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Survey on the incidence of South American tomato leaf miner, *Tuta absoluta* (Meyrick), in north coastal districts of A.P.

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Abstract
A roving survey was conducted on the incidence of *Tuta absoluta* (Meyrick) in tomato growing villages of three North Coastal districts in Andhra Pradesh. The number of mines per plant, per cent infested leaves per plant and per cent fruit damage per plant were recorded, ranging from 0.46 to 5.88, 6.72 to 32.34 and 10.56 to 37.60 per cent, respectively in the three districts. The maximum mean number of mines, 4.92 and a maximum of 27.88% mean infested leaves were recorded at vegetative stage of tomato crop. At flowering stage of the crop a maximum mean number of 3.64 mines per plant and mean infested leaves of 22.11% were recorded. The highest mean number of mines, 3.48 and 21.21% infested leaves were recorded at fruiting stage of the crop. The recorded per cent fruit damage was ranging from 10.56 to a maximum of 37.60 in the crop at harvesting stage in Srikakulam district. The maximum, mean number of mines (4.18), per cent infested leaves (24.50%) and damaged fruits (33.22%) were recorded in Srikakulam district. The least was recorded in Visakhapatnam district (2.07 mean numbers of mines, mean infested leaves of 14.43% and mean damaged fruits of 17.60%).

Keywords: South American tomato leaf miner, *Tuta absoluta*, tomato, survey

1. Introduction
Tomato (*Lycopersicon esculentum*), originated from Andean region (Peru, Chile, Bolivia and Ecuador) is relatively a short duration crop and high yielding with good economic prospects. It is one of the vegetable having prime importance for fresh sale, supply for canning, juicing, concentrated extracts and is a good source of minerals (Mg, P and Cu), vitamins like (A, Riboflavin, Thiamine, Niacin, Folate, C, E, K) and source of antioxidants which reduces the risk of several cancers and neurodegenerative diseases. It is also used as a salad, paste, peeled tomatoes, juice, sauces and soups.

In India tomato is cultivated in an area of about 789.2 hectares with 19759.3 M.t. of production and 25.0 M.t. ha^{-1} of productivity. In Andhra Pradesh, the crop is cultivated in an area of about 61.67 hectares with 2744.32 M.t. of production and 44.50 M.t. ha^{-1} of productivity (Horticultural Statistics at a Glance, 2018).

There are many known pests like fruit borers, *Helicoverpa armigera* (Hubner), *Spodoptera litura* (Fabricius), sucking pests like *Bemisia tabaci* (Gennadius), *Ferrisia virgata* (Cockerella) and serpentine leaf miner, *Liriomyza trifolii* (Burgess) causing damage to the tomato crop. Other than the existing pests a new invasive pest, South American tomato leaf miner, *Tuta absoluta* (Meyrick), (Lepidoptera: Gelechiidae) was recorded causing severe damage in tomato crop and reducing the marketable yield by making pin sized holes on tomato fruits. It was designated as alien pest of tomato and other crops belonging to the family Solanaceae.

Tuta absoluta is commonly known as tomato moth, tomato borer and South American tomato pinworm which is an extremely devastating, oligophagous insect that feeds on Solanaceous species (Siqueira *et al.*, 2000) [14]. The pest is multivoltine having nearly 12 generations per year. According to its rapid population growth this pest should be treated as r-selected species. The primary host of *Tuta absoluta* is tomato (*Solanum lycopersicum* L.), but it has also been reported on other secondary hosts belonging to Solanaceae family, *i.e.*, eggplant (*Solanum melongena* L.), pepper (*Capsicum annuum* L.), potato (*Solanum tuberosum* L.), sweet cucumber or melon pear (*Solanum muricatum* L.) and tobacco, *Nicotiana tabacum* L. (Pereyra and Sanchez, 2006) [9].

Tuta absoluta is native to Peru in South America. The pest did spread rapidly across Southern Europe and North Africa to the Mediterranean countries and many Asian countries after it being first noticed in Spain in late 2006.

