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Effect of Seasonal Variations and Weather Factors on Population Dynamics of Mango Mealybug (*Drosicha mangiferae*) in Bangladesh

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Abstract

An experiment was conducted in mango orchard of Sher-E Bangla Agricultural University (SAU) campus, Dhaka to determine the effect of seasonal variation round the year and weather on population dynamics of mango mealybug (*Drosicha mangiferae*) on mango tree. The mango mealybug was first appeared in early December and disappeared in June in a year. Its population started to increase gradually from December and continued up to February when the ambient average temperature was 20.95˚C, relative humidity 63% and rainfall was absent. The highest population of the insect (33.33/30 cm branch) was recorded in February and the lowest (3.75/30cm branch) in May. Adult insects appeared in February on the ground under the selected mango tree showing the population of 6.67 males and 123.33 females per 81 m^2. Population of males (32.5/81m^2) and that of females (352.75/81m^2) reached to the peak when the ambient temperature was 28.19˚C, relative humidity 61% and the rainfall was 0.00 mm. When relative humidity was high and rainfall started adult females enter into the soil and disappeared. Correlation between population of mealybug and temperature was positive. Its population was negatively correlated with relative humidity and rainfall.

Keywords

Seasonal Variations, Mango Mealybug, Weather Factors

1. Introduction

Mango (*Mangifera indica* L.) is a member of the family Anacardiaceae. It is regarded and appreciated for its strong aroma, delicious taste, and high nutritive

value [1] [2]. This tropical fruit mango is being grown in more than 100 countries [3]. Apart from that, it is also valuable ornamental and shade tree with medicinal virtues [4]. Annually, about 1,165,804 metric tons of mangoes from an area of 44,366 hectares of mango orchard are harvested in Bangladesh [5]. Production of fruits is still far behind the country's present requirement. About 78 g fruit is available for per person in Bangladesh whereas 200 gm is the daily requirement [6]. Among the fruits in Bangladesh banana stands in the top position in terms of area coverage (32%) and production (17%) followed by mango (25% area and 24% production) and pineapple (9% area and 4% production) [7]. Mango (*Mangifera indica* L.) is recognized as one of the choicest and well accepted fruits all over the world due to its attractive color, marvelous flavor, delicious taste and high nutritive value. It is a nutritionally important fruit being a good source of vitamin A, B & C and minerals. Sugar constitutes main bulk of the carbohydrates and most of the soluble solids are found in ripe mango [8] [9]. Area under mango production is fluctuated over the last decades whereas total production has been increased in Bangladesh. Insect pests have been regarded as an important constraint to garden fruits throughout the centuries [10]. A number of insect pests are known to attack the mango trees, which have economic importance [11] [12] [13]. Occurrence of pest outbreaks has increased with the change of pest complexities in the last few decades. Some insects have gained momentum, whereas others have declined in importance [14]. There are convincing documents that "minor pest species" have been favoured by selective crop intensification [15]. Insect pests are the major threat to underscore the mango production accounting for huge seasonal loss [16]. Grossly 400 insects and non-insect pests have been recorded from Indian subcontinents that have pest property. However, out of that thirty are obnoxious and serious pests to mango orchard [17]. Several insects attack mango from nursery stage to fruit maturity. Among all of the mango insect pests, mealybug, *Droschia mangiferae* (G.) is one of the notorious and destructive pests rendering huge scale of fruit loss [18]. Extent of loss may extend up to 50% in some occasional cases [19]. Severe infestation affects the growing fruits resulting in fruit drop. Both the quality and the quantity of the food are greatly affected due to this infestation [12]. Mango mealybug became a serious pest of mango and citrus in West Africa which reduced mango fruit 50% - 90% and pest caused serious nuisance [20]. *D. mangiferae*, *is* considered to be prime destructive mealybugs species of mangoes in subcontinent of South East Asia. *D. mangiferae* is the serious, dilapidating, polyphagus, dimorphic and notorious pest of mango orchards in Indian sub-continent. [21] had pointed out that mealybugs posed a serious threat for cultivation of many fruit crops including Mango. A total of nine mealybug species have been reported on citrus including *D. mangiferae* from Nagpur region of Maharashtra, India. [22] and [23] had mentioned that *D. mangiferae* was widely distributed in indogangetic plains from Punjab to Assam and found to attack about 62 host plants including jackfruit *Artocarpus heterophyllus* Lam.,

