Government of the People's Republic of Bangladesh
Office of the Project Director
Strengthening Phytosanitary Capacity in Bangladesh Project
Plant Quarantine Wing
Department of Agriculture Extension
Khamarbari, Farmgate, Dhaka-1205




Pest Risk Analysis of Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh

June 2019

Government of the People's Republic of Bangladesh
Ministry of Agriculture

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REPORT

ON

Pest Risk Analysis (PRA) of Mediterranean Fruit Fly (*Ceratitis capitta*) in Bangladesh

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FORWARD

The Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW), Department of Agricultural Extension (DAE), Ministry of Agriculture conducted the study for the "**Pest Risk Analysis (PRA) of Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Development Technical Consultants (DTCL) Limited on 22 November 2018. The PRA study is a five-month assignment commencing from 20 December 2018 under the SPCB-DAE.

The overall objectives of this Pest Risk Analysis are to identify presence or absence of *Ceratatis capitata* species; identify major pathways of *Ceratatis capitata* species; identify host plants and more damaging host plant species if present; assess potential loss by the pests; identify probability of survival during transport or storage & transfer of hosts; identify potential economic and environmental impacts; identify pathways and potentials for entry, establishment and spread of *Ceratatis capitata* sp.; and to identify risk management options. To carry out the PRA study, the study team conducted detection survey as per Pest Surveillance Guidelines in 39 upazila under 21 districts of Bangladesh. The study covered the pheromone trapping of Mediterranean fruit fly (*Ceratitis capitata*) using sex attractant namely Trimedlure (t-butyl-4(or 5)-chloro-2-methyl cyclohexane carboxylate) which is the most widely used lure for *C. capitata*. The key informant interviews (KII) and physical inspection and visits of the crop fields under sampled districts were also conducted. The consultants also reviewed secondary sources of information related to PRA of Mediterranean fruit fly.

The study findings evidenced that none of adult Mediterranean fruit fly (*Ceratitis capitata*) was captured in any one of the pheromone traps. Therefore, it was concluded that Mediterranean fruit fly (*Ceratitis capitata*) is absent in Bangladesh and further pest surveillance for Medfly has to be conducted if any interception of this pest occurs in future. Through this study the Mediterranean fruit fly (*Ceratitis capitata*) has been identified as quarantine pest for Bangladesh. Thus, as per ISPM 2 "Framework of Pest Risk Analysis", a PRA like report for Mediterranean fruit fly (*Ceratitis capitata*) has been prepared for public awareness as well as future program. The consultant team also conducted the risk assessment for Medfly species based on the consequences and potential of introduction of Medfly species and a risk rating was estimated. Based on the risk assessment and risk rating, Mediterranean fruit fly (*Ceratitis capitata*) was identified as high risk potential. The findings also suggested the risk management options for the Mediterranean fruit fly (*Ceratitis capitata*) in line with the pre and post harvest management and phytosanitary measures.

The findings of the PRA study had been presented in the National Level Workshop organized by the SPCB-PQW of DAE. The concerned professionals represented from the country's reputed agricultural universities, research organizations and other relevant personnel from different organizations were attended in the workshop. The online version of this report is available in the official website of DAE at www.dae.gov.bd

I would like to congratulate study team for conducting the PRA study successfully and also the concerned SPCB professionals in making the total endeavor a success. I express my heartfelt thanks to the officials of DAE, Ministry of Agriculture, BADC, BARI, Agricultural Universities and Research organizations for their assistance and cooperation extended in conducting the PRA study. Thanks are also due to all members of Technical Committees for cooperation. Special thanks to the Director General of DAE, Director (Plant Quarantine Wing) and other high officials of SPCB-DAE for providing us valuable advice and guidance. I hope that the report certainly would contribute to enhance the exports and imports of different commodities.

(Dr. Mohammad Ali)
Project Director
Strengthening Phytosanitary Capacity in Bangladesh Project
Plant Quarantine Wing
Department of Agricultural Extension
Ministry of Agriculture, Bangladesh

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ACRONYMS

AEZ	:	AGRO-ECOLOGICAL ZONE
BADC	:	BANGLADESH AGRICULTURE DEVELOPMENT CORPORATION
BARI	:	BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
BAU	:	BANGLADESH AGRICULTURAL UNIVERSITY
BBS	:	BANGLADESH BUREAU OF STATISTICS
CABI	:	CENTER FOR AGRICULTURE AND BIOSCIENCE INTERNATIONAL
DAE	:	DEPARTMENT OF AGRICULTURAL EXTENSION
DG	:	DIRECTOR GENERAL
DR.	:	DOCTOR
DTCL	:	DEVELOPMENT TECHNICAL CONSULTANTS PRIVATE LIMITED
e.g.	:	FOR EXAMPLE
EPPO	:	EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
et al.	:	AND ASSOCIATES
EU	:	EUROPEAN UNION
FAO	:	FOOD AND AGRICULTURE ORGANIZATION
FAOSTAT	:	FOOD AND AGRICULTURE ORGANIZATION STATISTICS
FGD	:	FOCUS GROUP DISCUSSION
GOB	:	GOVERNMENT OF BANGLADESH
IPPC	:	INTERNATIONAL PLANT PROTECTION CONVENTION
IPM	:	INTEGRATED PEST MANAGEMENT
ISPM	:	INTERNATIONAL STANDARD FOR PHYTOSANITARY MEASURES
J.	:	JOURNAL
KII	:	KEY INFORMANT INTERVIEW
LTD	:	LIMITED
MD	:	MANAGING DIRECTOR
NGO	:	NON-GOVERNMENT ORGANIZATION
NO.	:	NUMBER
NPPO	:	NATIONAL PLANT PROTECTION ORGANIZATION
^oC	:	DEGREE CELSIUS
PD	:	PROJECT DIRECTOR
PFA	:	PEST FREE AREA
PPW	:	PLANT PROTECTION WING
PQW	:	PLANT QUARANTINE WING
PRA	:	PEST RISK ANALYSIS
PROF.	:	PROFESSOR
PVT.	:	PRIVATE
RH	:	RELATIVE HUMIDITY
SAU	:	SHER-E-BANGLA AGRICULTURAL UNIVERSITY
SCA	:	SEED CERTIFICATION AGENCY
SID	:	STATISTICS AND INFORMATICS DIVISION
SPCB	:	STRENGTHENING PHYTOSANITARY CAPACITY PROJECT IN BANGLADESH
UK	:	UNITED KINGDOM
USA	:	UNITED STATES OF AMERICA
USDA	:	UNITED STATES DEPARTMENT OF AGRICULTURE
%	:	PERCENTAGE

EXECUTIVE SUMMARY

The study “Pest Risk Analysis (PRA) of Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh” documents the presence or absence of this pest species and its hosts and alternate hosts affected in Bangladesh and the risks associated with this pest. With the import pathway of plants or plant materials/fruits etc. from exporting countries of Mediterranean region namely Jordan, Cyprus, Lebanon, Egypt, Algeria, Tunisia, Turkey, Congo, Libya and other countries of the world. The reason behind the study is to know whether the pest *Ceratitis capitata* is present or absent in Bangladesh, because it is still not known to occur in Bangladesh. So, primary and foremost work is to design specific Plant Pest Surveillance program to detect the pest as per IPPC Pest Surveillance Guidelines.

As per requirement of the present study, the detection survey as a part of Plant Pest Surveillance was conducted throughout the PRA areas covering 39 upazila under 21 districts of Bangladesh using sex attractant namely Trimedlure (t-butyl-4(or 5)-chloro-2-methyl cyclohexane carboxylate) which is the most widely used lure for *C. capitata*. The study team used Trimedlure that has been imported from Pherobank B.V.—a pheromone lure producing and supplying company in the Netherlands. The Trimedlure has been imported in February, 2019 from Pherobank B.V. with the help of a multinational pesticide company named Haychem (Bangladesh) Limited, Dhaka. The number of pheromone traps was set in the specific location of the present PRA areas as per Pest Surveillance Guidelines considering four types of locations as follows: a) point of entry considered 6 to 10 pheromone traps/km^2; (b) urban areas considered 6 pheromone traps/km^2; (c) marginal areas considered 8 pheromone traps/km^2 and (d) production area considered 8 pheromone traps/ha (i.e. 2 traps/0.25 ha).

After conducting surveillance program, it was revealed from the findings that no adult Mediterranean fruit fly (*Ceratitis capitata*) as well as any larvae or pupae have been detected through this pest surveillance study using sex attractant (Trimedlure) in PRA areas of Bangladesh. Therefore, as per ISPM 2 “Framework of Pest Risk Analysis” detail PRA for Medfly has been stopped in Bangladesh, but as a serious pest for fruits like citrus, mango, guava, grape, fig, capsicum, pomegranate, ber, litchi, papaya etc, the PRA like activities for this pest have been conducted and prepared a PRA like report for awareness as well as for future program. In future, if any interception of Mediterranean fruit fly is taken place then further pest surveillance and complete PRA have to be conducted for Medfly (*C. capitata*).

The consultant team also evaluated the risk assessment for Medfly species based on the consequences and potential of introduction of this pest and a risk rating was estimated. The consequence and potential of introduction value was estimated by assessing biology, host range, distribution, hazard identification, risk assessment, consequence assessment, risk estimation and risk management of the pests. The two values were summed to estimate an overall Pest Risk Potential, which is an estimation of the risk in the absence of mitigation.

Based on the risk assessment and risk rating, Mediterranean fruit fly (*Ceratitis capitata*) was identified as high risk potential for Bangladesh. It was also suggested the risk management options for the Mediterranean fruit fly (*Ceratitis capitata*) for Bangladesh in line with the pre and post harvest management and phytosanitary measures. The high risk potential means that this species pose unacceptable phytosanitary risk. Visual inspection at port-of-entry for high risk potential pests is insufficient to safeguard Bangladesh and specific phytosanitary measures are strongly recommended. For the moderate and low risk potential pests, specific phytosanitary measures may be necessary to reduce pest risk.

CHAPTER I

PEST SURVEILLANCE APPROACH

1.1. Introduction

Bangladesh is importing huge amount of citrus, grapes, apples and other fruits from Mediterranean region, Australia and other countries of the world. At the same time Bangladesh is exporting considerable amount of citrus and other fruits and vegetables to EU, Middle East and other countries of the world. It is known to all that Bangladesh is still free from the pest Mediterranean fruit fly (*Ceratitis capitata*), which is devastating pest for fruits in the region where they occur. As Bangladesh is importing and exporting a lot of citrus and other fruits, so there is a high potential of entry and establishment of the pest Medfly (*Ceratitis capitata*), because there is lot of host plants for Medfly in Bangladesh.

As we know all that *Ceratitis capitata* is not present in Bangladesh and yet there was no interception report available, but to confirm the presence or absence of the pest Mediterranean fruit fly (*Ceratitis capitata*)—Strengthening Phytosanitary Capacity in Bangladesh Project (SPCBP) under Plant Quarantine Wing (PQW) of Department of Agricultural Extension (DAE), Bangladesh felt the need to conduct a surveillance program as per ISPM 6 (Guidelines for Surveillance). Upon the completion of the surveillance program, preventive measures need to be taken against this pest. So, for the sake of preventive measures, the PRA like activities for Mediterranean fruit fly have been conducted and prepared the report to describe the activities aiming to prevent the entry of this pest into Bangladesh.

