Research Article

Efficacy of various insecticidal modules against Mango hopper, *Idioscopus clypealis* Lethierry (Hemiptera: Cicadellidae) on Mango “Samar Bahisht Chaunsa” and their impact on yield

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Abstract

Mango hopper, *Idioscopus clypealis* Lethierry is one of the most destructive pests of mango globally which causes considerable monetary loss. Growers spray mango crop against this pest on flowering unwisely which destroys the pollinator which are the main source of fruit setting. So the main objective of this study was to change treatment regime from calendar to need based sprays to save the natural fauna of mango “Samar Bahisht (SB) Chaunsa” during 2017-18 and 2018-19. Three insecticidal modules viz., Module-I, single spray of insecticide, imidacloprid @ 120ml, Module-II consisted of two sprays, imidacloprid @ 120ml and clothianidin @100ml were tested against *I. clypealis*. Whereas, Module-III had three sprays i.e. imidacloprid @120ml, clothianidin @ 100ml and thiometaxam @10g per 100 liter of water throughout the year. The results indicated that Module-III proved to be the best and controlled the pest effectively when applied in February, April and August with highest yield i.e.297.23 kg per tree. Whereas, the mango hopper population i.e. 0.13 individual per inflorescence was recorded in full bloom period. Similarly, in Module-II, two sprays were made i.e. imidacloprid in February and clothianidin in April showed 2.81 mango hoppers per inflorescence with yield i.e. 172.58 kg per tree. Whereas, in Module-I where only one spray was applied in February, mango hopper population was 20.88 per inflorescence and the yield was 90.72 kg per tree. So this study, therefore, concluded that Module-III proved to be the best for management of mango hopper for better yield and save pollinator fauna of mango crop.

Keywords: Clothianidin; Imidacloprid; Mango Hopper; Pollinators; Samar Bahisht Chaunsa; Thiometaxam

Introduction

Mango (*Mangifera indica* L. Family: Anacardiaceae) is the most important and popular fruit globally. It is one of the choicest fruit of the subcontinent and is known as “The Mother of Tropical Fruits”. Mango is the second major fruit crop of Pakistan after citrus having an area of approximately 171 thousand hectares with production of 168 thousand tons [1]. Among different varieties
of mango “Samar Bahisht (SB) Chaunsa” is an exportable mango which is praised due to its unique taste and aroma. But the yield of mango in Pakistan is low as compared with other mango producing countries of the world. There are so many reasons e.g. insect pests, diseases, unfavorable climatic conditions, unwise use of chemicals and their time of application etc are the most important aspects of low production. The most prevalent insect pests in Pakistan are mango hoppers, midges, mealy bugs, scales, fruit flies, thrips, and bark beetle [2, 3]. Among these pests, Mango hopper, *I. clypealis* is one of the most severe and prevalent pest all over the country, which causes intense damage to mango crop. Both the young ones and adults of mango hopper pierce and suck the juice from inflorescence, tender shoot and leaves of mango crop, resulting in non-setting of flowers and falling of small fruits, thereby reducing the yield [4]. Further, it is noticed that in severe cases withering of flower buds and flowers occurred due to the attack of mango hopper [5]. Scientists worked on mango hoppers and reported that the hoppers may cause a loss of 20-100% of inflorescence [6]. Further it is observed that due to intense puncturing and constant draining of the juice leads to curling and drying of infected tissues [7]. The mango hopper also excrete honey dews that promote the growth of fungus like *Meliola mangiferae* which interferes in normal photosynthetic activity of the plant resulted in dropping of small fruits. Due to severe infestation, yield losses were recorded up to 50% or more [8], 50% [7] and 25-60% [9]. In our country, mango hoppers can only be managed with the use of synthetic chemicals with injudicious approach during flowering period, which not only control the hopper but also upset the pollinator fauna of mango crop which have 53% role in fruit setting [10]. Most of these chemicals applied as calendar spray in an excessive manner which resulted in several serious consequences viz; pest resurgence, elevation of minor pests to major ones, resistance, environmental dilapidation in mango ecosystem, destruction of natural enemies and pollution of environment[11]. However, exploration on the suitable use of these chemicals against mango hoppers in proper time is scarce in Pakistan.

Under these circumstances, the present study was undertaken to assess the number of sprays during whole year and their proper time of application for successful management of mango hopper, *I. clypealis* in mango ecosystem. Further, these studies will be helpful for the protection of natural fauna of mango flowers which is essential for fruit setting.

