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Research Article

The efficacy of some pesticides on cotton yield, damage symptoms, and population of the cotton shredder bug, *Creontiades pallidus* (Hemiptera: Miridae) under field conditions

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Abstract: The cotton shredder bug, *Creontiades pallidus* Rambur (Hemiptera; Miridae), is a significant pest of cotton, causing extensive damage to cotton leaves and bolls. This study assessed the effectiveness of commercial formulations of phosalone (PHO), thiamethoxam (THX), thiamethoxam + lambda-cyhalothrin (THX + LAM), and spirotetramat (SPI) under field conditions, using both one-time and two-times spray applications. In the one-time spray plots, THX and THX + LAM demonstrated the highest efficacy in reducing *C. pallidus* populations, as well as mitigating damage symptoms like black spots on cotton bolls and leaves and shredding of cotton blossoms for up to 49 days compared to the control group. However, the effects of SPI and PHO were temporary and diminished after approximately 31 days. When the plots were sprayed for the second time after 30 days, all pesticides significantly decreased pest populations and damage symptoms for up to 49 days. The highest cotton yield in the one-time spray plots was achieved with THX application (323.8 ± 10.62 g cotton/m^2), while the SPI-treated plots exhibited the lowest yield (275.7 ± 5.1 g cotton/m^2). All THX, THX + LAM, and PHO treatments yielded statistically similar results in the two-times spray plots. Our findings suggest that THX and THX + LAM were the most effective pesticides for controlling *C. pallidus* populations and mitigating damage symptoms in cotton fields.

Keywords: *Creontiades pallidus*, cotton, pesticides, cotton pests' control, cotton blossom shredding

Introduction

Cotton, a natural fiber derived from the genus *Gossypium* in the family Malvaceae, plays a significant role in global fiber production, accounting for approximately 35% of the world's total annual output (Huang *et al*., 2021). Among the major cotton-producing countries, Iran ranks 19th, with Khorasan provinces significantly contributing to cotton production,

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yielding 76,284 tons per hectare in 2021 (Aanon, 2021). However, cotton cultivation faces numerous challenges, with various mirid species threatening its productivity. Among these pests, the cotton shredder bug, *Creontiades pallidus* Rambur (Hemiptera; Miridae), stands out as the most significant (Khormali and Darvish Mojeni 2016). This pest can cause substantial qualitative and quantitative damage throughout different stages of cotton growth (Hosseini *et al*., 2002), with reports suggesting crop losses of up to 82%, particularly when attacks occur during the flowering season (Efil and Ilkan, 2003). Damage symptoms caused by *C. pallidus* include black spots on cotton bolls and leaves, shredding cotton bracts, and shredding of cotton blossoms (Musayev *et al*., 2020).

Pesticide application is crucial for managing major cotton pests, including *C. pallidus* (Khormali and Darvish Mojeni 2016). However, there is a paucity of research on the field efficacy of pesticides in reducing the damage and population of this particular pest. Khormali and Darvish Mojeni (2016) assessed the effects of pymetrozine, fenpropathrin, oxydemeton-methyl, pyriproxyfen, and imidacloprid on *C. pallidus* populations in cotton fields. They identified pymetrozine and fenpropathrin as highly effective pesticides, significantly reducing pest populations. Given the importance of *C. pallidus* damage to cotton and the limited knowledge regarding effective pesticides for its chemical control, it is crucial to investigate the field efficacy of pesticides in suppressing the population and mitigating damage symptoms caused by *C. pallidus* in cotton cultivation.

Therefore, this study aimed to evaluate the efficacy of commonly used pesticides, namely phosalone, thiamethoxam, thiamethoxam + lambda-cyhalothrin, and spirotetramat, in controlling *C. pallidus* populations and mitigating associated damage symptoms under field conditions. By elucidating the effectiveness of these pesticides, valuable insights can be gained regarding their potential for successful pest management in cotton cultivation.

Materials and Methods

Experimental site

Field experiments were performed in Ardameh, a village in Miyan Jolgeh District, Neyshaboor County, Razavi Khorasan Province (longitude: 58° 32′ 37.007″ E; latitude: 36° 2′ 0.841″ N; altitude: 1114 m) during spring and summer 2021.

Cotton plant cultivation

Seeds of the Varamin cotton cultivar were procured from the Cotton and Fiber Crops Department at the Varamin Agriculture Research Center in Varamin, Iran. Before sowing, the seeds underwent treatment with Vitavax (carboxin 37.5% + thiram 37.5% DS) and thiodicarb (Larvin®, 75% WP; Bayer.) to preemptively address potential infestations of *Verticillium* sp. and thrips, respectively. Following treatment, the seeds were planted at 3-5 cm depth, with row spacing set at 80 cm intervals. Subsequent agricultural operations were executed following customary regional practices.

