Research Article

Eco-Friendly Management of Pink Bollworm (*Pectinophora gossypiella)* in Cotton

Imran Nadeem[1], Qurban Ali[1], Muhammad Kamil Malik[1*], Asad Aslam[1], Imran Tariq[2], Muhammad Bilal Bin Iqbal[1], Muhammad Faheem Akhtar[1], Sikander Ali[3], Muhammad Jawad Saleem[1], Muhammad Zubair[3] and Aqsa Abbas[1]

[1]Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan; [2]Department of Entomology, University of Agriculture, Faisalabad, Pakistan; [3]Oilseeds Research Institute, Faisalabad, Pakistan.

Abstract | The Pink bollworm (*Pectinophora gossypiella)* is a key pest that attacks the cotton crop and it is distributed all over the world where cotton has grown. In the present study, four traps, viz., PB ropes, Delta traps, Light traps, Capsule lures, one entomopathogenic fungus, "*Beauveria bassiana*, and one noval insecticide, e.g., Radiant 120 SC (Spintoram), were evaluated to check the percentage infestation reduction of *Pectinophora gossypiella* under field conditions under the RCBD design. The results showed that the effectiveness of the traps was excellent in the early days but declined as time went on. The results showed that Pb rope traps had maximum control over the pink boll worm population (96.30%), followed by delta traps (85.03%), and light traps had the lowest population reduction (75.13%) when compared to the control plot.In the case of the entomopathogenic fungi and novel insecticide Radiant 120 SC, the results revealed that the maximum population reduction (79.16%) was observed with Radiant as compared to *Beauveria bassiana* (57.02%). The results regarding beneficial insects showed that the maximum survival rate was found in Radiant 120 SC (57.11%) while the minimum was observed in the case of entomopathogenic fungi (52.46%), which indicated that Radiant 120 SC was less toxic than *Beauveria bassiana.* Overall, it can be concluded that sex pheromone traps gave better results as compared to all other treatments, including novel insecticides.

Received | January 31, 2023; **Accepted** | August 28, 2023; **Published** | June 27, 2023
***Correspondence** | Muhammad Kamil Malik, Entomological Research Institute, Ayub Agricultural Research Institute, Faisalabad, Pakistan; **Email:** kamilmalik211@gmail.com
Citation | Nadeem, I., Q. Ali, M.K. Malik, A. Aslam, I. Tariq, M.B.B. Iqbal, M.F. Akhtar, S. Ali, M.J. Saleem, M. Zubair and A. Abbas. 2023. Eco-friendly management of pink bollworm (*Pectinophora gossypiella)* in cotton. *Pakistan Journal of Agricultural Research,* 36(2): 155-160.
DOI | https://dx.doi.org/10.17582/journal.pjar/2023/36.2.155.160
Keywords | Entomopathogenic fungi, *Pectinophora gossypiella,* Pb ropes, IPM, Spinetoram

Introduction

Agriculture is the backbone of Pakistan's economy and the majority of the population is attached to it through farming. In the region of South Asia, Pakistan is emerging as a developed state, comprising 207 million of the world's population (Radio Free Europe, 2017). A distinctive role is played by

agriculture in the economic system, which accounts 19.2% of GDP. Agriculture is indispensable in making sure food is secure, producing overall monetary growth, diminishing poverty and transforming in direction of mechanization (Economic Survey of Pakistan, 2011-12). Cotton (*Gossypium hirsutum* L.) is an important crop in agriculture as well as in the textile industry (Haider *et al*., 2023). It contributes around 0.6 percent to GDP and 3.1 percent to agricultural value addition (Economic survey of Pakistan, 2021-22). Cotton is one of the most important economic crops in Pakistan. It is extremely important to Pakistan's economy (Amin *et al*., 2017).

Cotton is a significant commercial crop, playing a spectacular role in a country's social, financial and political undertakings and it is gifted to human civilization from the Indian subcontinent (Atwal, 2002). It plays a supreme role in the economy of Pakistan. *Gossypium hirsutum,* main cash crop. is also popularly known as "Silver Fiber" (Gill and Dhawan, 2006). The Gossypium genus contains almost 50 species, of which 45 are diploids and the remaining 5 are tetraploids. *Gossypium hirsutum,* the tetraploid species, is among the most cultivated species (Waghmare *et al*., 2005). In Pakistan, the cultivation of cotton is mainly done in the provinces of Punjab and Sindh. About 77% of the cotton production in Pakistan comes from Punjab and 23% comes from other provinces. The main Punjab districts that contribute to huge cotton production are Faisalabad, Jhang, Raheem Yar Khan, Multan, Vehari, Khanewal, Lodhran, Bahawalpur, Ranipur and Bahawalnagar. The Sindh regions for cotton cultivation are (Nawabshah, Ghotki, Khairpur, Ahmed, Kazi and Naushero-feroze. The desired conditions required for cotton are a hot and dry climate; therefore, cotton is cultivated best in the above-mentioned regions (Shuli *et al*., 2018).

