Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(4): 421-425

Received: 19-05-2019
Accepted: 21-06-2019

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# Seasonal incidence of cotton mealybug, *Phenacoccus solenopsis* (Tinsley) on okra, *Abelmoschus esculentus* (L.) and comparative efficacy of insecticides on the mortality

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**Abstract**
Seasonal incidence of cotton mealybug, *Phenacoccus solenopsis* was studied on okra *Abelmoschus esculentus* at weekly interval from May to September 2017. The results showed that the population of mealybug started building up from the month of May and reached its peak in 3rd and 4th week of August. The population showed negative correlation with maximum temperature and positive correlation with relative humidity. Efficacy of twelve insecticides were also tested for this pest in laboratory conditions. Among insecticides tested quinalphos was found to be the most effective and buprofezin was the least in terms of mortality of second instar nymphs of *P. solenopsis*. Further the details of population dynamics and the efficacy of insecticides on the mortality of cotton mealybug are discussed in the present paper.

**Keywords:** Mealybug, population dynamics, correlation, bioassy

## Introduction

Cotton mealybug, *Phenacoccus solenopsis* (Tinsley) belongs to family Pseudococcidae. This polyphagous, soft bodied sap sucking insects has become a major threat to a number of important major agricultural and horticultural crops in tropical and subtropical countries. However, *P. solenopsis* was first time discovered in 1898 by Tinsley in New Mexico, USA. But in India occurrence, incidence and severity was reported for the first time on cotton from Gujarat during 2004-05, 2005-06 and 2006-07 cropping season by [1]. Further, cotton mealybug was also reported from non- cotton growing areas like Uttar Pradesh, Madhya Pradesh and Karnataka etc [2] and described as an exotic species by [3] Hayat (2009). Being polyphagous in nature, this insect attacks on more than 200 plant species including vegetable crops, ornamental crops and weeds [4, 5]. Ninety per cent loss of okra was recorded in the month of September in experimental field at CCS HAU, Hisar due to the infestation of this pest as reported by [10] Sharma in 2007. This insect cover's the whole plant which resembles like white cottony mass. Cotton mealybug found feeding on all plant parts including leaves, shoots, fruits and roots resulting in yellowing of leaves, stunting, distorted growth, defoliation and in extreme cases even leads to the death of the plants [6, 7]. In addition, this pest produce honeydew, which leads to the development of sooty mold which interferes the photosynthesis process. Ants were also seen feeding on honeydew, thus deters biological control agent and share symbiotic relationship with cotton mealybug. Due to wide host range and overlapping of generation, this insect pest was found throughout the year on various host plants. However, with the change in abiotic factors like temperature, humidity, rainfall and wind velocity etc, the population of this pest fluctuates and this trend was found throughout the year. Although, integrated pest management is the safest and cheapest method to manage this pest [8]. In the past, vary meager attempt was made to control this pest either by the use of predators or parasites or by the use of insecticides on number of host plants in field conditions. Keeping in view of the noxious nature and severity of this pest in field conditions, attempt was made to develop package of practices to control this pest infesting okra. Experiment was carried out to study the population dynamics of the cotton mealybug from May 2017 to September 2017 and efficacy of twelve insecticides belonging to organophosphate, organochlorine, pyrethroids etc groups as mention in table 1 were tested against this pest in laboratory conditions.

## Materials and Methods

To study the incidence of cotton mealybug, an experiment was conducted during Kharif season of 2017-18 on okra crop sown in the experimental field of Faculty of Agricultural Sciences, AMU, Aligarh. The seeds were sown in the microplots with the with the spacing of 60×30 cm between row to row in randomized block design (RBD) with 9 replications. All agronomic practices were followed to raise the crop except the plant protection measures. Weekly observations were recorded on the population of cotton mealybug on okra throughout the cropping season. The crop was monitored regularly from 1st week of May till the maturation of crop. For recording the population of cotton mealybug, nymphs and adults were recorded on 10 cm apical shoot length at weekly interval from 30 randomly selected plants. To determine the correlation analysis of aphid population with abiotic factors (weekly meteorological data) was collected from meteorological stations, Department of Physics, Aligarh Muslim University, Aligarh, India.

