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Post Harvest Insect Pests of Mango that Affect in Quality Mango Production for the Supply Chain of Mango

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ABSTRACT

Mango is one of the most commercially important fruits in Bangladesh. Globalization has created demand for healthy fresh mango fruits have increased throughout the world. In recent years, mango production is affected and decreased for the attraction of different insects like; Mango fruit fly, Mango leaf hopper, Mango pulp weevil and Mango seed weevil. Due to such reason, it affects the production, quality, supply chain and export barrier. The impact of the insects on mango crops is considerable losses occur from premature fruit drop, and markets refusing to accept fruits. The insect pest may spread as eggs, larvae, pupae, and adults within the flesh of mango fruits. If introduction and establishment of the insect pests should occur, it may result in the termination of trade arrangements. This study thus conducted to realize the losses by insects' infestation in mango production so as to guide the control measures of these insects and set up effective supply chain of mango in the country and abroad. Both primary and secondary data were used in this study. The primary data were collected through four focus group (FG) discussion and personal communication. mango growers (FG-1), agriculturists (FG-2), businessmen (FG-3) and mango supply chain specialists (FG-4). In this experiment it was observed that different kind of insects cause loss of production, quality of mango fruits, ultimately effective and quality supply chain of mango. The knowledge on the insect pest and it controls in the four FGs is disclosed in the study area. In the present study, the problems in mango production and quality supply chain can be solved through taking proper control measures in time.

Keywords: Focus group, Mango fruits, Mango insects, Quality, Supply chain

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1. INTRODUCTION

Fruits supply chains are different from other supply chains. Starting from the production and harvesting time until the delivery to the final consumers, there is variation and loss in the quality of the fruits, which is susceptible to change even under optimum distribution conditions throughout the entire supply chain. The losses in the perishable fruit supply chains are mainly due to the inadequate planning and execution of the inventory and supply chain processes. In Bangladesh, the problems mainly arise due to the high perishable of the fruits, inadequate management practices during; production (manure, fertilizer, pesticide, irrigation, pruning, bagging etc.) harvesting, processing (grading, washing, packaging etc.), storing and marketing tend to decrease the quality of supply chain. Mango (*Mangifera indica* L.) is one of the most valuable, popular and commercially important fruits in Bangladesh. In nutritional aspects, both ripe and unripe mango is rich in several vitamins as well as minerals (Paramanik, 1995). Mango contains appreciable quantity of

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iron, vit C, carotene and soluble sugar. Moreover, it provides a lot of energy (as much as 74 kcal/100g edible portion) which is nearly equals the energy values of boiled rice of similar quantity by weight (Hossain, 1989).

Mango is the main cash crop of Chapainawabganj. Mango growers of this district are known, Chapainawabganj as the mango capital of the country. There are 31,50,040 mango trees in Chapainawabganj district. Of them, 3,96,500 mango trees are in Chapainawabganj sadar upazila, 17,39,600 in Shibganj upazila, 3,44,535 in Gomostapur upazila, 3,48,710 in Nachole upazila and 3,07,375 in Bholahat upazila (Daily Sun, 2023). The farmers of this district are mostly cultivating popular varieties of mango like Gopalbhog, Haribhanga, Langra, Fazli, Nakfazlee, Khirsapat, Mohanbhog, Chyatapori, Lakhna, BARI-11, BARI-4 and Amrapali in this region. Local markets are witnessing a huge supply of different varieties of mango. Besides, large quantities of mangoes are being sent to other places in the country including capital Dhaka from Chapainawabganj by passenger-coaches, trains, trucks and private vehicles every day.

Globalization has created changes in world food consumption, demand for healthy fresh mango fruits have increased. Despite a positive record in recent years, mango production is affected by many constraints, including phytosanitary problems. The quality of mango is damaged by attacking different kinds of insects like; Mango fruit fly, Mango leaf hopper, Mango pulp weevil and Mango seed weevil. Due to such damage, it affects the production, quality and export barrier (Manzoor et al., 2017). The impact of the insects on mango crops is considerable losses occur from premature fruit drop, and markets refusing to accept fruits. The insect pest may spread as eggs, larvae, pupae, and adults within the flesh of mango fruits. Visual inspection of the fruit is not sufficient to determine infestation. If introduction and establishment of the insect pests should occur, it may result in the termination of trade arrangements. Despite the economic importance of insects in domestic food security and export market, there has been no assessment on the insects' infestation, the associated economic damage impact and required control on the fruits sub-sector in Bangladesh.

