



Outbreak of *Paracoccus marginatus* in Bangladesh and its control strategies in the fields

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Abstract

A field survey as well as market survey on Papaya mealybug, *Paracoccus marginatus* (Williams and Granara de Willink) was conducted in different regions of Bangladesh to know the infestation level, economic loss, and common management practices used by farmers to control this insect. Field survey revealed that more than one third of the papaya plants were affected by papaya mealybug and papaya growers faced a great economic loss. Severe infestation of papaya mealybug was also found in the nurseries of the survey areas. Market survey indicated that the retailers faced difficulties to sell infested papaya fruit. Seven plants other than papaya were recorded to which papaya mealybug also attacked. The plants were Hog plum (*Spondia spinnata*), Chili (*Capsicum frutescence*), Okra (*Abelmoscus esculentus*), Brinjal (*Solanum melongena*), Guava (*Psidium melongena*), Velvet-apple (*Diospyros blancoi*) and Hibiscus (*Hibiscus rosa-scinensis*). The farmers of the survey area used several chemical insecticides indiscriminately against the papaya mealybug and did not get satisfactory control. Some indigenous pest management tactics were also used against papaya mealybug including the use of wood ash and bark extract of mahogany tree.

Key words: Papaya mealybug, infestation, alternate host, economic loss, management strategies

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Introduction

Papaya (*Carica papaya*) is a soft-wooded perennial plant grown in all tropical countries and many subtropical regions of the world. Economically, *C. papaya* is the most important species within the Caricaceae family, being cultivated widely for consumption as a fresh fruit and for use in drinks, jams candies and as dried and crystallized fruit (Villegas, 1997). Green fruit and the leaves and flowers may also be used as a cooked vegetable (Saha, 2013). Nutritionally, papaya is a good source of calcium and an excellent source of vitamins A and C (Nakasone and Paull, 1998). In Bangladesh, millions of family farms cultivated papaya not only for their own consumption but also for sale on local markets as a side cash crop. Insects may be a limiting factor in growing papaya, especially from fruit set until harvest and the major insect pests which are likely to be a problem are the papaya mealybug, fruit

fly, webworm, whitefly, mites, aphids, scales, leafhoppers and hornworms (Peña and Johnson, 2006).

The papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcidae) is a small polyphagous sucking insect pest that attacks several genera of host plants, including economically important tropical fruits, vegetables and ornamentals (Chellappan et al., 2013; Tanwar et al., 2010). Infestation of the mealybug appears as clusters of cotton-like masses on the above-ground portion of plants with long waxy filaments. Immature and adult stages of *P. marginatus* suck the sap of the plant and weaken it. The leaves become crinkled, yellowish and wither. The honey dew excreted by the bug and the associated black sooty mould formation impairs photosynthetic efficiency of the affected plants.

Papaya fruit can be heavily infested with mealybugs, becoming white and essentially inedible (Tanwar et al., 2010).

The papaya mealybug has been identified firstly in Bangladesh in the year 2009 (Muniappan et al., 2011). Within the last few years this insect pest spreads many parts of the country very rapidly and has become major concern to papaya growers in Bangladesh (Karim et al., 2012). A drop in papaya production in Bangladesh is recorded in the recent years, and among other factors, it is assumed that mainly infestation of this non-indigenous pest is responsible and causing huge economic losses to farmers (Helemul, 2013). However, detail information on papaya mealybug outbreaks in Bangladesh and the management strategies that are practiced by farmers to combat this notorious insect pest in the field are not well known.

In the present research both field and market survey was conducted in three different regions of Bangladesh to know the level of infestation and economic loss caused by papaya mealybug as well as find out the management strategies practiced by farmers for controlling this insect in the field.

