Environment and Ecology 41 (1B) : 464—473, January–March 2023
ISSN 0970-0420

Seasonal Incidence and Management of Mango Mealy Bug, *Drosicha mangiferae* (Green)

Bandana Bhau, D. P. Abrol

Received 9 October 2022, Accepted 1 November 2022, Published on 6 March 2023

ABSTRACT

The studies were conducted to determine seasonal incidence and integrated management of mango mealy bug, *Drosicha mangiferae* (Green). Infestation was first observed after hatching of eggs and emergence of tiny nymphs (crawlers) as the temperature started rising in the month of early January (1st standard week) with an initial population of 3.00 nymphs per plant till 16th standard week and attained a maximum of 23.33 nymphs per plant. Seasonal incidence of mango mealy bug nymphal population at all the experimental sites was observed to be more or less similar with slight variation in population fluctuations. Correlation coefficient analysis between nymphal population and abiotic factors revealed a highly significant positive correlation between weekly mean minimum and maximum temperature and non-significant negative correlation with relative humidity (morning and evening) and rainfall, respectively. The overall impact of various treatments when observed individually after the 2nd spray applications, the average of all counts of mealy bug nymphal population per plant was low with sand application, imidacloprid, metasystox and sticky barrier, respectively. The overall mean impact of IPM modules after first treatment/application revealed the performance of treatments in descending order as follows: Module 4 (Soil raking + ploughing followed by irrigation +Sticky band+ Soil application (methyl parathion dust 2%) + Imidacloprid 1 spray; metasystox 1 spray) (0.667) > Module 3 (Sand application, soil racking +sticky band) (2.333) > Module 5 (Existing package and practices (soil raking+soil application 1.5% lindane dust + sticky band) (2.667) > Module 2 (Sand application + Methyl parathion 2% dust + imidacloprid 0.0025% 2 sprays) (5.333) > Module 1 (Methyl parathion 2% dust; metasystox 0.03% 2 spray + soil raking and ploughing followed by irrigation) (3.000 mean mealy bug nymphs).

Keywords Mango, *Drosicha mangiferae*, Seasonal incidence, Integrated pest management.

INTRODUCTION

Mango (*Mangifera indica* Linnaeus) is known as

Bandana Bhau[1]
[1]PhD Scholar, Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Faculty of Agriculture, Chatha Jammu 180009, J and K, India

D.P.Abrol[2*]
[2]Ex-Dean Faculty of Agriculture, Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Faculty of Agriculture, Chatha Jammu 180009, J and K, India.

Email: dharamabrol@rediffmail.com
*Corresponding author

'king of fruits' and belongs to family Anacardiaceae (Das and Chakraborty 2018, Akhter *et al.* 2022). It is an important tropical fruit, which is being grown in more than 100 countries of the world (Sauco 1997). Mango is the most popular fruit amongst millions of people in the Oriental region, particularly in Indo-Pakistan Sub-continent. India is the largest mango producer in the world (10.0 million tonnes) with 15% share in the world mango market. Mango is grown in vast range of agro climatic conditions and attacked by over 500 species of insect pests (Tandon and Varghese 1985) where 21 species are most important pests particularly in oriental region. Mango is usually attacked by four to five key pests damaging the crop to a considerable extent causing severe losses which includes fruit flies, stone weevils, mango hoppers, mealy bugs, scale insects and tree shoot borers. However, only a few important species are of major concern in Jammu region. Among the insect pest listed as above, fruit flies (*Bactrocera dorsalis* and *B. zonata*), mango mealy bug (*Drosicha mangiferae* Green) and mango hoppers (*Amortiodus atkinsoni* Leth and *Idoscopus* sp.) are most destructive.

Mango mealy bugs (*Drosicha mangiferae*, *Drosicha stebbingi* and *Rastrococcus iceryoides*) (Hemiptera: Pseudococidae), the polyphagous pests of mango in India are recorded as serious pests from Asia on several host crops (Tandon and Verghese 1985). The newly hatched nymphs ascend the trees, settle on inflorescence and feed by sucking sap and thereby causing flower drop and affecting fruit set. Serious attack by this insect follows drying of the leaves, terminal shoots, premature fruit fall. The occurrence of honey dew and sooty mould may reduce the market value of product such as fruits. In India, it is a major pest of grapes, reducing yield 50 to 100 % yield losses on the crops, such as jute and mesta ranges up to 70 %. Yields losses due to infestations and damage caused by mealybug on mango plant can rise up to 80 % (Moore, 2004, Karar *et al*. 2007). The damage due to mealybug could be as high as 80% of all losses (Kumar *et al.* 2012, Karar *et al*. 2013). Similarly, Tobih (2002) observed that the infestation due to mango mealybug caused significant loss in size and weight of fresh mango fruits. Mealy bugs are known to bribe ants with their sugary secretion (Honey dew) and in return ants help in spreading of mealy bug and provide protection from predators like ladybird beetle, parasitoides and other natural enemies.

