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MANAGEMENT OF LAC PREDATORS THROUGH BIORATIONAL MANAGEMENT APPROACHES

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ABSTRACT

An experiment was conducted at Lac Research Station at Nachole of Chapainawabganj district during July to October 2017 and 2018 which is kartiki lac crop season to evaluate botanical and biochemicals against two voracious lac predators *Eublemma amabilis* and *Pseudohypatopa pulverea* following RCB design. The highest reduction of lac predators, *E. amabilis* (79.1-80.6)% and *P. pulverea* (74.8-75.0)% was found when Sprayed with Neem seed extract @ 10g crushed seed/litre of water followed by Azadirachtin (Bio-neem plus 1EC) @ 1.0 ml/ litre of water and Spinosad (Success 2.5 SC) @ 1.2 ml/liter of water. Percent survival of lac insect was increased by applying biopesticides for the control of predators with the highest 28.5 and 29.6% survival at LRS and Nachole respectively, in Neem seed extract treated plants. Yield of lac was increased by 15.4-29% at LRS and 17.4-28.1% at Nachole over untreated control indicating that use of biopesticides successfully reduced the infestation of two dangerous predators in the crop field resulting in increased lac yield and the highest lac yield (6.7 kg/plant at LRS and 6.2 kg/plant at Nachole, respectively) was recorded in Neem seed extract treated plants.

Keywords: Lac, predators, management, insect survival, scrapped lac, lac yield

Introduction

Lac is the resinous substance of wide industrial applications, secreted by the tiny lac insect, *Kerria lacca* (Kerr) belonging to the family Tachardiidae (Kerriidae) and order Hemiptera (Pal 2009, Mohanta *et al*. 2012). It consists of resin, wax and dye, which has a wide range of applications in varnishes, paints, polishes, jewellery industries, textiles, cosmetics, perfumes, foods and pharmaceuticals. Annual production of lac in Bangladesh is around 700 tons (Mustafa 2002) which was increased in subsequent years yielding around 1000 tons per year (Sarker *et al*. 2014). Though the overall climatic condition of Bangladesh is favorable for lac production, lac grows well in the north-west region of Bangladesh, especially in Chapainawabganj, Rajshahi and Naogaon districts. Many farmers, mostly belonging to marginal groups, grow lac in those localities and earn a subsidiary income from its cultivation. The commercially important lac insect species in various lac producing countries are different according to the local environment. *K. lacca*, represented by two infra-sub specific forms, viz., *Kusmi* and *Rangeeni*. However, sub-species *Rangeeni* of *K. lacca* Kerr is being cultivated in Bangladesh in two seasons a year namely kartiki and baishakhi lac crop and the crops have been named according to their harvesting time (Rahman *et al*. 2009). Lac crop production in Bangladesh is vulnerable due to varying biotic and abiotic stresses (Bhagat and Mishra 2002, Jaiswal *et al*. 2008). During its life cycle, the lac insect spends only a few hours for active mobility and thereafter spends a complete sedentary life. Therefore, they are prone to be attacked by many insect predators and parasitoids, causing substantial damage to the lac crop qualitatively and quantitatively (Singh *et al*. 2011). Two Lepidopteran predators, namely *Eublemma amabilis* (Moore) and *Pseudohypatopa pulverea* (Meyr) are considered as the key predators since they cause nearly 30-40 per cent damage of lac crops (Mishra 2002; Jaiswal *et al*. 2008, Singh *et al*. 2009). According to Mishra and Malhotra (1976), the caterpillars of *Eublemma amabilis* destroy about one-third of the lac crop each year.

The use of chemicals in controlling lac predators (*E. amabilis* and *P. pulverea*) has been in practice under field

conditions without harming lac culture in India since a long time (Jaiswal *et al*. 2007, Arora *et al*. 2009). However, the deliberate use of conventional pesticides is causing environmental pollution and health hazards, which is now an important global concern for Sustainable Development Goals (SDGs). Biopesticides use can be a smart solution here to control insect pests and protect crops from its damages (Tijjani *et al*. 2016). Therefore, the present study was undertaken to develop and popularize a safe, effective and ecofriendly biorational management approach for the control of lac predators without harming lac insects.