This study thus conducted to realize the losses by insects' infestation in mango production so as to guide the control measures of these insects as well as set up effective supply chain of mango in the country and abroad.

2. MATERIALS AND METHODS

Data were collected from five upazilas of Chapainawabganj district from 1st November 2021 to 31st October 2022 to investigate the post harvest insect pests of mango that affect in quality mango production for the supply chain of mango. Both primary and secondary data were collected in this study. There are four focus groups namely; mango growers (FG-1), agriculturists (FG-2), businessmen (FG-3) and mango supply chain specialists (FG-4) were formed for collecting data. All the members of these focus groups are directly or indirectly engaged with the supply chain of mango in five upazilas of Chapainawabganj district. These focus groups were formed to find out the nature of damage and control measure of four insect pests of mango fruits that affect on quality supply chain of mango.

The respondents of focus group title mango growers (FG-1) were formed with 25 farmers. In this focus group there are 5 respondents (growers) were selected randomly from each upazila of Chapainawabganj district. The respondents of focus group title agriculturists (FG-2) were formed with 10 agriculturists. In this focus group there are 2 respondents (agriculturists) were selected randomly from each upazila of Chapainawabganj district. The respondents of focus group title businessmen (FG-3) were formed with 25 businessmen. In this focus group there are 5 respondents (businessmen) were selected randomly from each upazila of Chapainawabganj district. The respondents of focus group title mango supply chain specialists (FG-4) were formed with 10 supply chain specialists.

In this focus group there are 2 respondents (supply chain specialists) were selected randomly from each upazila of Chapainawabganj district. Therefore, the total numbers of respondents in this study were 70. A list of possible questions on four specific diseases for the participants were developed before conducting the survey to ensure some structure and direction in the discussions. Each focus group session ran for two hours and different aspects like; nature of damage and control measures of the four insect pests of mango was covered. In all focus groups, a thoroughly discussion was made with the peoples who are directly or indirectly engaged in production and supply chain of mango in five upazillas of Chapainawabganj district. For keenly observation, the nature of damage of different insect pests was collected through physically visiting to the mango farms and markets. Possible solutions were prepared through discussing with the respective specialists.

3. RESULTS

3.1. Important Post Harvest Insect Pests of Mango Fruits at Study Area

There are many insects like Mango fruit fly, Mango leaf hopper, Mango pulp weevil and Mango seed weevil that cause huge loss in mango production. Physical visit was conducted to different mango orchards for observing various losses occurred by insect pests in mango cultivation. Through focus group discussion different important post harvest insect pests of mango fruits were found. The list of different pests of mango fruits is placed in the Table 1.

Table 1 Four important post harvest insect pests of mango fruits

Insect pests	Scientific name
Mango fruit fly	*Bactrocera obliqua*
Mango leaf hopper	*Amritodus atkinsoni*
Mango pulp weevil	*Sternochetus frigidus*
Mango seed weevil	*Sternochetus mangiferae*

Table 2 Feedback of focus group title mango growers (FG-1) about four important post harvest insect pests of mango fruits (n=25)

Name of insects	Can Identify the insects (%)	Can identify the nature of damage (%)	Knew these insects before (%)	Having the knowledge on possible remedies (%)	Prescription received from the specialists (%)	Remedies can apply by own decision (%)
Mango fruit fly	90	40	100	10	85	10
Mango leaf hopper	100	50	100	15	90	15
Mango pulp weevil	50	15	60	10	40	08
Mango seed weevil	40	10	40	08	10	06

Table 3 Feedback of focus group title agriculturists (FG-2) about four important post harvest insect pests of mango fruits (n=10)

Name of insects	Can identify insects attack timely (%)	Knew the insects before (%)	Know the nature of damage (%)	Have knowledge on possible remedies (%)	Opined remedy is possible (%)	Can give treatment of the insects (%)
Mango fruit fly	100	100	100	100	100	100
Mango leaf hopper	100	100	100	100	100	100
Mango pulp weevil	100	100	100	95	90	100
Mango seed weevil	100	100	100	90	80	100