1.2. Surveillance Approaches and Application

ISPM 6 (*Guidelines for Surveillance*) recognizes two kinds of surveillance: general surveillance and specific surveys.

1.2.1. General surveillance

General surveillance is defined in ISPM 6 as “a process whereby information on particular pests which are of concern for an area is gathered from many sources, wherever it is available and provided for use by the NPPO”.

General surveillance:

- support NPPO declarations of pest status
- provide information on the early detection of exotic pests
- report to other organizations, such as other NPPOs, regional plant protection organizations (RPPOs) and the Food and Agriculture Organization of the United Nations (FAO)
- compile host and commodity pest lists and distribution records.

1.2.2. General surveillance approach and application

According to ISPM 6, a general surveillance approach should include the following.

1.2.2.1 Sources of information

These may include: NPPOs, other national and local government agencies, research institutions, universities, scientific societies (including amateur specialists), producers, consultants, museums, the general public, scientific and trade journals, unpublished data and contemporary observations. In addition, the NPPO may obtain information from international sources, such as FAO, the IPPC, RPPOs, etc.

1.2.2.2 Collection, storage and retrieval of information

To use data from these sources, it is recommended that NPPOs develop a system for collecting, verifying and compiling pest information.

Components of such a system include:

- the NPPO or another institution designated by the NPPO acting as the national repository for plant pest records
- a record-keeping and retrieval system
- data verification procedures
- communication channels to transfer information from the sources to the NPPO.

Components of such a system may also include incentives to report, such as:

- legislative obligations (for the general public or specific agencies)
- cooperative agreements (between the NPPO and specific agencies)
- use of contact personnel to enhance communication channels to and from NPPOs
- public education and awareness programs.

1.2.2.3 Use of information

Information gathered through such general surveillance will most often be used to:

- support NPPO declarations of pest freedom
- aid in the early detection of new pests
- report to other organizations such as RPPOs and the IPPC Secretariat
- compile host and commodity pest lists and distribution records.

An NPPO will establish a general surveillance activity as part of its regular work program. This would involve:

- designating staff to compile, screen and analyse comprehensive pest information from diverse sources, as appropriate
- keeping pest status information updated
- establishing and maintaining a system to store, analyse and retrieve data
- ensuring that third parties involved in surveillance are aware of the need to cooperate with the NPPO, particularly for pest reporting – designated staff would ensure that agreements made with such third parties are updated, amended, monitored, issued, reviewed and revoked, as necessary;
- establishing a reporting system internal to the NPPO as well as a reporting system for external inputs from third parties;
- establishing a system to analyse and validate information compiled through this activity before official reports are made to other contracting parties – this could be done through sector-specific groups, scientific panels, etc.

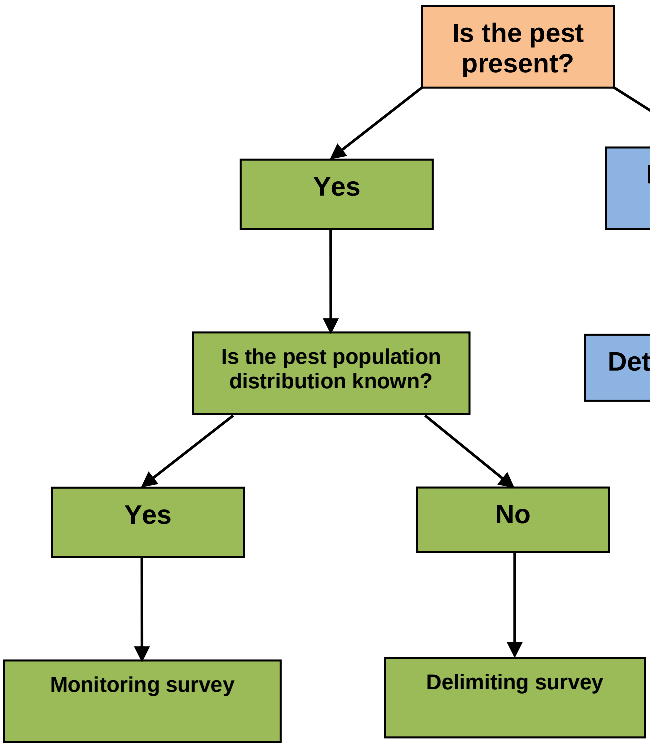
1.2.3 Specific surveillance

ISPM 6 defines specific surveys as "procedures by which NPPOs obtain information on pests of concern on specific sites in an area over a defined period of time".

Specific surveys may be focused on a pest or on a host or commodity. Types of specific survey include:

- detection
- delimiting
- monitoring.

Figure 1.1: Decision support process for planning pest surveillance



The presence or absence of Mediterranean fruit fly (Ceratitis capitata) is not known in Bangladesh. Therefore, in the present study for conducting Pest Risk Analysis (PRA) of Mediterranean fruit fly, the 'detection survey' is appropriate among three processes of pest surveillance approach aiming to determine whether the Medfly is present or not under the sampled PRA areas in Bangladesh.

1.3. Designing a specific Plant Pest Surveillance Program

Whether the Medfly, *Ceratitis capitata* is present or not in Bangladesh, a specific Pest Surveillance Program will have to design aiming to detect the incidence of this pest. The overall design of specific pest surveillance program is presented below:

1.3.1 Survey design

Survey design depends on the purpose of the survey, whether to look for a pest of unknown status in an area, to gather data about an existing pest population in an area or to determine the boundaries of an infestation.

ISPM 5 (*Glossary of phytosanitary terms*) defines the following survey designs:

Detection survey: "Survey conducted in an area to determine if pests are present". Detection surveys are appropriate if a pest's presence in an area is not known.

Monitoring survey: "Ongoing survey to verify the characteristics of a pest population". Monitoring surveys are appropriate to document changes in prevalence of a particular pest population over time and to assist with pest management.

Delimiting survey: "Survey conducted to establish the boundaries of an area considered to be infested by or free from a pest". Delimiting surveys are usually used to define the boundaries of spread for a new, invasive pest. A delimiting survey often precedes the implementation of an eradication program. Delimiting surveys may also be useful for shipping commodities outside of the pest range for a pest of limited distribution.

*In the present PRA study for Mediterranean fruit fly (Ceratitis capitata) in Bangladesh, the study team considered the "**Detection Survey**" as because the presence or absence of this pest is not known in Bangladesh. Therefore, the detection survey has been conducted in the sampled PRA areas of Bangladesh as determined by the client to make sure whether the Mediterranean fruit fly is either present or absent in Bangladesh*

1.3.2 Pest-specific surveillance

According to ISPM 6 (*Guidelines for Surveillance*), a pest-specific surveillance approach includes the following:

- identification of the target pest(s)
- identification of scope (e.g. geographic area, production system, season)
- identification of timing (dates, frequency, duration)
- in the case of commodity pest lists, the target commodity
- indication of the statistical basis (e.g. level of confidence, number of samples, selection and number of sites, frequency of sampling, assumptions)
- description of survey methodology and quality management based on an understanding of the biology of the pest, purpose of the survey and including an explanation of: sampling procedures (e.g. attractant trapping, whole plant sampling, visual inspection, sample collection and laboratory analysis)
    - diagnostic procedures
    - reporting procedures.

1.3.3 Commodity-specific surveillance

Specific pest lists of commodities can be useful in the context of cultural practices or to provide general data in the absence of general surveillance. Commodity-specific surveillance may also be useful to provide information to requesting countries to facilitate their PRAs.

According to ISPM 6, commodity-specific survey sites should be selected by the following parameters:

- geographic distribution of production areas and their size
- pest management programs (commercial and non-commercial sites)
- cultivars present
- points of consolidation of the harvested commodity.

Survey methodology depends on the harvesting time, target commodity pests and associated sampling techniques, and type of commodity.

*Under the present "**Detection Survey**" for Ceratitis capitata in Bangladesh, study team considered the four types of locations or survey sites considered for setting up of pheromone traps are as follows:*

(a) Point of Entry: First entry point, where imported fruits/products are opened;
(b) Urban areas: Where imported fruits/ products are marketed;
(c) Marginal areas: Border areas through which quarantine pests may enter into a country and
(d) Production area: Fruits/commodity cultivation areas where target pests may present.

1.4. Methodologies

Surveillance protocols and methodologies provide consistent instruction on the delivery of a surveillance activity. Surveillance managers and surveillance officers need to be aware of current methods associated with pests of interest and must ensure that the methods meet survey objectives. Methods of plant pest surveillance are further described in *Guidelines for surveillance of plant pests in Asia and the Pacific* (McMaugh, 2005); chapter 8 focuses on specific case studies.

Surveillance methods may be based on recognized guidelines and international protocols or negotiated equivalents.

In some cases NPPOs may need to derive new methodologies when faced with new and emerging pests.

1.4.1 General surveillance

General surveillance activities provide a useful means for NPPOs to gather pest information beyond specific surveys. The importance of general surveillance and the central collection of data for national plant biosecurity is discussed in the *National Plant Biosecurity Surveillance Strategy 2013–2020* (PHA, 2013). General surveillance also serves the purpose of potentially proving the absence of a pest for trade purposes. Participatory engagement of industry, citizens, growers and academia is a critical component of general surveillance.

General surveillance activities can be delivered in the following ways:

- undertake desktop reviews of scientific journals, publications and databases
- deliver outreach and awareness campaigns to inform the audience about the target pests and ways in which they can assist
- ensure mandatory reporting for agencies and institutions involved in scientific research and publication – in some cases this may involve legislative obligations or cooperative agreements to report.

General surveillance systems must comply with ISPM 8 (*Determination of pest status in an area*) validation process, and so require adequate screening, validation, data management and analysis to manage data before they are included in information management systems.

Before implementing these general surveillance initiatives, it is important to ensure that adequate human and physical resources (computer systems, databases, communication systems, etc.) are available.

1.4.2 Specific surveys

Specific surveys provide the means for NPPOs to actively gather pest distribution information through structured programmes.

A wide variety of technical methods are available, based on the three fundamental types of surveillance:

- **sampling survey:** host material, target pests or soil are collected for identification and analysis
- **trapping survey:** chemical or physical traps used to capture target pests in a given area
- **visual examination:** host or habitat examined for life stages, signs or symptoms associated with target pests.

These methods may not always be delivered independently and some surveys may include a combination of sampling, trapping and visual inspection.

The three specific surveys recognized by ISPM 6 (*Guidelines for surveillance*) are:

- **detection surveys:** conducted in an area to determine if pests are present
- **delimiting surveys:** conducted to establish the boundaries of an area considered to be infested by or free from a pest
- **monitoring surveys:** ongoing survey to verify the characteristics of a pest population.

