Pest Management in Horticultural Ecosystems
Vol. 26, No.1 pp 35-40 (2020)

DOI number: 10.5958/0974-4541.2020.00006.5

Bioecology, damage and management of bud worm, *Hendecasis duplifascialis*is Hampson : An overview

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ABSTRACT: *Jasminum multiflorum*, a non-fragrant flower species is mainly grown by small and marginal farmers in southern districts of Karnataka. The budworm, *Hendecasis duplifascialisis* Hampson has been posing a serious threat to jasmine cultivation in recent years. The species *J. multiflorum* is more prone to the bud worm attack. The total life cycle of the bud worm on *J. multiflorum* was found to be 27 ± 1.82 days. The natural enemy complex of bud worm includes the coccinellid and neuropteran predators, parasitoids like *Bracon* sp., *Phanerotoma hendecasiella*, *Brachymeria* sp. and *Xanthopimpla* sp. The green labled chemicals like chlorantraniliprole 18.5 SC, flubendiamide 480 SC, and spinosad 45 SC were more effective against bud worm and at the same time these chemicals are comparatively safe for those working every day in jasmine gardens.

Keywords: Jasmine, bud worm, biology, damage, natural enemy, review

INTRODUCTION

Genus *Jasminum* belongs to family Oleaceae and contains around 200 species. The *Jasminum* species consist both under fragrant and non-fragrant flower types. *Jasminum multiflorum*, a non-fragrant flower species is widely cultivated in tropical and subtropical regions. While other species of jasmine flowers are known for their attractive and intensely fragrant flowers, this species does not have any scent (Anonymous, 2012). It is known as winter jasmine, star jasmine and Indian jasmine. It is an evergreen shrub and blooming occurs throughout the year. Jasmine buds are used in decorating women's plait, making garlands and for religious offerings (Krishna Chaitanya and Kumar, 2018). In India, commercial cultivation of jasmine is confined to only a few states *viz*., Tamil Nadu, Karnataka, parts of Andhra Pradesh, Maharashtra, Uttar Pradesh, Rajasthan and West Bengal. Tamil Nadu is the leading producer of jasmine in the country (Prakash and Muniandi, 2014) and Karnataka is the second highest producer of jasmine flowers. In Karnataka state many small and marginal farmers grow jasmine whose livelihood mainly depends on the income from the flowers. In recent years insect pests, mites and diseases are main constraints in jasmine flower production. Among insects, bud worm, *Hendecasis duplifascialis* (Hampson) causes severe damage to the buds, resulting in very low flower production and demands frequent insecticidal sprays for stabilizing the flower yield.

The first incidence of the bud worm was reported on jasmine in West Africa, India and Ceylon by Hampson (1896). The incidence of the jasmine budworm is widely distributed in all the jasmine growing areas with jasmine as the sole host species. The occurrence of the pest is seen starting from April to October, with ovipositional peak in July, August and September (Lanfang *et al.,* 2007; Samata, 2019).

NATURE OF DAMAGE AND INCIDENCE

In recent years, the bud worm *H. duplifacialis* is known to pose a serious threat to jasmine cultivation. The influence of weather parameters on bud worm occurrence in jasmine was studied by Harini *et al.* (2018). The results revealed that evaporation, sunshine hours and morning relative humidity had positive effect and evening relative humidity and rainfall had negative effect on pest incidence. The damage caused by the bud worm ranges from 30 to 70 per cent, affecting the quality of the flowers and yield loss (Gunasekaran, 1989).

The larva of the bud worm is smooth, green in colour with black head. On hatching, the larva enter into the bud by making hole and feeds on the internal contents of the bud and deposits the excreta inside. It attacks adjacent two to three buds which are webbed by the silken threads (Muthukrishnan *et al.,* 2005). Initially, the bud worm larva bore into closed immature bud and feed on the inner floral structures. Later as the larva grows, it comes out through a small hole made on the bud for attacking the adjacent buds in the cymose (Jasmine growers personal communication, 2018). The larva even makes tunnels with silk and excreta within affected flower cluster/cymose thus affecting the opening of the

flower buds. During severe infestation, the larva makes a web like structure and the infested flowers dry up and drop off (Kamala and Kennedy, 2016).

