SHORT COMMUNICATION

Oryza Vol. 54 No. 1, 2017 (116-120)

Studies on the efficacy of synthetic jasmonates and salicylates on parasitism of brown planthopper, *Nilaparvata lugens* (Stal.) by *Anagrus* sp.

GT Jayasimha[1]*, RR Rachana[2] and R Nalini[1]

[1]Agricultural College and Research Institute, Madurai, Tamil Nadu, India

[2]National Bureau of Agricultural Insect Resources, Hebbal, Bangalore, Karnataka, India

***Corresponding author e-mail: jayaavavaa@gmail.com**

Received : 09 May 2016 Accepted : 08 May 2017 Published : 19 May 2017

ABSTRACT

A field experiment to evaluate the effect of synthetic jasmonates and salicylates on parasitisation of rice brown planthopper (BPH)by egg parasitoid, Anagrus sp. *was conducted during October - December, 2015. Jasmonic acid (JA), Methyl jasmonate (MeJ), Salicylic acid (SA) and Methyl salicylate (MeS) at three different concentrations (1, 10 and 100 mM) were tested for their effect on rice BPH population and their ability to attract egg parasitiod. Significantly, higher % parasitism and thereby less BPH population was noticed on plants treated with Jasmonates and salicylates than buffer and control. Even though all the evaluated treatments attracted parasitoids, Jasmonic acid @10 mM recorded the maximum mean parasitism of 34.69 % against control with 10.69 % only. These potential synthetic herbivore induced plant volatiles (HIPVs) can be explored in rice fields for attracting Anagrus* sp.

Key words: *Brown planthopper, jasmonates, parasitoid, salicylates, synthetic HIPV*

Plants can influence the natural enemies of herbivores by emitting behaviour-modifying volatile organic compounds (VOCs). Plants damaged by herbivores often produce a blend of volatiles (Pareand Tumlinson 1999), commonly referred to as herbivore-induced plant volatiles (HIPVs) (Mumm and Dicke 2010). Plants are known to release more than 30,000 different Volatile Organic Carbons (VOCs) including alkanes, alkenes, alcohols, ketones, aldehydes, ethers, esters and carboxylic acids (Niinemets *et al*. 2004). VOCs emitted as a consequence of herbivore attack may have a role in plant indirect defences, attracting natural enemies of herbivores and helping them to find the attacked plants (Induced Synomones) (Dicke and Sabelis 1988; Turlings *et al*. 1990; Agrawal *et al*. 1999; Walling 2000). The herbivore attack induces a variety of plant hormones, including jasmonic acid, salicylic acid and ethylene, which subsequently regulate defensive responses, including the release of VOCs in rice plants (Lou *et al*. 2005, 2006; Lu *et al*. 2006; Zhou *et al*. 2009).

The volatiles emitted from rice plants in response to *N. lugens* attack attracts the parasitoid, *Anagrus nilaparvatae* (Lou and Cheng 1996; Lou *et al*. 2002). Exogenous application of JA can mimic the defensive reaction of rice (Lou *et al*. 2005; Zhou *et al*. 2009) and can enhance the parasitism of *N. lugens* eggs by *A. nilaparvatae* in the glasshouse and the field (Lou *et al*. 2005). The parasitism of *N. lugens* eggs by *A. nilaparvatae* on plants that were surrounded by JA-treated plants is more than two fold higher than on control plants in the greenhouse and field (Lou *et al*. 2005). The egg deposition by herbivores can also induce a volatile response in plants and consequently attract egg parasitoids (Meiners and Hilker 1997 2000; Hilker and Meiners 2002; Colazza *et al*. 2004). This study explored the efficacy of synthetic jasmonates and salicylates on attraction of egg parasitoids of BPH under field conditions.

Field experiment to evaluate the efficacy of synthetic jasmonates and salicylates on parasitism of BPH eggs byegg parasitoid was conducted in rice variety NLR 3449 at Kondayampatti village, Madurai, Tamil Nadu (9^{0}56' N, 78^{0}19' E) during Oct-Dec, 2015. Jasmonic acid ($\geq$ 97.0 %), methyl jasmonate ($\geq$ 94.5 %), methyl salicylate ($\geq$ 99.0 %) and Salicylic acid ($\geq$ 99.0 %) were tested at three different dosages (1, 10 and 100mM). The treatments were compared with buffer and control and were replicated thrice. Size of each plot was 5m x 4 m. Five plants per treatment were selected and labelled. Each selected plant was individually damaged with a needle on rice leaves with 200 pricks and then the damage site was treated by applying 40 µl of each JA , MeJA, MeSA and SA (Sigma Aldrich) at different dosages (50mM sodium phosphate buffer titrated with 1 M citric acid until pH 8, including 0.01% Tween). In buffer treatment sodium phosphate buffer was treated @ 40 µl of 50mM solution whereas the control plants were kept non-manipulated without application. In each treatment number of BPH eggs(parasitizedand un parasitized) per plant were dissected and recorded before application as well as on 1, 3, 5 and 7 days after the application (DAA) of synthetic jasmonates and salicylates. Parasitism was determined by eggs with yellowish red colour and then per cent parasitism was calculated.

