Effect of Meteorological Factors on Population Dynamics of Mango Hoppers

[1] W.M.A.N. WARNASURIYA, [2] L.C. WIJETILAKA and [1] B. RANAWEERA

[1] *Department of Horticulture and Landscape Gardening, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka.*

[2] *Regional Agricultural Research and Development Centre, Makandura, Gonawila (NWP) Sri Lanka.*

ABSTRACT

An experiment was conducted to identify what meteorological factors have significant effects on the population dynamics of mango hoppers. The maximum temperature, minimum temperature and rainfall were chosen as the meteorological factors for the experiment which was conducted at Regional Agricultural Research and Development Centre in Makandura, Adaptive Research Station in Wariyapola and Horticultural Farm at Walpita. Mango hopper counts were taken fortnightly and categorized separately. The results revealed that mango hoppers inhabitant on the stem were significantly affected only by minimum temperature, but hoppers on leaves were significantly affected by minimum temperature and maximum temperature. Further, the results indicated that the mango hopper population inhabitant on leaves and stems had no significant effect by rainfall.

Key words: Meteorological Data, Population Dynamics, Mango Hopper.

INTRODUCTION

The mango (*Mangifera indica* L.) belongs to the family of Anacardiaceae is considered as one of the most important fruit crop in the world. It exists in two races of which the Indian race contains flushes of bright red new growth and high colour regular form monoembryonic fruits. Besides, the Philippine race includes flushes of pale green or red new growth and elongated kidney shaped polyembryonic fruits (Taparkum, 2005a).

Though mango is not endemic to Sri Lanka, it is mainly grown in Kurunegala, Anuradhapura, Moneragala, Jaffna districts and in Mahaweli systems H and C. Present extent under mango in Sri Lanka is about 27846ha and present production is about 72696mt (Anon, 2005b). Sri Lanka has a seasonal production of mango. In wet and intermediate zones, mango flowering occurs in January to March for the main Yala crop harvested in May-July. In the dry zone flowering takes place in July-September for the main Maha crop harvested in November-January.

The mango hoppers belong to the family of Cicadelidae and 18 species of them have been identified as pests on mango (Anon, 1996 and, Anon, 2005c). Of them *Amritodus brevistylus, Idioscopus clypealis* and *Idioscopus niviosparus* are causing serious damages in Sri Lanka. *Amritodus brevistylus and Idioscopus niviosparus* are born on new flushes and panicles but, *Idioscopus clypealis* are born on mango panicles. They all have incomplete metamorphism (Wijesekara and Menike, 2001).

Both adults and nymphs do the damage by heavy egg laying on stalklet and florets thus causing physical injuries. Moreover, they suck sap from the inflorescence, tender shoots and leaves resulting panicle damages, wilting of inflorescence, and reducing fruit setting as well as fruit growth. Besides, in severe infestations "Honey dew disease" occurs where trees are deprived of buds and blossoms, and leaves appear shiny. On honey dews that exist on leaves, sooty mould (*Capnodium mangiferae*) grows and reduces photosynthetic activities. When natural enemies are concerned small insect named Gryon (Hymenoptera: Mymaridae) is found to be egg parasite recorded in Sri Lanka (Wijesekara and Menike, 2001).

Year after year mango trees gradually loose their yielding ability up to 100% due to injuries done by mango hoppers. Although economical crop damage has not been estimated in Sri Lanka, it was observed that the damage may be a total crop loss during some mango seasons. Therefore, this study was carried out to identify how mango hopper population fluctuate with the meteorological factors such as maximum temperature, minimum temperature, rainfall and phenology of mango which would be lead to develop an effective and economical IPM program for the management of mango hoppers.

MATERIALS AND METHODS

Mango Hopper Sample Collection

This study was carried out from April 2004 to April 2005 at following locations.

- Regional Agricultural Research and Development Centre(RARDC), Makandura, Gonawila (Low Country Intermediate Zone;IL1a)
- Adaptive Research Station, Wariyapola (Low Country Intermediate Zone;IL3)
- Horticultural Farm, Walpita (Low Country Wet Zone; WL3).

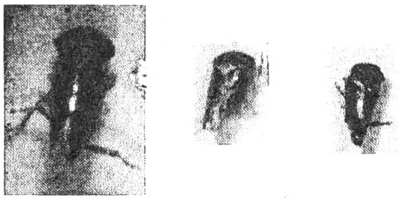
Mango hopper population was uniformly distributed in each of the mango tree in each location (Padmasili, 2004). Therefore, four mango trees were selected randomly from each location for the experiment. Subsequently three branches from each tree were selected randomly for the experiment.

