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Research Article

Eco-Friendly Management of Rice Striped Stem Borer *Chilo Suppressalis* (Walker) in Rice Crop

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ABSTRACT

Rice striped stem borer damage the rice crops from the seedling to crop maturity and in sever infestation result in white ear head during the reproductive stage and dead heart during the tillering stage, which causes huge yield loss up to 60.0 %. The most crucial and essential component of the IPM strategy is pest monitoring, which is consistently evaluate the population and crop damage. Thus, the present research was performed to monitor and control the RSSB by using the different trapping devices in rice filed. Attraction in different trapping devices revealed that initially adult were caught during the first week of August and increased subsequently weeks in all trapping devices up to the October. Further data showed overall maximum seasonal adult population (195.30 ± 19.25) was caught by pheromone traps followed by light traps (101.45 ± 14.58), yellow color sticky traps (97.50 ± 13.25) and yellow water pan trap (53.50 ± 09.25), respectively. Furthermore, data exhibited the highest trapping efficiency (43.71%) was observed by the installation of pheromone traps followed by light traps (22.61%), yellow color sticky traps (21.70%) and water pan trap (11.97%), respectively. In addition, impact of the treatments was observed by calculate the crop damage symptoms and minimum crop damages i.e white ears and dead hearts ($09.94 \pm 1.25\%$) and ($09.39 \pm 1.10\%$) were recorded pheromone traps followed by light traps ($12.59 \pm 1.25\%$) and ($11.88 \pm 1.62\%$), yellow color sticky trap (YCST) ($17.89 \pm 1.89\%$) and ($17.48 \pm 2.10\%$), and yellow water pan trap (YWPT) (25.64 ± 2.46) and (22.81 ± 3.23), control (42.68 ± 7.23) and (39.03 ± 07.12) were recorded, respectively. Furthermore, results showed the highest average yield ($4865.00 \text{ kg/ha}^{-1}$) was obtained in the plots where pheromone traps were installed, followed by light traps ($4608.00 \text{ kg/ha}^{-1}$), YCST ($4230.50 \text{ kg/ha}^{-1}$), YWPT ($4205.0 \text{ kg/ha}^{-1}$) and in control ($4037.60 \text{ kg/ha}^{-1}$), respectively. Based on the present findings, highest adult attraction, lowest crop damage and significant high yield, thus, pheromone and light traps are the convenient tools to control adults of rice striped stem borer in rice.

Keywords: Eco-friendly management, Rice striped stem borer, Cost-benefit ratio, IPM.



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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most significant crops in the world which provides a staple diet for almost half of the world's population and second largest staple food crop in Pakistan (Waheed et al., 2012). More than 90% of the world's rice is produced and consumed in Asian countries (Schoenly et al., 2019). The production of rice holds a specific position in the agriculture sector of Pakistan and the economy as well. It is the 2nd most important food crop; after wheat and it stands 2nd position as an exportable commodity it contributed 3.1% to the total value added in agriculture and 0.6% of GDP (GOP, 2023).

Rice productivity is affected by several biotic and biotic factors (Basavaraj et al., 2020). It is subject to attack from a range of insect pests that can significantly reduce yields. Several insect pests damage the rice crop, but stem borers are considered the most important rice pests. The rice yellow stem borer has been widely distributed in all rice cultivated areas of world. The rice stripe stem borer is a polyphagous pest feeding on rice and wild rice and the larva is largely internal feeders and feed the internal plant nutrients, resulting into “dead hearts” at the vegetative stage and “whiteheads” at the reproductive stage (Lu et al., 2014). Crop is attacked by larvae on the meristem during the flowering stage, empty and whitish-appearing rice ears describe as white heads and damaged rice crop these white ears and dead heads situate vertical and enclose with unfilled and unfilled glumes. To overcome the rice and other crops yield losses caused by the rice striped stem borer, in recent years, there have been outbreaks in many countries, because of the changes in the rice cultivation system (Peng et al., 2017). Among them rice striped stem borer *Chilo suppressalis* is the most dominant borer species in the rice field and remain in rice stubbles throughout the growing season which causes a lot of damage to the rice product every year (Catling and Islam, 2015; Aboutalebian et al., 2016).

Further, borer species had yearly crop losses of 3 to 20% due to rice stem borer, with severe infestations potentially resulting in 60% damage (Alfaro et al., 2015). Further, partly emerging white heads predominated in the rice field due to the deep circular stem feeding was seen by the larvae (Satpathi et al., 2012). The dead heart and white ear-head damage caused by the *C. suppressalis* result in a loss of grain production in rice crops (Muralidharan et al., 2006; Chen and Klein, 2012). Several control methods have been used. Among those, the most and widely used control measure for rice striped stem bore borer is one of them is the application of chemicals insecticides (Li et al., 2017; Yao et al., 2017). As a result, insect resistant development, environment pollution, insecticide-related food poisoning grower's health issues and in addition other ecological problems were regularly accounted (Khan et al., 2010; Zhang et al., 2021). Even certain agrochemical businesses now believe that a further rise of synthetic chemical is impractical, and as a result they encourage the development of eco-friendly techniques for the management for rice striped stem borer to keep pesticide use at sustainable level (Cork et al., 2005).

In the field, rice striped stem borer depends on rice crops and is mainly found in the rice growing areas and other closely related crops, where it is trapped by various trapping devices. Such trapping has also been reported in other lepidopteran species, especially those that are closely related to each other's or sibling species (Phelan and Baker, 2012). Sticky colored traps are mainly used and applied in the field crops for insect pest scouting and monitoring in agricultural ecosystems. Usually used in integrated pest control programs for a range of agricultural crops, sticky traps offer an easy way to monitor relative insect population assessments with little work (Gencsoylu, 2018). Recently, different coloured sticky traps have been employed to monitor and detect the presence of several significant insect pests of different crops including adult moths (Allsopp, 2010).

