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INSECT BIOLOGY, DISTRIBUTION, HOST PLANTS, NATURAL ENEMIES AND BIO-EFFICACY OF PESTICIDES AGAINST MAJOR PREDATORS OF LAC INSECT: A REVIEW

Vikas Yadav*1, Dr. Sitanshu*2

*1M. Sc. (Ag), Department of Agricultural Entomology, RBS, College, Bichpuri, Agra Uttar Pradesh India.

*2Assistant Professor, Department of Agricultural Entomology, RBS, College, Bichpuri, Agra Uttar Pradesh India.

ABSTRACT

Lac is the valuable Resin secrete by the lac insect. India is major lac producing country about 80% of the total world production. Lac insects are exploited for their products of commerce viz., Resin, dye, and wax. Cultivation of lac not only to provided the livelihood to lac growers it is also helps in conserving vast stretches of forests and biodiversity associated with lac insect complex in India. Lac flourish about 113 varieties of host plants Palas, kusum, ber and khair ,etc for completing their life cycle. During its life cycle the insects spends only few hours of active after that they are prone to be attacked by many insects predators and parasitoids to damage lac crop. About 22 species of lac predators, 30 species of primary and 45 species of secondary parasites besides several fungal pathogens represents a rich bio-diversity of this ecosystem. Lac insects are more vulnerable to predators, parasitoids and other pests it losses about 35-40% in lac production. Different insecticides such as dichlorvos, cartap hydrochloride, ethofenprox, fipronil, carbosulfan, spinosad and others to control the predators and parasitoids of lac insects but Spinosad 2.5% EC is the most effective insecticide to control the major predators Eublemma ambilis and Pseudohypatopa pulverea of lac insects.

Keywords: insect, lac, life cycle, culture, host plants.

I. INTRODUCTION

Lac insect Kerria lacca (Kerr) is a minute sized scale insect (Tachardiidae (Kerriidae): Hemiptera) it secrets a resin known as “Lac” which is considered as one of the most valued gifts of natural world.The main component of lac is the resin which is usually known as “Lac”, it is primarily processed as shel lac or seed lac or button lac. It has high economic importance as the products from lac are eco-friendly and nontoxic to the environment. In addition to this, the lac insects and their host relationship contribute to the protection of biodiversity viz., soil flora, fauna and soil microorganisms (Sharma et al. 2006). Lac insect basically yields three useful materials viz., resin, dye and wax.

II. INSECT BIOLOGY

The life cycle of lac insect takes about six months and consists of stages - Egg, Nymph, Adult. The lac insect usually passes through two generation in year.

(i)Egg- The lac insects have an ovoviviparous mode of reproduction. Female lays about 200-500 eggs which may be fertilized or unfertilized an individual eggs is 0.4mm×0.2mm long and pinkish in colour which changes into brown after sometimes.

(ii)Nymph- The newly hatched nymph is 0.6mm×0.25mm long pinkish colour. They moult thrice before reaching maturity and after 1st moult the nymph loses its eyes, legs,and antennae. In the case of male cell, the growth is more along the longitude while female cell. It is more along the vertical axis the male nymph developed the organs after second moult.

(iii)Adult- The adult male and female are different from each other. Female is about 3 times larger than male. Male are pinkish-red in colour and are two types- winged and wingless. They are survive only 3-4 days and die after copulation. The female is pinkish in colour and about 1.5mm length and the ventral surface of the body is flate.

III. DISTRIBUTION

India is the leading lac producer in the world in terms of the production of raw lac, About 80 per cent of the world's total production is in India, and 75 per cent of it is exported to over a hundred countries, mainly in processed and semi-processed forms (Mishra, A.K.,2019). After India, lac is also produced in Thailand, Indonesia, parts of China, Myanmar, the Philippines, Vietnam, and Cambodia etc. In India, lac production takes

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place in mainly restricted to the Chota Nagpur region of Jharkhand state, Chhattisgarh state, Madhya Pradesh, West Bengal, Orissa, Uttar Pradesh and Maharashtra. Among the lac growing states, Jharkhand state ranks 1st followed by Chhattisgarh, Madhya Pradesh, Maharashtra and Odisha and the Contribution of these five states in national lac production is about 53%, 17%, 12%, 8% and 3%, respectively. The major lac producing five states contribute around 93% of the national lac production (Yogi, 2015).

