

EFFECTS OF JUVENILE HORMONE ANALOGS ON SURVIVAL AND REPRODUCTION STATUS OF THE GLASSY-WINGED SHARPSHOOTER

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ABSTRACT

The impact of all of the currently recommended chemicals registered for use against glassy-winged sharpshooter (GWSS) is by direct or indirect mortality to the targeted life stages. One of the biggest problems in efforts to contain the spread of GWSS is the lack of effective treatments for GWSS egg masses that occur on many different host plants. Juvenile hormone analogs may have potential to suppress reproduction in GWSS. We have discovered that methoprene and perhaps other registered juvenile hormone analogs affect the reproduction of GWSS. This report summarizes our results to date which most notably include the observation of complete suppression by methoprene at label rates of the reproduction of GWSS females when treated during their diapause or preoviposition period.

INTRODUCTION

The primary tools available for regulatory suppression and eradication are early detection followed by chemical pesticide applications (Redak and Blua 2003). Containing the spread of GWSS could be improved by the availability of effective treatments for GWSS eggs. The CDFA web site containing the GWSS nursery shipping protocol lists the following chemicals with efficacy against GWSS: acephate, cyfluthrin, methiocarb, bifenthrin, deltamethrin, permethrin, fenprothrin, carbaryl, chlorpyrifos and imidaclopid. Many of these chemicals have logistical limitations including long reentry intervals and other potential side effects that restrict their use or result in added environmental costs, as well as elicit severe negative reactions from the public. The impact of the currently-recommended pesticides registered for use against GWSS is by direct or indirect (feeding suppression by neonicotinoids, repellency by kaolin clay, Surround) mortality to the targeted life stages.

Redak and Bethke (2003) summarized the results of the previous evaluations of pesticides against the GWSS. A large number of chemicals have been evaluated against GWSS life stages that include commercially-available organic, biorational and reduced-risk chemicals. Evaluations of the efficacy of the chemicals were based primarily on mortality to the target stages. Moreover, the results from most previous evaluations were based on short-term tests using typical laboratory and field protocols whereby the mortalities of untreated control organisms are compared to treated individuals over a period of hours or days. Some insect growth regulators, primarily synthetic chitin inhibitors, have been tested over a period of several weeks and found to be effective against GWSS nymphs but caused no adult mortality. However, Redak and Bethke (2003) concluded that the activity of these compounds (buprofizen, novaluron and pyriproxifen) was too slow to be useful for eradication purposes. Other researchers (Akey et al. 2003) have evaluated certain biorationals including cinnamon oil, pyrethrum and piperonyl butoxide - for use in organic production and found limited efficacy against GWSS. To our knowledge, evaluation of the efficacy of the currently registered formulations of the juvenile hormone analogs methoprene, kinoprene and hydroprene has not been reported. These materials may have direct and indirect impacts on the behavior, reproduction or other physiological systems of GWSS. Moreover, the potential long-term impact of treatments to nymphs on the subsequent reproductive activities of adult GWSS has not been evaluated.

OBJECTIVES

1. Determine the effects of the synthetic juvenile hormones methoprene (Diacon II), kinoprene (Enstar II) and hydroprene (Gentrol) on the survival and reproductive status of the life stages of GWSS.
2. Determine the effects of these hormones on GWSS parasitoids and two related leafhopper vectors.
3. Provide recommendations for use of these biorational chemicals against GWSS for eradication and other management objectives.

RESULTS

Parasitoids

We screened the compounds methoprene (1x rate= 0.009 ml/l AI), kinoprene (1x rate= 0.71 ml/l AI) and hydroprene (1x rate = 0.52 ml/l AI) in water solutions at concentrations of 0.1x, 1.0x and 10x the recommended rates for their impact on the GWSS egg parasitoids, *G. ashmeadi* and *G. morrelli*, by treating GWSS eggs containing the parasitoid larvae and by

topically treating the adult parasitoids. We observed no effect of the juvenile hormones tested on any life stage of either parasitoid species.

