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Efficacy of Different Insecticides against Cotton Mealybug, *Phenacoccus solenopsis* in Awaran District

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Abstract: *The efficacy of different insecticides (Kurifost 40EC, Asophate 75SP, Lorsban 40EC, Curacron 400EC and Control on the mealybug (Phenacoccus solenopsis) infestation was studied to evaluate their potential as a management strategy. Five treatments viz. Kurifost 40EC, Asophate 75SP, Lorsban 40EC, Curacron 400EC and Control plot were tested in three replicates. Curacron 400EC showed the best control against cotton mealybug population. Asophate 75SP and Lorsban 40EC did not notably lower the mealy bug population while Kurifost 40EC failed to produce any result. It is suggested that Asophate 75SP and Lorsban 40EC can be applied during initial or low mealybug infestation, however Curacron 400EC should remain as the last option during heavy infestations of the mealybugs in cotton crop.*

Keywords: Efficacy; Different Insecticides; *Cotton*; Mealybugs; *Phenacoccus solenopsis*

1. INTRODUCTION

Cotton crop has experienced a new and emerging threat from mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) that has attained the status of a serious pest (Arif *et al.,* 2009). This pest has been reported from 35 localities of various ecological zones of the globe (Ben-Dov *et al*., 2009) with initial reports from Texas, USA (Fuchs *et al*., 1991). From Pakistan, it has been recorded as a serious pest since 2005 on cultivated cotton *Gosspium hirsutum* in Punjab and Sindh (Abbas *et al.,* 2007; Muhammad, 2007; Hodgson *et al*., 2008). It has also been reported as a serious pest in India (Nagrare *et al*., 2009) and as a potential threat in China (Wang *et al*., 2009). Cotton mealybug is a soft-bodied insect that sucks the cell sap and plays havoc with the crop (Aijun *et al*., 2004). The attacked cotton plants remain stunted and produce fewer bolls of a smaller size; leaves become distorted, yellow and eventually drop off (Dhawan *et al*., 1980; Mark & Gullan, 2005). The insect also produces honey dew resulting in sooty mold growth, which hinders photosynthesis process (Saeed *et al.,* 2007).

Winged males and wingless females of mealybug (*P. solenopsis*) have two and three nymphal instars, respectively (Hodgson *et al*., [2008]). Eggs are normally laid in an ovi-sac (McKenzie, 1967; Hodgson *et al.,* 2008). This pest is also suspected as a vector of plant diseases (Culik & Gullan, 2005) and has a wide range of variation in morphological characters, biological adaptations and ecological adjustability (Hodgson *et al*., 2008). It has been recorded from 154 plant species including field crops, vegetables, ornamentals, weeds, bushes and trees (Arif *et al*., 2009; Saini *et al.,* 2009). Most of these belong to the family Malvaceae, Solanaceae, Asteraceae, Euphorbiaceae, Amaranthaceae and Cucurbitaceae, however, the economical damage has been observed on cotton, brinjal, okra, tomato, sesame, sunflower and China rose (Arif *et al*., 2009).

Integrated pest management of mealybug could be the safest and cheapest method of pest control (Ahmad *et al*., 2003). However, the use of insecticides is inevitable to check the mealybug outbreaks as compared to predators and parasitoids (McKenzie, 1967; Joshi *et al*., 2010). Several insecticides belonging to different groups have been documented as effective against cotton mealybug. For example, Suresh *et al*. (2010) recommended a need based application of insecticides like profenofos 50 EC 2 mL/L, chlorpyriphos 20 EC 2 mL/L, dimethaote 2 mL/L, imidacloprid 0.6 mL/L and thiamthoxam 0.6 g/L. Other insecticidal solutions like Buprofezin against nymphal and adult population of bunch infestation (Muthukrishnan *et al*., 2005) besides insect growth regulators and nicotine based insecticides in some vineyards (Danne *et al*., 2006). Some other non-insecticidal chemical control measures include use of petroleum spray, oils and soap sprays (Jain Hua, 2003).

Keeping in view the hazardous nature of insecticides and incomplete knowledge of control against *P. solenopsis*, the current study was planned to evaluate the efficacy of different insecticides for control of cotton mealybugs aiming to develop the best package of management practices for mealybug control.