Table 4 Feedback of focus group title businessmen (FG-3) about four important post harvest insect pests of mango fruits (n=25)

Name of insects	Can identify insects attack timely (%)	Knew the insects before (%)	Know the nature of damage (%)	Have knowledge on possible remedies (%)	Cool Supply Chain is needed (%)	Grading is needed (%)
Mango fruit fly	20	55	50	15	100	100
Mango leaf hopper	25	60	55	18	100	100
Mango pulp weevil	15	40	30	10	100	100
Mango seed weevil	10	20	25	08	100	100

Table 5 Feedback of focus group title mango supply chain specialists (FG-4) about four important post harvest insect pests of mango fruits (n=10)

Name of insects	Can identify insects attack timely (%)	Knew the insects before (%)	Know the nature of damage (%)	Have knowledge on possible remedies (%)	Cool Supply Chain is needed (%)	Grading is needed (%)
Mango fruit fly	10	50	45	10	100	100
Mango leaf hopper	15	55	50	12	100	100
Mango pulp weevil	05	30	25	08	100	100
Mango seed weevil	04	25	20	05	100	100

3.2. Feedback About Four Special Pests of Mango Fruits

In respect of mango fruit fly 90% mango growers opined that they can identify the insects, 40% opined that they can identify the nature of damage, 100% opined that they knew the insect before, 10% opined that they have knowledge on possible remedies, 85% stated that they have received prescription from the specialists and 10% opined that they can apply remedies by own decision. In case of mango leaf hopper 100% mango growers opined that they can identify the insect, 50% opined they can identify the nature of damage, 100% stated that they knew the insect before, 15% opined that they have knowledge on possible remedies, 90% stated that they have received prescription from the specialists and 15% opined that they can apply remedies by own decision. In case of mango pulp weevil 50% mango growers opined that they can identify the insect, 15% opined they can identify the nature of damage, 60% stated that they knew the insect before, 10% opined that they have knowledge on possible remedies, 40% stated that they have received prescription from the specialists and 08% opined that they can apply remedies by own decision. In respect of mango seed weevil 40% mango growers (FG-1) opined that they can identify the insect, 10% opined they can identify the nature of damage, 40% stated that they knew the insect before, 08% opined that they have knowledge on possible remedies, 10% stated that they have received prescription

Table 6 Some important post harvest insect pests of mango fruits that affect on mango trees and hampers effective quality supply chain of Mango (Based on FGD)

No. of FGs	Name of the Focus Group	Identification of the insect pests	Possible solutions
FG-1	Farmers (n=25)	Mango fruit fly, Mango leaf hopper, Mango pulp weevil, Mango seed weevil	1. Infected inflorescences and fruits should be removed from the tree. 2. Different insecticides should be applied to control the insect pests.
FG-2	Agriculturists (n=10)	Mango fruit fly, Mango leaf hopper, Mango pulp weevil, Mango seed weevil	1. Timely pruning, regular inspection of the mango gardens, sanitation and seedling certification are preventive measures against the insect pests. 2. Crop residues should be destroyed after harvesting the mango fruits. 3. Specific insecticides should be used to control the insect pests. 4. Infested inflorescence and fruits should be removed from the tree. 5. Dead tree material should be removed immediately from the garden.
FG-3	Businessmen (n=25)	Mango fruit fly, Mango leaf hopper, Mango pulp weevil, Mango seed weevil	1. Preventive measures should be taken against the insect pests. 2. Infested fruits should be removed from during harvesting. 3. Grading should be done. 4. Quality packaging materials should be used for packaging.
FG-4	mango supply chain specialists (n=10)	Mango fruit fly, Mango leaf hopper, Mango pulp weevil, Mango seed weevil	1. Infested fruits should be removed during packaging. 2. Grading should be done properly. 3. Quality packaging materials should be used for packaging.

from the specialists and 06% opined that they can apply remedies by own decision (Table 2).

