# Effect of Pyriproxyfen against Dipterans as a Growth Regulator

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**Abstract:**
*Class Insecta is a large group of the Arthropoda Phylum. Insects cause significant harm to humans and its associated concerns. Insects are capable of increasing their population at a faster rate which is an important concern. As many harmful pests can explode their population in a very short span of time, which in turn may cause diseases and other damages. Thus, the analysis of this issue in a view of using insect growth regulators, mainly Juvenile Hormone Analogs is a needed work. Insect growth regulators (IGRs) are the target specific chemical compounds which when used against insects in appropriate concentration can control their reproductive functions. Order Diptera include two-winged flies having sucking type of mouth parts. These can be a serious pest for humans and animals. As these causes Malaria, Dengue, Yellow fever, Typhoid, Cholera like diseases, it is important to study how to control their reproductive capability. In this review, the analysis of use of Pyriproxyfen, a juvenoid against Dipterans as its growth regulator is to be done.*

**Keywords:** *Pyriproxyfen, Juvenoid, Dipterans, growth regulator*

## 1. Introduction

IGRs is the term used for the chemical compounds which have the growth regulating properties, which act by regulating or inhibiting many biochemical pathways of insects and are species specific. IGRs is classified into some categories, Juvenile hormone analogs (JHAs) is one of them. JHAs are the potential biorational chemical alternatives used in regulating growth of insects.

One such JHA is a Pyriproxyfen, a 4-phenoxyphenoxy compound which has been tested for its growth regulating property against many insects including Dipterans. The need for the use of Pyriproxyfen against Dipterans is because these include species like Anopheles sp., Aedes sp., Culex sp., Stomoxys sp., etc. which cause harmful diseases like Dengue, Malaria, Typhoid, and yellow fever, etc.

The characteristic of the efficacy of Pyriproxyfen is that these do not result in rapid mortality of the treated larvae. The treating compound may enter into the insect body either through the cuticle or by digestion or by both pathways. These show their growth regulating properties in the pupal stage where pupae die and if they do survive during pupa stage, they will die during adult stage.

## 2. Role of Juvenile hormone in the development of insects

The chemical nature of JH is a sesquiterpenoid structure which is a methyl ester of epoxy farnesoic acid.

Insects follow some stages in their growth and development. Starts from egg→larva→ pupa→Adult. These stages include moulting and metamorphosis processes with the help of respective hormones. Different levels of Juvenile hormone results in different stages in insect development. If the level of JH is high, larval moults take place. JH is assigned a status quo hormone in 1934 by Wigglesworth as it hinders the mechanism of metamorphosis which causes immature insects to remain in their larval or nymphal forms.

The molecular action of JH is thought to be mediated by both membrane as well as intracellular receptors. Membrane basis of action has been reported for the ovarian follicle cells of Rhodnius prolixus. Intracellular basis of action of JH has been reported in the fat bodies of Locusta migratoria. The proper molecular mechanism of action of JH is not yet fully understood.

**3. Insect growth regulators (IGRs)**

This term is also referred to as "insect hormone mimics" as these mimic the functions of insect hormones as of Juvenile hormone. IGRs term was first used by Schneiderman in 1972. "Insect growth disruptors" term seemed more germane to use for these substances by Pener and Dhadialla (2012).

These are the substances which show negative effects and suppress the normal growth and development of insects. IGRs have target specific activity, i.e, these don't show their effect on non-target species. In 1956, the first-time prospective use of IGRs was done, when topical application of JH, which was extracted from the abdominal of the male Hyalophora cecropia, shows prevention of metamorphosis and multiplication of the moth. This finding was possible after the discovery of the "paper factor" in 1965.

Insect growth regulators can be classified into some categories - Chitin synthesis inhibitors, juvenile hormone analogs or mimics, moulting hormone analog, etc.

**4. Juvenile Hormone Analog**

Juvenile hormone is an insect hormone secreted from the gland- Corpora Allata and is insect specific substance. Because of its specificity, it was first suggested by Williams that it would be of use in controlling specific pests. Since then, many synthetic compounds or analogs have been tested for the activity of JH against many insect species. Carrol Williams (1967) suggested the term "Third-generation insecticide" for juvenoids.

Various chemical classes of carbamates, amides, terpenoids and oxime ethers have been shown to possess JH- like activity (George et al., 1989). In recent times, many more JH-like terpenoid compounds are being synthesised by changing their chemical structures and tested against insects for the broad-spectrum action.

