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Population dynamics of mango mealybug (*Drosicha mangiferae)* (Margorididae: Hemiptera) and its relation with weather parameters in subtropical climatic conditions

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ABSTRACT

Dynamics of mango mealybug (*Drosicha mangiferae* Green) in the mango (*Mangiferae indica* L.) growing agro-ecology of Lucknow region of Uttar Pradesh, India was studied during three seasons (2013-2015). Wider variations in the occurrence of mango mealybug were inferred from the study across 22 locations and three seasons. Weekly average mealybug incidence was tabulated against standard meteorological weeks (SMW), a range of 0.09 to 2.05, 0.13 to 1.57 and 0.11 to 2.56 mealybug per panicle during 2013, 2014 and 2015 was observed respectively. Peak incidence of 2.05, 1.57 and 2.10 mealybug per panicle was observed at mango orchards of Ulrapur (Fixed II), Navipana (Fixed I) and Ulrapur (Fixed I) respectively. The peak incidence of mango mealybug was found at 7th, 3rd, 10th SMW during the mango seasons of 2013 2014 and 2015 respectively. The mango mealybug incidence had significantly positive relation with maximum relative humidity and rainfall across the seasons. The linear regression models had explained upto 61% of variation in the mealybug population with the weather variables. Thus the study concluded wide spread dynamics of mango mealybug incidence across mango orchards of 22 locations. The seasonal changes were also depicted.

Key words: Agro-ecology, Mango, Mealybug, Population dynamics, Weather parameters

Mango (*Mangifera indica* L.) is an economically important fruit crop, popularly known as king of fruits. This crop suffers from several pest infestations through its growth period. Among them mango mealybug (*Drosicha mangiferae* Green) (Margorididae: Hemiptera) is a polyphagous insect pest, feeds on 71 plant species (Srivastava 1997). Infestation due to this pest leads to significant loss in size and weight of fresh mango fruits and causes yield loss up to 80 per cent (Karar *et al*. 2012). Mango mealybug is considered as serious pest in India, Banagladesh, Pakistan and China. In India, infestation of this pest is quite serious in Punjab, Uttar Pradesh, Bihar and Delhi. The nymphs and adults are damaging stages and they suck sap from inflorescence, tender leaves, shoots as well as fruit peduncles. As a result, the affected inflorescences are shriveled and get dried. Severe infestation affects the fruit set and causes fruit drop. They secrete honey dew over infested part, on which sooty mould develops. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected (Karar *et al*. 2010). Important management options for mango mealybug includes ploughing of orchard, soil application of dusts/granular insecticides, banding of tree trunk with alkathene above ground level, application of entomopathogenic fungi, *Beauveria bassiana*, spraying of 5% neem seed kernel extract (NSKE) around tree trunk, spraying of botanicals and spraying of insecticides as a last resort (Hussain 2012).

The population fluctuation as well as the distribution of the mealybug pests depends largely upon the prevailing environmental factors, as this pest known to multiply tremendously during favourable weather conditions leading to population outbreaks (Amarasekare *et al*. 2008). Climatic conditions also influence natural enemy populations such as parasitoids and predators either directly or indirectly (Thomson *et al*. 2010). For developing an early warning weather based system for any pest in a specific agro-ecosystem, it is necessary to have basic information regarding population dynamics in relation to prevalent weather parameters. This will help in determining appropriate times for intervention, and application of suitable methods for management. Population dynamics and impact of weather parameters on the incidence of mango mealybug have been studied by various workers (Yadav *et al*. 2004, Pandey and Kumar 2009). In this study effect of weather parameters on variations in the population dynamics of mango mealybug was carried out through correlation and regression analysis under subtropical agro-ecological region.