Earlier, mealy bug were considered to be minor pest in several crops and have now gained the status of major pest especially in cotton, vegetables and fruit crops. During last few years, mealy bug has become a major problems in several crops. The management is difficult particularly in view of its behavior and polyphagous nature. There has been consistent interest to evolve cultural and biological control methods. Yousuf (1993) reported the use of polyethylene bands for effective control of mealy bug. The major problem with the management is related to their mode of life. Mealy bug live in protected area such as cracks and crevices of bark at base or leaf are protected by waxy secretion of ovisac are almost impossible to reach with insecticides. Late instars nymph and adults of female mealy bug are not affected by foliar application since they are covered with waxy coating. Evidently, a combination of all suitable techniques is required for their management. In view of the economic importance of the mango cultivation in Jammu and the magnitudes of the damage caused by the mealy bug, the studies were conducted to determine the seasonal incidences of mango mealy bugs and their management.

MATERIALS AND METHODS

The observations on natural infestation of mealy bug were recorded at weekly intervals starting from 1st standard week i.e., soon after the hatching of crawlers in the month of early January, till 20th standard week i.e., last week of May during every proceeding year on different parts of mango trees in relation to abiotic factors such as temperature, humidity and rainfall. For management of mango mealy bugs different cultural, mechanical and chemical methods were employed with details as given below.

Pre-emergence treatment

Pre-emergence treatments comprising cultural control, soil raking, ploughing followed by irrigation, mechanical barrier, sticky barrier and sand application and chemicals as soil treatment as a general management practices were adopted for controlling mango mealy bug.

Cultural control

Soil raking

For the pre- emergence treatments soil digging was done in the month of June. Soil digging around the tree trunk upto 1 meter diameter having 8-10 cm depth was done to expose the eggs of mango mealy bug.

Ploughing followed by irrigation

After raking, the second treatment was ploughing followed by irrigation. In this treatment, the field was ploughed deeply and irrigated by water to wash away the eggs of the mealy bug in order to minimize the population.

Chemical as soil treatment

For soil treatment, the soil around the tree trunk was treated with Chlopyriphos 1.5% dust in the mango orchard in the first week of December. Similarly in the second treatment soil around the selected plants was digged and treated with Methyl parathion 2.0% dust in the first week of December to minimize the population.

Mechanical barrier

Two type of mechanical barrier were used in the experiment.

Sticky barrier and sand application

Sticky barriers of alkthane band 15-20 cm wide (400 gauge) was tied around the tree trunk ½ meter above the ground before the eggs started hatching in the month of December.

Sand application

In December end, a heap of sand was kept around the tree trunk to avoid crawling of the insect to reach the stem and twigs of the plant and during the crawling maximum insect found were found dead in the next day.

Post emergence treatment

Chemical treatment

Pre count of mango mealy bug infesting trees shall was taken before the application of insecticides. Two chemicals were selected for spray i.e. Metasystox 0.003% and Imidacloprid 0.0025%. First spray of

Table 1. Seasonal incidence of mango mealy bug at different locations during 2010.

Sl. No.	SW	Mean mango mealy bug population locations Udheywalla	Akhnoor	Miran Sahib	Temperature °C Min	Max	Relative humidity % Mor	Eve`	Rainfall (in mm)
1	1	3..00	1.33	1.333	3.1	17.1	85.0	40.1	0.0
2	2	4.00	2.66	2.66	4.2	18.0	85.1	42.0	0.0
3	3	1.66	1.33	1.33	4.5	19.1	87.0	43.1	0.1
4	4	8.00	5.66	5.66	5.5	20.1	88.1	55.1	0.1
5	5	8.66	7.66	7.66	6.1	21.1	89.1	69.5	0.0
6	6	9.66	8.00	8.00	7.5	22.1	91.1	65.1	0.0
7	7	11.33	8.33	8.33	8.1	23.0	93.2	63.1	0.0
8	8	7.33	5.00	5.00	9.1	24.1	90.2	62.0	0.7
9	9	9.66	8.00	5.33	9.9	25.2	89.1	48.5	0.0
10	10	12.33	5.00	6.66	10.5	26.1	85.2	46.0	0.6
11	11	15.00	4.33	4.66	11.7	27.1	83.5	45.1	0.6
12	12	16.00	15.33	14.00	15.2	28.6	82.1	43.5	0.0
13	13	11.66	12.00	13.66	16.2	29.1	80.1	42.1	0.0
14	14	19.33	16.33	14.00	17.1	30.1	79.1	40.0	0.0
15	15	20.00	19.33	18.33	18.1	31.0	75.1	38.1	0.0
16	16	23.33	22.00	21.00	19.0	32.2	71.2	35.0	0.0
17	17	17.66	16.00	15.66	19.1	33.1	70.1	40.0	0.8
18	18	14.00	12.33	11.00	20.0	34.1	65.2	50.1	0.6
19	19	8.66	7.00	6.00	20.5	35.0	64.0	55.1	0.0
20	20	3.66	3.00	2.33	21.5	36.1	63.0	60.0	0.0

Table 2. Correlation matrix of mango mealy bug in relation to population and abotic factors on mango during 2010 at different loacations.