Materials and Methods

Field survey

Field survey was conducted in three important papaya growing regions of Bangladesh such as Barisal, Jessore and Mymensingh districts during March 2014 to May 2014 with the purpose to explore the information regarding infestation levels and economic loss caused by Papaya mealybug, and the protective measures taken by the farmers to prevent this insect in the fields. A semi-structured interview schedule was used to collect necessary information on papaya mealybug. Five different fields from each region and five plants from each field were selected randomly. Therefore, a total of 25 plants from each region were carefully observed to collect data on mealybug infestation. Farmer of each papaya field was interviewed about their perception on papaya mealybug, economic loss caused by the pest and the pest management strategies practiced to control this

insect. Observation also made to the surrounding crops to identify alternate host.

Market survey

To find out the impact of papaya mealybug infestation on marketing papaya, three markets from each region and a total of nine markets were surveyed. Five retailers from each market were interviewed to determine the marketing problem of the infested papaya.

Nursery survey

To find out the situation of papaya mealybug infestation in the nursery, five nurseries from each region and a total of fifteen nurseries from Barisal, Jessore and Mymensingh districts were surveyed. Data were collected on the presence of mealybug in the nursery, percent seedling infestation, loss occurred due to attack of mealybug and the control tactics used by nursery owners.

Statistical analysis

Results were subjected to a one-way analysis of variance. Differences between mean values were tested using Tukey's-HSD-test at $p = 0.05$.

Results and Discussion

Infestation of papaya mealybug

Infestation of papaya mealybug was found in all the survey areas and all plant parts such as leaf, stem, and fruits were frequently infested (Figure 1). The average plant infestation was 40%. There was a significant variation in plant infestation among the survey areas, where highest infestation of papaya mealybug was found in Jessore district (60%) followed by Barisal (32%) and Mymensingh district (28%) (Table 1). In the field, seven crops were identified to which papaya mealybug also attacked and those were Hog plum (*Spondolia spinnata*), Chili (*Capsicum frutescence*), Okra (*Abelmoscus esculentus*), Brinjal (*Solanum melongena*), Guava (*Psidium melongena*), Velvet-apple (*Diospyros blancoi*) and Hibiscus (*Hibiscus rosa-scinensis*) (Table 1). In addition, balck- and red-ants were found in the papaya mealybug colony (Figure 1a). During field survey farmers reported that they did not know the name papaya mealybug as the outbreak

Outbreak and control of papaya mealybug

of this insect in the papaya fields occurred in the recent years (Table 2). The infestation levels of papaya mealybug was varied in different seasons of the year, while high infestation of mealybug was found in the summer to early rainy season (usually March to July) and low infestation was observed by farmers in the winter, December to February (Table 2). Farmer of the survey areas did not get any support



Figure 1. Infestation of Papaya mealybug in different plant parts observed during the field survey. (a) Heavily buildup colony under the older leaf, (b) severely affected plant, (c) attacked fruits

and services from government organization (GOs) to manage this insect in the field. However, advisory services of NGO workers towards the management of papaya mealybug were negligible in the study area. Most of the farmer taken control measures either based on their own experience or according to the suggestions of the pesticide sellers.

Table 1. Infestation rate, economic loss and alternate host of papaya mealybug in survey areas of Bangladesh

Survey areas	Plant infestation (%)	Economic loss (Taka ha ⁻¹ Year ⁻¹)	Alternate host plants
Barisal	32.00 b	39893.28 b	Brinjal, Guava, <i>Hibiscus</i>
Mymensingh	28.00 b	34906.68 b	Brinjal, Chili, Hog plum, Okra, Velvet-apple
Jessore	60.00 a	107213.28 a	Brinjal, Guava, Okra
Mean	40.00	60671.08	-

