



**ORIGINAL ARTICLE**

**Study of Lethal dose and Sub lethal effect of Thiocyclam  
Insecticide on life table of Tomato Meyrick (Lep: Gelechiidae)  
*Tuta Absoluta***

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**ABSTRACT**

*This study was performed in plant medicine department of agriculture and natural resources center of Tehran province that is located in Varamin. Tuta absoluta, an insect with high reproductive capacity, complete metamorphosis and oligophagy, that is one of the important pests of tomato and potato in the world, inflicts 50-100% damage. Today in many areas of the world such as South America, different toxins are used to control this pest. One of these toxins is thiocyclam. Life measurement test of Tuta absoluta with 5, 50, 150, 250, 500 and 1000 ppm was performed. Moderate sublethal effect (LC25) of thiocyclam insecticide on third-stage larvae of Tuta absoluta, equal to 9.94, totally was 24 and 48 hours. Intermediate period length of any growth stage of Tuta absoluta in treatment with thiocyclam insecticide with sublethal concentration LC25 of 9.94 milliliter per liter obtained as, egg (3.9±0.3) days, first stage larvae (2.03±0.18) days, second stage larvae (2.17±0.46) days, third stage larvae (2.012±0.32) days, fourth stage larvae (2.8±0.58) days, pupa (5.83±0.88) days, mature insect (16.5±6.3). Life table, reproduction and population growth parameters of this pest on its preferential host, tomato, were studied. Inherent rate of population increase (rm), was achieved 0.12 time unit-1 and finite rate of population increase λ was achieved 1.12 day/ female/female, average time of any generation (T) was 25.58 days.*

**Key words:** Tomato Meyrick, Tuta absoluta, Thiocyclam insecticide, Lethal, Sublethal.

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**INTRODUCTION**

Tomato with scientific name of *Lycopersicon esculentum* is an important crop of Solanaceae family that has the most variation among vegetables and summer crops. In Iran, tomato has special location in providing human nutritious requirement. Under-planted area production amount of this crop in Iran are 130 thousands hectares and 250 thousands tones [1]. All of grass crops such as leaf vegetables, fruit vegetables, summer and patch vegetables are damaged by more than ten injurious factors, include pests, pathogens and weeds, that some of these factors such as pests are discussed. As a key and first degree pest, due to high reproductive capacity, many generations per year, rapid incidence and transfer capacity. Tomato meyrick (*Tuta absoluta*), the insect with high reproductive potential, perfect metamorphosis [2], is oligophagy and feed from all Solanaceae crops [3]. Meyrick is one of the most important pests of tomato and potato in the world and has high economical importance [4]. Effective prevention and management of the pest is difficult and chemical control is failed due to pest resistance to many of chemical toxins. This fail can be resulted from settling many of the pest stages in plant and soil and being inaccessible to pesticides [5]. Regarding to the pest being imported, it has not been reported researches about effective toxic compounds for that in the country. In this research, imported adopted toxic compounds were collected from polluted area and the effect of thiocyclam on biological and reproductive characteristics, LD<sub>50</sub> of this toxin on the pest and lethal and sub lethal doses of that will be determinate and discussed.

## MATERIALS AND METHODS

All of this research tests was performed in plant medicine department of agriculture and natural resources research center of Tehran province in varamin. Host culture, pest colony propagation and all tests were performed in growth room with  $27\pm 2^{\circ}\text{C}$  and relative humidity of  $70\pm 5$  and 16:8 (lighting :darkness) photoperiod. But due to malfunction, the growth room temperature was increased from  $27\pm 2$  to  $33^{\circ}\text{C}$  and the next demography tests was performed at  $33^{\circ}\text{C}$  and the humidity of  $75\pm 5$ . In this study, thiocyclam insecticide (50 % ovysk emulsion sp) was used.

Host culture:

In this research, terrestrial- tomato , super chuff variety was used. At first, desired plant seeds were planted in culture bed that was containing coco peat and were irrigated every day. After three weeks, when the bushes reached to the trifoliate (three-leaf ) stage, those were transferred to the main culture medium, that is plastic pots, with soil combination in this order: Two part sand, one part leaves soil and one part cocopeat. Pots cultivation was performed every two weeks until enough pots be provided for experiment.

Pest colony:

To provide the third- stage larvae colony of *Tuta absoluta*, clear plastic cages with  $40\times 30$  cm were used .One pots and several mail and female pairs of Meyrick(*Tuta absoluta*) were placed in each cage to spawn. To provide ventilation in door part of the growth dishes two holes were created in the lid containers with  $10\times 15$  cm dimensions and it was covered with 50-mesh delicate ruche and was kept in growth room. After 24 hours , we omitted moths from growth dishes and waited to 3-age larval stages and the pots were irrigated every two days.

