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EVALUATION OF DIFFERENT MANAGEMENT PRACTICES AND THEIR INTEGRATION IN CONTROLLING SUCKING PESTS OF COTTON

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Abstract

*Cotton cultivation accounts for nearly 16% of global pesticide use, leading to serious environmental, health, and food security concerns, particularly in developing countries such as Pakistan. Among the major threats to cotton productivity are sucking pests, which require sustainable and ecologically sound management approaches. Biological control, through the use of beneficial organisms and biopesticides, derived from living organisms with pesticidal properties, represents a promising alternative to conventional chemical pesticides. However, the practical application of these approaches remains limited in local agro-ecosystems. Therefore, the present study was conducted at a farmer's field in Bahawalpur district, Pakistan, to evaluate four management strategies against cotton sucking pests: biological control (release of *Chrysoperla carnea* @ 600 eggs per treatment), biopesticide application (NIAB ECO SPRAY @ 2.5 L/acre), a combined approach (biological control + biopesticide), and chemical control (Tolfenpyrad + Emamectin Benzoate 12 SC @ 200 ml/acre). The experiment was arranged in a randomized complete block design (RCBD) with three replications and a plot size of 1360 ft² per treatment. Applications were made fortnightly from late June to late September 2024, and pest populations (thrips, whiteflies, and jassids) were recorded at three and seven days post-application. Results showed that the combined application of biological control and biopesticide was most effective against whiteflies and thrips, while chemical control provided better suppression of jassids. It can be concluded that for effective management of whiteflies and thrips, biological and biopesticide approaches can serve as sustainable alternatives, whereas integrated use of insecticides with biological methods may be necessary when targeting jassids.*

Keywords: *Biological control, Biopesticides, Chrysoperla carnea, Cotton, NIAB ECO SPRAY, Sucking pests*

INTRODUCTION

Cotton (*Gossypium hirsutum* L.) is a main fiber crop cultivated globally including Pakistan and known for its importance as a cash crop of Pakistan (1). Pakistan ranks fourth among the cotton producing countries of the world (2, 3). Cotton is a popular cash crop whose value is always increasing as a source of raw materials for the textile industry. Cotton contributes 5.2% to agricultural productivity and 0.8% of Gross domestic product (GoP 2024), cultivated across Punjab and Sindh provinces of Pakistan, Punjab being contributing 80% (4).

Cotton, being one of the most widely cultivated crops globally, is highly susceptible to insect pests. More than 230 different insect species have been recorded attacking cotton crops worldwide (5). Thrips (*Thrips tabaci*), jassid (*Amrasca devastans*) and whitefly (*Bemicia tabaci*) are sucking pests and their importance cannot be neglected. These insects suck the sap of leaves and ultimately damage the food producing unit (6). Consequently, it has been reported that 16% of all pesticides used globally are applied to cotton alone. (7). However, the extensive use of hazardous pesticides and chemicals has serious environmental consequences. It disrupts the ecosystem by disturbing the biological equilibrium, especially as pesticide-resistant insect species emerge and pest behavior patterns change. This not only increases production costs but also contributes to air and water pollution, ultimately reducing biodiversity (8).

Integrated pest management is an ecologically-based method which utilizes the most effective usage of each available technology to address pest issues in a sustainable manner. According to earlier research, adopting integrated pest management reduces the use of pesticides, saves cost on output and ensures productivity in agriculture for farmers (9-11). Integrated pest management aims to manage the pest below economic threshold level rather than entirely eradicate them unlike insecticides (12). The integration of many approaches and the utilization of their integrated benefits is a key component of Integrated pest management instead of individual effects (13). The adoption of ecological method for pest management that corresponds to local agroecosystems by using actions and some interaction of fully understood technologies. It can also be called as truly integrated pest management (14).

To mitigate pest damage, farmers can adopt several sustainable practices such as using insect predators, rotating crops, intercropping and applying biological pesticides like neem oil (15). These methods reduce dependence on harmful chemicals and help maintain ecological balance. Seven essential steps towards effective pest management: (i) proper diagnosis, (ii) planning a combat strategy, (iii) timing of application, (iv) selecting the appropriate pesticide, (v) choosing the right equipment, (vi) correct application and (vii) continuous supervision. Following this sequence increases the likelihood of successful pest control and plant protection (16).

