



Response of novel insecticides in enhancing the productivity of lac on *Flemingia semialata*

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Received: 23 March 2018; Accepted: 03 September 2019

ABSTRACT

The field experiment was conducted to evaluate the impact of some selected new insecticides in enhancing the lac productivity by containing the incidence of lac insect predators on *Flemingia semialata* during 2014-15, 2015-16 and 2016-17 at the Research Farm of ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand, India. Application of emamectin benzoate on *kusmi*-winter lac crop showed 4.57-157.14, 27.28- 322.73 and 69.56-339.12% increase in sticklac yield for one, two and three sprays, respectively, at different concentrations. Two spray of emamectin benzoate (25-30 and 38-40 days of inoculation) at 0.0025% caused 322.73% increase in sticklac yield over control. Similarly, application of chlorantraniliprole increased the yield to the tune of 5.56-61.33, 10.76-248.10 and 22.0-333.33%, respectively, for one, two and three sprays (25-30, 38-40 and 60-65 days of inoculation). Three sprays of 0.01% chlorantraniliprole results 333.33% increase in yield over control. The visible impact of novaluron on sticklac yield is not manifested. Earlier these insecticides have been evaluated for their response on population of lac associated insect fauna but this is first evaluation study for assessing their impact on sticklac productivity.

Key words: Chlorantraniliprole, Emamectin benzoate, lac crops, *Kerriallacca*, Novaluron

Lac is a commercial crop produced by lac insect, *Kerria lacca* (Kerr) (Homoptera: Tachardiidae) as a protective covering on its body. *Rangeeni* and *kusmi* are the two strains of lac insect each having two crop cycles in a year. Lac insect thrives on more than 400 host plant species but *Schleichera oleosa* (*kusum*), *Butea monosperma* (*palas*), and *Ziziphus mauritiana* (*ber*) are major tree species in India for commercial cultivation. *Flemingia semialata* is the quick growing bushy host plants, commercially exploited for lac cultivation (Jaiswal A K and Singh J P 2012). India is the world leader in best quality lac production. Other lac producing countries are Indonesia, Thailand, parts of China, Myanmar, Philippines, Vietnam and Cambodia etc. Lac crop is prone to attack by number of insect pests. Among them, the two lepidopteran predators, viz. *Eublemma amabilis* Moore (Lepidoptera: Noctuidae) and *Pseudohypatopa pulvereana* Meyr (Lepidoptera: Blastobasidae) are the key pests causing severe damage to the lac crop. It has been estimated that about 30-40% of lac crop is lost annually due to predatory ravages alone (Bhattacharya *et al.* 2005). In some cases, severe infestation of these predators has been reported to cause complete lac crop failure. Similarly, *Chrysopa* spp. is sporadic pest of *K. lacca* especially on

kusmi lac. It is a voracious feeder and sometimes destroy total crop. The chemical pesticides recommended by earlier workers for protecting lac crop resulting in significant insect-pest suppression include endosulfan and cartap hydrochloride (Bhattacharya *et al.* 2005), dichlorvos and ethofenprox (Jaiswal *et al.* 2004, 2007), indoxacarb, fipronil, spinosad (Singh *et al.* 2009, 2011, 2013, 2014) and flubendiamide, (Jaiswal and Singh 2016). Recent study indicated significant reduction in population of *E. amabilis* and *P. pulvereana* by application of emamectin benzoate, chlorantraniliprole and novaluron (Jaiswal *et al.* 2017, Singh and Jaiswal 2018, Jaiswal and Singh 2018). Considering the suitability of these insecticides in terms of safety to lac insect and toxicity on lac insect-predators, the present study was initiated to assess the impact of these insecticides on productivity of sticklac as this is prime parameter for lac cultivator.

MATERIALS AND METHODS

The present study was carried out at the Research Farm of ICAR-Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand, India (23°19'48"N, 85°22'20"E) during 2014-15, 2015-16, 2016-17. The *kusmi*-winter crop was raised on bushy lac host *F. semialata* in the month of July. The plantation of host was around 12 years old. The plants were pruned 5 cm above the ground in the month of January, so that tender shoots are available at the time of inoculation in the following July. 50 g *Kusmi* brood lac

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at just emerging stage was uniformly inoculated on each plant. The used-up broodlac sticks were removed after 15 days of inoculation.