Its incidence was also observed in several countries like Venezuela, Uruguay, Columbia, Ecuador, Paraguay, Chile, Brazil, Bolivia and Argentina. (Desneux *et al.*, 2010) [3].
In India, the incidence of the pest was reported throughout the year though the level of incidence varied (Nitin *et al.*, 2017) [7]. The occurrence of *Tuta absoluta* was first observed during December, 2014 to January 2015 causing >50% infestation in the tomato fields in Pune, Ghargaon, Saptashrungi, Malegaon localities and 10-50% infestation in Shirpur and Satara localities of Maharashtra (Shashank *et al.*, 2015) [13]. Incidence of pest was also recorded in several other states like Karnataka (Sridhar *et al.* 2014) [15], (Kalleshwaraswamy *et al.*, 2015) [5] and (Ballal *et al.*, 2016) [1], Tamil Nadu (Shanmugam *et al.*, 2016) [12], Andhra Pradesh (Rasheed *et al.*, 2017) [11], (Rasheed *et al.*, 2018) [10], Telangana (Kumari *et al.*, 2015) [6] and Madhya Pradesh (Swathi *et al.*, 2017) [17]. *T. absoluta* can cause 100% losses on crops grown in open field and greenhouses (Sridhar *et al.*, 2015) [16]. It is known to cause about 50% to 100% reductions in yield and fruit quality both in greenhouses and open fields (European and Mediterranean Plant Protection Organization, 2005). In Chittoor district of Andhra Pradesh *Tuta absoluta* showed maximum mean per cent infestation on plants (66.12%), leaves (34.25%) and fruits (32.65%) in Kalikiri Mandal during 2016-17 and 2017-18 (Rasheed *et al.*, 2017 and Rasheed *et al.*, 2018) [11, 10].

2. Materials and Methods

The roving survey pertaining to the incidence of South American tomato leaf miner, *Tuta absoluta* was carried out in 15 villages (5 mandals) in Srikakulam, 16 villages (4 mandals) in Vizianagaram and 10 villages (4 mandals) in Visakhapatnam districts in North Coastal Zone of Andhra Pradesh during *rabi*, 2018-2019. During the survey the average number of mines, per cent infested leaves and the per cent fruit damage per ten plants was recorded at fortnight intervals. The incidence was recorded in different stages of crop *i.e.*, at vegetative stage, flowering stage, fruiting stage and harvesting stage.
The *T. absoluta* infestation was identified by its characteristic blotching symptom on leaves and pin sized holes near to the pedicle of the fruit. The data was collected from randomly selected 10 plants in each village. The total number of mines on 10 plants was recorded and the mean number of mines per plant was calculated. The per cent infested leaves, and per cent fruit damage per plant were calculated using the formulae given below.

i) Per cent infested leaves/plant =

$$\frac{\text{Total number of infested leaves}}{\text{Total number of leaves}} \times 100$$

ii) Per cent fruit damage/plant =

$$\frac{\text{Total number of damaged fruits}}{\text{Total number of fruits}} \times 100$$

Standard sampling procedure adopted for the leaf miner was followed as per the manual of tomato pest surveillance (NICRA, 2012) [8] for assessing the intensity of damage.

3. Results and Discussions

3.1 Incidence of South American tomato leaf miner, *T. absoluta,* on tomato crop in different mandals of Srikakulam district of Andhra Pradesh

The survey was conducted from Oct. II fortnight to Jan. I fortnight in the villages of Srikakulam districts and the data recorded was presented in Table 1.
The results from the survey indicated that, during vegetative stage maximum number of mines (5.88 per plant) and infested leaves (31.24% per plant) were recorded in Antlavaram village, followed by Baruva, Maluva, Etcherla, Mandapalli, Pathapatnam villages and the lowest number of mines (3.36 per plant) and infested leaves (21.81% per plant) were recorded in Jinkibadra village.
At flowering stage, low infestation was recorded in Korasavada village with 2.93 mines per plant and 18.74% infested leaves per plant, preceded by lakkavaram village with moderate infestation (3.08 mines per plant and 19.75% infested leaves per plant). The high infestation, 4.93 mines per plant and 27.86% infested leaves per plant was recorded in Vaddivada village.
Moderate infestation was recorded in Fareedpeta, Palasapuram and Changudi villages, where the lowest infestation was recorded in R.L. Puram village (2.45 mines per plant and 15.10% infested leaves per plant) and the village Benkili recorded with high infestation of 6.08 mines per plant and 32.34% infested leaves per plant at fruiting stage.
The per cent fruit damage by *T. absoluta* ranging from 18.97% (Korasavada village) to the maximum of 46.47% (Benkili village) was recorded at harvesting stage of crop, followed by Fareedpeta (37.60%), Palasapuram (35.26%), R.L. Puram (32.84%), Lakkavaram (31.98%) and Changudi (29.45%).