Experimental design

The experiments were conducted following a complete randomized block design (CRBD) with triplicates. Two sets of experimental plots, each measuring 5 × 8 m in size with a spacing of 1 m between each plot, were established. Each plot accommodated 10 cotton shrubs. Regular monitoring of the *C. pallidus* population was carried out throughout the study. Once the maximum population was observed on August 5, 2021, sprayings were implemented using a calibrated backpack sprayer (Sam Kubota KF-2202, Japan) following standard regional practices.

The treatments consisted of applying commercial formulations of each pesticide at their recommended dosages. These included phosalone (PHO) (Zolone®; 35 EC; Giyah Corp.; 2500 ml/ha), thiamethoxam (THX) (Actara®; 25 WG; Syngenta Co.; 500 ml/ha), thiamethoxam + lambda-cyhalothrin (THX + LAM) (Eforia®; 247 SC; Syngenta Co.; 300 ml/ha), spirotetramat (SPI) (Movento®, 240 SC; Bayer Co.; 400

ml/ha), and a water spray as the control. The application of the pesticides was conducted on the designated date.

After 30 days (September 5, 2021), one set of plots received a second round of sprayings using the same treatments as mentioned above. Meanwhile, the other set of plots remained untreated, serving as a comparison group.

Samplings

To assess the population of *C. pallidus* and the associated damage symptoms, comprehensive samplings were conducted on all 10 cotton shrubs within each plot. The samplings were performed both before pesticide spraying and at regular intervals for up to 49 days following the spray application. Careful collection of cotton leaves and bolls took place, and meticulous counting of black spots resulting from *C. pallidus* feeding was performed using a binocular microscope. Additionally, the numbers of C. pallidus nymphs and adults were recorded during each sampling session, and the number of cotton blossom sheds due to *C. pallidus* feeding was assessed. To accurately attribute blossom shedding to *C. pallidus* activity and eliminate other potential factors, shed blossoms were considered only if evidence of *C. pallidus* feeding was observed on their pedicels.

Subsequently, after the 49-day monitoring period, the cotton yield was measured by weighing the harvested cotton from each plot, providing a quantitative evaluation of the impact of the pest and the effectiveness of the pesticide treatments.

Data analysis

One-way analysis of variance (ANOVA) was adopted for field data analysis, and means were compared using the least significant difference (LSD) method at $P = 0.05$ using the SAS software v. 9.4.

Results

One-time spraying

The analysis of variance (ANOVA) results revealed a significant effect of pesticides on reducing the number of black spots caused by *C. pallidus* infestation on cotton leaves and bolls in plots subjected to one-time spraying, starting from day 10 (F = 15.36; df = 4, 8; P = 0.0008). In control plots, the number of black spots on cotton leaves and bolls remained relatively low during the first two days (8-10 and 4-5 spots, respectively), but steadily increased up to day 49 (126 and 38 spots, respectively) (Figs. 1a and 2a).

In the initial days following the spraying and up to 14 days, THX, THX + LAM, and SPI significantly reduced the number of black spots on cotton leaves compared to the control, while PHO showed no effect (Fig. 1a). However, after 14 days, all pesticides significantly reduced the number of black spots (Fig. 1a). The effects of PHO and SPI diminished after 45 days, with no significant difference observed compared to the control (Fig. 1a). All pesticides significantly reduced the number of black spots on cotton bolls six days after spraying (F = 10.14; df = 4, 8; P = 0.003) (Fig. 2a). In plots treated with PHO, black spots increased after 18 days. Both PHO and SPI demonstrated a significant decrease in efficacy after 31 days (Fig. 2a). THX + LAM effectively controlled pest damage symptoms on cotton bolls and leaves for up to 41 days, while THX exhibited the best efficacy for up to 49 days (Fig. 2a).

Regarding one of the main damages caused by *C. pallidus* infestation, the number of shed cotton blossoms gradually increased in control plots and peaked after 37 days (approximately 23). Subsequently, a sharp decline in shed blossoms was observed up to day 49 (approximately 7 shed blossoms) (Fig. 3a). PHO exhibited the least efficacy in reducing cotton blossom shedding, while THX and THX + LAM demonstrated significant effectiveness for up to 33 days. Initially, THX also decreased the number of shed cotton blossoms compared to the control (F = 4.42; df = 4, 8; P = 0.04) (Fig. 3a). However, in plots with one-time spray, the effects of pesticides diminished over time, with no significant differences observed compared to the control at days 41 (F = 2.91; df = 4, 8; P = 0.09) and 45 (F = 3.94; df = 4, 8; P = 0.06) (Fig. 3a).