Locations	Temperature Min	Max	Relative humidity Morn	Even	Rainfall
Udheywalla	0.605**	0.563**	-300	-431	0.170
Akhnoor	0.643**	0.572**	-375	-414	-048
Miran Sahib	0.616**	0.544**	-344	-416	0.075

** Correlation is significant at the 0.05 level (2-tailed),
** Correlation is significant at the 0.01 level (2-tailed).

metasystox was done at early stage of panicale formation. Similarly the first spray of Imidacloprids was done at panicale formation after that observations was recorded at 1,3,7,14, and 21 days after application of each insecticide. Second spray of insecticide was done 21 days of first spray. After that observation were recorded at 1, 3, 7, 14, and 21 day after spray. The population present on three twigs of 10 cm length per plant were counted. The mean population was calculated by dividing the total population of tree plant by number of plants observed.

RESULTS AND DISCUSSION

The data presented in Table 1 shows that the trend in seasonal incidence of mango mealy bug nymphal population at all the experimental sites was observed to be more or less similar with slight variation in population fluctuations. However, infestation was observed to start at 1st standard week) with an initial load of 1.33 nymphs per plant at Akhnoor and 1.33 at Miran Sahib, respectively. Mango mealy bug nymphal population build-up observed on mango at both the sites were observed in 16th standard week recording a maximum of 22.00 and 21.00 nymphs per plant in Akhnoor and Miran Sahib, respectively. The nymphal population then decreased continuously up to 3.00 and 2.33 mean nymphs per plant by 20th standard week.

Table 2 shows the relationship of mango mealy bug nymphal incidence on mango with mean temperature, relative humidity and rainfall at different experimental sites during 2010. A highly significant positive correlation existed between weekly mean minimum and maximum temperature and mealy bug nymphal density and non-significant negative correlation with relative humidity (morning and evening) and non-significant correlation with rainfall, respectively.

The data presented in Table 3 shows the value of linear regression equations for the three locations as $Y = 14.971 - 3.906 X_1$, $Y_1 = 26.346 - 1.470X_1$ and $Y_1 = 14.971-3.906 X_1$ at different experimental sites of Udheywalla, Akhnoor and Miran Sahib, respectively. These equations showed the increasing trend of mealy bug nymphal incidence due to increase in temperature, preferably to some extent. The corresponding correlation co-efficient of multiple determination (R^2) values worked out to be 0.724 for Udheywalla and Akhnoor, 0.784 for Miran Sahib and was found statistically significant at 5% level of significance. The linear regression equations calculated from different locational sites also showed that with change in mean minimum temperature from 3.1 to 21.5°C and mean maximum temperature from 17.1 to 36.1°C, the values of coefficient of variation also varied from 72.4 to 78.4% which indicated a variation in the population density with an increasing trend. The overall impact of weather factors on population build up above mealy bug was 72.4% at Udheywalla, 72.4 % at Akhnoor and 78.4% at Miran Sahib (Table 1).

During the course of investigation, the mango mealy bug pest population showed the tendency to fluctuate by the influence of abiotic and biotic factors. It was observed that the mealy bug activities followed a similar trend in both the crop seasons of 2009-10 and 2010-11 (Table. 4-6). These findings are in conformity with those reported from India and other parts

Table 3. Regression equation and coefficient of multiple determination (R) of mango mealy bug in relation to abotic factors at different locations.

Sl.No.	Locations	Regression equation	R^2
1	Udheywalla	$Y= -11.600 - 3.141 X_1 + 4.256 X_2 + 0.623 X_3 + 0.52 X_4 - 9.131 X_5$	0.724
2	Akhnoor	$Y= -14506 - 2.983X_1 + 4.054 X_2 + 0.663 X_3 -0.20 X_4 - 7.149 X_5$	0.724
3	Miran Sahib	$Y= -13.896 -2.588 X_1 + 3.574 X_2 + 0.590 X_3 -0.020 X_4 - 6.376 X_5$	0.784s

Table 4. Seasonal incidence of mango mealy bug at different locations during 2011.