banyan *Ficus bengalensis*, guava *Psidium guajava* L., Papaya *Carica papaya* L., *Citrus* spp. and *Jamun Syzigium* spp. [24] from Kolhapur region of India had noted that *D. mangiferae* perpetuates on mulberry *Morus alba*, *D. guajava*, *C. papaya*, *Syzigium* spp., *Citrus Citrus* spp. and *Tamarandus indica* Lim., cotton, okra, *Hibiscus* and brinjal. [25] had mentioned that though this insect is mainly a pest of mango tree, however, in the areas of heavy populations, it has the tendency to attack a variety of other fruit trees like peach (*Prunus persica*), plum (*P. domestica*), papaya (*Carica papaya*) and all citrus species. [26] opined that mealybug preferred mango varieties differentially. Damage to plants is principally manifested due to the unremitting sucking of "cell sap" from tender leaves, stem, inflorescence and even from the growing fruits. The nymphs and females of this bug suck sap from inflorescence, tender leaves, shoots and fruit peduncles. Affected panicles shrive and become died. Infested plants are affected by the sooty mould [27]. Severe infestation often leads to fruit drops or makes the fruit unfit for marketing [28]. In general, *D. mangiferae* is found to infest almost all mango cultivars resulting in severe fruit necrosis. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected [29]. Further *D. mangiferae* secrete honey dew which provides effective medium for rapid growth of black and sooty fungi which decolorizes the fruit and makes it unacceptable to consume [30]. The climate as an extrinsic integrative factor plays a crucial role in determining the abundance and distribution of insect pest population. [31] had observed that abiotic factors are believed to be responsible for pest population dynamics. Hatching and transformation of different stages of life cycle depend on certain environmental condition. The mealybug female deposits eggs in the cracks in the soil in the month of April-May [32] that remain in diapauses from May to middle of December [33] and hatched in the last of December sometimes extending up to January [34] depending upon the climatic factors [35].

Reports from other country indicate that generally, its nymphs started emerging at the end of December or beginning of January in a year and the adult female enter into the soil in May [36] [37] [38]. [39] found that the highest population of mango mealybug was found in early April at an average temperature and relative humidity of 27.43˚C and 46.15% respectively. Decrease in population was found in late April and early May at an average temperature and relative humidity of 31.55˚C and 49.80%, respectively. However, no infestation was recorded in May 31 due to an increase of temperature (33.55˚) and relative humidity (63.50%). Available literature reveals that *D. mangiferae* is polyphagous insect and it occurs in November to May with variable level of infestation. Reports on the effect of seasonal variation and weather factors on population dynamics of the insect are not available in Bangladesh. Therefore, the present piece of research was undertaken to find out the effect of seasonal variation and yearly weather factors on population dynamics of mango mealybug under ecological conditions of Bangladesh.

2. Materials and Methods

The experiment was conducted during December to May in an orchard of SAU campus. Three mango trees of a local cultivar were selected. On each tree, four branches of 30 cm length were selected in four different directions, east, west, south and north. The populations of nymphs at different stages of mango mealybug, under natural infestation, were counted every week starting from December 2011 and continued up to May 2013. Populations of adult male and female were also recorded from an area of 81 m^2 in the ground under tree. In each year, average populations of the insect at three nymphal and adult stages were computed with respect to directions of branches.

The weather data on monthly average temperature, relative humidity and rainfall were obtained from the Weather office, Bangladesh Meteorological Department, Sher-e-Bangla Nagar, Dhaka. Relationship of mealybug population with three weather factors was analyzed statistically. Their relationship was shown studying correlation coefficient and coefficient of determination.

3. Results

Monthly distribution of weather factors in two consecutive years, Data on three weather factors viz. temperature, rainfall and relative humidity recorded during December 2011 to May 2013 are shown in Figure 1.

