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Research Article

Management of Tomato Leaf Minor Tuta Absoluta with Various Types of Traps in Field Grown Tomatoes

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ABSTRACT

Tomato leaf minor (*Tuta absoluta*) is a noxious insect pests of tomato crop globally, cause huge losses of tomato in every season. Therefore, the present research was conducted to evaluate effectiveness of management trapping devices for *T. absoluta* in tomato field. Management traps show varied significantly in their effectiveness to capture moths, maximum mean (25.25±3.52) moths were caught by delta pheromone trap followed by light traps (14.78±1.89), color sticky traps (10.23±2.67) and water pan trap (5.61±01.56), respectively. Due to maximum capture of adult in delta pheromone trap, light trap devices and cultural practices, the lowest (11.90±2.67 %) tomato leaves infestation was recorded in delta type pheromone trap followed by cultural practices (13±2.80 %), light traps (15.35±3.12 %), color sticky traps (20.00±2.80 %), water pan trap (31.13±05.56 %) and control (35.13±04.50 %). However, lowest (05.59±03.62 %) infestation tomato fruit was recorded in delta type pheromone trap followed by cultural practices (8.50±2.1 %), light traps (09.64±02.88 %), color sticky traps (13.81±03.10 %), water pan trap (19.88±03.15 %) and control (22.10±04.50 %), respectively. Results showed the highest yield (6546.60 kg/acre) was obtained in the plots where delta type pheromone traps were installed, followed by plots in which cultural practices were carried out (6476.80 kg/acre), light traps (5943.70 kg/acre), yellow color sticky traps (5863.20 kg/acre), water pan trap (5684.30 kg/acre) and in control (5426.00 kg/acre). The maximum cost benefit ratio (4:18) from the plots where delta pheromone traps were installed followed by cultural practices (4:16), light traps (4:12), color sticky traps (4:10), water pan trap (4:07) and control (4:02), respectively. The highest adult attraction and lowest crop damage with maximum fruit production was recorded after the application delta pheromone traps with cultural practices, thus it is recommended; that the delta pheromone traps along with cultural practices are the convenient practices to monitor and control adult population of tomato leaf miner in infested tomato field.

Keywords: Tomato, Tomato leaf miner, Eco-friendly management, Cost-benefit ratio.

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INTRODUCTION

The tomato (*Solanum lycopersicon* L.) is one of the most important and remunerative vegetable crops which have achieved tremendous popularity over the last century, grown and consumed worldwide (Safna et al., 2018). Besides tomato fruit possess nutritive and medicinal value (Shi et al., 2015). Tomatoes are

high in vitamins and nutrients that help to avoid ailments including heart disease, cancer, and other health issues (Shi et al., 2015).

Tomatoes, both as a vegetable and as a fruit, play an important role in a healthy diet owing to the presence of powerful antioxidants such as lycopene (Munde et al., 2017). The crop is normally invaded by a few pests which cause significant less production in the early and late phase of the development as far as unthrifty development or failure of natural product, tissue obliteration, scarring, abreaction, staining (Praveen and Dhandapani, 2016). The insect pest nuisance is defenseless to ecological changes and on account of the polyphagous species, one can decide their overflow by the sorts of plant developments. Because of variety in the agro circumstances insects show shifting patterns in their occurrence in nature and degree of harm to the harvest (Han et al., 2019). However, significant restricting factor in the term of crop efficiency, yield and development of tomato is its vulnerability to numerous insect pests. Several as types of insect pests have been recorded on tomato crop such as sucking complex and chewing complex which are the serious nuisance of tomato causing immense yield loss during the fruiting period (Gozel and Kasap, 2015). Both the phase of crop (vegetative and reproductive) both mature and immature stages of insects cause huge production losses (Singh et al., 2018). Since biological invasions are the major pose and threat to agriculture grown areas and human mobility increasing and they are important drivers of global change as well as (Paini et al., 2016).