The caterpillar of *H. duplifascialis* feeds on inner most petals of the closed bud of jasmine in initial instars and emerges through a circular hole made usually on the tubular portions of corolla to bore into the nearby bud. Budworm, *H. duplifacialis* larvae caused the greatest injury to immature buds of *Jasminum sambac* (Reddy *et al*., 1978). Ayyar (1940) observed two species of bud borers *E. jasminophagus* and *H. duplifacialis* infestation on *J. multiflorum* and *J. sambac* that resulted in severe damage to the flower buds. Sudhir (2002) observed maximum incidence of budworm, *H. duplifascialis* on *J. sambac* followed by *J. auriculatum* and *J. multiflorum* in Raichur and Bellary districts from May 2001 to April 2002. Whereas the bud and shoot worm, *E. jasminophagus* infestation was noticed only on *J. multiflorum* from October to February.

Shobitha (2002) attributed the reasons for bud worm preference for attack among the five jasmine species studied. Only *J. multiflorum* and *J. sambac* were infested by the bud borers. Variation in flower bud and cluster characteristics were observed among different jasmine species. The mean number of buds per cluster and inter cluster distance was reported to be high in *J. multiflorum* compared to other species. Whereas inter bud distance was lower in case of *J. multiflorum* and *J. rigidium*. Bud length and weight was higher in *J. multiflorum* while the bud diameter was greater in *J. sambac*. The *species J. multiflorum* was more prone to damage by bud borers since there was a high positive correlation between bud damage and the number of buds present in a cluster and bud weight. She also found that different stages of larvae of bud borers, *E. jasminophagus* and *H. duplifascialis* preferred to attack different stages of flowers of *J. multiflorum* and there was a high positive correlation between the total bud availability and the extent of damage. Early larval instars preferred to infest green buds, while later instars preferred white buds and open flowers.

Kamala and Kennedy (2017) found that the maximum incidence of bud worm was in Madurai (35.18%) followed by in Tirunelveli (31.35%) which are the two major jasmine growing districts of Tamil Nadu. Further, they reported that budworm (*H. duplifascialis*) is a serious pest of jasmine posing severe threat to the flower yield. Incidence of bud borer, *H. duplifascialis* was prevalent throughout the year with the maximum incidence during the first fortnight of August (31.87 % bored buds) and minimum incidence during the first fortnight of February (3.39 % bored buds). Samata (2019) observed that bud worm infestation on *J. multiflorum* during first fortnight of July in Ramanagara district and the population increased and reached a peak during August 2018 with 54.96 per cent average infestation.

BIOLOGY OF BUDWORM

The biology of jasmine budworm, *H. duplifascialis* was first time studied by Atwal and Dhaliwal, (2002). They reported that egg, larval, pupal periods of budworm lasted for 3-5 days, 11-17 days and 6-8 days, respectively. The adult longevity was just for 2-3 days. Thus the total life cycle of the bud worm lasted for 20-23 days. The adult moth is small, white with black wavy lines on hind wings and abdomen. The caterpillar is smooth and green with pale body hairs (Muthukrishnan *et al.*, 2005).

In the South zone of Andhra Pradesh, studies on biology of jasmine bud worm, *H. duplifascialis* Hampson and leaf web worm *Nausinoe geometralis* Guenee was done by Neelima (2005) on *J. sambac* and she found that the mean duration of egg, larval and pupal stages of bud worm lasted for 4.2, 10.34 and 6.4 days respectively. Further, she also reported that the total life cycle of bud worm completed within 24 days.

Krishna Chaitanya and Kumar (2018) studied the biology of budworm, *H. duplifascialis* on *J. sambac* and found that the incubation period, total larval and pupal period were 3.40 ± 0.23, 11.60 ± 1.30 and 5.80 ± 0.19 days. The longevity of male and female moths was 3.10 ± 0.23 and 4.10 ± 0.31 days. The total life cycle for male and female moths was found to be 23.90 ± 1.95 and 24.90 ± 2.03 days respectively. They also observed that the longevity of female moth was longer compared to the male moth. Samata (2019) reported that the average total life cycle of bud worm on *J. multiflorum* was 27.00 ± 1.82 days.

DISTRIBUTION PATTERN

The knowledge on the spatial distribution pattern of *H. Duplifascialis* is vital for a complete understanding of its bio-ecology in jasmine eco-system. The spatial distribution and sampling of infestation are very important in formulating pest management practices (Veeresh *et al.,* 1976). Further, most of the times, the distribution of natural enemies is governed by the distribution of their host / prey, competition and their tri-trophic relationships (Tandon and Verghese, 1995).