After the suggestion of Williams on use of JH to control pests, various agrochemical industries made attempts to discover a large number of new acyclic or alicyclic juvenoids. Of the first discovered analogs, Methoprene showed high efficacy in laboratory and field testing. Due to its low activity against agricultural pests, the use of Methoprene was restricted to household pests. Some structural alterations in slow acting and less potent analogs results in more potent compounds such as incorporation of 4-phenoxyphenol group into the juvenoid molecule results in the first such compound, i.e, Fenoxycarb. It was the first substance used against agricultural pests. It was followed by the discovery and use of Pyriproxyfen, a juvenoid. The effectiveness of analogs depends on their time of application against insects or can say there is always some critical period in showing their effect. For instance, JH is not capable of disturbing the formation of new cuticle in Rhodnius prolixus when applied after the sixteenth day after the feeding (Wigglesworth et al.,1940)

**5. Insecticidal activity of juvenile hormone analogs**

JH analogs show its effect on morphogenesis, embryogenesis, diapause, and reproduction processes. Some analogs show higher morphogenetic activity than the natural hormone. Stereochemical suitability, greater metabolic stability, ease of penetration, differences in the ability to induce enzymes that metabolize JH compounds can be the reasons for having higher morphogenetic activity.

JHAs are sensitive to freshly deciduous larval instars, pupal instars and deposited eggs. The sensitivity of last instar larvae to JHAs is between the JH disappearance and before the appearance of small amounts of ecdysteroid. When pupae are treated with JHAs, no normal adults develop. JHAs are not

capable of interfering with the growth and development of adult phase insects. (Retnakaran et al. 1985) suggested that some species of insects which are in adult stage may become sterile after the treatment with JHAs.

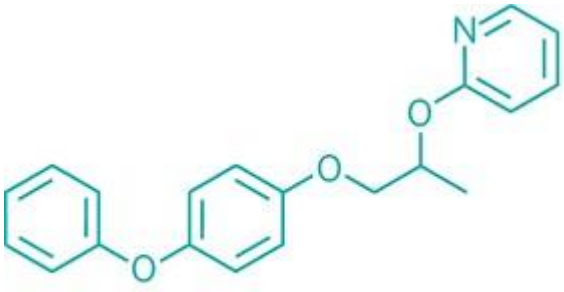
As JH binds to its binding proteins to prevent enzymatic metabolism and non-specific adsorption to various tissues, JHAs must bind to carrier proteins in the hemolymph to show its insecticidal activity. The insecticidal efficiency depends on the application dose, timing, duration. The application of JHAs after pupal commitment in Manduca sexta shows no effect on the morphological changes.

**6. A synthetic juvenile hormone analog, Pyriproxyfen (PPF)**

Pyriproxyfen is a 4-phenoxyphenoxy compound having a pyridyl structure, which was discovered in the early 1990s by the agrochemical industries in an attempt to discover more potent insecticide and which has the capability to show its effect against various insect species. (Hatakoshi et al. 2012) assigned this juvenoid as most potent for use. The World Health Organisation in 2001 also recommended the use of pyriproxyfen in controlling some mosquito species. Pyriproxyfen has been tested for the insecticidal use against many insect species including mosquitoes, ants and cockroaches, flies. Its toxicity affects embryonic, last larval, or reproductive stages of pests which are relatively insensitive to conventionally used insecticides.

(Ghasemi et.al, 2010) reported the controlling capability of pyriproxyfen against Indian meal moth, P. interpunctella. (Kavallieratos et.al,2012) observed the adult death of both the tested species, P. truncatus and R. dominica. Also, Pyriproxyfen showed its effect on the progeny production which got reduced by 90% and 100% respectively, in these species. Besides the larvicidal activity of pyriproxyfen, it also shows capability of decreasing fertility and fecundity of adult Aedes sp. of mosquito, when exposed sublethally.

Many compounds were discovered by the combination of compounds with pyriproxyfen to control veterinary pests, crop pests, phytophagous mites and vectors. (Stara et.al, 2011b) found the more or less susceptibility of storage mites against the combination of acaricide + pyriproxyfen + permethrin + benzoyl benzoate.




**Pyriproxyfen**

**7. Pyriproxyfen against dipteran species**

Since the discovery of juvenile hormone mimic, Pyriproxyfen, it has been tested for its efficacy against many dipterans in laboratories and fields. It has shown its toxic effect on houseflies, various species of mosquitoes, stable flies, etc.

The toxicity of the compound depends on its concentration which causes a particular percentage of mortality of insect species. For instance, compounds which have lesser concentration effective against insect species are more potent than the compound whose larger concentration is effective.

Much research has been done to find out the concentration of Pyriproxyfen which causes a particular percentage of mortality and other aberrations in an insect. Pyriproxyfen has the capability to induce morphogenetic aberrations and affect reproductive functions. (Hatakoshi et.al,1987) found the half

maximal inhibitory concentration (IC50) of active compound named S-31183 against the larvae of Culex pipiens pallens is 0.0046 ppb; Anopheles stephensi is 0.043 ppb ; Aedes aegypti is 0.023 ppb. The comparative effectiveness of S-31183 with methoprene, diflubenzuron, and temephos against the above three mosquito species has been given. The comparative sensitivity to S-31183 is Anopheles stephensi and Aedes aegypti were about 1-10th times as sensitive as Culex pipiens pallens.

