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BIOLOGICAL CONTROL IN LAC CULTIVATION - LIMITATIONS AND PROSPECTS

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ABSTRACT Lac is an important cash crop grown in India and more than 80 per cent of lac produced is exported. However, its production in the country has remained unstable particularly during the last 30 years, varying widely between 38.8 thousand tonnes in 1968 to 9.1 thousand tonnes in 1979, due to variety of reasons. Important among these is damage caused by insect enemies. Chemical control of these pests, though quite successful, is undesirable due to possible residue hazards as the lac and the dye obtained from this insect find use in coating, perfumery, textile industry and many other similar applications. Biological control in lac cultivation in the past also did not prove successful because studies centered mostly around only two predators namely, *Eublemma amabilis* Moore and *Pseudohypatopa pulverea* Meyr. and damage caused by parasitiods of lac insect remained unattended as it was considered negligible. Further, no attempt was made to tap naturally available parasitoids, status of some insects associated with lac still remained doubtful and lastly little information was available on influence of host on its biotic complex. Feasibility of successful biological control of lac insect enemies in the light of new findings has been discussed.
KEY WORDS Lac cultivation, biological control.

INTRODUCTION

Lac is an important cash crop grown in India especially in the plateau region of Bihar and adjoining States. Besides providing secondary income to more than three million families of tribals, lac is a valuable foreign exchange earner as more that 80 per cent of lac producted in our country is exported in one form or the other. However, lac production in the country has remained unstable particularly during the last 30 years as it varied widely between 38.8 thousand tonnes in 1968 to 9.1 thousand tonnes in 1979 due to variety of reasons. The soft bodied lac insects, particularly of genus *Kerria*, produce resinous secretion for their protection. Inspite of the protective covering the insect after settlement is always a sitting prey for its enemies due to its sedentary nature. Estimations have been made that the damage caused by insect enemies alone amounts to over 40 per cent on an average in a crop. Chemical control of these pests, though quite successful (Malhotra & Katiyar, 1979), is undesirable due to possible residue hazards as the lac resin and the dye obtained from this insect find use in coating, perfumery, textile industry and many other similar applications. Hence biological control caught the attention of Entomologists. Though work on this aspect started in thirties, various attempts made did not yield encouraging results. Moreover, the studies carried out were seldom taken to their conclusive end and the programme was abandoned in early sixties.

Factors responsible for failure of biological control in lac

Skewed approach : Amongst the twentytwo predators of lac insect, *Eublemma amabilis* Moore, *Pseudohypatopa pulverea* Meyr., *Chrysopa madestes* Banks and *C. lassiperda* Kimmins have been considered to be the most important and destructive ones (Varshney, 1976). *Eublemma amabilis* and *P. pulverea* are associated with lac insect throughout the year and biocontrol studies centered around these two only. The larvae of these predators bit holes in lac encrustation and fed on lac insects. As lac insect grew, the thickness of lac also increases and parasitoids of these two predators are rendered ineffective due to creptic mode of life of the predators. The potential value of *Trichogrammatoidea nana* Zehnt. and *T. minutum*, the two egg parasitoids of the predators appeared to hold great promise as they parasitised the hosts in their egg stage, while *T. minutum*, though quite effective under laboratory conditions, did not parasitise eggs of predators in the field. The chief drawback with *T. nana* was that most of the parasitoids which developed inside that eggs of *E. amabilis* were enable to cut holes and emerge. Moreover, activity of the parasitoids slackened by the time lac incrustation became thick and

continuous and these were covered with white waxy filaments (Krishnaswamy, 1956). The *Chrysopa* spp. though of sporadic nature was able to cause havoc at times during rainy season to lac crop grown particularly on *kusum*, *Schleichera oleosa* when left unattended.

Parasitoids ignored : Though about 30 parasitoids of the lac insect have been reported (Rizvi, 1986 and Varshney, 1976), they received practically no attention as the damage caused by them was considered to be negligible (Glover, 1937 and Narayanan, 1962). However, studies carried out recently have shown that the damage caused by the parasitoids is substantial. As a result of parasitisation, resin produced by lac insect and its fecundity reduced by about 15 and 30 per cent respectively (Sharma, personal communication). Biological control of these parasitoids particularly of chalcids does not seem feasibile as only three species of chalcids have been reported parasitic on other chalcids but all of them were primary parasitoids of lac insect as well.