In Asia tomato leafminer *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is a significant and invasive pest of tomatoes worldwide (Desneux et al., 2022). Other solanaceous plants, such as potatoes, eggplant and tobacco, are also somewhat attacked by leaf miner in addition to tomatoes (Verheggen and Fontus, 2019). All of the tomato parts above-ground such as the leaves, stems, blossoms and fruits, suffer severe losses at the hands of tomato leaf miner larvae. The larvae create numerous galleries with the ability to enter and exit leaves as a result of feeding on the mesophyll tissues (Ndereyimana et al., 2020). Consequently, tomato leaf miner has raised the expense of controlling it but resulted in considerable yield losses and tomato fruit quality degradation (Rostami et al., 2020). Synthetic insecticides are typically used to control the leaf miner in tomato plants. However, leaf miner populations are more susceptible to the development of multiple-insecticide resistance due to frequent pesticide application and the short developmental period of the pest (Mansour et al., 2019).

Using insecticides as the sole method of fruit borer control leads to specific undesirable effects (Ashfaq et al., 2012). The application of insecticides presents health risks to humans while diminishing beneficial predator insect and pollinator populations according to Grant et al. (2019). It becomes crucial to develop supplementary integrated pest management systems because insecticides cannot sustain long-term operations while preserving the ecological balance of tomato gardens. There exists a complex ester mix called trans3-cis-8-cis-11-tetradecatriene acetate (E3Z8Z11-14:Ac) which serves as the main sex pheromone of *T. absoluta* together with its trace component trans-3-cis-8-tetradecadiene acetate (E3Z814:Ac) (Chermiti et al., 2012). Field testing has shown that this sex pheromone is active. With *T. absoluta* sex pheromones, the specificity and trapping are obvious. But the only way to catch the males is with a sticky or water basin trap, which necessitates adding water or changing the sticky card frequently (Sabbahi et al., 2022). Both methods obviously impractical for bulk trapping in the field. Adults of *T. absoluta* can mate shortly after emerging. The male and female adults can mate close together without the sex pheromone attraction when the population density is high enough. Furthermore, the males captured by sex pheromone trapping had comparatively reduced testicular volumes, comparable to those of males between the ages of 7 to11 days (Shi et al., 2024). Therefore, it is not possible to manage this pest by mass trapping (Jabamo et al., 2023).

In integrated pest management programs comprehensive and alternative control approaches must be explored for application, particularly concerning resistance and heavy insecticide use (Polat and Tiryaki, 2019). Among the other approaches, pheromones are used to track the population of insects in order to determine when to apply different control strategies, like increasing the use of mass trapping, introducing natural enemies, and applying insecticides (Braham, 2014). Various kinds of traps, like coloured traps and water pans traps also obstruct the adults of *T. absolutas* attractiveness. IPM programs, based on the use of pheromones and mass trapping applications, have been used to control this pest in several countries throughout the world (Bayram et al., 2017). However, light traps have also been employed in conjunction with mass trapping as a means of controlling pests (Ozkan et al., 2017). Roll traps were used in another study to lower the *T. absoluta* population for tomato cultivation in greenhouses (Hassan and Alzaidi, 2010). Nevertheless, only a small number of various coloured and types of traps were used in these investigations. Furthermore, in open-field tomato cultivation, roll traps equipped with pheromones have not yet been utilized to identify leaf miner. Thus, the goal of this study was determined whether mass capturing for tomato leaf

miner by using various types of traps for the monitoring and management of tomato leaf miner in field grown tomatoes.

MATERIALS AND METHODS

A field trial entitled “Mass trapping and management of tomato leaf miner *Tuta absoluta* with various types of traps in field grown tomatoes” was conducted at the research area of Plant Protection, Agriculture Research Institute (ARI) Tandojam during 2024 to evaluate the mass trapping and management of tomato leaf miner *Tuta absoluta* with various types of traps in field grown tomatoes. The aim of the current study was determined the most trap technique for mass trapping of tomato leaf miner.

Experiment detail

For this purpose, tomato Rani variety was sown for research purpose on total size 1 acre area was cultivated for the determination of population of tomato leaf miner with three replications. The field trial was laid down on the design randomized complete block design (RCBD). All the traditional methods for crop growth and production were carried out according to the need for crops. Further plant sequence practices were made such as space row to row and plant to plant 65 cm distance was mentioned in the field trial. Further, initially seedling and plants were supported with wood sticks to avoid lodging. Application of fertilizers was applied equally throughout the season including control plot. However, there are no applied control measures that were initiated to targeted plots without necessary control. There were six treatments ie., T_1= 4 Pheromone delta trap per acre, T_2= 4 Water trap per acre, T_3= 4 Light trap per acre, T_4= 4 Yellow color sticky trap per acre, T_5= Cultural practices and T_6= Control (without any control practice) having three replication of each treatment.