Experiments:

Preliminary tests:

At first a mother solution equal to 100 milliliter from commercial formulation of thiocyclam insecticide in distilled water was used. Before main tests ,pretests were performed with seven concentrations included 500, 350, 250, 150, 10, 50 and 5 ppm, for thiocyclam insecticide in disposable plastic Petri dishes with 3.5 diagonal and 1 cm height, in the form of soaking leaves in the toxic solution. In addition control was performed to reach approximately 20 to 80 percent mortality rate. Furthermore, control treatment by using distilled water was provided. After reaching to these two concentrations, The concentrations between them with logarithmic distance calculation by sub dose method with original concentration of test was calculated.

Lethal experiment:

This experiment was performed in three replication in this manner ;tomato leaves were immersed in the said toxic solution for 30 seconds and after drying in laboratory , they were transferred to Petri dishes with 1.5 cm diagonal and 1 cm height and 20 larvae of the same age were placed on them for 48 hours in the said laboratory condition and larvae mortality was recorded. Concentration range in thiocyclam were (0.5, 5, 50, 100, 250, 500 and 1000 )ppm.

Demography test

Whereas thiocyclam insecticide is effective both on mature and larvae, in this research its effect on *Tuta absoluta* demography was studied. In this experiment, 50 pots including tomato plants that were reached to 5 to 6 larval step were selected and two eggs of the said pests were transferred on each plant. Embryonic period length, the number of hatched eggs, larval period length , number of those larvae that was converted to pupa, pupa period length to emergence time of perfect insects were recorded daily. After emergence of the perfect insects they were transferred in the form of male and female pairs in clear cylindrical pots (40 cm diagonal and 100 cm height) that one of its lids had been covered with 50 mesh ruche and a test tube containing water and sugar was placed in each pots for moths feeding .Perfect insects survival , their spawning amount were recorded daily (because malfunction, the room temperature increase to  $33^{\circ}\text{C}$  from first age larvae onwards, and the next demography tests was performed in  $33^{\circ}\text{C}$  and  $75\pm 5$  humidity)

Statistical methods:

Two SEX-MS chart software was used for life table and reproductive tests, that it was designed in visual basic for windows operating system. In order to express population age structure, frequency dispersion of the growth stage was used. This software classifies raw data and calculates all parameters of the life table. In this research the way of providing age life table – growth stage was used that considers changes at different growth stages' at of bioassay experiments were analyzed with SAS (2003) software in probit formula .The lethal concentrations ( $\text{LC}_{50}$ ) and sub lethal concentrations ( $\text{LC}_{25}$ ) were calculated .Comparison between insecticide lethal concentrations ( $\text{LC}_{50}$ ) was performed with [7] method.

## RESULTS AND DISCUSSION

Sub lethal (LC25) concentration effect of thiocyclam insecticide on third-stage larvae in Meyrick (*Tuta absoluta*) was performed by spraying considered dose on treated plants. According to the table (1), bioassay of thiocyclam insecticide on 1-day larvae of third stage is 24 and 48 hours in sum, that LC50 lethal dose of thiocyclam was 28.67 and its LC<sub>25</sub>, sublethal was 9.94 on Meyrick. Because of mortality on 24 hours and to be more precise calculation in 48 hours, the final amount is 24 and 48 hours.

Table1: Bioassay of thiocyclam insecticide on 1 day larvae of third stage in sum of 24 and 48 hours

Concentration number	Slop±SE	X <sup>2</sup>	LC <sub>25</sub>	LC <sub>50</sub>	Pr
7	1.46±0.27	2.53	9.94 (3.15-17.99)	28.67 (15.09-43.33)	0.77

Demography test with thiocyclam treatment:

To describe *Tuta absoluta* mortality, life table, that was particular to perfect insects age, was complete cohort life table form on the base of Chi and Liu (1984) method. In this model, population parameters after each male and female pair and the comparison of development rates variable are calculated so that the mortality of one remaining individuals group from immature stages of perfect insects exit to end of the life was recorded daily. Also it was single decrement model, means that dead, by any reason (decrease in number), was recorded. Average of period length in each growth stages of *Tuta absoluta* in treatment with thiocyclam with LC25 sub lethal concentration equal to 9.94ml per liter was achieved in this order: egg (3.9± 0.3) days, 1-age larvae (2.03±0.18), 2-age larvae (2.17± 0.46) days, 3-age larvae (2.012 ±0.32) days, 4-age larvae (2.8± 0.58) days, pupa (5.83±0.88) days, mature insect (16.5±6.3) days.

Jalali (2012), in his work at 27°C found each period length of *Tuta absoluta* in this order: egg (3.27± 0.45) days, 1-age larvae (2± 0), 2-age larvae (3± 0) days, 3-age larvae (2.04± 0.2) days, 4-age larvae (2.86± 0.83) days, pupa (7.36±1.49) days, mature insect (18.63±7.65) days.

