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Specialised Pheromone and Lure Application Technology (SPLAT-*Tuta*): Novel Approach for the Management of Tomato Leaf Miner, *Tuta absoluta* (Meyr.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The second most popular and widely cultivated vegetable in the world after potatoes is the tomato (*Solanum lycopersicum* M.). Tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the major invasive pests of tomato which is a destructive pest of tomato in field as well as greenhouse condition. Novel SPLAT (Specialized Pheromone & Lure Application Technology) for *Tuta absoluta* is a proprietary base matrix formulation of biologically inert materials used to control the release of semiochemicals and/or odors with or without pesticides. To check the efficiency of SPLAT technique three treatments were taken. When comparing the SPLAT field and conventional

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farmers practices field, SPLAT applied field (32.80 tonnes per ha) performed far superior than conventional field (21.50 tonnes per ha) in respective of leaf minor infestation and yield. Specialised Pheromone and Lure Application Technology (SPLAT) adoption favours sustainable pest management and reduces plant protection cost to the farmers.

Keywords: Tomato; Tuta absoluta; SPLAT; sustainable agriculture; mating disruption.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* M.) is one of the most popular and nutritious vegetable widely grown around the world, ranked second after potato. It is perennial in its habitat and grown as an annual in temperate climates.

World annual production of tomato accounts for 107 million metric tons, with fresh market tomato representing 72% of the total [1]. It is a warm season crop, sensitive to freezing temperature and frost. Tomatoes can be produced in open fields and in green house conditions. In India, this crop is cultivated over an area of 8.82 lakh ha, with a production of 187.35 lakh mt; the average productivity of this crop is 20.7 t/ha. Themajor tomato-growing states in India are Andra Pradesh, Odisha, Madhya Pradesh, Karnataka, West Bengal, Maharashtra, Chattisgarh, and Gujrat. In Karnataka, it has an area of 0.61 lakh ha with a production of 20.68 lakh mt and productivity of 33.90 t/ha [2]. Though the potential yield of tomato is around 50 to 80 t/ha, there are major bottlenecks to meeting this potential, due to both biotic and abiotic factors.

Among the biotic factors limiting tomato productivity, the prominent ones are pests and diseases, which reduce yields and quality of marketable fruits. Many insect pests are associated directly with fruit damage and yield losses in tomato. Leaf miner, *Tuta absoluta* (Meyrick) is considered one of the most important and devastating insect pests of tomato [3]. It is a nocturnal gelechid moth, belonging to the order Lepidoptera.In India, occurrence of this invasive pest was observed for the firsttime infesting tomato crop in Pune, Maharashtra [4]. The adult female moth (24 days) tends to lay eggs (162 eggs/female) on tender foliage, stem, flower buds, calyx, and young fruits. The tiny larvae mine into the young foliage, and later small blotches become visible. If the crop is affected severely, the foliage may appear burnt. Later, the larvae make small pin holes on fruits, which can lead to infections by secondary pathogens, further decreasing the quality of the fruit.

Tuta larvae mine within the tissues of their host plants (stem, leaves, and fruits) and are thus protected from contact with pesticides, limiting the efficacy of these chemicals. The large range of host plants fed on by *T. absoluta* increases its persistence in cultivated areas, as well as its overwintering potential. Despite the tomato being the primary host for *T. absoluta*, it has other hosts (cultivated solanaceae and wild solanaceae). Further complicating control efforts for this pest, resistance of *T. absoluta* to various chemical pesticides has been reported in Brazil, Chile, and Argentina, including diamide insecticide, chlorantriniliprole, abamectin, methamidophos and permethrin cartap. The pest has a high reproduction potential, producing 10 to 12 generations per year under favourable conditions. With such high reproduction potential, they are likely to undergo genetic changes (mutation), which in turn creates ample opportunity for resistance to develop.

Under these situations, the use of chemical pesticides for control of *T. absoluta* is highly sought to reduce its infestation. However, the need for alternative management strategies is encouraged and one such new, novel and eco-friendly mating disruption technology is Specialised Pheromone and Lure Application Technology (SPLAT), which has been developed by ATGC Biotech. Pvt. ltd., Hyderabad. In collaboration with University of Agriculture, Raichur, a large-scale experiment was performed on an area of about 8 ha, to assess the capacity of SPLAT *Tuta* to deliver effective control of the tomato leaf miner, compared to conventional farmers' practices. Researchers also sought to evaluate the cost economics of the application of this technology as a *T. absoluta* control solution.