Applications of mass trapping strategy

Based on the objectives of the study, mass trapping devices following different control approaches were arranged and installed in tomato field to evaluate the effectiveness of tomato leaf miner adult capturing.

Preparation and installation of pheromone delta traps

Pheromone chemical structure of the female sex pheromone of tomato leaf miner were identified as trans3-cis-8-cis-11-tetradecatriene acetate (E3Z8Z11-14: Ac) (Attygalle et al., 1996) with trans-3-cis-8-tetradecadiene acetate (E3Z814:Ac) as a trace component (Svatos et al., 1996). Commercial delta traps and synthetic sex pheromones were brought in from Zafar Shani Chemical Company, Multan. Standard delta traps were size about 6 inches length and 6 inches width in delta shape traps along 3 feet height were supported by wooden stand. In present study, the blend ratio 50µg/10 ul mixed with methanol and fixed in rubber tube of two sex pheromone components such as (E3Z8Z11-14:Ac) and (E3Z814:Ac) was used at unique concentrations such as 50µg/10 ul in rubber tube with each capsule which was exploited in tomato field.

Preparation and installation of water pan traps

Water pan traps were locally purchased and arranged cobalt’s (20 inches in diameter and 24 inches height) was filled with 10 litter normal water and 10 milliliter (ml) mobile oil was mixed in water for density purpose. In this regard captured adult of tomato leaf miner moths were fully dipped with oiley water. Total four water pan traps per acre were installing at soil surface for adult moth population traps.

Preparation and installation of light traps

The light trap (Jermy type) consists of four main components: a collecting chamber, a funnel-shaped lid, a light source, and a top lid to shield against sudden downpours. For the purpose of killing tomato leaf miner moths, the potassium cyanide was used, and 12 Walt standard electrical bulbs were utilized as the light source. The jermy style light traps were set up and hung at a height of around 3.5 feet with the support of iron raid. The number of light traps for every treatment was deployed in every subplot or replication.

Preparation and installation of color sticky traps

Yellow color sticky traps were locally made and arranged by self. Yellow plates were purchased separately (12×8 inches length and width) fixed with wooden stick at 3 feet height. Sticky lure was replaced at weekly basis from the color sticky plates. Total four yellow color sticky plate traps were installed per acre with triplicate to determine the effectiveness of management practices.

Application of cultural practices for leaf miner

For the management of tomato leaf miner standard cultural and farmers control practices were carried out in targeted plot to determine the importance of standard culture practices in tomato field. Tomato plants were cultivated on ridges keeping plant to plant and ridge to ridge distance accordingly. Proper and regularly monitoring of crop was

performed to investigate the insect infestation. And alternative day basis collection of the damaged and infested crop part and plants and destroyed. Staking and trellising tomato plants at the appropriate time. Three to four properly weeding were done with the help hand manually equipment throughout the cropping season. Proper fertilizer and other nutrients were supplied according to the need for crop.

Number of tomato leaf miner moth catches/trap/week

The number of tomato leaf miner adult moths were caught per trap was recorded at weekly intervals, starting from the installation of trapping devices up to the harvesting of the crop from each plot. The average data recorded during observations was transformed to subject to statistical analysis for determination to effectiveness of management practice devices.

