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Research article

BIO-EFFICACY OF NEWER INSECTICIDES AGAINST TOMATO LEAF CURL VIRUS DISEASE AND ITS VECTOR WHITEFLY (BEMISIA TABACI) IN TOMATO

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ABSTRACT: Tomato leaf curl begomovirus and its vector whitaefly (*Bemisia tabaci*) are the major limiting factors, which cause substantial yield loss in tomato. Present investigations on *Invitro* efficacy of new insecticide molecules on whitefly mortality and leaf curl virus transmission revealed that adult mortality varies with the length of incubation period of different insecticides, as increase in the concentration of insecticides, adult mortality was more in the initial hrs of incubation. Among the test chemicals, cyantraniliprole 10 OD at 60 and 75 g.a.i/ha have knockdown effect and caused 100 per cent mortality at 48 hrs after treatments and also recorded least virus transmission (10 and 5 % respectively). Whiteflies remained active and caused 100 per cent transmission of leaf curl virus in the untreated check. The incidence of *B. tabaci* and tomato leaf curl virus disease (disease inoculums) was stastically varied with respect to different dose of insecticides evaluated at two different levels of observation. Among the different concentrations of new molecule cyantraniliprole (Cyazypyr 10 OD) (45, 60 and 75 g.a.i/ha) tested, cyantraniliprole 10 OD at 60 and 75 g.a.i/ha. were found more effect in reducing both whitefly and disease incidence at first and final observation with the least whitefly population and leaf curl disease incidence. Correspondingly the yields were high in plot received cyantraniliprole 10 OD 75 g.a.i/ha (32.5tons/ha) and significantly superior over the standard check triazophos (23.5tons/ha.) followed by cyantraniliprole 10 OD at 60 g.a.i/ha (29.2 tons/ha) and cyantraniliprole 10 OD at 45 g.a.i/ha (27.4 tons/ha).

Key words: leaf curl virus disease, whitefly, insecticides, management

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular and widely grown vegetable crops of both tropics and subtropics of the world, belonging to the family Solanaceae. It is grown for its edible fruit and is an esteemed source of vitamin A and C. In the world, tomato is cultivated over an area of 46.15 lakh hectares with an annual production of 1279.9 lakh tones with the productivity of 27.73 tons/ha. In India, it occupies an area of about 5.35 lakh hectares producing over 93.62 lakh tonnes with the productivity of 17.5 tons/ha (Indian Horticulture database, 2006). In Karnataka, the crop is cultivating to an extent of 44,500 hectares with a production of 11.8 lakh tones and productivity of 26.7 tons/ha. (Anon,2006). Although area under tomato cultivation is high, crop is suffering from large number of diseases. Among them viral diseases, leaf curl virus complex caused by tomato leaf curl begomovirus and its vector whitefly (*Bemisia tabaci*) are the major limiting factors, which cause substantial yield loss in India and worldwide (Sastry and Singh, 1973; Muniyappa, 1980, Muniyappa and Veeresh, 1984; Saikia and Muniyappa, 1989; Harrison *et al.*, 1991; Muniyappa *et al* 2000, Reddy *et al.*, 2005). ToLCV disease incidence is correlated with the size of the *B.tabaci* population. The incidence of ToLCV in tomato growing areas of Karnataka range from 17 to 53 per cent in July - November and 100 per cent in crops grown in February - May. Fifty to 70 per cent yield loss was observed in tomato cv. Pusa Ruby grown in February - May. Yield loss exceeded 90 per cent when plants were infected occurred within four weeks after transplanting in the main field (Sastry and Singh, 1973; Seetaramareddy, 1978; Muniyappa and Saikia, 1989). The incidence of ToLCV disease in the crop depends primarily on the immigration of vectors from alternative hosts, which act as reservoir of both virus and vector and the ease with which the vectors could acquire the virus from infected plants had little impact on disease incidence in the tomato crop. It is also appeared that very low rate of vector immigration into tomato crop would suffice to cause almost total infection (Ramappa *et al.*, 1998, Holt *et al.*, 1998). Though it is an evident that in the infectivity test, 4 to 46 per cent of the whiteflies *B.tabaci* collected from ToLCV infected fields were found viruliferous (Ramappa, 1993). *B. tabaci* trapped on cylindrical sticky yellow traps on the day of tomato transplanting in the main field, The migration of *B.tabaci* increased in subsequent days of planting, indicating that only the migrating *B.tabaci* are highly responsible for the ToLCV spread (Venkatesh, 2000).