The following Table indicates different circumstances under which certain types of survey are deployed.

Table 1.1. Use of specific surveys for different pest situations

Specific survey	Pest situation				
	Pest present without control	**Pest present under suppression**	**Pest present under eradication**	**Pest absent under exclusion**	**Pest transient, eradication of an incursion**
Monitoring	Uncontrolled pest subject to monitoring surveys	Pest under suppression subject to monitoring	Pest under eradication subject to monitoring and verification surveys	-	-
Detection	-	-	-	No pest; detection surveys including intensive trapping for exclusion in a PFA	-
Delimiting	-	-	-	-	Incursion detected through ongoing detection surveys, therefore additional implementation of delimiting surveys

*Under the PRA study for Ceratitis capitata in Bangladesh, the "**Detection Survey"** considered Trapping Survey using sex attractant like Trimedlure to capture the adult Mediterranean fruit fly in the PRA areas of Bangladesh as defined by the client—Strengthening Phytosanitary Capacity in Bangladesh Project under Plant Quarantine Wing of Department of Agricultural Extension, Bangladesh. The visual examination was also conducted to find out the life stages, signs or symptoms associated with target pests.*

1.4.3 Methods

1.4.3.1 Standard operating procedures

According to the guidelines for quality management in soil and plant laboratories, produced by the Natural Resource Management and Environment Department (Bashour and Sayegh, 2007), "A Standard Operating Procedure (SOP) is a document which describes the regularly recurring operations relevant to the quality of the investigation. The purpose of a SOP is to carry out the operations correctly and always in the same manner. A SOP should be available at the place where the work is done".

SOPs include at least the information identified as a minimum requirement (refer to ISMP 6):

- purpose and scope
- timing and duration
- target pest
- target areas and site selection
- survey duration
- site selection
- statistical basis
- sample collection
- detailed survey methodology (procedures)
- biosecurity and sanitation considerations
- sample handling and laboratory submission
- equipment and supplies
- reporting.

1.4.3.2 Sampling

Sampling may be:

- random:
  - simple random sampling – unbiased; each unit has equal chance of being selected
  - stratified sampling – a form of random sampling that is based on knowledge of pest distribution and assures collection of pests

- systematic:
  - follows a predetermined pattern, such as X-, W- or Z-shaped transects
  - may involve collection of symptomatic or asymptomatic plants – visible field symptoms are often not immediately expressed at early-stage plant disease or nematode infections; the collection of asymptomatic plant samples provides valuable positive and negative data beyond the known infection range of a given pest.

Methods of sampling for pests are further described in McMaugh (2005): chapter 2 is devoted to designing a specific survey, and section 2.16 focuses on methods of collecting pest specimens.

1.4.3.3 Trapping

Traps can be used for many purposes, including:

- area pest control of a specific pest or type of pest, such as stink bug traps baited with a species-specific aggregation pheromone
- as part of a specific pest eradication effort
- surveillance (monitoring, delimiting and detection)
- sentinel traps for early detection of a new pest incursion in an area.

1.4.3.3.1 Trap types

Semiochemical-based traps use a message-bearing substance from a plant or animal (or a synthetic analogue) to solicit a behavioural response. See Table 5 for advantages and disadvantages.

Examples of semiochemicals include:

- allomones: a signal that benefits the sender, but not the receiving species
- kairomones: a signal that benefits a receiving species, but not the sender
- pheromones: a chemical released by a species for species-specific communication

Attractant-based traps often use food or insect-attracting visual clues to selectively trap a particular type of pest.

Attractant-based and semiochemical trap lures are generally easy to set up in the field, but field placement and the time frame for a new attractant or semiochemical lure must be known. The NPPO should establish protocols for monitoring and replenishing traps on the basis of the known life cycle of the target pest.

*Under the present "**Detection Survey"** for Ceratitis capitata in Bangladesh, study team used sex attractant like Trimedlure (t-butyl-4(or 5)-chloro-2-methyl cyclohexane carboxylate), which is the most widely used lure for C. capitata. Trimedlure/Ceralure is a new potent and persistent attractant for C. capitata (Avery et al., 1994). This Trimedlure is not available in Bangladesh. Therefore, the study team used the Trimedlure that has been imported from Pherobank B.V.—a pheromone producing and supplying company in the Netherlands. The Trimedlure has been imported in February, 2019 from Pherobank B.V. with the help of a multinational pesticide company named Haychem (Bangladesh) Limited, Dhaka.*

1.4.3.3.2 Application method

Trap site selection, mounting and placement depend upon the target pest and host density. Once a trap has been deployed, GIS coordinates should be recorded. Urban trap locations should also include the full street address. Placement in natural or rural area should include the nearest address and landmarks, in addition to the GIS coordinates.

The following factors need to be considered with trap set-up.

- **Concentration of attractants or semiochemicals**:
    - release rate should be understood for a given geographical area (e.g. fruit fly pheromones have faster release in hot and dry conditions);
    - release rate may also differ with trap type.
- **Trap density (monitoring and control):**
    - to be determined for each geographical region and species or species complex of concern plan for appropriate personnel resources for trap services.
    - Trapping period to be defined prior to initiating a trapping program.
- **Servicing and replacement:**
    - instructions on servicing and replacement of commercially available lures should be followed
    - spilling liquid lures during trap servicing will reduce overall trap effectiveness.

*Under the present "**Detection Survey"** for Ceratitis capitata in Bangladesh, study team considered the specific trapping density for using Trimedlure at field condition. The number of pheromone traps was set in the specific location of the present PRA areas as per Pest Surveillance Guidelines considering four types of locations which are as follows:*

(a) point of entry considered 6 to 10 pheromone traps/km^2;
(b) urban areas considered 6 pheromone traps/km^2;
(c) marginal areas considered 8 pheromone traps/km^2 and
(d) production area considered 8 pheromone traps/ha (i.e. 2 traps/0.25 ha).

The four types of locations considered for setting up of pheromone traps are as follows: (a) Point of Entry: First entry point, where imported fruits/products are opened; (b) Urban areas: Where imported fruits/ products are marketed; (c) Marginal areas: Border areas through which quarantine pests may enter into a country and (d) Production area: Fruits/commodity cultivation areas where target pests may present.

1.4.3.4 Sample screening

Traps are positioned so that specimens can be easily retrieved.

Protocols for handling samples need to be clearly provided to field survey specialists.

- Field sample screening should include observations on the presence or absence of the suspect target, symptoms of plant damage and other relevant information.
- Field symptoms that should trigger an urgent sample submission should be clearly identified in the protocol.
- Transportation of the sample needs to be defined as:
    - hand carry
    - standard mail or express delivery.
- Appropriate equipment for labelling and submitting samples should be provided.
- Digital images may be used to further support sample collection information
    - Digital images are not considered confirmatory for new pest detections or finds.

1.4.3.5 Data collection and reporting

Detailed overall trap information should be collected and related to a unique trap code.

Information specific to the sample of specimen collected may include:

- host plant
- stage of host plant
- collection date
- collector

Standards for initially reporting data in either paper-based or electronic form need to be clearly articulated in the protocol.

Additional general information, such as weather patterns during sample collection or changes in crop management practices, should be noted.

Here, the study team used a data sheet to record the survey data for each of pheromone traps set in the survey areas for 3 months mentioning number of adult fruit fly captured per trap at 2 days interval and name of host plant where the trap was set, data recording date, location, name of collector etc.

1.4.3.6 Quality assurance

The NPPO routinely conduct staff performance reviews in order to ensure that records are properly maintained and field staff time is managed appropriately.

Routine procedures for auditing equipment, supplies and data quality are recommended. Field personnel can also be periodically evaluated for competence by the assessment of marked specimens.

In the present study, the highly trained data collectors and supervisors had been deployed who had sufficient entomological knowledge to conduct the present detection survey. The study team along with officials of SPCBP also visited the study areas for monitoring the activities of Pest Surveillance as well as to ensure the quality of the works. The local level DAE officials also cooperated and monitored the pest surveillance activities under the present study.

1.4.4 Inspection

Inspection methods for plants will depend on the target pest and commodity. Examples of target pest survey protocols are included in section 2.3.4.

Additional details regarding inspection methods are described in McMaugh (2005): chapter 3 includes inspection information.

1.4.5 Sample coding

Each sample should be given a unique identifier (label, number, etc.) to enable tracking and monitoring from the point of collection in the field through to other stages of processing and identification.

1.4.6 Sample collection

Specimens must be collected in accordance with the relevant SOP and surveillance protocols to ensure specimen integrity for diagnostic processing.

The field data collection sheet may be electronic or in paper form, and will differ according to the purpose of the survey. Uniform sample collection information is to be included on all data sheets used by all users within a given survey.

1.4.7 Submission to diagnostic laboratory

Specimens must be handled, packaged and submitted to the diagnostic laboratory in accordance with the relevant SOP and surveillance protocols to ensure specimen integrity, preservation and timeliness for diagnostic processing. Additional details regarding the handling, packaging and submission of samples can be found in McMaugh (2005).

*After the completion of "**Detection Survey"** under the present PRA study, it was revealed that no adult Mediterranean fruit fly in the PRA areas of Bangladesh has been captured in the traps using Trimedlure as well as no life stages (larvae or pupae) were also found associated with target host plants considering the visual examination. Therefore, detail PRA for Mediterranean fruit fly (Ceratitis capitata) has been stopped, rather PRA like activities have been conducted and a PRA like report have been prepared for awareness and future program aiming to take initiative preventive measures against this pest.*