## Rearing of Mealybug

Mature (gravid) females were collected from infested okra field along with the infested twigs were brought to the laboratory. With the help of camel hair brush cotton mealybug were removed and collected from the twigs and were placed in acrylic cage of (35x35×35 cm). Sprouted potatos were provided in the cage as food material for adult mealybug as described by [9] Amarasekare *et al*, *2008* and were kept at 27±1°C temperature and 70-75% RH in BOD incubator. Daily observation was made to record the oviposition. Eggs further hatched into first instar nymph.

## Insecticides

Twelve insecticides @ 30µl (Table1) used for bioassay were tested against cotton mealybug.

**Table 1:** List of chemicals used in the management of *Phenacoccus solenopsis* on okra.

| S. No. | Chemical Name | Trade Name | Chemical Group |
|---|---|---|---|
| T1 | Bifenthrin10EC | Marker | Pyrethroids |
| T2 | Spinosad 40%SC | Success | Unclassified |
| T3 | Buprofezin 25% SC | Apple | Thiadiazine |
| T4 | Quinalphos | Flash | Organophosphate |
| T5 | Chlorpyriphos | Chlorban | Organochlorine |
| T6 | Cypermethrin | Cyrux | Pyrethroids |
| T7 | Deltamethrin | Dr. Den | Pyrethroids |
| T8 | Emamectine benzoate | Spolit | Macrocyclic lactone |
| T9 | Dichlorvas 76% EC | Doom | Organophosphate |
| T10 | Chlorpyriphos+ Cypermethrin | Ghambhir | Organophosphorous |
| T11 | Deltamethrin+ Trizophos | Deltex | Organophosphate |
| T12 | Profenofos+ Cypermethrin | Hitcel | Organophosphorous |

## Laboratory Experiment

Okra fruits were collected from the field, washed, dried and then with the help of hand automizer desired concentration of insecticides were sprayed on all over the okra fruits which was further left to dry and then was placed in Petri plates lined with moist filter paper. Ten newly moulted 2nd instar nymphs of the cotton mealybug were released on the treated fruits. Fruits treated with distilled water was taken as control. Each treatment was replicated three times including control. Mortality was assessed after 24, 48 and 72 hours exposure of all twelve insecticides used. Nymphs that were failed to show any movement after gentle touch of pin was considered as dead.

## Results

The incidence of *P.solenopsis* population on okra was recorded at weekly intervals from May 2017 to September 2017. The result exhibited that the mean population varied with the variation in weather parameters. The incidence of *P.solenopsis* on okra is presented in Figure 1. The result showed that the mealybug population starts to buildup from the month of May with 13.15/ 10cm apical shoot and reaches its peak upto 92.70/ 10cm apical shoot in the month of August, then further the population starts to decrease gradually in the mid of September with 26.94 mealybug/ 10cm apical shoot.