Pest attractiveness to trap crops depends on the timing of their planting as well as how far apart they are from the main crop. Further, due to their low technical requirements, simplicity in deployment and ability to capture adult moths and avoidance of destructive host tree sampling techniques, yellow color sticky traps are frequently used to monitor (Petrice et al., 2021). For instance, Jones et al. (2019) observed the spread of *Spathius agrilli* by using yellow sticky traps. However, previously the three different sex pheromone blends has been recognized from the pheromone glands of the female of Lepidoptera species such as Z11-16: Ald, Z9-16: Ald and Z13-16: Oct. Several studies reported that such type of substance blend mixture also identified from other related lepidopteran moth species such as rice striped stem borer *C. suppressalis* (Tatsuki et al., 1984; Kondo et al., 1991). All three compounds are synthesized with the aim of improving and regulating concentrations while maintaining marketability. The creation of this pheromone composition allowed for the execution of multiple field tests for mating disruption and monitoring aimed at managing this pest. The ratio in *C. suppressalis* that keeps these two compounds appealing within the regime, from 8:2 to 4:2 (Mochida et al., 1984). Because of the pheromone's appealing appearance in the field, the standard method of estimating these combinations of pheromone blends of insect species simplifies the concentration of the blends. Numerous investigations have demonstrated that while a little amount of minor sex pheromone mixture does not increase attraction, it is crucial for reproduction and multiplication in a closely related moth family (Zhang et al., 2021).

Agricultural pests including noctuid moths, weevils, and scarab beetles have long been monitored and controlled on-site using light traps (Shimoda and Honda, 2013). Conventional light traps, however, have several significant disadvantages, such as the relatively high energy consumption of incandescent light bulbs and the low trapping effectiveness of their continuous spectrum. By providing monochromatic light at a fraction of the energy cost of electric lighting, light-emitting diode (LED) technology addresses a number of these drawbacks. This allows for extended trap life, selective trapping of target pests, integration with pheromone or solar cell technologies, and off-grid monitoring.

Thus, in recent years, a wide variety of economically significant pests have been monitored and controlled with the use of LED-equipped traps. LEDs may be used to treat noctuid moths show a clear preference for specific wavelengths (Laszlo and Puskas, 2012). It is likely that yellow pan trap captures of several insects which are related to certain host crops under field conditions (Duan et al., 2018). In addition, Johnson et al. (2014) found that *S. agrili* was attracted to host plant cues such as ash stems containing larvae and ash leaf tissue. Because moths often use a combination of host and host-plant cues when locating their hosts and more than one tree variable may be important for attracting introduced parasitoids to host trees (Duan et al., 2019). Thus, yellow pan trap sampling efficacy may be improved by selecting crops that are most attractive to introduced against moths. Therefore, the alternative and eco-friendly control strategies is needed to control or killing the adults. Applications of trapping devices are one of the most substitute control methods to monitoring and control adult moths on large scale. Thus, the present research was subjected to determine the effectiveness of different trapping devices for attraction and control of rice striped stem borer *C. suppressalis* under field condition. This research not only provide the essential information to develop effective trapping devices against noctuid moths but in addition could reduce the oviposition rate and larval infestation which caused by rice striped stem borer *C. suppressalis* stem borer in rice field and monitor efficacy of different trapping devices at releasing sites.

MATERIAL AND METHODS

A field experiment entitled “management studies for rice striped stem borer *Chilo suppressalis* in rice crop” was conducted to determine the efficiency of different trapping devices for management of rice striped stem borer *C. suppressalis* at the local rice farmer field of District Badin during 2024.

Experiment detail

For research purpose, Super Basmati rice variety was sown during the first week of August. Approximately four week after the plantation of nursery was transferred into main field subjected to mature the rice nursery. The experiment was design by Randomized Complete Block Design (RCBD) with three replications and five treatments. All the agronomical practices such as land preparation, timely sowing, properly weeding, irrigation and fertilizer applications were carried out according to the need of crop. However, there is no any other control measure was initiated to subjected plots and as well control plots. Further different trap devices per acre were installed on rice field at three weeks after transplantation for early detection and control of adults of rice yellow stem borer. Treatment details; T1= Pheromone traps 3/acre, T2=Light traps 3/acre, T3=Yellow color sticky traps 3/acre T4=Yellow water pan trap 3/acre T5=Untreated only for crop damage and yield plots.

Installation of trapping devices

Based on the structure and material following different trapping devices was arranged and installed in rice field to evaluate the effectiveness of moth capturing.

Preparation and installation of pheromone traps

In order to evaluate the competency of trapping devices pheromone traps were installed in rice field. The pheromone chemical structure of the female sex pheromone of Lepidoptera moths were determined to be a (Z)-11-hexadecenal and (Z)-9-hexadecenal. Commercial traps and synthetic sex pheromones were brought in from Zafar Shani Chemical Company, Multan. The installation of the pheromone traps was 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 (Z)-11-hexadecenal and (Z)-9-hexadecenal was used at unique concentrations such as 50µg/10 ul in rubber tube with each capsule which was exploited in rice field.

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. To kill 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 yellow color sticky trap

Yellow color sticky traps were locally made and arranged by self. Yellow plates were purchased separately (12x8 inches length and width) fixed with wooden stick at 3 feet height. Lure was replaced at weekly basis from the plates. Total 3 sticky traps were installed per acre with triplicate.

Preparation and installation of water pan traps

Yellow water pan traps were locally purchased from District Badin. Yellow color cobalt's (15 inches in diameter and 18 inches height) was filled with 10 liter normal water and 10 milliliter (ml) mobile oil was mixed in water for density purpose. In this regard captured moths are fully dipped with oily water. Total three yellow water pan traps per acre were kept at soil surface for adult population traps.



Figure 1. Installation of different trapping devices in rice field. (A, B and C) Preparation and installation pheromone, (D) installation and night view of light traps, (E) installation of color sticky traps, (F) arrangements for trap devices at field side and (G) installation of water pan traps at rice field.

Data recordation for captured adults

Weekly basis captured adults were collected and identified the adult moths of rice yellow stem borer and counted from all three replications of each treatments and data noted in the data book in order to assess the effectiveness of the treatments.