Mean values followed by different letters indicate significant differences in infestation and economic loss by papaya mealybug (Tukey's HSD Test, $P < 0.05$). Taka is the currency of Bangladesh, where 1 US Dollar = 80 Taka. Although papaya mealybug first identified in May 2009 in Bangladesh and it is now spread many parts of the country, data on mealybug infestation for different regions in Bangladesh is very

few. Only a survey was conducted earlier by the scientist of Bangladesh Agricultural Research Institute (2008-2010) in six regions of the country viz. Gazipur, Norshingdi, Jessore, Sylhet, Rangpur and Pubna for documenting the pest status of mealy bug attacking different crops. This survey report indicated that the newly introduced mealybug, *P. marginatus* has been emerged as a major threat with varying levels of infestation to papaya along with different crops including guava, ber, custard apple, brinjal and okra (Karim et al., 2012). The mealy bug attack in different crops was quite severe in Gazipur and Norsingdi compared to other regions of the country (Karim et al., 2012). The present research identified four other crops namely Hog plum, Chili, Velvet-apple and *Hibiscus* that were attacked by papaya mealybug in Bangladesh. Papaya mealybug infested more than 40 host-plant species in Sri Lanka (Galanihe et. al., 2010) and many of these crops are cultivated in Bangladesh. In addition to identify mealybug attacked crops, the present research documented the status of mealybug infestation for two new regions in Bangladesh, Barisal and Mymensingh district.

However, severe infestation was recorded in Jessore district, the main papaya growing region in Bangladesh.

Economic losses due to attack of papaya mealybug

Farmers of the study area reported that infestation of papaya mealybug caused deformation of fruit, a heavy buildup of honeydew and aggregation of thick white waxy appearance on the fruit surface. For these reason, they could not sell infested papaya fruit to the wholesaler. Papaya growers also reported that they destroy infested papaya fruit in the field instead of brings them to the market, because the transporting cost did not meet from the sale price. As a result farmers faced great economic loss due to infestation of papaya mealybug and the economic loss was much higher in Jessore region (107213.28 Taka ha⁻¹ Year⁻¹) compared to Barisal (39893.28 Taka ha⁻¹ Year⁻¹) and Mymensingh district (34906.68 Taka ha⁻¹ Year⁻¹), (Table 1). Similar result found in the market survey, where the retailers faced difficulties to sell infested papaya as the consumers were not willing to buy infested papaya from the market. Papaya

mealybug caused havoc in agricultural and horticultural crops, and assumed the status of a major pest in 2009 when it caused severe damage to economically important crops and huge losses to farmers in Coimbatore, Erode, Tirupur and Salem districts of Tamil Nadu (Tanwar et al., 2010). In the same year, standing mulberry crop over 1,500 hectares in Tirupur was destroyed by the pest leading to enormous financial losses to mulberry growers across the district. Helemul (2013) reported that many farmers in Magura district of Bangladesh had stopped cultivating papaya in the last three years after suffering losses from attacks by the non-native pest *P. marginatus*. In this report one farmer said that he stopped cultivating papaya three years ago after incurring a loss of around Taka 50,000 from attacks of this potentially devastating pest. Opinion of farmers as well as retailers in the present study indicated the similar economic loss they have faced due to attack of papaya mealybug.

Management strategies practiced by farmers for controlling papaya mealybug

The farmers of the survey area used chemical insecticides indiscriminately against the papaya mealybug (Table 3). In Barisal region, farmers frequently used Malathion 57 EC @ 5 ml 10 l⁻¹ of

water. In Jessore region farmers preferred to use Admire @ 2 ml 10 l⁻¹ of water and in Mymensingh Cypermethrin 10 EC @ 2 ml l⁻¹ of water. Farmers reported that there were many insecticides available in the market but there was none in the local market that could effectively take out this alien invasive species. The farmers and NGO worker of Magura district expressed the similar opinion (Helemul, 2013).

In the study area, some farmers also followed indigenous approaches against this insect pest. In Jessore region, farmer used extract from bark of mahogany tree (Table 3). They soaked the bark of mahogany tree in water for two days (1 kg bark in 5 l water) and the obtained extract then sprayed with the help of hand sprayer. In Barisal and Mymensingh region, farmers were used wood ashes against papaya mealybug. Ahmed et al. (2011) observed the efficiency and persistent toxicity of mahogany oil against *P. marginatus*, where treatments with 5% mahogany oil resulted 80% mortality. Therefore, the conventional practices followed by farmers with the use of mahogany bark extract may have potential impact on mealybug mortality. Further investigation in the laboratory is needed to explore the toxicity effect of mahogany bark extract on the mortality of papaya mealybug.