Despite the inherent difficulties associated with vector borne viruses, several insecticides were evaluated by spraying of insecticides, dimethoate, methyl parathion, oxydematon methyl, phorate and phospomedon applied from the nursery stage, resulted not only in reduction of whitefly population but also in the disease incidence of tomato leaf curl virus in India (Sastry and Singh, 1974; Singh et al., 1973, 1975 and 1978 and Somashekar et al., 1997). Combined treatment of nylon net covering for tomato nursery beds followed by 2- 3sprays of monocrotophos or dimethoate or cypermethrin after transplanting in the field was effective in reducing the spread of leaf curl virus in tomato (Saikia and Muniyappa, 1983). A number of different classes of chemicals have been used to reduce whitefly populations including chlorinated hydrocarbons, organophosphates, neonicotinoids, pyridine-azomethines, and pyrethroids. In many locations whiteflies have developed resistance to many of these chemicals and efficacies have decreased over time (Ahmed et al., 2001; Polston & Anderson, 1997). In addition to these insecticides, oils, insecticidal soaps, and insect growth regulators have been used. The most effective and widely used class of insecticides to reduce whitefly populations is the neonicotinoids of which at least three (thiomethoxam, imidacloprid, and dinotefuron) have been used to reduce incidence of Tomato yellow leaf curl virus (TYLCV)-infected tomato plants in many tropical countries (Ahmed et al., 2001; Cahill et al., 1996;Polston & Anderson, 1997, Jane and Lapidot, 2007). Despite the use of several insecticides, the management situations have improved considerably in recent years with the advent of safer and more effective insecticides (Casida and Quistad, 1997). Hence, pesticides play an important role in managing vector populations by reducing the number of individuals that can acquire and transmit a virus, thereby potentially lowering disease incidence. In this research paper bio efficacy of selected new insecticide on whitefly (*B. tabaci*) mortality and leaf curl virus disease transmission and their ability in field to mitigate *B. tabaci* infestation as well as management of leaf curl virus disease were discussed.

MATERIALS AND METHODS

Invitro efficacy of selected insecticides on whitefly and Leaf curl virus disease:

Maintenance of Whitefly culture

The pure colony of whiteflies *B. tabaci* used for the *Invitro* evaluation and leaf curl virus transmission studies was maintained on cotton, *Gossypium hirsutum* cv. varalakshmi in an insect proof cages inside the glasshouse. The whitefly colony was regularly maintained by frequently introducing healthy cotton plants grown in earthen pots.

Maintenance of Tomato Leaf curl virus culture

Leaf curl virus (ToLCV) diseased tomato seedling with symptoms of vein cleared, severely curled and puckered leaves with bushy branch was collected from tomato fields in the experimental plots at University campus, Raichur was brought to the glasshouse and inoculated the leaf curl virus onto healthy tomato seedlings by using whitefly *Bemisia tabac*i. The virus inoculated seedlings were kept in insect proof cages for symptoms expression for period of three weeks. The seedlings exhibited symptoms of ToLCV were maintained frequently in the laboratory for transmission studies.

Method of evaluation of insecticides on *B. tabaci* and transmission:

For this study, healthy tomato hybrid Bejosheetal seedlings were raised in polyethene bags under protected condition in the glasshouse. Prior to whitefly inoculation, test seedlings were pre treated with respective insecticide as mentioned in the table.1. For each insecticide treatment, ten healthy seedlings were caged with insect proof inoculation bottles. After the treatment, each test seedling was inoculated with ten adult viruliferous whiteflies. Untreated seedlings were also caged with ten adult whiteflies/plant which were treated as check.

Table.1 Selected insecticides for evaluation

Sl. No	Name of Insecticides	Concentration
T1	cyantraniliprole 10 OD (Cyazypyr)	45 g.a.i/ha.
T2	cyantraniliprole 10 OD (Cyazypyr)	60 g.a.i/ha.
T3	cyantraniliprole 10 OD (Cyazypyr)	75 g.a.i/ha.
T4	Spinosad 45 SC (Tracer)	56 g.a.i/ha
T5	Emamectin Benzoate 5 SG (Proclaim)	8.5 g.a.i/ha
T6	Traizophos 40 EC (Hostathion)	500 g.a.i/ha.
T7	Control	Un-treated control

Method of leaf curl virus inoculation:

Healthy colony of whiteflies was collected using an aspirator and released to acquisition bottle containing leaf curl virus diseased tomato plant. Whiteflies were allowed to feed on disease branch for a period of 24 hrs as an acquisition period to acquire virus sap. After, 24 hrs of acquisition access period, whiteflies of known number (ten) were collected and inoculated to each tomato seedlings which were pre treated or sprayed with the respective dose of insecticide. For each insecticide treatment, ten seedlings were inoculated. Same was repeated for all the treatments. In the control, where untreated or unsprayed seedlings were caged with ten viruliferous whiteflies. Observation on adult *B. tabaci* mortality at different intervals was made and the rate of per cent disease transmission also observed in different treatments based on number of plants produced symptoms out of the total plants inoculated.