Evaluation of crop damage assessment

Impact of treatments were determined by capturing the population of rice striped stem borer *C. suppressalis* and to evaluate the crop damage assessment by inspecting the two major types of symptoms (white ears and dead hearts) were observed. However, for assessment of crop damage symptoms control untreated plot was also arranged. Rice crop damage symptoms were assessed by counting the infested plants of rice field. Stems and tillers of plant with symptoms were confirmed that the damage was caused by *C. suppressalis*. For damage appraisal 50 plants were randomly selected from each replication including control plots. Damage of the crop was examined from the start of September to November in rice season. Further the percentage of dead heart and white ears were calculated by using the previously standard formulas of Onate (1965).

$$DH \text{ or } WE \% = \frac{\text{Number of } DH \text{ or } WE}{\text{Number or total tillers}} \times 100$$

Whereas, DH= Dead heart in rice crop

WE= White ears of rice crop



Figure 2. Assessment crop damage symptoms of rice crop after installation of different trapping devices in rice field. (A and B) Dead heart symptoms and (C and D) white ear heads of rice crop.

Yield of rice

Rice yield per plot was noted and recorded from all replication of each treatment and average data values were converted in slandered unit per hector and subjected to appropriate statistical analysis for interpretation and find out the difference among the treatments.

Data analysis

Average data values for adult caught from all treatments and crop damage symptoms percentage and grain yield per plot were analyzed by using one-way analysis of variance (ANOVA) followed by the LSD test to determine treatment differences at ($P < 0.05$).

RESULTS

Rice striped stem borer moths captured by pheromone traps

The pheromone traps were installed in the rice field after 6 weeks of transplantation into the main field and data was recorded on weekly basis. The results in figure 4.1 revealed the weekly captured moth's population of rice striped stem borer in rice field and initially adult moth's population was captured on 7th August-2024 (01.30 ± 0.60) and gradually increasing during the subsequent weeks. Specifically weekly wise adult moths were counted which was captured on 14th August (03.00 ± 0.58), 21st August (06.00 ± 0.85), on the date 28th August (19.66 ± 0.84), 4th September ($27.00 \pm 0.4.16$), 11th September (33.66 ± 4.72), on the date 18th September ($28.60 \pm 0.3.75$), on the date 25th September (22.33 ± 3.28), on the date 2nd October (21.38 ± 3.56), on the date 9th October (15.30 ± 2.32), on the dated 16th October (02.33 ± 0.98), on the date 23th October (05.10 ± 1.02), on the dated 30th October (02.30 ± 0.58) was recorded respectively. Further, data revealed the significant difference at (DF: 12, F- 464.99 and $P < 0.001$) among the weekly captured adult population as shown in figure 3.

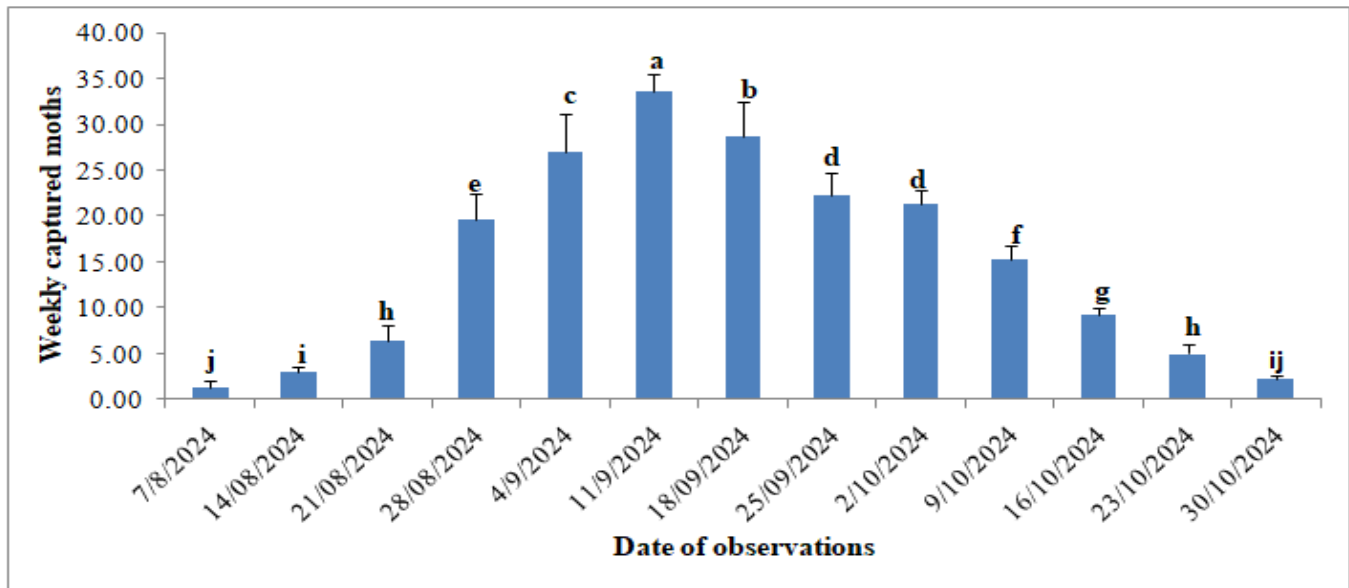


Figure 3. Weekly average adult captured populations of *Chilo suppressalis* after installation of pheromone traps. The value shown mean \pm SE of three replications.

Rice striped stem borer moths captured by light traps

The pheromone traps were installed in the rice field after 6 weeks of transplantation into the main field and data was recorded on weekly basis. The results in figure 4.2 revealed the weekly captured moth's population of rice striped stem borer in rice field and initially adult moth's population was captured on 7th August-2024 (02.30 ± 0.58) and gradually increasing during the subsequent weeks. Specifically weekly wise adult moths were counted which was captured on 14th August (04.00 ± 0.79), 21st August (08.60 ± 0.145), on the date 28th August (10.30 ± 0.225), 4th September (12.65 ± 0.371), 11th September (16.60 ± 2.85), on the date 18th September (17.45 ± 0.315), on the date 25th September (21.58 ± 4.34), on the date 2nd October (11.23 ± 2.34), on the date 9th October (17.34 ± 3.82), on the dated 16th October (06.60 ± 1.18) on the dated 23rd October (01.24 ± 0.25) and on the dated 30th October (1.60 ± 0.50) was recorded respectively. Further, data revealed the significant difference at (DF: 12, F-222.10 and P < 0.001) among the weekly captured adult population as shown in figure 4.