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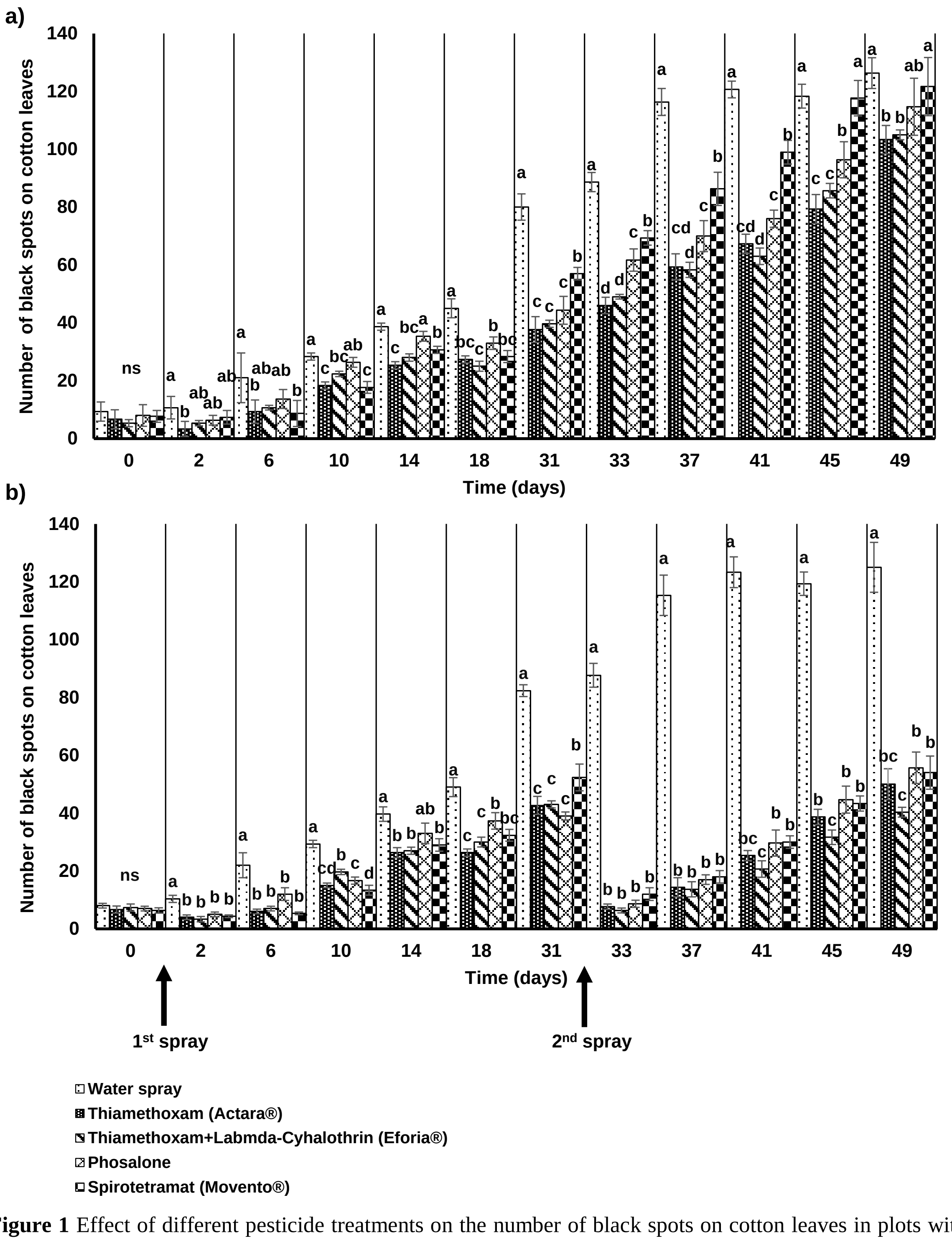

Figure 1 Effect of different pesticide treatments on the number of black spots on cotton leaves in plots with (a) one time and (b) two times spraying. **ns**: non-significant ANOVA test. Error bars represent standard deviations of triplicates. At each sampling time, columns with the same letters do not differ significantly (LSD, $P = 0.05$).

