Available online at https://scilett-fsg.uitm.edu.my/

ISSN: 1675-7785
eISSN: 2682-8626

Science Letters 20(2) 2026, 120-127

Science Letters

Trap Based Monitoring of Rice Hoppers: A Tool for Precision Rice Pest Management

Suhaila Ab Hamid*, Ahmad Mustaqim Rahim

School of Biological Sciences, Universiti Sains Malaysia. 11800 USM. Penang. Malaysia.

ARTICLE INFO

Article history:
Received 25 November 2025
Revised 27 January 2026
Accepted 27 January 2026
Published 30 June 2026

Keywords:
bucket light trap
cicadellidae
delphacidae
sticky trap
sweep net

DOI: 10.24191/scl.v20i2.10391

ABSTRACT

Rice production faces significant losses due to the attack of insect pests such as rice stem borers, planthoppers and leaf folders. To maintain the sustainability of rice production, monitoring and controlling the rice hopper population must be done effectively. Spraying chemical pesticides of various types and concentrations is often done; however, the problem of rice hopper attacks remains uncontrolled. Before control measures are taken, monitoring of the rice hopper population needs to be carried out first. Common methods used by several research agencies to collect data are through manual pest population sampling. However, this method is laborious and provides insufficient data. Therefore, a study was conducted on this rice hopper population by using the bucket light traps and the manual population sampling method (sweep net and yellow sticky trap). The present study was conducted at the 6-acre rice plot in Seberang Perai, Penang, and the results of the study revealed a good correlation between the use of light traps and manual sampling. Both families of rice hoppers (family of Cicadellidae and Delphacidae) were found at all three stages of the rice plant (vegetative, reproductive and ripening). Family Delphacidae (planthoppers) was recorded more during the rice vegetative stage, while the cicadellids (leafhoppers) were recorded in greatest numbers during the rice ripening stage. Leafhoppers from the family of Cicadellidae were once a predominant pest but have become the dominant species in this study, having been caught in large numbers using sticky traps (66.5%), followed by light traps (29.5%) and sweep nets (3.96%). Of the three sampling methods, the sticky trap was the most efficient, collecting a greater number of hoppers overall, at all three rice stages. Sticky traps are suitable for collecting rice hopper insects as both rice hoppers (planthoppers and leafhoppers) are winged insects that actively fly between rice plants, making them easy to trap mid-air. Sticky traps play a crucial role in rice pest management because they help to assess the effectiveness of control strategies by monitoring hopper population dynamics.

* Corresponding author. *E-mail address*: mailto:ahsuhaila@usm.my

https://doi.org/10.24191/scl.v20i2.10391

INTRODUCTION

Rice is a staple food for more than half of the world's population, and ensuring its sustainable production is critical for food security. Among the biotic stresses affecting rice, insect pests are one of the most serious constraints. Rice hoppers, particularly the brown planthopper (*Nilaparvata lugens*) and green leafhoppers (*Nephotettix* spp.), are notorious for causing significant rice yield losses (Iamba et al., 2021). The rice hoppers damage the rice plants by direct feeding, leading to "hopperburn," (Tao et al., 2024) and indirectly by transmitting viral diseases such as tungro virus. Outbreaks of these pests have devastated rice fields across Asia (Dale et al., 2012; Wang et al., 2024), including Malaysia, causing economic losses and threatening farmer livelihoods. Traditional pest monitoring methods, such as visual observation, are often labour-intensive, subjective, and prone to inaccuracy. Spraying chemical pesticides is often done; however, the problem of rice hopper attacks remains uncontrolled (Tudi et al., 2021). Early management practices relied heavily on the extensive use of chemical insecticides due to their rapid knockdown effect and ease of application. However, repeated and indiscriminate insecticide applications have led to serious challenges, including insecticide resistance, pest resurgence, and negative impacts on natural enemies and the environment. In response to these limitations, alternative and integrated approaches have been introduced, including host plant resistance, biological control using predators and parasitoids, cultural practices, and integrated pest management (IPM) programs. These previous applications aimed to reduce dependency on chemical control while promoting sustainable rice production. Understanding the effectiveness and limitations of past brown planthopper control applications is essential for improving current management strategies and developing environmentally sound and economically viable solutions for long-term pest suppression. Farmers usually rely on visual field inspection, which often detects insect pests only after populations have reached damaging levels. By this stage, plants may already be stressed or showing hopperburn symptoms, making control less effective and more costly. Besides, many farmers apply insecticides according to a fixed spraying schedule rather than actual pest pressure. This leads to unnecessary applications even when insect pest populations are below economic threshold levels, increasing production costs. Therefore, before control measures are taken, monitoring of the rice hopper population needs to be carried out first. Common practices used by several research agencies for monitoring pest attacks are done through manual pest population sampling. However, this method is laborious and provides insufficient data.

