



Effect of an Ecdysteroid Agonist on *Erionota thrax* (Banana Skipper)

Dr. Thanuja A Mathew

Department of Zoology, Little Flower College (Autonomous) Guruvayur, Kerala, India

Received:- 10 March 2026/ Revised:- 16 March 2026/ Accepted:- 27 March 2026/ Published: 05-04-2026

Copyright © 2026 International Journal of Environmental and Agriculture Research

This is an Open-Access article distributed under the terms of the Creative Commons Attribution

Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0>) which permits unrestricted

Non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract— *Erionota thrax* (Banana Skipper) is an important lepidopteran pest under the HesperIIDae family causing considerable yield loss of banana. In the present investigation, the potential of methoxyfenozide, which is an important Insect Growth Regulator (IGR) mimicking ecdysteroid hormone, has been evaluated. IGRs generally interfere with metamorphosis or reproduction of insects. IGRs have a tremendous role as third-generation pesticides and are also used as probes to elucidate the role of hormones in basic insect physiology. The efficacy of IGRs provides new strategies in Integrated Pest Management (IPM) Programmes. In the present study, methoxyfenozide treatments produced defective moulting, sclerotization of the cuticle, prolapse of the rectum, and lethality in the larvae of Banana Skipper.

Keywords— IGRs, Integrated Pest Management, Metamorphosis, Moulting, Sclerotization, Rectal Prolapse.

I. INTRODUCTION

Manipulating natural hormone levels in insects will interfere with hormone-dependent functions such as reproduction and morphogenesis. This idea has led to the development of numerous artificial insect hormone mimics known as Insect Growth Regulators (IGRs). By directly affecting the metabolism of endogenous ecdysteroids, synthetic ecdysteroids and their analogues/agonists have demonstrated efficacy in interfering with the larval moulting process.

One of the important pesticides to use in Integrated Pest Management (IPM) programs is methoxyfenozide, a synthetic environment-safe ecdysteroid agonist. According to studies by Carlson et al. (2001) and Retnakaran et al. (2001), methoxyfenozide causes an early, fatal moult by imitating natural ecdysone. *Spodoptera littoralis* has been shown to exhibit insecticidal activity when methoxyfenozide and spinetoram are combined (Fatma et al., 2022). Methoxyfenozide's ovicidal activity and overall superior efficacy at lower doses against a wide spectrum of lepidopteran pests have been reported. Methoxyfenozide has been shown to disrupt hormones in *Musca domestica* (El-Shewy et al., 2024).

Banana skipper (*Erionota thrax*) belongs to the HesperIIDae family and was first discovered in Hawaii (Davis and Kawamura, 1975). The larvae infest cultivated and wild bananas (Musaceae). The larvae cause damage to banana plants by feeding and rolling up the leaves. Due to this behaviour, they are also called banana leaf roller or palm red-eye. The caterpillars can damage 60% of the plant leaf area. Leaf damage lowers banana yields due to delayed fruit maturity and reduced bunch size.

The present study was undertaken to evaluate the effect of methoxyfenozide, an ecdysteroid agonist, on the larvae of *Erionota thrax* under laboratory conditions.

II. MATERIALS AND METHODS

2.1 Collection and Maintenance of Larvae:

About sixty larvae of *Erionota thrax* were collected from an infested banana plant from Ponnani, Kerala, India. The larvae were closely examined under a Magnus Binocular Stereo Zoom dissection microscope and their morphological features were studied. Forty developmentally synchronous fourth-instar larvae were segregated and were divided into three experimental sets of ten larvae each and one control set of ten larvae. Three larvae from the third experimental set were discarded as they skipped the treatment. Each set of larvae was kept in separate culture bottles and was maintained on fresh banana leaves regularly.

2.2 Methoxyfenozide Treatment:

Methoxyfenozide was obtained as a research sample and its different concentrations like 0.02 mg/0.02 mL, 0.2 mg/0.02 mL, and 0.4 mg/0.04 mL were prepared in distilled water and were topically applied on the experimental larvae, respectively. The control larvae were applied with 0.04 mL of distilled water only. The day of the treatment was considered as day 0 and successive days were counted as day 1, day 2, and so on. All sets of larvae were keenly observed on each post-treatment day for mortality, moulting abnormalities, cuticle changes, and other morphological alterations. Mortality was recorded when larvae showed no response to gentle probing.

2.3 Observations:

Observations were recorded daily for all treated and control larvae. Parameters recorded included mortality, feeding activity, moulting behaviour, cuticle coloration, and presence of rectal prolapse.

III. RESULTS

3.1 Effect of 0.02 mg/0.02 mL Methoxyfenozide:

On day 1 of treatment, no mortality was observed among the treated and control larvae. On day 2 of the treatment, 10% mortality (1 out of 10 larvae) was observed among the treated larvae. Lethal moulting was exhibited by the dead larvae. The rest of the larvae did not take food and they showed prolapse of the rectum. By day 3, 100% mortality (10 out of 10 larvae) was observed among the treated larvae. The colour of the cuticle changed to dark brown in all the dead larvae. The control larvae appeared normal and showed no mortality throughout the observation period.