CHAPTER II

PEST SURVEILLANCE PROCESS AND FINDINGS

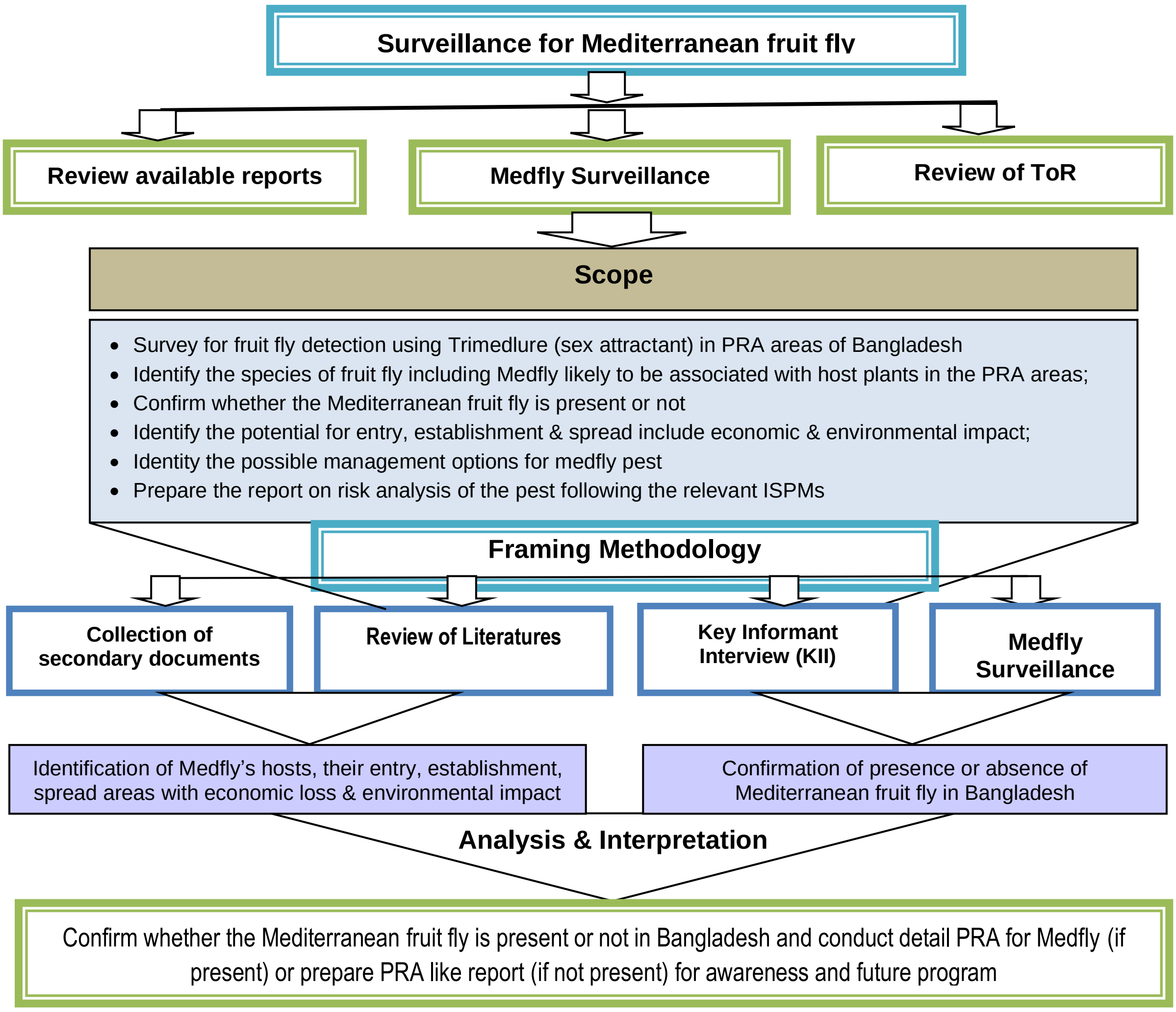
2.1. Introduction

The overall objective of the study is to identify the presence or absence of Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh. This section describes the technical aspect of the Pest Surveillance process and findings of the study in detail. In line with this, the section also provides a comprehensive description of the methodology for conducting Pest Surveillance on Mediterranean fruit fly in the PRA areas of Bangladesh.

The presence or absence of Mediterranean fruit fly in Bangladesh is not known and yet there was no interception report available, but to confirm the presence or absence of the pest Mediterranean fruit fly in Bangladesh—Strengthening Phytosanitary Capacity in Bangladesh Project (SPCBP) under Plant Quarantine Wing (PQW) of Department of Agricultural Extension (DAE), Bangladesh felt the need to conduct a pest surveillance program as per ISPM 6 (Guidelines for Surveillance). Thus, the pest surveillance program for Mediterranean fruit fly has been under taken.

2.2. Conceptual Framework

Figure-2.1: Conceptual Model for Pest Surveillance



The conceptual framework for the assignment has been developed based on the meticulous reviews of the available literature/documents relating to the study and based on understanding of the TOR provided by the client. While analyzing the ToR, special thought has been put on understanding the objectives, the scope of work, the suggested approach and methodology and the time allocated to undertake the assignment. The study team applied a conceptual framework of the level of interactions and probable study organization involving all concerned:

2.3. Methodology

The methodology for the present PRA study used system-wide approach involved wide-ranging and sequenced discussion with SPCB-DAE, PQW-DAE and professionals and officials related to identification of the Mediterranean fruit fly and identify its hosts, quarantine concern of this pest, its risk and management options.

2.3.1. Pest surveillance at field level

The presence or absence of Mediterranean fruit fly, *Ceratatis capitata* species in Bangladesh was identified considering the following activities:

2.3.1.1. Detection survey

The presence or absence of Mediterranean fruit fly in Bangladesh is not known; therefore, in the present study for conducting PRA of Mediterranean fruit fly, the '**detection survey**' is appropriate among three processes such as detection survey, monitoring survey and delimiting survey of pest surveillance approach aiming to confirm whether the Medfly is present or not under the sampled PRA areas in Bangladesh. The detail procedure of detection survey considered under the present study "Pest Risk Analysis of Mediterranean fruit fly in Bangladesh) have been presented below:

Pheromone lures and traps

The sex attractant namely Trimedlure (t-butyl-4(or 5)-chloro-2-methyl cyclohexane carboxylate) which is the most widely used lure for *C. capitata*. The Trimedlure/Ceralure is a new potent and persistent attractant for *C. capitata* (Avery *et al.*, 1994). This lure is not available in Bangladesh. Therefore, Trimedlure has been imported from Pherobank B.V.—a specialized company of the Netherlands engaging in the development and production of top quality pheromone lures and the synthesis of reference pheromone compounds for the international market. A sufficient quantity of Trimedlures have been imported from Pherobank B.V with the help of a multinational reputed pesticide company named Haychem (Bangladesh) Limited, Dhaka in February, 2019. The Trimedlures have been applied in the field using Water Traps that are appropriated for capturing Mediterranean fruit fly.

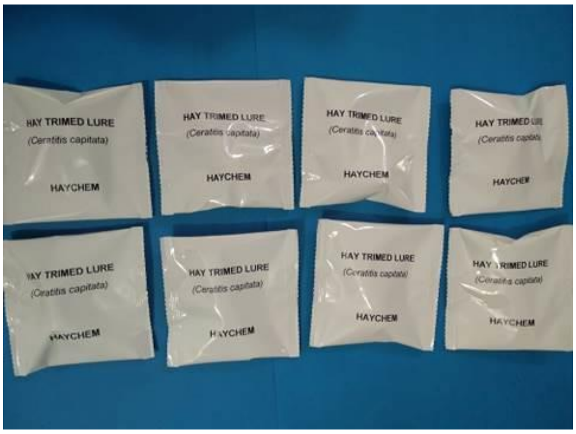


Plate-1: Trimedlure packets imported from Pherobank BV, the Netherlands

Plate-2: Application of Trimedlure in the water trap for capturing fruit fly adult

Site selection

Under the present “**Detection Survey”** for Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh, as per ISPM 6 (Guidelines for Surveillance), the study team considered the four types of locations or survey sites have been selected for detection survey using pheromone traps (Trimedlure) are as follows:

(a) Point of Entry: First entry point, where imported fruits/products are opened;
(b) Urban areas: Where imported fruits/ products are marketed;
(c) Marginal areas: Border areas through which quarantine pests may enter into a country and
(d) Production area: Fruits/commodity cultivation areas where target pests may present.

Density of Pheromone Traps

Under the present “**Detection Survey”** for *Ceratitis capitata* in Bangladesh, study team considered the specific trapping density for using Trimedlure at field condition. The number of pheromone traps was set in the specific location of the present PRA areas as per Pest Surveillance Guidelines considering four types of locations which are as follows:

- Point of Entry: 6 to 10 pheromone traps/km^2
- Urban areas: 6 pheromone traps/km^2
- Marginal areas: 6 pheromone traps/km^2
- Production area: 8 pheromone traps/ha (i.e. 2 traps/0.25 ha)

Crop fields for detection surveillance

Field/orchard/location of guava, mango, citrus, ber, litchi, papaya, and other fruits were considered for setting up of pheromone traps to detect the presence or absence of Medfly in these fields.

Pheromone traps setting

The pheromone traps were set on 17-21 February 2019 at a time in the respective PRA areas according to the guidelines of pest surveillance. The trained field assistance having MS degree in Entomology were deployed to set the pheromone traps in the sampled PRA areas and conducting survey including inspection the traps at alternate day starting from 25 February 2019 and continued for three (3) months upto 24 May 2019. Every 7 days interval the soap-mixed older water was replaced in each pheromone trap by new soap mixed water. The older lure in each pheromone trap was also replaced by new one at 30 days interval.

Plate-3: In house training for field assistant and supervisors on Detection Survey for Medfly in Bangladesh

Plate-4:Practical training for field assistant and supervisors on pheromone trap setting and data recording technique at field level

Plate-5: Pheromone trap set in the fruit market at Gulshan, Dhaka to capture Medfly

Plate-6: Pheromone trap set in the fruit market at Karwan Bazar, Dhaka to capture Medfly

Plate-7: Pheromone trap set in the Mango orchard at Shibganj, Chapainawabganj to capture adult Medfly

Plate-8: Pheromone trap set in the Citrus orchard at Jointapur, Sylhet to capture adult Medfly

Plate-9: Pheromone trap set in the Guava orchard at Nesarabad, Pirojpur to capture adult Medfly

Plate-10: Pheromone trap set in the Citrus orchard at Naikhongchari, Bandarban to capture adult Medfly

Inspection and monitoring

The field assistant with the help of Sub-Assistant Agriculture Officer (SAAO) of DAE in the respective areas monitored the pheromone traps whether any adult fruit fly was trapped or not and maintained a data sheet with date, location, number of adult fruit fly captured in the trap, host plants where the trap was set etc. The infested fruits nearby the traps were collected to check the immature stages of fruit flies like larvae and or pupae.