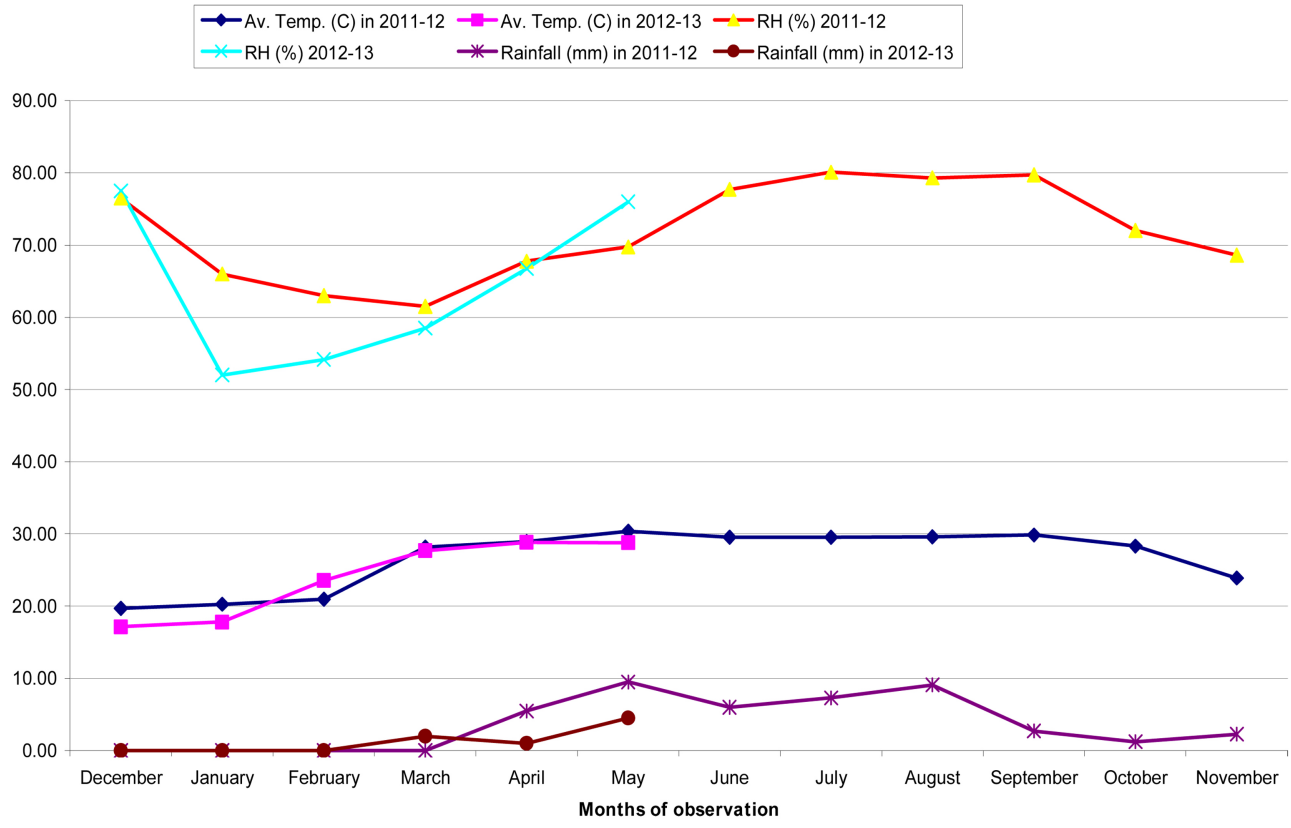

Figure 1. Distribution of average temperature (˚C), relative humidity (%) and rainfall (mm) during December 2011 to May 2013.

3.1. Monthly Population Dynamics of Mango Mealybug in Two Consecutive Years

In both the years, the mango mealybug appeared during December to May and disappeared during June to November. Its population increased gradually starting from December and continued up to February and decreased thereafter. The highest population was observed in February and the minimum population was recorded in May (Figure 2).

3.2. Populations of Adult Male and Female Insects

In each year, adult males and females first appeared in February. Their population reached the highest peak in February and declined to zero in June. Adult males disappeared in May whereas adult females disappeared in June and they entered into the soil for egg laying.

3.3. Influences of Weather Factors on Population of Mango Mealybug

Data on three important weather factors viz. temperature, relative humidity and rainfall, and populations of mango mealybug during December 2011 to May 2013 are shown in Figure 3.