Cotton shows a variety of insect pest spectrum and about 1326 species of insect pest have been reported worldwide (Parmar and Patel, 2016). Cotton is highly exposed to pest attacks, which may cause up to 87% yield losses (Talley *et al*., 2009). Due to the insect attack, its growth period is wrecked (Gangadhar *et al*., 2007). The average yield of cotton in Pakistan is lower as compared with other countries due to pest attacks. There are various reasons that cause the loss in yield from the beginning of its growth to maturity. Insect pest attacks cause the 5-10% losses. Due to lint quality and deterioration losses of cotton of 10-40%, that causes about 30-40% average yield loss (Khan *et al*., 2009).

Pink bollworm (*Pectinophora gossypiella*) is considered one of the most harmful cotton pests because it is harder to control with insecticides (Lykouressis *et al*., 2004). The incidence of *Pectinophora gossypiella* has been reported in nearly every cotton-producingcountry in the world (Salama *et al*., 2013). Surveys in the United States and Mexico show that *Pectinophora gossypiella* has 46 plant species as its preferred hosts in these two countries. Okra (*Hibiscus esculentus* L.), cotton and ornamentals plants are considered the most favorite hosts of *Pectinophora gossypiella* (Saleh *et al*., 2013).

Pink bollworm (*Pectinophora gossiypiella*) causes the most severe damage to the cotton crop worldwide and was declared the most injurious pest of cotton crop (Rajput, 2017). The present study was planned to explore the maximum reduction potential of eco-friendly techniques against *Pectinophora gossypiella*.

Materials and Methods

The present research was conducted in the field area of the Entomological Research Institute, AARI, Faisalabad, during 2021. The study was planned to check the impact of Eco-friendly management techniques against Pink Bollworm (*P. gossypiella*) on cotton crop. The crop was sown in a plot size of 10 x 30 m^2 on May 20, 2021, using a RCBD design with three replications. Pre-irrigated field for the experiment was prepared by ploughing. Common cultural practices were adopted.

Four different types of traps (viz. Pb ropes @120/ acre, Light traps @ 01 traps/acre, delta traps @ 08 traps/acre and capsule lure traps @ 05 traps/acre) and one entomopathogenic fungi (*Beauveria bassiana* @ 1×10^8 CFU/ml per acre) one novel insecticide (e.g., Radiant (Spintoram) 120 SC @ 100 ml/acre) with a check plot as a control was evaluated to manage the pink bollworm in an eco-friendly way. PB ropes were installed at a 10-meter distance, length and width wise The data regarding adult pest captured in traps was recorded after 10 days intervals. For entomopathogenic fungi and chemical treatments, data was recorded before application and 07 and 14 days of after treatment from 10 selected plants from each replication. The data regarding (%) infestation

reduction of *P. gossypiella* recorded at 10 days intervals by the time of pest appearance up to crop maturity. Infestation of *P. gossypiella* started in the 3rd week of July and the first data was collected on 16th July, 2021 just after the pest incidence. Five plants were selected randomly from each replication of each replication and the (%) infestation of *P. gossypiella* on each plant was recorded.

Data regarding the (%) Infestation of *P. gossypiella* and (%) Infestation reduction of *P. gossypiella* was recorded at 10 intervals from the time of pest appearance up to crop maturity. The data collected was analyzed by analysis of variance (ANOVA) and mean values between the genotypes were compared by using Tukey HSD Test at P≤0.05.