Sl. No.	SW	Mean mango mealy bug population locations			Temperature °C		Relative humidity %		Rainfall (in mm)
		Udheywalla	Akhnoor	Miran Sahib	Min	Max	Mor	Eve`	
1	1	2.00	1.33	1.22	2.2	16.1	84	39	0.0
2	2	3.00	3.22	2.66	3.1	17.2	86	40	0.0
3	3	1.00	1.00	1.11	4.5	19.1	87	42	0.1
4	4	6.66	5.66	4.11	5.5	20.1	88	54	0.0
5	5	8.66	7.22	7.66	6.1	21.1	89	69	0.0
6	6	9.66	8.11	7.33	6.7	22.1	90	66	0.0
7	7	12.33	9.11	8.22	7.5	22.5	92	63	0.0
8	8	6.33	5.00	5.00	8.1	23.2	93	62	0.5
9	9	8.33	7.00	6.00	9.9	24.1	88	49	0.0
10	10	4.33	5.00	3.00	10.1	25.5	86	47	0.3
11	11	6.00	4.33	5.11	11.7	27.1	85	46	0.0
12	12	16.22	15.33	14.00	14.3	28.6	82	45	0.0
13	13	12.66	15.11	13.00	16.2	29.1	80	42	0.0
14	14	19.33	16.33	14.00	17.0	30.1	78	40	0.0
15	15	19.22	18.11	17.11	18.3	31.1	76	39	0.0
16	16	23.33	20.00	20.00	19.1	31.3	71	36	0.0
17	17	16.22	15.00	14.11	20.1	32.2	70	39	0.3
18	18	14.00	13.00	10.00	21.1	34.1	65	55	0.0
19	19	9.11	4.00	4.00	22.1	35.1	64	55	0.0
20	20	3.66	1.22	2.33	21.1	37.1	63	60	0.2

of Asia by Culik *et al*. 2003, Dwivedi *et al*. 2003, Yadav *et al*. 2004, Ben-Dov *et al*. 2005, Kannan *et al*. 2006 Tanwar *et al*. 2007, Suresh and Kavitha 2008, Pandey and Kumar, 2009, Rajendran, 2009, Sharma *et al*. 2009 Karar 2010, Singh *et al*. 2010, Hala *et al*. 2011 who reported a high build-up of mealy bug nymphal population during second week of March to early April. While studying the seasonal incidence of this pest. Sen and Prasad (1956) at Bihar had also reported and recorded the descending in the months of April and May.

In the present study, the high nymphal population of the test insect observed could be mainly due to high temperature and relative humidity that reflects dry climatic conditions in this zone, from a safe threshold level of the insect. The results agree with those reported by Dwivedi *et al.* (2003) who recorded the seasonal incidence of insect pests of mango mealy bug in relation to mean temperature and humidity. The population of mealy bug (*Drosicha mangiferae*) was highest (84.6) at the base of the tree trunk in February and lowest (0.58) in December. Yadav *et al*. (2004) also observed that the highest population (17.50) of mango mealy bug was recorded on April 2000 at an average temperature and relative humidity of 27.43 ° C and 46.57%, respectively.

Table 5. Correlation matrix showing relationship between mealy bug in realation to population and abotic factors on mango 2011 at different locations.

Locations	Temperature		Relative humidity		Rainfall
	Min	Max	Morn	Even	
Udheywalla	0.623**	0.546*	-370	-271	-236
Akhnoor	0.557*	0.472*	-293	-358	-209
Miran Sahib	0.570**	0.489*	-311	-349	-197

** Correlation is significant at the 0.05 level (2-tailed),
** Correlation is significant at the 0.01 level (2-tailed).

Our results on impact of temperature and relative humidity on mealy bug nymphal population build-up coincide with the studies reported earlier by Singh *et al*. (2010) who found that the maximum incidence mealy bug was observed during first fortnight of March when maximum and minimum temperature, morning and evening relative humidity were 26.4° and 14.0° C, 90.3 and 53.7% respectively. After second fortnight of April, males were not observed when maximum and minimum temperature, morning and evening relative humidity were 37.3 °C, 22.1° C, 61.6% and 18.9%, respectively. Incidence of mealy bugs/twig had a highly significant positive correlation with maximum temperature (0.964)

Table 6. Regression equation and coefficient of multiple determination (R) of mango mealy bug in relation to abotic factors at different location.

Sl.No.	Locations	Regression equation	R
1	Udheywalla	$Y= -11.600 - 3.141 X_1 + 4.256 X_2 + 0.623 X_3 + 0.52 X_4 - 9.131 X_5$	0.801
2	Akhnoor	$Y= -14506 - 2.983X_1 + 4.054 X_2 + 0.663 X_3 -0.20 X_4 - 7.149 X_5$	0.794
3	Miran Sahib	$Y= -13.896 -2.588 X_1 + 3.574 X_2 + 0.590 X_3 -0.020 X_4 - 6.376 X_5$	0.766

and minimum temperature (0.938) and negative correlation with morning relative humidity (-0.740) and evening relative humidity (-0.910). Whereas, Hala *et al*. (2011) observed the mango mealy bug (*Rastrococcus invadens*) populations were affected mainly by rainfall and temperature variations and to a lesser extent by humidity. The level of live and dead insects is positively correlated with rainfall in contrast to temperature variations.

Effect of different management practices on the pest population of mango mealy

An experiment was conducted to determine the effect of different management practices on the pest population of mango mealy was studied during 2010. The data represented in these tables revealed that all the treatments proved significantly more or less superior over control in protecting the crop from the target pest during first and second treatments.

