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**Thakoor Pavan**
PhD. Research Scholar, Department of Agricultural Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

**Sunil Kr Ghosh**
Department of Agricultural Entomology, AINP on Agricultural Acarology, Directorate of Research, B.C.K.V, Kalyani, Nadia, West Bengal, India

**Suvash Chandra Bala**
Department of Agricultural Entomology, AINP on Agricultural Acarology, Directorate of Research, B.C.K.V, Kalyani, Nadia, West Bengal, India

**Corresponding Author:**
**Thakoor Pavan**
PhD. Research Scholar, Department of Agricultural Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

# Effect of abiotic factors on seasonal incidence and bio-efficacy of some newer insecticides against whitefly (*Bemisia tabaci* G.) on tomato crop (*Solanum lycopersicum* L.) in West Bengal

**Thakoor Pavan, Sunil Kr Ghosh and Suvash Chandra Bala**

**Abstract**
Tomato (*Solanum lycopersicum* L.) crop is susceptible to various insect pests of which whitefly (*Bemisia tabaci* Genn.) is the most predominant. Whitefly population first appeared in the field during 48$^{th}$ standard metrological week (SMW) that is 0.15 per three leaves. After that the population progressively increased and reached its peak (4.5whitefly per 3 leaves) in the 7$^{th}$ meteorological week when average temperature, relative humidity and bright sunshine were 21.9 $^{0}$C, 66.83% and 5.6 hrs respectively. Correlation studies between whitefly population and weather parameters revealed that whitefly population showed significant positive correlation with temperature maximum while significant negative correlation with relative humidity(maximum, minimum and average). Maximum population reduction was found in the insecticidal treatment Imidacloprid 30.5 SC @0.004% active ingredient concentration (90.62%) and Diafenthiuron 50 WP @ 0.05% active ingredient concentration (89.29%).These were followed by Dimethoate 30 EC @ 0.06%, Dinotefuran 20 SG @ 0.006%, Spinosad 45 SC @ 0.007%, Clothianidin 50 WDG @ 0.005% and Flonicamid 50 WG @ 0.015% active ingredient concentrations , which recorded (85.21, 78.03, 76.48, 71.00 and 68.46% reduction over control). In untreated control the maximum number of whiteflies recorded was 4.00 per 3 leaves.

**Keywords:** Tomato, whitefly, population dynamics, bio-efficacy

## 1. Introduction

Tomatoes originated in western South America, crossed Atlantic to Spain with the conquistadors in the 16th century, but only finally caught on in northern Europe in 19th century (Acquaah, 2002) [2]. Tomato is rich in minerals, fiber and vitamin A and B which are very essential for the human health. Tomato also contains carotene and lycopene the natural antioxidant. Lycopene is very essential which improves skins ability to protect against ultra-violate rays (Miller *et al.*, 2002) [14]. China ranks number one in production with 59.6 million tonnes followed by India with 20.70 million tonnes (Faostat, 2017) [13]. Share of West Bengal state in vegetable production is 14.60 per cent among India with 25.50 million tonnes. Area and production of tomato in West Bengal state is 57, 17,000 hectare and 12, 04, 43,000 tonnes. (Horticultural Statistics, 2017) [3]

According to Butani and Jotwani (1984) [4] whitefly is a polyphagous pest, found in most of the countries in tropics and sub tropics. Its main hosts are cotton, tobacco and some winter vegetables, including tomato. The infestation on this crop is sporadically severed. This pest sucks the cell sap from the various plant parts. The affected plant parts become yellowish, the leaves wrinkle, curl downwards and are ultimately shed. Besides the feeding damage, this insect also exudes honey dew which favours the development of sooty mould. In severe infestation, this black coating is so heavy that its interference with the photosynthetic activity of the plant resulting in stunted growth. The incidence and spread of the Tomato Leaf Curl Virus (TLCV) was directly correlated with whitefly population on tomato field (Gupta *et al.*, 2007) [12].