Experiment data was analysed using two-way analyses of variance (ANOVA) followed by Duncan's multiple range test when significant differences were detected. Statistical analyses were executed using software AGRES.

The mean BPH population recorded after the application of synthetic jasmonates and salicylates ranged from 69.14 to 106.80 nos./5 hills over the study period. Jasmonic acid @ 10mM (69.14 nos./5 hills) recorded the lowest mean BPH population followed by methyl salicylate @10mM and Salicylic acid @100mM with 80.30 and 81.23 nos./5 hills, respectively. The BPH population in jasmonic acid @10mM was approximately 1.32 times lesser as compared to the pre-count BPH population and 1.69 times lesser compared to the control (Fig. 1). At 5 DAA of the Jasmonates and salicylates the BPH population was minimum of 79.95 nos./5 hills followed by 3 DAA with 81.38 nos./5 hills. Jasmonic acid @10mM at 5 DAA and 3 DAA recorded a minimum population of

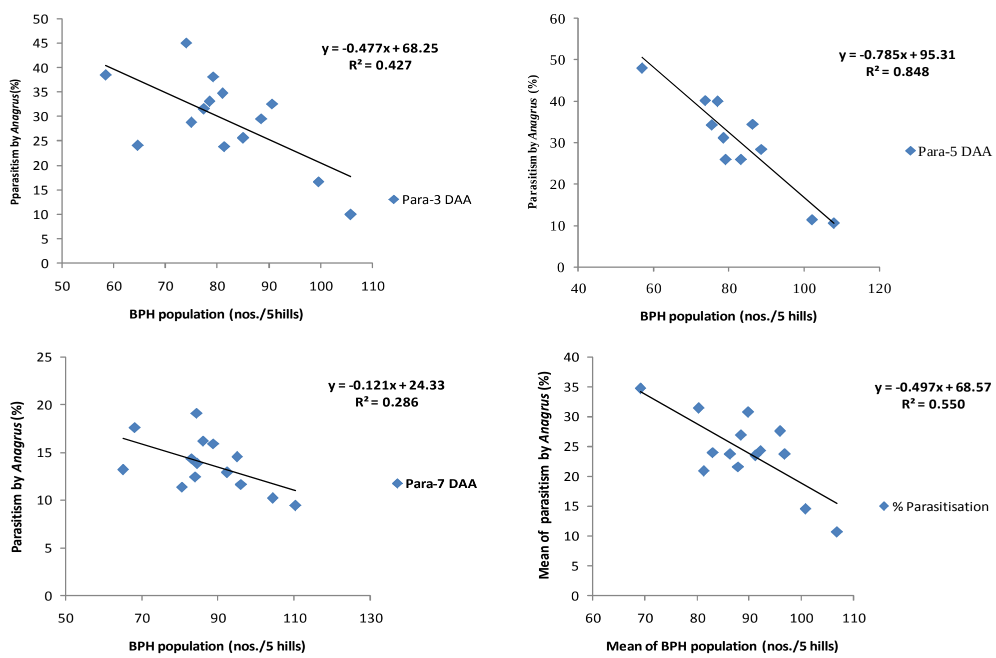

Fig. 1. Correlation between BPH population and per cent parasitism on 1, 3, 5 and 7 days after application of jasmonates and salicylates.

56.88 nos./5 hills and 58.45 nos./5 hills, respectively and were significantly different from each other as well as from all other treatments (P = 0.05). At 7 DAA, low BPH population was seen in Jasmonic acid @10mM (65.00 nos./5 hills) followed by methyl salicylate @100mM (68.11 nos./5 hills) and methyl salicylate @1mM (80.43 nos./5 hills). James *et al*. (2008) revealed that deployment of herbivore-induced plant volatiles in controlled release dispensers in hops and grapes orchards increased the populations of beneficial insects as well as improved the conservation of biological control.

