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Light cum suction trap based IPM for the management of South American Tomato Moth, *Phthorimaea absoluta* (Meyrick, 1917)

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ABSTRACT: South American Tomato Moth, *Phthorimaea absoluta* that has invaded India in 2014 is a key pest of Tomato causing a yield loss of 80-100 per cent. Over relying on synthetic insecticides, as a primary option for managing this devastating pest has resulted in the development of resistance to the novel insecticides too. In this direction by integrating different IPM tools, wherein Light cum Suction Trap (LCST) as one of the component was evaluated against *P. absoluta*. Efficacy of LCST was found 5 times higher trapping of insect when compared to conventional light trap without suction mechanism. In LCST, 8496 moths were trapped as against 1674.67 moths in conventional trap. Further the integration of the LCST with the IPM module resulted in significant reduction of tomato fruit damage. The IPM implemented plots recorded a tomato fruit damage of 12.05 and 8.79 per cent in two seasons which was significantly lower than the control plots (up to 35.87 %). The findings suggests that, IPM module by including light cum suction trap, egg parasitoid *Trichogramma pretiosum*, need based spray of insecticides resulted in effective management of *P. absoluta*.

Keywords: *Phthorimaea absoluta*, IPM, light cum suction trap, *Trichogramma*

INTRODUCTION

Biological invasions have been a significant social and economic consequence in the agricultural settings due to increased challenges with the globalization (McNitt *et al.*, 2019). The South American Tomato Moth, *Phthorimaea absoluta* which was first reported from India in 2014 has been a serious pest on the Tomato crop and is reported to cause an economic yield loss of 100 per cent, if timely management interventions are not followed (Sridhar *et al.*, 2014; Sankarganesh *et al.*, 2017). The solanaceae family is the main host of the insect and is reported on *Solanum nigrum, S. tuberosum, Capsicum annuum* apart from Tomato, *S. lycopersicum* (Bawin *et al.*, 2016). The insect is potential of expanding its range radius by an average of 600 km per year (Campos *et al.*, 2017) and is reported in China and Turkey other than India which shares almost half of the tomato growing land area worldwide (Desneux *et al.*, 2011; Zhang *et al.*, 2020). Ecological Niche modeling of the insect has shown a high niche expansion in Asia (38%) and Europe (19 %) indicating the spread of populations in new climatic areas (Yuan *et al.*, 2024). Globally, Chemical control is the primary option for the management in spite of its various disadvantages *viz.*, non target effects on the beneficial arthropods and insecticide resistance (Roditakis *et al.*, 2018; Grant *et al.*, 2019). Other environmental friendly approaches have registered a good amount of results in managing the pest but it is a long way ahead to promote the use of those options due to its delayed results, financial assistance *etc.* Integrated Pest Management (IPM) which involves various eco-friendly tactics and sensible use of pesticides serves as a solution to overcome the consequences.

The phototactic behavior of the insects helps in designing of the traps and this serves as a sustainable tool for the management of pest. This approach serves to be a great option for managing *P. absoluta*, adults being nocturnal. Among different light traps evaluated for the management of the *P. absoluta*, Incandescent yellow bulb of 60 W was most efficient in attracting the insects and was identified as an important component of IPM (Sridhar *et al.*, 2018). In order to reduce the escape of the attracted insects to the light trap, light cum suction trap was designed. The addition of suction force to the light trap offers a provision of preventing the escape of insects attracted to the light source. By including light cum suction trap (LCST) along with other Integrated Pest Management options, an IPM module was designed and was evaluated for the effective management of *P. absoluta.*