Efficacy on whitefly mortality:

To assess the efficacy of insecticide on adult *B. tabaci* mortality, the percent mortality of *B. tabaci* for each insecticide treatment was calculated by counting the number of dead adults at regular interval of 24, 48 and 72hrs out of the total whiteflies inoculated in each replication. Average of ten plants for each treatment was finally counted. The same was repeated for all the treatments.

Efficacy on leaf curl virus transmission:

Observation was made on per cent leaf curl transmission based on number of seedlings exhibited symptoms out of the total plants inoculated in each replication of insecticide treatment.

Efficacy of insecticides on To LCV disease and whitefly under field condition:

Plan of experiment: A field experiment was carried out to know the efficacy of insecticides on tomato leaf curl virus disease and its vector whitefly *B. tabaci* during Kharif-2010 and 2011 at the research stations of University of Agricultural Sciences, Raichur. For the study, the Leaf curl virus susceptible tomato hybrid bejoo sheetal was sown in raised nursery bed measuring 12ft x 4ft (l x b) and seedling were protected by using 40 mesh nylon net measuring 12.5ft x 4.5ft x 2.5ft (l x b x h) for about 25 days. Twenty-eight days after sowing, healthy tomato seedlings were transplanted to main field at 75 x 60 cm spacing. For each treatment of insecticide, 35 plants (5 rows of seven plants in each row) of subplots were prepared. All the treatments were replicated three times in a randomised block design. Insecticides were sprayed at their respective concentration at second and fourth week of transplanting. Unsprayed plots served as check.

Evaluation of insecticide on Leaf curl virus Incidence: ToLCV disease incidence was recorded on each treated plot at weekly intervals by counting the number of infected plants based on the visual leaf curl virus symptoms. The observation was made at regular intervals of 4 weeks after first and second spray. The per cent disease incidence values are taken for analysis.

Evaluation of insecticide on Whitefly (B. tabaci) population:

Whitefly population was monitored by direct *B. tabaci* count on trifoliate leaf. Total of six leaves (Top middle and bottom) per plant was pooled for each plant. Five plants were observed for each week of observation in each treatment. Average value of *B. tabaci* for each treatment at regular intervals of 4 weeks after first and second spray and the data was analysed statistically. The crop yield was harvested separately during different harvests in all the replicas of all the treatments and the data was analyzed statistically.

RESULTS AND DISCUSSION

In vitro efficacy of selected insecticides on whitefly mortality and leaf curl virus transmission:

Invitro efficacy of insecticides on whitefly mortality and leaf curl virus transmission revealed that adult mortality varies with the length of incubation period of different insecticides, as increase in the concentration of insecticides, adult mortality was more in the initial hrs of incubation. Among the test chemicals, cyantraniliprole 10 OD at 60 and 75 g.a.i/ha have knockdown effect and caused 100 per cent mortality at 48 hrs after treatments. However, the per cent mortality found directly proportional to increase in the concentration of insecticides and the extension of period of incubation period (Fig.1a). Increased mortality in the respective test chemical caused proportionate decreased per cent leaf curl virus transmission. cyantraniliprole 10 OD at 45, 60 and 75 g.a.i/ha recorded least virus transmission of 20, 10, 5 % respectively followed by triazophos (40%). where as in untreated control, whiteflies remained active and caused 100 per cent transmission of leaf curl virus with all the inoculated seedlings exhibited leaf curl virus symptoms (Fig.1b).