To address this challenge, trap-based monitoring systems have emerged as promising tools for precision pest management. By providing reliable, real-time data on pest population dynamics, trap-based approaches enable early detection, better forecasting, and more targeted control strategies. Trap-based monitoring tools, such as light traps, and sticky traps, offer a practical alternative for detecting and quantifying rice hopper populations (Bashir et al., 2014). By reducing reliance on indiscriminate pesticide use, trap-based approaches align with integrated pest management (IPM) principles and support sustainable rice cultivation. Current monitoring of rice hoppers relies largely on field scouting and visual observation, which are often time-consuming, subjective, and inconsistent. Farmers may fail to detect population build-ups early enough, leading to delayed responses and heavy dependence on broad-spectrum chemical pesticides. This not only raises production costs but also contributes to pesticide resistance, environmental degradation, and loss of beneficial insects. There is a pressing need for more accurate, timely, and efficient pest monitoring systems to support precision rice pest management (Cardim et al., 2020). This project seeks to evaluate the effectiveness of trap-based monitoring as a decision-making tool for rice hopper management. The study generates knowledge that can help farmers and agricultural extension officers improve early detection, optimize control strategies, and minimize pesticide misuse. Ultimately, the adoption of trap-based monitoring could lead to higher rice yields, reduced production costs, and more environmentally responsible farming practices.

https://doi.org/10.24191/scl.v20i2.10391

MATERIALS AND METHODS

Study site

The study was conducted in a 6-acre paddy field located in Seberang Perai, Penang (5.479632, 100.405389), that was managed under conventional farming practices. Sampling was carried out throughout a single rice cultivation season from November 2023 to February 2024. The sampling period covered three major growth stages of rice, including vegetative, reproductive, and ripening stages.

Insect sampling

Rice hopper populations were sampled using three different methods including yellow sticky traps, bucket light traps, and sweep nets. Sampling was conducted twice during each of the rice growth stages to capture temporal variations in hopper abundance.

For the sticky trap method, the procedure followed the protocol outlined by Siregar et al. (2024). The paddy field was first divided into four subplots. In each subplot, four yellow sticky traps were installed by fixing them onto wooden poles at the canopy height of the rice plants (Figure 1A). The traps were left in the field for two consecutive days before being collected. Following exposure, the sticky traps were carefully removed, sealed in plastic covers, and transported to the laboratory for analysis.

Meanwhile, for the bucket light traps, the procedure followed the method described by Han & Hong (2025). Two bucket light traps were randomly deployed within the paddy field. The traps were set up at dusk and operated for three hours during each sampling event (Figure 1B). All insects captured in the collection buckets were transferred into labeled plastic bags and brought to the laboratory for further examination.

For sweep net sampling, sweep netting was conducted according to the standard protocol outlined by Nasiruddin & Roy (2012). A sweep was defined as a single 180° arc swing of the net through the rice canopy (Figure 1C). Each replicate consisted of ten random sweeps, and ten replicates were performed per sampling occasion. The collected specimens were placed in plastic containers and transported to the laboratory for analysis.

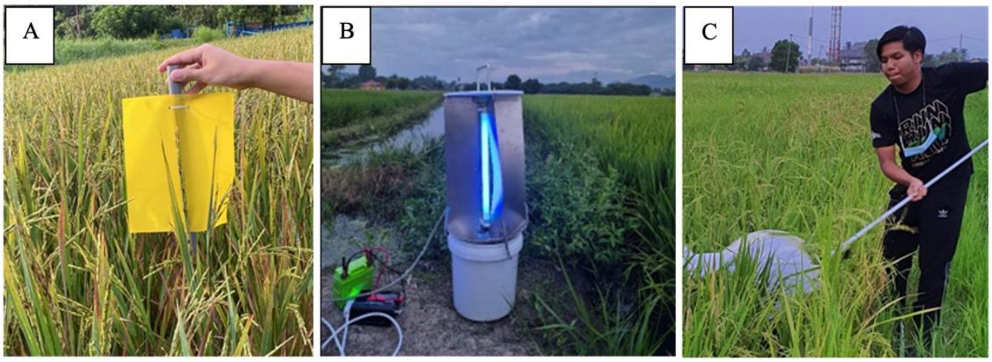

Fig. 1. The sampling methods used for this study: (A) sticky trap, (B) bucket light traps, and (C) sweep net.