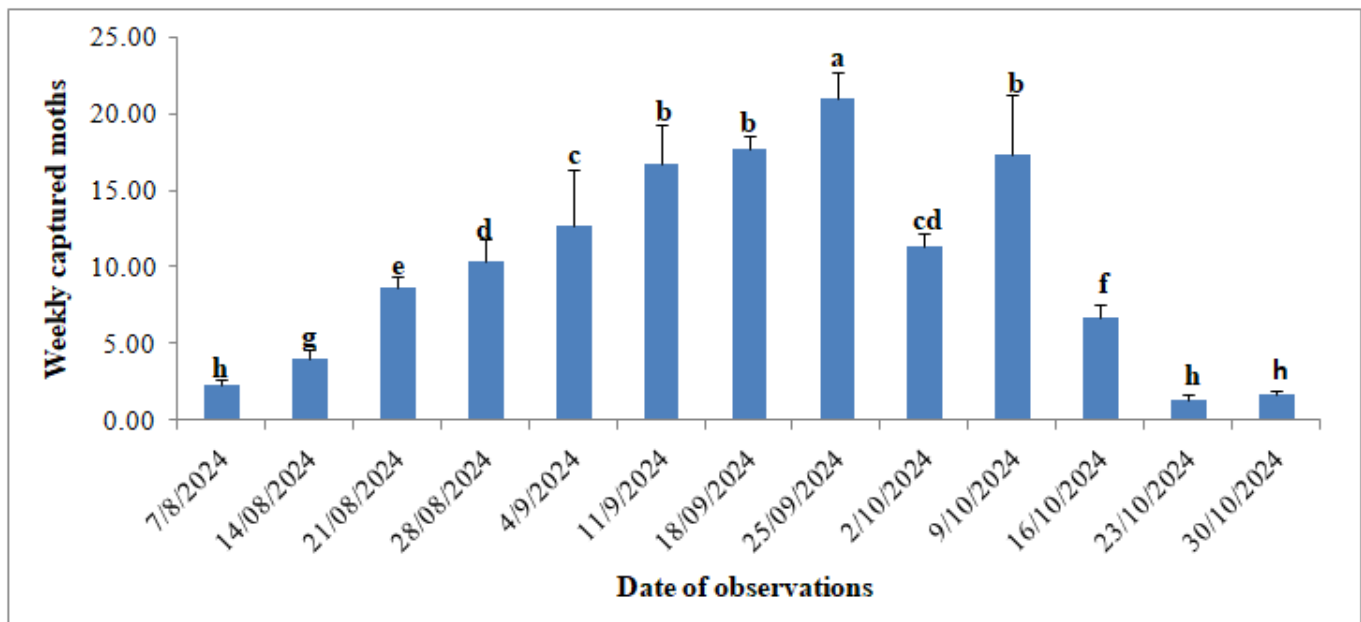


Figure 4. Weekly average adult captured population of *Chilo suppressalis* after installation of light traps. The value shown mean \pm SE of three replications.

Rice striped stem borer moths captured by color sticky traps

The pheromone traps were installed in the rice field after 6 weeks of transplantation into the main field and data was recorded on weekly basis. The results in Figure 4.3 revealed the weekly captured moth's population of rice striped stem borer in rice field and initially adult moth's population was captured on 7th August-2024 (02.10 ± 0.43) and gradually increasing during the subsequent weeks. Specifically weekly wise adult moths were captured on 14th August (03.20 ± 0.09), 21st August (02.66 ± 0.88), on the date 28th August (05.30 ± 0.80), 4th September (10.20 ± 0.10), 11th September (17.34 ± 1.52), on the date 18th September (13.66 ± 0.05), on the date 25th September (12.80 ± 2.40), on the date 2nd October (09.62 ± 1.76), on the date 9th October (06.30 ± 3.82), on the dated 16th October (05.10 ± 1.08) on the dated 23rd October ($06.20 \pm 0.1.20$) and on the dated 30th October (2.10 ± 0.80) was recorded respectively. Further, data revealed the significant difference at (DF: 12, F-value 115.00 and $P < 0.001$) among the weekly captured adult population as shown in figure 5.