2. MATERIALS AND MATHODS

A field experiment was conducted to determine the growth and yield performance of five new varieties of cotton (*Gossypium hirsutum* L.) at farmer field in Tehsil Jhal Jhao, District Awaran Balochistan during Rabi season, 2018 under the office of Horticulturist Agriculture Research Field Experimental Station (FES) Awaran. The experiment was laid out in a randomized complete block design (RCBD) with four replications having a plot size of 15 m x 6 m. The experiment comprised five varieties i.e. CIM-620, FH-142, CRIS-129, Krishma and MNH-786. The crop was sown with single row hand drill using a seed rate of 20 kg ha^{-1} in 75 cm apart rows on during Rabi season, 2018. The plant to plant distance of 15 cm was maintained by thinning at early growth stages. The fertilizer was applied at the rate of 85 kg N and 48 kg P_2O_5 ha^{-1} as urea and diammonium phosphate, respectively. Whole of the phosphorus and one third of nitrogen was applied at sowing while one third of nitrogen with first irrigation and remaining one third with second irrigation. All other agronomic practices were kept normal and uniform for all the treatments. Eight plants were selected at random for recording plant height, number of sympodial branches, number of bolls per plant and average boll weight. Seed cotton yield was recoded on per plot basis and was converted to t ha^{-1}. Ginning out turn was recorded as ratio between weight of the lint and weight of the seed cotton in percentage. Fiber length was measured in millimeters after ginning from each plot and fiber fineness recoded by micronare meter from the lint after ginning. Data collected was analyzed statistically using Fisher's analysis of variance technique at 5 % probability level (Steel *et al*., 1997).

2.1 Study area: The research trail was conducted at a farmer field in Tehsil Mashkai, District Awaran, Balochistan. The climate of the area is tropical to sub-tropical.

2.2 Experimental material and layout: The cotton variety FH-142 seeds were drilled in flat bed on an area of 1 acre during Kharif season, 2017. The experiment was laid out under Randomized Complete Block Design (RCBD) with three replicates. Five treatments were applied in each replication and each treatment was of 2904 square feet. The five treatments included: Control (un-treated), Kurifost, Asophate, Lorsban and Curacron.

On the whole, various insecticides were applied for the control of mealybug i.e., Kurifost, Asophate, Lorsban and Curacron. Four types of insecticides were tested *viz*., (Kurifost 40EC @ 1000 ml/acre), (Asophate 75SP @ 750 gm/acre), (Lorsban 40EC @ 1000 ml/acre) and (Curacron 400EC @ 800 ml/acre). The insecticides were sprayed with the help of knapsack sprayer. Five applications of insecticides were made throughout the study.

2.3 Data collection and analysis: The four insecticides were applied at 15 days intervals. Data on mealybug population (per plant) was recorded at weekly intervals. Five plants were observed randomly in each treatment for mealybug population. Mealybugs on top five inches of plant terminal portion were counted including stems and leaves irrespective of their life stage. Mean population of cotton mealybug in different insecticides and control plots, was compared with that of control plot to know their effectiveness. Percent population change (increase or decrease) among treatments in relation to control was calculated by using modified Abbot's formula (Flemings & Ratnakaran 1985).

Data on mealybug populations was subjected to statistical analysis using one way Analysis of Variance (ANOVA) and the means were compared by LSD test at P=0.05 .

3. RESULTS

Table I: Mean population (per plant) and percent population increase or decrease (%) of cotton mealybug before and after treatment applications

Treatmants	1ST Spray		2nd Spray		3rd Spray		4th Spray		5th Spray	
	Before	After	Before	After	Before	After	Before	After	Before	After
Kurifost	74.50	79.4 a (43.61)	102.70	92.6 ab (14.58)	95.00	108.7 a (-2.85)	108.00	89.6 b (20.07)	106.00	92.9 b (-4.110)
Asophate	72.93	67.4 a	83.93	77.46	87.26	82 b	95.40	82.06	97.53	78.6 c

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		(49.81)		bc (11.28)		(9.94)		bc (18.29)		(1.31)
Lorsban	98.26	90.8 a (51.50)	93.33	86.93 b (8.25)	102.60	107 a (-0.21)	110.33	91.8 b (21.01)	103.80	89.66 bc (-5.327)
Curacron	70.20	56.73 a (55.95)	69.26	57.73 c (19.76)	81.73	73.8 b (13.86)	76.40	67.06 c (14.62)	80.86	51.13 d (22.57)
Control	39.60	71.4 a (0.00)	69.26	110.06 a (0.00)	115.26	121.06a (0.00)	129.93	136.73 a (0.00)	146.66	120.2 a (0.00)

*Figures in parentheses refer to the percent increase or decrease of mealybugs in treatments over control

There was significant difference in mealybug population (df = 4.0, f = 4.60, p = 0.027) before the application of insecticides during the 1^{st} observation. First application of insecticides Kurifost, Asophate, Lorsban and Curacron were applied at the 2^{nd} observation, there was a non-significant difference (df = 4.0, F = 1.37, P = 0.316) among the four treatments and control plots. However, the maximum population decrease was observed in Curacron insecticide, (Table I).