https://doi.org/10.24191/scl.v20i2.10391

Rice hopper identification

In the laboratory, all collected insects were sorted, and only hoppers belonging to the families Delphacidae and Cicadellidae were considered for this study. Identification was carried out to the family level using standard taxonomic keys provided by Johnson & Triplehorn (2004).

RESULTS

Both families of rice hoppers (Delphacidae and Cicadellidae) were recorded across all three rice growth stages (Figure 2). However, the abundance of hoppers differed between growth stages and families. During the vegetative stage, family of Delphacidae was more abundant, with 233 individuals recorded compared to 115 individuals of cicadellids. In contrast, during the ripening stage, cicadellids were dominant with 434 individuals, while delphacids were much lower in abundance, with only 86 individuals recorded.

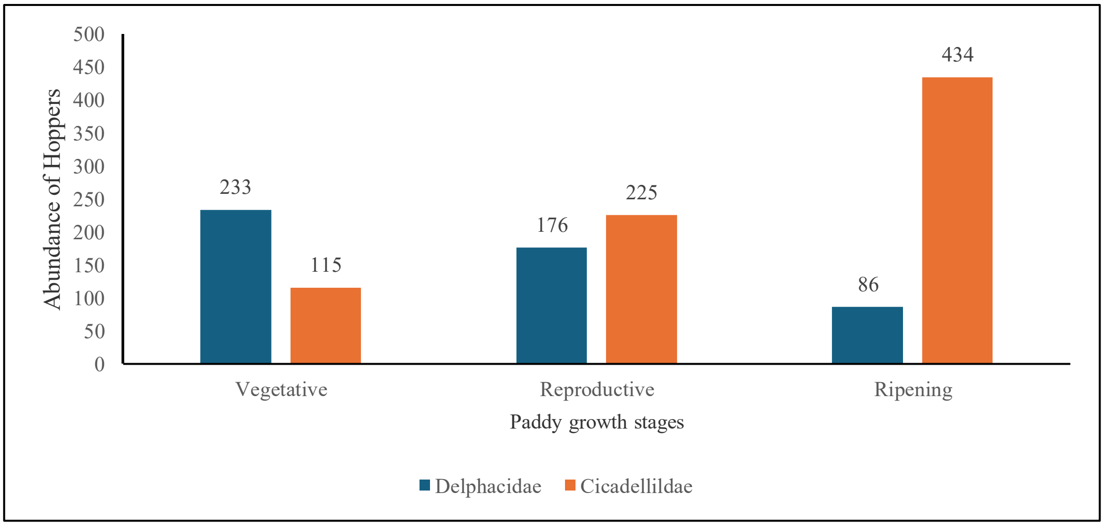

Fig. 2. Abundance of hoppers (family of Delphacidae and Cicadellidae) on each paddy growth stage.

The abundance of rice hoppers varied among the three sampling methods used (Figure 3). Sticky traps recorded the highest number of hoppers overall, followed by light traps, while sweep nets captured the least. A total of 521 individuals of the family Cicadellidae and 262 individuals of the family Delphacidae were collected using sticky traps, representing the most effective method across both families. Light traps captured comparatively fewer individuals, with 231 individuals of cicadellids and 206 individuals of delphacids. Sweep net was the least effective, yielding only 31 and 27 individuals of Cicadellidae and Delphacidae families, respectively.