In the field trials conducted during 2010, the mean pest population of mango mealy bug varied from 7.900 to 9.167 per plant initially i.e., a day prior to the management practices (Table 7). After first management treatments, the mean pest population of mango mealy bug varied from 2.000 to 7.33 per plant 1st day after treatments (DAT) after 1st treatment. After first insecticidal treatments, the mean mango mealy bug nymphal population in plant receiving sand application was low (1.667 per plant) when observed after third days of treatment followed by Imidacloprid 0.0025%, Metasystox 0.03%, which recorded of 2.667 and 3.000 mealy bug nymphs per plant, respectively. The mean nymphal population in the plants receiving sticky barrier, chloripyriphos dust 1.5%, methyl parathion 2% dust, ploughing followed by irrigation and soil racking treatments was observed to be high recording 4.000, 5.000, 5.333, 7.000 and 5.667 nymphs per plant, respectively after third days in 1st treatment and significant difference was observed between sand application and imidacloprid and between imidacloprid and metasystox at 5 % level of significance. However, on the seventh day after application, the mean mealy bug nymphal population in the treatment receiving sand application followed by imidacloprid was low and at par with metasystox treatments having 1.000, 2.333 and

Table 7. Effect of different management practices on the pest population of mango mealy bug after 1st treatment during 2010.

Sl. No.	Name of treatments	Pre count	Days after treatments (DAT)					Mean
			1	3	7	14	21	
1	Soil racking	8.667 (3.108)	7.000 (2.936)	5.667 (2.570)	5.000 (2.426)	3.333 (2.061)	3.000 (2.000)	4.800 (2.374)
2	Ploughing followed by irrigation	8.567 (3.093)	7.333 (2.879)	7.000 (2.775)	6.333 (2.426)	5.667 (2.061)	3.667 (2.157)	6.000 (2.616)
3	Methyl parathion 2% dust	8.433 (3.070)	6.333 (2.570)	5.333 (2.515)	4.667 (2.378)	4.667 (2.378)	6.000 (2.646)	5.400 (2.525)
4	Chloripyriphos dust 1.5%	8.233 (3.038)	6.333 (2.505)	5.000 (2.426)	4.000 (2.229)	4.000 (2.229)	6.000 (2.641)	5.067 (2.446)
5	Sticky barrier	8.167 (3.027)	4.333 (2.229)	4.000 (2.229)	2.333 (1.821)	2.000 (1.732)	1.667 (1.626)	2.867 (1.942)
6	Sand application	7.900 (2.983)	2.000 (1.626)	1.667 (1.626)	1.000 (1.414)	0.667 (1.276)	0.667 (1.276)	1.200 (1.462)
7	Metasystox 0.03%	8.167 (3.027)	4.000 (2.229)	3.000 (1.989)	2.667 (1.911)	2.333 (1.805)	2.000 (1.688)	2.800 (1.924)

Table 7. Continued.

Sl. No.	Name of treatments	Pre count	Days after treatments (DAT) 1	3	7	14	21	Mean
8	Imidacloprid 0.0025%	8.767 (3.125)	3.333 (1.955)	2.667 (1.883)	2.333 (1.821)	3.000 (2.000)	1.333 (1.520)	2.533 (1.849)
9	Control	9.167 (3.188)	15.000 (4.007)	18.333 (4.295)	20.000 (4.561)	25.000 (5.083)	26.667 (5.239)	21.000 (4.629)
	SEM ±	0.044	0.214	0.290	0.155	0.154	0.164	
	CD at 5 %	NS	0.64	0.878	0.469	0.466	0.495	

2.667 nymphs per plant, respectively. A mean of 2.333 nymphs per plant recorded in sticky barrier treated plants after 7 days of spray which was again found to be on par with imidacloprid and metasystox treatment. The nymphal population was observed to be high in ploughing followed by irrigation treated plants recording 6.333 nymphs per plant and were significantly differed from rest of all the insecticidal and controlled treatments. On the 14th day after treatment, the lowest mean number of mealy bug nymphal population was recorded in sand application and metasystox treated plants recording 0.667 and 2.333 nymphs per plant, respectively. After 21st days of application, the effectiveness of sand application was quite high and the population recorded in these treatment was low recording 0.667 mealy bug nymphal poppulation followed by Imidacloprid (1.333) and Metasystox (2.000), respectively. Overall, after first treatment, the mean value showed that the treatment receiving sand application (1.200 nymphs per plant) was found to be the best treatment in controlling the mean nymphal mealy bug population followed by imidacloprid (2.533) and metasystox (2.800).

A day before commencement of second management practices, the mean mealy bug nymphal population number ranged from 8.567 to 9.100 nymphs per plant as observed after 21 days of the first treatment (Table 8). A day after second treatment, the lowest mean mealy bug nymphal population was recorded in sand application (2.000 nymphs/plant) and was closely followed by imidacloprid and metasystox treated plants. No difference in nymphal population at 5 % level of significance was observed between Chloripyriphos dust 1.5% and Methyl parathion 2% dust treatments and also between soil racking and ploughing followed by irrigation, respectively. The maximum mean nymphal population number was recorded in plots receiving in controlled treatments. On third day after application of second insecticidal spray, the nymphal population recorded in all the treated plants receiving different treatments was significantly lower than controlled plots. The mean mealy bug nymphal population per plant in the plants receiving sand application (1.667) was low followed by imidacloprid (2.667), metasystox (3.000) and sticky barrier (4.000).