In case of mango fruit fly 100% agriculturists opined that they can identify the insects timely, 100% stated that they knew the insect before, 100% stated that they knew the nature of damage, 100% opined that they have knowledge on possible remedies, 100% stated that the remedy of this insect is possible and 100% opined that they can give treatment of the insect. In case of mango leaf hopper 100% agriculturists opined that they can identify the insects timely, 100% stated that they knew the insect before, 100% stated that they knew the nature of damage, 100% opined that they have knowledge on possible remedies, 100% stated that the remedy of this insect is possible and 100% opined that they can give treatment of the insect. In case of mango pulp weevil 100% agriculturists opined that they can identify the insects timely, 100% stated that they knew the insect before, 100% stated that they knew the nature of damage, 95% opined that they have knowledge on possible remedies, 90% stated that the remedy of this insect is possible and 100% opined that they can give treatment of the insect. In case of mango fruit fly 100% agriculturists (FG-2) opined that they can identify the insects timely, 100% stated that they knew the insect before, 100% stated that they knew the nature of damage, 90% opined that they have knowledge on possible remedies, 80% stated that the remedy of this insect is possible and 100% opined that they can give treatment of the insect (Table 3).

In respect of mango fruit fly 20% businessmen opined that they can identify this insect timely, 55% respondents said that they knew the insect before, 50% respondents stated that they know the nature of damage, 15% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed. In respect of mango leaf hopper 25% businessmen opined that they can identify this insect timely, 60% respondents said that they knew the insect before, 55% respondents stated that they know the nature of damage, 18% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed. In respect of mango pulp weevil 15% businessmen opined that they can identify this insect timely, 40% respondents said that they knew the insect before, 30% respondents stated that they know the nature of damage, 10% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is

needed. In respect of mango seed weevil 10% businessmen (FG-3) opined that they can identify this insect timely, 20% respondents said that they knew the insect before, 25% respondents stated that they know the nature of damage, 08% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed (Table 4).

In respect of mango fruit fly 10% mango supply chain specialists opined that they can identify this insect timely, 50% respondents said that they knew the insect before, 45% respondents stated that they know the nature of damage, 10% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed. In respect of mango leaf hopper 15% mango supply chain specialists opined that they can identify this insect timely, 55% respondents said that they knew the insect before, 50% respondents stated that they know the nature of damage, 12% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed. In respect of mango pulp weevil 05% mango supply chain specialists opined that they can identify this insect timely, 30% respondents said that they knew the insect before, 25% respondents stated that they know the nature of damage, 08% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed. In respect of mango seed weevil 04% mango supply chain specialists (FG-4) opined that they can identify this insect timely, 25% respondents said that they knew the insect before, 20% respondents stated that they know the nature of damage, 05% respondents opined that they have knowledge on possible remedies, 100% respondents opined that the cool supply chain is needed and 100% respondents opined that the grading of mango fruits is needed (Table 5).

3.3. Associated Problems and Possible Solutions from Focus Groups

There are a lot of problems are associated in quality mango production for supply chain of mango. Four focus groups namely; mango growers (FG-1), agriculturists (FG-2), businessmen (FG-3) and mango supply chain specialists (FG-4) were formed for collecting data and to find out the problems created by different insect pests of mango fruits and their possible solutions at Chapainawabganj district (Table 6).

4. DISCUSSION

More importantly, mango is an economically important crop that is both locally consumed and internationally exported. This growing global market might be seen as an interesting economic opportunity for countries that produce mango. Insect pest is the main factor that affect quality mango production ultimately quality mango supply chain. The total amount of mango production is decreased due to attacking by different pests that ultimately hampers in supply of quality mango in supply chain. Mangoes are good substrates for insect pest growth and survival when stored in a variety of temperatures. This fruit could be considered as potential vehicles for completing the life cycle of different insect pests. Mangoes are commonly eaten in a raw state, and the possible presence of pests on their surface or inside the fruits can be problematic during the manipulation process or even in the case of internalization, which would allow the growth/survival of insect's larvae as well as food borne pathogens in the fruits and pose a problem for the consumers. Pest internalization into fruits is a great problem that should be controlled with attention to maintain the quality of mango fruits. Different studies have shown that the application of preventive and control measures can reduce pest's contamination on fresh fruits. Therefore, different pests of mango, nature of damage and control measures of the pests that hampers in quality mango production as well as quality supply chain are discussed in this part in different heads and sub heads.

