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Resistant insecticides of cotton mealybug, *Phenacoccus solenopsis* (Tinsley) under laboratory conditions

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Abstract
The cotton mealybug, *Phenacoccus solenopsis* (Tinsley) is well known as most vulnerable sucking insect pest of cotton crop which was found on different alternate host plants of different genera. Therefore, the synthetic and bio-synthetic pesticides namely; Lambda cyhalothrin, Imidacloprid, Profenofos, Cypermethrin and Neem oil (repellent) were applied to check their effect which was replicated five interval times. Thus, data were taken at uniform pre-treatments (100) counted mealybugs and the post-treatments on 1st, 2nd and 3rd day after application of insecticides at Entomology laboratory, department of Zoology, SALU - Khairpur during, 2015 under maintained room temperature 25±2 ºC and air conditions 20±2 ºC. The data were formulated under LDP line (Schneider-Orelli) formula. The insecticide Profenofos gave 42% mortality on 1st day after application smoothly less effected on 2nd and 3rd day. The neem oil provided the good results up to 20% reduction on 1st day after application. Whereas, the Cypermethrin and Imidacloprid were also found to be less effective up to 5-10% mortality and lambda cyhalothrin was failed to produce any significant result. The analysis of variance showed the significant difference among all pesticides (P<0.05). It is concluded that the Profenofos and neem oil (repellent) proved more effective up to 3 days when compared with other insecticides under both compared temperatures. Thus, the other tested insecticides are here by recommended to do not apply for the purpose of control this vigorous cotton pest and this rational Lambda pesticide should be banned and strongly forbidden for their application.

Keywords: Cotton, pesticides, *P. solenopsis*, room temp and air-conditioned temp

1. Introduction
The cotton mealybug, *Phenacoccus solenopsis* Tinsley; (1898) (Hemiptera: Pseudococcidae) discovered from weed, a home of the ant, *Solenopsis geminata* (Fabricius) from New Mexico, USA. It has threatened the cultivation of cotton in Pakistan and caused 14 percent loss at starting its flare up during, 2005. It is an invasive polyphagous pest species, first time recorded in Asia, Pakistan [1-3]. Mealybug is devastating to many other economic crops such as; vegetables, ornamental plants and has been reported infesting 149 plant species [4]. That feeds on plant tissues, suck the cell sap and cause leaves to distort, malformed, and fall down [4-5] also produces honey dew which causes sooty mould that hinders to the process of photosynthesis in plants about 5000 species of mealybug have been recorded from 246 families of plants throughout the world. Adult females and crawlers are phloem feeder [6] and inject toxic saliva into the plant. Damage can be as much as 90% occasionally [7]. In cotton, the growing parts are attacked resulting in bunchy-type symptoms attacked plants remain stunted and produce fewer bolls of a smaller size. Boll opening is adversely affected and yield reduction ranges from 58-73 percent [8]. This pest is a serious pest of cotton and resulted in severe damage to cotton during the last few years in Pakistan and India [9].
In Pakistan, cotton mealybug has been tried to be controlled with mixed application of insecticides in the form of spray. The insecticide, Profenofos has been reported one of the effective insecticides against *P. solenopsis* [10]. The management strategies *P. solenopsis* on cotton have been described by various scientists from India [11]. *Aenasius bambawalei* Hayat was reported for the first time from Tandojam, Sindh, Pakistan in August, 2008. It was identified as *Aenasius* sp. nov. nr. *longiscapus* Compere (Hymenoptera: Encyrtidae) from the Natural History Museum of London, UK reported by CABI [12]. Later, it was described as *Aenasius bambawalei* by [13, 14] regulated *P. solenopsis* through sprays with chlorpyrifos and

Carbofuran. Utilization of chemicals might have been a fundamental part of IPM [15, 16] reported efficacy of bio-pesticide extracts on mealybugs that were slower to insecticides, but known as less toxic and eco-friendly. [17] Reported the control through chemical measures incorporated petroleum sprays, oils and soap sprays against mealybug. [6] Concluded that chemicals such as, Profenofos, Chlorpyrifos and methomyl can produce 4.30, 85.20 and 91.80 current mortality ratio in cotton mealybugs. Insecticides of different groups were screened for their effectiveness against *P. solenopsis*. Keeping in the view, the resistant different insecticides against this menace pest was used and its findings are being shared with cotton growers to get better production.