3.2 Incidence of South American tomato leaf miner, *T. absoluta,* on tomato crop in different mandals of Visakhapatnam district of Andhra Pradesh

The data regarding the incidence of *T. absoluta* in villages of Visakhapatnam district was presented in Table 2. Shows that more mean number of mines (4.18) and infested leaves (25.08%) per plant were recorded in Chodavaram village followed by Bullepalli, Tavvanipalem, Arli villages with moderate infestation and lowest infestation was recorded in K. Sonthapalem village with 0.65 mines per plant and 8.24% infested leaves per plant during vegetative stage.
At flowering stage, Aripaka village recorded the lowest infestation (1.32 mines per plant and 10.85% infested leaves per plant) preceded by Chinnayapalem, Amruthapuram and Addam villages in ascending order of infestation. The highest number of mines (2.88 per plant) and per cent infested leaves (18.30 per plant) was recorded in Adduru village.
The highest infestation during fruiting was recorded in G. Bhimavarm village with 1.80 mines per plant and 12.15% infested leaves per plant and the lowest of 0.46 mines per plant and 6.72% infested leaves per plant were recorded in L. Kothuru village preceded by Vissannapeta village with moderate level of infestation (1.25 mines per plant and 9.14% infested leaves per plant).
The ranging from 10.56 to 24.91 at near harvesting stage. The maximum per cent fruit damage (24.91) was recorded in G. Bhimavaram village followed by L. Kothuru village. The lowest per cent fruit damage, 10.56 was recorded in Bullepalli village during harvesting stage.

3.3 Incidence of South American tomato leaf miner, *T. absoluta*, on tomato crop in different mandals of Vizianagaram district of Andhra Pradesh

The survey data furnished in Table 3 indicated the infestation level of *T. absoluta* in the villages of Vizianagaram district during vegetative, fkowering, fruiting and harvesting stages of the crop. The highest infestation of 5.25 number of mines per plant and 29.14% infested leaves per plant were recorded in Rambadrapuram village followed by the villages, Thangadapalli and Narapam with moderate infestation. The lowest number of mines (3.40 per plant) and lowest per cent infested leaves (22.44 per plant) were recorded in Thammapuram village during vegetative stage.

Only two villages were observed with infestation during flowering stage of the crop, of which devada village recorded high infestation with 2.76 number of mines per plant and 18.28 per cent infested leaves per plant followed by Lottapalli village with 2.50 mines per plant and 15.34 per cent infested leaves per plant.

The mean number of mines 2.76, 2.50 and infested leaves 18.28, 15.34 were recorded in Devada and Lottapalli village, respectively and the mean number of mines and infested leaves recorded at flowering stage of crop were 2.63 and 16.81%, respectively.

At fruiting stage, lowest infestation due to *T. absoluta* was recorded in Ramayyapalem village (0.96 number of mines per plant and 10.05% infested leaves per plant) preceded by the villages Ommi and Viginigiri with moderate infestation. The highest infestation was recorded in Peddaravipalli village with 3.26 number of mines per plant and 21.32% infested leaves per pant.

The per cent infested fruits during harvesting stage of the crop recorded maximum (38.28) in Viginigiri village followed by Peddaravipalli village with 35.78% fruit infestation. The lowest per cent fruit damage (16.80) was recorded in Ramayyapalem village.

3.4 Occurrence of South American tomato leaf miner, *T. absoluta*, on tomato crop in North Coastal districts of Andhra Pradesh during survey, 2018-2019.