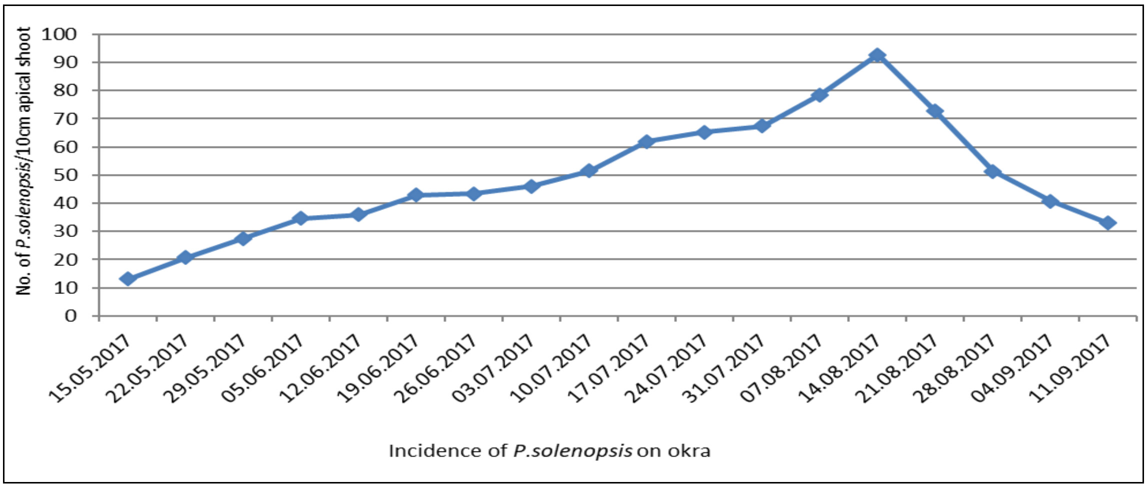


**Fig 1:** Population dynamics of cotton mealybug, *P. solenopsis* at weekly interval on okra.

**Correlation between cotton mealybug population and weather parameters**

The mealybug population was present throughout the cropping season of okra but their mean population fluctuated with weather parameters viz., temperature, relative humidity and rainfall throughout the cropping season. A relationship was established between abiotic factors and mean weekly population of mealybug (Figure 1). The mealybug population showed significant linear negative correlation (-0.581) with maximum temperature (Table 2). Temperature is one of the important abiotic factor which effects synchronization in phenology between the host plant and insect thus affecting the behavior and physiology of the insect population. But with decrease in temperature, mealybug population showed a non significant linear positive correlation (0.691). Whereas, relative humidity and rainfall showed significant linear positive and negative correlation with population of cotton mealybug (0.337 and -0.101).

**Table 2:** Correlation matrix between cotton mealybug population and weather parameters.

| | Cotton mealybug | Temp.ºC(max) | Temp.ºC(min) | R.H. | Rainfall |
|---|---|---|---|---|---|
| Cotton mealybug | 1 | | | | |
| Temp.(max) | -0.581* | 1 | | | |
| Temp.(min) | 0.691** | -0.366 | 1 | | |
| R.H. | 0.337 | -0.430 | 0.254 | 1 | |
| Rainfall | -0.101 | -0.101 | -0.381 | 0.271 | 1 |

*p<0.05; **p<0.01.