IV. SELECTION OF HOST PLANTS

Lac insects thrive on twings of certain plants species, suck plant sap and grow secreting lac resin from their bodies. The site should be selected on the basis of host plants, where environmental conditions suitable for host tree should be preferred. Lac insect flourish on about 113 varieties of host plants are mentioned as lac host plant. Of these host plants, palas, kusum, ber and khair

Lac Culture-

The lac industry is well developed in India and at present it accounts to about 70-80% of the total world production. There are two strain of lac insect namely Rangeeni and Kusumi are known to prevail dominantly in our country. Aghani crop of Kusumi contribute the most with the contribution of 32 % followed by Jethwi (26 %) of Kusumi strain and Baisakhi (24 %) and Katki (18 %) of Rangeeni strain in total lac production. This is the crop with high economic returns to farmers and also has a high value for foreign exchange through its export. Kusumi and Rangeeni during rainy season for the effect of parasitization on the fecundity and resin production capability of the Indian lac insect, Kerria lacca (Kerr). Incidence of parasitization on female lac insects was 28.13% and 32.18% respectively for Kusumi and Rangeeni strains and the quantity of the resin produced declined by 32.55% and 34.71% for Kusumi and Rangeeni strains, respectively. However, there was no significant difference in the size of healthy and parasitized lac cells. **(**Sharma and Ramani 2001).

Losses in production-

After having the wide distribution of the lac insect through the country on diverse hosts, lac production is limited because of environmental factors viz., biotic (predators and parasitoids) and abiotic (adverse climatic factors), causing hinderance in lac production. Losses in lac production because of predators have been estimated around 35 to 40 per cent (Jaiswal et al, 2008). One of the major restricting factors in the production of lac. Rangeeni crop is more vulnerable to pest attack and the damage is more in the rainy season crop which occasionally destroy whole crop. Eublemma amabilis (Noctuidae; Lepidoptera), Psuedohypatopa pulverea (Blastobesidae; Lepidoptera), Chrysopa lacciperda and Chrysopa madestes (Chrysopidae; Neuroptera) are the major predators of regular occurrence causing severe losses to lac production (Sharma et al., 2006).

Natural enemies of lac insect-

The lac insect during its life cycle spends only few hours of active mobility and thereafter spends a complete sedentary life and hence 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). The vertebrate enemies include squirrels and rats (Thomas, 2004) . The invertebrate enemies of lac insects are of two types viz., parasites and predators (Sharma et al. 1997). Twenty-two species of lac insect predators, 30 species of primary parasites, 45 species of secondary parasites (Das, 1990). About 22 predators to be closely associated with lac insects of which three were screened as major predators of the lac insect viz., Eublemma amabilis, , Psuedohypatopa pulverea and Chrysopa sp. (Sah and Gupta 1983). Lac insect predators Eublemma amabilis and parasitoids Parechthrodryinus clavicornis, Coccophagus tschirchii and Tachardiaephagus tacharidae were initially present whereas predator Pseudohypatopa pulverea and parasitoids Aprostocetus (Tetrastichus) purpureus and Eupelmus tachardiae were recorded even after eight months of storage. Bracon greeni and Elasmus claripennis recorded as beneficial fauna. (Jaiswal et al.1998). Fourteen species of parasitoids under thirteen genera representing ten families were found associated with Kerria lacca, of these Aprostocetus purpureus and Tachardiaephagus tachrdies constituting 55.82% and 28.37% of the total population of parasitoids, were most abundant. Among the beneficial fauna, only B.greeni was of some significance accounting for 5.37% of the total population.(Sharma et al.1997).The larval stages of two Lepidopteran predators, E. amabilis and P. pulverea predate on different stages of the lac insect and are responsible for a cumulative average crop damage of 3 to 4 per cent. **(**Bhattacharya et al. 2004).Twenty-two species of lac predators, three species of primary parasitoids and forty-five species of secondary parasitoids from lac

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ecosystem, which shows that it is a multi-trophic web of flora and fauna, besides this the association of several fungal pathogens, represents the rich biodiversity of this ecosystem.(Sharma et al. 2006). E. amabilis as the major predator of lac causing 4 per cent losses to lac crop. (Bhattacharya et al.2007). Predators (E. amabilis and P. pulverea) population in the lac crop was found to be lowest in February pruned trees (5.11 times lesser than the farmer's method). May-pruned trees showed the lowest yield ratio, which was 2.17 times lesser than the farmer's method. E. amabilis is very destructive to lac insect as well as to lac encrustation. The newly hatched larva enters in the lac encrustation either through one of the opening in the cell or by excavating a hole through the encrustation. (Ghosal 2008). A single larva damages 42 to 45 matured lac cells prior to pupation. It completes 6 generations in a year and causes relatively more injury to the Katki crop in comparison to the Baishaki crop. (Rahman et al. 2009). P. pulverea, a predator of lac insect, found in all lac growing areas of the country. It feeds on the living as well as on dead lac insects and it is found in large numbers in stored lac. It is also responsible for the qualitative and quantitative deterioration of stored lac. A single larval predator is capable of destroying 45 to 60 mature lac cells. (Chattopadhyay, 2011). The rich biodiversity of flora and fauna associated with that lac insect ecosystem, which includes more than 22 lac predators, 30 primary parasitoids, 45 secondary parasitoids and several microbes. (Sharma and Jaiswal 2011). Eight moths E. amabilis and three moths P. pulverea from lacstick of rain tree (weight of 50 g and length of 60 cm). (Rao et al.2013). Lepidopterans (E. amabilis and P. pulverea) and Neuropterans (Chrysopa madestes, C. lacciperda) lac insect has some vertebrate predators like rats, squirrels, lizards, woodpeckers and monkeys. (Mohanta et al.2014).