3.2 Effect of 0.2 mg/0.02 mL Methoxyfenozide:

On day 1, 10% mortality (1 out of 10 larvae) was observed among the treated larvae. The remaining larvae appeared less active and they all showed symptoms of precocious moulting, and their bodies were slightly shrunken. On day 2, 20% mortality (2 out of 10 larvae) was observed among the treated larvae. On day 3, 60% mortality (6 out of 10 larvae) was observed among the treated larvae. The remaining larvae appeared less active and were not feeding. They showed prolapse of the rectum also. In some larvae, darkening of the cuticle was noted on the mid-dorsal body with exudation of fluid. By day 4, 100% mortality (10 out of 10 larvae) was observed among the treated larvae. The control larvae appeared normal and no mortality was observed among them.

3.3 Effect of 0.4 mg/0.04 mL Methoxyfenozide:

On day 1, the larvae became less active. On day 2, 28.57% mortality (2 out of 7 larvae) was observed among the treated larvae. The colour of the cuticle changed to dark brown in the dead larvae. The remaining larvae were not feeding at all and showed prolapse of the rectum. On day 3, 85.71% mortality (6 out of 7 larvae) was observed and they showed dark-coloured cuticle. The remaining larvae were inactive and showed prolapse of the rectum also. By day 4, 100% mortality (7 out of 7

larvae) was observed among the treated larvae. The colour of the cuticle changed to dark brown in all the dead larvae. The control larvae were alive and appeared normal.



FIGURE 1: *Erionota thrax* larvae showing darkening of cuticle after methoxyfenozide treatment (0.2 mg/0.02 mL) on day 2.



FIGURE 2: *Erionota thrax* larvae showing dark cuticle and rectal prolapse after methoxyfenozide treatment (0.4 mg/0.04 mL) on day 2.



FIGURE 3: Control *Erionota thrax* larva appearing normal.

IV. DISCUSSION

Early studies show that methoxyfenozide treatments have a prolonged effect and produce progressive mortality on post-treatment days in *Aphidius colemani*, *Aphidoletes aphidimyza*, and *Neoseiulus cucumeris* (Stara et al., 2011) and in *Spodoptera frugiperda* (Zarate et al., 2011). In the present investigation, the occurrence of mortality was also progressive on post-treatment days. In the third experimental set, though the larvae received a high concentration of methoxyfenozide (0.4 mg/0.04 mL), the larvae did not show any mortality on day 1. The delayed effect of mortality in the 0.4 mg/0.04 mL treatment is assumed to be due to the delayed absorption of methoxyfenozide into the body of the larvae, as double the volume (0.04 mL) of the solvent was used to administer the agonist.

In the present investigation, topical application of methoxyfenozide is thought to impair moulting and cause sclerotization of the cuticle. The larvae could not shed their old cuticle completely, and it was found beneath the partially formed new cuticle, as reported by Darvas et al. (1998) in *Aedes aegypti*. Kumar and Santharam (2008) have reported that when methoxyfenozide gets absorbed into the haemolymph, it would bind to the ecdysone receptor and the moulting process is initiated. If this normal process is disrupted, the insects may not be able to shed their old cuticle, which would eventually lead to their death.

It is assumed that methoxyfenozide treatment would have produced an excess of ecdysteroid titer, interfering with the enzymatic activity and digestion of the procuticle. This might be the reason why the complete shedding of the old cuticle did not take place in treated larvae.

In the present study, another important finding is prolapse of the rectum in the treated larvae. Rectal prolapse by methoxyfenozide treatments has been reported (Carton et al., 2003). Cuticular deposition of pigment has been reported in *Aedes aegypti* (Sanjay et al., 2025). In the present study also, methoxyfenozide treatment caused dark cuticle and rectal prolapse in treated larvae.

The concentration-dependent effects observed in this study suggest that higher concentrations of methoxyfenozide lead to more rapid mortality and more pronounced morphological abnormalities. The progressive mortality observed across all treatment groups indicates that the compound has a sustained effect on larval physiology, consistent with its mode of action as an ecdysteroid agonist.

V. CONCLUSION

In the present investigation, methoxyfenozide treatment disrupted the normal moulting process of the banana skipper (*Erionota thrax*). It also caused mortality, sclerotization of the cuticle and rectal prolapse. The results demonstrate the potential of methoxyfenozide as an effective insect growth regulator for the management of banana skipper larvae. Further studies with larger sample sizes, replicated experiments, and field trials are warranted to validate these findings and establish optimal dosage for practical pest management applications.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to the institutional facilities and support provided for carrying out this research work.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper

