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Efficacy of some selected synthetic chemical insecticides and bio-pesticides against cotton mealybug, *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Pseudococcidae) under agro ecological conditions of Peshawar, Pakistan

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Abstract
Field studies were carried out for the control of cotton mealybug (*Phenacoccus solenopsis* Tinsley) during July 2015-16, at new developmental farm of the University of Agriculture Peshawar-Pakistan in RCBD arrangements with five treatments i.e. Movento, Confidor, Actara, Tobacco and Neem extract. IR-1524 variety of cotton was grown for investigating mealybug infestation as the population of mealybug started proliferating we applied treatments. Results indicated that maximum mortalities was observed after 72 hours of application Memento Energy 240 Sc caused highest mortality of 92.96% followed by Confidor 200 O-Teq, Actara® 25WG, Tobacco Extract @ 2.00 % and Neem Extract @ 2.00 % 57.2%, 51.32% and 45.03% and 29.76 % respectively. Neem and Tobacco Extracts showed considerable mortalities of cotton mealybug with edge of having environment friendly, and safe for natural enemies, humans and other animals but low as compared to the synthetic insecticides which have ill effects on environment and natural enemies.

Keywords: Cotton, Bio-pesticides, Synthetic insecticides, Neem, Tobacco

Introduction
Cotton, *Gossypium hirsutum* L. (Family Malvaceae), is one of the most commercially important fibre crops in the world. It is a perennial semi-shrub grown as an annual crop in both tropical and warm temperate regions. In addition to textile manufacturing, it produces seeds with a potential multi product base such as hulls, oil, lint and food for animals (Ozyigit *et al.*, 2007) [9]. In Pakistan, cotton was grown on 3054.3 thousand ha in 2007-2008 with an average production of 649 kg/ha (MINFAL, 2008) [7].

The mealybug *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Pseudococcidae) has recently emerged as a serious pest of cotton in Pakistan (Abbas *et al*., 2005, 2006) [1, 2]. During 2006, it played havoc with the cotton crop in 11 out of 18 districts in the Punjab, Pakistan. An estimated 14% crop loss was calculated during this year (Abbas *et al*. 2005) [1].

The name Mealy has been given because of wax secretion that covers their whole body with wax. Winged males and wingless females of mealybug (*P. solenopsis*) have two to three nymphal instars (Hodgson *et al*., 2008) [5].The mealybug feed on phloem tissue, removing plant sap and causing the leaves to distort, yellow, and even drop. Severely affected plants may die. *P. solenopsis* produces large amounts of honeydew similar to that produced by other sucking insect pests of cotton such as whiteflies and aphids. Ants feeding on honeydew may deter biological control agents (Cudjoe *et al*., 1993) [3]. Growing of sooty mould on honeydew interferes with photosynthesis.

Granular insecticides are ineffective against cotton mealybug. Systemic insecticides are only used to control heavy infestations. Although effective, repeated use of chemical insecticides for decades has disrupted biological control by natural enemies and led to outbreaks of other insect species and has sometimes resulted in the development of resistance to pesticides (Mani, 1989) [6].

Bio-pesticides are good and alternative to synthetic pesticides because they are environment friendly, and safe for natural enemies, humans and other animals, e.g. most botanical

pesticides have low to moderate mammalian toxicity (Hassan, 1992) [4].

Keeping in view the importance of cotton crop in Pakistan the present investigations was conducted to investigate rapid and effective control of the cotton mealybug, and to screen the effective less persistence insecticides and bio-pesticides for the control the mealybug in cotton crop.

Materials and Methods

Field location

The Experiment was carried out at new developmental farm of the University of Agriculture Peshawar-Pakistan in a Randomized Complete Block Design (RCBD) with three replications and 5 treatments for comparison of percent mortalities data were noted from the plots before application of treatments. Cotton variety IR-1524 was sown in a plot size of 9x3 m^2 using dibbling method. Row to row and plant to plant distance maintained was 45-60 cm and 60-75 cm respectively. All the pesticides were applied as foliar application when sufficient population of mealybug was seen on cotton crop with the help of knapsack sprayer.

Extracts of Neem and Tobacco leaves in laboratory

The leaves of Neem and Tobacco were collected from University field. The leaves were washed with distilled water to remove dust and other pollutants and then shelter dry for one week. The dried leaves were crushed with grinder to make fine powder. 50 g of powdered was weighed and then passed to a cellulose extraction tube. Plant materials were extracted by using 250 ml ethanol for 5 hours at (70 °C) in a Soxhlet apparatus (250 ml) and the extracts obtained were pour in to the flask separately. The abstract was measured and from each plant materials a final volume of 200 ml was made and pour into the round bottom flasks. The flasks contain plant materials were fitted at the bottom of Rotatory evaporator (Buchi; R-114; Switzerland) separately and evaporated to dryness at a temperature 85 °C. The flasks which contain plant dried materials were detached and weighed. Weight of dried extracts was calculated by subtracting the already noted weight of empty flask and few milliliters of ethanol to help in dissolution of extract with water. To the extract add 50 ml of distilled water to get 1 g/ml (100% w/v) concentration (Prishanthini, 2014) [8].