2. Material and Methods

The resistant different rational and bio-rational insecticides were evaluated under Entomology laboratory, Department of Zoology, SALU–Khairpur during, 2015 against cotton mealybug. This pest was found not only in cotton crop but also on ornamental, medicinal plants, vegetables, weeds in the farmer's field as well as in the SALU, Khairpur where there was greenish plants in summer season due to its polyphagous in nature. The cotton leaves were brought from unsprayed cotton field cultivated at farmer fields nearby SALU-Khairpur. The five insecticidal concentrations were replicated 5 interval times to check their poisonous quality under ventilated room temperature at 20 and 25±2 °C. Similarly, a serial dilution of each insecticide was made with fresh water and also tested at each temperature. The bioassay procedure was conducted on third and an adult stage of *P. solenopsis* under laboratory condition using the leaf dip method for 30 seconds [18] later the leaves were dried for one hour under room temperature. The dried leaves were kept in Petri dishes (6 cm diameter), and in each Petri dish placed a blotting paper to avoid dehydration. The counted (100) mealybugs were placed as uniform data in each Petri dish on dried leaves for feeding purpose. In control experiment was performed with same technique with neem oil in Petri dishes under both temperatures at 14:10 h (Light: Dark) photoperiod. Further, the description of insecticides is given as under.

2.2 Common name, company and formulation of insecticides

T_1 = Lambda Cyhalothrin (Parathroid), (R.B. Avari Ltd.), 90 cc/ tank, 600 ml/acre.

T_2 = Profenofos 50% (Profenofos) (OP), (Agro Mart Warbal Ltd.), 60 cc/ tank, 1000 ml/acre.

T_3 = Imidacloprid 20 SL, (Neonicotinoid), (Byer) 60 cc/ tank, 100 ml/acre.

T_4 = Cypermethrien (Parathroid) (R.B. Avari Ltd.), 100 cc/ tank, 1000 ml/acre.

T_5 = Control= Neem oil+Surf® (detergent) = 60 cc/liter of water with 1 tea spoon, 3 liters and half kg/acre, (repellent) NARC- PARC, Pakistan.

2.3 Statistical analysis

Before analysis, the data entered into MS Excel spread sheet and later exported to obtain frequencies, means and standard error using Statistix software, SXW, USA version 8.1. Thus, the data collected were subjected to analysis of variance and mean values were compared with LSD test to check the significant differences, were considered at $P<0.05$ level. The mortality percentage will be taken through (Schneider-Orelli's formula), a software to calculate the probit analysis LDP, Line, according to Finney (1971), which is used to illustrate the relation between stimulus and response in toxicological and biological studies, illustrate dose-response regression line.

Schneider-Orelli's formula

$$\text{Corrected \%} = \left(\frac{\text{Mortality \% in treated plot - Mortality \% in control plot}}{\text{100 - Mortality \% in control plot}}\right) * 100$$

3. Results

Among all the insecticides, the Profenofos provided the better results up to 42% mortality on 1st day after application of insecticide found to be less toxic on 2nd day and 3rd day. Whereas, the neem oil was also found on second number that reduced the mealybug population up to 20% on 1st day of application smoothly on 2nd day and 3rd day as well. The Cypermethrin and Imidacloprid were also found to be less effective up to 5-10% and the Lambda cyhalothrin did not provide any fruitful results to diminish the pest population under laboratory conditions in normal room temperature (25±2 °C) (Fig. 1). The results of all screened insecticides to check its resistant ability of pest under well maintained air conditioned room temperature (20±2 °C) were observed in which the insecticide Profenofos found to be highly effective as compared to others. Besides, the neem oil was also found to be effective in consequent days 1st, 2nd and 3rd day under air conditioned temperature. The other insecticides did not provide any effective results to control this vigorous pest of cotton crop (Fig. 2) due to heavily usage and made a resistance against this pest. The analysis of variance showed the non-significant difference in the mortality% among the days ($F= 1.55$; $DF= 4, 2$; $P<0.26$) at ($P=0.05$).