The commercial formulations of insecticides, viz. emamectin benzoate (Eb) (EM-1 5% SG, by Dhanuka Agritech Ltd), chlorantraniliprole (Coragen® 20% w/v SC by DuPont) and novaluron (RimOn 5% EC by Indofil Industrial Ltd, Mumbai) were procured from the market. These insecticides have already been identified and recommended in lac production system in view of their safety on lac insect and toxicity on insect-pests associated with lac. There were 21 treatments (T1-T21) including control with Eb and chlorantraniliprole, and three replications for each treatment. These treatments include six concentrations of the Eb, viz. 0.00025, 0.0005, 0.0010, 0.0015, 0.0020 and 0.0025%, corresponding to T1-T6 for one spray; T8-T13 for two sprays and T15-T20 for three sprays, respectively. Similarly, T7, T14 and T21 were control for one, two and three sprays, respectively. Similar treatments were made with six concentrations of chlorantraniliprole, viz. 0.001, 0.002, 0.004, 0.006, 0.008 and 0.015 %. However, with novaluron, five concentrations, viz. 0.000125, 0.00025, 0.0005, 0.0010 and 0.0015 % were tried corresponding to T1-T5 for one, T7-T11 for two and T13-T17 for three sprays, respectively, and T6, T12 and T18 for control of one, two and three sprays. These formulations of Eb, chlorantraniliprole and novaluron were sprayed on *kusmi* lac culture under different treatments. First, second and third spray was carried out at 28-30, 38-40 and 60-65 days of inoculation, respectively. For all formulations and in control, fungicide carbendazim (0.05%) was added to prevent fungal infection on lac crop. The crop was harvested 15 days prior to maturity (larval emergence), and after separating lac encrustation from sticks, it was quantified in terms of weight. The plant wise yield data for sticklac was recorded. The effect of insecticidal treatments on lac productivity was assessed on the basis of weight of scrapped lac. The per cent increase in lac

productivity over control was calculated. The experiment was laid out in Randomized Block Design (RBD). Data obtained was subjected to square root transformation before running an analysis of variance (ANOVA) (Gomez and Gomez 1984). Treatment means were compared at $P < 0.05$ level of significance using least square difference (LSD). Duncan's multiple range test was carried out to calculate the differences between various means using statistical software AGRES.

RESULTS AND DISCUSSION

Effect of emamectin benzoate (5% SG): Six concentrations (0.00025, 0.0005, 0.001, 0.0015, 0.0020, and 0.0025%) of Eb were evaluated on lac culture with variation in one, two and three number of sprays. The mean yield varied from 183-450, 233-775 and 325-842 g/plant for one, two and three sprays against 175, 183 and 192 g in control, respectively. The % increase in yield over control varied from 4.57-157.14, 27.28-322.73 and 69.56-339.12% for one, two and three sprays, respectively. The comparison of mean values with respective control of one, two and three sprays indicates significant increase in yield over control with 0.0005%, and higher concentration in case of single spray. With two sprays, even lowest concentration (0.00025%) recorded significant increase in yield over control ($P < 0.05$). Similar result was observed with three sprays. Considering highest yield with lowest concentration, it was observed that a concentration of 0.0025% will be suitable option with two sprays as it enhanced yield to the tune of 322.73% (Table 1).