Data recording

Data were recorded as number of mealybug/plant from selected five plant in each plot before application, after application data were noted as number of dead mealy bug fallen from per plant collected in the muslin cloth which was placed below each five selected cotton plant. Infestation data were noted after interval of 24, 48, 72 and 168 hours (Abbas *et al*., 2005) [1].

Chemical control

The synthetic pesticides Movento Energy 240 SC, Confidor 20 SL and Actara 25 W/G were applied at their recommended dose (Table I) while Neem and Tobacco were applied @ of 2.00%.

Table I: Dose of treatments used against *P. solenopsis*

Treatments	Active ingredient	Calculated dose Rate/10 litre water
Movento Energy (240 SC)	Spirotetramat + Imidacloprid	12.5 ml/9x3 m^2 10 litre water
Confidor (20SL)	Imidacloprid	12.5ml/9x3 m^2 10 litre water
Actara (25)W/G	Thiamethoxam	2.4g/9x3 m^2 10 litre water
Neem Extract @ 2.00%	Azadirachtin	20ml/9x3 m^2 10 litre water
Tobacco Extract @ 2.00%	Nicotine	20ml/9x3 m^2 10 litre water

Statistical analysis

The experiment was laid out in Randomized Complete Block design (RCBD) with four treatments and three replications. The experiment was laid out in randomized complete block design with three replications. The collected data were subjected to ANOVA and means was separated, using LSD test at 5% level of significance (Steel and Torrie, 1980) [12].

Results

Efficacy of selected synthetic insecticides and bio-pesticides against cotton mealybug

After the application of selected synthetic chemical insecticides and bio-pesticides data were taken after the interval of 24, 48, 72 and 168 hours, respectively. The data after 24 hours of application revealed that statistically all the treatments are significantly different from each other Movento Energy 240 Sc showed significantly highest mortality (17.74%) followed by Confidor 20 SL (13.83%), Actara® 25 WG (13.33%), Tobacco Extract @ 2.00% (10.84 %) and lowest mortality caused by Neem Extract @ 2.00% (5.50 %) which was non-significant from other three treatments. The data taken after 48 hours of application revealed that Movento Energy 240 Sc significantly caused highest mortality (27.23%) followed by Confidor 200 O-Teq, Actara® 25 WG, and Tobacco Extract @ 2.00% and Neem Extract @ 2.00% 16.23, 15.44, 12.41 and 8.393% respectively (Rashid, 2011). Maximum mortalities of mealybug was recorded after 72 hours of application every synthetic chemical insecticides and bio-pesticides showed their maximum results. Movento Energy 240 Sc caused highest mortality of 92.96% followed by Confidor 200 O-Teq, Actara® 25 WG, Tobacco Extract @ 2.00% 57.2, 51.32 and 45.03% while lowest mortality was recorded from the plot treated with Neem Extract @ 2.00% was 29.76% the findings are similar to the results of (Abbas *et al*., 2005) [1]. Data were taken after 168 hours of application data showed that Movento Energy 240 Sc, Confidor 20S Land Actara® 25 WG caused mortalities 13.12, 10.29 and 11.25% while Tobacco Extract @ 2.00% and Neem Extract @ 2.00% were least effective against control of mealybug (Rashid, 2011) [11] (Table II).

Table II: Efficacy of selected synthetic insecticides and bio-pesticides against cotton mealybug after 24, 48, 72 and 168 hours after application

Treatments	Number of mealybug per plant before spray	Number of mealybug per plant after 24 hours of spray	Number of mealybug per plant after 48 hours of spray	Number of mealybug per plant after 72 hours of spray	Number of mealybug per plant after 168 hours of spray	Overall mean
Movento Energy 240 Sc	154.67a	17.74a	27.22a	92.96a	13.12a	37.78a
Confidor 20SL	144.67a	13.83b	16.23bc	57.2b	10.29b	24.38b
Actara 25 W/G	322.67a	13.33b	15.44bc	51.32b	9.25c	22.33c
Neem Extract @2.00%	136.01a	5.50d	8.393c	29.76d	4.39e	11.83e
Tobacco Extract@2.00%	121.33a	10.84c	12.41b	45.02c	8.33d	19.15d
LSD value	82.3	11.87	15.61	47.03	8.52	

Mean in column sharing dissimilar letters are statistically different at 5 % level of probability (LSD test)

Overall efficacy of different treatments against cotton mealybug (*P. solenopsis*) the data showed that Movento Energy 240 Sc significantly caused highest mortality (37.78%) followed by Confidor 200 O-Teq, Actara® 25 WG, and Tobacco Extract @ 2.00 % and Neem Extract@2.00% as 24.38, 22.33, 19.15 and 11.83% respectively (Fig I).