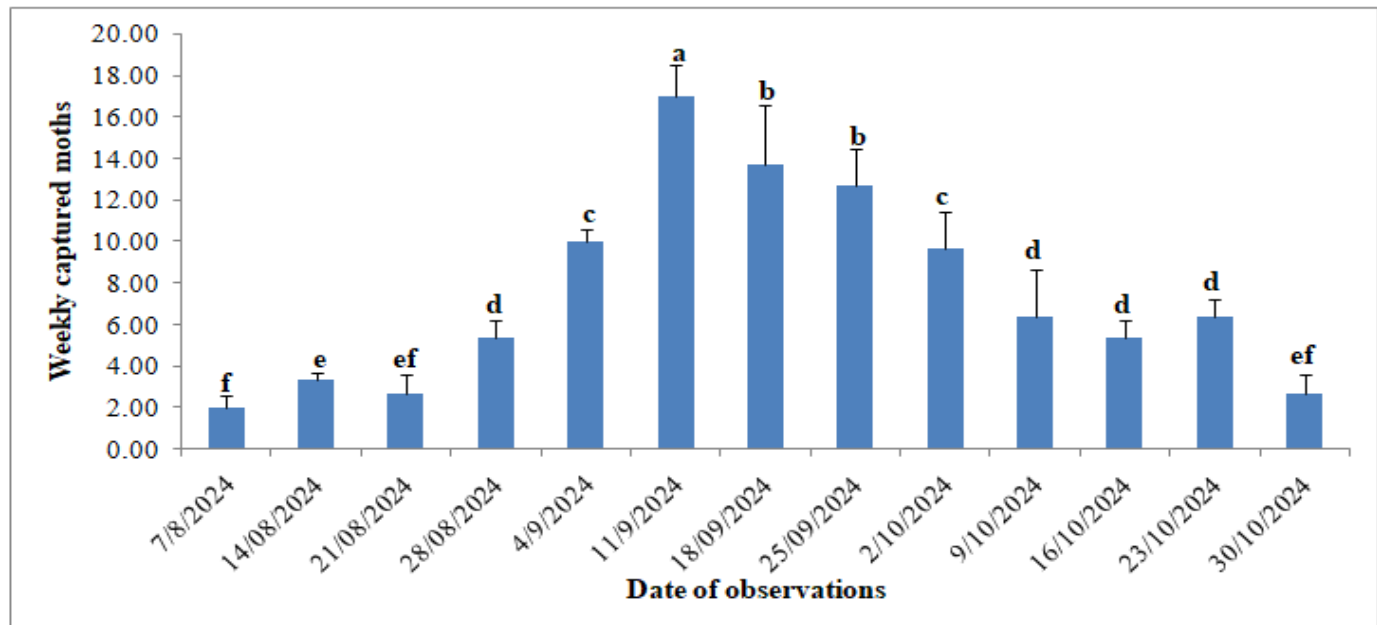


Figure 5. Weekly average adult captured population of *Chilo suppressalis* after installation of yellow color sticky trap. The value shown mean \pm SE of three replications.

Rice striped stem borer moths captured by water pan trap

The pheromone traps were installed in the rice field after 6 weeks of transplantation into the main field and data was recorded on weekly basis. The results in figure 4.4 revealed the weekly captured moth's population of rice striped stem borer in rice field and initially adult moth's population was captured on 7th August-2024 (0.33 ± 0.13) and gradually increasing during the subsequent weeks. Specifically weekly wise adult moths were counted which was captured on 14th August (01.00 ± 0.35), on the date 21st August (02.00 ± 0.58), on the date 28th August (03.00 ± 0.78), on the date 4th September (03.66 ± 0.88), on the date 11th September (06.25 ± 1.50), on the date 18th September ($10.45 \pm 0.1.45$), on the date 25th September (09.35 ± 1.73), on the date 2nd October (08.13 ± 0.76), on the date 9th October ($04.10 \pm 0.1.00$), on the dated 16th October ($02.10 \pm 0.0.65$) on the dated 23rd October ($02.10 \pm 0.0.60$) and on the dated 30th October ($01.00 \pm 0.0.58$) was recorded respectively. Further, data revealed the significant difference at (DF: 12, F- 56.50 and $P < 0.000$) among the weekly captured adult population as shown in figure 6.

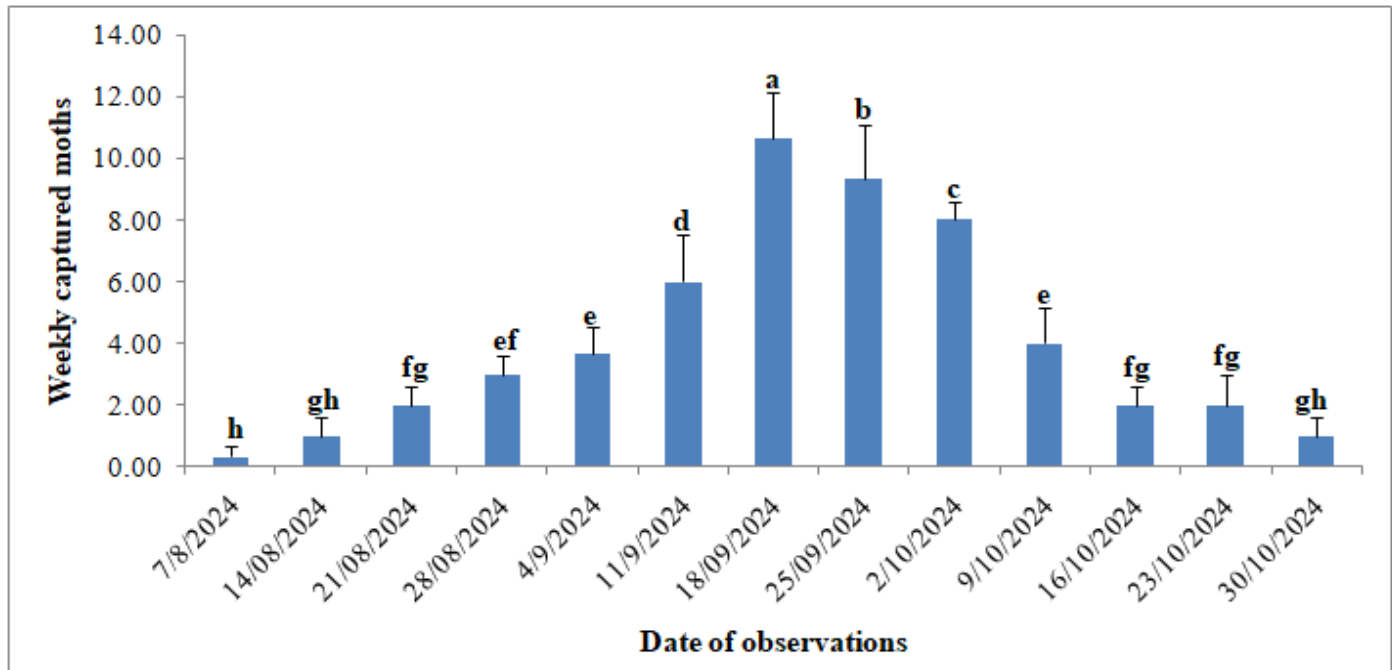


Figure 6. Weekly average adult captured population of *Chilo suppressalis* after installation of water pan trap. The value shown mean \pm SE of three replications.

Overall seasonal captured adult moth population

Further results demonstrated seasonal captured adult population after the installation of different trap devices in rice field. Subsequently, surprisingly variation was seen in different trapping devices (DF= 3, F= 214.00, P <0.0009). However, the maximum seasonal adult population (195.30 ± 19.25) was caught by pheromone trap devices followed by light traps (101.45 ± 14.58), Yellow color sticky traps (97.50 ± 13.25) and yellow pan trap (53.50 ± 09.25), respectively shown in Figure 7.