Eb is a semisynthetic derivative of abamectin and has been developed for the purpose of controlling lepidopterous pests on a variety of vegetable crops worldwide (Liguori *et al.* 2010). This pesticide stimulates the release of the neurotransmitter γ -aminobutyric acid (GABA). The efficacy of Eb on different crops against several lepidopteran pests have been evaluated and established by various workers

Table 1 Response of emamectin benzoate (5% SG) on *kusmi*-winter lac crop yield

Conc. (% a.i.)	One spray		Two spray		Three spray	
	Mean yield per plant (g)*	% increased yield over control	Mean yield per plant (g)*	% increased yield over control	Mean yield per plant (g)*	% increased yield over control
0.00025 (0.05 g/l)	183 (13.25) ^a	4.57	233 (15.14) ^{ab}	27.28	325 (13.09) ^{abc}	69.56
0.0005 (0.1 g/l)	208 (14.29) ^{ab}	19.05	275 (16.41) ^{ab}	50.00	333 (13.55) ^{abc}	73.91
0.0010 (0.2 g/l)	208 (14.19) ^{ab}	19.05	267 (15.25) ^{ab}	45.46	350 (15.18) ^{abc}	82.61
0.0015 (0.3 g/l)	283 (16.67) ^{ab}	61.90	325 (17.74) ^{abc}	77.28	367 (15.70) ^{abc}	91.30
0.0020 (0.4 g/l)	342 (18.41) ^{abc}	95.24	375 (18.14) ^{abc}	104.55	583 (21.83) ^{cd}	204.34
0.0025 (0.5 g/l)	450 (20.87) ^{bc}	157.14	775 (27.84) ^d	322.73	842 (25.41) ^d	339.12
Control	175 (13.17) ^a	0.00	183 (13.43) ^a	0.00	192 (12.70) ^a	0.00
SE				3.31		
Df				20		
F				3.54		
P				0.0		

*Figures in parentheses are transformed values to $\sqrt{n+0.5}$. Means marked with different letters are significantly different ($P < 0.05$)

(Ishaaya *et al.* 2002, Lioriatti *et al.* 2009, Bengochea *et al.* 2014). The evaluation trials have also been carried out in lac culture to suppress lepidopteran pests of lac crops successfully (Jaiswal *et al.* 2017). In the present study, Eb has been found effective in enhancing the yield of sticklac basically due to fact by reducing the population of insect-pest in lac ecosystem.

Effect of chlorantraniliprole (20% w/v SC): Six concentrations (0.001, 0.002, 0.004, 0.006, 0.008, and 0.01%) were evaluated with variation in one, two and three number of sprays. The mean yield varied from 158-392, 175-550 and 183-650 g/plant for one, two and three sprays compared to 150, 158 and 175 g in control, respectively. The per cent increase in yield over control varied from 5.56-161.33, 10.76-248.10 and 22.0-333.33% for one, two and three sprays, respectively, with different concentrations of insecticide. The comparison of mean values with respective control of one, two and three sprays indicates significant increase in yield over control at 0.006%, and higher concentration in case of single spray. With two and three sprays, a lower concentration (0.004%) recorded significant increase in yield over control. Considering highest yield with lowest concentration, the concentration of 0.01% will be better option with three sprays as it enhanced yield to the tune of 333.33 % (Table 2).

Chlorantraniliprole is a new compound belonging to a new class of selective insecticides (anthranilicdiamides), which features a novel mode of action (group 28 in the IRAC classification) (IRAC 2009). By activating the insect ryanodine receptors (RyRs) it stimulates the release and depletion of intracellular calcium stores from the sarcoplasmic reticulum of muscle cells, causing impaired muscle regulation, paralysis and ultimately death of sensitive species (Anonymous 2007, Cordova *et al.* 2006). It is effective on broad range of crops to control pests belonging to the order lepidoptera and some coleopteran, Diptera, Hemiptera and Isoptera. In the European Union,

the product is under registration at the rates between 10-60 g a.i./ha. Considering these features and the novelty of the compound, the bio-safety and bio-efficacy potential of chlorantraniliprole was successfully applied in lac insect-pest management programme (Singh and Jaiswal 2018). Similar to Eb, chlorantraniliprole was also found to be effective in enhancing yield of sticklac after field application in the present study. Earlier study on insect-pest management of lac with selected insecticides, viz. indoxacarb, fipronil, spinosad, ethofenprox and formulations of bio-pesticides showed bio-efficacy on insect- predators and enhanced productivity of sticklac crop growing on lac host trees, viz. *B. monosperma*, *Z. mauritiana* and *S. oleosa* (Singh *et al.* 2014). Recently, increase in broodlac productivity was also reported by application of indoxacarb, fipronil, spinosad and flubendiamide on kusmi lac crop growing on *Z. mauritiana* (Jaiswal *et al.* 2018). The present study is the first report on the response of emamectin benzoate and chlorantraniliprole for enhancing sticklac yield on *F. semialata*.