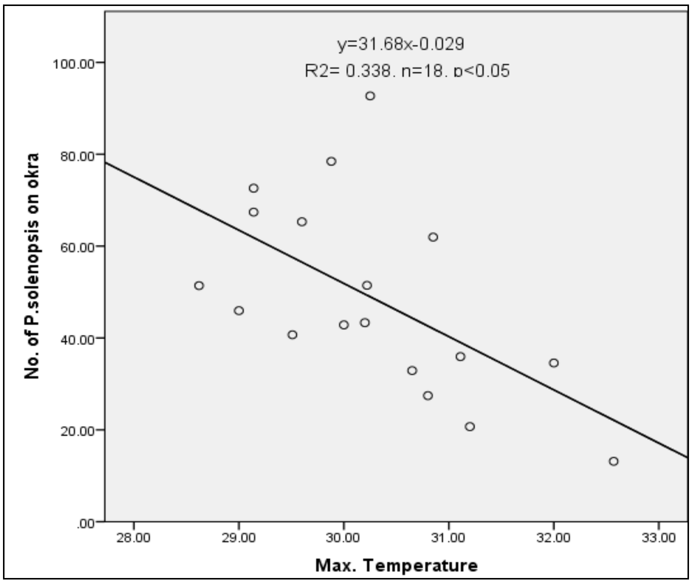


**Fig 2**

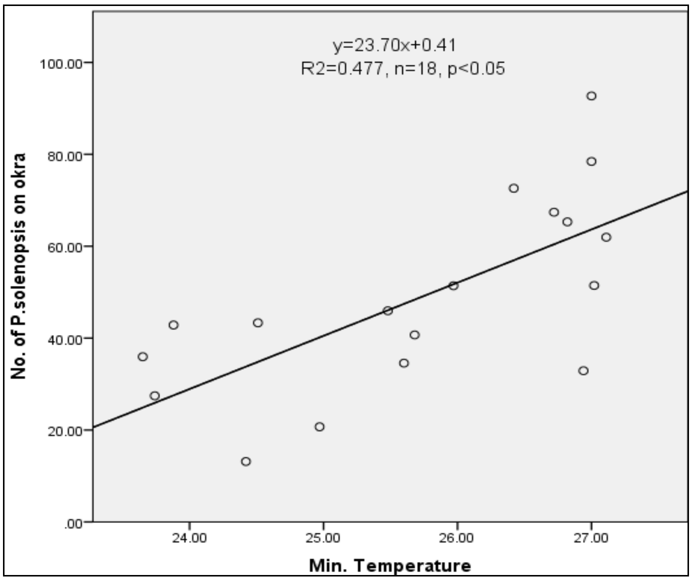


**Fig 3**

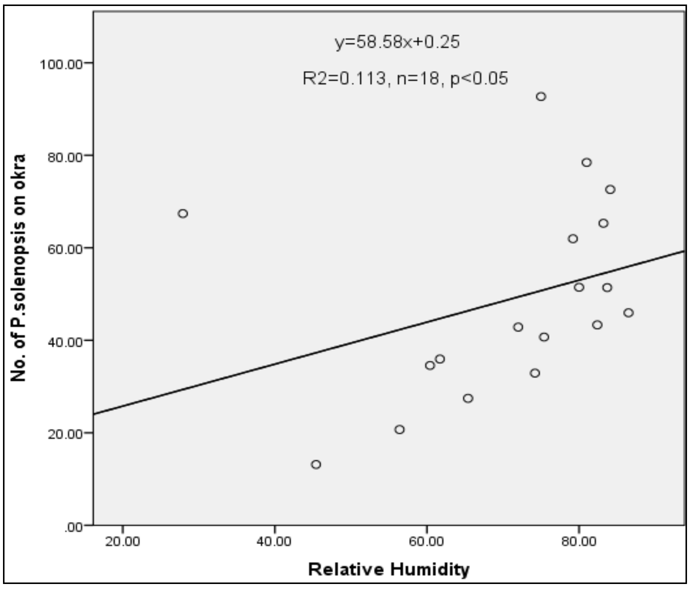


**Fig 4**

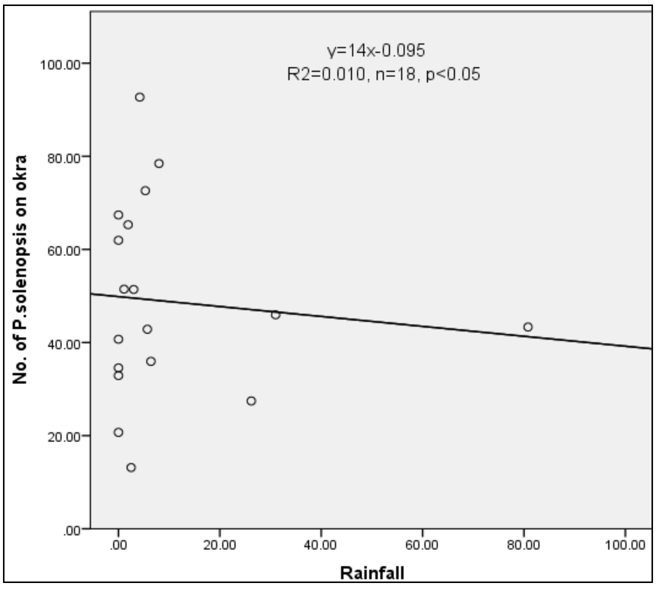


**Fig 5**

**Fig 2-5:** Correlation between population of cotton mealybug and maximum temperature, minimum temperature, relative humidity and rainfall.