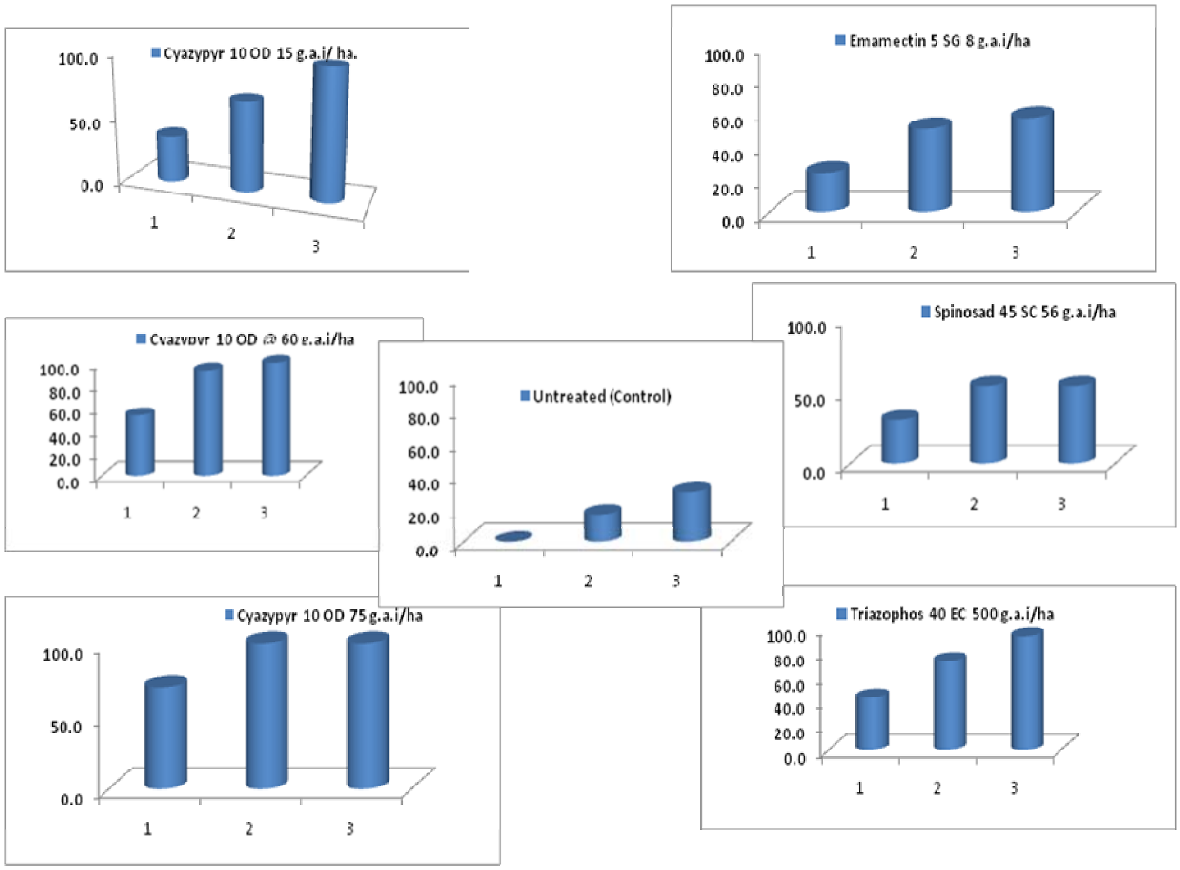

Fig.1a. *Invitro* efficacy of insecticides on mortality whiteflies at 24hr (1), 48hrs (2) and 72hrs (3) after treatment under greenhouse condition

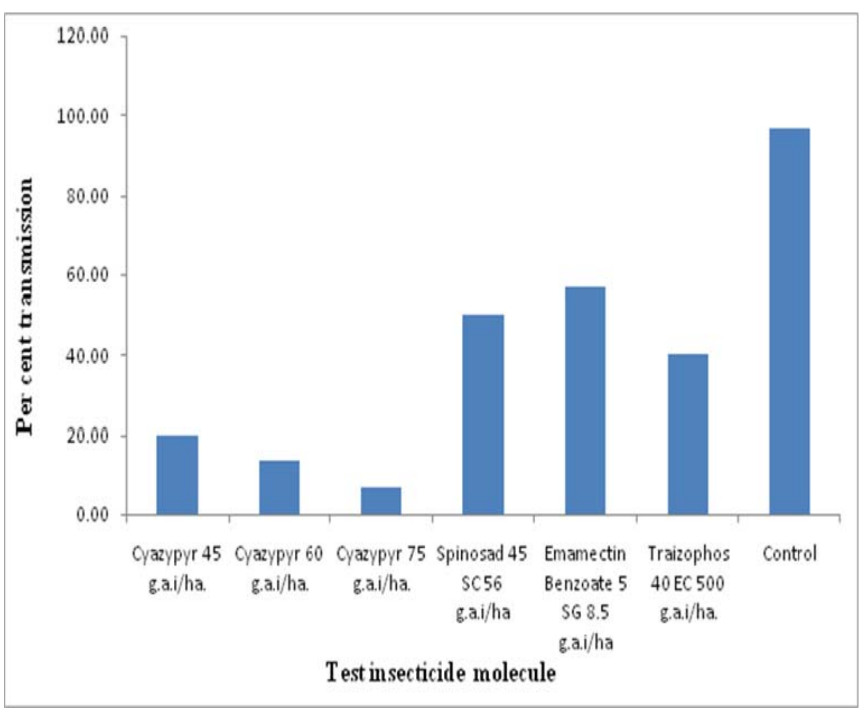

Fig.1b. Invitro efficacy of insecticides on per cent transmission of leaf curl virus under greenhouse condition