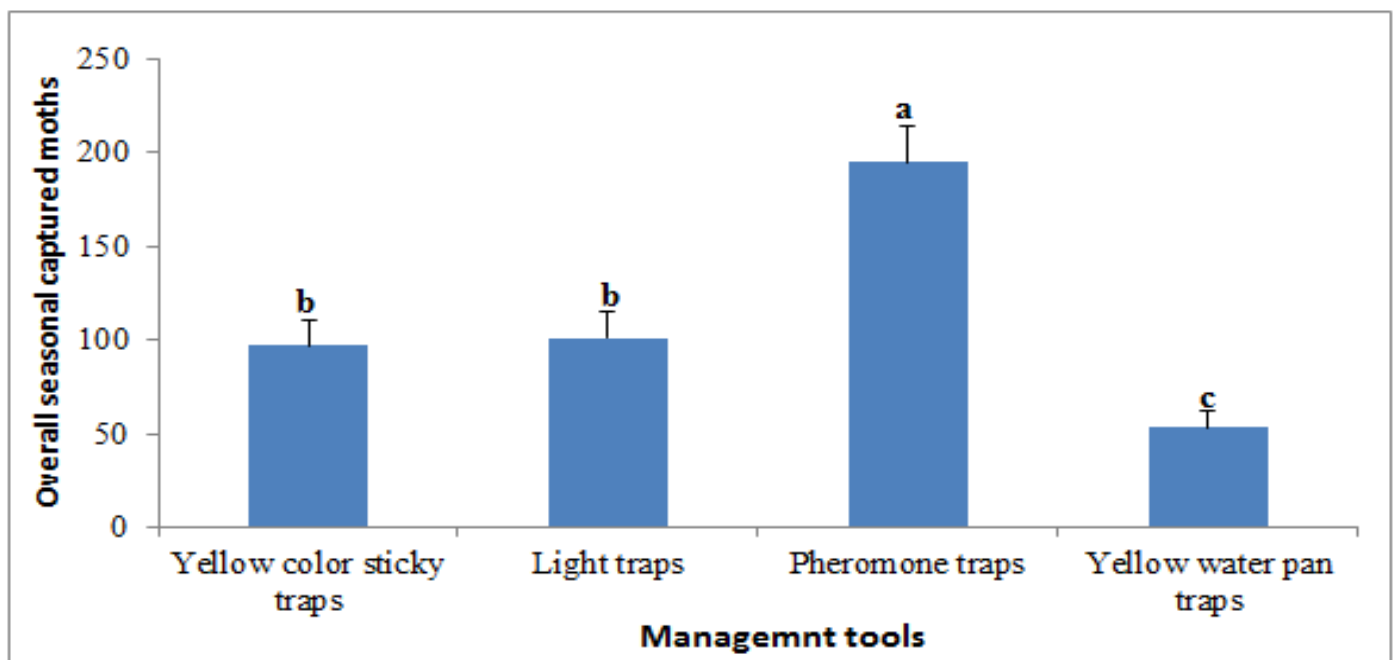


Figure 7. Overall seasonal captured adult population of *Chilo suppressalis* after installation of different trap devices. The value shown mean \pm SE and different letters are showing the significance difference at (P < 0.05).

Trapping efficiency % against moths of *Chilo suppressalis*

Results revealed in figure 8 stated that the trapping efficiency of different trap methods against rice striped stem borer moths. Maximum trapping efficiency (43.71%) was observed by the installation of pheromone traps followed by light traps (22.61%), yellow color sticky traps (21.48%) and water pan trap (11.97%), respectively.

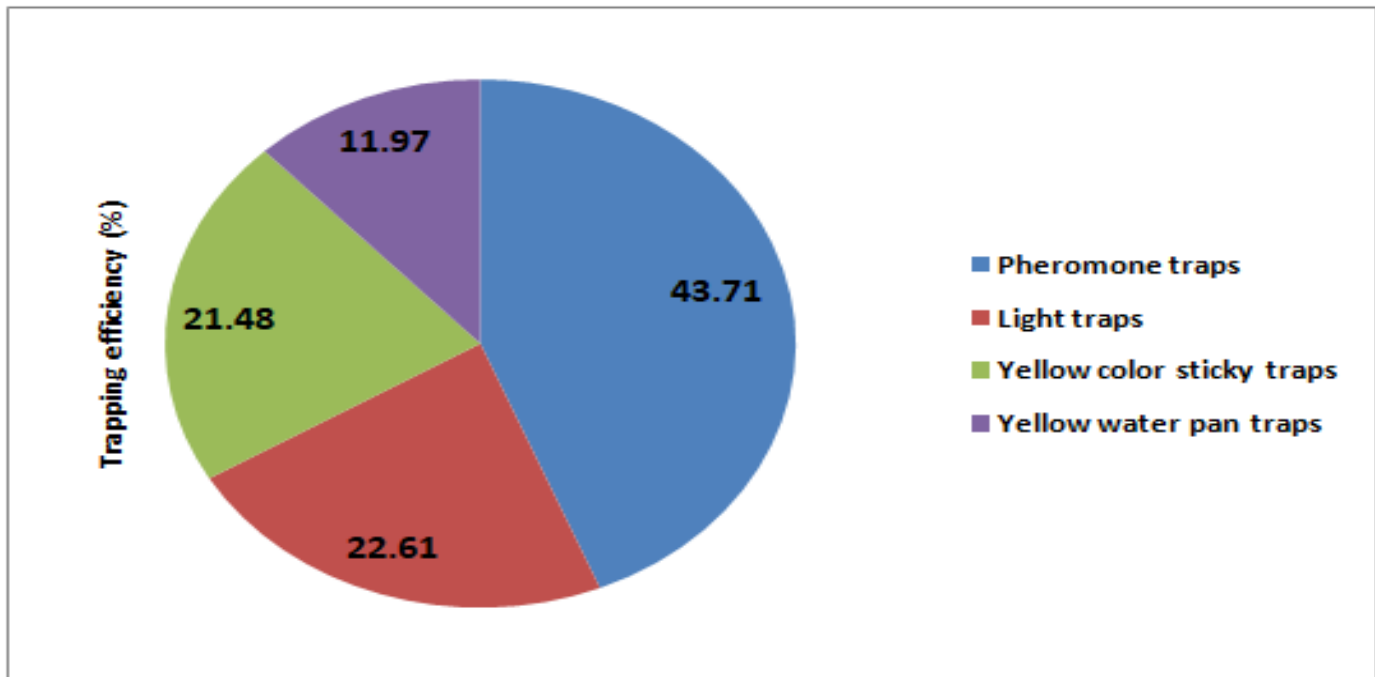


Figure 8. Trapping efficiency (%) of different trap devices versus adult moth population of *Chilo suppressalis*.