Alkaloids, phenols and terpenoids are secondary metabolites found in several plants with insecticide properties, including repellency, toxicity and feeding inhibitor to prevent pests (17). Crop protection towards insects has long been achieved through the use of botanical such as essential oils and extract of various plants (18, 19). Because of their quick breakdown, selectivity and a lower chance of insecticide resistance, biopesticides are regarded as comparatively non-threatening to non-target species (20-24). When compared to chemical insecticides, plant extracts are less expensive for managing pests and are extracted from different plants and are easily accessible costing just labor (25, 26).

Chrysoperla carnea is one of the most significant and widely used predators in the bio-control of pests (27). Their many qualities make them the perfect match for augmentative releases and effective biological control agents. Their tendency to feed on a variety of soft bodied insects, including lepidopterans, whiteflies, thrips and aphids that are frequently target pests in bio-control programs (28). While adults mostly consume nectar, pollen and honeydew (29), the larvae are highly mobile and voracious predators (30, 31). Furthermore, *Chrysoperla carnea* are easy to reared under laboratory conditions and are used as bio-control agents for agricultural crops worldwide (32).

Pesticide use is not always effective since it may also affect natural enemy, which could result in an appearance of the pest population. Furthermore, the use of pesticides may have long-term effects, such as infecting groundwater and creating environmental problems that may have a negative impact on human health (33). Pesticides caused increased risk of cancer, disruption of endocrine function and reproductive problems. Humans experience a range of negative effects including dysfunction of liver and kidney, birth problems and changes in developmental patterns (34).

Since, the environment, human health and natural enemies are all negatively impacted when chemicals are used to manage pest population; there is always a concern for developing environment friendly pesticides and combining them as part of integrated pest management approaches to control major pests. Therefore, this study was intended to assess the effectiveness of biopesticides, biological control, chemical control and their integration towards management of sucking insects of cotton under field conditions.

METHODOLOGY

STUDY AREA

The study was carried out at a farmer field in the village of Abbas Nagar in the Bahawalpur district (29.467786, 71.913722). The region experiences hot summers and cool winters due to its semi-arid environment. The region's average monthly temperature ranges from 18°C to 34°C with minimums of 18°C and 22°C and maximums of 35°C and 44°C. In terms of agroecology, it is a mix zone where four main crops i.e. rice, wheat, cotton and maize are cultivated all year round.

EXPERIMENTAL MATERIAL AND LAYOUT

The cotton var. FH-333 was used in the experiment. The experiment was laid out under Randomized Complete Block Design (RCBD) with three replicates. Five treatments were applied in each replication and each treatment was of 1360sq ft. The five treatments included: biological control, biopesticide, integration of biological control + biopesticide (NIAB ECO SPRAY), chemical control (Tolfenpyrad + Emamectin Benzoate) and control (un-treated). The NIAB ECO SPRAY was used @2.5L/100 of water and Tolfenpyrad + Emamectin Benzoate 12 SC @ 200ml/acre. The chemicals were sprayed with the help of knapsack sprayer. Seven applications of chemicals and biological control agent were made throughout the study. *Chrysoperla carnea* was used as biological control agent.

REARING AND RELEASE OF *C. CARNEA*

Rearing of *C. carnea* was done in bio-control laboratory of WWF-Pakistan Bahawalpur on artificial diet. Augmentation of *C. carnea* was done at egg stage. Grey eggs of *C. carnea* stalked on black paper were stapled with the plant leaves fortnightly in the form of paper strips at the rate of 15-20 eggs/card (600 eggs per treatment/fortnight).

