ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 49(3): 239-248, September 2024

POPULATION DYNAMICS OF MAJOR INSECT PESTS OF FRUIT CROPS IN A ROOFTOP GARDEN AT GAZIPUR IN BANGLADESH

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Abstract

The population dynamics of the insect pests of fruit crops, namely mealybug, spiraling whitefly, leaf miner and fruit fly were studied in a rooftop garden containing guava, mango, lemon, pumelo and dragon fruits at Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during April 2022 to March 2023. Number of insects per leaf and leaf infestation data were collected by visual observation. Fruit fly population was counted using pheromone traps. The results showed that mealybug and spiraling whitefly population were present in guava plant where mealybug population was higher than spiraling whitefly population. Mealybug population was also observed on mango plant. Leaf miner infestation was observed in lemon and pumelo plant. Percent leaf infestation was higher in pumelo plant compare to lemon plant. Mealybug population, spiraling whitefly population and leaf miner infestation were low at December-February, increased at March-April, slightly reduced at May-July and again increased at August-November. Fruit fly population found the highest at July and lowest at January. Most of the cases, weather parameter showed significant role on population abundance and infestation occurrences of insect pest at fruit crop-based rooftop garden.

Keywords: Rooftop garden, mealybug, spiraling whitefly, leaf miner, fruit fly, fruit crops.

Introduction

Rooftop gardening is the art and science of growing plants on the highest levels of industrial, commercial, and residential structures. Rooftop gardens can supplement the food of society, which contributes to food security by increasing the supply of meals to urban consumers (Bellows and Hamm, 2003). Up to 2050, the world will need 70–100% more food (World Bank, 2008). Rooftop gardeners can play an important role in supplying fruit and vegetables at urban markets and meeting the food demand of growing urban communities (FAO, 2012; Orsini *et al*., 2014).

Plants are grown on rooftop gardens for both utilitarian and non-utilitarian purposes (Sajjaduzzaman *et al*., 2005). Rooftop gardens guide social life as well

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as provide experiences of self-identification and independence, the place one can in particular acquire self-satisfaction (Rashid *et al*., 2010). With fast and unplanned urbanization, poverty and food insecurity have been growing alarmingly in Dhaka city (Choguill, 1995). Rooftop gardening can be a positive approach to ensuring meals are furnished and satisfying the dietary desires of city dwellers. It is hopeful that many people are involved in rooftop gardening, especially in urban areas of Bangladesh. Their efforts are helping to make the cities greener, despite the lack of cultivable land there. People expect chemical-free organic vegetables and fruits, but insect pest attacks occur in rooftop gardens where people apply chemical insecticides without knowing the insect pest. A total of 24 families and 46 species of insect attacks were reported at the rooftop garden (Han *et al.*, 2017). Insect pest attack and its severity may be different in roof gardens compared to field agriculture, but in Bangladesh, research work is very scanty related to insect pest attack at the rooftop gardens. Insect pest status and their population dynamics study will help develop a sustainable pest management strategy for rooftop gardens. The present study was, therefore, conducted to know the status of insect population at rooftop garden, their relationship with weather parameter and the contribution of weather parameter to build up the insect population.

Materials and Methods

Study area

The survey was conducted at rooftop garden of Horticulture Research centre (HRC), Bangladesh agricultural Research Institute (BARI), Gazipur (23.9942°N, 90.4119°E, altitude 15 meter from ground level) during April 2022 to March 2023. The rooftop garden of HRC was eastablished with fruit crops, viz. guava, mango, lemon, pumelo, dragon fruit etc. Most of the plants were 2-3 years old, moderately populated and at fruit bearing condition.

Data recorded and analysis

Data were recorded by visual observation at 30 days interval. For counting insect pest number and infested leaf, two plants were selected randomly from each crop species then four branches of selected plants were again selected randomly. Insect number and infested leaf data were recorded from upper ten leaves of selected branch and leaf infestation was calculated into percentage.