Samata (2019) studied spatial distribution of *H. duplifascialis* on *J. multiflorum* and found aggregated pattern of distribution in bud worm infestation at middle and top region of jasmine plants. Further she observed this may be due to the availability of the maximum number of buds and also dense clusters present at 101-

150cm and 151-200 cm canopy height intervals. Even the ample sunlight and micro climate conditions around the plants may also be favourable for the aggregation of bud worm infestation at middle and top regions of the plants. Thus the distribution pattern of bud worm damage in a plant is very important for planning effective sampling strategies. Sampling plan in turn was very crucial for estimating pest densities or infestation intensity for scheduling pest management programs as reported by Keshavareddy (2008).

MANAGEMENT OF JASMINE BUDWORM

Natural enemies

Many natural enemies like parasitoids and predators play very important role in regulating the pests in jasmine ecosystem. Kamala and Kennedy (2017) reported few parasitoids and predators on bud worm and web worm that controlled the pest to the maximum extent. The natural enemy complex on bud worm includes the coccinellid and neuropteran predators, parasitoids like *Bracon* sp. and *Phanerotoma hendecasiella*. Even the pentatomid predator, *Cantheconidia furcellata* (Wolff) was also found preying on bud worm Prasad *et al*. (1983). Shobitha (2002) recorded few parasitoids like *Phenarotoma hendecasiella, Brachymaria* sp., Ichnemonid and Scelionids from *J. multiflorum* field. An unidentified braconid parasitoid on final instar of bud worm, *H. duplifascialis* (Hampson) was reported by Neelima (2005). Samata (2019) observed a Chalcid, *Brachymeria* sp. and Ichneumonid, *Xanthopimpla* sp. parasitizing bud worm in *J. multiflorum* gardens in Ramanagara district.

Chemical and botanical insecticides

Ponsekha and Muthusamy (2016) observed that monocrotophos caused 100% mortality when treated with 0.005% and out of two oils tested against jasmine bud worm, neem oil at 0.02% was found to be more effective followed by pungam oil (0.03%). Dandapani *et al.* (1989) reported that deltamethrin @ 25g a.i/ha and cypermethrin 150g a.i/ha reduced the infestation of the bud worm on jasmine by 90 per cent and 90.2 per cent during the first spray and 87.3 per cent and 87.9 per cent during the second spray. The in vitro bio-assays of microbial agents on *H. duplifascialis* revealed that the treatment *Bacillus thuringiensis* (Bt) recorded maximum per cent larval mortality (80.20%) over untreated control followed by *Beauveria bassiana* (74.61%) and *Lecanicillium lecani* (65.88%). Later the field evaluation of the same treatments against bud worm for confirmation with in vitro results revealed that similar trends were observed with respect to efficacy of *Bt* with minimum infestation of 8.82 per cent followed by *B. bassiana* (10.41%) and *L. lecani* (12.70%). The mean per cent reduction in infestation over control was maximum in *Bt* treated plots (77.60 %) followed by *B. bassiana* (74.45 %) and *L. lecani* (69.06%) (Kamala and Kennedy, 2016).

Suganthi *et al.* (2006) studied the efficacy of λ-cyhalothrin @ 10, 20, 30 and 40 g ai ha^{-1}, against bud worm, *H. duplifascialis* and found that the effectiveness was dose dependent when compared with recommended insecticide, monocrotophos. Further, though the effect was dose dependent, considering the efficacy, λ-cyhalothrin at 20 g ai ha^{-1} was recommended for the management of bud worm in jasmine. Reddy *et al.* (2016) evaluated few chemicals against bud worm, *H. duplifascialis* infesting *J. multiflorum* and found that chlorantraniliprole 18.5 SC @ 0.2 ml/lt reported the lesser population of the bud worm with high yield. Insecticides efficacy studies with chlorantraniliprole 18.5 SC, flubendiamide 480 SC, spinosad 45 SC, quinolphos 25 EC, NSKE 5% and *B. bassiana* 1×10^{8}spores/g by Kiran *et al*. (2017) indicated that chlorantraniliprole was significantly superior compared to the rest of the treatments, followed by flubendiamide which was on par with the spinosad and quinolphos. However, NSKE and *B. bassiana* were found to be less effective against budworm.