DATA COLLECTION AND STATISTICAL ANALYSIS

The chemical (Tolfenpyrad + Emamectin Benzoate) and the biological control agent (*C. carnea*) were applied at fortnightly from the last week of June to the last week of September 2024. Data regarding populations of thrips, whiteflies and jassids (per plant) were recorded three and seven days after the applications. For this purpose, fifteen plants were randomly selected from each treatment for the population of pests. Regardless of their stage of life, their populations were counted from the top, middle and bottom of each plant. Mean population of pests in biological and chemicals control plots was compared with that of control plot to know their effectiveness. Percent population change (increase or decrease) among treatments in relation to control was calculated by using modified Abbot's formula as below:

$$\% \text{ Population Change} = \left\{1 - \frac{\text{Post treatment population in treatment}}{\text{Pre treatment population in treatment}} x \frac{\text{Pre treatment population in control}}{\text{Post treatment population in control}}\right\} \times 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots (35)$$

One-way analysis of variance (ANOVA) was used to statistically analyze data on populations of jassids, whiteflies and thrips.

RESULTS

There was a significant difference in thrips population among all the five treatments after three (d.f = 4, P = < 0.00, F = 3396.1) and seven days (d.f = 4, P = < 0.00, F = 3781.8) of applications. At both observation days, the minimum thrips population was recorded in *C. carnea* + NIAB ECO SPRAY followed by *C. carnea.* The synthetic insecticide mixture and NIAB-Eco were statistically similar in thrips population (Fig. 1).

There was a significant difference in whitefly population among all the five treatments after three (d.f = 4, P = < 0.00, F = 490.7) and seven days (d.f = 4, P = < 0.00, F = 769.4) of applications. At the both observation days, the minimum whitefly population was recorded in *C. carnea* + NIAB ECO SPRAY followed by *C. carnea.* The synthetic insecticide mixture and NIAB ECO SPRAY were statistically similar in whitefly population at day three but their population was higher in synthetic insecticide mixture than NIAB ECO SPRAY at day seven (Fig. 1).

There was a significant difference in jassid population among all the five treatments after three (d.f = 4, P = < 0.00, F = 770.7) and seven days (d.f = 4, P = < 0.00, F = 942.4) of applications. At day three, the minimum jassid population was recorded in synthetic insecticide mixture followed by *C. carnea* + NIAB ECO SPRAY and *C. carnea*. At day seven, except control, the population of jassid was statistically similar in all the treatments. The control treatment exhibited the highest populations of thrips, whitefly and jassid at both the observation days (Fig. 1).

DISCUSSION

The excessive use of hazardous pesticides to control thrips, jassid and whitefly in cotton crop has led to serious economic and environmental concerns during last few decades (8). Integrated pest management integrates all the available control methods in a sustainable manner to keep the pest populations below economic threshold levels (11). This ecological based pest management not only reduces pesticide application but also conserves natural enemies (36).