**Materials and methods**

A study was carried out at private mango grower fruit farm, located in Mouza Sair Kharak, Tehsil and District Multan with the coordination of Mango Research Institute, Multan, Punjab- Pakistan (30°09 N Latitude and 71°26 E Longitude with an elevation of 126 meters above sea level) during two consecutive years i.e. 2017-18 and 2018-19. The experiment was laid out in a Completely Randomized Design (CRD) with three modules. There were three trees per treatment under three replications. The trees of mango variety “SB Chaunsa” about 20 years of age in a block of 25 trees per acre were selected for this experiment planted in a square method. Three insecticides i.e. Confidor 200SL (imidacloprid, Bayer Crop sciences) @120ml, Tresta 20SC (clothianidin, FMC United Pvt. Ltd) @ 100 ml and Actara 25WG (thiamethoxam, Syngenta, Pak Ltd.) @10g were sprayed against mango hoppers in their respective modules. The calculated amount of insecticide was applied in February, April and August with the help of tractor mounted sprayer after calibration. The first spray was done in February (protective measures) on the appearance of panicles and rest of the sprays was done after the appearance of
mango hopper. The data on mango hopper population (nymph and adult) was recorded from the twenty inflorescences (ten on each date) selected at random on 15\textsuperscript{th} and 30\textsuperscript{th} of March during peak flowering period of both the study years. The panicle / inflorescence were shed in plastic trays of 1 x 1.5 feet, counted hopper and then calculate their average. Data was recorded from 10.00 AM to 12.00. Before application of each insecticide, spray machine was cleaned thoroughly with clean water to avoid insecticide mixture. The data was compiled and graphically shown.

Average number of hoppers per inflorescence=$\frac{X_1+X_2+\ldots+X_{20}}{20}$

**Module-I**

In this module only one spray was done in the month of February at the emergence stage of panicles/inflorescence during a year. The insecticide imidacloprid (Confidor 200SL) @ 120 ml per 100 liter of water was sprayed.

**Module-II**

In this module two sprays were made during the year. The first spray of imidacloprid (Confidor 200SL) @ 120 ml per 100 liter of water was sprayed in the month of February at the emergence stage of panicles/inflorescence followed by second spray of clothianidin (Tresta 20SC) @100ml/ 100L water in the month of April after fruit setting on the appearance of mango hoppers.

**Module-III**

Three sprays i.e. imidacloprid, clothianidin and thiamethoxam belongs to neonicotinoids (Table 1) were applied during the year. The first spray of imidacloprid (Confidor 200SL) @ 120 ml per 100 liter of water was done in the month of February at panicles/inflorescence emergence stage followed by second spray of clothianidin (Tresta 20SC) @ 100ml/ 100L water in the month of April after fruit setting on the appearance of mango hoppers.

**Yield**

The yield was recorded and percent loss was calculated.

**Percent loss of yield in module-I=**

\[
\text{Av. yield in Kg obtained in module-III - Av. yield in Kg obtained in module-I \times 100} \\
\text{Av. yield in Kg obtained in module-III}
\]

**Percent loss of yield in module-II=**

\[
\text{Av. yield in Kg obtained in module-III - Av. yield in Kg obtained in module-II \times 100} \\
\text{Av. yield in Kg obtained in module-III}
\]

**Percent loss of yield in module-III=**

\[
\text{Av. yield in Kg obtained in module-III - Av. yield in Kg obtained in module-III \times 100} \\
\text{Av. yield in Kg obtained in module-III}
\]
Table 1. Information of insecticides with different mode of action used against, Mango hopper, Idioscopus clypealis

<table>
<thead>
<tr>
<th>Insecticides</th>
<th>Trade Name</th>
<th>Common Name</th>
<th>Formulation</th>
<th>Group</th>
<th>WHO hazard classification</th>
<th>IRAC group</th>
<th>Dose (ml or g/100liter water)</th>
<th>Mode of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confidor</td>
<td>imidacloprid</td>
<td>200SL</td>
<td>Neonicotinoids</td>
<td>Ii</td>
<td>4A</td>
<td>120ml</td>
<td>Nicotinic acetylcholine receptor (nAChR) competitive modulators Nerve action</td>
<td></td>
</tr>
<tr>
<td>Tresta</td>
<td>clothianidin</td>
<td>20SC</td>
<td>Neonicotinoids</td>
<td>Ii</td>
<td>4A</td>
<td>100ml</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Actara</td>
<td>thiamethoxam</td>
<td>25WG</td>
<td>Neonicotinoids</td>
<td>Ii</td>
<td>4A</td>
<td>10g</td>
<td>Same</td>
<td></td>
</tr>
</tbody>
</table>

Results
Impact of modules on population of mango hoppers

Population during 2017-18
The results regarding mango hoppers population in different modules presented in (Graph 1) during 2017-18 showed that average less number of mango hoppers, i.e. 0.10 per inflorescence was recorded in Module-III, in the month of March which had three insecticidal sprays throughout the year followed by Module-II with average population of 3.63 individuals per inflorescence where two sprays were made. While in Module-I where only one spray was applied in a year showed more number of mango hoppers i.e. 13.42 individuals per inflorescence.

Population during 2018-19
The results presented in (Graph 2) showed that average less number of mango hoppers i.e. 0.15 per inflorescence was recorded during 2017-18 in the month of March which has three insecticidal sprays throughout the year followed by module-II with average population 1.98 individuals per inflorescence where two sprays were done. Whereas in module-I where only one spray was done throughout the year have more number of mango hopper i.e. 28.17 individuals per inflorescence.