V. POPULATION IN STORAGE STRUCTURE

The population fluctuation of P. pulverea and E. amabilis in storage structures. The mean monthly population (larvae and pupae) of P. pulverea and E. amabilis at its peak were (16.33) and (15.33) in month of December and November 2015, respectively. In Kuchcha storage structures the populations of these pests were high. The adult emergence of P. pulverea was highest (81.99 %) from the samples collected during October, whereas, E. amabilis was highest (80.18 %) from the samples collected during August. The mean population of P. pulverea (16.33) and E. amabilis (15.33) was highest in Kuchcha storage in comparison to Pucca storage with lowest mean population of P. pulverea (6.00) and E. amabilis (6.67). (Virendra et al.2017).

Bio-efficacy of pesticides against major predators-

Bio-efficacy is a measure of the biological efficacy of an active ingredient of agrochemicals such as insecticides etc. It determined the minimum dose of insecticides required for maximum control of diseases.

(i) Evaluation of different insecticides-

Evaluated different insecticides are found dichlorvos, cartap hydrochloride and ethofenprox effective against predators of K. lacca. (Jaiswal et al. 2004). Cartap hydrochloride (0.05, 0.075 and 0.1%) against the second instar of E amabilis larvae reared on B. monosperma during the rainy season. They found that all the tested doses proved to be safer to the lac insect in respect to decrease in the population of E amabilis and consequent increase in lac yield. (Bhattacharya et al. 2005). The toxicity of ethofenprox to male lac insect and found to be a suitable insecticide for management of all three major predators, if applied at proper time. Application of this insecticide, a day prior to the emergence of male lac insect, caused toxic action to the male lac insect, resulting loss of brood lac, as most of the female insects remained unfertilized. Resin producing ability of unfertilized females was greatly reduced which around one third of that was secreted by fertilized female. (Jaiswal et al. 2005). The effect of ethofenprox and cartap hydrochloride on the survival of lac insects and the incidence of its parasitoids viz., A. purpureus and T. tachardiae on rainy season Rangeeni lac crop on Butea monosperma revealed that the incidence of these parasitoids was not affected by these insecticides and as well as the mortality percentage of lac insects was non-significant among the treatments. (Jaiswal et al. 2006). 0.02% ethofenprox against Chrysopa madestes, a serious predator of Kusumi strain of lac insect concentration was more suitable for protecting the lac crop, against C. madestes under field conditions (Jaiswal et al. 2007). The commercial formulation of B.t.k, ethofenprox (0.02), dichlorvos (0.02 & 0.03) against E. amabilis and P. pulverea during rainy season crop on B. monosperma. B.t.k formulation with different concentrations (0.008, 0.017, 0.034, 0.05, 0.07, and 0.085) reduced the incidence of predators and increased the yield of brood lac over control. (Jaiswal et al. 2008).

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(ii) Safest insecticides against first and second instar larvae-

Spinosad (0.0025, 0.005, 0.01 and 0.02%), indoxacarb (0.003, 0.005, 0.007, 0.01 and 0.02%), fipronil (0.0025, 0.005 and 0.01%) and carbosulfan (0.01 and 0.02%) are relatively safer against first and second instar larvae of both Kusumi and Rangeeni strain of lac insect under field conditions, and can be incorporated in pest management programme to achieve the desired control of lac insect predators in lac production system without harming lac culture. Ovicidal action of different insecticides by dipping the egg masses of E. amabilis in insecticidal solutions resulted in the egg inhibition activity, which was varied from 1.71 to 67.15 per cent, among different treatments. Indoxacarb, fipronil, spinosad and ethofenprox exhibited inhibition activity of 36.82-75.44 per cent, 81.61-100 per cent with and 82.02-100 per cent, respectively. **(**Singh et al. 2011**).** The residual efficacy of indoxacarb and spinosad against adults of two major parasitoids associated with lac insect viz., A. purpureus and T. tachardiae, by residual film contact method and based on mortality within 24 hours of treatment concluded that the spinosad is more effective than indoxacarb as far as A. purpureus is concerned, the effectiveness of spinosad on both parasitoids is almost at par.(Jaiswal et al. 2013).