For the family of Cicadellidae, sticky traps accounted for 66.5% of the total catch, followed by the light traps (29.5%) and sweep nets (3.9%). Similarly, for delphacids, sticky traps contributed the highest proportion of captures, followed by light traps, with sweep nets again contributing minimally. Overall, the sticky trap proved to be the most efficient sampling method for monitoring rice hoppers across all rice growth stages, consistently collecting higher numbers of individuals compared to the other methods.

https://doi.org/10.24191/scl.v20i2.10391

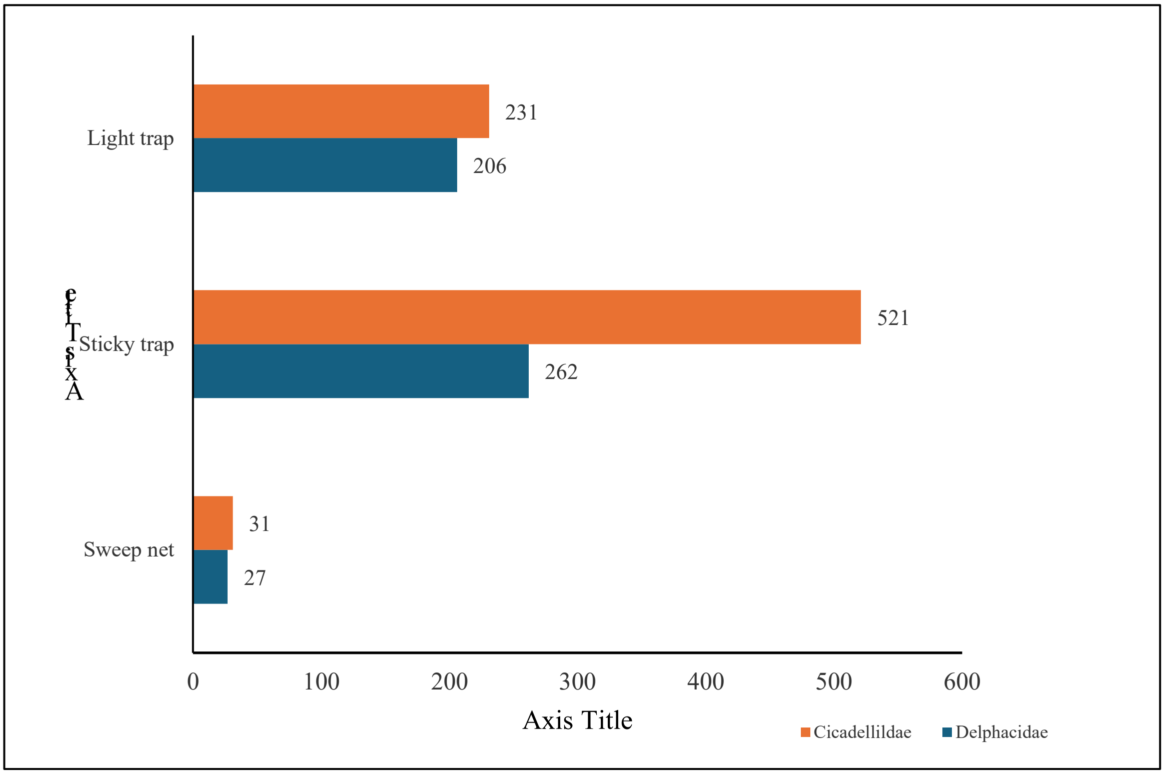

Fig. 3. Abundance of hoppers (family of Delphacidae and Cicadellidae) for each sampling method.

DISCUSSION

The monitoring and management of rice hopper populations are critical in ensuring sustainable rice production, as these pests, particularly brown planthopper (family of Delphacidae) and green leafhopper (family of Cicadellidae), pose serious threats to crop health and yield. In this study, three different methods; light trap, sticky trap, and sweep net were evaluated to determine their effectiveness in assessing the abundance of rice hopper populations in rice fields. Among the tested methods, sticky traps demonstrated the highest effectiveness in capturing rice hoppers. The findings are consistent with those reported by Atta et al. (2024). The high capture rate observed with sticky traps can be attributed to their passive and continuous nature of trapping. Sticky traps remain suitable to be used throughout the day and night, providing a consistent sampling effort without human intervention. Visual attraction, especially with yellow coloration commonly used in insect sticky traps, is highly effective (Roberts et al., 2025) for attracting rice hoppers. Yellow coloration is highly effective at attracting many insects to sticky traps because it mimics cues found in flowers and young shoots (Allan et al., 2020), which many insects use to locate food and host plants. According to Lunau et al. (2024), flowers with center yellow features that serve as floral guides and flower visitors reacting to these signals make up the most specialised mimicry system in the world. Yellow light reflects on wavelengths that are particularly noticeable to insect photoreceptors, effectively capturing their attention. In addition, the adhesive surface ensures that once the hoppers make contact, they are unable to escape, leading to a higher count and more accurate estimation of population density.

https://doi.org/10.24191/scl.v20i2.10391

The light trap ranked second in effectiveness. Light trap is known to attract phototactic insects during dusk and nighttime (Kardinan & Maris 2020) and is particularly efficient at drawing adult rice hoppers that are active during those periods. While light traps are useful for monitoring flying adult populations, their effectiveness is influenced by several environmental factors such as moonlight intensity, weather conditions and surrounding light sources.