Low proportion of hyperparasites in nature : Out of the 30 reported parasitoids of lac predators (Varshney, 1976), 12 were of *P. pulverea*, 9 of *E. amabilis*, 7 of *Chrysopa* spp. and 4 were common to both *P. pulverea* and *E. amabilis* (Table 1a). Among all the beneficial parasitoids, *Bracon greeni* Ashm., *B hebetor* Say., *Pristomerus sulci* Mahd. & Kolub and *Apanteles tachardiae* Cam. showed some prospects. But unfortunately beneficial parasitoids form only a small (7.78%) proportion (Sharma *et al.* 1997) to the injurious insects and thus, an unfavourable equilibrium between lac predators and their parasitoids have been reached over the years.

Doubtful status of some lac associated fauna : Status of some of the insects associated with lac insect still remains doubtful. Some of these are *Tyndarichus* sp., *Thomsonica* sp. (Gokulpure *et al.* 1979), *Eupelmus tachardiae* (Howard) and 13 others listed by Varshney (1976). Whether they are parasitic on lac insect or its predators remains to be confirmed *Eurytoma pallidiscapus* Cam. has

Table 1 a. Reported parasitoids of predators of lac insect

Eublemma amabilis	*Pseudohypatpa pulverea*	Both *E. amabilis* and *P. pulverea*	*Chrysopa spp.*	Doubtful status
Aphrastobracon flavipennis Ashm.	*Agathis bischoffi* Fab.	*Brachymeria tachardiae* Cam.	*Anagyrus greeni* Howard	*Chelonus* sp.
Brachycyrtus eublemmae Rao	*A coryphae* Nixon	*Bracon hebetor* Say	*Brachycyrtus* sp.	*Eupelmus tachardiae* (Howard)
Bracon greeni Ashm.	*A. festiva* Muesback	*Trichogramma* sp.	*B. eublemmae* Rao	*Eurytoma sp.* (near to pallidiscapus)
B. tachardiae Cam.	*Apanteles fakhrulhajiae* Mahd.	*T. nana* Zehnt.	*Cheiloneurus* sp.	
Brasema annulicaudis Cam.	*A tachardiae* Cam.		*Conostigmus* sp.	
Cedria paradoxa Wlkn.	*Chelonus cyclopyrus* Franz.		*Perilampus* sp.	
Elasmus claripennis Cam.	*Elasmus albomaculatus* Gahan		*Telenomus* sp.	
E. colemani Mahd.	*Eurytoma pallidiscapus* Cam.			
E. indicus Rohwer	*Perisierola* sp. *P. pulveriae* Kurien *Pristomerus sulci* Mahd. & Kolub. *Phaneratoma buchneri* Fab.			

(After Varshney, 1976)

Table 1 b. New parasitoids of predators of lac insect (including mites & fungus) reported after 1976

Parasitoid	Target pest / stage	Reference
Anastatoidea sp.	Pupal endoparasite of *Eublemma amabilis*	Malhotra & Bhattacharya (1995)
Apanteles angaleti Muesback	Endoparasite of *Pseudohypatopa pulverea*	Gokulpure *et al.* (1978)
Euremeros namkumense sp. nov.	*E. amabilis*	Sharma (1993)
E. tumespiraculum Bhat	*E. amabilis*	Sharma (1993)
Isodromus axillaris Timberlake	Larva of *Chrysopa lacciperda*	Krishnamoorthy & Mani, (1989)
Tetrastichus sp.	- do -	- do -
Trichogrammatoidea bactrae	Egg parasitoid of *E. amabilis* & *P. pulverea*	Sushil *et al. (1995)*
Trichogrammatoidea brasiliensis	- do -	- do -
T. chilonis Ishii	- do -	- do -
T. pretiosum Riley	- do -	- do -
Telenomus remus Nixon	- do -	- do -
Dinothrombium sp. (Trombidiidae Acarina)	*E. amabilis* caterpillars	Mishra & Malhotra (1976)
Paecilomyces sp. (Fungus)	*E. amabilis*	Bhattacharya *et al.* (1996)

been reported to be larval/pupal parasitoid of *P. pulverea* but Chowdhury and Bhattacharya (1971) have observed that it cannot parasitise the host unless they are paralysed by *B. hebetor* and *Perisierola pulveriae* Kurien or parasitised by *Brachymeria tachardiae* Cam.