In both graphs, the data indicated that the overall mean reduction% observation of all insecticides against cotton mealybug under room and air conditioned room temperatures. The insecticides Lambda cyhalothrin, Imidacloprid and Cypermethrin did not capably lower the reduction% of mealybug population under both maintained temperatures, also these three insecticides were failed to produce any significant results on different days. However, neem oil was known as the safest insecticide to predators and parasitoids, which is known as eco-friendly to natural enemies recommended reducing the insecticide hazards and preventing the nature. The results showed little variation in the effectiveness of pesticides. However, the overall mean reduction% population of mealybug showed the significant difference among the days ($F= 3.96$; $DF= 4, 2$; $P<0.05$) at ($P=0.05$) in the effectiveness of insecticides.

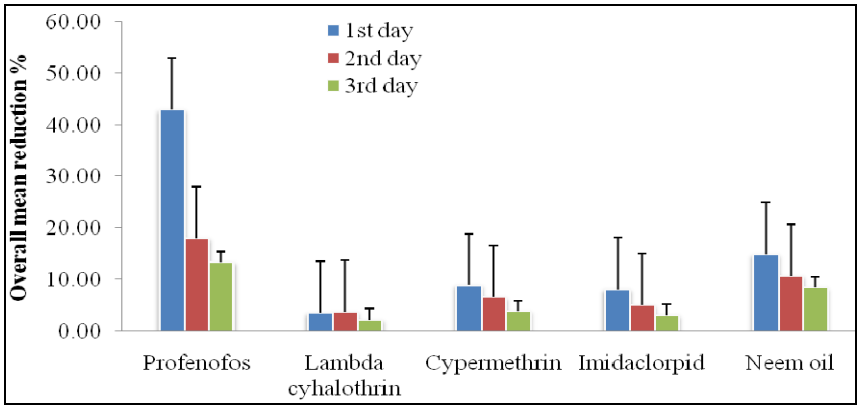

Fig 1: Overall mean reduction % of mealybug through different insecticides under normal room temperature.

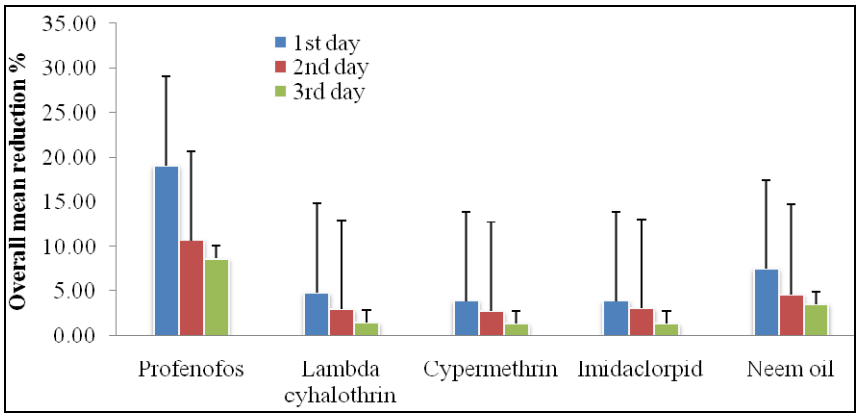

Fig 2: Overall mean reduction % of mealybug through different insecticides under air conditioned room temperature.

Doses of different insecticides under laboratory conditions at SALU, Khairpur during, 2015

4. Discussion

The cotton mealybug, *Phenacoccus solenopsis* (Tinsley) attacked on cotton crop and different alternate host plants in district Khairpur, which was controlled through different techniques of synthetic and bio-synthetic pesticides namely; Lambda cyhalothrin, Imidacloprid, Profenofos, Cypermethrin and Neem oil (repellent) were evaluated to check their effect at Entomology laboratory, department of Zoology, SALU - Khairpur during, 2015 under maintained room temperature 25±2 ºC and air conditions 20±2 ºC, respectively. It was observed that, mealybug spread quickly on cotton growing areas. [19] described that the application of pesticides applied on cotton mealybug but did not reduce the population due to its waxy layer. Therefore, the pesticides barely penetrate the body structure of females [20]. Some time the insecticides reduce the egg laying capacity of this pest [21-23] observed the starting from USA from various plants due to polyphagous in nature that is harming 200 plant species from 24 tropical and subtropical areas of the world.