Fruit fly population was counted by using pheromone trap. Three methyl eugenol water traps were placed at HRC rooftop garden from where dead fruit flies were sorted out and counted at every seven days interval. Monthly average number of fruit fly/trap was calculated from recorded data. Weather data were collected from meteorological observatory section of Bangladesh Rice Research Station (BRRI), Gazipur. Data were analyzed by using Microsoft Excel software.

Results and Discussion

Results on population fluctuation of mealybug and spiraling whitefly on guava plants in a rooftop garden at Gazipur in Bangladesg during April, 2022 to March, 2023 are presented in Fig. 1. It was observed that the highest 8.1 mealybugs leaf^{-1} were found at September and the lowest 3.1 mealybugs leaf^{-1} were found at January during the study period. Mealybug population was higher at July to November, reduced lowest at January and after that population was gradually increased up to April. After April, with some fluctuation population reached peak at September. In case of spiraling whitefly population fluctuation, the highest population (4.25 leaf^{-1}) was found at November and the second highest population observed both at December and April (3.45 leaf^{-1}). Spiraling whitefly population was lower at May to July where the lowest population 2.15 leaf^{-1} was found at the month of June.

Monthly distribution of meteorological parameters like average temperature, rainfall and average relative humidity during April 2022 to March 2023 are presented in Table 1. During the study period, average temperature (28.90-30.93^{0}C) was high in April to October. The lowest average temperature (19.34^{0}C) was found in January followed by December (22.11^{0}C) and February (23.01^{0}C), respectively. Rainfall was high in May to October and was very low or nil in November to February. Relative humidity was comparatively higher in April to October than November to March.

The multiple linear regression analysis showed that the effect of temperature, rainfall and relative humidity on guava mealybug population was 39.7, 5.6 and 0.2%, respectively, where effect of temperature was significant. The effect of temperature and rainfall was 45.3% and the effect of temperature along with rainfall and relative humidity was 45.5% on mealybug population abundance where both equations were insignificant. On the other side, guava spiraling whitefly population was controlled 18.2% by temperature, 33% by rainfall and 11% by relative humidity. Combined effect of temperature and rainfall was 51.2%, combined effect of all three weather parameters was 62.2% and both equations were significant (Table 2).

Population dynamics of mealybug and spiraling whitefly were studied by different researchers at field condition but scanty at rooftop condition. At field condition, Abdelgayed *et al*. (2020) found two peaks population of mealybug, one in mid-August and another at end of September. They also observed that temperature had positive effect on population of mealybug. Sultana *et al.* (2015) found temperature and relative humidity had a positive correlation to mealy bug population while the rainfall had a negative correlation. Khan (2017) found the highest incidence of spiraling whitefly population in September followed by October, November and May while the lowest was in July followed by June, January and February, respectively. Chavan *et al* (2022) showed weather parameters contributed to 56.0 percent of the total variation in the population of spiraling whitefly.