An abiotic factor is the long-term effect and determines what insects are present and how many generations are possible in a single active season, while weather is the short term or day to day effect, and plays primary role in influencing insect abundance and damage. These two probably are the most important factors that directly or indirectly limit the abundance the pests. Subba *et al.*, (2017) [18] reported that the maximum population level of whitefly

(*Bemisia tabaci* Genn.) infesting tomato (*Lycopersicon esculentus* L.) was maintained during 11th standard week to 18th standard week that is during 2nd week of March to 3rd week of March with peak population (0.47/leaf) was recorded. They also reported that weekly population counts on white fly on tomato showed non-significant negative correlation (p=0.05) with temperature and weekly total rainfall where as significant negative correlation with relative humidity. Ghosh (2014) [7] reported that the *Bemisia tabaci* on ladyfinger was active throughout the growing period with a peak population (3.98 white fly /leaf) and (4.33 /leaf) during 20$^{rd}$ SMW (standard meteorological week) (middle of May) in the pre-kharif and during 42$^{nd}$ -43$^{rd}$ SMW (middle of October) in the post kharif crop respectively. Sudden fall of population was found during July because of heavy rains. He also reported that whitefly showed insignificant positive correlation (p=0.05) with maximum temperature, minimum relative humidity whereas insignificant negative correlation with maximum RH and significant negative correlation with weekly total rainfall. Chakraborty (2012) [5] observed initiation of *B. tabaci* population on tomato crop at 48th standard meteorological week (SMW). Thereafter, it further increased first slowly up to 1st SMW then steadily up to 5th SMW attaining peak at 6th SMW which continued up to about 9th SMW. Thereafter, it declined slowly then abruptly indicating significant negative influence on *B. tabaci* population. Relative humidity showed positive influence on the population. White fly was found active throughout the year and highest population (1.66/leaf) on eggplant was recorded on 32 standard week in terai zone of West Bengal (Ghosh *et al.*, 2004) [8]. They also reported that whitefly had significant negative correlation with temperature and non-significant negative correlation with relative humidity and weekly total rainfall.

Indiscriminate use of chemical pesticides resulted in problems such as development of resistance in insects to pesticides, pest resurgence and accumulation of toxic residues in the ecosystem rendering the agriculture system unsustainable. So to have a good idea of what amount of pesticide is needed and which kind of pesticide is giving good control of whitefly this experiment is conducted. A rapid degradation of persistency was observed in imidacloprid than monocrotophos which has a great importance where fruits are consumed as raw or after little cooking like ladyfinger Ghosh *et al.*, 2012) [9]. Imidacloprid provided the best suppression of white fly populations (77.00 %), followed by microbial toxin spinosad *(Saccharopolyspora spinosa)* (69.80%) (Ghosh, 2012) [6]. Gosalwad *et al.*, (2015) [11] revealed that the insecticides imidacloprid 17.8 SL @ 20 g a.i/ha was most effective against whitefly, followed by acetamiprid 20 SP @ 15 g a.i/ha up to 25 and 45 days after transplanting. Ghosh *et al.*, (2013) [10] reported that a rapid degradation of persistency was observed in imidacloprid closely followed by neem oil than other insecticides tested. Satisfactory control (>60% population suppression) was achieved with imidacloprid and neem oil. Imidachloprid, having lower persistency is suitable for white fly control. Through the control of insect pests, the aim is to increase the production both in quantity and quality and to minimize the insecticidal residue in the surrounding environment.

## 2. Materials and Methods

### 2.1 Study Location and Period

The field experiment was conducted to study the seasonal incidence and bio efficacy of newer insecticides against whitefly an important sucking pests of tomato during Rabi 2017 at district seed farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. The geographical details of the site are 23° N latitude, 89° E longitude and 9.75 meter above mean sea level (MSL). The soil of the field is gangetic alluvial soil with sandy clay loam texture, neutral in reaction and moderate in fertility (Priyadarsini *et.al.*, 2019) [15]. The climate of this zone is humid subtropical with a winter spell during December - January.

### 2.2 Experimental Layout and Treatments

The experiment was conducted in Randomized Block Design with eight treatments and three replications and standard agronomic practices were carried out as usual. Each treatment plot is 5X4 meters. The observations on *Bemisia tabaci* were recorded at weekly interval. Observations on the number of adults of whitefly were recorded from three leaves per plant selected from top, middle and bottom canopy from the selected plants at weekly interval starting from 15 days after germination till the removal of the crop. Plots were kept completely free from the insecticidal spray. The details of treatments used for conducting experiment are given in (Table 1).