The highest mean % parasitism was recorded in methyl salicylate @10 mM of 31.40 and was followed by methyl jasmonate @10 mM (30.71) and Methyl jasmonate @100 mM (27.55). The lowest mean % parasitism was seen in control and buffer @50 mM of 10.69 and 14.52, respectively. At 5 DAA, the maximum % parasitism of 49.35 was observed in methyl jasmonate @10 mM and was followed by jasmonic acid @10 mM with a % parasitism of 47.98. The next best treatments were methyl salicylate @10 mM at 3 DAA and 5 DAA and jasmonic acid @100 mM at 5 DAA representing a % parasitism of 45.03, 40.19 and 39.96, respectively and the later two treatments were also on par with each other (Fig. 2). The results are in agreement with the findings of Lou *et al*. (2004 and 2005) who reported that both BPH and its parasitoids preferred to settle on JA-treated rice plants immediately after release and because of the action of these parasitoids the population of BPH decreased after 24h of application.

There was an abrupt decline in % parasitism from 49.35 (5 DAA) to 16.19 (7 DAA) in methyl jasmonate @10 mM and Salicylic acid @100 mM recorded the maximum per cent parasitism of 19.10 at 7 DAA. It was followed by methyl jasmonate @10mM and methyl jasmonate @100 mM representing a per cent parasitism of 16.19 and 14.52, respectively.The per cent parasitism in Jasmonic acid @10 mM at 5 DAA was approximately 5.20 times higher compared to before application and 4.54 times higher compared to the control. At 5 DAA of jasmonates and salicylates the per cent parasitism was maximum (30.94) followed by 3 DAA with 29.43 per cent. Lou *et al*. (2004 and 2005) reported that the parasitoid *A. nilaparvate* was more attracted to the volatiles emitted from jasmonic acid treated rice plants than to volatiles from control plants. This was evident from greenhouse and field experiments in which parasitism of *N. lugens* eggs by *A. nilaparvatae* on plants that were surrounded by JA-treated plants was two fold higher than on control plants. Correlation between BPH population and per parasitism by egg parasitoidon 3 DAA of JA and SA (r= 0.42*), 5 DAA (r= 0.84*), 7 DAA(r= 0.28*) and Mean (r= 0.55*) showed significant and positive correlation with BPH population (Fig. 1).

It could be concluded that rice plants treated with Jasmonic acid @10 mM at 5 DAA harboured maximum number of *Anagyrus* sp. and minimum number of BPH as compared to all other treatments. The % parasitism in Jasmonic acid @10 mM at 5 DAA was approximately 5.20 times higher as compared to the % parasitism before application and 4.54 times higher compared to the control. The BPH population showed a 1.69 fold decrease when compared to control. Even though, our preliminary results have shown that egg parasitiod responded to the tested jasmonates and salicylates, further experiments to verify the functions of these synthetics over multiple seasons are needed.

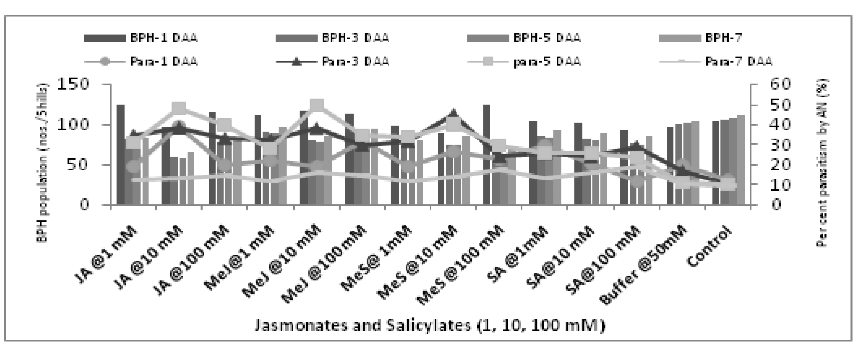

Fig. 2. Influence of jasmonates and salicylates on BPH population and per cent parasitism on 1, 3, 5 and 7 DAA.