During the survey period (Oct. II fortnight to Jan. I fortnight), the incidence of *Tuta absoluta* was recorded in three districts of North Coastal Zone, Andhra Pradesh. As per the data recorded in the three districts, highest incidence of *T. absoluta* was recorded in Srikakulam district with 4.18 overall mean number of mines per plant, 24.50% overall mean infested leaves and 33.22% overall infested fruits per plant followed by Vizianagaram and Visakhapatnam districts, where 2.86, 2.07 overall mean number of mines per plant, 19.15%, 14.43% overall per cent infested leaves per plant and 28.56%, 17.60% overall per cent infested fruits per plant were recorded, respectively (Table 4 and Fig. 1).

Based on the observations recorded, it was noticed that the South American tomato leaf miner, *Tuta absoluta*, has adapted to the climatic conditions existing in North Coastal region of Andhra Pradesh. The typical damage symptoms of *Tuta absoluta* on leaves were blotch like mines that are visible from both sides of leaf, consisting of excreta inside and outside the mines on leaf. Severe infestation on leaves leading to death and drying up of tomato leaves was observed in Benkili village. The damage was observed on unripen and ripened tomato fruits. The incidence of *Tuta absoluta* was low in Visakhapatnam compared to Vizianagaram and Srikakulam districts during *rabi*, 2018-19.

The incidence of *Tuta absoluta* was observed to be varying in the three districts, which might be due to the impact of abiotic factors like temperature, rainfall, relative humidity; biotic factors like the occurrence of natural enemies and other factors like date of sowing, variation in cultivable varieties, extent of cultivable area, fertilizer management, irrigation schedule etc.,

The maximum per cent leaf damage, fruit infestation and number of mines per

Table 1: Incidence of South American tomato leaf miner, *T. absoluta*, on tomato crop in villages of different mandals in Srikakulam district, Andhra Pradesh during *Rabi*, 2018-19

District	Mandal	Villages	Month	Number of mines/plant*			Per cent infested leaves/plant*			Per cent fruit damage at harvest/plant*
				Veg.	Fl.	Fr.	Veg.	Fl.	Fr.	
SRIKAKULAM	Etcherla	Etcherla	Oct. II FN	4.60	-	-	27.38	-	-	-
		Fareedpeta	Oct. II FN	-	-	3.82	-	-	23.32	37.60
	Kaviti	Jinkibadra	Oct. II FN	3.36	-	-	21.81	-	-	-
		Benkili	Nov. I FN	-	-	6.08	-	-	32.34	46.47
		Mandapalli	Nov. I FN	4.46	-	-		26.56	-	-
		Palasapuram	Nov. I FN	-	-	3.76	-	-	22.65	35.26
		Lakkavaram	Nov. II FN	-	3.08		-	19.75	-	31.98
		Baruva	Nov. II FN	5.46	-	-	29.94	-	-	-
	Santhbommali	Antlavaram	Dec. I FN	5.88	-	-	31.24	-	-	-
		Vaddivada	Dec. I FN	-	4.93	-	-	27.86	-	-
	Saravakota	Maluva	Dec. II FN	5.19	-	-	28.62	-	-	-
	Pathapatnam	Korasavada	Dec. II FN	-	2.93		-	18.74	-	18.97
		Pathapatnam	Dec. II FN	3.88	-	-	23.84	-	-	-
		R.L. Puram	Jan. I FN	-	-	2.45	-	-	15.10	32.84
		Changudi	Jan. I FN	-	-	2.92	-	-	18.42	29.45
Mean infestation at different stages of crop				4.92	3.64	3.48	27.88	22.11	21.21	33.22
Mean				4.18			24.50			33.22

*An average from 10 tomato plants, FN-Fort night, Veg.-Vegetative, Fl.-Flowering, Fr.-Fruiting

Table 2: Incidence of South American tomato leaf miner, *T. absoluta*, on tomato crop in villages of different mandals in Visakhapatnam district, Andhra Pradesh during *rabi*, 2018-19