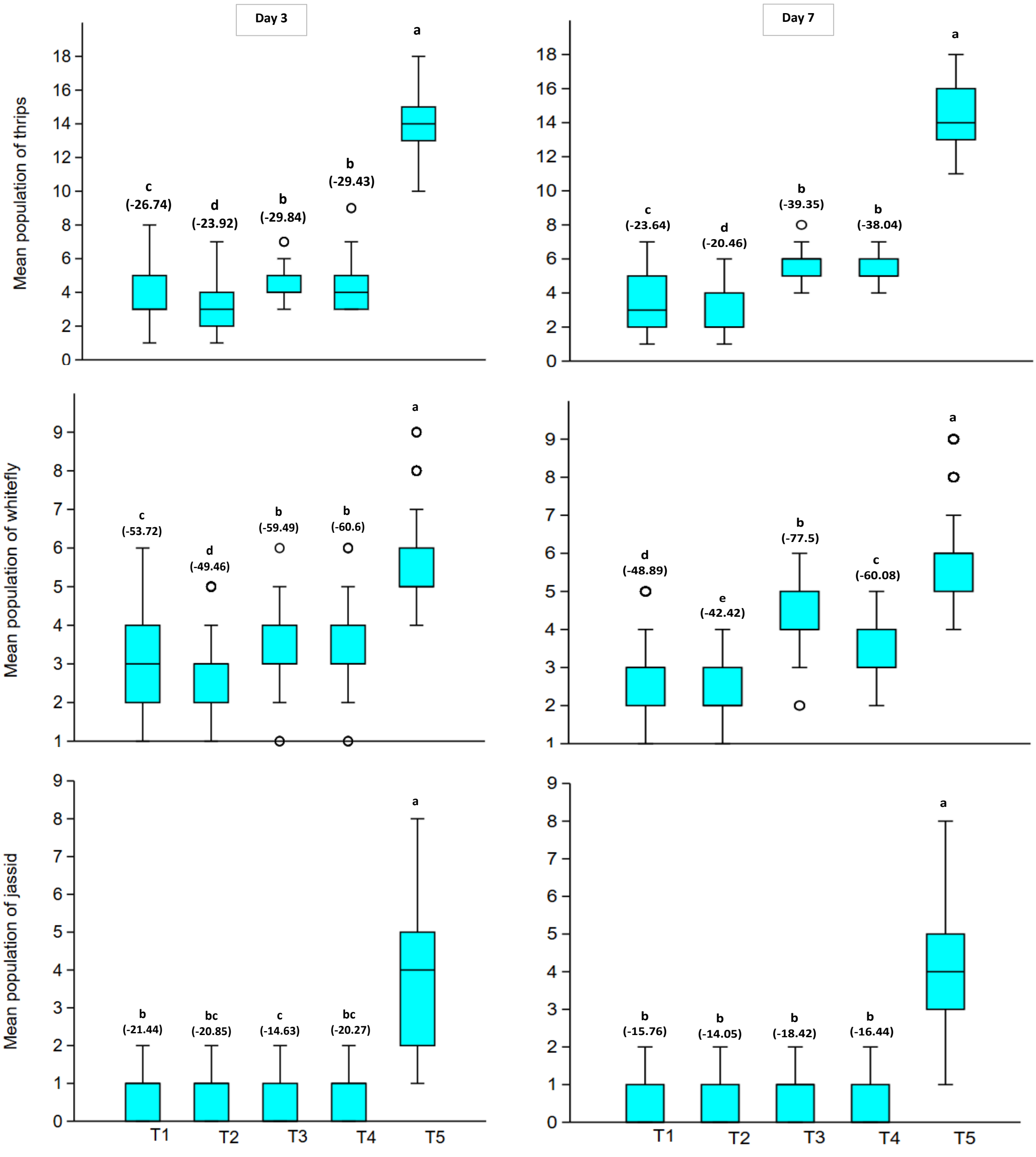

Figure 1. Box and whisker plots showing comparison of different management strategies against populations of thrips, whitefly and jassid (T1 = *C. carnea*, T2 = *C. carnesa* + NIAB ECO SPRAY, T3 = Tolfenpyrad + Emamectin Benzoate, T4 = NIAB ECO SPRAY, and T5 = Control). In parenthesis, given is the percent change in the populations. Boxes sharing similar letter are statistically similar in terms of their means

In the present study, the minimum populations of whitefly and thrips were recorded in *C. carnea* + NIAB ECO SPRAY followed by *C. carnea* alone. For jassid, Tolfenpyrad + Emamectin Benzoate proved most effective followed by *C. carnea* + NIAB ECO SPRAY. This finding is in accordance with (Khan et al., 2013; Hanumantharaya et al., 2010) who reported that integration of neem oil and *C. carnea* reduced the population of sucking insects. Another study also suggested that the inoculative release of *C. carnea* reduced bollworms and increased the seed cotton yield by 73 percent (38).

Insects have a propensity to develop resistance against insecticides. Our results suggested that Tolfenpyrad + Emamectin didn't perform well against whitefly and thrips as compare to jassid. This is may be because of resistance in the said insects against the Tolfenpyrad + Emamectin mixture. Previously many folds resistance has been reported in whitefly, jassid and thrips against different commonly used insecticides and their mixtures in South Punjab. Abbas *et al*., (2012) (39) reported some resistance in thrips against thiomethoxam, Saleem *et al*., (2022) (40) recorded highest level of resistance in whitefly against insecticides belonging to pyrethroid and organophosphate, Shamraiz *et al*., (2023) (41) reported moderated resistance in thrips against pyriproxyfen, diafenthiuron and buprofezin, Wakil *et al*., (2023) (42) showed the high level of resistance in thrips against synthetic pyrethroids (20–86 fold). However, Das and Islam, (2014) (43) revealed that whitefly and jassid moderate level of resistance against mixture of insecticides i.e., Thiamethoxam + Emamectin Benzoate.