### 2.3 Observations

Observation on whitefly population was recorded from randomly selected plants. Data regarding weather parameters were collected from All India Co-ordinated Research Project on Agricultural Meteorology, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal. The observations on *Bemisia tabaci* for bio efficacy were recorded at 1 day before spray and 1, 5,7,10 and 14 days after spray. First spray was done at starting of pest incidence and the second spray was done 15 days after the first spray. All the insecticides were applied in the form of foliar spray with the help of knapsack sprayer. For deciding the quantity of spray fluid required per plot, the control plot was sprayed with water and the required spray fluids were determined. Spray fluid was prepared by mixing measured quantity of water and insecticide. Care was also taken to rinse the sprayer thoroughly before and after each spray with soap water to avoid contamination from treatment to treatment (Thakur *et. al.*, (2019) [19].

### 2.4 Data Analysis

The relationship between weather factors and sucking pest whitefly was established by using simple correlation coefficient and regression analysis.

Spraying of formulations was done in early morning hours to avoid the midday heat. The insecticidal concentration for different treatment was prepared and spraying was done using knapsack sprayer. Per cent reduction of whitefly population over control was calculated by the following formula (Abbott, 1925) [1]:

$$\text{Corrected \%} = \left(1 - \frac{\text{n in T after treatment}}{\text{n in Co after treatment}}\right) * 100$$

Where : n = Insect population , T = treated plot , Co = control plot.

## 3. Results and Discussion

### 3.1 Population dynamics of whitefly, *Bemisia tabaci* in tomato during Rabi season, 2016-2017

The seasonal fluctuation of whitefly, *Bemisia tabaci* was monitored in tomato under field condition during 2017 (Fig. 1). The abundance of this pest population is dramatically affected by changes of weather factors. However, whitefly population first appeared in the field during 48th standard metrological week (SMW) that is 0.15 per three leaves. After that the population progressively increased and reached its peak (4.5whitefly per 3 leaves) in the 7th meteorological week when average temperature, relative humidity and bright sunshine were 21.9 $^0$C, 66.83% and 5.6 hrs respectively. When the population first appeared in the field the crop was in early vegetative stage and this pest was highly active during winter period due to favourable environmental condition. Later the infestation of whitefly population gradually declined from 8th to 10th standard metrological week (SMW) when the atmospheric temperature was quite high.

Correlation studies between whitefly population and weather parameters revealed that whitefly population showed significant positive correlation with temperature maximum while significant negative correlation with Relative humidity (maximum, minimum and average) (Table 2). On the contrary non-significant positive correlation was found between whitefly population and temperature (minimum, difference and average) and bright sunshine hours. Rishikesh *et al.* (2015) [16] revealed that *B. Tabaci* found during 5 to 11 November with peak between 26th February to 4th March. Sharma *et al.* (2013) [17] observed that the correlation between whitefly and temperature (maximum and minimum) and sunshine was positive, while it was negative with relative humidity (maximum and minimum) and rainfall. A similar trend was also obtained in the present investigation. It is recorded that whitefly population was appeared in the early vegetative stage of the tomato crop and at this early stage as well as in the seed bed the pest generally transmit tomato leaf curl virus and so damage becomes high if the pest is not controlled at early stage.

### 3.2 Bio-efficacy of insecticides against sucking pest whitefly, *Bemisia tabaci* in tomato

A field experiment was conducted for the control of major sucking pest Whitefly of tomato using chemical insecticides, microbial toxins. The results of the experiment are discussed as under.

#### 3.2.1 First application

Before the imposition of the treatments the mean number of whiteflies per 3 leaves ranged from 3.93 to 4.33 (Table 3). After the imposition of treatments, the number of whiteflies decreased gradually till tenth day and all the treatments were significantly superior to the untreated control. At fourteen days after the application, the infestation i.e. 0.47 and 0.60 was recorded in the treatments Imidacloprid 30.5 SC @ 0.004% a.i concentration and Diafenthiuron 50 WP @ 0.05% a.i concentration(89.49% and 86.58% reduction over control) and were on par with each other.These were followed by Dimethoate 30 EC @ 0.06%,Dinotefuran 20 SG @ 0.006%, Spinosad 45 SC @ 0.007%,Clothianidin 50 WDG @ 0.005% and Flonicamid 50 WG @ 0.015% active ingredient concentrations, which recorded 0.73, 1.07, 1.13, 1.33 and 1.40 whiteflies per 3 leaves (83.67, 76.06, 74.72, 70.25 and 68.68% reduction over control). In untreated control the maximum number of whiteflies recorded was 4.47 per 3 leaves.