The mango mealybug appeared in December, the neonate nymph crawl to the branches and 0.81 nymphs were found per 30 cm branch. The population increased gradually in the subsequent months of observation and reached a peak

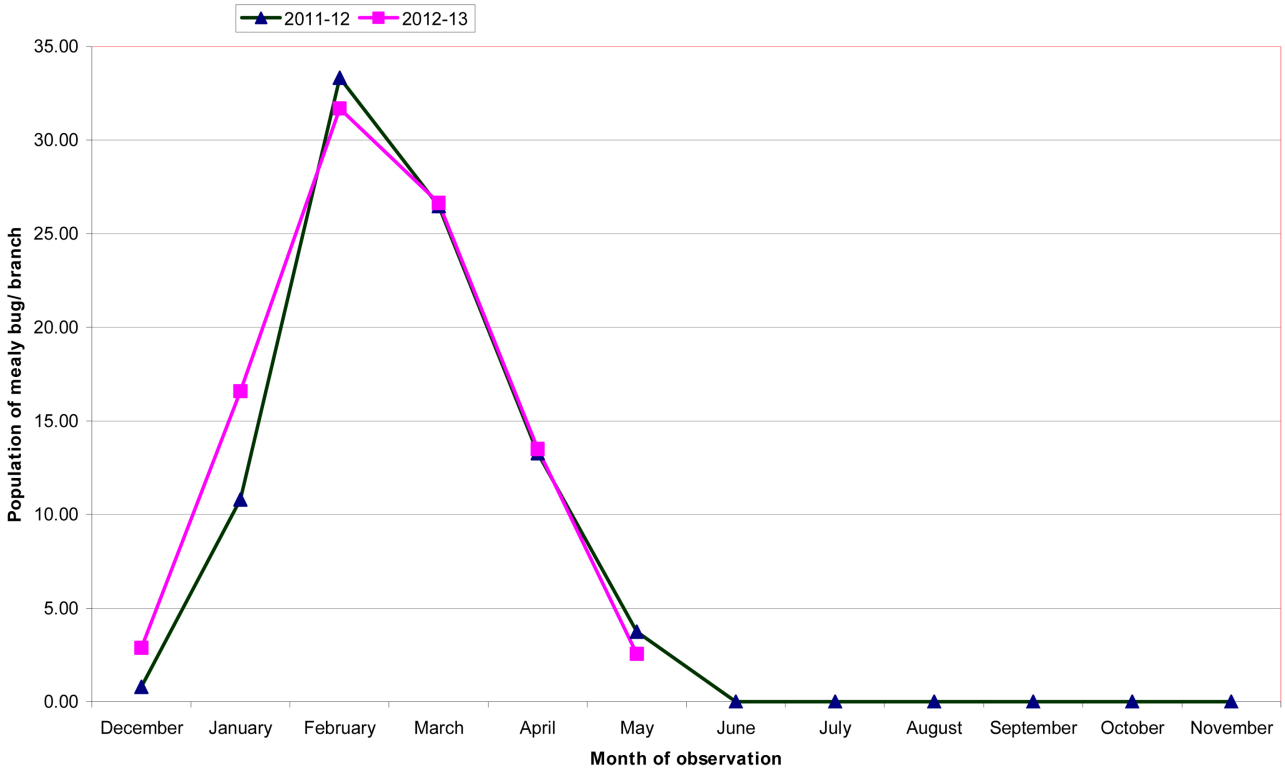

Figure 2. Population dynamics of mango mealybug on mango tree under natural conditions during December 2011 to May 2013.