Mango fruit flies are serious pest of mango fruits. They belong to the order Diptera, family Tephritidae and the attacking genera are *Nastrepha* - 8 species, *Bactrocera* - 30 species, *Ceratitis* - 7 species, *Dirioxa* - 2 species and Toxotrypana -1 species (Rahman, 2005). Fruit flies (Diptera:Tephtritidae) are recognized worldwide as the most important insect pests to fruits, especially mangos (Ekesi et al., 2009). Female fruit flies lay eggs under the skin of the fruit, which hatch into larvae that feed in the decaying flesh of the crop. Infested fruits quickly rot and become inedible or drop on the ground, thus causing direct loss to the farmer. Without control, direct damage has been reported from 30 to 100% depending on the fruit maturity stage, variety, location and season (Vayssieres et al., 2009). Mango fruit flies basically attack the mature semi ripen fruits during the months of April and May. Both adults and maggots damage the mango fruits. Adult female flies puncture the rind of the mature fruits with its sharp small needle like ovipositor and lays eggs inside the mango fruits. After hatching the eggs, yellowish legless larva (maggots) are born. The maggots bore and feed on fruit pulp. Some cases, after maturation of the mango, drops on the ground and then the maggots go under the soil through boring the fruits for pupation. After pupation, the mature fly come out from the soil and attacks the fruits. In case of ripe mangoes the maggot or mature fly open after pealing the mango. Thus the maggots destroy the pulp making it foul smelling and discolored. Infested fruits develop brown rotten patches on them and fall to the ground ultimately. Sometimes premature fruits drop and mature fruits per plant is reduced due to fruit fly infestation. Eventually, fruit drops from the tree and decomposition take place due to secondary microorganisms. Larval tunnel provides entry for bacteria and fungi and rotting occur. Maggots also attack the seedlings, succulent tap roots and buds of the host plant. Due to such damage, it affects the production, quality and export barrier (Manzoor et al, 2017). Infested fruits quickly rot and become inedible or drop on

the ground, thus causing direct loss to the farmer (Nankinga et al., 2014). Rahman (2005) reported 37.5% infestation in mango due to fruit fly. Indiscriminate and improper use of pesticides create major problems such as development of pest resistance to pesticide, outbreak of secondary pests, destruction of beneficial organisms, hazards to the human health and pollution of the environment. To overcome the problems of pesticide use, environmentally sound and safe methods of pest management is of prime importance (Islam et al., 2013). Integrated Pest Management (IPM), recently termed as Integrated Crop Management (ICM) can play an important role in this respect (Islam et al., 2013). Rahman (2005) reported 37.5% infestation in mango due to fruit fly. Integrated pest management is the successful way to control mango fruit fly. Sex pheromone trap and bait trap are two traps, which used to catch fruit fly. According to Mohyuddin & Mahmood (1993), 75% fruit fly can be controlled through the sex pheromone traps Methyl eugenol. According to Islam et al., (2013), bagging is the most suitable management practice in all varieties of mango to reduce premature fruits drop per plant. In their experiment the lowest (4.77%) premature fruits drop was found under bagging management practice and the highest (11.13%) premature fruits drop was found in control where no management practices were applied. The lowest premature fruits drop was found under bagging (5) management practice followed by bait trapping (8.66), insecticide (9.66), sexpheromone (10), and control (10.66) and the highest (11.33) was in sanitation. Infested fruits must be removed from the field and buried deep 3 feet inside the soil (Manzoor et al., 2017). Most of the farmers of Bangladesh are not aware of the harmful effects of this pest and do not take proper control measure against them. Bait spray: Different proteins with insecticide are used as bait. After feeding on bait, fruit flies are killed (Manzoor et al, 2017). Sterile Insect Technique (SIT) should be applied. This is very effective modern technique in which male is sterilized and become unable to fertilize the female. It uses against small scale population (Manzoor et al., 2017). Different insecticides like Deltamethrine, Diptrex, Confidor and Diazinon etc. are being used for fruit fly management. Sometimes different mixtures are also used for effective control of this fly (Manzoor et al., 2017). Pheromone traps having methyl eugenol, Liquid trap with food bait and mass trapping are used for fruit fly monitoring and management (Manzoor et al., 2017).