2.3.1.2. Identification

The collected insects were critically observed using Taxonomic Key under the high magnification Stereomicroscope in the Department of Entomology at Sher-e-Bangla Agricultural University, Dhaka. *This identification provided the information whether the insects captured through pheromone traps was Medfly or not aiming to confirm the presence or absence of Ceratatis capitata in Bangladesh.*

2.3.1.3. Field visit and interview of experts

The field visit was conducted in major citrus, guava, mango, litchi, pomegranate, jujube, cucurbits and other fruits under PRA areas of Bangladesh. The study team also conducted interviews of officials of DAE at field level and head quarter level, quarantine stations of DAE, Entomologist at researcher organizations, Agricultural Universities in Bangladesh. *This survey provided the information about presence or absence of Ceratatis capitata in Bangladesh along with the host plants affected.*

2.3.1.4. Review of secondary documents

The secondary documents related to Mediterranean fruit fly (*Ceratitis capitata*), its hosts, quarantine importance for Bangladesh, risk assessment and management options were collected from different sources, The documents were also collected through internet browse using different websites particularly CABI, EPPO, IPPC, FAO etc. These documents were then thoroughly reviewed by the study team to identify *Ceratatis capitata*. *The review of secondary documents provided the absence or presence of Ceratatis capitata and its major and minor hosts in Bangladesh and other countries of the world along with its identity, quarantine importance for Bangladesh, risk and management options.*

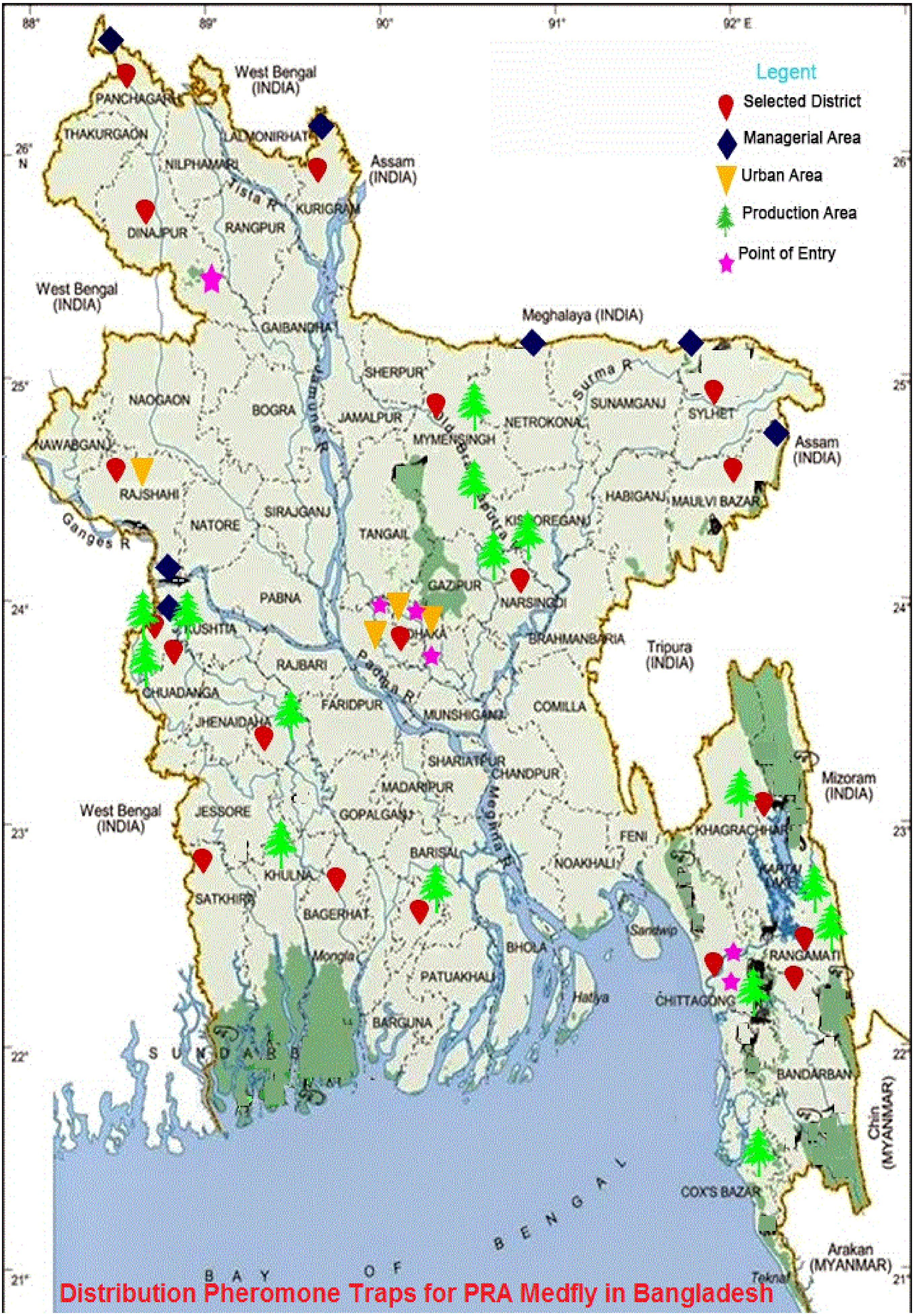
2.3.2. Pest Surveillance Area

According to the ToR, twenty-one (21) districts were considered as sampled PRA areas for conducting Pest Risk Analysis (PRA) of Mediterranean fruit fly (*Ceratitis capitata*) in Bangladesh. According the density of traps under four types of locations, the district and upazila-wise distribution of pheromone traps have been presented in the following table and on the map of Bangladesh:

Table 2.1: Distribution of Pheromone Traps with Setting Location in PRA areas of Bangladesh

Sl. No.	District	Upazila/City/Market	Type of location	No. of traps set	Place of Trap Set
01.	Dhaka	Gulshan	Point of entry	6	Gulshan-1, 2 fruit Market
		Kawran bazaar	Point of entry	6	North and South Corner of Kawran bazar fruit market, Farmgate fruit market, Mohammadpur Towon Hall fruit market, Mohammadpur Krishi Market
		Mirpur	Urban area	6	Shahi Market-10, Mirpur-1, Mirpur-2, Mazar road fruit market
		Gulistan	Urban area	6	Gulistan Road side fruit Market
		Shayam bazaar	Point of entry	6	Shayam Bazar Market
		Uttara	Urban area	6	Uttra fruit Market
2	Norshindhi	Shibpur	Production Area	8	Fruit Garden
		Raipura	Production Area	8	Fruit Garden
		Sadar	Production Area	8	Fruit Garden
3	Tangail	Sadar	Production Area	8	Jughi hat
		Madupur	Production Area	8	Sholabari
4	Mymensingh	Sadar	Production Area	8	Sadar Boyra area
		Haluyagat (Land port)	Marginal Area	6	Talikhali bazaar

Sl. No.	District	Upazila/City/Market	Type of location	No. of traps set	Place of Trap Set
5	Chattrogram	Reazuddin bazar	Point of entry	6	Potenga Bazar
		Potenga	Point of entry	6	Potenga Bazar
6	Rangamati	Bagaichori	Production Area	8	Bagaichori area fruit garden
		Kaptai	Production Area	8	Kaptai fruit garden
7	Khagrachari	Sadar	Production Area	16	Sadar
8	Bandarban	Naikhanchari	Production Area	8	Naikhanchari
		Sadar	Production Area	8	Balagata fruits Garden
9	Khulna	Sadar fruit market area	Urban area	6	Boyra, Daulatpur
10	Satkharia	Sadar	Production area	8	Sadar area fruit garden
		Kolaroa (Bhomra land port)	Marginal Area	6	Helatala area
11	Pirojpur	Nesarabad	Production Area	16	Jalabari area
12	Meherpur	Sadar	Production Area	8	Razur hat
		Mujibnagar	Production Area	8	Monakhalihat
13	Chuadanga	Damurhuda	Production Area	8	Naltipota
14	Jashore	Sarsha (Benapole port)	Marginal Area	6	Ulshi Bazar
		Sadar	Production Area	8	Taragonj hat (Bagerpara)
15	Sylhet	Sadar fruit market area	Urban area	6	Bataser Bazar, Dewaner Chak, Shah Puran Bazar Fruit market
		Jointapur (Tamabil land port)	Marginal area	12	Research Center
		Jokigonj	Marginal Area	12	Tamabil Port area
16	Maulivibazar	Sadar	Production area	8	Sadar upazilla Kaba bazar Fruit garden
17	Rajshahi	Sadar fruit market & local area	Urban area	18	Railway Fruit Market, Shaheb bazaar fruit market, Medical college more
18	Chapainawabganj	Shibgonj (Sonamasjid land port)	Marginal area	18	Selimabad mango garden, Academic More Mango garden, Telkupi mango garden
		Sadar	Production area	6	Baligram mango garden, Chowdhuripara mango garden, Alampur mixed fruit garden
19	Lalmonirhat	Patgram (Burimari land port)	Marginal Area	6	Beside port area fruit market
20	Dinajpur	Hakimpur (Hili land port)	Point of Entry	6	Beside port area fruit market
21	Panchagarh	Tentulia (Banglabandha land port)	Marginal Area	6	Bangla Bandha Port Area, Telulia Uzalia cirus garden
Total	**21**	**39**	**-**	**338**	**-**


Legent
Selected District
Managerial Area
Urban Area
Production Area
Point of Entry
West Bengal (INDIA)
Assam (INDIA)
Meghalaya (INDIA)
Tripura (INDIA)
Mizoram (INDIA)
Chin (MYANMAR)
Arakan (MYANMAR)
BAY OF BENGAL
PANCHAGARH
THAKURGAON
NILPHAMARI
LALMONIRHAT
KURIGRAM
DINAJPUR
RANGPUR
GAIBANDHA
NAOGAON
BOGRA
JAMALPUR
SHERPUR
MYMENSINGH
NETROKONA
SUNAMGANJ
SYLHET
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
TANGAIL
KISHOREGANJ
HABIGANJ
MAULVI BAZAR
GAZIPUR
NARSINGDI
PABNA
KUSHTIA
DHAKA
BRAHMANBARIA
RAJBARI
CHUADANGA
FARIDPUR
MUNSHIGANJ
COMILLA
JHENAIDAHA
SHARIATPUR
CHANDPUR
MADARIPUR
JESSORE
GOPALGANJ
FENI
KHAGRACHHARI
BARISAL
NOAKHALI
KHULNA
SATKHIRA
BAGERHAT
BHOLA
RANGAMATI
CHITTAGONG
PATUAKHALI
BARGUNA
BANDARBAN
COX'S BAZAR
Mongla
Sandwip
Hatiya
Teknaf
Tista R
Jamuna R
Ganges R
Padma R
Meghna R
Surma R
Brahmaputra
SUNDARBANS
88°
89°
90°
91°
92° E
26° N
25°
24°
23°
22°
21°
Distribution Pheromone Traps for PRA Medfly in Bangladesh

2.4. Pest Surveillance Findings

According to the findings of the pest surveillance setting pheromone traps in the sampled PRA areas of Bangladesh and identification through Stereomicroscope in the laboratory, none of adult Mediterranean fruit fly (*Ceratitis capitata*) had been captured in any one of the pheromone traps. Therefore, it was decided that Mediterranean fruit fly (*Ceratitis capitata*) is absent in Bangladesh. From this finding it was also concluded that the Mediterranean fruit fly has been identified as quarantine pest for Bangladesh, The location-wise findings of the pest surveillance for Medfly have been illustrated in the following table:

Table 2.2. Distribution of Pheromone Traps with Setting Location for PRA of Mediterranean Fruit fly (*Ceratitis capitata*) and findings