Crop damage symptoms assessment (%)

Larvae of tomato leaf miner can feed on different parts of plant particularly larvae mine the leaves and produce blotch-shaped mines. Crop damage symptoms assessment (%) was assessed by counting the number of healthy and infested leaves through observing the characteristic based on leaf mine and producing blotch-shaped mines symptoms were accounted by randomly checked 10 plants and two leaves from each plant from each replication. So far, crop damage symptoms were confirmed by using the technique as described by Pedigo et al. (1986).

$$\text{Damage \%} = \frac{\text{No. infested leaves}}{\text{No. of total leaves}} \times 100$$

Tomato fruit damage %

For data observation of tomato leaf miner fruit infestation percentage was record from the tomato fruits. Data was recorded from all treatments from each replicated plot. Further randomly 100 small, medium, and large size tomato fruits were examined at each picking from each replication. However, further fruit infestation percentage was calculated according to following formula as described by Pedigo et al. (1986).

$$\text{Percent fruit damage (\%)} = \frac{\text{No. of infested fruit}}{\text{Total number of fruits}} \times 100$$

Fruit yield of tomato

The fruit yield per plot was recorded for each treatment and data was subjected to appropriate statistical analysis for interpretation and find out the difference among the treatments.

Data analysis

Average captured adults of leaf miner moths and crop damage percentages was analyzed using one-way analysis of variance (ANOVA) followed by the LSD test to determine treatment differences. Efficiency was considered significantly different at ($P < 0.05$). All analyses were performed by using SPSS and Graph-Pad Prism software.

RESULTS

A field trial entitled “Mass trapping and management of tomato leaf miner *Tuta absoluta* with various types of traps in field grown tomatoes” was conducted at the research area of Plant Protection, Agriculture Research Institute (ARI) Tandojam during 2024.

Weekly captured adult population of *T. absoluta*

The data presented in figure 1 exhibited weekly captured population of tomato leaf miner adults (male and female) after the application of management trap devices in tomato infested field. The delta type pheromone on the 5th August (09.33 ± 01.80), 12th August (13.00 ± 21.45), on the date 19th August (16.28 ± 2.70), on the date 26th August (28.67 ± 3.56), on the dated 2nd September (33.66 ± 04.10), on the date 9th September (36.30 ± 05.60), on the date 16th September (40.00 ± 05.79), on the date 23rd September (41.25 ± 4.80), on the date 30th September (26.52 ± 4.86), on the date 7th October (30.20 ± 4.10), on the date 14th October (22.00 ± 3.40), on the date 21st October (18.18 ± 3.14) and on the date 28th October (12.15 ± 3.20), respectively.

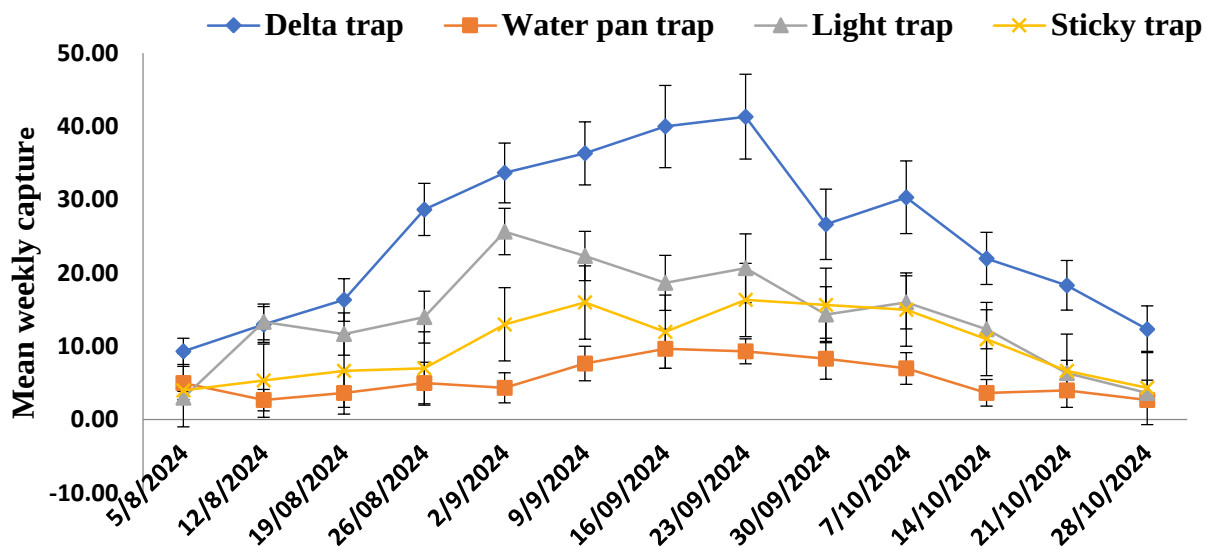

Figure 1. Weekly mean capture adult of tomato leaf miner *Tuta absoluta* moths (males and females) in trapping and management devices under field condition.