Adult GWSS females in diapause

All GWSS used in the experiments were taken from a greenhouse culture and were in the process of terminating winter reproductive diapause. Female GWSS in groups of 10 were sprayed until visibly wet with methoprene at the label rate described above. They were then placed into a wooden 1m screened cage that was provisioned with five males and glabrous soybean, *Glycine max* (L.). A similar untreated control cage was also set up with females sprayed with distilled water. Females were checked daily for the presence of brochosomes and plants were checked for egg masses. Cages were in a greenhouse maintained at 32°C and equipped with artificial lighting for a 14:10 photoperiod. Surviving females were dissected after 30 days and their reproductive status was evaluated. No eggs were produced by any treated GWSS females. Dissections revealed that all surviving treated females had not begun reproductive activity, even after 30 days. There was little or no brochosome material in the Malpighian tubules and no development of ova. All control females when dissected were reproductively active.

Newly-eclosed adult GWSS females treated during the preoviposition period

All GWSS used in the experiment were reared under summer conditions in a greenhouse from 4-5 instar to eclosion. Newly eclosed adult female GWSS in groups of 10 were treated until visibly wet with methoprene at the labeled rate. After treatment, females were placed in a 1m-screen cage that was provisioned with crape myrtle, eastern saltbush, and soybean. Five males of unknown ages were added to each cage. Females were dissected after 36 days. Males were discarded. No eggs were produced by any treated GWSS females. Dissection of treated females indicated that ovariole (reproductive) development was inhibited. Under normal green house conditions, untreated female GWSS begin to oviposit 10-12 days after eclosion. A few days prior to oviposition, their bodies swell and they begin to display brochosomes on the forewings. The treated females did not display any of these traits while the untreated females were reproductively active.

Actively-reproducing female GWSS

Female GWSS collected in the field during the months of July and August in north Florida, were divided into ten groups of 15 and treated with either a juvenile hormone analog or distilled water as the control. Juvenile hormone analogs consisted of hydroprene, methoprene and kinoprene, each with concentrations as described above of the recommended label rate, 0.1x the recommended rate, and 10x the recommended rate. Each cohort of 15 leafhoppers was randomly assigned to a treatment, sprayed until visibly wet and placed in a 1.3m long sleeve cage on a crape myrtle branch. This experiment was replicated four times. After one week the leafhoppers were removed, mortality was assessed and females were dissected to evaluate their reproductive status. In addition, the number of egg masses on the leaves within the cages was determined. There was no significant effect of the juvenile hormones on GWSS egg production by active females (Figure 1).

GWSS nymphs

Ten cohorts of five nymphs, consisting of fourth and fifth instar GWSS were collected from a greenhouse culture and placed on a cowpea, soy or lemon basil plant in a plexiglass cylindrical cage 46cm in length and 15cm in diameter. The plants were placed in a laboratory next to a window to provide adequate sunlight. Each cohort was sprayed either with distilled water or a juvenile hormone analog until visibly wet. Juvenile hormone analogs consisted of hydroprene, methoprene and kinoprene, each with concentrations as described above of the recommended label rate, 0.1x the recommended rate, and 10x the recommended rate. Daily observations were taken to record survivorship and the number of individuals developing into adults. This experiment was replicated twice. Hydroprene at the 1x and 10x rates and methoprene at the 10x rate caused significant mortality to GWSS nymphs (Figure 2 and Figure 3).