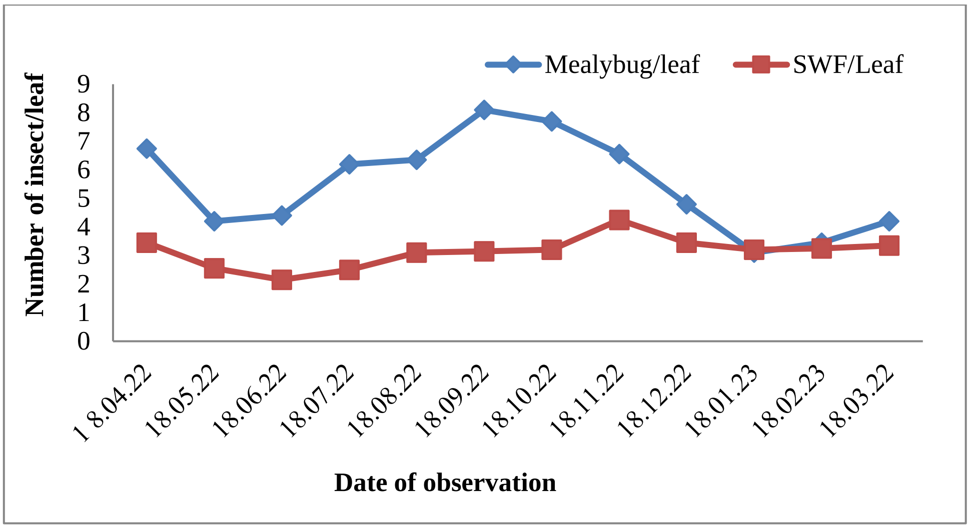

Fig.1. Population fluctuation of mealybug and spiraling whitefly on guava plants in a rooftop garden at Gazipur in Bangladesh during April, 2022 to March, 2023.

Table 1. Monthly distribution of meteorological parameters during April 2022 to March 2023

Month	Average temperature (°C)	Rainfall (mm)	Average relative humidity (%)
April 2022	30.08	58.40	70.22
May 2022	29.24	297.80	77.13
June 2022	30.18	311.00	80.17
July 2022	30.93	176.00	76.10
August 2022	30.80	110.00	74.73
September 2022	29.95	215.80	78.50
October 2022	28.90	288.20	74.02
November 2022	25.81	0.00	62.10
December 2022	22.11	2.20	68.60
January 2023	19.34	0.00	70.56
February 2023	23.01	16.40	61.10
March 2023	26.28	114.40	65.30

Source: Meteorological observatory section, Bangladesh rice research Station (BRRI), Gazipur

Table 2. Multiple regression models along with coefficients of determination (R^2) and the impact of weather parameters on the seasonal abundance of guava insects during April 2022 to March 2023

Insect name	Regression equation	R^2	100 R^2	Role of individual factor (%)	F statistic
Guava mealybug	$Y= -1.86 + 0.26 X_1$	0.397	39.7	39.7	$F_{1,10}= 6.6$ $P < 0.05$
	$Y= -3.90 + 0.366X_1-0.004X_2$	0.453	45.3	5.6	$F_{2,9}= 3.72$ $P= 0.06$
	$Y= -4.87 + 0.363X_1-0.005X_2 +0.016X_3$	0.455	45.5	0.2	$F_{3,8} = 2.22$ $P = 0.16$
Guava Spiraling Whitefly	$Y= 4.75 - 0.059 X_1$	0.182	18.2	18.2	$F_{1,10} = 2.23$ $P= 0.16$
	$Y= 3.08 + 0.019X_1-0.003X_2$	0.512	51.2	33	$F_{2,9} = 1.21$ $P= < 0.05$
	$Y= 6.06 + .031X_1-0.001X_2-0.049X_3$	0.622	62.2	11	$F_{3,8} = 5.00$ $P < 0.05$

Y = Insect population/leaf; X_1 = Average temperature (°C); X_2 = Rainfall (mm); X_3 = Relative humidity (%)

Mealybug population at mango plant

Figure 2 shows population fluctuation of mealybug at rooftop garden's mango plant. Population of mealybug at rooftop mango plant was fluctuated throughout the season but become lowest (2.10 leaf^{-1}) at January. After January mealybug population increased and took the highest peak (4.85 leaf^{-1}) at April. The second highest mango mealybug (4.75 leaf^{-1}) was found in the month of October.

Table 3 indicated the individual effect of temperature, rainfall and relative humidity on mango mealybug abundance was 43.3, 0.2 and 18.3%, respectively. The effect of temperature was significant. The combined effect of temperature, rainfall and relative humidity was also significant and exerted 61.8% abundance.

Mealybug population was low at mango plant compare to guava plant at rooftop garden but effect of weather parameters on mealybug population were almost similar at both host plant.