Crop damage symptoms assessment

Data from this trial demonstrated a distinctly significant difference in both crop infestation symptoms (White ear and dead hearts) among all tested trapping devices. Further significant difference was observed white ear damage symptoms between the trapping devices at (DF; 04, f value 277.00 and $P < 0.0005$ by using one-way ANOVA as depicted in Figure 9). The minimum crop damage symptoms of white ears ($09.94 \pm 1.25\%$) were recorded pheromone traps followed by light traps ($12.59 \pm 01.72\%$), yellow color sticky trap ($17.89 \pm 01.89\%$) and yellow water pan trap (25.64 ± 2.46), control plot (42.68 ± 7.23) were recorded, respectively. In addition, minimum crop damage symptoms of dead hearts ($09.39 \pm 1.10\%$) were recorded pheromone traps followed by light traps ($11.88 \pm 1.62\%$), yellow color sticky trap ($17.48 \pm 02.10\%$) and yellow water pan traps (22.81 ± 3.23), control plot (39.03 ± 07.12) respectively. However, significant difference was observed dead hearts crop damage symptoms between the trapping devices at (df; 04, f 182.0 and $P < 0.001$ by using one-way ANOVA , respectively).

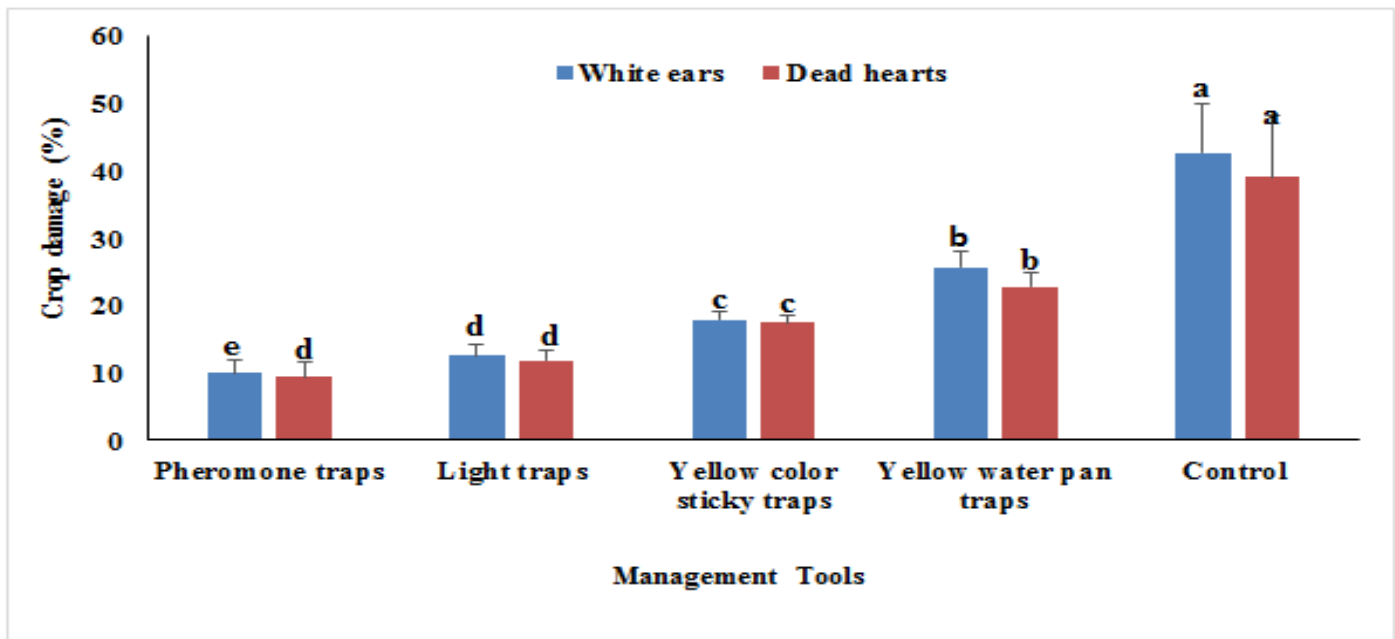


Figure 9. Crop damage (White ears and dead hearts) assessment caused by *Chilo suppressalis* after installation of different trap devices in rice crop. Different letters are showing the significant difference among the damage symptoms at ($P < 0.05$).

Yield performance after control operations

After the installation of various trapping devices in rice field for the monitoring and control the adult population of rice striped stem borer. At the same time impact of treatments also evaluated based on the yield. Results in table 4.1 showed the highest average yield ($4865.00 \text{ kg/ha}^{-1}$) was obtained in the plots where pheromone traps were installed, followed by light traps ($4608.00 \text{ kg/ha}^{-1}$), yellow color sticky traps ($4230.50 \text{ kg/ha}^{-1}$), yellow water pan trap ($4205.0 \text{ kg/ha}^{-1}$) and in control ($4037.60 \text{ kg/ha}^{-1}$). Raise yield over control ($827.78 \text{ kg/ha}^{-1}$) was noted from pheromone traps as compared to light trap ($570.00 \text{ kg/ha}^{-1}$), yellow color sticky trap ($192.74 \text{ kg/ha}^{-1}$) and yellow water pan trap ($168.04 \text{ kg/ha}^{-1}$) was higher than the control. Further statistical analysis revealed the remarkable difference at ($Df = 4$, F -value 176.0 and $P < 0.00000$) yield over control within the trapping devices as shown in Table 1.