Overall average seasonal captured adult moth population of *T. absoluta*

Results in figure 2 indicate the overall mean adult captured population of tomato leaf miner *Tuta absoluta*. As data showed overall seasonal captured adult population male and female after the installation of different management trap devices in tomato under field condition. Subsequently, surprisingly remarkable variation was recorded in different management trapping devices at statically level (DF= 3.0, MS= 282.06, P <0.001) (Table 1). However, the maximum average seasonal tomato leaf miner *T. absoluta* adult (male and female) population (25.25±3.52) was caught by delta pheromone trap devices followed by light traps (14.78±1.89), Yellow color sticky traps (10.23±2.67) and water pan trap (5.61±01.56), respectively.

Table 1. Statistically analysis of overall seasonal averages caught of tomato leaf miner *Tuta absoluta* in trapping and management devices under field conditions.

Traps	df	Error	MS	P
Delta	3	76	282.06	0.001
Water Pan	3	76	569.25	0.003
Light	3	76	2869.2	0.001
Sticky	3	76	387.14	0.009
Significant P-value (P<0.05)				

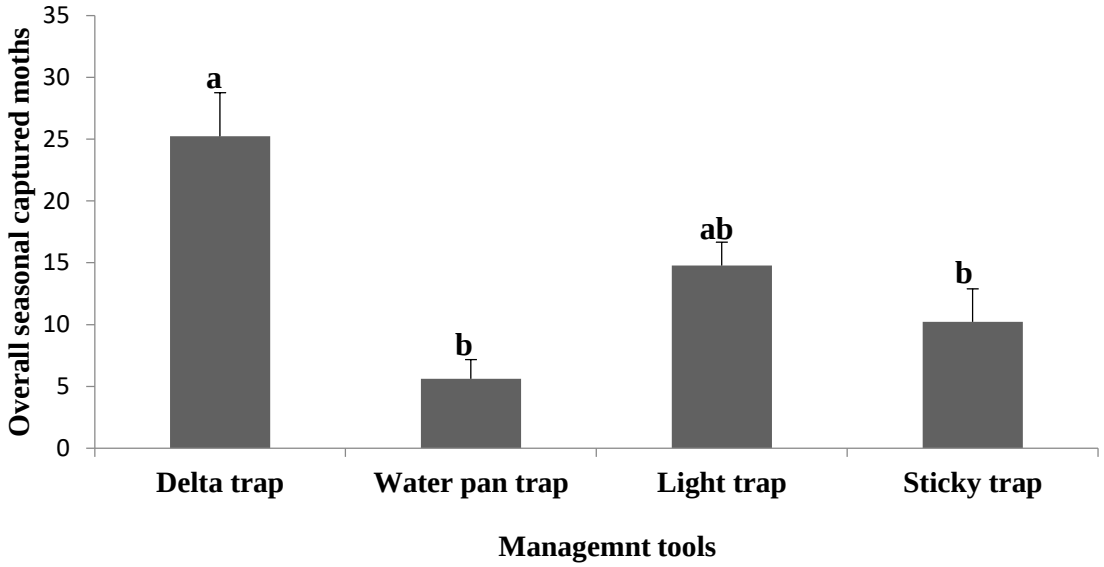

Figure 2. Overall seasonal averages population caught of tomato leaf miner *Tuta absoluta* in trapping and management devices under field condition. Different alphabetically letters are representing the significant difference between the treatments at (P <0.05).