Materials and Methods

The experiment was carried out at Lac Research Station (LRS) and Nachole upazilla of Chapainawabganj district in two consecutive kartiki crop seasons during July to October 2017 and July to October 2018. The pooled data were used for analysis and interpretations. Four treatments were studied and each treatment was replicated thrice following RCB design. The treatments were as follows: T_1= Spraying of Neem seed extract @ 10g crushed seed/ litre of water, T_2= Spraying of Azadirachtin (Bio-neem plus 1 EC) @ 1.0 ml/litre of water, T_3= Spraying of Spinosad (Success 2.5 SC) @ 1.2 ml/litre of water and T_4= Control (water spray only). The hosts were 20-years old ber plants and one ber plant was considered as one replication of a treatment. Thus 12 ber plants were used for the experiment at each site. The host plants were inoculated by broodlac in the last week of June with 50 sticks of 30 cm length in each plant. During inoculation, the broodlac sticks were tied onto the host branches both vertically and horizontally for the reason that the young shoots get full inoculation. After 7 days, when the inoculation was completed the broodlac sticks were collected from the host and brought to the store for collection of sticklac.

After settlement of the tiny lac nymphs on young shoots, 5 samples, each of 10 cm^2 area, were selected from different shoots in each replication and the number of nymphs was recorded (in-situ) separately at 15-days interval up to crop harvest. After cell formation by the nymphs, the population was enumerated on the estimated basis of the number of cells on a10 cm^2 area of 5 shoots selected from each replication. The individual cells were recorded with the help of fine needle and forceps separately at 15-days interval up to crop harvest. Regular observations were made on the incidence of lac predators. The treatments were applied twice: First immediately after the pest infestation noticed while the second in one month after the first application. The appearance of lac predators, *E. amabilis* and *P. pulverea* was observed at 10-days interval up to crop harvest. This observation was made at the same time of counting of lac nymphs at the same place. The stages of the predator were examined and its number was recorded. The yield of scrapped lac was recorded separately during harvest. Per cent survival of lac insects was calculated on the basis of initial and final population data. Per cent reduction of predator population was calculated over control treatment.

$$\%\text{Lac Insect survival} = \frac{\text{Final population}}{\text{Initial population}} \times 100$$

Results and Discussion

The highest reduction (79.1-80.6)% of *E. amabilis* populations in both locations was found in the tree sprayed with Neem seed extract @ 10g crushed seed/L followed by (72.9-75.5)% reduction in Azadirachtin 1 EC @ 1.0 ml/L and (67.3-73.3)% reduction in Spinosad 2.5 SC @ 1.2 ml/L of water (Table 1 and 2). This reduction of population was observed up to 30 days of its application as compared to untreated control. The use of chemicals in controlling lac predators *E. amabilis* and *P. pulverea* has been in practice under field conditions without harming lac culture in India since a long time (Jaiswal *et al*. 2007, Arora *et al*. 2009). Jaiswal *et al*. (2004) reported that Cartap hydrochloride and Ethofenprox could be used for the management of lepidopteran (*E. amabilis* and *P. pulverea*) and the neuropteran (*Chrysopa* spp.) predators of *K. lacca*. Gupta and Bhattacharya (2007) evaluated the toxicity of naturalyte compound against a lac predator *Spilarctia obliqu*a and reported that Spinosad was more active after 48 h of treatment. Considering the hazardous effects of chemicals on the environment, the use of biopesticides is presently in practice to control insect pests in crop fields and thus neem seed extract exhibited to be most effective in controlling lac predator *E. amabilis* and can be used as a substitute for the currently used conventional insecticides.

The highest reduction (74.8-75.0)% of *P. pulverea* populations in both locations (Table 3 and 4) was found in the tree sprayed with Neem seed extract @ 10g crushed seed/L followed by (68.5-70.2)% reduction in Azadirachtin 1 EC @ 1.0 ml/L and (64.1-65.3)% reduction in Spinosad 2.5 SC @ 1.2 ml/L of water. This

Table 1. Effect of different treatments in controlling *Eublemma amabilis* at Lac Research Station, Chapainawabganj

Treatments	Mean no. of *E. amabilis* per 10 cm^2 area of shoot						
	Pretreatment data 09 Aug. (1DBA)	1st application			2nd application		
		20 Aug. (10DAA)	30 Aug. (20DAA)	09 Sept. (30DAA/ (1DBA)	19 Sept. (10DAA)	29 Sept. (20DAA)	09 Oct. (30DAA)
Neem seed extract @ 10g seed/L	0.9	0.5 (74.9)	0.6 (75.2)	0.7 (79.1)	0.7 (74.6)	0.7 (75.5)	0.6 (70.5)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	0.9	0.6 (70.1)	0.7 (72.9)	1.0 (69.7)	0.8 (70.6)	0.9 (70.5)	0.8 (64.5)
Spinosad (Success) 2.5 SC @ 1.2ml/L	0.9	0.7 (62.6)	0.9 (64.7)	1.3 (59.4)	0.9 (67.3)	1.0 (67.1)	0.9 (57.1)
Control (water spray only)	1.1	1.9	2.6	3.2	2.8	3.0	2.2