District	Mandal	Villages	Month	Number of mines/plant*			Per cent infested leaves/plant*			Per cent fruit damage at harvest/plant*
				Veg.	Fl.	Fr.	Veg.	Fl.	Fr.	
VISAKHAPATNAM	K. Kotapadu	K. Sonthapalem	Oct. II FN	0.65	-	-	8.24	-	-	-
		Arli	Oct. II FN	2.48	-	-	15.96	-	-	-
		Sonthapalem	Oct. II FN	-	-	-	-	-	-	-
	Sabbavaram	Amruthapuram	Nov. I FN	-	1.86	-	-	12.32	-	12.48
		Tavvanipalem	Nov. I FN	2.49	-	-	16.50	-	-	-
		Chinnayapalem	Nov. I FN	-	1.35	-	-	11.98	-	-
		Bullepalli	Nov. II FN	3.69	-	-	22.87	-	-	10.56
	Chodavaram	Adduru	Nov. II FN	-	2.88	-	-	18.30	-	-
		Aripaka	Nov. II FN	-	1.32	-	-	10.85	-	-
		Chodavaram	Dec. I FN	4.18	-	-	25.08	-	-	16.75
		Venkannapalem	Dec. I FN	-	-	-	-	-	-	-
	Kasimkota	L. Kothuru	Dec. II FN	-	-	0.46	-	-	6.72	22.36
		G. Bhimavaram	Dec. II FN	-	-	1.80	-	-	12.15	24.91
		Teeda	Dec. II FN	-	-	-	-	-	-	-
		Addam	Jan. I FN	-	2.62	-	-	17.58	-	-
		Vissannapeta	Jan. I FN	-	-	1.25	-	-	9.14	18.54
Mean infestation at different stages of crop				2.69	2.00	1.17	17.73	14.20	9.33	17.60
Mean				2.07			14.43			17.60

*An average from 10 tomato plants, FN-Fort night, Veg.-Vegetative, Fl.-Flowering, Fr.-Fruiting

Table 3: Incidence of South American tomato leaf miner, *T. absoluta*, on tomato crop in villages of different mandals in Vizianagaram district, Andhra Pradesh during *rabi*, 2018-19

District	Mandal	Villages	Month	Number of mines/plant*			Per cent infested leaves/plant*			Per cent fruit damage at harvest/plant*
				Veg.	Fl.	Fr.	Veg.	Fl.	Fr.	
VIZIANAGARAM	Nellimarla	Thammapuram	Oct. II FN	3.40	-	-	22.44	-	-	-
		Thangadapalli	Oct. II FN	4.39	-	-	26.08	-	-	-
		Ommi	Nov. I FN	-	-	1.36	-	-	12.65	21.64
	Rambadrapuram	Rambadrapuram	Nov. I FN	5.25	-	-	29.14	-	-	-
	Kothavalasa	Peddaravipalli	Nov. II FN	-	-	3.26	-	-	21.32	35.78
		Devada	Nov. II FN	-	2.76	-	-	18.28	-	25.37
		Narapam	Dec. I FN	3.45	-	-	22.65	-	-	-
	Jami	Viginigiri	Dec. I FN	-	-	1.86	-	-	13.55	38.28
		Ramayyapalem	Dec. II FN	-	-	0.96	-	-	10.05	16.80
		Lottapalli	Dec. II FN	-	2.50	-	-	15.34	-	33.51
Mean infestation at different stages of crop				4.12	2.63	1.86	25.07	16.81	14.39	28.56
MEAN				2.85			19.15			28.56

*An average from 10 tomato plants, FN-Fort night, Veg.-Vegetative, Fl.-Flowering, Fr.-Fruiting

Table 4: Occurrence of South American tomato leaf miner, *T. absoluta*, on tomato crop in North Coastal districts of Andhra Pradesh during *Rabi*, 2018-2019

District	Mean number of mines per plant*	Mean per cent infested leaves per plant*	Mean per cent damaged fruits per plant*
Srikakulam	4.18	24.50	33.22
Visakhapatnam	2.07	14.43	17.60
Vizianagaram	2.85	19.15	28.56