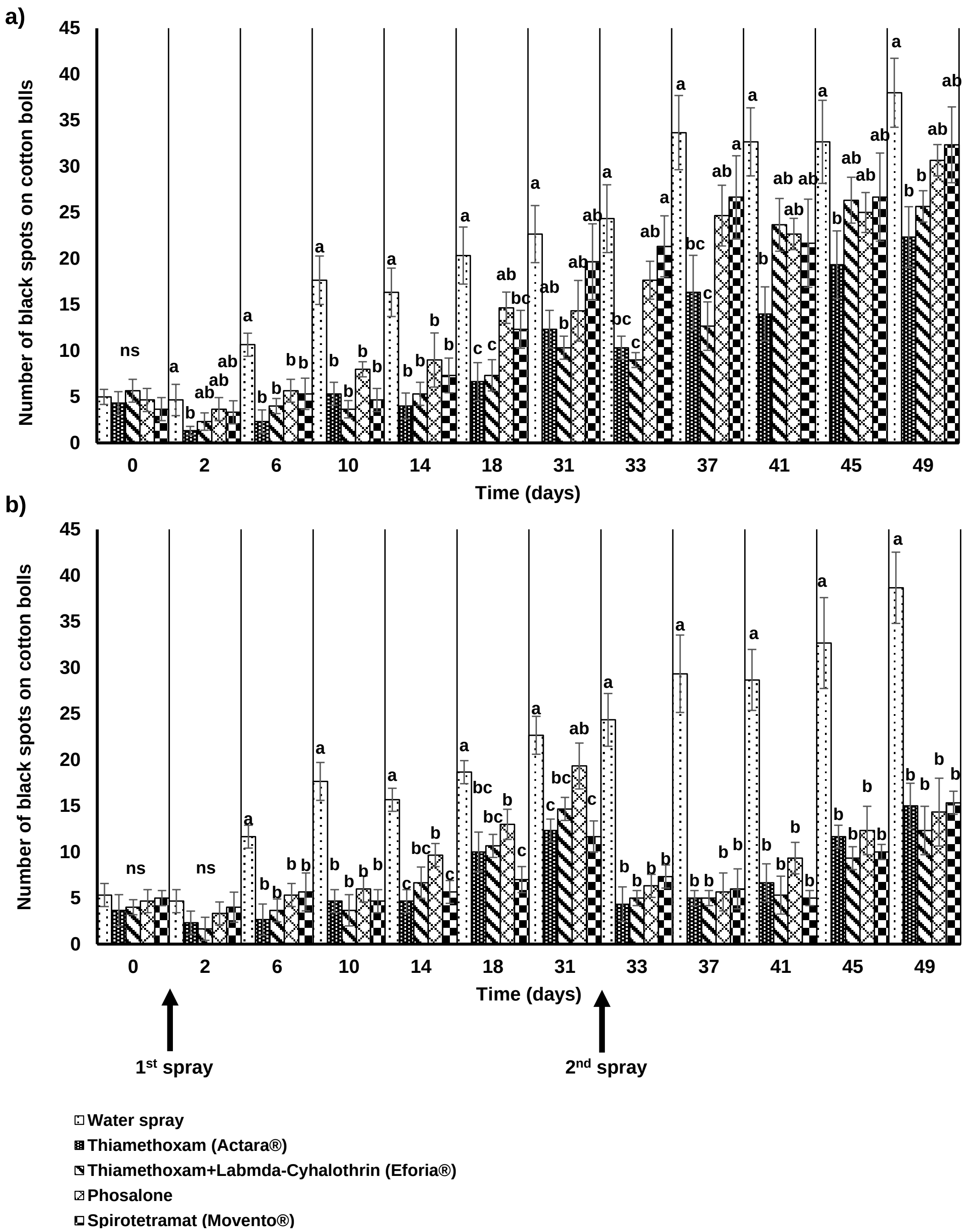

Figure 2 Effect of different pesticide treatments on the number of black spots on cotton bolls in plots with (a) one time and (b) two times spraying. **ns**: non-significant ANOVA test. Error bars represent standard deviations of triplicates. At each sampling time, columns with the same letters do not differ significantly (LSD, *P* = 0.05).

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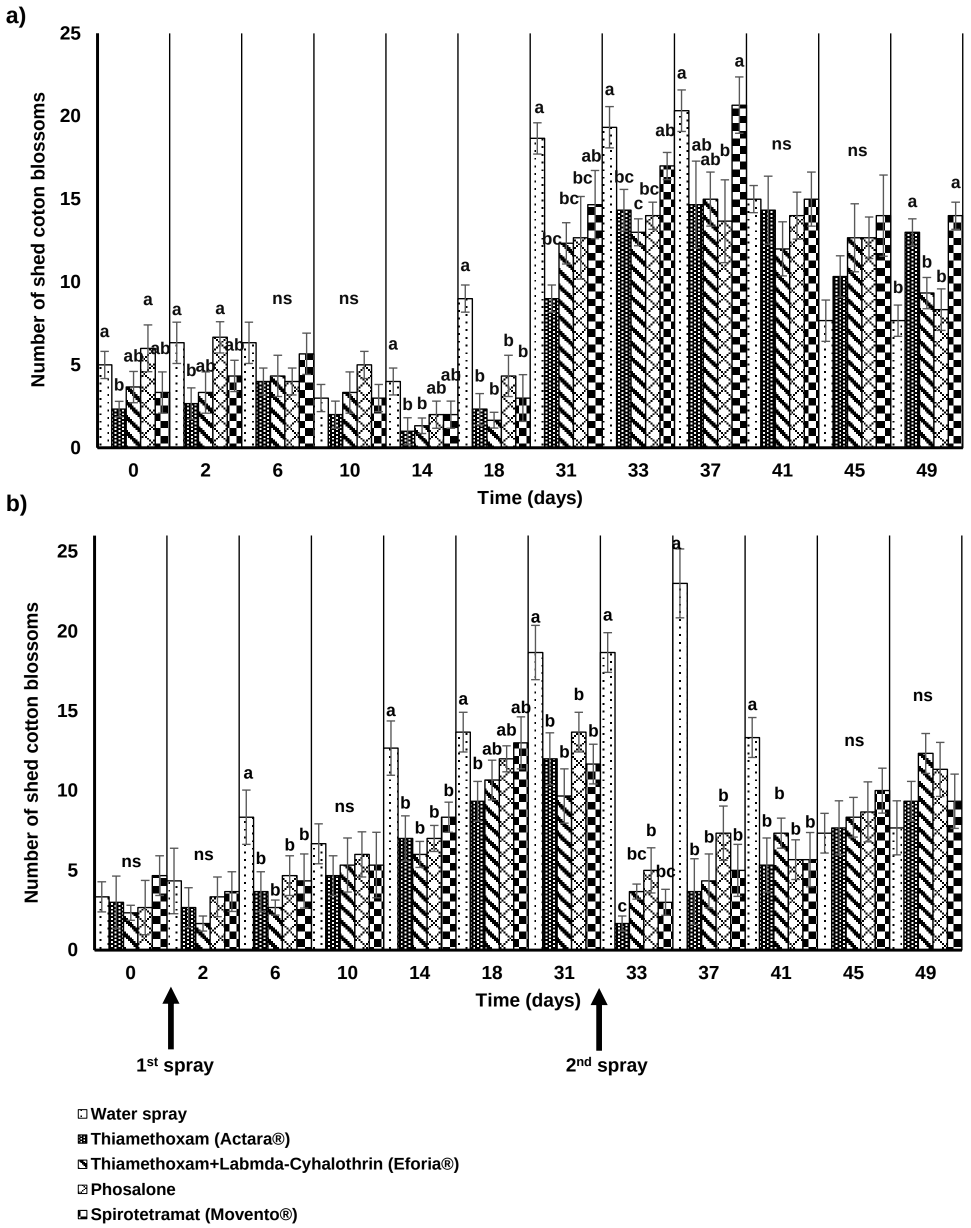