Values in the parentheses are per cent reduction of predator population over control. DBA = Day Before Application, DAA = Day After Application

Table 2. Effect of different treatments in controlling *Eublemma amabilis* at Nachole, Chapainawabganj

Treatments	Mean no. of *E. amabilis* per 10 cm^2 area of shoot						
	Pretreatment data 09 Aug. (1DBA)	1st application			2nd application		
		20 Aug. (10DAA)	30 Aug. (20DAA)	09 Sept. (30DAA/ (1DBA)	19 Sept. (10DAA)	29 Sept. (20DAA)	09 Oct. (30DAA)
Neem seed extract @ 10g seed/L	1.0	0.4 (73.2)	0.6 (77.8)	0.9 (70.4)	0.5 (80.6)	0.5 (75.1)	0.5 (74.9)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	1.0	0.5 (69.9)	0.7 (73.2)	1.1 (64.0)	0.7 (75.5)	0.7 (69.5)	0.5 (71.7)
Spinosad (Success) 2.5 SC @ 1.2ml/L	0.8	0.5 (65.4)	0.9 (65.0)	1.3 (57.6)	0.7 (73.3)	0.8 (62.4)	0.8 (58.3)
Control (water spray only)	0.9	1.5	2.6	3.1	2.7	2.1	1.9

Values in the parentheses are per cent reduction of predator population over control. DBA = Day Before Application, DAA = Day After Application

Table 3. Effect of different treatments in controlling *Pseudohypatopa pulverea* at Lac Research Station, Chapainawabganj

Treatments	Mean no. of *P. pulverea* per 10 cm^2 area of shoot						
	Pretreatment data 09 Aug. (1DBA)	1st application			2nd application		
		20 Aug. (10DAA)	30 Aug. (20DAA)	09 Sept. (30DAA/ (1DBA)	19 Sept. (10DAA)	29 Sept. (20DAA)	09 Oct. (30DAA)
Neem seed extract @ 10g seed/L	0.3	0.2 (70.2)	0.2 (75.0)	0.4 (64.6)	0.5 (71.9)	0.7 (66.5)	1.0 (65.2)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	0.1	0.2 (70.2)	0.3 (66.3)	0.5 (58.4)	0.5 (68.3)	0.7 (63.5)	1.1 (60.6)
Spinosad (Success) 2.5 SC @ 1.2ml/L	0.3	0.3 (59.7)	0.3 (58.8)	0.5 (53.1)	0.6 (64.1)	0.9 (53.5)	1.3 (53.7)
Control (water spray only)	0.2	0.7	0.8	1.1	1.7	2.0	2.9

Values in the parentheses are per cent reduction of predator population over control. DBA = Day Before Application, DAA = Day After Application

Table 4. Effect of different treatments in controlling *Pseudohypatopa pulverea* at Nachole, Chapainawabganj

Treatments	Mean no. of *P. pulverea* per 10 cm^2 area of shoot						
	Pretreatment data 09 Aug. (1DBA)	1st application			2nd application		
		20 Aug. (10DAA)	30 Aug. (20DAA)	09 Sept. (30DAA/ (1DBA)	19 Sept. (10DAA)	29 Sept. (20DAA)	09 Oct. (30DAA)
Neem seed extract @ 10g seed/L	0.5	0.2 (72.0)	0.4 (72.0)	0.5 (71.9)	0.5 (74.8)	0.6 (74.2)	0.5 (73.9)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	0.5	0.3 (65.3)	0.4 (66.4)	0.6 (64.1)	0.7 (67.2)	0.7 (68.5)	0.6 (67.7)
Spinosad (Success) 2.5 SC @ 1.2ml/L	0.5	0.3 (65.3)	0.5 (62.4)	0.7 (61.1)	0.7 (64.7)	0.8 (63.4)	0.9 (60.0)
Control (water spray only)	0.4	0.8	1.3	1.7	2.0	2.1	2.0

Values in the parentheses are per cent reduction of predator population over control. DBA = Day Before Application, DAA = Day After Application

reduction of population was observed up to 30 days of its application as compared to untreated control. Lac growers mainly depend on chemical uses for the control of *P. pulverea* since long time (Bhattacharya *et al*. 2005, Janghel *et al*. 2014). Jaiswal *et al*. (2004) reported that Cartap hydrochloride and Ethofenprox could be used for the management of lepidopteran (*E. amabilis* and *P. pulverea*). Gupta and Bhattacharya (2007) reported that Spinosad was more active after 48 hr of treatment against *P. pulverea*. These findings are similar with the present findings, where an eco-friendly, safe and biodegradable biopesticide Neem seed extract exhibited as a better option for the control of lac predators.