Fragmentary information on related aspects : Although lac insects have been reported to thrive on more than 400 plant-hosts, tetratrophic interactions have not been studied so far. It is relevant here to point out that some natural enemies favoured the same host/ prey occurring on certain host plants but not on others. Despite a complex of native parasites no serious attempts have been made to find out why they were unable to exercise adequate control of the predators. *Bracon greeni, A. tachardiae* and few others could be bred on alternate hosts in the laboratory (Table 2) but they failed to maintain their population at effective level when released in the field. Differences in crop-wise and locality-wise relative abundance of insects associated with lac insect have been observed (Sah, 1990 and Sharma *et al.* 1997). This factor was not taken care of while carrying out large scale releases of beneficial insects. Similarly no serious attempts were made to introduce indigenous / exotic parasitoids of the important predators. Recent interest in developing biocontrol management in lac insect revealed how basic aspects of even the various diseases (fungal/ microbial) affecting lac insect are still unknown,

Table 2. Parasitoids used in biological control of lac insect predators

Parasitoid	Host	Mass reared on	Potentiality
Apanteles tachardiae Cam.	*Pseudohypatopa pulverea* Meyr.	*Corcyra cephalonica*	+
Aphrastobracon flavipennis Ashm.	*Eublemma scitula* Rambr.	*E. amabilis* (did not paralyse *E. amabilis)*	-
Bracon hebetor Say	*E. amabilis Moore*	*Etiella zinckenella* Triet	+
Elasmus claripennis Cam.	- do -	could not be reared	+
Perisierola pulveriae Kurien	*P. pulverea*	*C. cephalonica*	-
Trichogrammatoidea nana Zeht.	*E. amabilis* and *P. pulverea*	*Ephestia* sp.	+ in lab

not to mention the lack of such information on their natural enemies.

Prospects of effective biological control

Augmentation of beneficial parasitoids : Broodlac after inoculation is scraped for processing. In this process, beneficial parasitoids along with predators and inimical parasitoids are destroyed. A simple low cost indigenous device which is capable of seperating out predators, beneficial and injurious parasitoids into seperate chambers has been developed (Jaiswal *et al.* 1998). The beneficial ones can be released in the field to enable to improve their performance by augmentation in nature. The method can be easily incorporated in the integrated pest management programme.

Large scale production of host/prey organism in the insectary to enable natural colonies to be increased and made available on large scale was hampered as *P. pulverea*, a major predator, could not be bred in the laboratory. Ability to rear this predator on artificial diet has now made host-prey studies amenable to laboratory experiments (Bhattacharya *et al.* 1998).

Introduction of new parasitoids : Some new parasitoids / fungus affecting predators of lac insect have been reported (Table 1 b). Potential of some of these as biocontrol agents is yet to be assessed. Malhotra and Mishra (1971) have reported 91 per cent parasitisation of *E. amabilis* by *Elasmus claripennis* Cam. in nature showing potentiality of this parasitoid as a powerful biocontrol agent. Similarly, a mite *Dinothrombium* sp. has been found attacking caterpillars of *E.amabilis*, its incidence being to the extent of 72 per cent. Five egg parasitoids, viz. *Trichogramma brasiliensis, T. chilonis, T. preticsum, Trichogrammatoidea bactrae* and *Telenomus remus* which were assessed for their parasitising efficiency have been able to parasitise the eggs of *E. amabilis* and *P. pulverea* and have shown promising results in the laboratory (Sushil *et al.* 1995).

Microbial pesticides : Malhotra and Choudhary (1968) have reported *Bacillus thuringiensis* to be safe against lac insect and two ectoparasites of *E. amabilis* and it is highly toxic against early stage predators (Malhotra & Choudhary, 1976). Sushil *et al.* (1997) reported safety of dichlorvos as compared to endosulfan to four beneficial parasitoids, viz. *B. greeni, Brachymeria tachardiae, P. sulci* and *E. claripennis* of lac insect at a concentration of 0.03% which effectively controlled predators. Five fungi (unidentified as yet) affecting lac insect have been observed.

It may be concluded that the recent findings reported above have opened new vistas for making a fresh wholehearted attempt in making biological control a success in lac cultivation. At present, biocontrol alone may not work but there are enough evidences to suggest that it would serve as an effective component of Intergrated Pest Management for controlling losses due to insect pests.

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