MATERIALS AND METHODS

The efficacy of LCST in attracting *P. absoluta* was evaluated simultaneously in three polyhouses at ICAR-IIHR, Bengaluru located at 13° 8' 18.8088" N, 77° 28' 40.4040" E. The conventional light trap was included for the comparison and number of adult *P. absoluta* attracted was observed for ten nights, regularly. Further, IPM module was designed by including effective tools against *P. absoluta* as identified during the year 2019 with slight modifications (Sridhar *et al.*, 2019) and by including LCST as a major component. The IPM trials were carried out in *rabi*-summer seasons of 2019-20 and 2020-21 under open field conditions. The IPM evaluation experiment was laidout in one acre and a Non IPM plot was maintained with same tomato variety, 500 m away. Tomato hybrid 'Arka Rakshak' was planted with a spacing of 75 X 45 cm. The crop was grown by following recommended package of practices except plant protection aspects. The detailed components of the plant protection module (IPM) includes – Selection of pest free planting material, Clean cultivation and destruction of infested plant parts; Installation of Light cum suction Trap with incandescent bulb 60 W @ 5 per ha and pheromone traps @ 8 per acre immediately after transplanting ; Release of *Trichogramma pretiosum/T. chilonis* - egg parasitoid (100000/Ac – distributed in 5 weeks, starting from first notice of *Phthorimaea* adults in pheromone/light traps); Encouraging *Nesidiocoris tenuis* as predator; Use of microbials*, Bacillus thuringiensis* (1ml/l) or *Metarhizium anisopliae* @ 3 ml/l; Application of botanicals and chemicals *i.e.,* Azadirachtin 1 % EC @ 4 ml/l (when the incidence is low). Need based spray of spinetoram 12 SC / spinosad 45 SC (1.25/ 0.3 ml/l) or flubendiamide 480 SC (0.3 ml/l) or indoxacarb 14.5 SC (0.75 ml/l) in rotation, keeping in view the mode of action (during higher incidence).

Five sprays of need based insecticides were taken up in rotation with an interval of 2 weeks during the experimental period. Observations were made on damaged fruits due to *P. absoluta* in the IPM and non IPM plots at each harvest and per cent fruit damage was estimated. Healthy and damaged yield was calculated per hectare basis. For assessing the difference between IPM module and Non IPM (Farmers practice), the observational data was subjected to t-test.

RESULTS AND DISCUSSION

Efficacy of light cum suction trap in trapping the adult moths of *P. absoluta* over conventional light trap (Polyhouse trial)

In all the three trials evaluated LCST showed significantly higher trapping of *P. absoluta* adults over conventional light trap (($t = 8.23$, $P < 0.05$). The LCST captured a total of 8496 adult moths in ten nights and the number was five times higher than the moths captured in the conventional light trap (1674.67 moths). The details of mean no. of adults captured at each night are furnished in Table 1. The principle behind the suction of insects is mainly due to suction mechanism. The differential pressure between the fan that links to the air outside with suction port exerts a suction force on the target pest (Han *et al.*, 2024). The findings of the study were in accordance with Cocco *et al.* (2012) who evaluated the effectiveness of light trap equipped with 2 black light tubes and downdraught suction motor against *P. absoluta* and revealed a reduced population density and damage during the summer-winter season**.** Similarly, the findings of the Girardeau *et al*. (1952) who reported that light cum suction trap with 30 W black light fluorescent tubes were effective in trapping night-flying insects proves the effectiveness of suction trap.

Table 1: Relative efficacy of 'Light cum suction trap (LCST)' over conventional light traps in trapping *P. absoluta* adults (mean of three trials)

Number of nights	No. of adults trapped in LCST	No. of adults in normal light trap (conventional)
1	1361.33	340.00
2	440.33	206.67
3	482.00	154.67
4	1131.67	165.67
5	679.00	126.67
6	675.33	88.67
7	846.33	84.00
8	1112.67	193.67
9	917.00	155.67
10	850.33	159.00
Total	8496.00	1674.67
Mean	849.60	167.47
Sig. (P=0.05)	**	
t value	**8.23**	

** Significant at 1%

Impact of IPM module against *P. absoluta* damage and tomato yield (Open field)

