprid was a flexible insecticide that could be used as a foliar treatment. Tests conducted on *T. palmi* (Germeli *et al.,* 1993; Menoto, 1993; Seal *et al.,* 1994) and *F. schultzei* (Albuquerque *et al*., 1999) showed that imidacloprid (Confidor 350 SL / Provado) gave effective control of thrips, with residual effect for 20 days (Albuequerque *et al*., 1999). In addition, imidacloprid had both antifeeding and repellency mode of action and was safe to beneficial insects (Seidel and Matthiessen, 1999).

Seed treatment with imidacloprid@0.25 ml/l + nursery net+ foliar spray with imidacloprid @ 2ml/l at 15, 30, 45, 60 DAT was the most effective in reduction of disease incidence and vector population count with maximum yield of 91.27 q/ha. Disease incidence of 14.8% (CMV+PVY), 7.4% (ChLCV), 11.1% (GBNV) with average of 11.1% and average vector population count of 3.19 nos.(aphid), 3.43 nos.(whitefly) and 16.33 nos.(thrips) were recorded in the treatment T_{12} which was much lesser as compared to control.(Borsha Rani *et al.* (2016)

Seed treatment with imidacloprid @5gm/kg seed and spray of the chemical spinosad and incorporated with sorghum as barrier crop along with yellow sticky traps recorded lowest incidence of bud necrosis in tomato. These results were in agreement with that of Suzuki *et al.* (1982); Cho *et al.* (1984); Ramakrishna *et al.* (1984); Burries *et al.* (1995), Pappu *et al.* (2000) on the management of the bud necrosis in tomato. Treatments having plastic mulching and marigold intercropping found to reduce the air borne diseases of tomato than the non mulched and non intercropped. (Jambhulkar, 2012)

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