Table 2. Opinion of farmers towards papaya mealybug outbreaks

Survey area	Since when papaya mealybug appeared as a problem (Years)	Time of outbreak in the year (month)			Support/services obtained regarding control measures		
		High	Medium	Low	GOs	NGOs	Others
Barisal	4	March-July	August-November	December-February	0	0	100
Mymensingh	6	March-August	September-November	December-February	0	20	80
Jessore	5	March-June	September-November	December-February	0	40	60
Average	5	-	-	-	0	20	80

Table 3. Management strategies practiced by farmers for controlling papaya mealybug in the survey areas

Survey area	Insecticides used in the fields	Indigenous approaches
Barisal	Malathion 57 EC *, Carbosulfan 20 EC	Use of wood ash
Mymensingh	Cypermethrin 10 EC*, Chlorpyrifos 20 EC, Diazinon 60 EC	Use of wood ash
Jessore	Admire 200SL*, Sevin 85 SP	Use bark extract of mahogany tree

Asterisk (*) indicate the most frequently used insecticide in the survey areas

Table 4. Situation of papaya mealybug infestation in the nursery

Survey area	Nursery attacked (%)	Seedling infested (%)	Control measures	
			Chemical	Non-chemical
Barisal	100a	11a	Malathion 57EC (Malathion), Shobicron 425 EC (Profenofos 40% + Cypermethrin 2.5%), Marshal 20EC (Carbosulfan), Tafgor 40EC (Dimethoate)	None
Mymensingh	60b	25b	Phytro 55EC (Chlorpyriphos 50% + Cypermethrin 5%), Ostad 10EC (Cypermethrin)	None
Jessore	100a	34b	Ripcord 5EC (Cypermethrin), Dursban 20EC (Chlorpyriphos)	None
Mean	86.67	23.33		

Mean values followed by different letters within a column indicate significant differences in infestation levels among different regions (Tukey's HSD Test, $P \leq 5$).

Situation of papaya mealybug infestation in the nursery

Infestation of papaya mealybug was also found in the nurseries of the survey areas and an average of 86.67% nursery was attacked with this insect pest, where 23.33% seedlings were infested. There was a significant variation found in seedling infestation among the survey areas, where highest seedlings were infested in Jessore district (34%) followed by Mymensingh (25%) and Barisal district (11%) (Table 4).

Nursery owners of the study area reported that infestation of papaya mealybug caused deformation of leaf and hampered plant growth. The affected seedlings were mostly stunted with curly leaf and had difficulty to sell them. The nursery owners used various chemical insecticides to protect the seedlings from the attack of papaya mealybug and there was a difference found in type of insecticide use among the survey areas (Table 4). In Jessore and Mymensingh region farmers preferred to use Chlorpyriphos and Cypermethrin based insecticides, where as in Barisal region farmers frequently used Malathion 57 EC, Shobicron 425EC, Marshal 20EC, Tafgor 40EC. Low seedling infestation in the nursery of Barisal region may be associated with the use of different types of insecticide compared to Jessore and Mymensingh region. None of the nursery owners in the survey areas used non-chemical approaches to control papaya mealybug in the nursery.

Conclusions

This study provides useful information about the papaya mealybug infestation in Bangladesh, where more than one third of the papaya plants are affected with this invasive alien species. The papaya mealybug is extending its range to other crops and seven economically important plant species are identified to which papaya mealybug also attacked. Seedling infestation in the nursery may be a great source of expanding papaya mealybug attack in the field. Both the nursery owners and the papaya growers must be careful to sale and collect planting materials from the nursery to prevent the spread of papaya mealybug in the new fields. The chemical insecticides used by farmers do not provide good control of this insect and as a consequence they are facing great economic loss. Further research is needed to find out suitable control options for combating this noxious invasive insect species in the field.

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