MATERIALS AND METHODS

A field experiment was conducted for three consecutive

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Table 1 Weather parameters during study

SMW	Temperature maximum (˚C)	Temperature (minimum) (˚C)	Relative humidity maximum (%)	Relative humidity minimum (%)	Sunshine hours (hr/d)	Wind speed (km/hr)	Rainfall (mm)	Evaporation in 24 hr (mm)
				2013				
7	22.0	8.8	88.4	57.4	5.7	3.1	0.0	2.8
8	23.7	9.3	88.9	55.9	7.4	2.6	3.1	3.5
9	25.5	10.4	83.0	44.7	9.5	3.6	0.0	3.4
10	29.8	11.0	80.4	36.9	8.7	2.5	0.0	3.0
11	31.1	13.0	80.7	35.6	8.2	2.4	0.0	3.8
12	32.5	14.6	71.1	29.3	8.4	4.2	0.0	4.3
13	31.9	14.1	73.0	31.7	8.3	4.2	0.0	3.8
14	34.9	14.2	58.7	21.3	10.0	4.8	0.0	7.1
15	38.2	17.2	59.0	22.7	8.8	2.9	0.0	7.8
16	37.0	17.8	63.7	33.1	7.4	3.6	0.0	8.4
17	36.9	19.3	71.9	33.4	10.0	3.6	0.0	6.2
18	40.3	20.2	69.4	31.0	10.8	3.7	0.0	8.8
19	40.3	22.5	81.3	50.1	9.4	3.7	0.0	9.3
20	39.3	22.6	69.6	43.6	10.4	3.1	0.0	9.3
				2014				
1	20.3	6.2	89.8	51.0	5.4	2.3	0.0	2.3
2	17.0	6.9	87.6	67.0	2.2	2.6	2.5	2.1
3	15.1	8.0	89.4	77.3	1.5	3.2	5.7	2.2
4	19.2	8.8	88.4	67.0	3.9	2.4	0.5	2.4
5	17.4	8.9	88.6	67.4	3.0	2.2	0.0	2.3
6	25.1	9.2	87.6	41.4	7.8	2.7	0.0	3.0
7	19.6	7.7	82.4	50.4	5.4	3.6	3.8	3.0
8	20.3	8.2	83.3	54.6	5.8	2.7	0.0	3.9
9	24.3	11.8	90.6	51.1	5.9	2.9	0.0	3.3
10	25.7	9.3	84.9	38.4	7.7	2.5	0.0	3.7
11	28.7	11.5	84.0	37.7	8.3	2.5	0.0	4.5
12	31.4	12.2	74.0	30.9	8.5	2.6	0.5	5.5
13	33.5	15.5	70.0	29.6	8.3	2.4	0.9	4.7
14	34.7	13.6	57.1	19.6	9.3	4.2	0.0	6.9
15	35.8	14.7	55.9	20.6	9.2	3.0	0.0	8.9
16	32.8	16.4	62.4	38.3	7.4	3.6	0.0	8.3
17	38.5	17.4	53.4	23.7	10.3	4.1	0.0	8.7
18	39.5	19.1	53.4	26.4	9.7	3.8	0.0	10.2
19	38.5	21.4	62.0	30.7	9.1	3.3	0.0	9.9
20	38.6	20.0	51.7	24.1	10.4	3.5	0.0	11.0
				2015				
6	22.1	8.1	87.1	53.1	4.6	2.5	0.0	3.8
7	25.3	6.9	90.7	36.1	8.0	2.2	0.0	3.4
8	27.8	11.6	91.6	47.0	5.9	2.1	0.0	4.4
9	27.0	13.6	89.8	53.7	5.2	2.3	1.9	4.3
10	24.9	11.6	88.0	44.8	8.0	4.3	3.6	3.6
11	28.7	11.5	86.4	33.8	6.4	3.2	1.1	4.2
12	28.9	13.0	89.8	39.2	8.9	3.6	2.0	4.0
13	34.9	15.5	83.7	31.5	8.3	2.0	0.0	5.8
14	30.9	16.7	89.2	41.4	6.9	3.4	0.0	4.9
15	33.8	14.7	63.2	27.7	7.1	3.1	0.0	5.7
16	33.2	18.5	77.2	36.8	6.2	2.6	4.9	4.5
17	36.2	20.1	66.4	31.4	7.5	4.8	0.0	6.3
18	35.0	20.4	73.0	41.5	9.5	4.5	1.1	6.3