#### 3.2.2 Second application

Similar trend was observed after the second application imposition (Table 4). Before the imposition of treatments, the mean number of whiteflies per 3 leaves ranged from 3.93 to 3.60. After the imposition of treatments, the number of Whiteflies decreased gradually till tenth days and all the treatments were significantly superior to the untreated control. At fourteen days after application, the infestation i.e. 0.33and 0.40 was recorded in the treatments Imidacloprid 30.5 SC @ 0.004% a.i concentration and Diafenthiuron 50 WP @ 0.05% a.i concentration (91.75% and 90.00% reduction over control) and were on par with each other. These were followed by Dimethoate 30 EC @ 0.06%, Dinotefuran 20 SG @ 0.006%, Spinosad 45 SC @ 0.007%, Clothianidin 50 WDG @ 0.005% and Flonicamid 50 WG @ 0.015% active ingredient concentrations, which recorded 0.53, 0.80, 0.87, 1.13 and 1.27 whiteflies per 3 leaves (86.75, 80.00, 78.25, 71.75& 68.25% reduction over control). In untreated control the maximum number of whiteflies recorded was 4.00 per 3 leaves.

From overall observation it is found that maximum population reduction was found in the insecticidal treatment imidacloprid 30.5 SC @ 0.004% a.i concentration (90.62% population reduction) closely followed by difenthiuron 50 WP @ 0.05% a.i concentration (88.29% population reduction) and dimethoate 30 EC 0.06 % a.i. concentration (85.21 % population reduction) (Table 4). Ghosh *et al.*, (2013) [10] reported that a rapid degradation of persistency was observed in imidacloprid. So imidacloprid may be recommended for general use of the farmers for its higher efficacy and rapid degradation.

**Table 1:** Treatment details of experiment on bio-efficacy of insecticides

| Sr. No. | Treatments | a.i. concentration % | Dose per 1 liter |
|---|---|---|---|
| 1 | Imidacloprid 30.5 SC | 0.004 | 0.12 ml |
| 2 | Spinosad 45 SC | 0.007 | 0.15 ml |
| 3 | Clothianidin 50 WDG | 0.005 | 0.1g |
| 4 | Dinotefuran 20 SG | 0.006 | 0.3g |
| 5 | Diafenthiuron 50 WP | 0.050 | 1.0 g |
| 6 | Flonicamid 50 WG | 0.015 | 0.3g |
| 7 | Dimethoate 30 EC | 0.06 | 2.0 ml |
| 8 | CONTROL | | |