Sl. No.	District	Upazila/City/Market	Type of location	No. of traps set	Place of Trap Set	Status of Medfly
01.	Dhaka	Gulshan	Point of entry	6	Gulshan-1, 2 Fruit Market	Not captured
		Kawran bazar	Point of entry	6	North and South Corner of Kawran bazar fruit market, Farmgate fruit market, Mohammadpur Towon Hall fruit market, Mohammadpur Krishi Market	Not captured
		Mirpur	Urban	6	Shahi Market-10,Mirpur-1, Mirpur-2, Mazar road fruit market	Not captured
		Gulistan	Urban	6	Gulistan Road side fruit Market	Not captured
		Shayam bazar	Point of entry	6	Shayam Bazar Market	Not captured
		Uttara	Urban area	6	Uttra fruit Market	Not captured
2	Norshindhi	Shibpur	Production Area	8	Shibpur UpazialaFruit Garden	Not captured
		Raipura	Production Area	8	Raipura local areaFruit Garden	Not captured
		Sadar	Production Area	8	Sadar area Fruit Garden	Not captured
3	Tangail	Sadar	Production Area	8	Jughi hat	Not captured
		Madhupur	Production Area	8	Sholabari	Not captured
4	Mymensingh	Sadar	Production Area	8	Sadar Boyra area	Not captured
		Haluyagat (Land port)	Marginal Area	6	Talikhali bazaar	Not captured
5	Chattrogram	Reazuddin bazar	Point of entry	6	Potenga Bazar	Not captured
		Potenga (Sea port)	Port of entry	6	Potenga Bazar	Not captured
6	Rangamati	Bagaichori	Production Area	8	Bagaichori area fruit garden	Not captured
		Kaptai	Production Area	8	Kaptai fruit garden	Not captured
7	Khagrachari	Sadar	Production Area	16	Sadar	Not captured
8	Bandarban	Naikhanchari	Production Area	8	Naikhanchari	Not captured
		Sadar	Production Area	8	Balagata fruits Garden	Not captured
9	Khulna	Sadar fruit market area	Urban area	6	Boyra, Daulatpur	Not captured
10	Satkharia	Sadar	Production area	8	Sadar area fruit garden	Not captured
		Kolaroa (Bhomra land port)	Marginal Area	6	Helatala area	Not captured
11	Pirojpur	Nesarabad	Production Area	16	Jalabari area	Not captured
12	Meherpur	Sadar	Production Area	8	Razur hat	Not captured
		Mujibnagar	Production Area	8	Monakhalihat	Not captured
13	Chuadanga	Damurhuda	Production Area	8	Naltipota	Not captured
14	Jashore	Sarsha (Benapole land port)	Marginal Area	6	Ulshi Bazar	Not captured
		Sadar	Production Area	8	Taragonj hat (Bagerpara)	Not captured
15	Sylhet	Sadar fruit market area	Urban area	6	Bataser Bazar, Dewaner Chak, Shah Puran Bazar Fruit market	Not captured

Sl. No.	District	Upazila/City/Market	Type of location	No. of traps set	Place of Trap Set	Status of Medfly
		Jointapur (Tamabil land port)	Marginal area	12	Research Center	Not captured
		Jokigonj	Marginal Area	12	Tamabil Port area	Not captured
16	Maulivibazar	Sadar	Production area	8	Sadar upazilla Kaba bazar Fruit garden	Not captured
17	Rajshahi	Sadar fruit market & local area	Urban area	18	Railway Fruit Market, Shaheb bazaar fruit market, Medical college more	Not captured
18	Chapainawabganj	Shibgonj (Sonamasjid land port)	Marginal area	18	Selimabad mango garden, Academic More Mango garden, Telkupi mango garden	Not captured
		Sadar	Production area	6	Baligram mango garden, Chowdhuripara mango garden, Alampur mixed fruit garden	Not captured
19	Lalmonirhat	Patgram (Burimari land port)	Marginal Area	6	Beside port area fruit market	Not captured
20	Dinajpur	Hakimpur (Hili land port)	Port of Entry	6	Beside port area fruit market	Not captured
21	Panchagarh	Tentulia (Banglabandha land port)	Marginal Area	6	Bangla Bandha Port Area, Telulia Uzalia cirus garden	Not captured
-	Total =21	39	-	**338**	-	-

2.5. Concluding remark

As per study findings it was decided that Mediterranean fruit fly (*Ceratitis capitata*) is absent in Bangladesh. Therefore, as per ISPM 2 "Framework of Pest Risk Analysis" the detail PRA for Mediterranean fruit fly has been stopped, but as a serious pest for fruits like citrus, mango, guava, grape, fig, capsicum, pomegranate, ber, litchi, papaya etc, the PRA like activities for this pest have been conducted and prepared a PRA like report for awareness as well as for future program and this has been furnished in the following sections. In future, if any interception of Mediterranean fruit fly is taken place then further pest surveillance and complete PRA have to be conducted for *C. capitata.*

REFERENCES

Ali A.Y., Ahmad A.M., Amar J.A., 2015. Hymenopteran parasitoids (Figitidae and Pteromalidae) of *Ceratitis capitata* (Diptera: Tephritidae) on loquat and guava in Tartous, Syria. Biocontrol Science and Technology, 25(2):223-228. http://www.tandfonline.com/loi/cbst20

Araujo M. Rde., Lemos Wde. P., Silva L.Cda., França L.P.N., Adaime R., 2016. New host records for *Ceratitis capitata* (Diptera: Tephritidae) in the state of Pará, Brazil. Florida Entomologist, 99(2):327-328. http://www.bioone.org/loi/flen

Argov Y., Gazit Y., 2008. Biological control of the Mediterranean fruit fly in Israel: introduction and establishment of natural enemies. Biological Control, 46(3):502-507. http://www.sciencedirect.com/science/journal/10499644

Baker R.T., Cowley J.M., 1991. A New Zealand view of quarantine security with special reference to fruit flies, In: Vijaysegaran S, Ibrahim AG, eds. First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, 1988. Kuala Lumpur, Malaysia: Malaysian Agricultural Research and Development Institute, 396-408.

Baruffi L., Damiani G., Guglielmino C.R., Bandi C., Malacrida A.R., Gasperi G., 1995. Polymorphism within and between populations of *Ceratitis capitata*: comparison between RAPD and multilocus enzyme electrophoresis data. Heredity, 74(4):425-437

BBS 2002: Yearbook of Agricultural Statistics of Bangladesh 2000. Bangladesh Bureau of Statistics, Ministry of planning, Govt. of the people's republic of Bangladesh, Dhaka. pp. 178.

BBS 2013: Yearbook of Agricultural Statistics of Bangladesh 2011. Bangladesh Bureau of Statistics, Ministry of planning, Govt. of the people's republic of Bangladesh, Dhaka. pp. 338.

Bennett F. D., Squire F. A., 1972. Investigations on the biological control of some insect pests in Bolivia. PANS, 18(4):459-467

Beris E. I., Papachristos D. P., Fytrou A., Antonatos S. A., Kontodimas D. C., 2013. Pathogenicity of three entomopathogenic fungi on pupae and adults of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae). Journal of Pest Science, 86(2):275-284. http://rd.springer.com/article/10.1007/s10340-012-0468-4

CBD (2000). Cartagena Protocol on Biosafety to the Convention on Biological Diversity, 2000. CBD, Montreal.

Cunningham R. T., 1989. Control; insecticides; male annihilation. In: Robinson AS, Hooper G, eds. Fruit Flies; Their Biology, Natural Enemies and Control. World Crop Pests 3(B):345-351. Amsterdam, Netherlands: Elsevier

Davies N., Villablanca F. X., Roderick G. K., 1999. Bioinvasions of the medfly *Ceratitis capitata*: source estimation using DNA sequences at multiple intron loci. Genetics, 153(1):351-360; Many ref.

EPPO, 2014. PQR database. Paris, France: European and Mediterranean Plant Protection Organization. http://www.eppo.int/DATABASES/pqr/pqr.htm

EPPO, 2016. EPPO Global database (available online). Paris, France: EPPO. https://gd.eppo.int/

Epsky N. D., Heath R. R., Uchida G., Guzman A., Rizzo J., Vargas R., Jeronimo F., 1996. Capture of Mediterranean fruit flies (Diptera: Tephritidae) using color inserts in trimedlure-baited Jackson traps. Environmental Entomology, 25(2):256-260; 22 ref.

FAO (1990). FAO Glossary of phytosanitary terms, FAO Plant Protection Bulletin, 38(1) 1990: 5-23.

FAO (1996). Report of the 3rd meeting of the FAO Committee of Experts on Phytosanitary Measures, 1996. FAO, Rome.

FAO (1998). Report of the 1st meeting of the Interim Commissionon Phytosanitary Measures, 1998. FAO, Rome.

FAO (1999). Report of the 6th meeting of the FAO Committee of Experts on Phytosanitary Measures, 1999. FAO, Rome.

FAO (2001).Report of the 3rd meeting of the Interim Commission on Phytosanitary Measures, 2001. FAO, Rome.

FAO (2002).Report of the 4th meeting of the Interim Commission on Phytosanitary Measures, 2002. FAO, Rome.

FAO (2003).Report of the 5th meeting of the Interim Commission on Phytosanitary Measures, 2003. FAO, Rome.

FAO (2004). Report of the 6th meeting of the Interim Commission on Phytosanitary Measures, 2004. FAO, Rome

FAO (2005). Report of the 7th meeting of the Interim Commission on Phytosanitary Measures, 2005. FAO, Rome

FAO (2007). Report of the 2nd session of the Commission on Phytosanitary Measures, 2007. FAO, Rome.

Foote R. H., Blanc F. L., Norrbom A. L., 1993. Handbook of the Fruit Flies (Diptera: Tephritidae) of America North of Mexico. Ithaca, USA: Comstock

Gasparich G. E., Silva J. G., Han HoYeon, McPheron B. A., Steck G. J., Sheppard W. S., 1997. Population genetic structure of Mediterranean fruit fly (Diptera: Tephritidae) and implications for worldwide colonization patterns. Annals of the Entomological Society of America, 90(6):790-797; 31 ref.

Harris E. J., 1989. Pest status; Hawaiian Islands and North America, In: Robinson AS, Hooper G, eds. Fruit Flies; their Biology, Natural Enemies and Control. World Crop Pests. Amsterdam, Holland: Elsevier, 3(A):73-81.

Hasson O., 1995. A fly in spider's clothing: what size the spider?. Proceedings of the Royal Society of London. Series B, Biological Sciences, 261(1361):223-226; 11 ref.

IPPC (1997). International Plant Protection Convention, 1997. FAO, Rome.

IPPC, 2018. Medfly detections. In: IPPC Official Pest Report (No. BLZ-01/2) Rome, Italy: FAO, https://www.ippc.int/

ISPM No. 10 (1999). Requirements for the establishment of pest free places of production and pest free production sites, 1999. ISPM No. 10, FAO, Rome.

ISPM No. 11 (2004). Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms, 2004. ISPM No. 11, FAO, Rome.

ISPM No. 12 (2001). Guidelines for phytosanitary certificates, 2001. ISPM No. 12, FAO, Rome.

ISPM No. 13 (2001). Guidelines for the notification of non-compliance and emergency action, 2001. ISPM No. 13, FAO, Rome.

ISPM No. 14 (2002). The use of integrated measures in a systems approach for pest risk management, 2002. ISPM No. 14, FAO, Rome

ISPM No. 15 (2002). Guidelines for regulating wood packaging material in international trade, 2002. ISPM No. 15, FAO, Rome.

ISPM No. 16 (2002). Regulated non-quarantine pests: concept and application, 2002. ISPM No. 16. FAO, Rome.

ISPM No. 18 (2003). Guidelines on the use of irradiation as a phytosanitary measure, 2003. ISPM No. 18, FAO, Rome.