*An average from 10 tomato plants

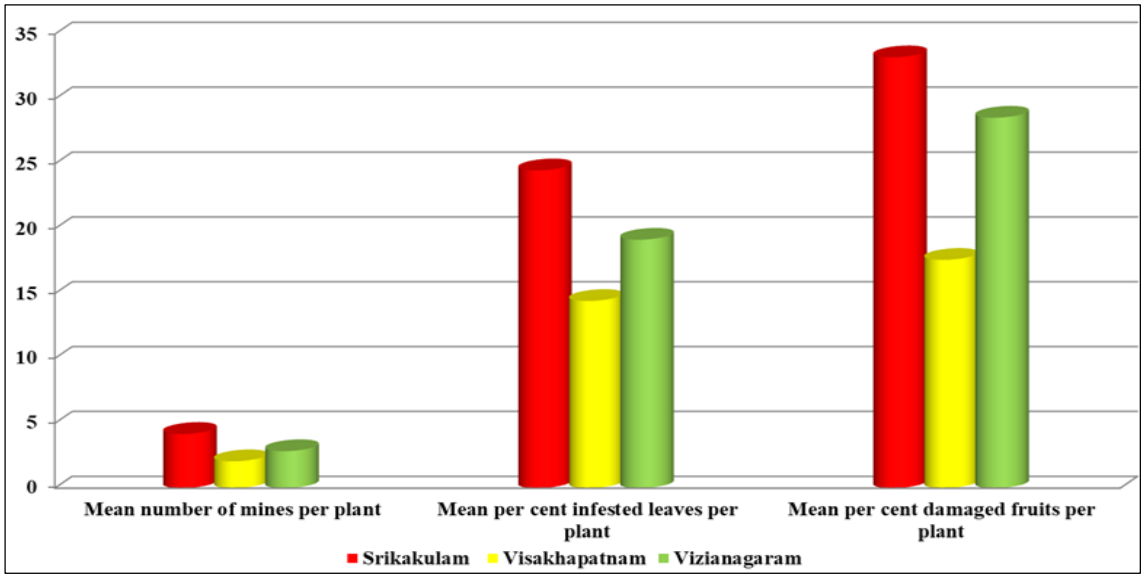

Fig 1: Occurrence of South American tomato leaf miner, *T. absoluta*, on tomato crop in villages of North Coastal Districts, Andhra Pradesh during *rabi*, 2018-19

plant in Srikakulam district of Andhra Pradesh recorded to be 24.50, 33.2 and 4.18,respectively, which were in similarity with the level of infestation recorded by Rasheed *et al.* (2018) [10] who reported 34.25% infested leaves, 32.65% infested fruits in Kalikiri mandal and 24.99% infested leaves, 25.00% infested fruits in Madanapalli mandal of Chittoor district, Andhra Pradesh. Rasheed *et al.* (2017) [11] who recorded the damage on leaves and fruits up to 86% and 50%, respectively, at larval stage in Piler, Chittoor district of Andhra Pradesh. Shanmugam *et al.* (2016) [12] recorded 20-32% infestation on lower and middle leaves and 28 to 53% fruit damage mostly on half ripened and full ripened fruits in Karimangalam block of Dharmapuri district, Tamil Nadu, Kumari *et al.* (2015) [6] observed 14.4 to 97.9 per cent damaged leaves per plant in Vegetable Research Station, Rajendranagar, in Telangana State, Sridhar *et al.* (2014) [15] reported 0.08 to 15 mines per plant and severe infestation of *T. absoluta* up to 87% was recorded in six districts of Bengaluru, Karnataka. Also with the findings of Balaji *et al.* (2018), Sharma and Gavkare (2017), Kalleshwaraswamy *et al.* (2015) [5] and Ballal *et al.* (2016) [1].

Fig 2: This figure shows *Tuta absoluta* larvar, Mine blotch and pin head size holes

4. Conclusion

The results of a roving survey carried out at fortnight intervals in selected villages of North Coastal districts during *rabi* 2018-19. The incidence of *Tuta absoluta* was found to be more in Srikakulam district which recorded 4.18 overall mean numbers of mines per plant, 24.50 per cent leaf infestation per plant and 33.22 per cent damaged fruits per plant, when compared to other two districts (Vizianagaram and Visakhapatnam) of North Coastal Zone, Andhra Pradesh.