Crop damage assessment (%)

Data showed in figure 3 impact of captured tomato leaf miner adult (male and female) population on the infestation of tomato plant parts (leaves and fruits). A highly significant mean infestation of tomato leaf miner on tomato leaves entire the one season cropping period was analyzed and recorded at in different management trapping devices at statically level (DF= 5.0, SS= 1890.24, MS= 278.049, F= 117.0, P <0.0009). Due to maximum capture of adult in delta pheromone trap, light trap devices and culture practices, tomato leaves infestation percentage was less as compared to other treatments. Although, specifically lowest infestation leaves (%) was recorded (11.90±2.67 %) in delta type pheromone trap devices followed by cultural practices (1362±2.80 %), light traps (15.35±3.12 %), Yellow color sticky traps (20.00±2.80 %), water pan trap (31.13±05.56 %) and control untreated plots (35.13±04.50 %), respectively. In addition, further, data showed highly significant mean infestation of tomato leaf miner on tomato fruits entire the one season cropping period was analyzed and recorded at in different management trapping devices at statically level (DF= 5.0, MS= 173.495, P <0.001). Due to maximum capture of adult in delta pheromone trap, light trap devices and culture practices, tomato fruit infestation percentage was less as compared to other treatments. Although specifically lowest infestation tomato fruit (%) was recorded (05.59±03.62 %) in delta type pheromone trap devices followed by cultural practices (8.50±2.1 %), light traps (09.64±02.88 %), Yellow color sticky traps (13.81±03.10 %), water pan trap (19.88±03.15 %) and control untreated plots (22.10±04.50 %), respectively.

Table 2. Statistically analysis of overall mean percentage infestation caused by tomato leaf miner *Tuta absoluta* on tomato leaves and fruits.

	Leaves (%)				Fruits (%)			
Practices	**df**	**Error**	**MS**	**P**	**df**	**Error**	**MS**	**P**
Delta	5	97	173.25	0.001	5	97	2568	0.001
Water Pan	5	97	589.52	0.001	5	97	4125	0.001
Light	5	97	5263	0.003	5	97	3214	0.023
Sticky	5	97	2569	0.001	5	97	987	0.005
Cultural	5	97	1247.25	0.001	5	97	2014	0.001
Control	5	97	3687.10	0.001	5	97	6587	0.001

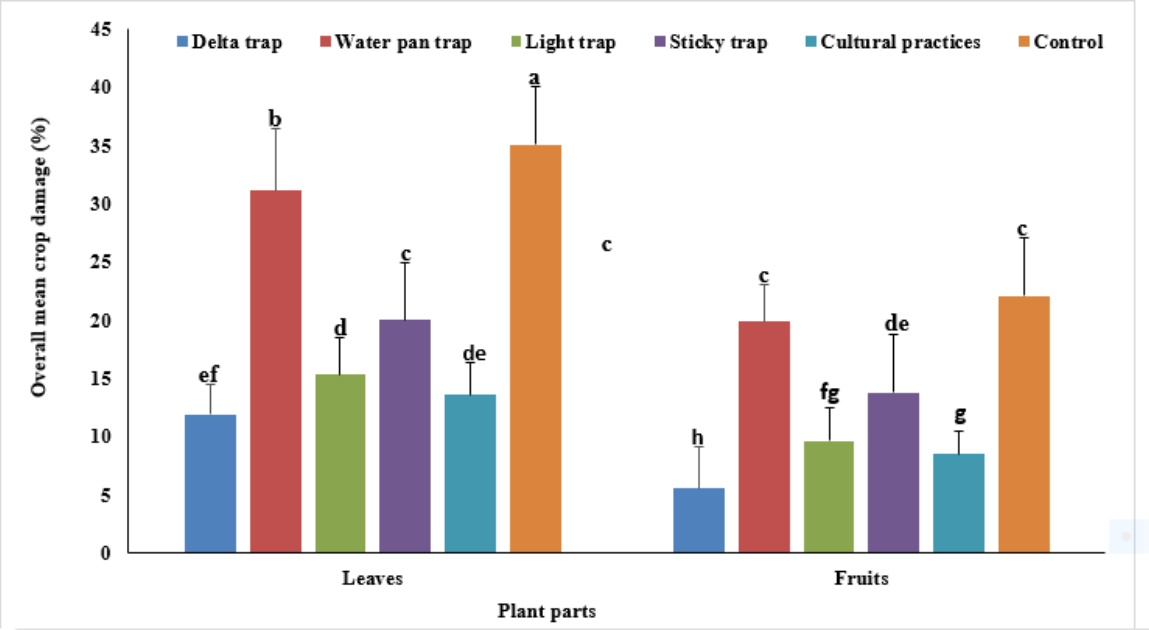

Figure 3. Overall mean percentage infestation caused by tomato leaf miner *Tuta absoluta* on tomato leaves and fruits after the application different trapping and management devices under field condition