Figure 3 Effect of different pesticide treatments on the number of shed cotton blossoms in plots with (a) one time and (b) two times spraying. ns: non-significant ANOVA test. Error bars represent standard deviations of triplicates. At each sampling time, columns with the same letters do not differ significantly (LSD, *P* = 0.05).

The population of *C. pallidus* in control plots remained consistently low up to 31 days, followed by a sharp increase (Fig. 4a). In plots subjected to one-time spraying, pesticide treatments did not significantly affect *C. pallidus* populations up to day 31 (F = 1.67; df = 4, 8; P = 0.25). However, after 37 days, all pesticides, particularly THX and THX + LAM, significantly decreased the pest population compared to the control (Fig. 4a). The effectiveness of pesticides on *C. pallidus* was transient in one-time spray plots, with a subsequent increase observed from day 41 without any significant difference from the control (F = 3.38; df = 4, 8; P = 0.07).

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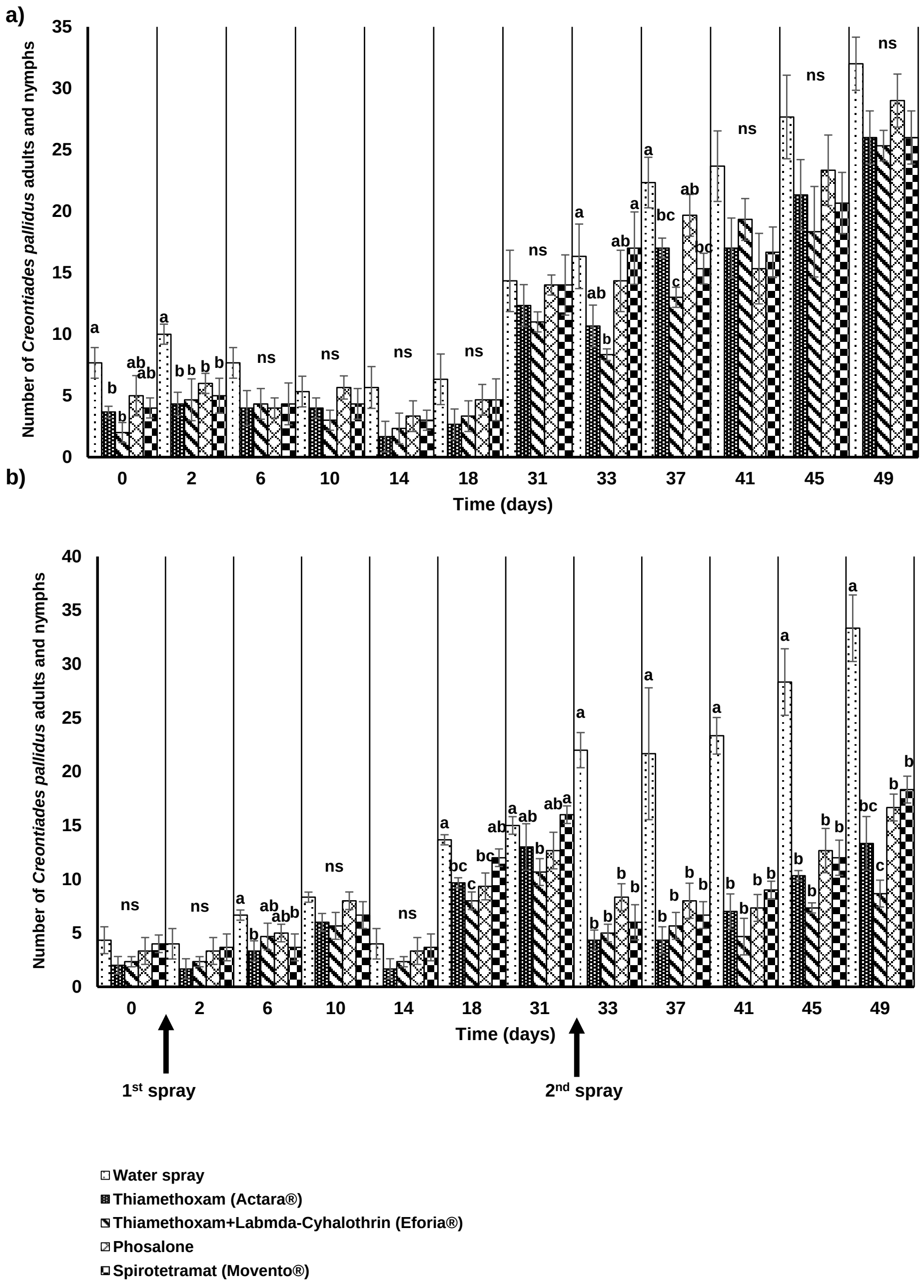