Spraying of biopesticides for controlling lac predators increased lac insect survival and the highest 28.5% and 29.6% survival at LRS and Nachole respectively, were observed in Neem seed extract treated plants followed by Azadirachtin and Spinosad over untreated control plants (Table 5 and 6). The lowest lac insect survival (17% at LRS and 17.4% at Nachole) was found in control plants and this was natural survival, survival against hard competition for food and space after settlement, survival against different biotic and abiotic constraints during its life cycle. Singh *et al*. (2011) reported that the lac insects are prone to be attacked by many insect predators and parasites during their life cycle and this finding was supported by Mishra (2002) and Jaiswal *et al*. (2008). Table 5 and 6 also showed that biopesticide application increased lac insect survival by 24.3-40.2% at LRS and 25.6-41.3% at Nachole over untreated control. The increase in lac insect survival in biopesticides treated plants might be happen due to the control of two voracious predators *E. amabilis* and *P. pulverea* without affecting lac insect populations. Similar findings were reported by Jaiswal *et al*. (2004 and 2007), Bhattacharya

Table 5. Effect of different treatments on lac insect survival and yield of lac at Lac Research Station, Chapainawabganj

Treatments	Lac nymph per 10 cm^2 area of shoot			Yield of Scrapped lac (kg/ tree)
	Initial population	Final population	Survival (%)	
Neem seed extract @ 10g seed/L	923.3	262.7	28.5 (+40.2)	6.7 a (+29.0)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	987.5	255.2	25.8 (+34.2)	6.1 ab (+22.2)
Spinosad (Success) 2.5 SC @ 1.2ml/L	981.9	220.7	22.5 (+24.3)	5.6 b (+15.4)
Control (water spray only)	985.6	167.5	17.0	4.7 c
Level of Significance	-	-	-	*
LSD value	-	-	-	0.641

Means in a column having same letter(s) did not differ significantly by LSD test at 0.01 level. Values in the parentheses are per cent increase of survival and lac yield over control.

Table 6. Effect of different treatments on lac insect survival and yield of lac at Nachole, Chapainawabganj

Treatments	Lac nymph per 10 cm^2 area of shoot			Yield of Scrapped lac (kg/ tree)
	Initial population	Final population	Survival (%)	
Neem seed extract @ 10g seed/L	893.3	264.7	29.6 (+41.3)	6.2 a (+28.1)
Azadirachtin (Bio-neem plus) 1 EC @ 1.0ml/L	827.5	213.2	25.8 (+32.5)	5.6 ab (+21.5)
Spinosad (Success) 2.5 SC @ 1.2ml/L	861.9	200.7	23.3 (+25.6)	5.4 b (+17.4)
Control (water spray only)	905.6	157.5	17.4	4.4 c
Level of Significance	-	-	-	*
LSD value	-	-	-	0.590

Means in a column having same letter(s) did not differ significantly by LSD test at 0.01 level. Values in the parentheses are per cent increase of survival and lac yield over control.

et al. (2005), where they successfully controlled lac predators by applying insecticides at a certain dose under field conditions without harming lac culture.

A significant difference of lac yield was observed in different treatments (Table 5 and 6). The highest lac yield (6.7 kg/plant at LRS and 6.2 kg/plant at Nachole) was found in Neem seed extract treated plants identically followed by Azadirachtin treated plants (6.1 kg/plant at LRS and 5.6 kg/plant at Nachole). The lowest yield of lac (4.7 kg/plant at LRS and 4.4 kg/plant at Nachole) was recorded from untreated control plants. Yield of lac was increased by 15.4-29% at LRS and 17.4-28.1% at Nachole over untreated control indicating that use of biopesticides successfully reduced the infestation of two dangerous predators in the crop field resulting in increased lac yield. The results were at par with the findings reported by Malhotra and Katiyar (1975) mentioning that lac crop being vulnerable to both biotic and abiotic factors resulting in lowering the yield. Two lepidopteran predators *E. amabilis* and *P. pulverea* cause 30-40 per cent damage to lac crop (Mishra 2002, Bhattacharya *et al.* 2008, Jaiswal *et al*. 2008, Singh *et al*. 2009). They reported that use of chemicals and botanicals reduced the population of lac predators and increased the lac yield.

Lac production is seriously affected by two lepidopteran predators *E. amabilis* and *P. pulverea* that requires a sustainable management. The findings of this study revealed that a biorational approach in management of lac insect predators is viable and can reduce the load of chemical pesticides. The biopesticides are environment friendly and can reduce the predator population without harming lac insect population and thereby increase lac production.

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