The IPM module evaluation against *P. absoluta* in two seasons revealed a significant difference between IPM Module and Non IPM module (t = 3.49, P <0.05 and t = 2.37, P<0.05), where there was a significantly lower fruit damage in IPM module (Table 02). During first year, the mean per cent tomato fruit damage in IPM Plot was 12.05 per cent and significantly lower when compared to the non IPM plots (34.14 %). Similarly, during second year trial also, a maximum of 35.87 per cent damage was observed in non IPM plots as against only 8.79 per cent damage in IPM Plots. In addition, highest healthy tomato yield was recorded in IPM fields when compared to Non IPM plots in both the years (t = 7.36, P<0.05 and t = 6.64, P<0.05) (Table 3). In first and second years, the total healthy tomato yield recorded in IPM plot was 75.19 and 76.13 t/ha, respectively and was found superior to non IPM plots (51.17 and 46.87 t/ha, respectively). The overall findings reveal that the IPM interventions significantly reduced the damage to tomato fruits due to *P. absoluta* and reduced the insecticide spray by 50 percent.

The benefit-cost ratio (BCR) worked out revealed that IPM module recorded a BCR of 3.87 and 4.03, respectively in First year and Second year, respectively.

Table 2: Impact of IPM module against *P. absoluta*

No. of Harvests	First Year % fruit damage		Second Year % fruit damage	
	IPM	Non IPM	IPM	Non IPM
1	9.23	26.08	5.37	30.16
2	11.94	25.24	10.71	27.20
3	15.05	29.49	12.91	27.91
4	9.56	31.74	7.75	30.15
5	10.86	36.42	10.19	34.09
6	12.82	37.67	8.00	38.76
7	12.87	39.85	6.82	48.10
8	13.53	39.62	8.58	50.57
Total	12.05	34.14	8.79	35.87
t-value (0.05)	3.49*		2.37**	

* Significant at 5% ** Siginificant at 1%

Table 3: Impact of IPM module on healthy tomato yield (t/ha)

No. of Harvest	First Year		Second Year	
	IPM	Non IPM	IPM	Non IPM
1	7.38	4.11	3.7	2.57
2	8.48	6.19	5.55	3.8
3	9.31	6.01	9.11	5.14
4	9.93	7.29	10.48	6.37
5	11.08	7.84	11.45	7.50
6	11.22	7.81	12.31	6.84
7	9.61	6.52	12.31	6.84
8	8.18	5.41	11.24	7.81
Total	75.19	51.17	76.13	46.87
Sig. (P=0.05)	**		**	
t-value	7.36		6.64	