2. MATERIALS AND METHODS

Specialized Pheromone and Lure Application Technology (SPLAT) is a revolutionary tool that is long-lasting, flowable and allows for controlled release of semiochemicals. SPLAT formulations for control of pink bollworm through mating disruption are composed of a biologically inert and biodegradable matrix along with the female-

produced sex pheromone, (*ZZ*/*ZE*) 7,11-Hexadecadienyl acetate (SPLAT-PBW). The investigations on the management of tomato leafminer, *Tuta absoluta* through mating disruption technology was demonstrated over a large scale of 8 ha in Manvi taluka, Raichur district, Karnataka during 2017–2018.

SPLAT-*Tuta* was applied at the test sites at a dosage of 200 g per ha applied four times, starting from 3 days after transplanting and later at 35-40, 65-70 and 95-100 days after transplanting. During the first application, SPLAT-*Tuta* was applied with the help of spoon: the SPLAT-*Tuta* dollop was taken in the spoon which was then hung to the leaf petiole at the growing tip. Subsequent applications were made on the poles which were erected for training of tomato plants. However, the application of SPLAT-*Tuta* was made intentionally in the beginning of the crop establishment in order to saturate the pheromone completely before the pest appears to have an effective mating disruption. Later, farmers were instructed not to apply any chemical sprays for the tomato leaf miner in the SPLAT-treated blocks. In addition, ten water traps for *Tuta* and 20 yellow sticky traps per acre were installed in the SPLAT applied blocks, so as to manage the leaf miner as well as sucking insect pests *viz.,*whiteflies, aphids and leafminers which in tern will aid in reducing the chemical application.

The SPLAT-*Tuta* applied at 200 g/acre was compared with the conventional farmer's practice. Irrespective of the size of the demonstrative block area, it was divided into 11 quadrants to meet statistical requirements and from each block 25 plants were selected randomly to document percent leaf mining and fruit damage at weekly interval. Besides these, moth catches from the water trap were also recorded.

The data obtained on percent leaf and fruit damage caused by *Tuta* was transformed to arc sin values while, the data on the number of moth trap catches per trap were converted to square root ($\sqrt{x+1}$) values prior to statistical analysis, and the treatment means were compared by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).The fruit yield obtained from each harvest was documented treatment wise, later, the yield data from all the pickings were added and converted to hectare basis and the data from the SPLAT treated blocks were compared with conventional farmer's practice.

3. RESULTS AND DISCUSSION

Results from the evaluation of SPLAT-*Tuta* against leaf miner in tomato treated with a dose of 500 g per acre in two different fields conducted in the first season over an area of 15 acres in Manvi taluka of Raichur district in comparison with 0.5 acres of conventional farmers' practice. Results indicate that the percent leaf damage by *Tuta absoluta* and fruit damage in treatment 1 was found to be less *i.e.,* 5.91% and 2.49%, respectively. Similarly, in treatment 1A field incidence of pest was 3.18 and 2.08, respectively. The pest incidence in plots treated by conventional farmers' practice was 25.09 and 24.06, respectively, even after several rounds of pesticide sprays. The yields realized in the SPLAT-treated farms were 32.80 and 30.83 tons per hectare, showing a highly significant difference with that of yield from conventional farmer's practice (21.50 tons/ha) (Table 1, Fig. 1 and Fig. 2).

Present studies are in line with the earlier studies by Stoltman et al. [5], who conducted tomato field trials in South America. The major component of the sex pheromone of *T. absoluta*, (3*E*,8*Z*,11*Z*)-3,8,11-tetradecatrien-1-yl acetate, was identified by Attygalle et al. in [6]. The results of field trials conducted to assess the efficacy of ISCA-Lure *Tuta* for attraction of *T. absoluta* both for monitoring and mass trapping, as well as SPLAT-*Tuta* A &K for specific attraction and killing action in large scale field plots. Results indicated that both products provided effective attraction and control of *T. absoluta* in tomatoes.

Subsequently, the same authors conducted a study on SPLAT controlled-release semiochemical bait-and-kill formulations for sustained fruit fly management under humid conditions [7]. Experiments were conducted in southern Brazil with the South American fruit fly, *Anastrepha fraterculus* (Wiedemann), a key pest of apple cultivations in the area. Although the results indicate that SPLAT formulations perform as well as the commercial standards for controlling *A. fraterculus* under experimental conditions, without losing its efficacy even under rainfall conditions.

Agenor et al. [8] made a preliminary study on Hook Fall armyworm (FAW), *Spodoptera frugiperda* (Smith) was conducted in large corn plots in Mogi Mirim, Sao Paulo, Brazil in an area of 150 ha plots and efficacy was evaluated with three pheromone lure-baited traps per plot. Moth captures per trap were reduced in plots treated

with Hook-FAW versus plots only treated with insecticides. Plant damage was also significantly reduced in all plots treated with Hook-FAW as compared to plots only treated with insecticides [9-11].