REFERENCES

- [1] BenchChem. (2025). *Tebufenozide vs. methoxyfenozide: A comparative guide to insect control efficacy*. Retrieved March 30, 2026, from <https://www.benchchem.com/product/b1682728#tebufenozide-vs-methoxyfenozide-forinsect-control-efficacy>
- [2] Carlson, G. R., Dhadialla, T. S., Hunter, R., Jansson, R. K., Jany, C. S., Lidert, Z., & Slawicki, R. A. (2001). The chemical and biological properties of methoxyfenozide, a new insecticidal ecdysteroid agonist. *Pest Management Science*, 57(2), 115–119.
- [3] Carton, B., Smagghe, G., Mourad, A. K., & Tirry, L. (1998). Effects of RH-2485 on larvae and pupae of *Spodoptera exigua* (Hubner). *Proceedings of the 50th International Symposium on Crop Protection*, 63(2b), 537–545.
- [4] Carton, B., Smagghe, G., & Tirry, L. (2003). Toxicity of two ecdysone agonists, halofenozide and methoxyfenozide, against the multicoloured Asian lady beetle *Harmonia axyridis* (Col., Coccinellidae). *Journal of Applied Entomology*, 127(4), 240–242.
- [5] Darvas, B., Pap, L., Kelemen, M., & Polgar, L. A. (1998). Synergistic effects of verbutin with dibenzoylhydrazine-type ecdysteroid agonists on larvae of *Aedes aegypti* (Diptera: Culicidae). *Journal of Economic Entomology*, 91(6), 1260–1264.
- [6] Davis, C. J., & Kawamura, K. (1975). Notes and exhibitions: *Erionota thrax* L. *Proceedings of the Hawaiian Entomological Society*, 22(1), 21.
- [7] El-Shewy, A. M., Hamouda, S. S. A., Gharib, A. M., & Gad, H. A. (2024). Potential of insect growth regulators for the control of *Musca domestica* (Diptera: Muscidae) with respect to their biochemical and histological effects. *Journal of Basic and Applied Zoology*, 85(1), Article 43.
- [8] Fatma, S. A., Yasser, S. H., & Walid, S. H. (2022). Toxicity and biochemical impact of methoxyfenozide/spinetoram mixture on susceptible and methoxyfenozide-selected strains of *Spodoptera littoralis* (Lepidoptera: Noctuidae). *Scientific Reports*, 12, Article 6974.
- [9] Kumar, K., & Santharam, G. (2008). Toxicity of RH-2485 (Methoxyfenozide 20F) against *Helicoverpa armigera* (Hub.). *Journal of Biopesticides*, 1(2), 199–200.
- [10] Retnakaran, A., Gelbic, I., Sundaram, M., Tomkins, W., Ladd, T., Primavera, M., Feng, Q., Arif, B., Palli, R., & Krell, P. (2001). Mode of action of ecdysone agonist tebufenozide (RH 5992) and an exclusion mechanism to explain resistance to it. *Pest Management Science*, 57(10), 951–957.
- [11] Retnakaran, A., MacDonald, J. A., Tomkins, W. L., Davis, C. N., Brownwright, A. J., & Palli, S. R. (1997). Ultrastructural effects of a non-steroidal ecdysone agonist, RH-5992, on the sixth instar larva of the spruce budworm, *Choristoneura fumiferana*. *Journal of Insect Physiology*, 43(1), 55–68.
- [12] Riddiford, L. M. (1994). Cellular and molecular actions of juvenile hormone I. General considerations and premetamorphic actions. *Advances in Insect Physiology*, 24, 213–274.

- [13] Stará, J., Ouredníčková, J., & Kocourek, F. (2011). Laboratory evaluation of the side effects of insecticides on *Aphidius colemani* (Hymenoptera: Aphidiidae), *Aphidoletes aphidimyza* (Diptera: Cecidomyiidae), and *Neoseiulus cucumeris* (Acari: Phytoseiidae). *Journal of Pest Science*, 84(1), 25–31.
- [14] Sanjay, K., Roopa, R. S., Manu, S., Sarita, K., & Arvind, K. S. (2025). Methoxyfenozide as a potent insect growth regulator: Disruption of growth, development and chitin synthesis in *Aedes aegypti* for sustainable vector control. *Journal of Applied and Natural Science*, 17(2), 951–960.
- [15] Truman, J. W., Rountree, D. B., & Reiss, S. E. (1983). Ecdysteroids regulate the release and action of eclosion hormone in the tobacco hornworm, *Manduca sexta* (L.). *Journal of Insect Physiology*, 29(12), 895–900.
- [16] Zárate, N., Díaz, O., Martínez, A. M., Figueroa, J. I., Schneider, M. I., Smaghe, G., Viñuela, E., Budia, F., & Pineda, S. (2011). Lethal and sublethal effects of methoxyfenozide on the development, survival and reproduction of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae). *Neotropical Entomology*, 40(1), 129–137.
- [17] Žitňanová, I., Adams, M. E., & Žitňan, D. (2001). Dual ecdysteroid action on the epitracheal glands and central nervous system preceding ecdysis of *Manduca sexta*. *Journal of Experimental Biology*, 204(20), 3483–3495.