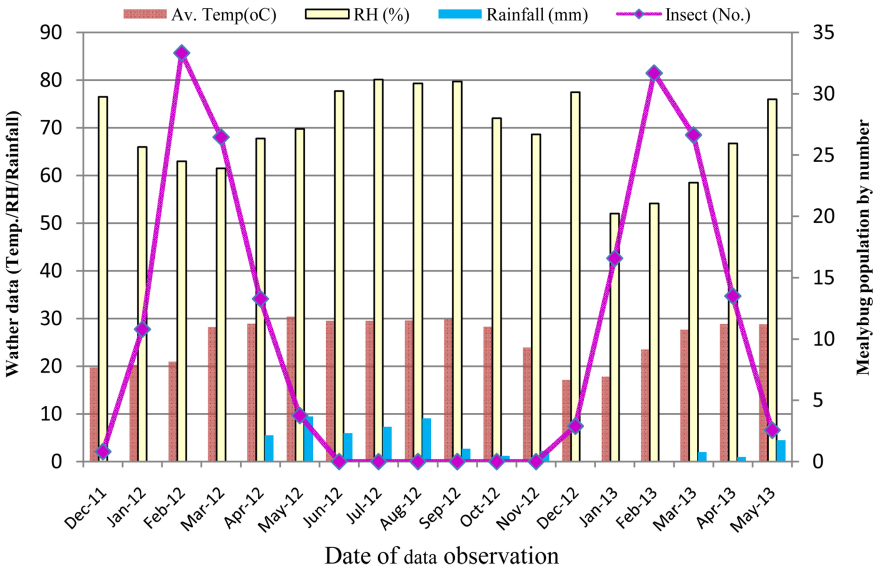

Figure 3. Population dynamics of mango mealybug and variation in three weather factors during December 2011 to May 20013.

of 33.33 individuals per 30 cm branch in February 2011 when the average temperature was 20.95˚C, relative humidity 63% and rainfall was 0.00 mm. The decreasing trend in the population was observed thereafter on the subsequent months of observation and reached to a minimum of 3.75 in May, 2012. Data presented in **Figure 3** show that humidity might have a strong effect on population of mango mealybug when humidity was low the population reached at the peak but when the humidity increased the mean population was reduced to zero. Rainfall might have influences on the population dynamics. Adult female quickly went into the soil when rainfall occurred. Similar trend was found in 2012-2013, the population of mealybug appeared in December 2012 and increasing trend was observed thereafter. The population reached to its highest peak in February (31.67 number per 30 cm branch). The decreasing trend was observed consequently in the subsequent months of observation and reached to a minimum level of 2.56 individual per 30 cm branch in May 2013.

3.4. Relationship between Male and Female Mango Mealybug and Different Weather Factors

Figure 4 shows the relationship between weather parameters and adult (male and female) mango mealybug. Adults appeared in February and found 6.67 males and 123.33 females per 81 m^2 ground under the tree. In March (2012) the population (Male and female) reached at peak 32.5 males and 352.75 females per 81 m^2 at 28.19˚C temperature, 61% relative humidity and without rainfall. When relative humidity increased and rainfall started no males and females were found. The mealybug number was observed zero when the relative humidity was 77.70%. Again, in the consecutive year they appear in February and similar trend was observed in 2013.

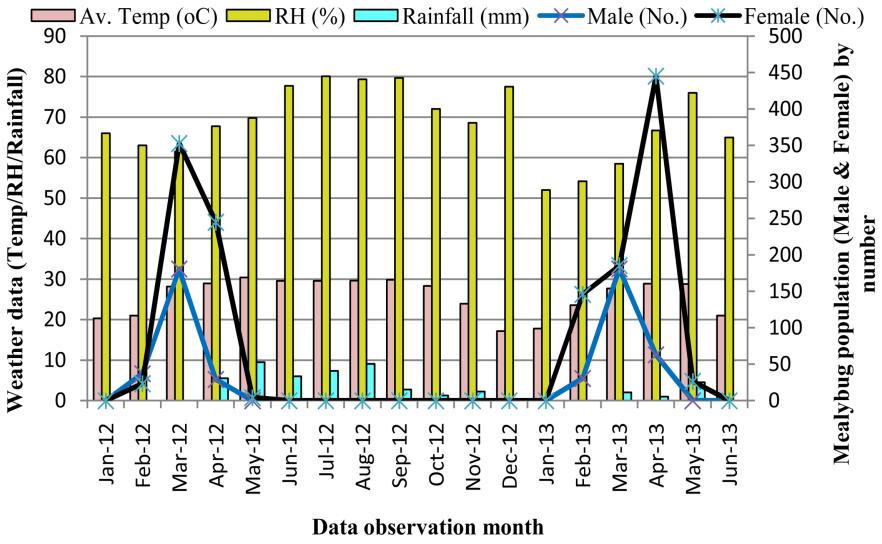

Figure 4. Male and female populations and weather parameters.