** Siginificant at 1%

The success of the IPM module is attributed to the incorporation of various effective components such as raising healthy seedlings, mechanical destruction, use of botanicals, microbials at early stage of infestation, light cum suction traps from transplanting stage of the crop itself, pheromones and eco-friendly molecules that are proved to be effective in managing *P. absoluta* population. The raising of the healthy seedlings, clean cultivation serves to be critical considerations as the damage to the crop by *P. absoluta* is possible from seedling stage to final harvest of the crop. The bio controls plays a significant role in managing the pest populations. Release of egg parasitoids decreases the insect population in the initial days of the crop and in turn reduces further damage. The adoption of the *T. pretiosum/T. chilonis* egg parasitoid and encouraging the predator *N. tenuis* have resulted in significant reduction of the pest. Efficacies of these biocontrol agents against *P. absoluta* were observed in earlier studies by different authors (Faria *et al.,* 2007; Calvo *et al.*, 2012; Sridhar *et al.,* 2019). The studies with *T. pretiosum* has resulted in 45 and 28 per cent parasitization of the *P. absoluta* eggs (Faria *et al.,* 2007; Sridhar *et al.*, 2019). Further, the combination of LCST and Pheromone traps resulted in significant reduction of moths (both male and females). Our previous findings regarding LCST efficiency and the findings of Cocco *et al.* (2012) supports the present findings in reducing the pest damage. With reference to the Entomopathogens, several studies on *Bacillus thuringiensis* (Bt) and *M. anisopliae* insecticide formulations have demonstrated their efficacy in controlling *P. absoluta* larvae without any side effects on beneficial arthropods (Pires *et al.*, 2010; Molla *et al*, 2011; Hashemitassuji *et al.*, 2013; Contreras *et al.*, 2014; Erol *et al.*, 2021). The botanical, Azadirachtin 1 % EC has registered 69.87 per cent reduction in live mines and is found to be effective against the *P. absoluta* (Sridhar *et al.*, 2016). Studies from others conducted with different insecticides *viz*., spinetoram, spinosad, flubendiamide and indoxacarb were reported as effective against *P. absoluta* (Roditakis *et al.*, 2013; Abdelgaleil *et al.*, 2015; Dilipsundar and Srinivasan, 2019; Erol *et al.*, 2021). Hanafy and El-Sayed (2013) has reported higher toxic effect of spinetoram and spinosad with the lower leaf infestation. Similarly, the application of spinosad at 120 g a.i./ha has resulted in 99.8 per cent reduction of damage after 28 days of application (Bratu *et al.*, 2015). Further, application of indoxocarb has reported 67 and 56 per cent of reduction in damage in the tomato fields (Berxolli and Shahini, 2018). Patel and Mehta (2019) have reported 77.05 per cent mortality of *P. absoluta* by the application of Flubendiamide 480 SC.

The IPM incorporated plots registered a healthy tomato yield of 75.19 and 76.13 t/ha with a BCR of 3.87 and 4.03 in two seasons, respectively and is line with the studies conducted by Kumar *et al.* (2020) who recorded a yield of 40.62 t/ha with BCR of 2.50 with an IPM approach consisting of traps, botanicals and synthetic insecticides.

Thus the present study confirms the efficacy of the Integrated Management of *P. absoluta,* wherein LCST played an important role in attracting both male and female moths of the pest thereby reducing the infestation levels. Further, the inclusion of other IPM practices like mechanical, physical (pheromone traps), biological (*B*t and *M. anisopliae*) and chemical (Insecticides) components effectively contributed for the reduction in *P. absoluta* population levels and served as an effective strategy for its management.

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REFERENCES

Abdelgaleil, S. A., El-Bakary, A. S., Shawir, M. S. and Ramadan, G. R. 2015. Efficacy of various insecticides against tomato leaf miner, *Tuta absoluta*, in Egypt. *Applied Biological Research*, **17**(3): 297-301.

Bawin, T., Dujeu, D., De Backer, L., Francis, F. and Verheggen, F. J. 2016. Ability of *Tuta absoluta* (Lepidoptera: Gelechiidae) to develop on alternative host plant species. *The Canadian Entomologist*, **148**(4): 434-442.

Berxolli, A. and Shahini, S. 2018. Indoxacarb as alternative for controlling *Tuta absoluta* (Meyrick) (Lepidoptera: Gelichiidae). *European Journal of Physical and Agricultural Sciences,* **6**(1): 100-106.

Bratu, E., Petcuci, A.M. and Sovarel, G. 2015. Efficacy of the product Spinosad an insecticide used in the control of tomato leaf miner (*Tuta absoluta*-Meyrick, 1917). *Bulletin UASVM Horticulture*, **72**(1):209-210.

Calvo, F. J., Lorente, M. J., Stansly, P. A. and Belda, J. E. 2012. Preplant release of *Nesidiocoris tenuis* and supplementary tactics for control of *Tuta absoluta* and *Bemisa tabaci* in greenhouse tomato. *Entomologia Experimentalis et Applicata*, **143**(2): 111-119.

Campos, M. R., Biondi, A., Adiga, A., Guedes, R. N. and Desneux, N. 2017. From the Western Palaearctic region to beyond: *Tuta absoluta* 10 years after invading Europe. *Journal of Pest Science*, **90**: 787-796.