The efficacy of five botanicals and eleven insecticides was evaluated by Harini *et al.* (2018) against jasmine bud worm, *H. duplifascialis* (Hampson) infesting *J. sambac*. The treatments included chlorantriniliprole 18.5 SC @ 0.1 ml/l, flubendiamide 39.35 SC @ 0.75 ml/l, thiacloprid 21.7 SC @ 0.30 ml/l, dimethoate 30 EC @ 2 ml/l and novaluron 10 EC @ 1 ml/l recorded lower infestation. Among the botanicals, NSKE @ 5.0% was superior against budworm followed by pungam oil @ 2.0 % with 81.67 per cent and 76.10 per cent reduction in budworm infestation, respectively. Further, Kamala *et al.* (2017) reported that when botanicals efficacy was evaluated against jasmine bud worm in two separate bioassays with plant extracts and plant oils under *in vitro* and *in vivo* conditions revealed that neem seed kernel extract @ 5% recorded the maximum per cent mortality (71.69%), followed by Sweet flag rhizome extract 5% (69.90), Vitex leaf extract 5% (68.38) and Wild sage leaf extract 5% (65.97), whereas in vivo bio-assay on plant oils revealed the superiority of neem oil in controlling budworm larvae with a maximum per cent mortality of 71.37%, followed by Horticultural mineral oil recording 69.58% mortality followed by lemon grass oil with 63.15% mortality. Similar research was conducted by using six botanicals against the jasmine bud worm both in laboratory and at field conditions. The results

indicated that the neem cake extract 5% was found to be more effective followed by neem seed kernel extract 5% and neem oil 1% (Nelson *et al*., 1993).

David *et al*. (1990) evaluated insecticides against budworm, *H. duplifascialis* and blossom midge, *Contarinia maculipennis* Felt and found that quinolphos (@ 0.054%) and monocrotophos (@ 0.05%) were more effective against the two jasmine pests. Soil application of carbofuron 3G @ 40 g per bush and foliar application of cypermethrin @ 25 g ai/ha, fenitrothion @ 0.1% and monocrotophos @ 0.08% at fortnightly intervals effectively reduced purple discoloration and drying of flower buds in *J. sambac* caused by blossom midge. Among the insecticides evaluated against bud worm, *H. duplifascialis* in two field trials, deltamethrin 2.5 EC at 25 g ai per ha gave maximum reduction in damage up to 90.21 per cent followed by cypermethrin 10 EC @150 g ai per ha (90.11%) and monocrotophos 36 SL @ 360 g ai per ha (78.28%) and it was suggested that alteration of monocrotophos 36 SL @ 360 g ai per ha with pyrethroids, cypermethrin 10EC @ 150 g ai per ha or deltamethrin 2.5 EC @ 25 g ai per ha also avoids sucking pest resurgence (Dhandapani *et al*., 1989). Field experiments conducted by Neelima (2005) to evaluate the efficacy of insecticides on jasmine bud worm, *H. duplifascialis* showed that carbosulfan (0.05%), fipronil (0.01%), *B. thuringiensis* var Kurstaki (1gm/l) and cartaphydrochloride (0.05%) were highly effective in reducing bud worm damage followed by NSKE (5%), which was superior to azadirachtin @1500 ppm (0.0003%). Sundararaj and David (1990) reported that monocrotophos (0.1%), cypermethrin (0.012%) and neem oil (2%) were more effective than endosulfan (0.1%) or chlorpyrifos (0.05%) in controlling the blossom midge of jasmine. Kamala *et al*. (2018) reported that thiacloprid @ 0.6 ml/l was effective in managing the major pests like bud worm and midges infesting the jasmine buds. Recently the use of the microbial pathogens like virus, bacteria, fungi and nematodes are the most eco-friendly and valuable approaches in the pest management (Anand *et al*., 2009). The efficacy studies of different insecticides, botanicals and bio-agents against jasmine bud worm by Samata (2019) revealed that flubendiamide 39.35%SC @ 0.3ml/l, profenophos 50%EC @ 1.5ml/l and cypermethrin 5%EC @ 0.4ml/l emerged as most promising treatments in managing bud worm from three trials during July to September, 2018.

CONCLUSION

In recent years, jasmine is gaining popularity as one of the most important commercial flower crops growing in southern states of the country. Bud worm, *H. duplifacialis* has emerged as a major limiting factor in jasmine cultivation. The distribution pattern of bud worm in a plant and its natural enemies are very important for planning effective sampling strategies. An overview on the status of bud worm research helps to undertake further investigations on jasmine bud worm and its management.

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MS Recieved - 23 February 2020
MS Accepted -25 April 2020