ISPM No. 2 (1996). Guidelines for pest risk analysis, 1996. ISPM No. 2, FAO, Rome.

ISPM No. 2 (2007). Framework for pest risk analysis, 2007. ISPM No. 2, FAO Rome.

ISPM No. 20 (2004). Guidelines for a phytosanitary import regulatory system, 2004. ISPM No. 20, FAO, Rome.

ISPM No. 22 (2005). Requirements for the establishment of areas of low pest prevalence, 2005. ISPM No. 22, FAO, Rome.

ISPM No. 23 (2005). Guidelines for inspection, 2005. ISPM No. 23, FAO, Rome.

ISPM No. 24 (2005). Guidelines for the determination and recognition of equivalence of phytosanitary measures, 2005. ISPM No. 24, FAO, Rome.

ISPM No. 25 (2006). Consignments in transit, 2006. ISPM No. 25, FAO, Rome.

ISPM No. 27 (2006). Diagnostic protocols for regulated pests, 2006. ISPM No. 27, FAO, Rome.

ISPM No. 28 (2007). Phytosanitary treatments for regulated pests, 2007. ISPM No. 28, FAO, Rome.

ISPM No. 3 (1996). Code of conduct for the import and release of exotic biological control agents, 1996. ISPM No. 3, FAO, Rome

ISPM No. 3 (2005). Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms, 2005. ISPM No. 3, FAO, Rome.

ISPM No. 4 (1996). Requirements for the establishment of pest free areas, 1996. ISPM No. 4, FAO, Rome.

ISPM No. 5 (1995). Glossary of phytosanitary terms, 1995. ISPM No. 5, FAO Rome. [published 1996]

ISPM No. 6 (1997). Guidelines for surveillance, 1997. ISPM No. 6, FAO, Rome.

ISPM No. 7 (1997). Export certification system, 1997.ISPM No. 7, FAO, Rome

ISPM No. 8 (1998). Determination of pest status in an area, 1998. ISPM No. 8, FAO, Rome.

ISPM No. 9 (1998). Guidelines for pest eradication programmes, 1998. ISPM No. 9, FAO, Rome

Israely N., Yuval B., Kitron O., Nestel D., 1997. Influence of trap location on trapping efficacy of Mediterranean fruit flies. Alon Hanotea, 51(4):164-168; 18 ref.

Malacrida A. R., Marinoni F., Torti C., Gomulski L. M., Sebastiani F., Bonvicini C., Gasperi G., Guglielmino C. R., 1998. Genetic aspects of the worldwide colonization process of *Ceratitis capitata*. Journal of Heredity, 89(6):501-507; 38 ref.

NAPPO, 2014. Phytosanitary Alert System: Mediterranean Fruit Fly (Ceratitis capitata) - Removal of Quarantine Area in the Los Angeles area of Los Angeles County, California. Phytosanitary Alert System: Mediterranean Fruit Fly (*Ceratitis capitata*) - Removal of Quarantine Area in the Los Angeles area of Los Angeles County, California. NAPPO. http://www.pestalert.org/oprDetail_print.cfm/oprid=602

Navarro-Llopis V., Alfaro F., Domínguez J., Sanchis J., Primo J., 2008. Evaluation of traps and lures for mass trapping of Mediterranean fruit fly in citrus groves. Journal of Economic

Entomology, 101(1):126-131. http://www.bioone.org/doi/abs/10.1603/0022-0493%282008%29101%5B126%3AEOTALF%5D2.0.CO%3B2

Worner S. P., 1988. Ecoclimatic assessment of potential establishment of exotic pests. Journal of Economic Entomology, 81(4):973-983

WTO (1994). Agreement on the Application of Sanitary and Phytosanitary Measures, 1994. World Trade Organization, Geneva.

CHAPTER III

PEST RISK ANALYSIS BACKGROUND AND PROCESS

3.1. Pest Risk Analysis Background

3.1.1. Background of the study

Pest risk analysis provides the rationale for phytosanitary measures for a specified PRA area. It evaluates scientific evidence to determine whether an organism is a pest. If so, the analysis evaluates the probability of introduction and spread of the pest and the magnitude of potential economic consequences in a defined area, using biological or other scientific and economic evidence. If the risk is deemed unacceptable, the analysis may continue by suggesting management options that can reduce the risk to an acceptable level. Subsequently, pest risk management options may be used to establish phytosanitary regulations.

The reason behind the study is to know whether the pest *Ceratitis capitata* is present or absent Bangladesh, because it is still not known to occur in Bangladesh. So, primary and foremost work is to Bangladesh is to designing or specific Plant Pest Surveillance program to detect the pest. The designing a specific Plant Pest Surveillance program is the specific areas will be conducted as per IPPC pest surveillance guideline.

After conducting surveillance program, if the pest is detected, the PRA program will be continued as per ISPM 2 “Framework of Pest Risk Analysis”, but if not detected a short PRA will be conducted for awareness as well as future program.

3.1.2. Rationale for the study

The pest Mediterranean fruit fly (*Ceratitis capitata*) is highly destructive to some fruits grown areas of the world including Mediterranean region from where Bangladesh is importing fruits regularly. So, there is a high potential of introduction of this pest into Bangladesh. Till to date, the presence or absence of Mediterranean fruit fly in Bangladesh is not known and yet there was no interception report available. Thus, to confirm the presence or absence of the pest Mediterranean fruit fly in Bangladesh—Strengthening Phytosanitary Capacity in Bangladesh Project (SPCBP) under Plant Quarantine Wing (PQW) of Department of Agricultural Extension (DAE), Bangladesh conducted a pest surveillance program as per ISPM 6 (Guidelines for Surveillance) in mango, citrus, guava and other fruits growing areas as well as fruit markets, point of entry of pests through imported fruits. The study team followed the International Standards for Phytosanitary Measures (ISPMs) and conducted “Detection Survey” using pheromone lures (Trimedlures) in PRA areas to confirm the presence or absence of *Ceratitis capitata* in the PRA areas.

3.1.3. Objectives of the PRA study

The overall objective of the Pest Risk Analysis (PRA) is to support National Plant Protection Organization (NPPO) to identify pests which may pose potential threat and/or pathways of quarantine pests to be associated with the commodity which brings along with them a certain risk of the introduction of diseases and pests that are harmful to agriculture. The specific objectives of the PRA are to:

- identify presence or absence of *Ceratatis capitata* species;
- identify major pathways of *Ceratatis capitata* species;
- identify host plants and more damaging host plant species if present
- assess potential loss by the pests;
- identify probability of survival during transport or storage & transfer of hosts;
- identify potential economic and environmental impacts;

- identify pathways and potentials for entry, establishment and spread of *Ceratatis capitata*;
- identify Risk management options; and
- detect pest it is recommended to follow relevant ISPMs where procedures are being described

3.1.4 Scope of the PRA study

The scope of activities of the study were as follows to:

a. Collect and review scientific evidence to determine whether an organism is a pest
b. Provide the rationale for phytosanitary measures for a specified PRA areas
c. Formulate an appropriate PRA methodology;
d. Develop sampling procedure for selection of target people such as DAE, BARI, BADC, NGOs scientist/officials;
e. Prepare data collection instruments with guidelines incorporating project relevant and intervening variables;
f. Prepare plan of operations to conduct the proposed PRA of the project target people;
g. Conduct PRA study on target people in sample districts/upazila based on citrus, chilies and other fruits production prone area;
h. Organize regional level workshop with the participation of BARI/DAE representative including different level regional stakeholders
i. Identify pertinent variables relating to project to be followed up by monitoring and evaluation;
j. Prepare an analytical/draft report of the PRA;
k. Computerized data-base for further analysis to be conducted by the project and others in future.
l. Present draft report to the stakeholders for their comments and suggestions
m. Prepare and submit different reports such as inception report, draft final report and final report.
n. Finalize and submit final print version reports incorporating the comments and suggestions of the workshop stakeholders

3.2. Pest Risk Analysis (PRA) Process

After conducting surveillance program, if the pest is detected, the PRA program will be continued as per ISPM 2 “Framework of Pest Risk Analysis”, but if not detected a short PRA will be conducted for awareness as well as future program.

If the pest is detected, the consultants will follow a systematic process of pest risk analysis framed as per ISPM No. 2. As per the 3 stages (I) Initiation (II) Pest Risk Assessment (III) Pest Risk Management the consultants will evaluate the commodity and regulated articles and detection of pest for initiation stages.

PRA STAGE 1: INITIATION

Initiation is the identification of organisms and pathways that may be considered for pest risk assessment in relation to the identified PRA area.

A PRA process may be triggered in the following situations:

- a request is made to consider a pathway that may require phytosanitary measures
- a pest is identified that may justify phytosanitary measures
- a decision is made to review or revise phytosanitary measures or policies
- a request is made to determine whether an organism is a pest.

The initiation stage involves four steps:

- determination whether an organism is a pest
- defining the PRA area
- evaluating any previous PRA
- conclusion

PRA STAGE 2: PEST RISK ASSESSMENT

The process for pest risk assessment can be broadly divided into three interrelated steps:

- pest categorization
- assessment of the probability of introduction and spread
- assessment of potential economic consequences (including environmental impacts).

In most cases, these steps will be applied sequentially in a PRA but it is not essential to follow a particular sequence.
Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity, minimal impact, transparency, equivalence, risk analysis, managed risk and non-discrimination set out in ISPM No. 1: Principles of plant quarantine as related to international trade (FAO, 1995).

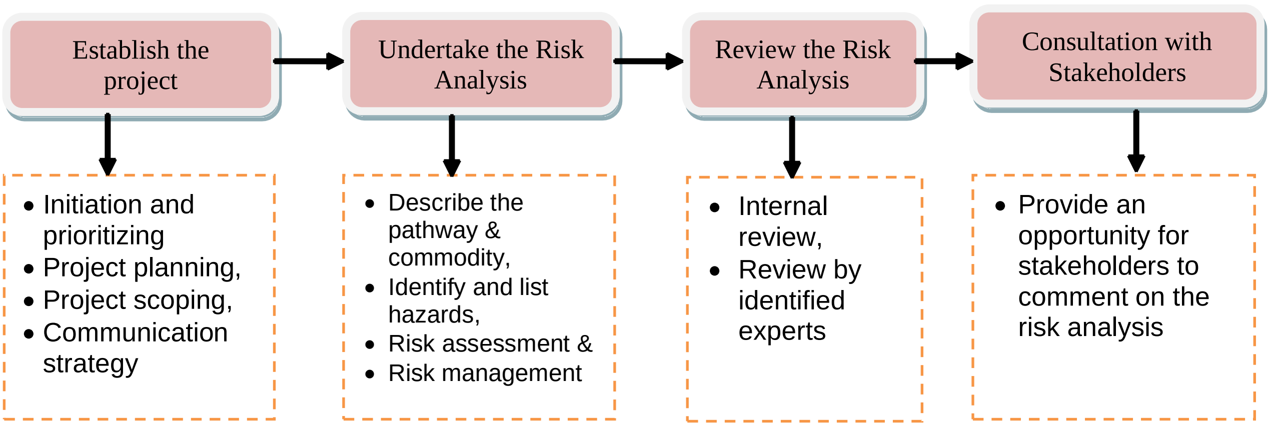
PRA STAGE 3: PEST RISK MANAGEMENT

The conclusions from pest risk assessment are used to decide whether risk management is required and the strength of measures to be used. Since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. Pest risk management (in the analytical sense) is the process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options. The uncertainty noted in the assessments of economic consequences and probability of introduction should also be considered and included in the selection of a pest management option.