Table 1. Yield of rice crop after the installation of different trap devices for the control of rice striped stem borer during 2024.

Treatments	Yield (kg ha^{-1})	Yield over control (kg ha^{-1})
Pheromone Traps	4865.39 a	827.78
Light Traps	4608.41 b	570.80
Yellow Color Sticky Traps	4230.35 c	192.74
Yellow Water Pan Traps	4205.65 c	168.04
Control (Untreated plots)	4037.61 d	-----

* For overall yield (kg ha^{-1}) all five means and groups (A, B, C, and D) are significantly different from one another by showing different alphabetical letters at ($P < 0.05$).

DISCUSSION

In the present research different trapping devices such as pheromone traps, light traps, yellow colour sticky traps and yellow pan traps were installed and results revealed that initially adult moths of rice yellow stem borer were caught during the week of September and coughing trend increased subsequently weeks in all four trapping devices up to the mid November and gradually decline the during the end weeks. Further results demonstrated the overall seasonal mean captured population of rice striped stem borer *Chilo suppressalis* that maximum seasonal population was caught by pheromone trap devices followed by light traps, yellow color sticky traps and yellow pan trap and significant variation was seen in different trapping devices ($DF = 3$, $F = 06.29$, $P < 0.0009$). These findings of current study is similar to the

recent studies (Witzgall et al., 2008; Stelinski et al., 2013) who used different pheromone dispensers with different densities to monitor and control the *Phyllocnistis citrella* (Su et al., 2003) as well as *C. suppressalis* (Alfaro et al., 2015; Wang et al., 2011) in rice fields. The current research was also inspired from these researchers to control the same group of pests and quit similar results were obtained. Because the perception mechanism of olfactory system in moth species is directly associated with the detection of pheromone plumes (Pophof et al., 2015). The present work revealed that the effect of light traps on *C. suppressalis* at weekly basis and light traps also showed the potential trapping devices against the capture of adult of rice yellow stem borer in rice field. These findings are agreed with Bhutto et al. (2016) and Lima et al. (2015) reported that light sources were found the most attractive source for attracts the noctuid moths. Further previous studies (Kakde and Patel, 2014) who recorded the attraction of adults of rice striped stem-borer from throughout research period. Less number of adult's attraction because their eye systems are made to be sensitive to tiny light photons, nocturnal insects have behaviour that avoids bright lighting.

The performance of insect visual receptors will be affected by the excessive photon exposure. Certain light intensities seem to attract nocturnal insects Szentkiralyi (2012) claimed that ultraviolet colours are the ones that attract rice stem borer the most. However, according to Shimoda and Honda (2013) insects particularly nocturnal ones have sensors for UV radiation. Plant stress increases as a result of retaining by UV as a light trap (Kuhlmann and Muller, 2009). Conversely, yellow color sticky and yellow pan traps also able to attract the few number of adults of striped stem borer but lowest as compared to pheromone and light traps. This might be adults of rice striped stem borer is noctuid by nature and mainly active during the dark period, further color sticky water pant traps are effectively used to capture the diurnal insect in field crops. However, several studies documented the trapping efficiency of yellow colour sticky traps against insect pest species such as according to Wallis and Shaw (2008) who reported that out of all the sticky coloured cards that were placed the adults of *Elatobium abietinum* were mostly attracted to the sticky yellow cards and Mainali and Lim (2010) revealed that *Franklinville occidentalis* attraction by yellow color sticky traps. Sticky traps are primarily used in integrated pest control programs for a range of agricultural crops because they offer an easy and low-effort method of tracking relative insect population assessments (Gencsoylu, 2018).

Although water pan traps are commonly employed to monitor and control adult specie, their trapping efficiency is inadequate when it comes to monitoring the flying insect species. The effectiveness of yellow water pan traps as a monitoring tool might be enhanced by attraction rate of noctuid adult seasonal abundance. In the present study, yellow pan trap also trapped few number of adult of rice striped stem borer in rice field and these findings are similar with the findings of Duan et al. (2020) who stated the lower catch rates and numbers of emerald ash borer *Tetrastichus planipennis* might have resulted from a new sampling procedure which utilized in the earlier research. These traps are favored due to their simplicity and ease deployment, collection and ability to capture the moths. Additionally, they eliminate the need for destructive sampling methods on host crops (Petrice et al., 2021). Targeting to the monitoring and control of adult population rice striped stem borer by using different trapping devices; assessment of the crop damage can directly provide the clues related to the treatment potential. In the present research the frequency of damage symptoms indicates that pheromone traps could significantly reduce the both white ears and dead hearts caused by striped stem borer more efficiently than followed by light traps and control plots. This might be maximum caught adults by pheromone traps as compared to other treatments. These findings are agreed with Alfaro et al. (2015) and Chen et al. (2014) they conducted the experiment of application of sex pheromone and stated that that applications of pheromones might be decrease the critical both white ears and dead hearts caused by *C. suppressalis* more proficiently than control strategies. Further based on light traps our finding agreed with Sharma et al. (2011) who recorded 5.98 % dead heart and 5.79% white ear at during rice kharif seasons. Further similar with Kumar and Sudhakar, (2017) who examined that damage caused by yellow stem-borer (18.48% dead heart and 24.21% white ear).

CONCLUSIONS

Attraction in different trapping devices revealed that initially adult were caught during the first week of August and increased subsequently weeks in all trapping devices up to the October month. Further, maximum overall seasonal adults were caught by pheromone trap devices followed by light traps, yellow color sticky traps and yellow pan trap respectively. In addition, minimum crop damage symptoms of white ears and dead hearts were pheromone and light traps as compared to yellow color sticky and yellow water pan trap, respectively. In addition high yield was obtained from pheromone traps as compared to light trap, yellow color sticky trap, yellow water pan trap, control untreated plots.

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AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

No conflicts of interest have been disclosed by the authors.

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