Figure 4 Effect of different pesticide treatments on the number of *Creontiades pallidus* adults and nymphs in plots with (a) one time and (b) two times spraying. **ns**: non-significant ANOVA test. Error bars represent standard deviations of triplicates. At each sampling time, columns with the same letters do not differ significantly (LSD, *P* = 0.05).

The superior efficacy of THX and THX + LAM in controlling both damage symptoms and the population of *C. pallidus* can be attributed to the combined systemic and contact properties of these pesticides, ensuring a prolonged effect on cotton leaves and bolls.

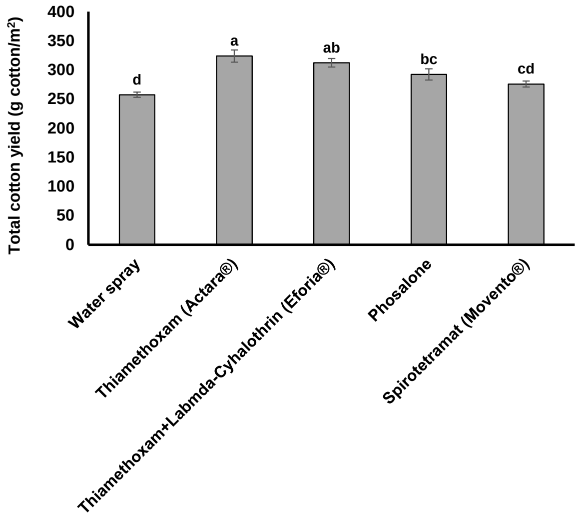
Two times spraying

In plots with two times spraying, all pesticides significantly reduced *C. pallidus* damage to cotton leaves (F = 189.54; df = 4, 8; *P* = 0.00000006) and bolls (F = 31.55; df = 4, 8; *P* = 0.00006) up to day 49 (Fig. 1b, 2b, and 3c). Unlike one-time spray plots where the effect of pesticides on *C. pallidus* populations was transient, applying a second spray on day 30 they resulted in a significant decrease in the pest population up to day 49 for all pesticide treatments (F = 39.01; df = 4, 8; *P* = 0.00002) (Fig. 4b).

Effect of pesticides on cotton yield

Except for SPI, all pesticide treatments significantly increased the cotton yield compared to the control in both plots sprayed one time (F = 23.36; df = 4, 8; *P* = 0.0002) and two times (F = 16.08; df = 4, 8; *P* = 0.0007) (Fig. 5). When sprayed once, THX showed a significantly higher yield (323.8 ± 10.62 g cotton/m^2) than PHO (292.4 ± 43 g cotton/m^2) (Fig. 5a). However, with a second spray, all THX, THX + LAM, and PHO treatments resulted in statistically equal yields (Fig. 5b).

a)



b)

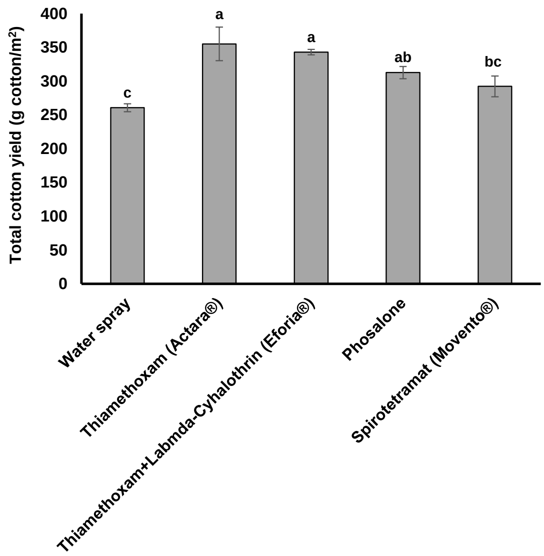


Figure 5 Effect of different pesticide treatments on the total cotton yield in plots with (a) one time and (b) two times spraying. Error bars represent standard deviations of triplicates. At each sampling time, columns with the same letters do not differ significantly (LSD, *P* = 0.05).