Mango hopper is one of the serious pests of mango fruits which may cause up to 50% crop loss in case of severe infestation. The most important species of Mango hoppers are *Amritodus atkinsoni* (Leth.), *Idioscopus niveosparsus* (Leth.) and *Idioscopus clypealis* (Leth.) which are found in Bangladesh. Among of them *Amritodusatkinsoni* has become the most damaging one (Shawan et al., 2018). This pest is emerged from the last week of February to first week of March. *Amritodus atkinsoni*, *Idioscopus clypealis* and *Idioscopus nitidulus* are the common species of hopper that can be easily identified on the basis of their body color, size and spots on the abdomen. *A. atkinsoni* is bigger in size about 4.2 to 5 mm long with dark grey in color having two spots on abdomen and scutellum. *I. nitidulus* is slightly smaller in size about 4 to 4.8 mm long with three spots on the scutellum and a prominent band across its light brown wings, whereas *I. clypealis* is the smallest in size about 3.5 mm with two spots on the scutellum, dark spots on the vertex and light brown in color. A low population of mango hoppers is normally recorded in mango gardens throughout the year but it peaks up during February to April and June to August. Shade and high humid weather are suitable for their multiplication. In summers the total life of a mango hopper lasts 2-3 weeks. Mango hoppers have incomplete metamorphosis and pass three life stages such as egg, nymph and adult. Both the nymphs and adults of the hoppers puncture and suck the sap from tender shoots, inflorescences, and leaves of mango crop, which cause non-setting of flowers and dropping of immature fruits. Adult hoppers lay eggs from middle of February to March on the floral tissues. They lay egg singly on the floral shoots, buds and tender leaves of mango trees which hatch within a week. After hatching, a large number of nymphs and adults puncture and suck the sap of tender parts like panicles, inflorescence, leaves and fruits ultimately reducing the vigor of the plants and particularly destroying inflorescence and causing fruit drop. Heavy puncturing and continuous draining of the cell sap causes curling and drying of infested cells and tissues. Hoppers also damage the crops through excreting a secretion, called honey dew. In shade and moist weather, it encourages the development of fungi like *Meliolam angiferae* (Earle), resulting in growth of sooty mould fungus on dorsal surface of leaves, branches, and fruits. This black coating interferes with the normal photosynthetic activity of the plant, ultimately resulting in non-setting of flowers and dropping of immature fruits. (Shawan et al., 2018). Good orchard management practices like keeping the orchard clean, regular ploughing, removal of weeds should be applied. Pruning of overcrowded and overlapping branches in the month of December will reduce the hopper population. In order to control mango hoppers, first spray of imidacloprid (0.005%, 0.3 ml per liter of water) should be done at early stages of panicle formation, if hopper population is more than 5 per panicle. The second spray of thiamethoxam (0.005%, i.e., 0.2 g per liter of water) or acephate (1.5 g per liter of water) should be carried out after fruit set. If substantial hopper population still persists, third spray of carbaryl (0.15%, i.e., 3 g per liter of water) should be done before maturity of fruits. Orchardists are advised not to spray if more than 50 per cent flowering has already occurred because it will affect the pollinator activity leading to low fruit set. Synthetic pyrethroids such as cypermethrin, permethrin, fenvalerate and deltamethrin should not be sprayed in mango as they are harmful to human health. Neem based products have extensively been used and have proved their pest control efficacy against several insect pests both in field and storage Singh (Singh, 2000). An experiment was undertaken by Shawan et al. (2018) to manage mango hopper, *Amritodus atkinsoni* (Lethierry), using three non-persistence chemical

insecticides, namely, Acetamiprid 20 SP, Q-fos 25 EC, Confidor 70 WG and two natural products Neem extract and Mahogoni extract. The highest mortality of mango hopper 35.0% and 30.0% were found with the application of Neem extract and Mahogoni extract for 1.5% concentration. In an experiment conducted by Adnan et al. (2014) chemical insecticides, Imidacloprid (0.3%), Endosulfan (0.5%), Cypermethrin (0.4%), and Neem oil (3%) were effective in managing mango hopper in comparison to the control. Imidacloprid showed the highest efficacy in percentage of reduction of hopper population at 72 hours after treatment in case of 2nd spray. It also showed the highest overall percentage of reduction of hopper population and less toxicity to natural enemies of mango hopper. In case of biopesticide, azadirachtin based Neem oil was found effective against Mango hopper as 48.35, 60.15, and 56.54% reduction after 24, 72, and 168 hours, respectively. The population of natural enemies was also found higher in case of Neem oil evenafter1stand2ndspray.So, it could be concluded that sole dependency on conventional insecticides may easily be modified by incorporating Neem oil as an environment friendly management program for mango hopper (Adnan et al., 2014).