Tomato fruit production and cost benefit ratio after control operations

Data in table 1 exhibited the mean production kilogram per acre of tomato fruit after installation of various management trapping devices in tomato field for the monitoring and control the adult population of tomato leaf miner. At the same time impact of treatments also evaluated based on the yield. Results in table 3 showed the highest average yield (6546.60 kg/acre) was obtained in the plots where delta type pheromone traps were installed, followed by plots in which culture practices were carried out (6476.80 kg/acre), light traps (5943.70 kg/acre), color sticky trap (5863.20 kg/acre), water pan trap (5684.30 kg/acre) and in control (5426.00 kg/acre). Further cost benefit ratio was analyses for treatment efficiency was counted and calculated that maximum cost benefit ratio (4:18) noted from the plots where delta pheromone traps were installed followed by cultural practices (4:16), light traps (4:12), color sticky traps (4:10), water pan trap (4:07) and control (4:02), respectively.

Table 3. Assessment for cost-benefit ratio of treatments and expenditure for the management of tomato leaf miner *Tuta absoluta* during 2024.

Expenditure and benefit	Control practices					
	Pheromone delta trap	Water pan trap	Light trap	Yellow color sticky trap	Cultural practices	Control
Yield (kg)	6546.60	5684.30	5943.70	5863.20	6476.80	5426.00
Common cost/ ha^{-1} (Pak. Rs:)	88450.00	88450.00	88450.00	88450.00	88450.00	88450.00
Treatment cost	6240.00	4780.00	5960.00	6150.00	14840.00	------
Total cost	94690.00	93230.00	94140.00	94600.00	103290.0	88450.00
Gross income	458226.0	397901.0	416059.0	410424.0	453376.0	379820.0
Net income	363536.0	304671.0	321919.0	315824.0	350086.0	291370.0
C:B ratio	4:18	4:07	4: 12	4:10	4:16	4:02

DISCUSSION

Numerous insect pests that infest at various stages of crop growth have a significant impact on tomato fruit output and quality. Even though there are many pests that affect tomatoes, some of them have significant negative economic effects (Bansode and Purohit, 2007). Among them tomato leaf miner *Tuta absoluta* has recently been regarded as the primary tomato pests and a limiting effect on tomato production which attacked throughout crop

season and cause damage directly by eating on plants parts and tomato fruit (Salama et al., 2015). To limit the spread and harm caused by invasive species in newly invaded areas, early detection and monitoring are essential (Retta and Berhe, 2015; Desneux et al., 2022). Because they offer reliable information about the detection, population monitoring, and management of a specific species, sex pheromones have been used extensively throughout the world (Caparros et al., 2013). Many nocturnal insects, especially lepidopteran insects, are monitored for presence and population using a variety of colored lights supplied by various sources, such as light bulbs or light-emitting diodes (LEDs), in addition to pheromones (Shimoda and Honda, 2013). As a result, the pheromone and different colored light traps employed in this investigation also worked well to draw in and catch *T. absoluta* moths. All colored light traps, particularly golden ones, attracted both sexes with a comparatively higher number of females, whereas pheromone only caught male moths. Data of the present study indicate the overall mean adult captured population of tomato leaf miner *T. absoluta* by different management devices, surprisingly remarkable variation in caught the adult moths was recorded in different management trapping devices. However, the maximum average seasonal tomato leaf miner *T. absoluta* adult (male and female) population was caught by delta pheromone trap devices followed by light traps, yellow color sticky traps and water pan trap as shown in (figure 4.2). These results are agreed with the previous study by Kadel et al. (2018) found that pheromone trap attracted comparatively more moths than conventional light traps and other trapping devices. Additionally, it was discovered that *T. absoluta* preferred delta type pheromone traps and damage of *T. absoluta* may be reduced by using a delta pheromone which may be more successful in attracting and keeping both moths (Castresana and Puhl, 2017). Although, *T. absoluta* produced pheromones are frequently employed in mass trapping, male annihilation, and early monitoring. In previous study Mansour et al. (2019) recommended using 1 to 4 traps per hectare to monitor *T. absoluta*. Consequently, our study usage of 4 delta type pheromone traps per acre proved successful in reducing tomato damage by capturing moths per trap per week in addition to aiding in the early monitoring of *T. absoluta*. In pheromone traps, the average number of males captured can also be used to determine the severity of infestation, with captures of less than 3, four to thirty, and more than thirty men per trap per week being categorized as low, moderate, and high risk (Vacas et al., 2013). The present study further revealed that light traps were the most appealing to both male and female *T. absoluta* moths. Our results were corroborated by Abbes et al. (2021) who found that red color light traps did not take any moths, whereas black light blue color traps significantly captured the most moths, followed by yellow and white colors. Additionally, they caught more males than females, however in our investigation comparatively more females were drawn to and caught in different colored light traps. Considering the effectiveness of light traps in mass trapping of *T. absoluta* moths due to their nocturnal behavior, many light traps have been evaluated and tested against it (Cocco et al., 2019).