On 7th day after application of 2nd insecticidal spray, except sand application and imidacloprid, metasystox and sticky barrier, the rest of all the treatments recorded significantly high nymphal number per plant ranging from 4.000 to 6.333. The nymphal population observed in sand application, imidacloprid, metasystox and sticky barrier treated plants were significantly differed from chloripyriphos dust, methyl parathion dust, ploughing followed by irrigation and soil racking treatments.

After 14th day of application also the population recorded in sand application, sticky barrier, metasystox, and imidacloprid treated plants was low recording 0.667, 2.000, 2.333 and 3.000 nymphs per plant, respectively and was found statistically different from population recorded on plants receiving chloripyriphos dust, methyl parathion dust, ploughing followed by irrigation and soil racking treatments. Though the mean mealy bug nymphal population was high in the plots receiving chloripyriphos dust, methyl parathion dust, ploughing followed by irrigation and soil racking treatments but significantly differed with the nymphal population recorded on controlled plots. The overall impact of various treatments when observed individually after the 2nd spray applications, the av-

Table 8. Effect of different management practise on the pest population of mango mealy bug after 2nd treatment during 2010.

Sl. No.	Name of treatments	Pre count	Days after treatments (DAT)					Mean
			1	3	7	14	21	
1	Soil Racking	8.833 (3.136)	7.000 (2.183)	5.667 (2.570)	5.000 (2.426)	3.333 (2.061)	3.000 (2.000)	4.800
2	Ploughing followed by irrigation	8.633 (3.103)	7.333 (2.879)	7.000 (2.775)	6.333 (2.688)	5.667 (2.580)	3.667 (2.157)	6.000
3	Methyl parathion 2% dust	8.533 (3.087)	6.333 (2.707)	5.333 (2.515)	4.667 (2.378)	4.667 (2.378)	6.000 (2.646)	5.400
4	Chloripyriphos dust 1.5%	8.833 (3.136)	6.333 (2.707)	5.000 (2.426)	4.000 (2.229)	4.000 (2.229)	6.000 (2.641)	5.067
5	Sticky barrier	8.567 (3.093)	4.333 (2.300)	4.000 (2.229)	2.333 (1.821)	2.000 (1.732)	1.667 (1.626)	2.867
6	Sand application	9.033 (3.167)	2.000 (1.715)	1.667 (1.626)	1.000 (1.414)	0.667 (1.276)	0.667 (1.276)	1.200
7	Metasystox 0.03%	8.567 (3.093)	4.000 (2.229)	3.000 (1.989)	2.667 (1.911)	2.333 (1.805)	2.000 (1.688)	2.800
8	Imidacloprid 0.0025%	8.900 (3.146)	3.333 (2.020)	2.667 (1.883)	2.333 (1.821)	3.000 (2.000)	1.333 (1.520)	2.533
9	Control	9.100 (3.178)	15.000 (3.966)	18.333 (4.295)	20.000 (4.561)	25.000 (5.083)	26.667 (5.239)	21.000
	SEM ±	0.028	0.218	0.290	0.155	0.154	0.164	
	CD at 5 %	NS	0.658	0.879	0.469	0.466	0.495	

erage of all counts of mealy bug nymphal population per plant was low with sand application, imidacloprid, metasystox and sticky barrier, respectively.

Almost, similar findings were recorded in both the treatments during 2010. After 1st management treatments, the mean mealy bug nymphal population varied from 0.733 to 21.200 per plant during 2010. During this year also, the more effect on nymphal population was observed with sand application at the later dates of observations even after 21 days after treatment sand application (0.333) followed by imidacloprid (1.333), sticky barrier (1.333) and metasystox (2.000), respectively.

The overall impact of these treatments (1st and 2nd) showed that after 2nd treatment, the mean number of mealy bug nymphal population per plant in plants receiving ploughing followed by irrigation treatment was maximum (5.733) and all the treatments were statistically significant at 5% level when compared with the controlled treatments . The impact of different treatments on mealy bug nymphal population observed during 2010, nymphal population counts was similar to that observed in previous years of experimentation.