Effect of novaluron (5% EC): Five concentrations (0.000125, 0.00025, 0.0005, 0.001, 0.0015%) were evaluated on lac culture with one, two and three number of sprays. The mean yield varied from 200-283, 200-400 and 208-467 g/plant for one, two and three sprays, respectively, compared to 158, 158 and 150 g in control. The per cent increase in yield over control varied 26.58-79.11, 26.58-153.16 and 38.67-211.33 for one, two and three sprays, respectively, with different concentrations of insecticides. The comparison of mean values under different treatments and control was observed at par, indicating that yield is not affected with novaluron.

Novaluron is an insect growth regulator with pesticidal properties. It is inhibitor of chitin biosynthesis with types 0 growth regulation [IRAC 2017]. It is a benzoylphenyl urea developed by Makhteshim-Agan Industries Ltd. In the United States, the compound has been used on food crops, including apples, potatoes, brassica, ornamentals and cotton.

Table 2 Response of chlorantraniliprole (20% w/v SC) on kusmi-winter lac crop yield

Conc. (% a.i.)	One spray		Two spray		Three spray	
	Mean yield per plant (g)*	% increased yield over control	Mean yield per plant (g)*	% increased yield over control	Mean yield per plant (g)*	% increased yield over control
0.001 (0.05 ml/l)	158 (12.54) ^a	5.56	175 (13.10) ^a	10.76	183 (13.09) ^a	22.00
0.002 (0.1 ml/l)	167 (12.36) ^a	11.33	183 (13.09) ^a	15.82	183 (13.55) ^a	22.00
0.004 (0.2 ml/l)	167 (12.87) ^a	11.33	200 (13.89) ^{ab}	26.58	242 (15.18) ^{ab}	61.33
0.006 (0.3 ml/l)	275 (16.34) ^{abc}	83.33	292 (17.08) ^{abc}	84.81	275 (15.70) ^{ab}	83.33
0.008 (0.4 ml/l)	275 (15.91) ^{ab}	83.33	292 (17.08) ^{abc}	84.81	492 (21.83) ^{cde}	228.00
0.010 (0.5 ml/l)	392 (19.54) ^{bcd}	161.33	550 (23.45) ^{de}	248.10	650 (25.41) ^e	333.33
Control	150 (12.19) ^a	0.00	158 (12.35) ^a	0.00	175 (12.70) ^a	0.00
SE				2.81		
Df				20		
F				3.86		
P				0.0		

* Figures in parentheses are transformed values to $\sqrt{n+0.5}$. Means marked with different letters are significantly different ($P < 0.05$)

It has been also evaluated on lac ecosystem by treatment of broodlac and found effective in suppressing lepidopteran population under laboratory condition (Jaiswal *et al.* 2018) but in the present study, effect on yield of sticklac was not manifested as recorded with other two insecticides evaluated.

Production of lac is one of the major interventions for livelihood support to resource constraint farmers inhabiting in forest and sub-forest areas of the country. Like other crops, lac crop is also attacked by insect-pest and thus, one of the major risk factor to get a sustained lac yield. In the present study, the *kusmi* lac crop was raised on bushy lac host, *Flemingia semialata* and three pesticides, earlier evaluated for insect-pest suppression, have been evaluated for their response on productivity of sticklac. Field application of emamectin benzoate (0.0025% a.i.) and chlorantraniliprole (0.01% a.i.) on standing lac crop resulted in significant increase in yield to the tune of 339 and 333%, respectively, over control after three sprays. However, effect of novaluron on yield of sticklac was not manifested in the present study. This is first report of emamectin benzoate, chlorantraniliprole and novaluron response on yield of sticklac on *F. semialata*.

ACKNOWLEDGEMENTS

The authors are grateful to Mr A K Sinha and P Patamajhi, Senior Technical Officer for assistance in experimental work.

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