The 3^{rd} observation during the research trial were revealed The 5^{th} observation were revealed significant differences (P<0.01) in mealybug population among the five treatments. The 3^{rd} application of insecticides were done at and the data was recorded during the research trial. The 6^{th} observation revealed significant (P<0.01) differences in mealybug population among the five treatments. At this stage, mealybug population decreased only in the plots, where Curacron and Asophate were applied. However, in Kurifost and Lorsban treatments mealybugs increased slightly.

The 7^{th} observation showed that there were significant (P < 0.01) differences among mealybug populations of five treatments. The 4^{th} application of insecticides were done at followed by 8^{th} observation at this stage, there were significant (P<0.01) differences among the four treatments and control plots. Contrary to the previous observations, the Kurifost and Lorsban plots proved to be the best towards lowering the mealybug population.

The 9^{th} observation taken during the experiment were The percent population change obtained through modified Abbot's formula revealed that population change in Asophate and Curacron plots was always positive (decreasing) whereas a couple of negative trends (increasing) were observed in Lorsban and Kurifost plots significant differences (df = 4.0, F = 4.431, P = 0.030) in mealybug population among treatments. The 2^{nd} application of insecticides were applied and the 4^{th} observation of data were recorded at this stage, there was a significant difference (df = 4.0, F = 8.572, P = 0.004) among the four treatments and control plots however, Curacron insecticide was showed maximum population decrease followed by Kurifost insecticide. Lorsban and Asophate insecticides could not effectively reduce the mealybug population.

revealed a significant (P<0.01) difference in mealybug population among the five treatments. The last (5^{th}) application of insecticides were done at and the 10^{th} observation were showed significant (P<0.01) differences for mealybug population among the five treatments. At this stage, the population decrease was observed only in Curacron plots, while other three treatments proved ineffective.

The seasonal dynamic pattern of control plot revealed a sharp increase in mealybug population, where population increase was from 39.60±9.59 to 104.67±6.87 individuals/plant. Afterwards a slow but continuous increase in population was evident until the end of the research; the time when the maximum population (146.67 ± 5.48 individuals/plant) was observed. Beyond this stage, a sharp decline in mealybug population was observed with a population of 60.33±10 individuals/plant during the research.

after 3^{rd} and 5^{th} sprays. Comparison of seasonal average population of mealybugs among the five treatments indicated best control offered by Curacron followed by Asophate and Lorsban. Kurifost did not prove to be efficient towards lowering the mealybug population.

4. DISCUSSION

The population of mealybug was not similar statistically before the application of insecticides during the research trial. This is a usual problem faced in such kind of studies, where crop is grown under natural field conditions and natural infestation of insects is accounted for (Hanchinal *et al*., 2009). To overcome this problem in this study, a transformed Abbot formula (Flemings & Ratnakaran, 1985) was used in which percent mortality was predicted out of the average populations amongst pre and post treated and control plots.

The results showed that Curacron (400 EC) effectively controlled cotton mealybug (*P. solenopsis*) and had lowest population over other treatments during all the observation dates throughout the crop season. Organophosphates have already been reported to be the best for mealybug control e.g., methomyl, chlorpyrifos, methidathion and profenofos (Saeed *et al*., 2007; Aheer *et al*., 2009; Suresh *et al*., 2010) along with some other insecticides belonging to synthetic Pyrethroid group e.g., Mustang 380 EC (ethion + zeta Cypermethrin) and bifenthrin.

Organophosphate insecticides have also been documented as effective control measures against other mealybug species i.e., citrus root mealybug *Rhizoecus falcifer* (Huang *et al*., 1983). Furness (1977) reported aminocarb and methomyl as toxic and effective towards dense infestation of the *Pseudococcus longispinus* (Targioni-Tozzetti) (Hemiptera: Coccidae) on citrus. Likewise, the root mealybug (*Paraputo* spp.) and spherical (*Nipaecoccus viridis*) mealybug were effectively controlled by chlorpyrifos (Bekele, 2001; Gross *et al*., 2001).

In conclusion, it is suggested that Asophate insecticide and Lorsban can be applied during initial or lower mealybug infestations, while heavy infestations require the use of Curacron insecticide. The validity of this experimentally derived recommendation needs further profundity of the management approaches by all four integrating insecticides for evolving effective and efficient strategies of cotton mealybug suppression.

5. CONCLUSION

Curacron 400EC gave best results among all the insecticides and control, therefore Curacron 400EC is recommended against Cotton mealybugs in district Awaran province of Balochistan, Pakistan. The Cotton should be regularly monitored for mealybugs attack and if the number increased mealybugs population per plant the crop should be sprayed with recommended insecticide on recommended dose. The spray can be repeated 15 days intervals if mealybugs population exceeds the number.

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