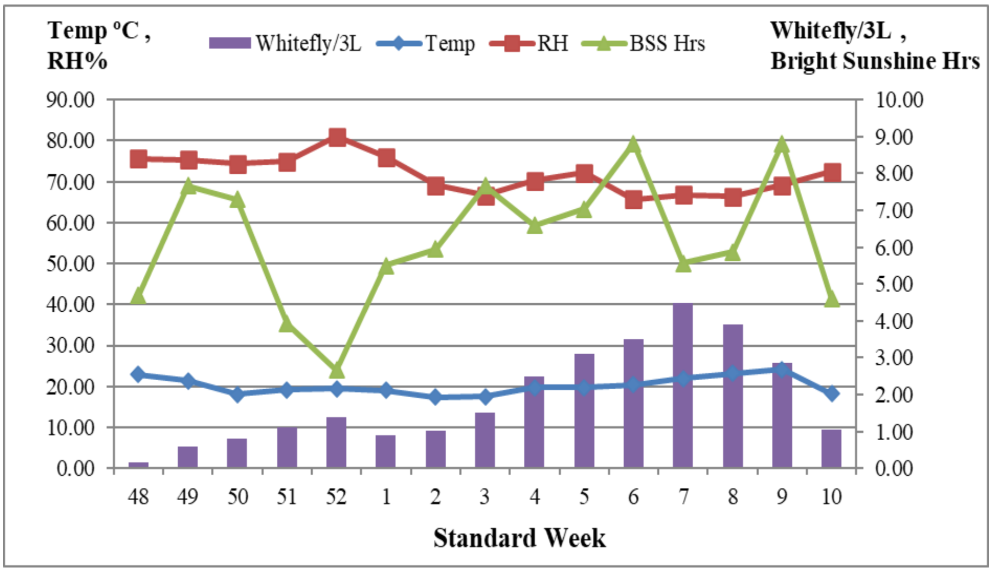


**Fig 1:** Population fluctuation of whitefly, *Bemisia tabaci* on tomato, *Rabi* season 2016- 17.

**Table 2:** Correlation and Regression Coefficient of whitefly, *Bemisia tabaci* in tomato with weather factors during 2016-17.

| Environmental parameters | | Correlation co-efficient (r) | Co-efficient of determination (R2) | Regression equation |
|---|---|---|---|---|
| Temperature $^{0}$C | Maximum | 0.535* | 0.287 | Y= 0.8096X+25.597 |
| | Minimum | 0.303 | 0.091 | Y= 0.5351X+12.102 |
| | Difference | 0.291 | 0.084 | Y=0.2837X+13.488 |
| | Average | 0.428 | 0.182 | Y=0.6725X+18.851 |
| Relative Humidity (%) | Maximum | (-)0.720** | 0.517 | Y= -1.1172X+94.047 |
| | Minimum | (-)0.656* | 0.430 | Y= -3.4449X+58.179 |
| | Average | (-)0.688* | 0.474 | Y= -2.2827X+76.12 |
| Bright Sunshine | (hrs) | 0.311 | 0.097 | Y= 0.4074X+5.3922 |

*Significant at 5% level of significance, ** Significant at 1% level of significance

**Table 3:** Bio-efficacy of insecticides against whitefly, *Bemisia tabaci* (First application)

| Sr. No. | Treatments | Active ingredient Concentration (%) | Dosage per 1 litre (ml/g) | Mean No. of aphids per 3 leaves | | | | | | % reduction at 14 days after application over control |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Pre Treatment | 1DAS | 5 DAS | 7 DAS | 10DAS | 14DAS | |
| T1 | Imidacloprid 30.5 SC | 0.004% | 0.12 ml | 4.13 (0.98) | 2.16 (1.63) | 1.23 (1.31) | 0.75 (1.12) | 0.32 (0.91) | 0.47 (0.98) | 89.49 |
| T2 | Spinosad 45 SC | 0.007% | 0.15 ml | 4.2 (1.28) | 2.50 (1.73) | 1.68 (1.47) | 1.23 (1.31) | 0.95 (1.20) | 1.13 (1.28) | 74.72 |
| T3 | Clothianidin 50 WDG | 0.005% | 0.1 g | 4.33 (1.35) | 2.69 (1.78) | 1.79 (1.51) | 1.35 1.36) | 0.99 (1.22) | 1.33 (1.35) | 70.25 |
| T4 | Dinotefuran 20 SG | 0.006% | 0.3 g | 4.13 (1.25) | 2.45 (1.72) | 1.56 (1.44) | 1.10 (1.26) | 0.70 (1.10) | 1.07 (1.25) | 76.06 |
| T5 | Difenthiuron 50 WP | 0.05% | 1.0 g | 4.00 (1.05) | 2.28 (1.66) | 1.32 (1.35) | 0.88 (1.17) | 0.50 (1.00) | 0.60 (1.05) | 86.58 |
| T6 | Flonicamid 50 WG | 0.015% | 0.3 g | 3.93 (1.38) | 3.15 (1.91) | 2.56 (1.75) | 1.25 (1.32) | 1.15 (1.28) | 1.40 (1.38) | 68.68 |
| T7 | Dimethoate 30 EC | 0.06% | 2.0 ml | 4.27 (1.11) | 2.36 (1.69) | 1.48 (1.41) | 0.89 (1.18) | 0.65 (1.07) | 0.73 (1.11) | 83.67 |
| T8 | Control | | | 4.27 (2.23) | 4.33 (2.20) | 4.40 (2.21) | 4.33 (2.20) | 4.40 (2.21) | 4.47 (2.23) | |
| | Sem± | | | NS | 0.07 | 0.06 | 0.05 | 0.04 | 0.05 | |
| | CD (p=0.05) | | | | 0.23 | 0.18 | 0.15 | 0.12 | 0.14 | |
| | CV % | | | 7.94 | 7.25 | 6.55 | 6.17 | 5.56 | 5.96 | |