seasons (2013-15) in Lucknow, Uttar Pradesh, India at 22 orchards. The climate of the experimental site is characterized as semi-arid subtropics. Mango orchards (cv. Dashehari) of 20-35 years were selected with 10 × 10 m spacing. Data on mango mealybug incidence was recorded at weekly intervals from 5 randomly selected trees in four direction of the mango tree. Mango mealybug incidence was taken by visual counting of number of mealybug on 10 cm long shoot or panicle. For analysis, mean number of mealybug per panicle was taken. Concurrently, Daily weather data was recorded in the agromet observatory located within the experimental site. Mean weekly data of weather parameters were taken for the analysis.

The mealybug counts taken from each mango orchard

Table 2 Univariate descriptive statistics for population of mango mealybug in fixed plots during 2013 -2015

	2013				2014				2015			
	Mean	Range	Skewness	Kurtosis	Mean	Range	Skewness	Kurtosis	Mean	Range	Skewness	Kurtosis
Malihabad (Fixed I)	0.16 ± 0.01	1.65-0.1	3.47	11.55	0.51 ± 0.03	2.75-0.25	1.93	3.82	0.46 ± 0.06	2.70-0.2	2.06	3.56
Malihabad Fixed II	0.18 ± 0.01	0.95-0.1	1.77	1.35								
Navipana (Fixed I)	0.26 ± 0.03	2.4-0.05	3.32	10.74	1.57 ± 0.30	7.50-0.25	1.62	1.20				
Navipana Fixed II	1.10 ± 0.14	4.6-0.05	1.56	1.34	1.39 ± 0.32	8.75-0.20	2.33	4.47				
Methe Nagar (Fixed I)	1.95 ± 0.59	8.8-0.1	2.03	2.57	0.30 ± 0.02	2.25-0.35	2.40	5.45				
Methe Nagar Fixed II	0.26 ± 0.07	3.7-0	3.74	13.00	0.30 ± 0.04	4.00-0.25	4.25	18.61				
Hafizkhera(Fixed I)	0.94 ± 0.05	2.2-0.25	0.45	-1.53	1.54 ± 0.20	6.50-0.25	1.54	1.12				
Hafizkhera Fixed II	0.17 ± 0.00	0.7-0.2	1.21	0.92	1.19 ± 0.18	6.45-0.15	1.62	1.71				
Mahmood Nagar (Fixed I)	0.85 ± 0.11	3.65-0.15	1.59	1.07	1.18 ± 0.09	3.90-0.25	1.29	0.18	0.85 ± 0.09	3.40-0.3	1.35	1.41
Mahmood Nagar Fixed II	0.70 ± 0.09	4-0.1	2.33	4.86	1.16 ± 0.11	4.70-0.25	1.54	0.96				
Kakori (Fixed I)	1.25 ± 0.08	3.9-0.15	1.22	1.54	1.44 ± 0.15	6.60-0.20	1.78	2.85				
Kakori Fixed II	0.25 ± 0.01	1.3-0.25	1.89	2.02	1.52 ± 0.21	7.05-0.20	1.68	1.76				
Ulrapur (Fixed I)	1.90 ± 0.82	12.6-0.15	2.79	7.96	0.95 ± 0.11	5.10-0.25	1.83	2.51	2.10 ± 0.51	7.55-0.5	1.31	0.49
Ulrapur Fixed II	2.05 ± 0.99	11.1-0.1	2.12	2.75	1.02 ± 0.12	5.15-0.40	1.93	2.72	1.18 ± 0.21	5.65-0.2	2.02	4.142
Kanar (Fixed I)	2.03 ± 0.34	7.7-0.1	1.55	2.20	0.96 ± 0.06	4.15-0.15	1.98	3.64	2.56 ± 0.19	5.65-0.6	0.58	-0.54
Kanar Fixed II	0.09 ± 0.00	0.95-0.35	3.25	10.01	0.89 ± 0.07	4.35-0.35	1.71	2.44				
Dadupur (Fixed I)					0.37 ± 0.01	1.70-0.20	1.61	2.28				
Dadupur Fixed II					1.08 ± 0.11	5.25-0.20	1.82	2.65	1.52 ± 0.24	5.60-0.35	1.11	0.62
CISH Block-III					0.13 ± 0.00	0.50-0.05	1.13	-0.20	1.69 ± 0.52	9.00-0.75	2.18	5.17
CISH Block-II												
Kitna Khera (Fixed I)	0.27 ± 0.01	0.75-0.4	0.35	-1.76	0.60 ± 0.04	3.65-0.25	2.49	6.74	0.11 ± 0.01	1.40-0	3.60	13
Kitna Khera Fixed II	0.36 ± 0.02	1.4-0.3	1.18	-0.44	0.47 ± 0.04	3.15-0.15	2.30	4.32				