Cocco, A., Deliperi, S. and Delrio, G. 2012. Potential of mass trapping for *Tuta absoluta* management in greenhouse tomato crops using light and pheromone traps. *IOBC-WPRS Bull*, **80**: 319-324.

Contreras, J., Mendoza, J. E., Martinez-Aguirre, M. R., Garcia-Vidal, L., Izquierdo, J. and Bielza, P. 2014. Efficacy of enthomopathogenic fungus *Metarhizium anisopliae* against *Tuta absoluta* (Lepidoptera: Gelechiidae). *Journal of Economic Entomology*, **107**(1): 121-124.

Desneux, N., Luna, M. G., Guillemaud, T. and Urbaneja, A. 2011. The invasive South American tomato pinworm, *Tuta absoluta*, continues to spread in Afro-Eurasia and beyond: the new threat to tomato world production. *Journal of Pest Science,* **84**: 403–408.

Dilipsundar, N. and Srinivasan, G. 2019. Bio-efficacy of insecticides against invasive pest of Tomato pinworm, *Tuta absoluta* (Meyrick, 1917). *Annals of Plant Protection Sciences*, **27**(2): 185-189.

Erol, A.B., Erdogan, O. and Karaca, I. 2021. Effects of some bio insecticides on the tomato leaf miner, *Tuta absoluta* (Meyrick, 1917) (Lepidoptera: Gelechiidae). *Egyptian Journal of Biological Pest Control*, **31**: 1-4.

Faria, C. A., Torres, J. B., Fernandes, A. M. V. and Farias, A. M. I. 2008. Parasitism of *Tuta absoluta* in tomato plants by *Trichogramma pretiosum* Riley in response to host density and plant structures. *Ciencia Rural*, **38**: 1504-1509.

Girardeau, Maratha, F., Stanly, J.M. and La Hue, D.W. 1952. Primary report on light traps for catching night flying insects. Ga. Costal Plain Expt. Sta. Tech. paper 5.

Grant, C., Jacobson, R., Ilias, A., Berger, M., Vasakis, E., Bielza, P., Zimmer, C. T., Williamson, M. S., Richrad, H., Vontas, J., Roditakis, E. and Bass, C. 2019. The evolution of multiple-insecticide resistance in UK populations of tomato leafminer, *Tuta absoluta*. *Pest Management Science*, **75**(8): 2079-2085.

Han, Y., Song, Z., Yi, W. and Zhan, C. 2024. Design of and Experimentation with a Suction-Based Pest-Capture Machine for the Tea Pest *Empoasca vitis*. *Agriculture*, **14** (6): 964.

Hanafy, H. E. and El-Sayed, W. 2013. Efficacy of bio- and chemical insecticides in the control of *Tuta absoluta* (Meyrick) and *Helicoverpa armigera* (Hubner) infesting tomato plants. *Australian Journal of Basic and Applied Science*, **7**(2): 943-948.

Hashemitassuji, A., Safaralizadeh, M. H., Aramideh, S. and Hashemitassuji, Z. 2015. Effects of *Bacillus thuringiensis* var. *kurstaki* and Spinosad on three larval stages 1st, 2nd and 3rd of tomato borer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in laboratory conditions. *Archives of Phytopathology and Plant Protection*, **48**(5): 377-384.

Kumar, Y. P., Ramadevi, A., Charan, G. S., Kumar, M. S., Raghuveer, M. and Poshadri, A. 2020. Field assessment on management of South American pin worm, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in tomato. *Journal of Entomology and Zoology Studies*, **8**(5): 360-363.

McNitt, J., Chungbaek, Y. Y., Mortveit, H., Marathe, M., Campos, M. R., Desneux, N., Brevault, T., Muniappan, R. and Adiga, A. 2019. Assessing the multi-pathway threat from an invasive agricultural pest: *Tuta absoluta* in Asia. *Proceedings of the Royal Society B*, **286** (1913). doi/10.1098/rspb.2019.1159.