Average population during 2017-18 & 2018-19
Average of the data during both the study years i.e. 2017-18 & 2018-19 from the inflorescence showed that low population of mango hoppers i.e. 0.13 was recorded in module-III which has three insecticidal spray per year followed by module-II with average population 2.81 individuals having two sprays throughout the year. Whereas, in Module-I where only one spray was applied in a year showed more number of mango hoppers i.e. 20.88 per inflorescence (Graph 3).

Yield
The results presented in (Graph 4) revealed that the average maximum yield i.e. 297.22 kg per tree was recorded in module-III where three sprays were done remained superior over module-II having 172.58 kg/tree with two sprays. The lowest yield i.e. 90.72 kg per tree in module-I was recorded where only one spray was made.

Percent loss in yield
The results presented in (Graph 5) depicted that the average maximum yield loss 69.48 percent was recorded in module-I followed by module-II where 41.94 percent yield losses was recorded when compared with module-III.
Graph 1. Population of mango hoppers per inflorescence of mango cultivar “SB Chaunsa” during 2017-18

Graph 2. Population of mango hoppers per inflorescence of mango cultivar “SB Chaunsa” during 2018-19
Graph 3. Population of mango hoppers per inflorescence of mango cultivar “SB Chaunsa” during 2017-18 and 2018-19

Graph 4. Average yield in Kg per tree of modules of “SB Chaunsa” during 2017-18 and 2018-19
Graph 5. Average loss in yield Kg per tree of different modules of “SB Chaunsa”

Discussion
Chemicals are used regularly on mango to overcome the insect pest complex for better production. But broad spectrum, non-judicious use of unrelenting chemicals are causing numerous problems such as upsetting of parasites, predators complexes, development of pesticides resistance, eruption of secondary pest, pest resurgence and environmental effluence[11]. So to overcome these harms, proper and judicious utilization of these chemicals are mandatory. In mango crop flowering stage is the most vulnerable to mango hoppers (I. clypealis). Unfortunately the pesticides are plentifully used on flowering against mango hoppers, resulted in pandemonium of pollinator fauna of mango flowers which are at its peak at this time [9] help in 53% of fruit setting [10]. So it is important to overcome hoppers population and at the same time saving of pollinator at this stage too. Further the application of chemicals at flowering stage kills the harmful hoppers as well as useful insect fauna. To overcome such situation the present task was planned to overcome hoppers without disturbing biodiversity during flowering stage of mango crop. In this project three insecticidal management modules were applied against I. clypealis during 2017-18 to 2018-19. Our results suggested that module-III consists of three sprays i.e. imidacloprid, clothianidin and thiamethoxam belongs to neonicotinoids at different months of the year reduced the mango hoppers population effectively during flowering stage resulted in zero spray. Further our results reported that first spray of imidacloprid (as protective measures) in February during panicle emergence stage will keep away hopper population on flowers with more yield. Whereas second and third spray will only be appropriate on the appearance of the hoppers population. By the application of such schedule the hoppers can easily be managed without disturbing the pollinator fauna of mango crop. The present findings can be compared with [7] who recommended the growers community not to spray the mango crop at flowering stage because it will
affect the pollinator activity leading to low fruit set. Similarly the results are in line with that of [12] who concluded that 1st spray of thiamethoxam at inflorescence appearance stage followed by 2nd spray of profenofos and the 3rd spray of carbaryl was found effective in management of mango hoppers. The results can be compared with that of [13] who concluded that spray of thiamethoxam remained best against mango hoppers. Similarly the results are not in line with that of [14] who stated that two sprays of thiamethoxam against mango hoppers on mango crop effectively prevented the hopper population. The other important aspect is the pollinator at flowering stage which plays an important role in fruit setting, their shortage leads to failure of yield. Our results suggest that application of chemicals at panicle emergence stage protect the flowers from deleterious effects of hoppers and there will be no need of spray during flowering period. The present findings can be compared in part with those of [15] who reported that honey bee are affected and declined by the use of pesticides. So it is necessary to avoid the use of chemicals during flowering stage. Moreover there are numerous scientific studies have revealed that the declining of bee colonies is an outcome of exposure to pesticides especially to the systemic neonicotinoids insecticides [16].

Conclusions and recommendations
It is accomplished from the present studies that Module-III with three sprays each of imidacloprid, clothianidin, thiamethoxam (neonicotinoids) insecticides or any other effective chemicals in the month of February (at panicles appearance stage) and second, third spray in April and August (on the appearance of mango hoppers) proved to be the most effective for the management of mango hoppers and saved the pollinators activity which ultimately resulted in good production.

Author’s contributions
Conceived the idea, designed the experiment and prepared the manuscript: H Karar, Recorded and analyzed the data: AH Khan & S Kiran, Arranged insecticides and sprays the selected trees: A Iqbal, Reviews the manuscript critically and suggestions for improvement: H Ullah.

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