across the seasons were subjected for the univariate statistical analysis. Correlation and regression analyses were carried out between mealybug incidence as a dependent factor and weather variables as independent factor. Significant correlation coefficient (r) values are the criteria to select suitable factor (s) to develop linear models with mealybug incidence on the Y-ordinate. The extent of variability in the mango mealybug incidence due to the factor was determined based on the R-value (R^2) or coefficient of determination. All the required statistical analyses were carried out by using Microsoft excel (Microsoft office 2007).

RESULTS AND DISCUSSION

Weather conditions during the study period

The monthly average weather parameters during the incidence (7-20, 1-20, 6-18 standard meteorological weeks) during the three seasons of 2013, 2014 and 2015 were analyzed (Table 1). It was inferred that the maximum temperature varied between 22 to 40.3, 15.1 to 39.5, 22.1 to 36.2°C, while minimum temperature was in the range of 8.8 to 22.6, 6.2 to 21.4 and 6.9 to 20.4°C respectively in 2013, 2014 and 2015 mango growing seasons**.** A range of 50.17 to 91.6 percent relative humidity was recorded across these SMW and seasons. Wider variations in case of bright sunshine (BSS) hours and wind velocity were observed. A range of 5.7 to 10.8, 1.5 to 10.4 and 4.7 to 9.6 h BSS and 2.4 to 4.8, 2.2 to 4.2 and 2-4 km/h wind velocity was recorded respectively in three seasons. Of course at the time of peak occurrence 5.7, 1.5 and 8.0 h BSS was observed. Scattered rainfall was recorded during the 2013 season with only 3.1 mm during the mealybug incidence period. It was inferred that 5.7 and 3.63 mm rainfall was received during 2014 and 2015 season at the time of peak incidence. Pan evaporation in the range of 2.8 to 9.3, 2.2 to 11.0 and 3.4 to 6.3 mm per day was noted during three seasons.