3.1 Cost Economics of SPLAT-*Tuta* Used for the Management of *Tuta absoluta* in Tomato Ecosystem

SPLAT tested in area wise two different treatment (1&1a) at a dose of 500 g per acre did not show any significant difference between them. SPLAT-*Tuta*, applied at a dose of 200 g per ha, applied four times (5-10, 35-40,65-70 and 95-100 days after transplanting) was found to be the most effective treatment to keep the tomato leaf miner under check. Hence, the net returns obtained from treatment 1 was Rs. 2,76,500 per acre with highest benefit-cost ratio (B:C) of 6.37 followed by Rs. 2,56,800 by treatment 1a having a B:C ratio of 6.0 (Table 2).

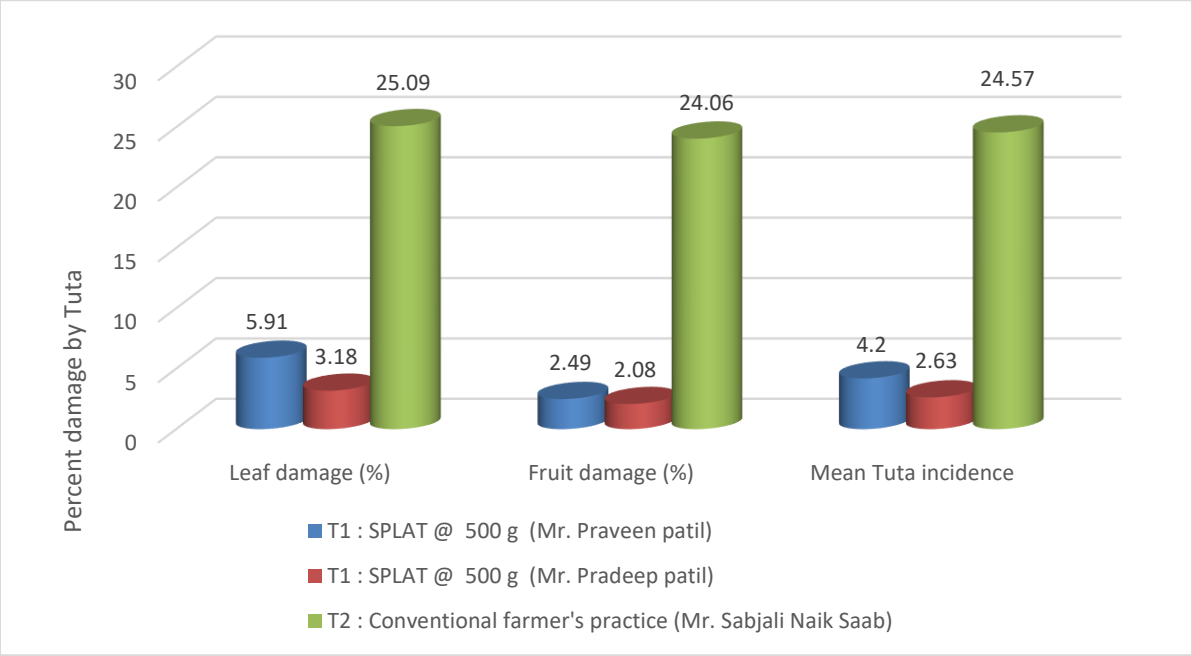

Fig. 1. Effect of SPLAT-*Tuta* mating disruptant tool against *Tuta absoluta* in tomato ecosystem