Mango hoppers are sampled by sweeping the one feet diameter insect trapping net four times at each of the three branches in the canopy and the three locations at the main stems. Then the samples were tightly sealed in polythene bags for two days until laboratory identification and counting. This process was repeated fortnightly.

Categorization of Mango Hoppers

This study was mainly focused on three mango hopper species namely *Amritodus brevistylus*, *Idioscopus clypealis* and *Idioscopus niviosparus*. They all had wedge shaped bodies with broad heads and narrow abdomens towards their back. Adult hoppers were found hidden in the foliage, in the cracks of the main trunks and branches of mango.

From those mango hoppers, *Idioscopus niviosparus* had a greenish body about 4 mm in size with white spots and stripes on the forewings. And *Amritodus brevistylus* was the largest species about 5 mm in length. It had three black spots on the mesoscutellum with a cross mark posterior to the black spot in the middle. *Idioscopus clypealis* had a pale green colour body (3.5 mm in length) with two black spots on the mesoscutellum (Wijesekara and Menike, 1997) (Plate 1). Population counts were recorded according to the hopper species identified. Hoppers were categorized and population counts were recorded in each species separately.



Amritodus brevistylus *Idioscopus clypealis* *Idioscopus niviosparus*

Plate 1. Three Mango Hopper species present in Sri Lanka

Study on Phenological Cycle of Mango

The phenological stages of mango trees, from which the population counting of mango leaf hoppers were taken in each location, were recorded fortnightly according to the following scale.

Scale		Growth Stage
1.Leaves	1.1	Brown
	1.2	Light Brown
	1.3	Dark Green
2.Flower	2.1	10% flowering
	2.2	25% flowering
	2.3	50% flowering
	2.4	75% flowering
3. fruits	3.1	Unripe
	3.2	Moderately ripen
	3.3	Ripen

Meteorological Data

For this study, meteorological data, namely maximum temperature, minimum temperature and rainfall were collected from all the locations. From those meteorological data, corresponding mean values were calculated. Data of the minimum temperature were not available at the Horticultural Farm in Walpita.

Statistical Analysis

Data were analyzed by Statistical Analysis System (SAS) using Pearson's correlation formula

$$r_{xy} = \frac{\sum_i ((x_i - \bar{x})(y_i - \bar{y}))}{\sqrt{\sum_i (x_i - \bar{x})^2 \sum_i (y_i - \bar{y})^2}}$$

where;

x, y :Variables(maximum temperature, minimum temperature, rainfall, mango hopper population)

r_{xy} :Correlation coefficient

$\bar{x}$:Sample mean of x

$\bar{y}$:Sample mean of y.

i :Number of samples.