Mango pulp weevil is small insect with long snouts. It is about 6-9 mm long, thick bodied and mottled brown in color. It has plump, whitish, legless grubs, with a well-defined brown to black head having 5 growth stages (instars). Pupa generally up to 10 mm in length, and vary from white to pale red in color. This insect lays the tiny eggs are about 0.6 x 0.3mm, roughly elliptical and white to pale yellow in color. Mango pulp weevil is a serious insect pest of mango fruits. The mango pulp weevils are considered as major pest as it caused significant damage to the mango pulp contaminating the edible portion. At laying, the weevil cut a very small nick into the fruits and the resulting sap flow covers the eggs case. This helps to protect the eggs and adheres them to the fruits. Several eggs may be laid on each fruit and each female can lay up to 15 eggs per day and up to 300 eggs during the season. The immediately hatched young larva enters into the fruit directly by cutting a hole on the site in contact with the fruit. The third instar larva becomes a voracious feeder. The fourth instars larva is also bit larger and voracious feeder. The fifth instar larva is quite peculiar in size and color. It feed actively and made more tunnels leaving more excreta. The fifth instar larva is followed by the pre-pupal stage. During this, it stops feeding and started to search or suitable place for pupation. Pupa remains in complete rest. After emergence, the adult weevil is found to live for sometimes inside the pulp and come out by cutting through the skin of the fruit (Devi et al., 2011). The larvae of mango pulp weevils do the damage by feeding in the flesh of the mango fruit making them unfit to eat. Mango pulp weevil causes premature fruit drop and loss of marketable fruits. The pest can cause significant fruit damage, resulting in economic loss to the mango industry. Mango pulp weevil completes much of its life cycle within mango fruit, and infested fruit can look normal on the outside. Externally, there may be no or little sign that the weevil is present inside the fruit, until the adult weevil tunnels its way out of the fruit. This pest could spread long distances by people moving infested fruit or plant material. Where mango pulp weevil is known to occur, orchard infestations tend to be localized. Adult weevils can fly, but generally do not spread far after they emerge from infested fruit. Fallen fruits that contain larvae, pupae and/or adults should be collected and destroyed them by burning deeply at least 50 cm under soil. Fruits should be harvested as soon as possible, just before they are ripe. Bagging should be applied for individual fruits when they are immature, about 6 cm diameter (less than the size of a chicken's egg). Chemical control is not an effective method of control as the life stages are inside the fruit. However, the synthetic pyrethroid, lambda-cyhalothrin has been recommended in the Philippines, and in India, a single application of a persistent insecticide has been suggested at the time of fruit-setting. Countries which are still free from the pulp weevil, or those that have areas recognized officially as free, and export the crops, should take all practical and necessary measures to prevent its introduction or further spread. To contain the risk of further spread of the mango pulp weevil, 'area freedom' should be used as a management strategy, following the guidelines of the International Standards for Phytosanitary Measures.