Population dynamics of mango mealybug

A wide variation was observed in the mango mealybug population across the 22 fixed plot orchards and between three seasons (Table 2). During the year 2013, 2014 and 2015 peak incidence of mango mealybug was observed at Ulrapur (Fixed II), Navipana (Fixed I) and Ulrapur (Fixed I) with 2.05, 1.57 and 2.10 mealybugs per panicle respectively. The variation in the mealybug incidence is attributed to the microclimatic conditions existing within the orchard and management practices followed by the farmers. It was observed that well managed orchards are having low incidence compared to the orchards with poor management. The mealybug incidence was varied across the standard meteorological weeks (SMW). The peak incidence of mango mealybug was found at 7th SMW during the year 2013 with 2.39 mealybugs per panicle. In the year 2014 the peak incidence of mango melaybug was recorded at 3rd SMW with 2.90 mealybugs per panicle. Whereas during the year 2015, the peak incidence of mango mealybug was found at 10th SMW with 1 mealybug per panicle (Fig. 1). Cutting across the seasons the higher incidence of the mango mealybug was observed during 2014, this variation in incidence attributed to high day temperature and maximum relative humidity in the preceding week. The existing warm humid climate has enhanced the growth and development of the mealybug. Hence, compared to the 2013 and 2015 occurrence of the mealybug was advanced to four weeks. Pandey and Kumar (2009) reported that emergence first instar mealybugs start from mid February and its incidence persists till last week of May in Jhansi conditions. Singh *et al*. (2011) reported that optimum increase in the mealybug population was observed at 6th SMW and peak population of mealybug was found at 10th SMW in two year monitoring in different coloured traps.

Relationship between mealybug population and weather parameters

Mango mealybug incidence was subjected to correlation analyses where mealybug incidence was taken as dependent factor and weather parameters as independent factor. The results showed that mango mealybug incidence was found to be significant and negatively correlation with temperature, bright sunshine hours, wind speed and evaporation while positive and significantly correlated with maximum relative humidity and rainfall across the seasons. The same trend of correlation was observed for the pooled data (Table 3). Results of this study are similar to Yadav *et al.* (2004) reported that increasing in the temperature had reduced the mealybug population. In contrast Singh *et al.* (2011) reported that the incidence of mealy bug had a highly significant positive correlation with maximum temperature and minimum temperature and negative correlation with morning relative humidity and evening relative humidity in Haryana conditions.

The regression analysis was carried out by considering weather factors as an independent variables and mealybug

Table 3 Correlation of mango mealybug population with weather parameters

Weather parameters	2013	2014	2015	Pooled
Temperature Maximum (˚C)	-0.87**	-0.75**	-0.40**	-0.73**
Temperature Minimum (˚C)	-0.77**	-0.64**	-0.37**	-0.62**
Relative Humidity Maximum (%)	0.66**	0.64**	0.60	0.53**
Relative humidity Minimum (%)	0.64**	0.79**	NS	0.71**
Sunshine hours (hr/day)	-0.76**	-0.77**	NS	-0.65**
Wind speed (km/hr)	-0.35*	-0.36*	NS	-0.27*
Rainfall (mm)	0.50**	0.53**	NS	0.37*
Evaporation in 24 hr (mm)	-0.65**	-0.69**	-0.42**	-0.63**