The present findings agree with the earlier investigators (Batra *et al*. 1979; Saeed *et al*. 2007, Srivastava 2008, Dhawan *et al*. 2008, Mansour *et al*. 2010, Karar *et al*. 2010) who evaluated various insecticides as the alternative chemical for successful control of the mango mealy bug and cotton mealy bug. They further observed that most of the potent chemicals such as lamda cyhalothrin, alphamethrin, decamethrin, cypermethrin, methyl parathin, fenvalerate, monoctophos, endosulfan, respectively offered promising result in controlling mealy bugs. Tandon (1988) observed that the spray of Monocrotophos (0.05 %) or Chloropyrphos yielding good results when bugs settle on inflorescene panicles. Ahad *et al*. (1988) opined that Phorate was ineffective in suppressing the infestation on the aerial plant parts but soil applications were very effective and Quinalphos, Monocrotophos, Dimethoate when used as soil drenches or aerial sprays significantly reduced the pest population above and below ground. Nayer *et al*. (1986) advocated application of aldrin (5 % dust around the base of the tress and spraying of aerial parts with Parathion (0.05 %) or Melathion (0.05 %) for the effective control of early instar nymphs. Methyl demeton (0.05 %) Dimethoate (0.05 %) and Dichloros (0.1 %) have been proved equally effective when used as foliar sprays (Singh *et al*. 1988). Similarity in the proportion of insect mortality by this chemical (Dimethoate) at higher concentration (0.15 %) observed in the present studies and at lower concentration (0.03 %) recorded by above workers may be due to higher toxic effect of the chemical on the insect immediately after spraying and later on its transformation into a less toxic product. This finding leads us to summarize that evaluation of systemic products for management of a sucking type insect like mealy bug merits detailed investigation. The insect knockdown with Dimethoate (0.05 %) and oxydemeton methyl (0.05 %) has ranged between 59.88 and 49.20 % at 2 and 6 DAT respectively. These chemicals have not evinced any better performance over contact insecticides even when used as foliar applicants. Relatively much less proportion of insect motility observed in our studies testify the findings of Sandhu *et al*. (1979) who have recorded 38.7 % mortality with Oxydemeton methyl at 7 DAT even at a higher concentration of 0.1 %. The observations of Prasad *et al.* (1976), however, differ as they have recorded 81.07 % mortality with Dimethoate (0.03 %). The reason for variability in the proportion of mortality is not fully understood. The variations in the size of population may, however, be due to variations in the size of sample unit as also the variations in the population pressure. Effect of different management practices for the management of mango mealy bugs (Farooq *et al*. 2019, Subramanium *et al*. 2021) showed that an integrated approach of various methods such as with sand application, imidacloprid, metasystox and sticky barrier will be quite beneficial in suppression of mango mealy bug population.

REFERENCES

Akhter N, Latif MA, Alam MZ (2022) Effect of seasonal variations and weather factors on population dynamics of mango mealy bug (*Drosicha mangiferae*) in Bangladesh. *Am J Pl Sci* 13: 564-575.

Culik MP, Martins DS, Entura JA (2003) Indice de Artropodes Pragas do Mamoeiro (*Carica papaya* L.). Vitoria, Espirito Santo, Brazil: INCAPER, pp 48.

Das T, Chakraborty K (2018) A preliminary review on mango mealy bug, *Drosicha mangiferae* (Green) a notorious pest to mango orchards. *Int J Phar Biol Sci* 8(2): 555-561.

Dhawan AK, Saini S, Singh K, Bharathi M (2008) Toxicity of some new insecticides against *Phenacoccus solenopsis. (*Tin sely*)* (Hemiptera:Pseudococudae) on cotton. *J Insect Sci Ludhiana* 21(1): 103-105.

Dwivedi SC, Kuldeep S, Singh M, Katiyar RR (2003) Seasonal incidence of insect pests associated with mango crop. Department of Entomology, CSA Univ Agric Tech Kanpur 208002, India. *Ann Pl Prot Sci* 11(1): 159- 160.

Farooq MA, Arif MJ, Gogi MD, Atta B, Nawaz A (2019) Impact of different integrated pest management modules on pest infestation, pesticide residue and yield in Mango fruits. *J Innov Sci* 5(2): 72–82.

Hala N, Dembele B, Coulibay F, Kehe M, Doumbia M (2011) Population dynamics of the mango mealy bug, *Rastrococcus invadens* Williams (Homoptera:Pseudococcidae) in northern Cote d'Ivoire. *J Animal Pl Sci* (*JAPS*) 12(1): 1481-1492.

Ishaq M, Usman M, Asif M, Khan IA (2004) Integrated pest management of mango against mealy bug and fruit fly. *Int J Agric Biol* 6: 452-454.

Kannan M, Rao NV (2006) Influence of age and stage of the host plant on insect pests of mango (*Mangifera indica* L.). *Int J Agricult Sci* 2: 2, 351-353.

Karar H, Arif MJ, Saeed S, Abbas G (2007) Mechanical control of mango mealybug *Drochica mangifera* Green in mango orchards. XI International Symposium on Scale Insect Studies ISSIS 2007 in Oeiras, Portugal 24-27 Sep, pp 46.

Karar H, Arif MJ, Sayyed HA, Ashfaq M, Khan MA (2010) Comparative efficacy of new and old insecticides for the control of mango mealybug (*Drosicha mangiferae*) in mango orchards. *Int J Agric Biol* (12) 3: 443-446.