As tomatoes grew, more succulent leaves and fruits became available for the pest to inhabit, resulting in a steady increase in the number of *T. absoluta* moths captured. The effectiveness of pheromone and light traps depends on the low density of target pests according to Mansour et al. (2019). The research conducted by Bayram et al. (2017) aligned with our study's findings because it showed means of *T. absoluta* male captures in pheromone traps rising continuously until the peak during the crop's maximum vegetative and fruiting period. The research carried out by Bayram et al. (2017) showed pheromone traps caught greater numbers of male *T. absoluta* throughout the crop period starting from plant growth through to peak fruit development. The use of mass trapping alone fails to achieve effective pest control of *T. absoluta* populations therefore it must be applied together with other control practices to ensure proper crop protection (Cherif et al., 2018; Mansour and Biondi, 2021). The infestation rates of leaves and fruits showed their lowest numbers in delta type pheromone traps before cultural practices followed by light traps and yellow color sticky traps and water pan traps and the control untreated plots lastly. Mahmoud et al. (2020) also found that using pheromone traps significantly reduced the mean infestation of *T. absoluta* on tomatoes, which was as low as 18%, whereas the control plots showed a 55% infestation. According to Bayram et al. (2017) several types of traps were also ineffectual in minimizing *T. absoluta* harm to tomatoes because, although the infestation of the pest steadily increased as the crop grew, it decreased as the crop matured. These results are closely related with our study findings, which revealed that miner infestation increased until tomatoes reached full ripeness. In their investigations Karut et al. (2011) also found a similar type of *T. absoluta* infestation. It has been noted that only males are caught in delta traps because the female-produced sex pheromone in *T. absoluta* guides mating, which could result in a decrease in the male population and crop damage (Witzgall et al., 2010). However, due to the males polygenic nature and average mating instances (Wang et al., 2021) *T. absoluta* unique mating and reproductive traits make mass trapping challenging (Desneux et al., 2022). To achieve the intended outcomes of mass trapping,

pheromone traps can be made more effective by integrating other management tools and adding a light trap to capture both males and females (Desneux et al., 2022).

CONCLUSION

The mass trapping method is effective with low pest population and can keep the tomato leaf miner population below harmful economic. Adults of tomato leaf miner *T. absoluta* captured different management trapping devices and initially adult were caught during the first week of August and increased subsequently weeks in all trapping devices up to the October month. However, management traps varied significantly in their effectiveness to capture moths with delta type pheromone and light traps captured the highest number of moths, whereas the color sticky and water pan traps attracted the least number of moths. The lowest plant parts damage infestation % in leaves and tomato fruits were recorded delta trap, cultural practices and light trap followed by color sticky trap, water pan trap and control plots, respectively. Thus, significant impact was recorded between the highest mean capture of *T. absoluta* moths and lowest infestation % on tomato leaves, and fruits. The highest tomato fruit production and significant cost-benefit ratio over control was recorded from delta pheromone traps and cultural practices, light traps as compared to color sticky trap, water pan trap and control untreated plots.

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AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

There are no known conflicts of interest or personal relationships that could have appeared to influence the results of this study.

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