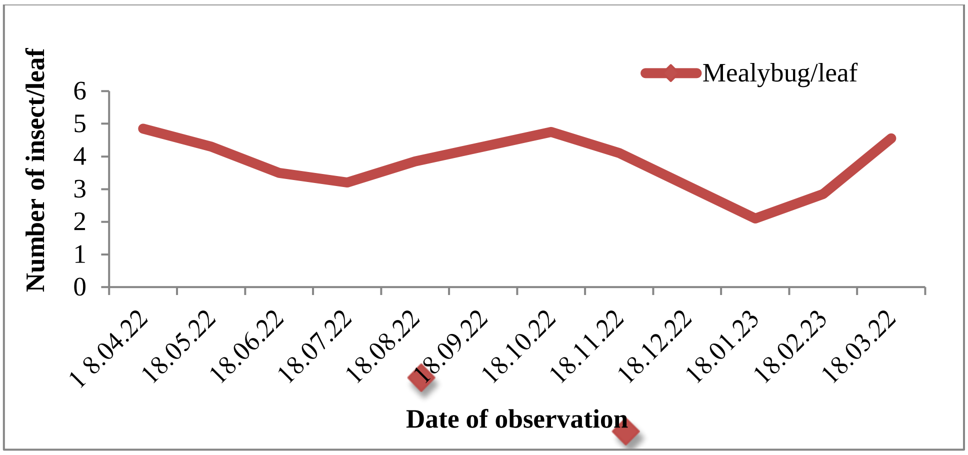

Fig. 2. Population fluctuation of mealybug mango plants in a rooftop garden at Gazipur in Bangladesh during April, 2022 to March, 2023.

Table 3. Multiple regression models along with coefficients of determination (R^2) and the impact of weather parameters on the seasonal abundance of mango mealybug during April 2022 to March 2023

Insect name	Regression equation	R^2	100 R^2	Role of individual factor (%)	F statistic
Mango mealybug	$Y= -0.11 + 0.143 X_1$	0.433	43.3	43.3	$F_{1,10}= 7.64$ $P < 0.05$
	$Y= -0.283 + 0.151X_1-0.0004X_2$	0.435	43.5	0.2	$F_{2,9}= 3.36$ $P= 0.07$
	$Y= 5.47 + 0.175X_1+0.003X_2-0.095X_3$	0.618	61.8	18.3	$F_{3,8} = 4.31$ $P < 0.05$

Y = Insect population/leaf; X_1 = Average temperature (°C); X_2 = Rainfall (mm); X_3 = Relative humidity (%)

Leaf miner infestation at lemon and pumelo plant

Figure 3 shows percent leaf miner infested leaf at rooftop garden's lemon and pumelo plant. Leaf miner infested leaf percentage was higher in pumelo (36.25 to 78.00%) compare to lemon (30 to 70%) at rooftop garden. In both plant species, leafminer infestation was higher at the time before and after winter. After January, leaf miner infestation was gradually increased and reached the 2nd highest peak at April (67.5% pumelo leaf infestation, 66.25% lemon leaf infestation). In May to July leaf miner infestation reduced, after that infestation increased and reached the highest peak at September.

The multiple linear regression analysis presented in Table 4 showed that the temperature individually contributed 68.2% infestation abundance of lemon leaf miner, temperature with combination of rainfall contributed 72.1% infestation abundance and combined effect of temperature, rainfall and relative humidity was 72.7% on abundance of lemon leaf miner infestation where all equations were significant. Individual effect of rainfall and relative humidity was 3.9 and 0.6, respectively.

In case of pumelo, temperature controlled 41.11% leaf infestation and its effect was significant. Individual effect of rainfall and relative humidity was 0.03 in both cases and the effect was insignificant. Combined effect of temperature, rainfall and relative humidity was 41.17 and the equation was insignificant (Table 4).

Rahman *et al.* (2005) observed that the citrus leaf miner infestation occurred throughout the year with two peak populations in the months of April and September while the minimum incidence was found in January and July which is similar to the result of present study. They also found that the temperature had positive and rainfall had negative effect on leaf miner infestation in the field.