Results and Discussion

The data was recorded at a 10-days interval. The results revealed significant differences among the treatments. The results showed that the effectiveness of the traps was excellent in the early days but declined as time went on (Table 1). Bhute *et al.* (2021) also described similar results, finding that adult catches increased gradually but declined in the last week of the growing season. The present study findings revealed that Pb rope traps was found highest control over pink boll worm population, followed by delta traps, while a minimum population reduction was observed in light traps as compared to the check plot. Here, after days of installation of traps, the maximum population percentage reduction was recorded (96.30%), followed by delta traps (85.03%). While a minimum population reduction was observed in the case of light traps (75.13%). As time of installed traps increased, the results showed that Pb ropes reduced the pest infestation by 63.96%, while minimum population reduction (42.23%) was found in the case of light traps as compared to the check plot after 120 days (Table 1). Shrinivas *et al.* (2019) also mentioned similar results and indicated that PBW population can significantly decrease as a result of sex pheromones such as SPLAT (Specialised Pheromone and Lure Application Technology), which was used to confuse the adults under field conditions, so it may be recommended as an alternative to hazardous insecticides, while delta trap was found to be less efficient than PBW sex pheromone. Harter *et al.* (2010) reported similar outcomes and stated that the use of sex pheromone traps like Pb rope traps, etc. resulted in reduced mating and eventually a decrease in insect population. The delta and light traps were also found to have a significant reduction in the PBW population, well but less significant than the Sex pheromone traps. These findings were in line with those of Attique *et al.* (2000), who assessed the effectiveness of five different trap design, viz., yellow funnel, delta red and white, universal, and yellow and white funnel traps, against the pink bollworm. He found that all traps significantly decreased the pest population, but the yellow funnel trap was determined to be the most effective of all the traps. These traps were also used to determine the pest population within a specific area to ensure that- IPM techniques should be applied or not. Spear-O'Mara and Allen's (2007) finding were in line with present studies and described that in order to forecast future pest abundance and crop damage, the adult densities were determined by using different traps.

In the case of the entomopathogenic fungi and novel insecticide Radiant 120 SC the results revealed that the maximum population reduction was observed with Radiant as compared to *Beauveria bassiana*. The finding indicated that Radiant 120Sc showed maximum population reduction (69.71% and 79.16%) while minimum population reduction was present in *Beauveria bassiana* (44.15% and 57.02%) after 7 and 14 days of treatment, respectively. The percentage survival rate of biologically beneficial insects was also recorded. The results regarding beneficial insects showed that the maximum survival rate was found in Radiant 120 SC (57.11%) while the minimum was

Table 1: *Mean Comparison of (%) infestation reduction of P. gossypiella treated with Pb ropes, delta traps, light traps and capsule lures after 10 days interval.*

Treatments	After 10 days	After 20 days	After 30 days	After 40 days	After 50 days	After 60 days	After 70 days	After 80 days	After 90 days	After 100 days	After 110 days	After 120 days
Pb ropes	96.30a	96.10a	96.20a	96.33a	89.43a	87.06a	85.30 a	82.96a	77.53a	72.76a	71.73a	73.96a
Delta traps	85.03b	74.76b	72.73b	63.76b	59.00b	53.00b	56.20b	58.40b	52.30b	52.23b	52.66b	54.33b
Light traps	75.13c	61.00c	56.16c	43.60d	41.83c	38.10c	45.20 c	38.96c	36.40c	39.86c	37.60d	42.23c
Capsule lures	81.33bc	71.93b	68.50b	54.70c	47.96c	46.60b	52.06b	49.80b	42.83c	43.10c	43.70c	46.93bc

Table 2: *Mean Comparison of (%) Infestation and (%) Infestation reduction of P. gossypiella against Beauveria bassiana and radiant after 7 and 14 days.*

Treatments	Pre-treatment	% Infestation reduction		Bio-control/ plant	Survival %
		7-DAA	14-DAA	14-DAA	14-DAA
Beauveria bassiana	17.24	44.15 b	57.02 b	1.72	52.46 bcd
Radiant (Spintoram)	17.97	69.71 a	79.16 a	1.87	57.11 bcd
Check	17.63	0.00 c	0.00 c	3.27	100.0 a
Tukey HSD at 5%		6.751	5.196		4.092

observed in the case of entomopathogenic fungi (52.46%), which indicated that Radiant 120 SC was less toxic than *Beauveria bassiana* (Table 2). Farooq *et al*. (2020) also found similar results and indicated that Entomopathogenic fungi can be used for long-term protection against PBW population. The efficacy of EPF's combination of plant extracts was also enhanced and may be used as IPM strategy against *P. gossypiella* and a potential replacement for pesticides. These findings are in line with those of Sufyan *et al.* (2019), who conducted trails on *C. partellus* and found that Entomopathogenic fungi were effective against larval and adult stages of pest.

Overall, it was observed that sex pheromone trap (Pb ropes) showed that the best control over pink bollworm as compared to all other treatments, including the novel insecticide "Radiant 120SC" throughout the cropping season. Similar results were defined by El-Bassaouiny (2021) and described that sex pheromone traps and parasitoids significantly decreased the infestation of pink bollworms (90%) as compared to the eco-friendly insecticides (88-87%) so sex pheromone traps had good potential to manage the PBW.