Botanicals pesticides don't harm the population of predators as compare to synthetic pesticides. Arshad *et al*., (2019) (44) showed that abundance of predators was high in those plots which were treated with botanical pesticides and the lowest population was found in those plots which were treated with a synthetic pesticide (bifenthrin). Sayed *et al*., (2020) (45) performed and experiment to evaluate the effect of five different botanical extracts on *Aphis craccivora* and its predator *C. carnea*. They reported that botanical insecticides rapidly degrade as compare to synthetic insecticides, have less harmful effect on environment and don't developed resistance in insects. They showed that *Ochradenus baccatus* extract had a maximum effect on *A. craccivora* and was safest for *C. carnea*.

It was concluded that *C. carnea* and NIAB ECO SPRAY can be used if the primary emphasis of control is on thrips and whiteflies. Nevertheless, Tolfenpyrad + Emamectin Benzoate in combination with *C. carnea* and NIAB ECO SPRAY should be chosen if jassid is the main emphasis

CONCLUSION

This study concluded that integrating biopesticides with biological control gave alternative to chemical insecticides for managing sucking insect pests of cotton crop. The combination of NIAB ECO SPRAY and *C. carnea* proved most effective in reducing whitefly and thrips populations, while synthetic pesticides were comparatively more effective against jassid. These findings highlight the potential of IPM strategies in minimizing chemical pesticide dependence and conserving bio control agents in the cotton ecosystem.

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Authors' contribution:

MWTA Statistical analysis and writing; IB Data collection and writing; AUI Conceptualized and supervision; MA Conceptualized; MMAK Supervision; MI Supervision; GK Designed the study, supervision and reviewed; MAH Supervision and data collection & MA Data collection and supervision.

References:

1. Tayyib M, Sohail A, Shazia AM, Jamil FF. Efficacy of some new-chemistry insecticides for controlling the sucking insect pests and mites on cotton. Pakistan Entomologist. 2005;27(1):63-66.
2. Ashraf S, Sangi AH, Hassan ZY, Luqman M. Future of cotton sector in Pakistan: A 2025 Outlook. Pakistan Journal of Agricultural Research. 2018;31(2).
3. Ali MA, Farooq J, Batool A, Zahoor A, Azeem F, Mahmood A, Jabran K. Cotton production in Pakistan. Cotton production. 2019;249-276.
4. Ali H, Ali H, Faridi Z, Ali H. Production and forecasting trends of cotton in Pakistan: An analytical view. Journal of Basic and Applied Sciences Research. 2013;3(12):97-101.
5. Brader L. Integrated pest control in the developing world. Annual Review of Entomology. 1979;24(1):225-254.