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Similar amount of *Cucurbit yellow stunting disorder virus* (CYSDV) transmission to potted Cucurbit plants treated with the lower dose of imidacloprid actually exceeded that of the untreated control plants. However, the higher dose provided some protection as virus infections were fewer at the 10 and 30 adult infestations, although differences among the three treatments (including untreated control) were non significant (All plants recorded positive for CYSDV expressed symptoms within 10–14 days following the IAP. At the three-adult density, 4–12 plants became infected in the high dose treatment compared to 3 of 12 in the low dose treatment or the untreated control plants (Jane, et al., 2009). The incidence of *B. tabaci* and tomato leaf curl virus disease (disease inoculums) was stastically varied with respect to different dose of insecticides evaluated at two different levels of observation. During the first and second level of observations (fourth week after first and second spray), the lowest incidence were found in cyantraniliprole 10 OD treated plots followed by standard check triazophos, where as spinosad and emamectin benzoate were found least effect in reducing whitefly and disease incidence. Among the different concentrations of new molecule cyantraniliprole 10 OD (45, 60 and 75 g.a.i/ha) tested, all were found statistically significant over the standard check triazophos 40 EC 500 g.a.i/ha. However, cyantraniliprole 10 OD at 75 g.a.i/ha. was found more effect in reducing both whitefly and disease incidence at first and final observation with the least whitefly population (0.5 *B.tabaci*/plant) and leaf curl disease incidence (25.2%) (Table.2). correspondingly the yields were high in plot received cyantraniliprole 10 OD 75 g.a.i/ha (32.5tons/ha) and significantly superior over the standard check triazophos (23.5tons/ha.) followed by cyantraniliprole 10 OD at 60 g.a.i/ha (29.2 tons/ha) and cyantraniliprole 10 OD at 45 g.a.i/ha (27.4 tons/ha). Where as in untreated check, the yield was greatly reduced (9.6 ton/ha) (Table-2).

Table. 2: Evaluation of insecticides on incidence of *B. tabaci* and tomato leaf curl virus disease (Pooled analysis of 2010 and 2011)

Treatment details	4th Week after first spray		4th week after second spray		Yield ton/ha.
	Avg. *B.tabaci*/Plant	PDI	Avg. *B.tabaci*/Plant	PDI	
Cyantraniliprole 45 g.a.i/ha.	1.3	14.2	0.8	39.8	27.4
Cyantraniliprole 60 g.a.i/ha.	1.0	12.0	0.7	32.7	29.2
Cyantraniliprole 75 g.a.i/ha.	0.9	7.9	0.5	25.2	32.5
Spinosad 45 SC 56 g.a.i/ha	1.6	18.4	1.4	62.1	15.6
Emamectin Benzoate 5 SG 8.5 g.a.i/ha	1.6	18.5	1.3	55.0	18.6
Traizophos 40 EC 500 g.a.i/ha.	1.2	12.3	1.2	44.4	23.5
Control	1.9	25.3	2.1	83.3	9.6
Sem	0.1	1.4	0.1	2.1	4.2
CD 0.01	0.3	4.2	0.3	6.6	6.3
CV %	12.3	16.1	14.1	7.5	17.2

Treatments: 7; Replication: 3; Design: RCBD; Tomato hybrid: Bejoosheetal; Spacing: 60cms x 45cms

Several insecticides dimethoate, methyl parathion, oxydematon methyl, phorate and phospomedon applied from the nursery stage, not only in reduction of whitefly population but also in the disease incidence of tomato leaf curl virus in India (Sastry and Singh, 1974; Singh et al., 1973, 1975 and 1978 and Somashekar et al., 1997). Combined treatment of nylon net covering for tomato nursery beds followed by 2- 3sprays of monocrotophos or dimethoate or cypermethrin after transplanting in the field was effective in reducing the spread of leaf curl virus in tomato (Saikia and Muniyappa, 1983). Besides, the most effective and widely used class of insecticides to reduce whitefly populations is the neonicotinoids of which at least three (thiomethoxam, imidacloprid, and dinotefuron) have been used to reduce incidence of Tomato yellow leaf curl virus (TYLCV)-infected tomato plants in many tropical countries (Ahmed et al., 2001; Cahill et al., 1996; Polston & Anderson, 1997, Jane and Lapidot, 2007).

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