Karar H, Jalal H, Arif A, Ali A, Hussain M, Shah Fiaz H (2013) Effect of Cardinal Directions and Weather Factors on Population Dynamics of Mango Mealybug, *Drosicha mangiferae* (Green) (Margarodidae: Homoptera) on Chaunsa Cultivar of Mango. *Pak J Zool* 45 (6): 1541-1547.

Khan MA (1989) Control of insect pests of mango Pro Inter Mango Workshop 27th Feb, 1st Mar Direct Agric Multan region Punjab, pp 224.

Kumar R, Nitharwal M, Chauhan R, Pal V, Kranthi KR (2012) Evaluation of ecofriendly control methods for management of mealy bug, *Phenacoccus solenopsis* Tinsley in cotton. *J entomol* 9 (1): 32- 40.

Mansour R, Grissa LK, Rezgui S (2010) Assessment of the performance of some new insecticides for the control of the vine mealy bug *Planococcus ficus* in a Tunisian vineyard. *Entomel Hell* 19(1): 21-33.

Moore D (2004) Biological control of *Rastrococcus invadens*. Review article. *Biocontrol News Information* 25(1): 17-27.

Nayer NK, Anantha Krishnan TN, David BV (1986) Generall Applied Entomology. Tata McGraw Hill Publishing Company Ltd, Bombay.

Pandey AK, Rajesh K (2009) Population dynamics of mango mealy bug, *Drosicha mangiferae* Green from Jhansi, Uttar Pradesh. *Biol Forum* (1) 2: 66-68.

Pushpa V, Rao GPRM, Appa P, Rao P (1973) A note on the biology and control of mealybugs (*Maconellicoccus hirsutus* Green) on mesta. *Jute-Bull* 36(1-2): 25-28.

Rajendran TP (2009). Integrated pest management-policy directions in the context of climate change. In:Ramamurthy VV, Gupta GP, Puri SN (eds). Proc Natn Symp IPM Strategies to combat Emerging Pests in the Current Sceario of Climate Change. January 28-30, 2009, Pasighat, Arunachal Pradesh, pp 8-13.

Saeed S, Ahmad M, Known YJ (2007) Insecticidal control of the mealy bug *Phenacoccus gossypiphilous* (Hemiptera: Pseudococcidae), a new pest of cotton in Pakistan. *Entomol Res* 37: 76-80.

Sandhu GS, Sohi AS, Batra RC, Bhalla JS (1979) Stem infection for the control of mango pests with particular reference to mango mealy bug *D. mangiferae* Green (Hemiptera: Margarodidae). Proceedings of Mango Worker Meeting Held at Goa, pp 248-249.

Sauco V (1997) Mango World Production (Outside Israel, Egypt and India). *Acta Hort* 455:15-22.

Sen AC, Prasad D (1956) Biology and control of the mango mealy bug. *Drosicha mangiferae* Green. *Ind J Entomol* 18 (2): 127-140.

Sharma DR, Arora PK (2009) Status and control of mealy bugs on fruit crops in Punjab. *J Insect Sci* 22 (2) 156-161.

Singh K, SharmaVK, Shant PS (1988) Efficacy of banding materials and insecticidal foliar sprays against mango mealy bug, *Drosicha mangiferae* Green (Margarodidae: Homoptera).*Pesticides* 22(10): 26-27.

Srivastava RP (2008) Field efficacy of neem kernel extracts against mango mealy bug nymphs, *Drosicha mangiferae* Green *J Eco friendly Agric* 3 (2): 150-152.

Subramanium S, Boopathi T, Nebapure SM, Yele Y, Shankarganesh K (2021) Mealybugs. In: Omkar eds. *Poly Pest Crops Springer Singapore* 5: 231–272.

Suresh SK (2008) Seasonal incidence of economically important cocide pest in Tamil Nadu. In: Branco M, Franco Jc, Hodgson Cj eds. Proceedings of the xi International symposim on scale insect studies held on 24-27 September 2007 at oeiras. Portugal USA press; 2008, pp 285-291.

Tandon PL (1988) Present status of pests and their management, Insect Pests of Tropical Fruit Trees and their Management. *Indian of Institute Horticultural Research* Bangalore, pp 278-293.

Tandon PL, Verghese A (1985). World List of Insect, Mite and other pests of Mango Technical Document No. 5, IIHR, Banglore, pp 22

Tanwar RK, Jeyakumar P, Monga D (2007) Mealy bug and their management.National Center for Intergated Pest Mangement of New Delhi.

Tobih FO, Omoloye AA, Ivbijaro MF Enobakhare DA (2002) Effects of field infestation by *Rastrococcus invadens* Williams (Hemiptera: Pseudococcidae) on the morphology and nutritional status of mango fruits, *Mangiferae indica* L. *Crop Prot* 21(9): 757-761.

Yadav JL, Singh SP, Kumar R (2004) The population density of the mango mealy bug (*Drosicha mangiferae* G.) in mango. *Prog Agric* 4: 35-37.

Yousuf M (1993) Mango mealybug control with polyethylene bands. *Pak Entomol* 15: 129.