6. Babar TK, Karar H, Hasnain M, Shahazad MF, Saleem M, Ali A. Performance of some transgenic cotton cultivars against insect pest complex, virus incidence and yield. Pakistan Journal of Agricultural Sciences. 2013;50(3), 367-372.
7. Chapagain AK, Hoekstra A, Savenije H, Gautam R. The water footprint of cotton consumption: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries. Ecological Economics. 2006;60(1):186-203.
8. Josipović M, Plavšić H, Kovačević V, Marković M, Iljkić D. Impacts of irrigation and genotype on yield, protein, starch and oil contents in grain of maize inbred lines. Genetika. 2014;46(1):243-253.
9. Cuyno LCM, Norton GW, Rola A. Economic analysis of environmental benefits of integrated pest management: a Philippine case study. Agricultural Economics. 2001;25(2-3):227-233.
10. Dasgupta S, Meisner C, Wheeler D. Is environmentally friendly agriculture less profitable for farmers? Evidence on integrated pest management in Bangladesh. Applied Economic Perspectives and Policy. 2007;29(1):103-118.
11. Carrión Yaguana V, Alwang J, Norton G, Barrera V. Does IPM have staying power? Revisiting a potato-producing area years after formal training ended. Journal of Agricultural Economics. 2016;67(2):308-323.
12. Barzman M, Barberi P, Birch ANE, Boonekamp P, DachbrodtSaaydeh S, Graf B, Sattin M. Eight principles of integrated pest management. Agronomy for Sustainable Development. 2015;35(4):1199-1215.
13. Stenberg JA. A conceptual framework for integrated pest management. Trends in Plant Science. 2017;22(9):759-769.
14. Abrol DP, Shankar U. History, overview and principles of ecologically-based pest management. In: Abrol DP, Shankar U (eds) Integrated pest management: principles and practice. CAB International, Cambridge. 2012:1–26.
15. Husnain T. Transformation and transgenic expression studies of glyphosate tolerant and cane borer resistance genes in sugarcane (Saccharum officinarum L.). Molecular Plant Breeding. 2015;6(12):1-17.
16. Singh K, Singh H, Singh K. Weed management in cotton with pre-and post-emergence herbicides. Indian Journal of Weed Science. 2016;48:348.
17. Koul O. Insect antifeedants. CRC, Boca Raton. 2004
18. Isman MB. Botanical insecticides: for richer, for poorer. Pest Management Sciences. 2008;64:8-11.
19. Belmain SR, Amoah BA, Nyirenda SP, Kamanula JF, Stevenson PC. Highly variable insect control efficacy of Tephrosia vogelii chemotypes. Journal of Agricultural and Food Chemistry. 2012;60:10055-10063.
20. Isman MB. Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Review of Entomology. 2006;51:45-66.
21. Koul O, Walia S, Dhaliwal G. Essential oils as green pesticides: potential and constraints. Biopesticides International. 2008;4:63-84.
22. Dubey N, Shukla R, Kumar A, Singh P, Prakash B. Global scenario on the application of natural products in integrated pest management programmes. In: Dubey NK (ed) Natural products in plant pest management. CAB International, Wallingford. 2011:1-20.
23. Amoabeng BW, Gurr GM, Gitau CW, Nicol HI, Munyakazi L, Stevenson PC. Tri-trophic insecticidal effects of African plants against cabbage pests. PLOS One. 2013;8:78651.
24. Tembo Y, Mkindi AG, Mkenda PA, Mpumi N, Mwanauta R, Stevenson PC, Ndakidemi PA, Belmain SR. Pesticidal plant extracts improve yield and reduce insect pests on legume crops without harming beneficial arthropods. Frontiers in Plant Sciences. 2018;9:1425.
25. Amoabeng BW, Gurr GM, Gitau CW, Stevenson PC. Cost: benefit analysis of botanical insecticide use in cabbage: implications for smallholder farmers in developing countries. Crop Protection. 2014;57:71-76.
26. Isman MB. Bridging the gap: moving botanical insecticides from the laboratory to the farm. Industrials Crops and Product. 2017;110:10-14.
27. Tauber MJ, Tauber A, Daane KM, Hagen KS. Commercialization of predators: Recent lessons from green lacewings (Neuroptera: Chrysopidae: Chrysoperla). American Entomologist. 2000;4(6) 26-38.
28. Bezerra CES, Nogueira CHF, Sombra KDS, Demartelaere AEF, Araujo EL. Green lacewings (Neuroptera: Chrysopidae):Biological aspects, potential of use and future perspectives. Revista Caatinga. 2009;22:252-256.