On the other hand, the sweep net method proved to be the least effective among the three. This may be due to its reliance on manual operation and the skill of the operator, leading to potential variability in results. Sweep netting is also time-bound and only captures insects that are present and active during the sampling period. Moreover, rice hoppers that remain in concealed or lower parts of the rice plant canopy may escape detection through sweep netting.

Rice hoppers from the family of Delphacidae occur in high abundance during the rice vegetative stage, which spans from germination to initiation of panicle development, offers an ideal environment for the proliferation of delphacids. During the vegetative stage, rice plants are rich in young, tender tissues and high nitrogen content (Gu & Yang, 2022), which is highly attractive and nutritious to rice hoppers. The soft plant tissue makes it easier for hoppers to insert their stylets and feed efficiently on phloem sap (Shi et al., 2021). Delphacids hoppers, particularly the brown planthopper (*Nilaparva lugens*), exhibit rapid life cycles and high fecundity under suitable conditions (Namirtha et al., 2026). According to Mohapatra et al (2025), the favourable host quality during the rice vegetative stage supports faster development and higher egg-laying rates of delphacids.

CONCLUSION

Trap-based monitoring proved to be an effective approach for assessing rice hopper populations in the paddy ecosystem. Among the methods tested, sticky traps and light traps consistently recorded higher numbers of hoppers compared to sweep nets, highlighting their reliability as monitoring tools. Incorporating these traps into regular pest surveillance can strengthen Integrated Pest Management (IPM) programs by providing accurate data for early detection and timely intervention. Such approaches reduce reliance on indiscriminate pesticide use, thereby supporting sustainable and environmentally friendly rice farming practices while safeguarding crop productivity.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support of Universiti Sains Malaysia (USM) and staff at the School of Biological Sciences for providing the facilities and physical support for this research.

CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

SAH conceptualized the research idea, provided the theoretical framework, designed the study, supervised the research progress, contributed to the writing, and revised the manuscript. AMR conducted the field experiments, performed data collection and analysis, and prepared the draft of the manuscript. Both authors read and approved the final version of the manuscript.

https://doi.org/10.24191/scl.v20i2.10391

REFERENCES

Allan, S. A., George, J., Stelinski, L. L., & Lapointe, S. L. (2020). Attributes of Yellow Traps Affecting Attraction of *Diaphorina citri* (Hemiptera: Liviidae). *Insects*, 11(7), 452. https://doi.org/10.3390/insects11070452

Atta, B, Sabir, A.M, Ayub, M.A, Saleem, M.U, Nisar, M.J. (2024). Technology Development for Optimal Trap Colors and Density Assessment against Rice Planthoppers. *Universal Journal of Agricultural Research*, 12(6), 666 - 678. https://doi.org/10.13189/ujar.2024.120603

Bashir, M.A, Alvi, A.M, Naz, H. (2014). Effectiveness of sticky traps in monitoring insects. *Journal of Environmental and Agricultural Sciences*, 1(5).

Cardim, F.LM., Damascena de, A.L., M. E., Valero, C., Pereira Coronel, L. C., & Gonçalves, B.C.O. (2020). Automatic Detection and Monitoring of Insect Pests—A Review. *Agriculture*, 10(5), 161. https://doi.org/10.3390/agriculture10050161

Dale, G., B. & Kenneth, G., S. (2012). Resurrecting the ghost of green revolutions past: The brown planthopper as a recurring threat to high-yielding rice production in tropical Asia. *Journal of Asia-Pacific Entomology*, 15(1), 122-140. https://doi.org/10.1016/j.aspen.2011.09.004

Gu, J. & Yang, J. (2022). Nitrogen (N) transformation in paddy rice field: Its effect on N uptake and relation to improved N management. *Crop and Environment*, 1, 7-14. https://doi.org/10.1016/j.crope.2022.03.003

Han, Y. & Hong, E. J. (2025). Efficiency of Bucket Light Traps with Different Light Sources for the National Ecosystem Survey of Korea. *Proceedings of the National Institute of Ecology of the Republic of Korea*, 6(2), 74-83, https://doi.org/10.22920/PNIE.2025.6.2.74

Iamba, K. & Dono, D. (2021). A Review on Brown Planthopper (*Nilaparvata lugens*), a Major Pest of Rice in Asia and Pacific. *Asian Journal of Research in Crop Science,* 6(4), 7-19. https://doi.org/10.9734/ajrcs/2021/v6i430122

Johnson, N., & Triplehorn, C.A. (2004). *Borror and DeLong's introduction to the study of insects* (7th ed.). Brooks/Cole.