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Discussion

The present manuscript delves into a comprehensive investigation concerning the efficacy of diverse pesticide formulations in combatting *C. pallidus*, an eminent cotton pest with widespread prevalence in Iran and across the globe. Given the grave ramifications of this issue, resorting to chemical interventions for pest control is deemed indispensable.

The obtained research findings reveal that certain pesticides, specifically THX, THX + LAM, and SPI, exhibited noteworthy efficacy in diminishing the occurrence of black spots on cotton leaves, compared to the control group, during the initial stages following spraying, and up to 14 days. Notably, PHO failed to manifest any discernible impact. This disparity can be ascribed to the systemic attributes inherent in THX, THX + LAM, and SPI, which confer a heightened shield of protection to the foliage. The augmented effectiveness of THX and THX + LAM in ameliorating damage symptoms and curbing the *C. pallidus* population may be attributed to the combined systemic and contact properties these pesticides possess, thereby causing a protracted effect on cotton leaves and bolls.

Several previous studies have also reported the efficacy of THX or THX + LAM in combatting various piercing-sucking pests. For instance, Khormali and Darvish Mojeni (2016) identified pymetrozine and fenpropathrin as the most potent pesticides, resulting in a reduction of *C. pallidus* populations by 67.60% and 63.21%, respectively. Alizadeh and Safavi (2019) demonstrated that THX + LAM displayed superior contact and systemic toxicity against *Brevicoryne brassicae* compared to SPI. Additionally, Varghese and Mathew (2015) observed a complete eradication of *Aphis gossypii* populations on chili peppers within three days of treatment with 100 g a.i/ha of THX. Moreover, Golmohammadi *et al*. (2014) recommended THX + LAM as an efficacious pesticide for controlling *Bemisia tabaci* infestations on cucumber plants.

In contrast to plots subjected to a single spray application, where the effects of pesticides on *C. pallidus* populations proved temporary, implementing a second spray on day 30 led to a substantial decline in pest populations until day 49 for all pesticide treatments. This strategic timing of the second application, coinciding with the emergence of the second generation of *C. pallidus*, known for its heightened destructive potential in terms of damage and infestation, underpins the efficacy of this approach. Consequently, additional sprays should be considered to maintain pest populations at manageable levels if a notable surge in *C. pallidus* population is observed in the field.

Significantly, our investigation revealed that all pesticides, except for SPI, engendered a noteworthy positive impact on cotton yield. This study represents a pioneering endeavor to evaluate the effect of chemical pest control measures on cotton yield.

Conclusion

In conclusion, the results obtained from this study underscore the efficacy of specific pesticides, namely THX, THX + LAM, and SPI, in managing *C. pallidus* populations and minimizing cotton plant damage. The prolonged impact of these pesticides can be attributed to their systemic and contact properties. Furthermore, the timing of pesticide application, with particular attention to the emergence of the second generation of *C. pallidus*, plays a vital role in successful pest management. It would be beneficial for future research to explore alternative approaches, such as integrated pest management strategies, to further enhance *C. pallidus* control and decrease reliance on chemical methods.

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Conflict of interest

The Authors state that there is no conflict of interest.

References

Alizadeh, S. and Safavi, S. A. 2019. Toxicity of spirotetramat, spiromesifen, thiamethoxam + lambda-cyhalothrin and azadirachtin on cabbage aphid, *Brevicoryne brassicae* (Hem.: Aphididae). Plant Pests Research, 9(1): 37-49.

Anon. 2021. Agricultural Statistics Book 2020: Volume 1 .Information and Communication Technology Center Statistics, Ministry of Agriculture-Jahad, Iran. available from: https://www.jkgc.ir/fa/Page-346 [Accessed 20th November 2022].

Efil, L. and Ilkan, A. 2003. Determination of population alteration of harmful insect *Creontiades pallidus* Rmb. (Hemiptera: Miridae) in cotton in Harran Plain. Proceeding of Third GAP Agriculture Congress, Sanlur-fa, Turkey. pp. 395397.

Golmohammadi, G., Hosseini-Gharalari, A., Fassihi, M. and Arbabtafti, R. 2014. Efficacy of one botanical and three synthetic insecticides against silverleaf whitefly, *Bemisia tabaci* (Hem.: Aleyrodidae) on cucumber plants in the field. Journal of Crop Protection, 3(4): 435-441.