29. Andrade KA, Aguiar-Menezes EL, Gonçalves-Esteves V, Mendonça CBF, Vieira GRM, Melo SJ, Magalhães JLA, Melo GJB. Pollen ingestion by *Chrysoperla externa* (Hagen) adults in a diversified organic agroecosystem. Neotropical Entomology. 2018;47:118-130.
30. Maia WJMS, Carvalho CF, Souza B Cruz I Maia TJAF. Predatory capacity and biological aspects of *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) fed on *Rhopalosiphum maidis* (Fitch, 1856). Science and Agrotechnology. 2004;28:1259–1268.
31. Palomares-Perez M, Bravo-Nunez M, Arredondo-Bernal HC. Functional response of *Chrysoperla externa* (Hagen,1861) (Neuroptera:Chrysopidae) fed with *Melanaphis sacchari* (Zehntner, 1897) (Hemiptera: Aphididae). Proceedings of the Entomological Society of Washington. 2019;121:256-264.
32. De Bortoli SA, Ferreira RJ, De Bortoli CP, Magalhães GO, Dibelli W. Phenotypic frequency of wings and eyes along the generations of *Chrysoperla externa* (Neuroptera: Chrysopidae) in laboratory populations. Revista Caatinga. 2014;27:254-263.
33. Wabale AS, Kharde MN. (2010). Bioefficacy of plant extracts against sugarcane woolly aphid (*Ceratovacuna lanigera*. Zehntner). Asian Journal of experimental biological Sciences. 2010;1(3):592-595.
34. Rahman HU, Asghar W, Nazir W, Sandhu MA, Ahmed A, Khalid N. (2021). A comprehensive review on chlorpyrifos toxicity with special reference to endocrine disruption: Evidence of mechanisms, exposures and mitigation strategies. Science of The Total Environment. 2021;755:142-649.
35. Fleming R, Ratnakaran A. Evaluating single treatment data using Abbot's formula with modification. Journal of Economic Entomology. 1985;78: 1179.
36. Dhawan AK, Singh S, Kumar S. Integrated pest management (IPM) helps reduce pesticide load in cotton. 2009.
37. Khan MH, Ahmad N, Masoom SM, Rashdi S, Ismail M, Rauf I, Tofique M. Studies on the compatibility of neem oil with predator, *Chrysoperla carnea* for the management of aphids (Homoptera: Aphididae) in canola (Brassica napus L.). Journal of cereals and oilseeds. 2013;4(6):85-88.
38. Hanumantharaya L, Basavanagoud K, Ramegowda GK. Use of green lacewing, *Chrysoperla carnea* (Stephens) and neem seed kernel extract for management of insect pests on cotton. Karnataka Journal of Agricultural Sciences. 2010;21(1).
39. Abbas Q, Arif MJ, Gogi MD, Abbas SK, Karar H. Performance of imidacloprid, thiomethoxam, acetamaprid and a biocontrol agent (Chrysoperla carnea) against whitefly, jassid and thrips on different cotton cultivars. World Journal of Zoology. 2012;7(2):141-146.
40. Saleem M, Hussain D, ul Hasan M, Sagheer M, Ghouse G, Zubair M, Cheema SA. Differential insecticide resistance in Bemisia tabaci (Hemiptera: Aleyrodidae) field populations in the Punjab Province of Pakistan. Heliyon. 2022;8(12).
41. Shamraiz RM, Saeed S, Qayyum MA, Khan, Z. Insecticidal Resistance Monitoring in mitotypes of Bemisia tabaci in South Punjab region of Pakistan. 2023.
42. Wakil W, Gulzar S, Wu S, Rasool KG, Husain M, Aldawood AS, Toews MD. Development of insecticide resistance in field populations of onion thrips, Thrips tabaci (Thysanoptera: Thripidae). Insects. 2023;14(4):376.
43. Das, G, Islam, T Relative efficacy of some newer insecticides on the mortality of jassid and whitefly in brinjal. International Journal of Research in Biological Sciences. 2014;4(3):89-93.
44. Arshad M, Ullah MI, Çağatay NS, Abdullah A, Dikmen F, Kaya C, Khan RR. Field evaluation of water plant extracts on sucking insect pests and their associated predators in transgenic Bt cotton. Egyptian Journal of Biological Pest Control. 2019;29(1):39.
45. Sayed SM, Alotaibi SS, Gaber N, Elarrnaouty SA. Evaluation of five medicinal plant extracts on Aphis craccivora (Hemiptera: Aphididae) and its predator, Chrysoperla carnea (Neuroptera: Chrysopidae) under laboratory conditions. Insects. 2020;11(6):398.