** Correlations coefficients significant at P=0.01; * Correlations coefficients significant P=0.05; NS=Non significant

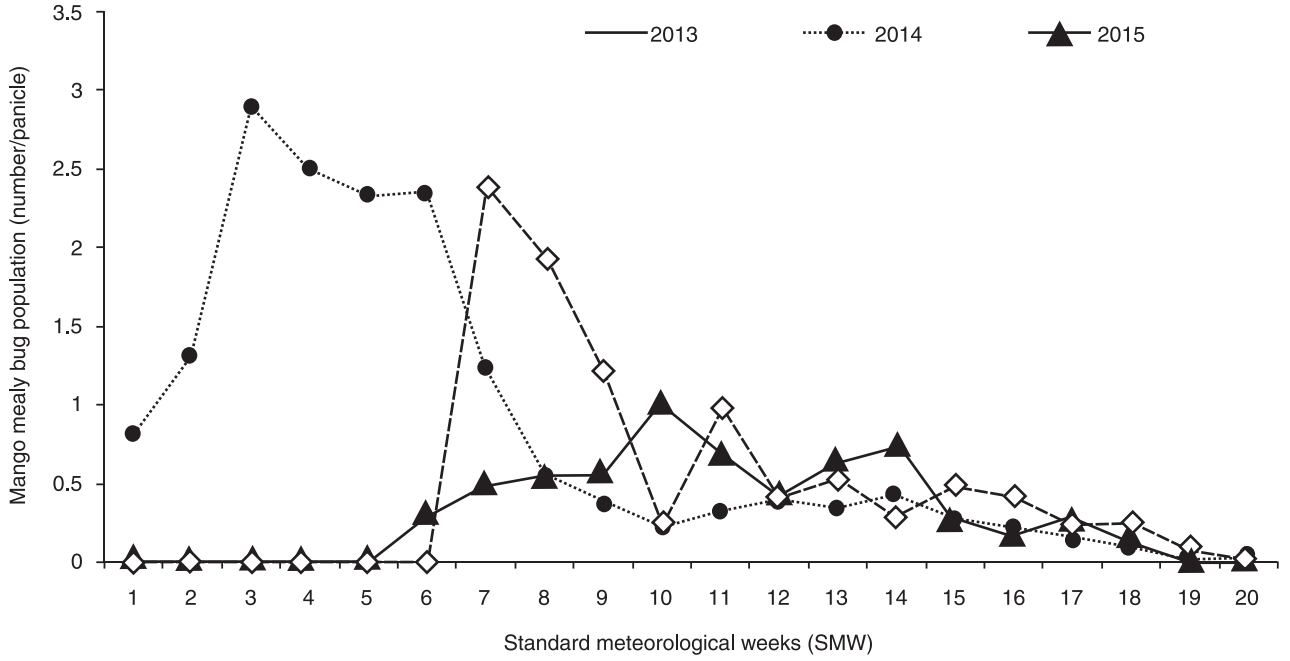

Fig 1 Population dynamics of mango mealybug during the year 2013 to 2015.

Table 4 Regression of mango mealybug population with weather parameters

Year	Equation	R^2	SE	F	P value
2013	Y=-1.55+0.0179(Tmax) – 0.17 (Tmin) +0.006(RHmax) + 0.031 (RHmin) -0.07 (SS)-0.012 (WS) +0.05 (RF) + 0.045 (Evp.)	0.99	0.19	20.24	0.005
2014	Y=-3.16+0.87 (Tmax) – 4.05 (Tmin) –0.007 (RHmax) + 0.84 (RHmin) -0.39 (SS)-0.07 (WS)+ 0.064 (RF)-0.24 (Evp.)	0.74	0.64	3.22	0.040
2015	Y=-0.40-0.143 (Tmax)+0.006 (Tmin) + 0.048 (RHmax) -0.048 (RHmin) -0.084 (SS)+0.103 (WS)+0.124 (RF) +0.706 (Evp.)	0.76	0.24	1.06	0.533
Pooled	Y=1.13+0.03 (Tmax)-0.07 (Tmin) – 0.03 (RHmax) +0.05 (RHmin) +0.03 (SS)+0.03 (WS)+0.03 (RF) - 0.12 (Evp.)	0.61	0.50	7.62	0.000

Tmax= Temperature Maximum; Tmin= Temperature Minimum; RHmax= Relative Humidity Maximum; RHmin= Relative humidity Minimum; SS = Sunshine hours; WS= Wind speed; RF= Rainfall; Evp=Evaporation.

incidence as dependent variable. The results revealed that linear models for the mango mealybug had explained 99, 74, 76 per cent variation during the year 2013, 2104 and 2015 respectively. The pooled data had explained 61 per cent of variation (Table 4).

Conclusions

The seasonal variations of mealybug population on mango were observed across the 22 locations as well as standard meteorological weeks. The peak population was recorded on 7th, 3rd, 10th SMW during the mango seasons of 2013, 2014 and 2015 respectively. This peak was coincided with the phenophases of flower bud and panicle emergence stages of mango. The population was found significantly positive relation with humidity and rainfall. This study entails the 61 per cent variations in the population dynamics attributed to weather variations. Thus, based on this study mealybug population can be predicted using weather based regression models and can be used for forewarning to take suitable management measures.

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