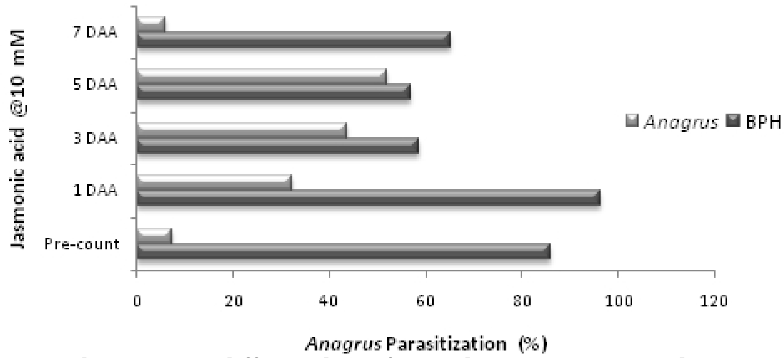

Fig. 3. Effect of Jasmonic acid @10mM at different days after application on BPH and Anagrus population

Current research in this area focuses on the possibility of exploiting the practical application of these in crop protection and hence this study provides baseline information.

REFERENCES

Agrawal AA, Strauss SY and Stout MJ 1999. Costs of induced responses and tolerance to herbivory in male and *Anagrus nilaparvatae* Pang et Wang to the eggs of *Nilaparvata lugens* (Stål). Chin. J. Appl. Ecol. 7: 61-66

Colazza S, Fucarino A, Peri E, Salerno G, Conti E and Bin F 2004. Insect oviposition induces volatiles emission in herbaceous plant that attracts egg parasitoids. J.of Experimental Biology 207: 47-53

Dicke M and Sabelis MW 1988. How plants obtain predatory mites as bodyguards. Netherlands Journal of Zoology 38: 148-165

Dicke M 1999 Are herbivore-induced plant volatiles reliable indicators of herbivore identity to foraging carnivorous arthropods. Entomologia Experimentalis at Applicata 91: 131-142

Halitschke R, Schittko U, Pohnert G, Boland W and Baldwin IT 2001. Molecular interactions between the specialist herbivore *Manduca sexta* (Lepidoptera, Sphingidae) and its natural host *Nicotiana attenuata*: III. Fatty acid-amino acid conjugates inherbivore oral secretions are necessary and sufficient for herbivore-specific plant responses. Plant Physiology 125: 711-717

Lou Y and Cheng J 1996. The behavioral responses of *Anagrus nilaparvatae* Pang et Wang to the volatile of rice varieties. Entomol. J. East China 5: 60-64

Lou Y, Cheng J, Ping X, Tang F, Ru S and Du M 2002. Mechanisms on host discrimination between two hosts *Nilaparvata lugens* and *Sogatella furcifera* by the egg parasitoid *Anagrus nilaparvatae*. Acta Entomol. Sin. 45: 770-776

Lou Y, Xiaoyan H, Turlings TCJ, Cheng J, Xuexin C and Gongyin Y 2006. Differences in induced volatile emissions among rice varieties result in differential attraction and parasitism of *Nilaparvata lugens* eggs by the parasitoid, *Anagrus nilaparvatae* in the field. Journal of Chemical Ecology 32: 2375-2387

Lou Y, Du, MH, Turlings TCJ, Cheng JA and Shan WF 2005. Exogenous application of jasmonic acid induces volatile emissions in rice and enhances parasitism of *Nilaparvata lugence*. Chinese science Bulletin 51(20): 2457-2465

Meiners T and Hilker M 1997. Host location in *Oomyzusgallerucae* (Hymenoptera: Eulophidae), an egg parasitoid of the elm leaf beetle *Xanthogalerucaluteola* (Coleoptera: Chrysomelidae). Oecologia 112: 87-93

Mumm R and Dicke M 2010. Variation in natural plant products and the attraction of bodyguards involved in indirect plant defense. Canadian Journal of Zoology 88: 628-667

Mumm R, Schrank K,Wegener R, Schulz S and Hilker M 2003. Chemical analysis of volatiles emitted by pinus *Nilaparvata lugens* and *Sogatella furcifera* by the egg parasitoid *Anagrus nilaparvatae*. Acta Entomol. Sin. 45: 770-776

Niinemets U, Loreto F and Reichstein M 2004. Physiological and physico-chemical controls on foliar volatile organic compound emissions. Trends Plant Sci. 9: 180-186

Pare PW and Tumlinson JH 1999. Plant volatiles as a defense against insect herbivores. Plant Physiology 121:

325-331

Turlings TCJ, Tumlinson JH and Lewis WJ 1990. Exploitation of herbivore-induced plant odors by host-seeking parasitic wasps. Science 250: 1251-1253

Walling LL 2000. The myriad plant responses to herbivores. Journal of Plant Growth Regulation 19: 195-216

Zhou G, Qi J, Ren N, Cheng J, Erb M, Mao B and Lou Y 2009. Silencing OsHILOX makes rice more susceptible to chewing herbivores, but enhances resistance to a phloem feeder. Plant Journal 60: 638-648