Molla, O., Gonzalez-Cabrera, J. and Urbaneja, A. 2011. The combined use of *Bacillus thuringiensis* and *Nesidiocoris tenuis* against the tomato borer *Tuta absoluta*. *BioControl*, **56**: 883-891.

Patel, N. M. and Mehta, D. M. 2019. Bio-efficacy of insecticides against tomato pinworm, *Tuta absoluta* (Meyrick). *Journal of Entomology and Zoology Studies*, **7**(4): 732-734.

Pires, L. M., Marques, E. J., de Oliveira, J. V. and Alves, S. B. 2010. Selection of isolates of entomopathogenic fungi for controlling *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) and their compatibility with insecticides used in tomato crop. *Neotropical entomology*, **39**: 977-984.

Roditakis, E., Vasakis, E., Garcia-Vidal, L., del Rosario Martinez-Aguirre, M., Rison, J. L., Haxaire-Lutun,

M. O., Nauen, R.,Tsagkarakou, A. and Bielza, P. 2018. A four-year survey on insecticide resistance and likelihood of chemical control failure for tomato leaf miner *Tuta absoluta* in the European/ Asian region. *Journal of Pest Science*, **91:** 421-435.

Roditakis, E., Skarmoutsou, C., Staurakaki, M., del Rosario Martinez-Aguirre, M., Garcia-Vidal, L., Bielza, P., Haddi, K., Rapisarda, C., Rison, J. L., Bassi, A. and Teixeira, L. A. 2013. Determination of baseline susceptibility of European populations of *Tuta absoluta* (Meyrick) to indoxacarb and chlorantraniliprole using a novel dip bioassay method. *Pest Management Science*, **69**(2): 217-227.

Sankarganesh, E., Firake, D. M., Sharma, B., Verma, V. K. and Behere, G. T. 2017. Invasion of the South American Tomato Pinworm, *Tuta absoluta*, in northeastern India: a new challenge and biosecurity concerns. *Entomologia Generalis*, **36**(4): 335-345.

Sridhar, V. and Kumaran, G. S. 2018. Light trap, an effective component of integrated management of *Tuta absoluta* (Lepidoptera: Gelechiidae) on Tomato. *Journal of Horticultural Sciences*, **13**(1): 126-128.

Sridhar, V., Chakravarthy, A. K., Asokan, R., Vinesh, L. S., Rebijith, K. B., & Vennila, S. 2014. New record of the invasive South American tomato leaf miner, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) in India. *Pest Management in Horticultural Ecosystems*, **20**(2): 148-154.

Sridhar, V., Naik, S. O., Nitin, K. S., Asokan, R., Swathi, P. and Gadad, H. 2019. Efficacy of integrated pest management tools evaluated against *Tuta absoluta* (Meyrick) on tomato in India. *Journal of Biological Control*, **33**(3): 264-270.

Sridhar, V., Onkara naik, S. and Nitin, K. S. 2016. Efficacy of new molecules of insecticides against South American tomato moth, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae). *Pest Management in Horticultural Ecosystems*, **22**(2): 137-145.

Yuan, X., Zhang, Y., Hu, L., Sang, W. and Yang, Z. 2024. Investigating the effects of species niche shifts on the potential distribution of *Tuta absoluta* (Lepidoptera: Gelechiidae) by using global occurrence data. *Journal of Insect Science*, **24**(3): 8.

Zhang, G. F., Wang, Y. S., Gao, Y. H., Liu, W. X., Zhang, R., Fu, W. J.., Xian, X., Wang, J., ,Kuang, M. and Wan, F. H. 2020. First report of the South American tomato leaf miner, *Tuta absoluta* (Meyrick), in China. *Journal of Integrative Agriculture*, **19**(7): 1912-1917.

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