The present study suggested that, Profenofos was found to be most effective insecticide against cotton mealybug population and the Neem oil also provided the good results to control vigorous pest of cotton crop [24]. found the impact of different insecticides for *P. solenopsis* infestation viz., Compound control (Profenofos 50 EC), plant item (Neemosal 0. 5% EC), homeo-chemical (Fierce) and *Chrysoperla carnea* found and replicated three times. Profenofos indicated the best control against cotton mealybug. The Imidacloprid also bit reduced the mealybug in 1st mealybug spray [25]. proposed that Imidacloprid had been discovered effective against, *Planococcus* sp., than different mealybug species in grapevines [26] whereas, Prophenophos had rapid knockdown action against the *P. solenopsis* compared to other insecticides. In our research study the mortality percentage of mealybugs showed that all the treatments were highly significant over control at 24 hours, respectively. The highest percent mortality was observed in Profenofos and neem oil compared to other treatments. It was observed that Lambda cyhalothrin, Cypermethrin, Imidacloprid insect sprays little bit reduced the mealybug population up to 3 days under both maintained temperatures whereas, Neem-oil gave the exceptional effects under room and air conditioned room temperatures at 1st, 2nd and 3rd day after application. Plant extracts acquired from, *Azadirachta indica*, *Ocimum sanctum*, *Calotropis gigantea*, *Nicotiana tabacum* and *Allium sativum* utilizing standard techniques. [27] described that cotton mealybug, *P. solenopsis* was found a polyphagous and genuine pest of cotton that restricts the production, fiber and lint stock [28]. Assessed acephate, Chlorpyriphos, Neem oil, Nirma powder, Fish oil rosin soap against nymphs, and mature stages of *P. solenopsis* [29, 30]. described viability of distinctive mealybug sprays on cotton crop and whitefly with their toxicity on cv. Bt. included four pesticides, i.e; Neem oil (repellent), Profenofos, Imidacloprid (SL), Imidacloprid (WP) compared with control at 24, 48, 72 hrs 7th up to 10th day. Four insecticides viz., supracide (as standard), thiacloprid, nitenpyram, and pyriproxyfen were used to control the cotton mealybug under field conditions at per recommended dose for sucking insect pest. Further, [31] surveyed different districts of Sindh for management of cotton mealybug, *P. solenopsis* in which the farmers different insecticides for protecting their crop. The current study compares the effects of temperature under laboratory conditions on the effectiveness of five individual insecticides from different groups / classes against this vigorous cotton mealybug, *P. solenopsis* pest. [32-34] investigated the living and morphological characters, alternate host plants and cotton varieties of Sindh, which discovered with large variations.

The analysis of variance showed the significant difference among all pesticides whereas; non-significant results were observed among the replicated treatments on different days after application of all pesticides [35]. described under laboratory conditions in Kharif season with the application of Commando, Confidor, Lannate, Actara and Neem oil against cotton mealybug, *P. solenopsis* at field proposed doses. In which the Neem oil and Profenofos fundamentally reduced the mealybug population up to 72 hours. It is concluded that among these pesticides, Profenofos furnished with best control of cotton mealybug under both compared temperatures, the other insecticide sprays should be banned and do not apply for controlling purpose of energetic pest because of resistant ability and the rational Lambda cyhalothrin pesticide should be strongly forbidden for its application. The present study suggests that more research work should be carried out on the cotton mealybug with their biological control measures, bio-diversity, ecology, biology, varietal resistance, occurrence on vegetables, medicinal plants, different host plants and different proper insecticides with doses, because of less work has been reported from this region (upper Sindh), Khairpur, Sindh – Pakistan.

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