PT = Pre Treatment, Figures in the parenthesis are Arc Sine transformed values

**Table 4:** Bio-efficacy of insecticides against whitefly, *Bemisia tabaci* (Second application)

| Sr. No. | Treatments | Active ingredient Concentration (%) | Dosage per 1 Litre water (ml/g) | Mean No. of aphids per 3 leaves | | | | | | % reduction at 14 Days after application over control | Mean of % reduction over control for both the applications |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PT | 1DAS | 5 DAS | 7 DAS | 10DAS | 14DAS | | |
| T1 | Imidacloprid 30.5 SC | 0.004% | 0.12 ml | 3.93 (2.10) | 1.89 (1.55) | 0.93 (1.20) | 0.56 (1.03) | 0.30 (0.89) | 0.33 (0.91) | 91.75 | 90.62 |
| T2 | Spinosad 45 SC | 0.007% | 0.15 ml | 3.73 (2.05) | 2.35 (1.68) | 1.75 (1.50) | 1.33 (1.35) | 0.80 (1.14) | 0.87 (1.17) | 78.25 | 76.48 |
| T3 | Clothianidin 50 WDG | 0.005% | 0.1 g | 3.87 (2.08) | 2.46 (1.71) | 1.78 (1.50) | 1.52 (1.42) | 1.05 (1.24) | 1.13 (1.27) | 71.75 | 71.00 |
| T4 | Dinotefuran 20 SG | 0.006% | 0.3 g | 3.73 (2.06) | 2.20 (1.64) | 1.72 (1.49) | 1.27 (1.33) | 0.75 (1.12) | 0.80 (1.14) | 80.00 | 78.03 |
| T5 | Difenthiuron 50 WP | 0.05% | 1.0 g | 3.67 (2.03) | 1.98 (1.57) | 1.56 (1.43) | 0.85 (1.16) | 0.37 (0.93) | 0.40 (0.95) | 90.00 | 88.29 |
| T6 | Flonicamid 50 WG | 0.015% | 0.3 g | 3.73 (2.06) | 3.00 (1.87) | 2.25 (1.66) | 1.72 (1.49) | 1.22 (1.31) | 1.27 (1.33) | 68.25 | 68.46 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T7 | Dimethoate 30 EC | 0.06% | 2.0 ml | 3.87 (2.09) | 2.13 (1.62) | 1.68 (1.48) | 0.89 (1.18) | 0.42 (0.96) | 0.53 (1.02) | 86.75 | 85.21 |
| T8 | Control | | | 3.60 (2.02) | 3.67 (2.04) | 3.87 (2.09) | 3.73 (2.06) | 3.93 (2.10) | 4.00 (2.12) | | |
| | Sem± | | | NS | 0.07 | 0.06 | 0.05 | 0.04 | 0.04 | | |
| | CD (p=0.05) | | | | 0.21 | 0.18 | 0.15 | 0.12 | 0.12 | | |
| | CV % | | | 8.54 | 7.14 | 6.72 | 6.26 | 5.45 | 7.60 | | |

PT = PreTreatment, Figures in the parenthesis are Arc Sine transformed values.

**4. Conclusion/Recommendation**

It is found that the Whiteflies population reached its peak (4.5 whitefly per 3 leaves) in the 7th meteorological week when average temperature, relative humidity and bright sunshine hours were 21.9 $^{0}$C, 66.83% and 5.6 hrs respectively. It is recorded that whitefly population was appeared in the early vegetative stage of the tomato crop. At this early stage as well as in the seed bed the pest generally transmit tomato leaf curl virus and so damage becomes high. Therefore, at early stage of the crop growth control measure should be adopted. From overall observation it is found that maximum population reduction was found in the insecticidal treatment Imidacloprid 30.5 SC. A rapid degradation of persistency was observed in imidacloprid. Though imidacloprid is synthetic chemical insecticides but it is less harmful to environment. So imidacloprid may be recommended for general use of the farmers for its higher efficacy and rapid degradation.

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