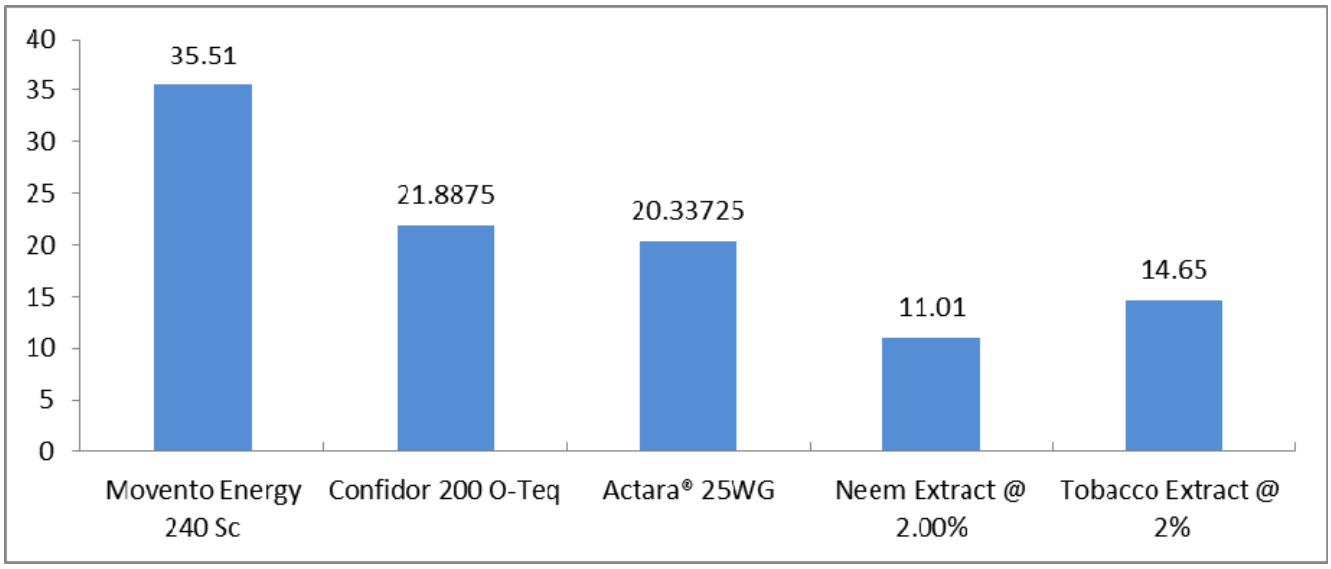

Fig I: Overall percent mortalities of *P. solenopsis* caused by different treatments

Discussions

In the present investigation the efficacy of selected synthetic chemical insecticides and bio-pesticides was studied. Bio-pesticides were made from Neem and Tobacco plant extracts against cotton mealybug. IR-1524 variety of cotton was grown in the field, and when the infestation rate of mealybug increased, subsequently different treatments were applied. Data were taken as percent mortalities caused by each treatment after interval of 24, 48, 72 and 168 hrs, respectively. Results indicated that maximum mortalities were observed after 72 hours of application. Regarding the overall efficacy of different treatments against cotton mealybug (*P. solenopsis*) the data revealed that Movento Energy 240 Sc significantly caused highest mortality (37.78%) followed by Confidor 200 O-Teq, Actara® 25 WG, and Tobacco Extract@2.00% and Neem Extract @ 2.00% as 24.38, 22.33, 19.15 and 11.83% our findings are quite similar to the findings (Peng *et al.,* 2010) [10]. The synthetic insecticides kill non targeted beneficial insects including predators, parasite and parasitoids while the bio-pesticides have less effect on the beneficial insects (Zehnder, 2007) [13]. From the present investigation we conclude that for environmental safety and health hazards and protection of beneficial insects we suggest the use of Tobacco Extract @ 2.00 % and Neem Extract @ 2.00% for the control of cotton mealybug when infestation of mealybug is at initial stage and should be applied with cultural control practices. If the infestation rate increases to economic injury level then Movento Energy 240 Sc should be applied for the control of cotton mealybug.

Conclusion and Recommendations

The results of present investigation revealed that Movento Energy 240 Sc is very helpful for the control of cotton mealybug. We recommended that use Bio-pesticide when infestations were seen in field in early stage as bio-pesticides are eco-friendly. If the infestation reached the economic injury level then use Movento Energy 240 Sc for the control of mealybug.

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