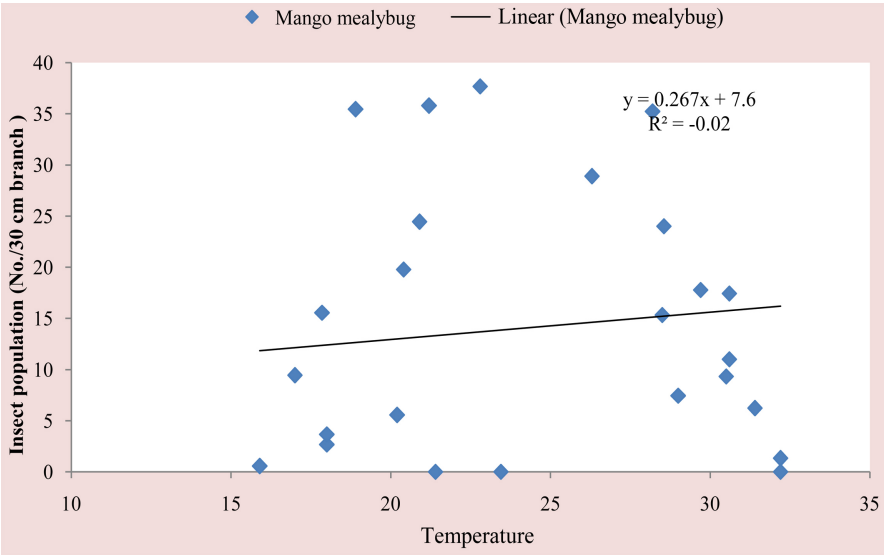

Figure 5. Relation between mango mealybug and temperature.

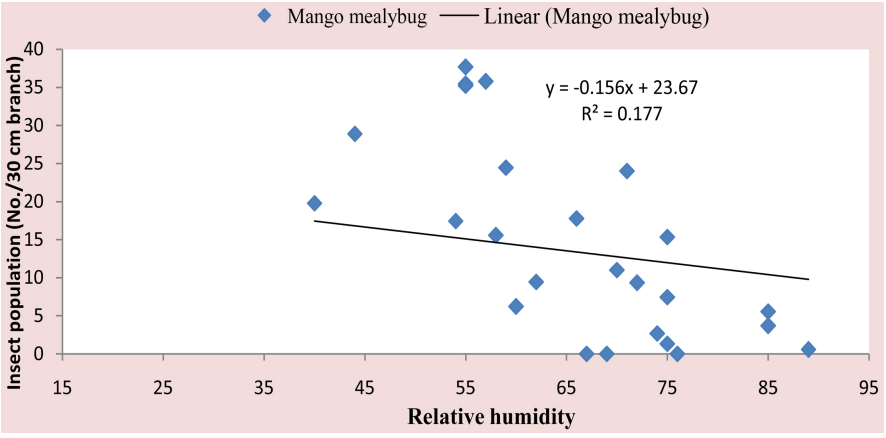

Figure 6. Relation between mango mealybug and relative humidity.

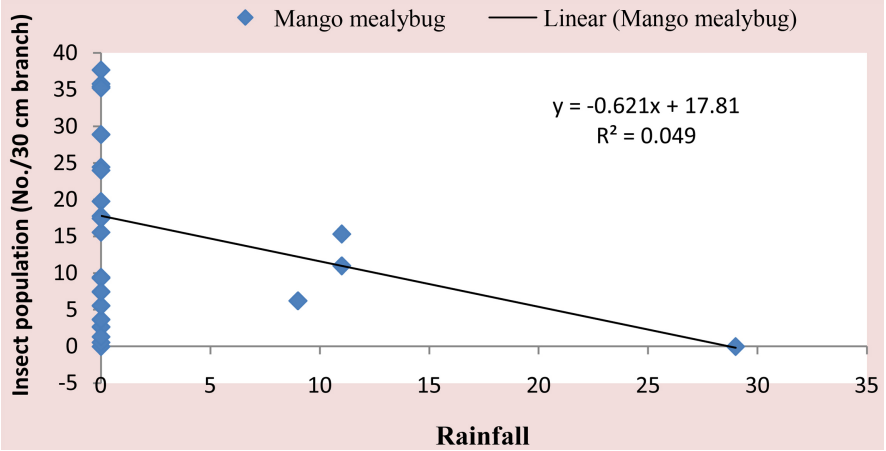

Figure 7. Relation between mango mealybug and rainfall.