RESULTS AND DISCUSSION

1. Effect of Meteorological Factors on Mango Hopper Population

a) Temporal Variation of Mango Hopper Population at Makandura

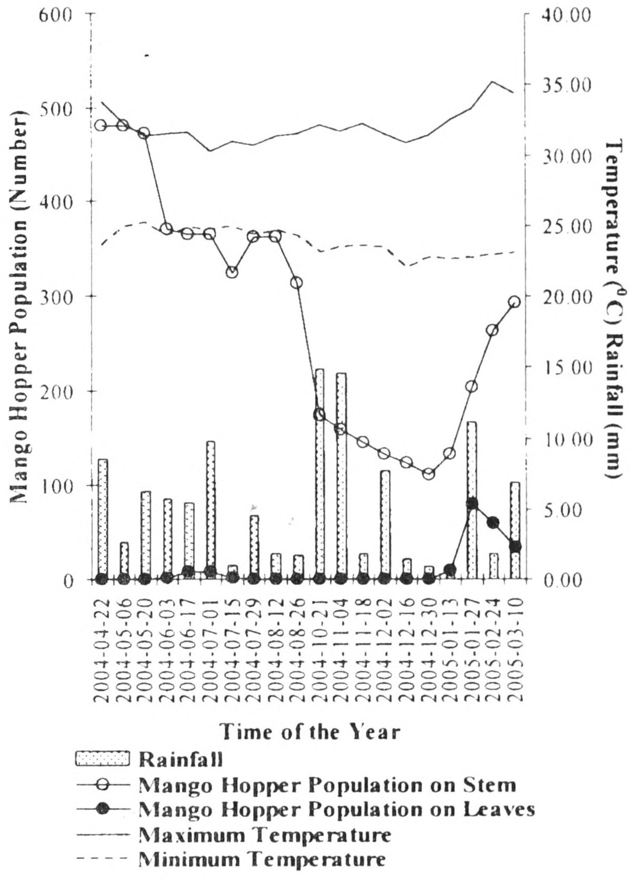


Figure 1. Temporal variation of mango hopper population in RARDC, Makandura

A significant variation of mango hopper population was observed on stem (Figure1). The highest population (480 hoppers) was recorded in April while the lowest (111 hoppers) was recorded in December. A prominent decline of hopper population from April - December followed by a rapid increase of population from January - March was recorded.

A significant increase of population on leaves was recorded from early January to late January with the maximum number (80) of hoppers in mid January (Figure 1).

b) Temporal Variation of Mango Hopper Population at Wariyapola

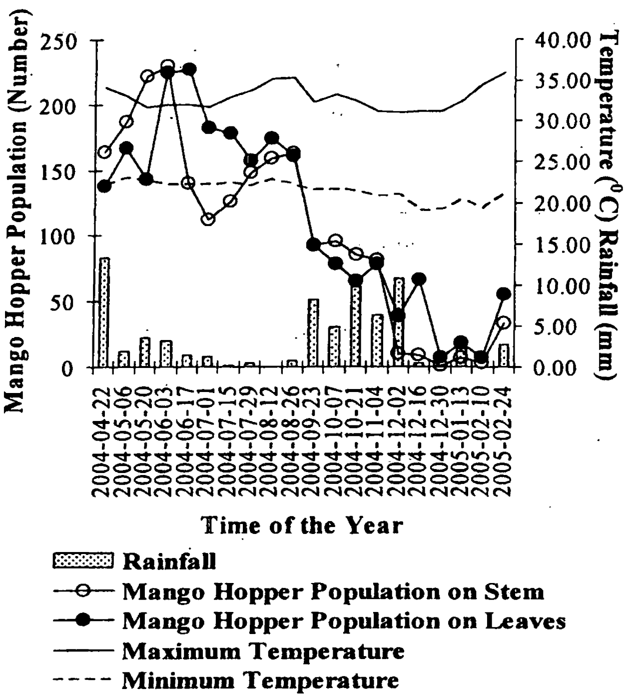


Figure 2. Temporal variation of mango hopper population in Adaptive Research Station, Wariyapola

A significant change of mango hopper population with time was observed on stem and leaves of mango (Figure 2). The highest hopper population (230 hoppers) on stem was recorded in June while the lowest (1 hopper) was recorded in December. Population was increased up to June and then rapidly decreased up to July. Then again an increase followed by a rapid decrease of hopper population was observed.

Similar to the hopper population on the stem, the hopper population on leaves was rapidly increased up to a maximum level of 227 hoppers in June. Then it was significantly decreased from July to December where the lowest population of 7 hoppers was recorded in late December (Figure 2).

c) Temporal Variation of Mango Hopper Population at Walpita

An overall decrease of hoppers on stem was observed according to the figure 3. A rapid population increase was observed from January to February with the highest population of 184 hoppers in March while the lowest population of 3 hoppers was recorded in January. On leaves, hopper population was slightly increased in two periods (June – July and January – March) while in other periods the population was slowly decreased. The highest population of 14 hoppers was recorded in March while the lowest (zero hoppers) was recorded from July – December (Figure 3).

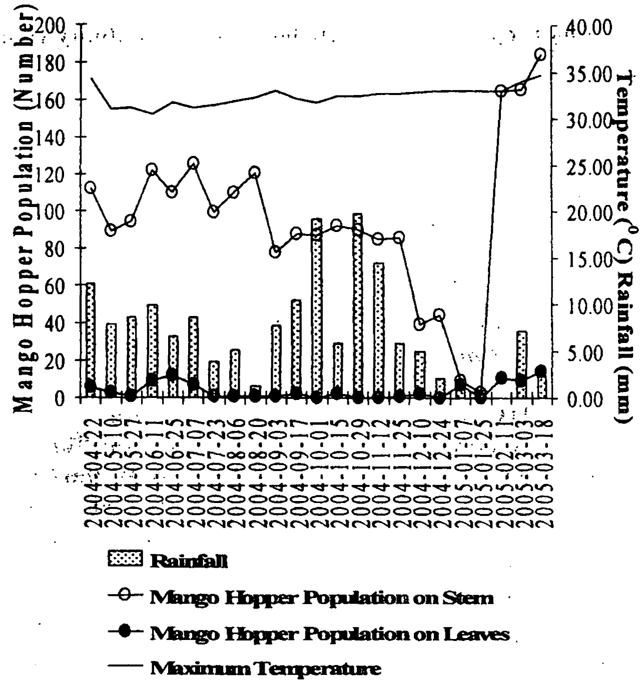


Figure 3. Temporal variation of mango hopper population in Horticultural Farm, Walpita