Kardinan, A. & Maris, P. (2020). Response of Insects to the Light and Coloured Sticky Traps. Proceedings of the International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020). *Advances in Biological Sciences Research, 13*,1-7. https://doi.org/10.2991/absr.k.210609.001

Lunau, K., De Camargo, M.G.G. & Brito, V.L.G. (2024), Pollen, anther, stamen, and androecium mimicry. Plant Biology Journal, 26, 349-368. https://doi.org/10.1111/plb.13628

Mohapatra, P.K., Sarkar, R.K., Panda, D., & Kariali, E. (2025). Staging of Rice Plant Growth and Development. In: *Tillering Behavior of Rice Plant*. Springer, Singapore. https://doi.org/10.1007/978-981-97-5235-5_4

Namirtha, A.P., Vairam, N., Mavilashaw, V.P., Thamizharasu, T. & Murugan, N. (2026). Brown Planthopper, *Nilaparvata lugens* (Stål, 1854): Biology, Ecology, Outbreak History and Integrated Management in Rice Ecosystems. *Journal of Advances in Biology & Biotechnology,* 29 (4), 254-62. https://doi.org/10.9734/jabb/2026/v29i43787.

Nasiruddin, M., & Roy, R. C. (2012). Rice Field Insect Pests During the Rice Growing Seasons in Two

https://doi.org/10.24191/scl.v20i2.10391

Areas of Hathazari, Chittagong. *Bangladesh Journal of Zoology*, 40(1), 89–100. https://doi.org/10.3329/bjz.v40i1.12898

Roberts, N.S., Ndayiragije, J.C., Özek, T., Butt, M., T, Karaca, I., Shah F., & Allen, W.L. (2025). Visual modelling can optimise sticky trap design for simultaneous monitoring of multiple species of insect pests. *Scientific Reports,* 15, 17280.

Shi, S., Wang, H., Nie1, L., Tan, D., Zhou, C., Zhang, Q., Li, Y., Du, B., Guo, J., Huang, J., Wu, D., Zheng, X., Guan, W., Shan, J., Zhu, L., Chen, R., Xue, L., Walling, L.L.& He, G. (2021). *Bph30* confers resistance to brown planthopper by fortifying sclerenchyma in rice leaf sheaths. *Molecular Plant*, 14, 1714-1732. https://doi.org/10.1016/j.molp.2021.07.004

Siregar, A. Z., Herwina, H., & Trisnawati, I. (2024). Monitoring Insect Diversity with a Variety of Traps in Rice Plantations Supports Food Security. *Universal Journal of Agricultural Research*, *12*(1), 1–12. https://doi.org/10.13189/ujar.2024.120101

Tao, Z., Zhu, L., Li, H. Bo, S., Xue, L., Dayong, L., Wenli, H., Shanshan, W., Xuexia M. & Zhenying, S. (2024) ACL1-ROC4/5 complex reveals a common mechanism in rice response to brown planthopper infestation and drought. *Nature Communication,* 15, 8107. https://doi.org/10.1038/s41467-024-52436-w

Tudi, M, Daniel, R.H, Wang, L., Lyu, J., Sadler, R., Connell, D., Chu, C., & Phung, D.T. (2021). Agriculture Development, Pesticide Application and Its Impact on the Environment. *International Journal of Environmental and Research Public Health*, 18(3), 1112. https://doi.org/10.3390/ijerph18031112

Wang, X., Wang, Y., Yang, H., Liu, F., Cai, Y., Xiao, J., Fu, Q., & Wan, P. (2024). Integrative Omics Strategies for Understanding and Combating Brown Planthopper Virulence in Rice Production: A Review. *International Journal of Molecular Sciences*, *25*(20), 10981. https://doi.org/10.3390/ijms252010981

https://doi.org/10.24191/scl.v20i2.10391