3.5. Relationship of Mango Mealybug Population with Three Weather Factors

There was a weakly positive correlation (R^2 = 0.02) between population of mango mealybug and average temperature (**Figure 5**). A negative correlation (R^2 = 0.177) found between incidence of mango mealybug and relative humidity (**Figure 6**). Relationship of population of mango mealybug with rainfall was negative (r = 0.049) (**Figure 7**).

4. Discussion

The impact of the agro-ecological parameters such as temperature, rainfall, and relative humidity greatly influence the outbreak of the insect population as observed [39] and [40]. The results supported by the findings of [39], who found the highest population (17.50) of mango mealybug in April, when the mean temperature and relative humidity were 27.43˚C and 46.15%, respectively. Decreasing trend in population was found in April and May at an average temperature and relative humidity of 31.31˚C, 31.55˚C and 48.35%, 49.80%, respectively. Similarly [26] reported that the maximum peak in population of mango mealybug was 26.6 per 30 cm branch and was observed at maximum temperature of 24.6˚C, minimum temperature of 10.4˚C and RH of 78.9%. Contradictory result was reported by [41] who found that the population of *D. mangiferae* decreased from mid February to last week of May. Peak of incidence of *Rastrococcus iceryoides* reached when temperature ranged 23˚C to 33˚C, relative humidity varied from 54% to 86% and total rainfall up to 63 mm [42]. Present observation is also in agreement with [43] who had also recorded the seasonal incidence of mango mealybug in relation to mean temperature and humidity. [44] had observed that the mango mealybug populations were affected mainly temperature variations and to a lesser extent by humidity. The present study explained that incidence of mealybugs has a weakly positive correlation (R^2 = 0.02) with average temperature. A negative correlation (R^2 = 0.177) found between incidence of mango mealybug and relative humidity. Relationship of population of mango

mealybug with rainfall was negative (r = 0.049). Atwal (1963) had reported that the activity of *D. mangiferae* was restricted to December to May only. He had also noted that mealybug deposited eggs in soil mostly in April that hatched in the last week of December to the first week of January. First instar nymphs were noted during December to February, second instars during February to mid March and third instars from March to April and then became adults. Present study is in consonance with Tanga (2013) who from Kenya and Tanzania, had observed on the effects of climatic factors on the occurrence and seasonal variations in population of a mango mealybug *Rastricoccus inceryoides* (Pseudococcidae). The study evicted that the populations of *R. inceryoides* followed as annual cycle which was synchronized with the mango fruiting season, with a peak incidence occurred during the Northeast monsoon (December-February) at a temperature range of 23˚C - 33˚C and relative humidity of 54% - 86% and total rainfall from 0 - 63 mm. The population trend of *R. inceryoides* was climate dependent and declined sharply following the onset of the heavy rains from March-May and continued through the coldest and driest period of year from June-October (Southern monsoon). Kumar *et al.* 2009 had reported that the occurrence of mealybug on mango plants started from 1st week of December till May.

5. Conclusion

Present study revealed that climatic factors have relation to the mealybug population. The mango mealybug first appeared in early December and disappeared in June in a year. Its population started to increase gradually from December and continued up to February when the ambient average temperature was 20.95˚C, relative humidity 63% and rainfall was absent. The highest population of the insect (33.33/30cm branch) was recorded in February and the lowest (3.75/30cm branch) in May with the variation of agro-climatic conditions. It would be beneficial to predict pest outbreak time and accordingly Integrated Pest Management practices, like pesticide application schedule, ploughing of orchard, water spray and banding of trunks to be implemented. Present work can be considered as the bench mark for the construction of pest calendar for future warning and will be helpful to prevent mango mealybug to minimize mango crop loss.

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Authors' Contributions

This work was carried out in collaboration among all authors. Author NA conducted the research work. Author MZA designed and edited the manuscript. Author MAL designed and supervised the study, managed the literature searches

and edited the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors have declared that no competing interests exist.

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