d) Correlation of Mango Hopper Population with the Meteorological Factors

I. Regional Agricultural Research and Development Centre, Makandura

On the stem, mango hopper population was positively correlated with minimum temperature ($r = 0.78$, $p < 0.0001$) while maximum temperature ($r = -0.02$, $p = 0.9286$) and rainfall ($r = -0.02$, $p = 0.9192$) were negatively correlated with the population (Table 1). And minimum temperature had a significant effect on the hopper population ($p < 0.0001$).

On leaves, maximum temperature ($r = 0.67$, $p = 0.0011$) and rainfall ($r = 0.14$, $p = 0.5607$) were positively correlated with the population while minimum temperature ($r = -0.38$, $p = 0.1019$) had a negatively correlation (Table 1). And maximum temperature had a significant effect on the hopper population ($p < 0.0011$).

II. Adaptive Research Station, Wariyapola

On the stem, hopper population was positively correlated with maximum temperature ($r = 0.15$, $p = 0.5213$) and minimum temperature ($r = 0.88$, $p < 0.0001$) whereas rainfall had a negative correlation ($r = 0.00$, $p = 0.9967$). And minimum temperature had a significant effect on the hopper population ($p < 0.0001$).

On leaves, maximum temperature ($r = 0.09$, $p = 0.6968$) and minimum temperature ($r = 0.83$, $p < 0.0001$) were positively correlated with the population while rainfall($r = -0.19$, $p = 0.4247$) had a negatively correlation (Table 1). And minimum temperature had a significant effect on the hopper population ($p < 0.0001$).

Table 1. Correlation coefficients and probability values of mango hopper population

	Makandura				Wariyapola				Walpita			
	Stem		Leaves		Stem		Leaves		Stem		Leaves	
	r	p	r	p	r	p	r	p	r	p	r	p
Maximum Temperature (^{0}C)	-0.02	0.9286	0.67*	0.0011	0.15	0.5213	0.09	0.6968	0.11	0.6208	0.24	0.2639
Minimum Temperature (^{0}C)	0.78*	<0.0001	-0.38	0.1019	0.88*	<0.0001	0.83*	<0.0001	NA	NA	NA	NA
Rainfall (mm)	-0.02	0.9192	0.14	0.5607	-0.00	0.9967	-0.19	0.4247	0.05	0.8080	-0.28	0.2034

NA : No Data Available *** Highly Significant Correlation Coefficient***
r : Correlation Coefficient ***p : Probability value***

III. Horticultural Farm, Walpita

According to the table 1, on the stem, maximum temperature (r = 0.11, p = 0.6208) and rainfall (r = 0.05, p = 0.8080) showed a positive correlation with hopper population (Table 1). But there was no any significant effect by maximum temperature (p = 6208) and rainfall (p = 0.8080).

On leaves, maximum temperature (r = 0.24, p = 0.2639) had a positive correlation with the hopper population while rainfall had a negative correlation (r = -0.28, p = 0.2034). However there was no any significant correlation with maximum temperature (p = 0.2639) and rainfall (p = 0.2034).

2. Population Dynamics of Mango Hoppers in Relation to Phenological Cycle of Mango

a) Regional Agricultural Research and Development Centre (RARDC), Makandura

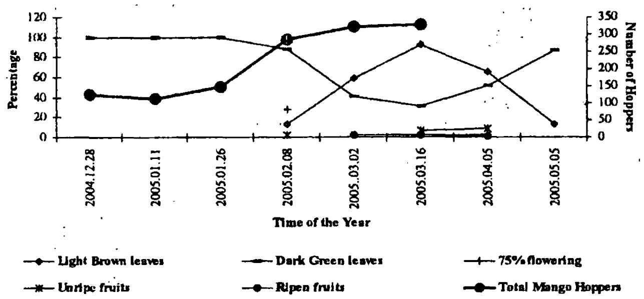


Figure 4. Population dynamics of mango hoppers in relation to phenological stages of mango at Regional Agricultural Research and Development Centre, Makandura

Formation of new flush was significantly increased from February to March where the maximum percentage of 91.67% was observed in March. Then it was rapidly decreased up to a lower percentage of 13.33% recorded in May. The percentage of dark green leaves was significantly decreased from January to March (100% - 31.25 %) and was again showed sharp increase (31.25 % - 86.67 %). The flowering was started in February and increased up to a peak of 5 % in April. The fruit formation was started in March where the highest percentage of fruits of 25 % was recorded in April (Figure 4).