The mango seed weevil is one of major pests of mango fruits. This insect is widely distributed in the tropics. It is a serious pest of mango that hampering export of Bangladeshi mangoes. Among the varieties of mango the sweet varieties are more prone to attack by this weevil. Mango seed weevils are quarantine pest. Probably their greatest significance as pest is to interfere with the export of fruits because of quarantine restrictions imposed by importing countries and the market requirement for blemish free fruit. This is particularly troublesome in the case of the mango seed weevil because, in many instances, weevil attack remains undetected in the field level and is first noticed in storage in transit or in table during consumption. All these evidence suggests that weevils spread into clean areas through the movement of infested fruit for propagation and consumption. In Australia, young orchards planted from weevil-free-nursery stock have been shown to be free of seed weevil infestation for a number of years after establishment, even in areas known to have seed weevil (Pinese & Holmes, 2005). The female weevils lay eggs on the epicarp of the partially developed fruits and under the rind of the ripening fruits. After hatching the eggs the newly emerged grubs bore through the pulp, feed on seed coat and later damage to cotyledons of the mango seed. The pupation of the weevils takes place inside the mango seed. Discoloration of the pulp is observed adjacent to the affected portion. The cuts made by egg-laying female weevils are small and generally soon heal, leaving very small, dark, crescent shaped marks on the fruit skin. The infested fruits present internal rot on the outer surface of the stone. The stones also show holes and the cotyledons turn black and become a rotten mass. When the adult weevil emerges, a hole is visible in the fruit skin, which also serves as an entry point for secondary fungal infection. The larva, which is the damaging stage of the pest,

enters the fruit burrowing through the flesh into the seeds, where they feed until pupation, destroying the seed. Early attack (when the fruits are forming) by this insect leads to premature fruit fall. If the attack occurs at a later stage, fruit infestation is very difficult to detect, since there are no external signs of infestation, except for an inconspicuous egg-laying scar, and consequent feeding activity in the seed remains undetected. Weevils leave the fruits after it has fallen and decayed or when the fruits are ripe. Thus, yield is usually not significantly affected by this insect. When the adult weevil emerges, it tunnels through the flesh into the open, leaving a hole in the fruit skin. In late-maturing varieties, it causes post-harvest damage to the pulp as the tunnel turns hard making the fruit unmarketable. This hole also serves as an entry point for secondary fungal infection. The affected fruits should be destroyed and buried the affected fruits with weevils by digging the soil. Spray the tree in proper time with proper dose and proper insecticides. It is a quarantine pest and therefore proper care should be taken to avoid its entry into the other countries where mango fruits are exported. A combination of the removal of fallen fruits, trash and spot spray application of salute up to a meter around the stem of the mango trees greatly reduces the population of the weevil. Mango seed weevil attack can be detected through monitoring for egg-laying marks on the young fruits. Regular fruit scouting is important for detecting adult activity during fruit growth. Good orchard sanitation is very important to protect from this insect. All scattered stones and fallen fruits should be collected, destroyed and buried them deeply about 50 cm deep under soil. Keeping the tree basins clean, removing fallen fruit, seed and plant debris is necessary to prevent hiding of adult weevils. Avoiding movement of fruits from areas known to have mango seed weevils to areas where young orchards, free of seed weevil, have been established. A strict policy of not bringing mango fruit into the orchard and its surroundings will greatly reduce the chance of infestation.

The focus group research is potential for the investigation on the agricultural sector. The EIP-AGRI focus group on innovative short food supply chain management was launched under the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI, 2022). The Focus Group brought together 20 experts with different backgrounds and experiences (scientists, farmers, advisers, etc.) to identify the main needs or instruments required to implement short food supply chain (SFC) which can increase farm incomes; to highlight the factors that currently hamper scaling up and to make recommendations for solutions to the problems. The report focuses on setting up and getting support for collaborative activities in which more than one farmer, food producer, organization or individual agree to work together to develop short food chains for mutual benefit. Vasco (2010) developed a framework that highlights the factors influencing focus groups' effectiveness in the logistics discipline. In recent years researchers have shown more interest in supply chain quality management perspective (Rashid & Aslam, 2012; Zhang et al., 2011). Quality management (QM) traditionally focuses on internal process control and improvement and lacks a systems view of the supply chain network. QM has a impact on managing the supply network's quality (Robinson & Malhotra, 2005; Romano & Vinelli, 2001). The research on the synergy of QM has increased over the years, according to Zu & Kaynak (2012).

5. CONCLUSION

As perishable good, mango supply chains are different from other supply chains. Starting from the production to deliver the mango fruits to the final consumers, there is a loss in the quality of mango throughout the entire supply chain due to inadequate management practice. During production, mango is attracted by different insects like; Mango fruit fly, Mango leaf hopper, Mango pulp weevil and Mango seed weevil. For this reason, the quality of mango decreases ultimately hampers in the supply chain. These problems can be solved through proper control measures of these insects.

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