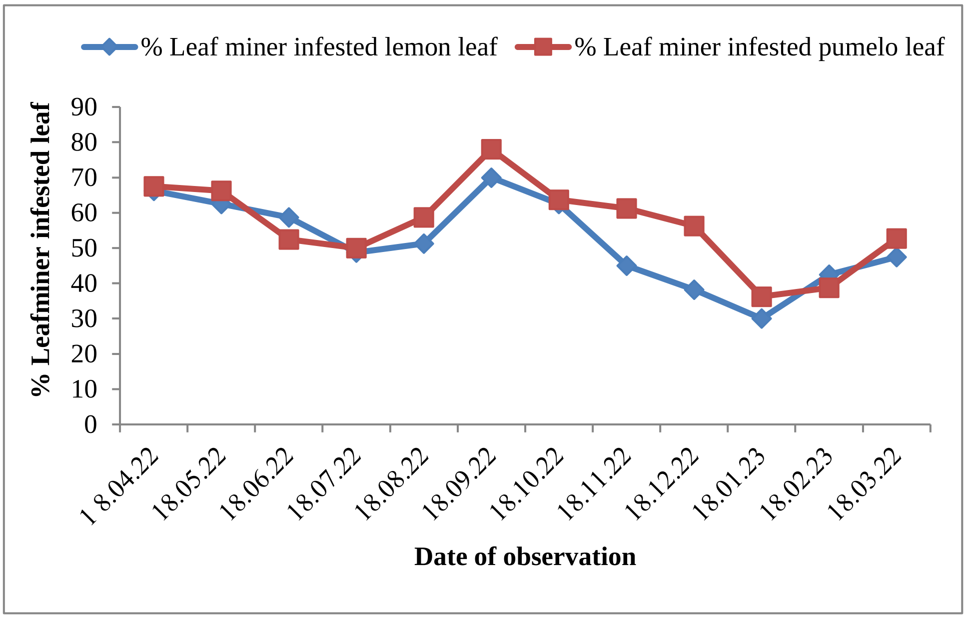

Fig.3. Infestation levels (%) of leaf miner on lemon and pumelo plants in a rooftop garden at Gazipur in Bangladesh during April, 2022 to March, 2023.

Table 4. Multiple regression models along with coefficients of determination (R^2) and the impact of weather parameters on the seasonal incidance of leafminer infestation at lemon and pumelo leaf during April 2022 to March 2023

% Leaf infestation	Regression equation	R^2	100 R^2	Role of individual factor (%)	F statistic
% Lemon leaf infestation	$Y= -18.55 + 2.59 X_1$	0.682	68.2	68.20	$F_{1,10}= 21.5$ $P < 0.01$
	$Y= -5.997 + 1.995X_1+0.027X_2$	0.721	72.1	3.90	$F_{2,9}= 11.67$ $P= < 0.01$
	$Y= 8.12 + 2.054X_1+0.035X_2-0.235X_3$	0.727	72.7	0.60	$F_{3,8} = 7.1$ $P < 0.05$
% Pumelo leaf infestation	$Y=3.53+1.958 X_1$	0.411	41.11	41.11	$F_{1,10}= 6.98$ $P < 0.05$
	$Y= 2.39 + 2.01X_1-0.002X_2$	0.411	41.14	0.03	$F_{2,9}= 3.14$ $P= 0.09$
	$Y= -0.93 + 1.99X_1-0.004X_2+0.055X_3$	0.411	41.17	0.03	$F_{3,8} = 1.86$ $P= 0.21$

Y = % Leaf infestation f; X_1 = Average temperature (°C); X_2 = Rainfall (mm); X_3 = Relative humidity (%)

Fruit fly population at rooftop garden

Monthly cached fruit fly per pheromone trap is shown in Fig. 4. It was found that *B. dorsalis* population was found though out the observation period ranged from 28 to 104.67 per trap. The lowest population was found at January and the highest population was found at the month of July.