The adult emergence inhibition depends on the stability of the S-31183. (Hatakoshi et.al, 1987) used artificial and chicken manure medium to expose houseflies to the compound S-31183. He found out that S-31183 is more stable than methoprene in both the artificial medium and the chicken manure medium in which its activity against eggs decreased to 1/3rd and 1/4th, respectively, of that against 4-day old larvae. He suggested it as a strong compound to be used in the future against mosquitoes and houseflies.

(El-shazly et.al, 2002) examined the efficacy of pyriproxyfen against Culex pipiens under ranging constant temperatures. The median lethal concentration ( LC50) at 20°C was found to be 0.00111ppm and was reduced to 0.00013ppm at 32°C. The adult emergence inhibited as 11% emerged when treated at 20°C and 6% emerged when treated at 32°C as compared to controlled at respective temperatures.

(Kawada et al., 1993) and (Ali et.al, 1995) reported 0.024 ppb and 0.11 ppb, respectively as LC50 for Aedes albopictus. (Ali et al.,1995) reported exceptional activity of pyriproxyfen with LC90 of 0.000376 ppm against Aedes albopictus and also suggested that pyriproxyfen was 21.5 times more active than methoprene.
(Bull & Meola in 1993&1994) reported its LC50 of 9.3 ppb and 12.8 ppb against the horn fly and the stable fly, respectively. (Liu et.al, 2012) reported concentration dependent effect of pyriproxyfen on immature development and reproduction of Stomoxys calcitrans (L.) with the LC50 of 0.002 ppm.

## 8. Conclusion

Pyriproxyfen has been successfully tested for its capability of controlling a wide range of Dipterans. Hence, useful in controlling the widespread diseases caused by mosquitoes and flies. In present, many researches are going on for the developed resistance in insects against Pyriproxyfen. It is of much importance to study the mechanism of action of Pyriproxyfen and the reason for developing resistance in insects against pyriproxyfen as the developed resistance can decrease the efficacy of Pyriproxyfen. The result of which can be an increase in spreading of diseases.

## References

1. Ali, A. R. S. H. A. D., Nayar, J. K., & Xue, R. D. (1995). Comparative toxicity of selected larvicides and insect growth regulators to a Florida laboratory population of Aedes albopictus. Journal of the American Mosquito Control Association, 11(1), 72-76.
2. Bull, D. L., & Meola, R. W. (1993). Effect and fate of the insect growth regulator pyriproxyfen after application to the horn fly (Diptera: Muscidae). Journal of economic entomology, 86(6), 1754-1760.
3. Bull, D. L., & Meola, R. W. (1994). Interactions of the insect growth regulator pyriproxyfen with immature and adult stages of the stable fly. The Southwestern entomologist (USA).
4. El-Shazly, M. M., & Refaie, B. M. (2002). Larvicidal effect of the juvenile hormone mimic pyriproxyfen on Culex pipiens.
5. George, N., Vasuki, V., & Kalyanasundaram, M. (1989). Structure-activity relationships in diphenyl ethers for insect growth regulating activity against mosquitoes. The Indian Journal of Medical Research, 89, 344-349.
6. Hatakoshi, M., Kawada, H., Nishida, S., Kisida, H., & Nakayama, I. (1987). Laboratory evaluation of 2-[1-methyl-2-(4-phenoxyphenoxy) ethoxy] pyridine against larvae of mosquitoes and housefly. Medical Entomology and Zoology, 38(4), 271-274.
7. Journal of the American Mosquito Control Association-Mosquito News, 18(4), 321-328.

8. Kawada, H. (1993). Can mosquitoes be carriers of larvicides? Potential new strategy for mosquito control using insect growth regulator. In Proc. Int. Conf. Insect Pests in Urban Environ., Cambridge, England (pp. 14-17).
9. Liu, S. S., Li, A. Y., Lohmeyer, K. H., & Perez De Leon, A. A. (2012). Effects of pyriproxyfen and buprofezin on immature development and reproduction in the stable fly. Medical and veterinary entomology, 26(4), 379-385.
10. Miyamoto, J., M. Hirano, Y. Takimoto and M. Hatakoshi. 1993. Insect growth regulators for pest control, with emphasis on juvenile hormone analogs: Present status and future prospects. ACS Symp. Ser., ACS, Washington, DC.524: 144-168
11. Mulla, M. S. (1995). The future of insect growth regulators in vector control. Journal of the American Mosquito Control Association-Mosquito News, 11(2), 269-273.
12. Reddy, G., & Krishnakumaran, A. (1972). Synergistic effect of ecdysterone on morphogenetic activity of juvenile hormone analogues. Life Sciences, 11(16), 781-792.