The mango hopper population was significantly increased with new flushing and flowering followed by a slight increase with fruit formation.

b) Adaptive Research Station, Wariyapola

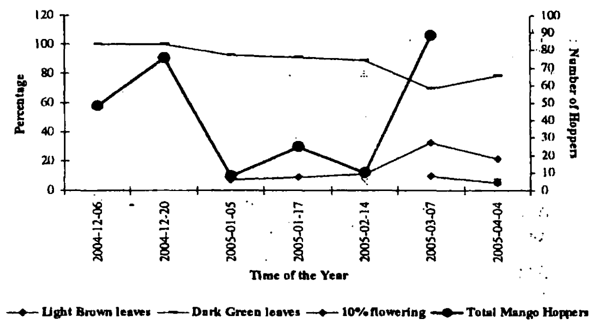


Figure 5. Population dynamics of mango hoppers in relation to phenological stages of mango at Adaptive Research Station, Wariyapola

According to the figure 5, new flush formation was slowly increased from January to February (7.5 % - 11.25 %) followed by a rapid increase up to an upper limit of 32.5 % recorded in March. Then it was slightly decreased over time to 21.25 %. The dark green leaves percentage was slowly decreased up to a lower level of 70 % recorded in March and was rapidly increased up to 78.75 %. The highest percentage of flowering of 10 % was recorded in March and was reduced slightly to a level of 5 % (Figure 5). Mango hopper population was significantly decreased with the slight reduction in dark green leaves. At latter stages it showed a rapid increase with the formation of new flushes.

c) Horticultural Farm, Walpita

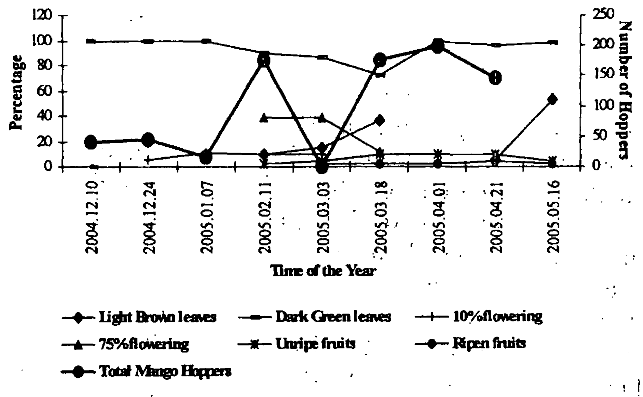


Figure 6. Population dynamics of mango hoppers in relation to phenological stages of mango at Horticultural Farm, Walpita

New flush formation was notably increased from February to March (10 % - 36.67 %). Then again it was rapidly increased from April to May (5 % -52.5 %) where the highest percentage of 52.5 % was recorded in May. In contrast, the percentage of dark green leaves was slightly decreased up to March (100 % - 72.5 %) and then was rapidly increased up to a maximum level of 100 % in April. Then it was slowly reduced again. Flowering was started in December and the highest percentage of flowering (80 %) was observed from February to March. And it was rapidly reduced to 25 % in March. Fruit formation was significantly increased up to a maximum of 20 % in April (Figure 6). Mango hopper population was increased sharply with the formation of new flushes but was rapidly decreased followed by another sharp increase with flowering.

CONCLUSION

The study reveals that the minimum temperature has a significant effect on mango hopper population on the stem in Low Country Intermediate Zone (IL1a) and Low Country Intermediate Zone (IL3). But for the hopper population on leaves, minimum temperature and maximum temperature have a significant effect. Furthermore, this study shows there is no any significant effect of rainfall on hopper popuiation. And further studies should be carried out in a long term basis to find the effect of other meteorological factors on the mango hopper population. Because, for the management of mango hopper population, information on the effect of meteorological factors, macroclimatic factors and microclimatic factors will be very useful.

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