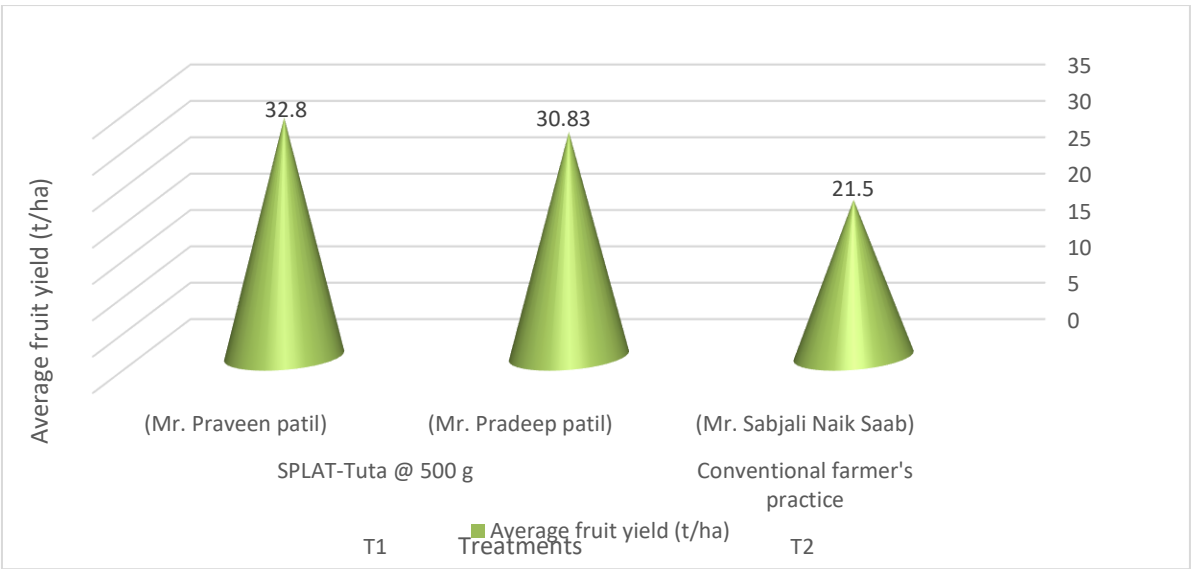

Fig. 2. Effect of SPLAT-*Tuta* mating disruptant tool on tomato yield

Table 1. Evaluation of Specialized Pheromone and Lure Application Technology (SPLAT) against *Tuta absoluta* during 2017

Treatment details	Area of demonstration (ha)	Percent leaf damage*	Percent fruit damage*	Percent mean *T. absoluta* incidence	Percent decrease in *T. absoluta* incidence over farmer's practice	Average number of moths catches/week**	Tomato fruit yield (ton/ha)
T_1: SPLAT-*Tuta* @ 200 g/ha	2.0	5.91 (14.06)	2.49 (9.07)	4.20	119.16	5.18 (2.48)	32.80
T_{1a}: SPLAT-*Tuta* @ 200 g/ha	6.0	3.18 (10.27)	2.08 (8.29)	2.63	204.96	6.83 (2.79)	30.83
T_2: Conventional Farmer's practice	0.10	25.09 (30.05)	24.06 (29.37)	24.57	-	8.52 (3.08)	21.50
S.Em(±)	-	0.11	0.13	-	-	0.05	0.52
CD @ 5 %	-	0.33	0.39	-	-	0.15	1.56
CV (%)	-	8.62	9.80	-	-	8.04	9.16

** Figures in the parentheses are arc sin transformed values*

******* *Figures in the parentheses are square root ($\sqrt{x+1}$) transformed values*

Table 2. Cost Economics of SPLAT-*Tuta* for the management of *Tuta absoluta* in tomato ecosystem

Treatments	Tomato yield (t/ha)	Cost of cultivation (Rs./ha)	Cost of Treatment (Rs./ha)	Total Cost (Rs./ha)	Gross returns (Rs./ha)	Net Returns (Rs./ha)	B:C ratio
T_1 : SPLAT-*Tuta* @ 200 g/ ha applied in 4 splits (Mr.Praveen patil)	32.8	40,000	11,500	51,500	3,28,000	2,76,500	6.37
T_1a: SPLAT-*Tuta* @ 200 g/ha applied in 4 splits (Mr.Pradeep patil)	30.83	40,000	11,500	51,500	3,08,300	2,56,800	6.0
T_2 : Conventional farmer's practice (Mr.Sabjali Naik Saab)	21.50	40,000	-	40,000	2,15,000	1,75,000	5.38

Note: Price of Tomato: Rs. 10000/t

Cost of SPLAT: Rs. 4600 (Rs. 900/application hence, for 4 applications it is 3600 plus cost of application Rs.1000 for four times)

Cost in farmer's practice: Rs. 5000/acre (Rs. 4000 is chemical cost and Rs. 1000 for labour cost)

4. CONCLUSION

Tuta absoluta (Meyrick) was found to be devastating pest and is likely to disseminate rapidly and potential to cause sizeable damage to tomato farmers. From the results, SPLAT applied field significantly superior when compared to traditional farming practice. Considering the problems associated with the use of chemical insecticides, the only way out is use of Specialised Pheromone and Lure Application Technology (SPLAT) has array of hopes for tomato growers. Considering sustainable agriculture and plant protection cost, SPALT is a novel ecofriendly method to control tomato leafminer *Tuta absoluta.*

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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