Hosseini, S. M. 2001. Collect and Determine the Most Important Cotton Bugs and Study of their Biology and Damage. Khorasan Agricultural Research Center Publication. Project Final Report.

Hosseini, S. M., Bayat, A. H., Kamali, K., Shojai, M. and Ostovan, H. 2002. Study on bio-ecology of cotton shedder bug *Creontiades pallidus* Rambur (Het; Miridae) in cotton fields of Khorassan Iran. Iranian Journal of Agricultural Science, 8(2): 9-10.

Huang, G., Huang, J. Q., Chen, X. Y. and Zhu, Y. X. 2021. Recent advances and future perspectives in cotton research. Annual Review of Plant Biology, 72: 437-462.

Jafar,i A., Fathipour, Y., Hosseini, S. M., Talebi, A. A. and Moharamipour, S. 2006. Preference of *Nabis Capsiformis* and *Chrysopa carnea* to different nymph instars of *Creontiades pallidus*. Journal of Agriculture Science, 12(1): 57-65.

Khormali, S. and Darvish Mojeni, T. 2016. The effect of some insecticides on *Creontiades pallidus* in cotton fields of Gorgan and Gonbad-e Qabus. Iranian Journal of Cotton Researches, 3(2): 73-85.

Khormali, S. and Karimian, Z. 2010. Identification of harmful bugs of cotton farms of Golestan province. Electronic Journal of Cotton and Fiber Crops, 1(2): 59-67.

Musayev, D. M., Kholmatov, B. R., Sattarov, N. R., ugli Amirov, I. B. and Kodirberdiyevna, M. 2020. Cotton shredder bug *Creontiades pallidus* (Rambur, 1839) damage to cotton crop in Surkhandara region of South Uzbekistan. Eurasian Journal of Biosciences, 14: 4683-4687.

Sun, W., Shahrajabian, M. H., Khoshkharam, M., Shen, H. and Cheng, Q. 2020. Cultivation of cotton in China and Iran with considering biological activities and its health benefits. Cercetari Agronomice in Moldova, 1(181): 105-120.

Varghese, T. S. and Mathew, T. B. 2012. Evaluation of newer insecticides against chilli aphids and their effect on natural enemies. Pest Management in Horticultural Ecosystems, 18(1): 114-117.

اثر برخی آفت‌کش‌ها بر عملکرد پنبه، آثار خسارت و جمعیت سنک غوزه پنبه، *Creontiades pallidus* (Hemiptera; Miridae)، تحت شرایط مزرعه

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چکیده: سنک غوزه پنبه، *Creontiades pallidus* Rambur (Hemiptera; Miridae)، از مهم‌ترین آفات پنبه است و خسارت زیادی را به برگ‌ها و غوزه‌ها وارد می‌کند. در این پژوهش، اثر فرمولاسیون‌های تجاری فوزالون (PHO)، تیامتوکسام (THX)، تیامتوکسام + لامبدا-سای‌هالوترین (THX + LAM) و اسپیروتترامات (SPI) تحت شرایط مزرعه و در کرت‌های یکبار و دوبار سم‌پاشی شده بررسی شد. در کرت‌های یکبار سم‌پاشی شده، THX و THX + LAM بیش‌ترین تأثیر را در کاهش جمعیت *C. pallidus* و علایم خسارت آن (تعداد خال‌های سیاه روی غوزه و برگ پنبه و تعداد غنچه‌های ریزش کرده) تا ۴۹ روز در مقایسه با شاهد داشتند. این درحالی است که اثرات SPI و PHO موقتی بوده و پس از ۳۱ روز از بین رفتند. هنگامی‌که کرت‌ها بعد از ۳۰ روز برای مرتبه دوم سم‌پاشی شدند، تمامی آفت‌کش‌ها به‌صورت معنی‌داری باعث کاهش جمعیت آفت و علایم خسارت آن تا روز ۴۹ شدند. بیش‌ترین میزان عملکرد پنبه در کرت‌های یکبار سم‌پاشی شده با THX به‌دست آمد (۱۰/۶۱ ± ۳۲۳/۸ گرم پنبه در مترمربع)، درحالی‌که سم‌پاشی با SPI منجر به کم‌ترین عملکرد (۵/۱ ± ۲۷۵/۷ گرم پنبه در مترمربع) شد. در کرت‌های دوبار سم‌پاشی شده، تیمارهای THX، THX + LAM و PHO میزان عملکرد مشابهی را از لحاظ آماری نشان دادند. به‌طور کلی، نتایج این پژوهش THX و THX + LAM را به‌عنوان مؤثرترین آفت‌کش‌ها در کنترل جمعیت *C. pallidus* و علایم خسارت آن در پنبه توصیه می‌نماید.

واژگان کلیدی: *Creontiades pallidus*، پنبه، آفت‌کش‌ها، کنترل آفت پنبه، ریزش غنچه‌های پنبه