Multiple regression equation shows temperature, rainfall and relative humidity individualy controled 56.1, 0.8 and 9.3% fruitfly population abundance at rooftop garden, respectively. Temperature and rainfall controled 56.9% fruitfly population abundance and the combined effect of weather parameter exerted 66.2% population abundance where all the equations were significant (Table 5).

Uddin *et al.* (2016) observed fruit fly population using methyl eugenol water traps at mango orchard. They found the highest fruit fly population in the month of July (7236.30 ± 18.69) and the lowest from January (6.70 ± 0.70) while temperature, relative humidity, rainfall and host availability influenced the fruit fly population. At rooftop condition, fruit fly population fluctuation showed the similar trend like Uddin *et al.* (2016) study but the average fruit fly population was low at present study might be due to lower host availability.

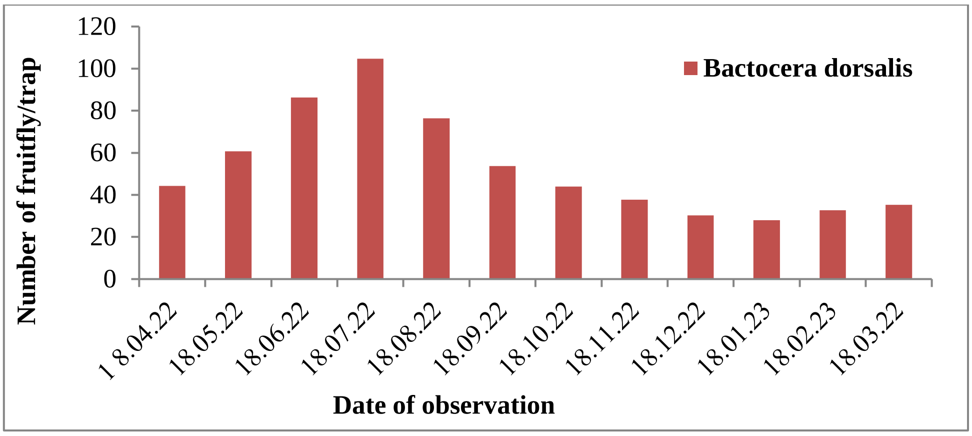

Fig. 4. Monthly catched fruit fly per pheromone trap at rooftop garden during April, 2022 to March, 2023.

Table 5. Multiple regression models along with coefficients of determination (R^2) and the impact of weather parameters on the seasonal abundance of fruit fly during April 2022 to March 2023

Insect name	Regression equation	R^2	100 R^2	Role of individual factor (%)	F statistic
Fruitfly	$Y= -75.86 + 4.72 X_1$	0.561	56.1	56.1	$F_{1,10}= 12.79$ $P < 0.01$
	$Y= -64.68 + 4.199X_1+0.024X_2$	0.569	56.9	0.8	$F_{2,9}= 5.94$ $P< 0.05$
	$Y= -183.98 + 3.703X_1- 0.046X_2+1.987X_3$	0.662	66.2	9.3	$F_{3,8} = 5.23$ $P < 0.05$

Y = Fruit fly population/trap; X_1 = Average temperature (°C); X_2 = Rainfall (mm); X_3 = Relative humidity (%)

Conclusion

Both mealybug and spiraling whitefly insects were found in rooftop garden's guava plant and it was observed that mealybug population was higher than spiraling whitefly population. Mealybug was also found in mango plant. Leaf miner infestation was found in lemon and pumelo plant. Mealybug population, spiraling whitefly population and leaf miner infestations were low at winter and monsoon but increased in summer and autumn. Fruit fly population was higher at mango during bearing season but was lower at winter. Most of the case, weather parameter had significant effect on insect population and infestation at fruit crop-based rooftop garden.

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