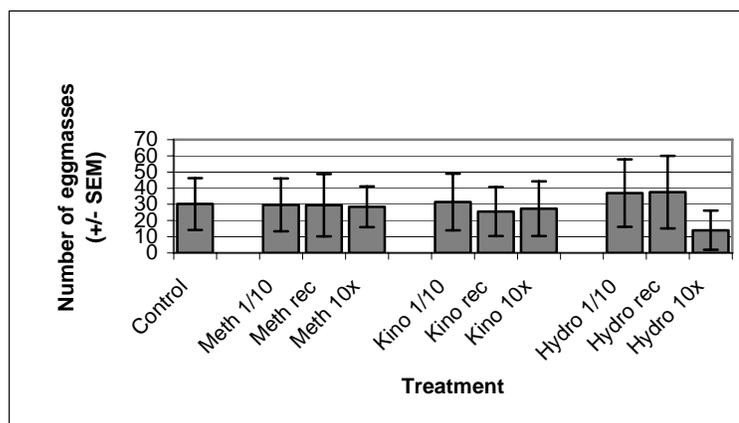


Figure 1. Number of egg masses produced by reproducing GWSS females following treatment with juvenile hormones and a water control.

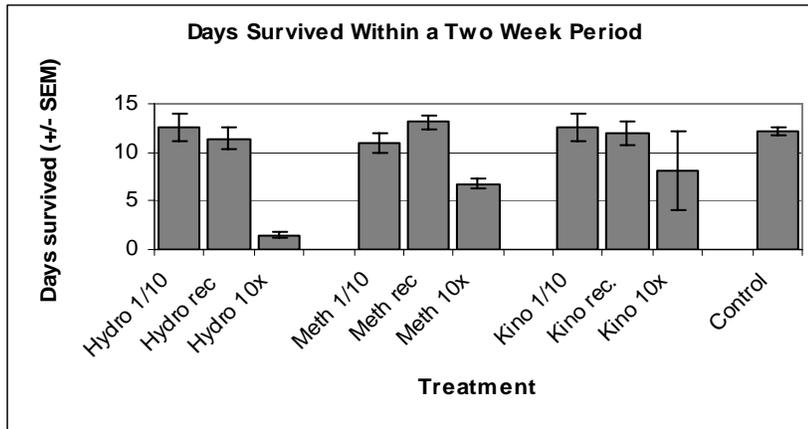


Figure 2. Survival of GWSS females after treatment with three juvenile hormones at 3 concentrations.

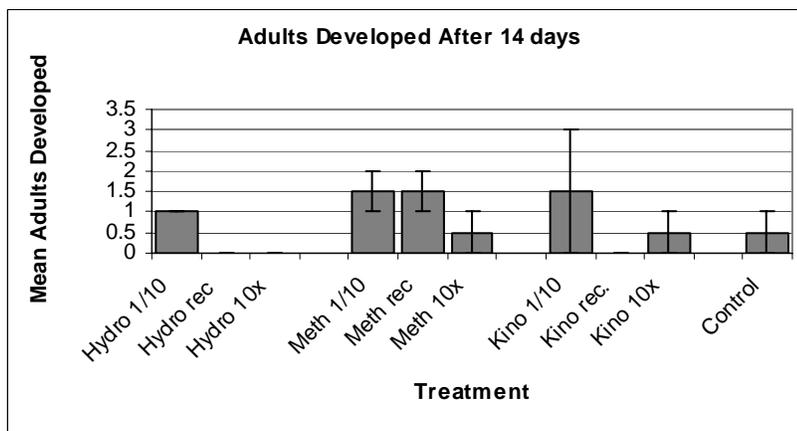


Figure 3. The number of treated nymphs developing into adults after treatment with juvenile hormones at three concentrations.

CONCLUSIONS

We tested the effects of three juvenile hormones on GWSS females in several different physiological states. While high mortality to nymphs was observed from hydroprone and methoprene at the 10X rate, no other direct mortality was observed. However, methoprene at the 1x labeled rate caused complete sterilization for at least 30-35 days when applied to GWSS females in diapause or during their preoviposition stage just after eclosion to adults. We are continuing these evaluations with the other JV analogs on female GWSS and other species of leafhopper vectors in different physiological states.

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