Conclusions and Recommendations

Eco-friendly techniques have effective results against pink bollworm. All treatment had shown significant results to reduce infestation of this pest o cotton crop. Overall sex pheromones traps gave better results as compared to other treatments including novel insecticides hence sex pheromones are recommended for best eco-friendly control of pink bollworm along with other IPM technologies.

Acknowledgement

Not applicable.

Novelty Statement

The results predicted that Sex pheromones showed highly significant results against pink boll worm along with IPM techniques

Authors Contribution

Imran Nadeem and Qurban Ali: Conceived and designed the experiment.
Imran Nadeem, Qurban Ali, Muhammad Kamil Malik, Imran Tariq, Muhammad Bilal Bin Iqbal and Muhammad Faheem Akhtar: Performed the experiment.
Muhammad Kamil Malik, Imran Nadeem, Muhammad Zubair, Sikander Ali and Asad Aslam: Analyzed the data and wrote the manuscript.
All authors read and approved the manuscript.

Conflict of interest

The authors have declared no conflict of interest.

References

Amin, A., W. Nasim, M. Mubeen, M. Nadeem, L. Ali, H.M. Hammad, S.R. Sultana, K. Jabran, M.H. Rehman, S. Ahmad, M. Awais, A. Rasool, S. Fahad, S. Saud, A.N. Shah, Z. Ihsan, S. Ali, A.A. Bajwa, K.R. Hakeem, A. Ameen, Amanullah, H.U. Rehman, F. Alghabar, G.H. Jatoi, M. Akram, A. Khan, F. Islam, S.T. Ata-Ul-Karim , M.I.A. Rehmani, S. Hussain, M. Razaq and A. Fathi. 2017. Optimizing the phosphorus use in cotton by using CSM-CROPGRO-cotton model for semi-arid climate of Vehari-Punjab, Pakistan. Environ. Sci. Pollut. Res., 24: 5811-5823. https://doi.org/10.1007/s11356-016-8311-8

Attique M.R., M.M. Ahmad and Z. Anmad. 2000. Efficacy of different sex pheromone traps for monitoring and control of pink bollworm,

Pectinophora gossypiella (Saunders): Gelechiidae: Lepidoptera. Pak. J. Biol. Sci., 3: 309-312. https://doi.org/10.3923/pjbs.2000.309.312

Atwal, A.S., 2002. Agricultural pests of South Asia and their management. Kalyani Publ., Ludhiana, India. pp. 221.

Bhute, N.K., Y.K. Pathan and S.A. Gaikwad. 2021. Evaluation of solar light trap against pink bollworm, *Pectinophora gossypiella* (Saunders) in Bt cotton. Pharm. Innov. J., 10(12): 297-300.

Economic Survey of Pakistan. 2012. Ministry of Finance and Revenue, Government of Pakistan.

Economic Survey of Pakistan. 2022. Ministry of Finance and Revenue, Government of Pakistan.

El-Bassouiny, H.M., 2021. Environmental friendly technique to control cotton pink bollworm Pectinophora gossypiella in Egypt. Int. J. Trop. Insect. Sci., 41: 1683–1687. https://doi.org/10.1007/s42690-020-00369-4

Farooq, M.A., B. Atta and M.D. Gogi. 2020. Compatibility of entomopathogenic fungi and *Azadirachta indica* extract against the cotton pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) under controlled conditions. Egypt. J. Biol. Pest. Contr., 30: 63. https://doi.org/10.1186/s41938-020-00260-x

Gangadhar, B., K.K. Dahiya and B.L. Takar. 2007. Impact of abiotic factors on population dynamics of sucking pests in transgenic cotton. J. Cotton Res., 21: 103-105.

Gill, H.K. and A.K. Dhawan. 2006. Global status of insectcides resistance in *Helicoverpa armigea* on cotton. J. Cott. Res. Dev., 20: 226-231.

Haider, I., M. Riaz, S. Ali, Q. Ali, A. Noman, D. Hussain, I. Nadeem, M.F. Akhtar, A. Abbas, A. Aslam, H.S.B. Mustafa, E.U. Hassan, M. Zubair, M. Saleem and M.K. Malik. 2023. Efficacy of different insecticides alone and in combination with salicylic acid against cotton white-fly *Bemisia tabaci* Gennadius (Homoptera: Aleyrodidae). Pak. J. Agri. Res., 36(1): 58-62. https://doi.org/10.17582/journal.pjar/2023/36.1.58.62

Harter, W.R., A.D. Grutzmacher, D.E. Nava and M. Botton. 2010. Toxic bait and mating disruption to control the american fruit fly and the oriental fruit moth on peach orchards. Pesquisa Agropecuária Brasileira. 45: 229-235.