(iii) Combination of different insecticides-

The bio efficacy of different insecticides in combination i.e., cartap hydrochloride + mancozeb (T1), emamectin benzoate + dithane M-45 (T2) along with control (T3) for the management of predators of K. lacca on the natural stand of B. monosperma trees of 10 women lac growers of village Malhara (Seoni district), Madhya Pradesh during July- October, 2012. Incidence of E amabilis (90 & 87 %) and P. pulverea (90 & 86.18 %) was significantly reduced after the application of T2 and T1, respectively, over the control (T3). (Janghel et al. 2014)**.**

(iv) Treated brood lac under laboratory conditions-

The response of insecticides on emergence of predators and parasitoids from treated brood lac under laboratory conditions by dipping lac stick of Kusumi brood lac in insecticidal formulations and subsequent inoculation of treated brood lac on, F. semialata in field. Brood lac stick obtained from summer season Kusumi l ac crop raised on S. oleosa (Kusum) was dipped in insecticidal solution of indoxacarb (0.007, 0.014 and 0.021%), spinosad (0.005, 0.007 and 0.01%), fipronil (0.007, 0.014 and 0.02%) and ethofenprox (0.02, 0.03 and 0.04%) for 15 min. Normal emergence and settlement on lac host F. semialata was noticed, indicating the safety responses of insecticides for lac insect, with significant reduction in the population of lepidopteran predators and hymenopteran parasitoids in treated brood lac. Maximum reduction in the emergence of E. amabilis was recorded with spinosad (100%) followed by indoxacarb (97.92 to 100%), ethofenprox (75 to 93.75%) and fipronil (72.92 to 91.67%). All the insecticides were found effective in reducing the P. pulverea poputation. Reduction in population of parasitoids of lac insect viz., T. tachardiae, A. purpureus and male and female of E. tachardiae was significantly low from treated brood lac and it varied from 47.06 to 89.71, 61.54 to 100, 38.46 to 100 per cent (male) and from 45.45 to 100 per cent (female), respectively. Study clearly indicates that these treatments of brood lac with indoxacarb, fipronil, spinosad and ethofenprox, prior to inoculation can be safely and effectively used in IPM programmes. (Singh and Jaiswal 2015).

(v) Bio-efficacy at different concentration-

The bio-efficacy of flubendiamide at different concentrations ranging from 0.0039 % (0.1 ml/ L) to 0.0315 % (0.8 ml/ L) against insect-predators on lac culture by dipping of brood lac for 5, 10 and 15 min. No significant differences were observed between various treatments and control on the survival of emerging 1st instar of lac insect which indicating safety of the evaluated insecticide. Treatment of brood lac in insecticidal solutions for the same durations showed significant reduction in the population of key lepidopteran predators, E. amabilis and P. pulverea predating on lac insects. (Jaiswal at el. 2016). The efficacy of different insecticides against, E. amabilis during year 2014-15 and 2015-16 at Korba District of Chhattisgarh. Overall impact of insecticidal application, emamectin benzoate @ 0.002 per cent was found very much effective in management the population of lac predator, E. amabilis over control with minimum 1.11 and 0.88 insect/30 cm of lac stick at first spray 30 day after BLI and second spray 60 day after BLI, respectively and relatively safer for lac cultivation followed by indoxacarb @ 0.02 %, spinosad @ 0.02 %,

indoxacarb @ 0.005 %, fipronil @ 0.005 %, fipronil @ 0.02 %, spinosad @ 0.005 %, spinosad @ 0.0025 %, fipronil @ 0.0025 % growers practice ethofenprox @ 0.02 per cent and indoxacarb @ 0.003 % accept fipronil 0.02%.(Meshram et al. 2018).

(vi) Most effective treatment-

The insecticides evaluated, the most effective treatment was spinosad 2.5% EC against Predators viz., Eublemma amabilis and Pseudohypatopa pulverea with 84.85 and 78.95 mean per cent reduction in the population over control, respectively. Application of spinosad 2.5% EC was also recorded as the most effective treatment in terms of survival percentage of lac insect. Emamectin benzoate 5% SG was found next effective treatment, whereas, Neem oil was found least effective treatment in reducing the population of predators of lac insect as well as in terms of survival percentage of lac insect. **(**Vikram et al. 2020).

VI. CONCLUSION

In the total losses of lac production about 3-4% crop damage by the larval stage of two Lepidopteran predators Eublemma amabilis and Pseudohypatopa pulvera on the different stage of lac insect are responsible. Spinosod 2.5 EC @ 2.0 ml/litre was effective insecticide for lac insect against major predators Eublemnna amablis and Pseudohypatopa pulverea. This ecofriendly pesticide was also proved to be the safest for lac insect survival as well as environment.

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