Results in this research in comparison with the results of Jalali [8] experiments have more pupa and mature growth period length. This difference is because of temperature condition differences that was performed at 27°C in Jalali's research, but in this study prematurity period was performed at 32°C and from maturity onward temperature was 27°C and thiocyclam insecticide effect is another reason too. Brrientos et al [6], in laboratory studies showed growth steps of *Tuta absoluta* from egg to perfect insect at 27.1 °C is 23.8 days. Also survival from egg to perfect insect was performed at 27.1°C, eggs hatched within 4-6 days, larvae completed their growth period within 11 to 13 days and pupas converted to perfect insects within 5-8 days whereas in our research growth steps of *Tuta absoluta* from egg to perfect insect at 27.1 °C is 28 days and survival from egg to perfect insect was investigated at 27.1°C, eggs hatched within 3-4 days, larvae completed their growth within 8 to 13 days and pupas converted to perfect insects within 5-14 days. This difference can be resulted from tomato variety. In population growth study, time setting and the age of spawning start are very important and may have significant effect on population growth. Amount of APOP and TPOP in *Tuta absoluta* were 0.21± 0.53 and 19.53± 0.96 respectively and Jalali [8] achieved to 6.93±5.69 and 27.36±5.63 for APOP and TPOP respectively at 27°C.

Life expectancy in *Tuta absoluta* in treatment by thiocyclam (with LC25=9.94) at the time of perfect female emergence was obtained 8.32 days and 8.74 days for males. Jalali [8], reported that life expectancy in *Tuta absoluta* at the time of perfect female insects emergence was 9.12 days at 27°C.

Population parameters:

The most important parameter for the population growth of *Tuta absoluta* was calculated in this order: inherent rate of population increasing ( $r_m$ ), is the highest increase rate in a population with stable age distribution that can be used to predict population growth under specified condition and its amount for this pest is 0.12 time unit<sup>-1</sup>. The intrinsic rate of birth (b), in other word is population birth rate per capita that its rate is 0.13 in time unit<sup>-1</sup> in relatively stable distribution, rate of mortality or the intrinsic rate of death (d) and in other word, rate of population birth per capita is 0.01 in time unit<sup>-1</sup>. Pure rate of reproduction ( $R_0$ ) is the average number of female progeny that were increased to population by one female within one generation, that it's amount was obtained 19.7 generation/female/female after treatment on 3-age larvae of *Tuta absoluta*. Infinite rate of population increasing ( $\lambda$ ) was 1.12 days/female/female. Gross reproductive rate (GRR) was 30.2 generation/female female and medium length of one generation (T) was calculated as 25.58 days. Jalali (2012), obtained population parameters of *Tuta absoluta* at 27°C in this order: intrinsic rate of population growth ( $r_m$ ) 0.03, pure rate of reproduction ( $R_0$ ) 2.9, intrinsic rate of birth (b) 0.06, intrinsic rate of death (d) 0.02, infinite rate of population increasing ( $\lambda$ ) 1.03, and gross reproductive rate (GRR) 6.55, one generation medium length (T) 28.35. In comparison of population parameters of *Tuta absoluta* in this research with Jalali [8], observed

differences is because that prematurity period was performed at 32°C and perfect insects period was performed at 27°C. Temperature effect combined with the effect of sub lethal amount of thioacyclam insecticide treatment can be resulted from these differences. Concerning age- specific mortality,  $q(x)$ , in this research rate of the mortality is more at maturity and Jalali [8] reported that the most mortality has been occurred at pupas and matures. Stable age distribution percentage (SAD% or C%) and distribution of stable growth stage of treatment are in following table(2). As it is observed in the table, contribution amount of maturity stage is minimum at stable age distribution and maximum at prematurity stage that its main reason is mortality in different ages at prematurity stage.

Table-2: Age distribution percent-growth stage

	male	female	pupa	4-age larva	3-age larva	2-age larva	1-age larva	egg
Treatment with thiocyclam	4.40	3.28	9.09	8.10	9.13	11.75	14.61	39.60
Jalali's results		19.08	15.96	9.99	8.68	14.20	10.44	21.64

According to the findings of Fernandez and Montagne [9] lifelong of unmated females is  $27.81 \pm 10.78$  days and intermediate period of pre spawning period of female is  $2.4 \pm 0.61$  days whereas in current research long life of unmated females is  $18.63 \pm 7.65$  days and intermediate period of pre spawning of females is  $6.93 \pm 5.69$  days. This difference can be due to tomato variety or line. The reason for the observed differences in this research compare to Jalali's finding, at first is the effect of Thiocyclam insecticide on developmental and reproductive stages and consequently temperature condition of the experiment that lead to decrease the amount of each of these stages.

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