Khan, R., S. Ahmad, M. Saleem and M.K. Nadeem. 2009. Field evaluation of different insecticides against spotted bollworms *Earias* spp. at district Sahiwal. Pak. Entomol., 29(2):129-134.

Lykouressis, D., D. Perdikis, C. Michalis and A. Fantinou. 2004. Mating disruption of the pink bollworm *Pectinophora gossypiella* (Saund.) (Lepidoptera: Gelechiidae) using gossyplure PB-rope dispensers in cotton fields. J. Pest Sci., 77: 205-210. https://doi.org/10.1007/s10340-004-0055-4

Parajulee, M.N., D.R. Rummel, M.D. Arnold and S.C. Carroll. 2004. Long-term seasonal abundance patterns of *Heliocoverpa zea* and *Heliothis virescens* (Lepidoptera: Noctuidae) in the Texas high plains. J. Econ. Entomol., 97: 668–677. https://doi.org/10.1093/jee/97.2.668

Parmar, V.R. and C.C. Patel. 2016. Pink bollworm: A notorious pest of cotton: A review. Agric. Res. Int. J. 5: 88-97.

Radio Free Europe/Radio Liberty. 2017. Census shows Pakistan's Population has reached over 207 million.

Rajput, 2017. Effect of different synthetic pesticides against pink bollworm *Pectinophora gossypiella* (Saund.) on Bt. and non-Bt. cotton crop. J. Basic Appl. Sci., 13: 454-458. https://doi.org/10.6000/1927-5129.2017.13.75

Salama, M.A., M.A. Abd El-Baki, J.B.A. El-Naggar and E.Y. El-Naggar. 2013. Efficiency of some insecticides sequence on cotton bollworms and histopathological effects of some biocides on pink bollworm larvae. Egypt. J. Agric. Res., 91: 429-448. https://doi.org/10.21608/ejar.2013.163443

Saleh, A.A., L.R. Elgohary, W.M. Watson and A.S. Elabasy. 2013. Efficiency of some new insecticides on cotton bollworms, *Pectinophora gossypiella* (Saund.) and *Earias insulana* (boisd.). J. Plant Prot. Res., 4: 617-624. https://doi.org/10.21608/jppp.2013.87410

Shrinivas, A.G., S.G. Sreenivas, S. Hanchinal, Hurali and R.V. Beldhadi. 2019. Evaluation of different mass trapping and mating disruption tools against pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) in Bt cotton ecosystem. J. Entomol. Zool. Stud., 7(1): 1043-1048.

Shuli, F., A.H. Jarwar, X. Wang, L. Wang and Q. Ma. 2018. Overview of the cotton in Pakistan and its future prospects. Pak. J. Agric. Res., 31: 396. https://doi.org/10.17582/journal.pjar/2018/31.4.396.407

Spear-O'Mara, J. and D.C. Allen. 2007. Monitoring

populations of saddled prominent (Lepidoptera: Notodontidae) with pheromone-baited traps. J. Econom. Entomol., 100: 335-342. https://doi.org/10.1603/0022-0493(2007)100[335:MPOSPL]2.0.CO;2

Sufyan, M., A. Abbasi, W. Wakil, M.D. Gogi, M. Arshad, A. Nawaz and Z. Shabbir. 2019. Efficacy of Beauveria bassiana and Bacillus thuringiensis against maize stem borer *Chilo partellus* (Swinhoe) (Lepidoptera: Pyralidae). Gesunde Pflanzen, 71(3): 197-204. https://doi.org/10.1007/s10343-019-00465-7

Talley, Y.M., R.I. Thote and S.A. Nimbekar. 2009. Assessment of losses due to insect pest of cotton and benefit of protection schedule. J. Plant Prot. Res., 12: 88-91.

Waghmare, V.N., J. Rong, C.J. Rogers, G.J. Pierce, J.F. Wendel and A.H. Paterson. 2005. Genetic mapping of a cross between *Gossiypium hirustum* and the *Hawaiian endemic*, *Gossipiyum tomentosum*. Thero. Appl. Genet., 111: 665-676. https://doi.org/10.1007/s00122-005-2032-6