**Table 3:** $LD_{50}$ of insecticides on the mortality of second instar nymph of cotton mealybug.

| S. no. | Chemical Name | Observations (hours later) | $LD_{50}$ | $X^2$ |
|---|---|---|---|---|
| 1 | Bifenthrin10EC | 24hr | 35.21 | 0.02 |
| | | 48hr | 32.77 | 0.10 |
| | | 72hr | 23.97 | 0.55 |
| 2 | Spinosad 40%SC | 24hr | 54.38 | 0.12 |
| | | 48hr | 27.83 | 0.14 |
| | | 72hr | 17.20 | 1.82 |
| 3 | Buprofezin 25% SC | 24hr | 127 | 0.00 |
| | | 48hr | 129.39 | 0.02 |
| | | 72hr | 49.02 | 0.03 |
| 4 | Quinalphos | 24hr | 20.98 | 0.04 |
| | | 48hr | 16.52 | 0.47 |
| | | 72hr | 13.72 | 0.61 |
| 5 | Deltamethrin | 24hr | 100.27 | 0.00 |
| | | 48hr | 29.88 | 0.00 |
| | | 72hr | 19.41 | 0.38 |
| 6 | Cypermethrin | 24hr | 46.63 | 0.00 |
| | | 48hr | 26.16 | 0.03 |
| | | 72hr | 18.77 | 0.04 |
| 7 | Chlorpyriphos | 24hr | 57.89 | 0.08 |
| | | 48hr | 48.39 | 0.02 |
| | | 72hr | 31.02 | 0.02 |
| 8 | Emamectine benzoate | 24hr | 40.45 | 0.12 |
| | | 48hr | 17.98 | 0.15 |
| | | 72hr | 17.84 | 1.21 |
| 9 | Dichlorvas 76% EC | 24hr | 77.47 | 0.13 |
| | | 48hr | 30.08 | 0.00 |
| | | 72hr | 21.65 | 0.03 |
| 10 | Chlorpyriphos+ Cypermethrin | 24hr | 69.85 | 0.05 |
| | | 48hr | 27.83 | 0.14 |
| | | 72hr | 20.20 | 0.23 |
| 11 | Deltamethrin+ Trizophos | 24hr | 100.27 | 0.00 |
| | | 48hr | 47.12 | 0.03 |
| | | 72hr | 32.44 | 0.10 |
| 12 | Profenofos+ Cypermethrin | 24hr | 46.63 | 0.00 |
| | | 48hr | 36.81 | 0.02 |
| | | 72hr | 25.96 | 0.04 |

The result of the bioassay test thus reveal that quinolphos was most promising among all the tested insecticides with lowest $LD_{50}$ after 24 hours which implies highest mortality of cotton mealybug. Beside quinolphos, bifenthrin 10EC and emamectine benzoate was also found effective after 24 hours. Whereas, buprofezin 25% SC had highest $LD_{50}$ value against the pest which implies the ineffectiveness of the insecticide against cotton mealybug.

Further, with the increase in duration of treatment of insecticides i.e., 48 and 72 hours, quinolphos was again found effective and had shown lowest $LD_{50}$ value among all the evaluated insecticides. Emamectine benzoate was found effective showing the similar result as of quinolphos with high mortality rate. Lowest mortality was observed in case of buprofezin 25% SC with highest $LD_{50}$ value in all the evaluated hours.

## Discussion

Results of present studies indicates that cotton mealybug has emerged as a serious pest of okra. Sharma 2007 [10] has recorded a serious loss in okra production due outbreak of cotton mealybug form Haryana, India. Further, the result showed that population of cotton mealybug fluctuated from the month of May to September reaching its peak population in the month of August. Our results are in conformation with the finding of [11] who also had recorded the peak population of cotton mealybug on okra in the month of August. While the decreasing trend of population are in conformation with the result of [12] who had recorded decrease in population of cotton mealybug in the month of September. The population of mealybug varied in field due to change in weather parameters and also other abiotic factors.

Since, maximum temperature ranged between (32ºC-28ºC) from the month of May to September, but relative humidity ranged between (45-80%) in the respective months. A huge variation of 35% in relative humidity was recorded during the study period (May 2017- September 2017). The present studies showed the relative humidity plays an important factor in population buildup of cotton mealybug. Further, the correlation with rainfall are in conformation with the result of [13, 6, 15] who also had observed negative correlation with rainfall. Results of present studies revealed that among all the weather parameters, temperature and humidity together were found to influence the survival, development and dynamics of the insect.

Studies related to bioassay of insecticides on the mortality of cotton mealybug showed that quinolphos (oraganophosphate) was the most effective insecticide for the control of cotton mealybug among all the treatments when applied at different concentrations. It had lowest $LD_{50}$ value after 24, 48 and 72 hours of exposure among all the treatments (table 3). Our results are in conformation with the result of [15, 8], who also reported similar trends of mortality of cotton mealybug using quinolphos which belong to organophosphate group. Our results shows, the highest mortality of mealybug was found using quinolphos since, it inhibits the enzymes acetylcholinesterase responsible for the degradation of acetylcholine and other cholinesterases, disrupting nerve impulses and thus leads to the killing or disabling the insect.

## Conclusion

From the above studies it may be safely concluded that studies related to population dynamics of cotton mealybug on okra in relation to weather parameters showed that at high temperature (32 ºC) and low relative humidity (45%) had negative influence on the population buildup which reached at peak during August. Bioassay studies of all the tested insecticides showed that quinolphos could be recommended for the management of cotton mealybug as the most important component of integrated pest management of mealybug on okra in field conditions.

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