5. References

1. Ballal CR, Gupta A, Mohan M, Lalitha Y, Verghese A. The new invasive pest *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in India and its natural enemies along with evaluation of Trichogrammatids for its biological control. *Current science* 2016;110(11):2155-2159.
2. Department of Agriculture, Cooperation and Farmers' Welfare. Horticultural Statistics at a Glance 2018, 150-239. www.agricoop.nic.in.
3. Desneux N, Wajnberg E, Wyckhuys KAG, Burgio G, Arpaia S, Vasquez CAN *et al*. Biological invasion of European tomato crops by *Tuta absoluta*: Ecology, geographic expansion and prospects for biological control. Journal of Pest Science 2010;83(3):197-215.
4. EPPO (European and Mediterranean Plant Protection Organization). Data sheets on quarantine pests: *Tuta absoluta*. OEPP/EPPO Bulletin 2005;35:434-435.
5. Kalleshwaraswamy CM, Murthy MS, Viraktamath CA, Kumar NKK. Occurrence of *Tuta absoluta* (Lepidoptera: Gelechiidae) in the Malnad and Hyderabad-Karnataka regions of Karnataka, India. Florida Entomologist

2015;98(3):970-971.
6. Kumari DA, Anitha G, Anitha V, Lakshmi BKM, Vennila S, Rao NHP. New record of leaf miner, *Tuta absoluta* (Meyrick) intomato. Insect Environment 2015;20(4):136-138.
7. Nitin KS, Sridhar V, Kumar KP, Chakravarthy AK. Seasonal incidence of South American tomato moth, *Tuta absoluta* (Meyrick) (Gelechiidae: Lepidoptera) on tomato ecosystem. International Journal of Pure Applied Biosciences 2017;5(1):521-525.
8. NICRA team of tomato pest surveillance. Manual for tomato pest surveillance. Jointly published by National Centre for Integrated Pest Management, New Delhi; Central Institute for Dryland Agriculture, Hyderabad; Indian Institute of Horticultural Research, Bengaluru and Indian Institute of Vegetable Research, Varanasi 2012, 39.
9. Pereyra PC, Sanchez NE. Effect of two solanaceous plants on developmental and population parameters of the tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). Neotropical Entomology 2006;35(5):671-676.
10. Rasheed VA, Rao SRK, Babu TR, Krishna TM, Reddy BVB, Naidu GM. Incidence of South American tomato leaf miner, *Tuta absoluta* (Meyrick) in Chittoor district of Andhra Pradesh, India. Journal of Entomology and Zoology Studies 2018;6(5):2407-2414.
11. Rasheed VA, Rao SRK, Babu TR, Krishna TM, Srinivasulu A, Ramanaiah PV. New record of invasive South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) on tomato in Andhra Pradesh. International Journal of Pure & Applied Bioscience 2017;5(3):654-656.
12. Shanmugam PS, Ramaraju K, Indhumathi K. First record of South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in Tamil Nadu, India. Entomon 2016;41(1):61-66.
13. Shashank PR, Chandrashekar K, Meshram NM, Sreedevi K. Occurrence of *Tuta absoluta* (Lepidoptera: Gelechiidae) an invasive pest from India. Indian Journal of Entomology 2015;77(4):323-329.
14. Siqueira HAA, Guedes RNC, Picanço MC. Insecticide resistance in populations of *Tuta absoluta* (Lepidoptera: Gelechiidae). Agricultural and Forest Entomology 2000;2:147-153.
15. Sridhar V, Chakravarthy AK, Asokan R, Vinesh LS, Rebijith KB, Vennila S. New record of the invasive South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelichiidae) in India. Pest Management in Horticultural Ecosystems 2014;20(2):148-154.
16. Sridhar V, Nitin KS, Onkaranaik S, Nagaraja T. Comparative biology of South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) on three solanaceous host plants. Pest Management in Horticultural Ecosystems 2015;21(2):159-161.
17. Swathi P, Swathi B, Das SB, Sridhar V, Giribabu O, Snehalatha G *et al*. First report of South American tomato leaf miner, *Tuta absoluta* (Meyrick) from Madhya Pradesh, India. Pest Management in Horticultural Ecosystems 2017;23(1):92-93.