3.2.1. Risk Analysis Process and Methodology

The following briefly describes the Bio-security process and methodology for undertaking import risk analyses. The risk analysis process leading to the final risk analysis document is summarized in Figure 3.1 below:

Figure 3.1: A summary of the risk analysis development process



3.2.1.1. Pathway Description

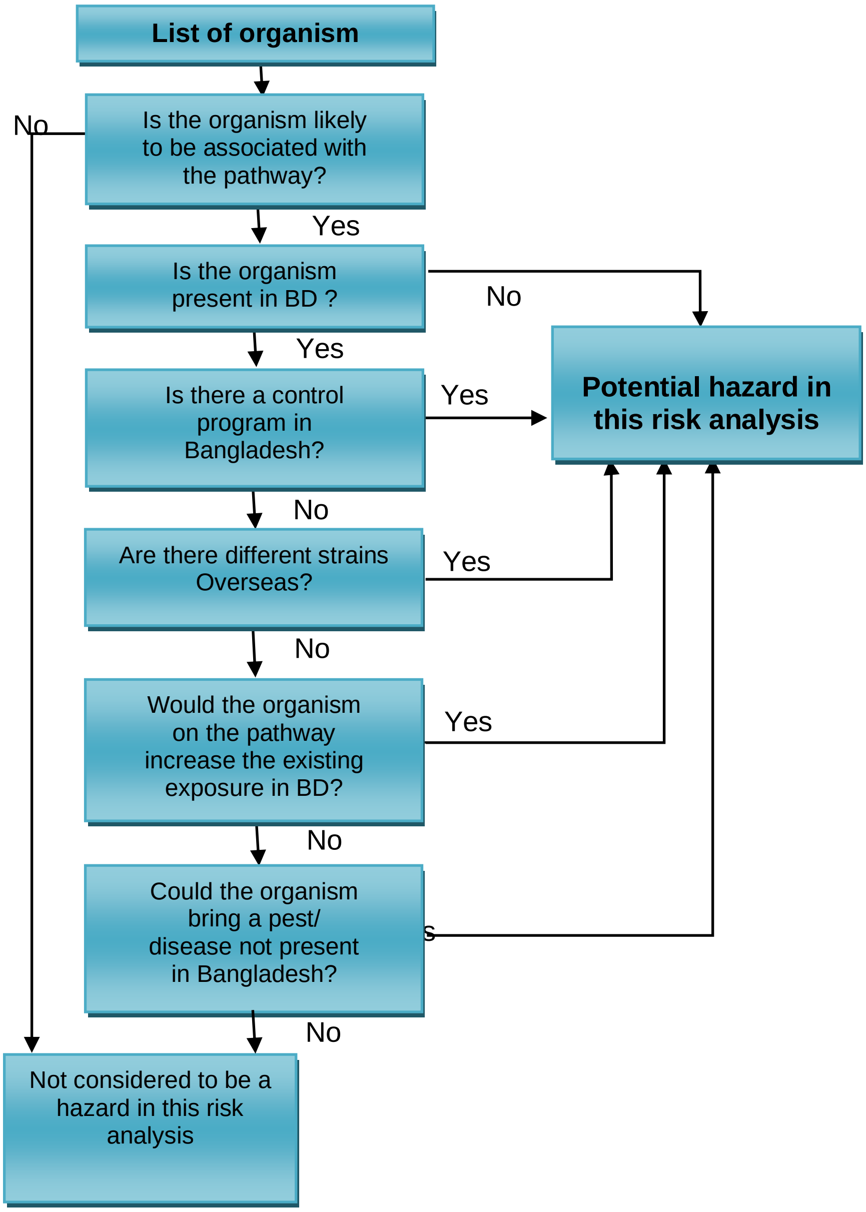
The first step in the risk analysis process is to describe the entry pathway of the Medfly pest to be associated with different host plants/commodity. This includes relevant information on:

- the country of origin, including characteristics like climate, relevant agricultural practices, phytosanitary system;
- pre-export processing and transport systems of the host plants/commodity;
- export and transit conditions, including packaging, mode and method of shipping;
- nature and method of transport and storage on arrival in Bangladesh;
- characteristics of Bangladesh's climate, and relevant agricultural practices.

3.2.1.2 Hazard Identification

Hazard identification is the essential step conducted prior to a risk assessment. Unwanted organisms or pests, which could be introduced by risk commodities/goods into Bangladesh, and are potentially capable of causing unwanted harm, must be identified. This process begins with the collection of a list of organisms that might be associated with the commodity in the country of origin. This list is further refined and species removed or added to the list depending on the strength of the association and the information available about its biology and life cycle. Each species of the pest is assessed mainly on its biological characteristics and its likely interaction with the Bangladesh environment and climate. Hitch-hiker organisms sometimes associated with a commodity but that don't feed on it or specifically depend on that commodity in some other way are also included in the analysis. This is because the potential for economic environmental and human health consequences can outweigh the low likelihood of the organism being associated with the commodity. The process of hazard identification of any organism has been represented diagrammatically as follows:

Figure 3.2: Diagrammatic representation of hazard identification



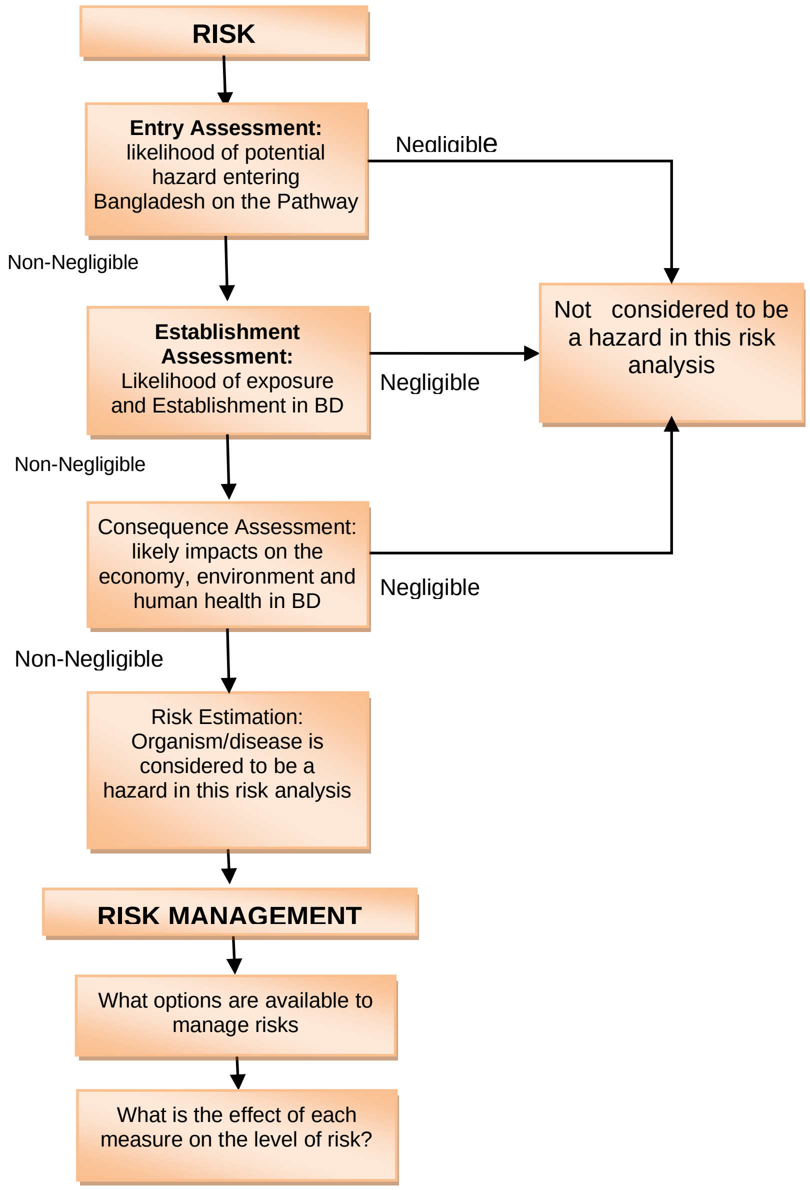
3.2.1.3. Risk Assessment of Potential Hazards

Risk assessment is the evaluation of the likelihood of entry, exposure and establishment of a potential hazard, and the environmental, economic, human and animal health consequences of the entry **(Sea Port, Land port and Airport)** within Bangladesh. The aim of risk assessment is to identify hazards which present an unacceptable level of risk, for which risk management measures are required. A risk assessment consists of four inter-related steps:

- assessment of likelihood of entry;
- assessment of likelihood of exposure and establishment;
- assessment of consequences;
- risk estimation.

In this risk analysis hazards have been grouped to avoid unnecessary duplication of effort in the assessment stage of the project. Where there is more than one species in a genus for example, the most common or potentially damaging species is researched and analyzed in detail and used as an example to cover major biological traits within the group. Any specific differences between congeners are highlighted in individual analyses. The process for risk assessment and management of any potential hazard has been represented diagrammatically as follows:

Figure 3.3: Diagrammatic representation of the process followed for risk assessment and management



3.2.1.4. Assessment of Uncertainties

The purpose of this section is to summarize the uncertainties and assumptions identified during the preceding hazard identification and risk assessment stages. An analysis of these uncertainties and assumptions can then be completed to identify which are critical to the outcomes of the risk analysis. Critical uncertainties or assumptions are considered for further research with the aim of reducing uncertainty or removing the assumption.

Where there is significant uncertainty in the estimated risk, a precautionary approach to risk management may be adopted. In these circumstances the measures should be consistent with other measures where equivalent uncertainties exist and be reviewed as soon as additional information becomes available.

3.2.1.5. Analysis of Measures to Mitigate Bio-security Risks

Risk management in the context of risk analysis is the process of deciding measures to effectively manage the risks posed by the hazard(s) associated with the commodity or organisms under consideration. It is not acceptable to identify a range of measures that might reduce the risks. There must be a reasoned relationship between the measures chosen and the risk assessment so that the results of the risk assessment support the measure(s).
Since zero-risk is not a reasonable option, the guiding principle for risk management should be to manage risk to achieve the required level of protection that can be justified and is feasible within the limits of available options and resources. Risk management identifies ways to react to a risk, evaluating the efficacy of these actions, and presenting the most appropriate options.

The uncertainty noted in the assessments of economic consequences and probability of introduction should also be considered and included in the consideration of risk management options. Where there is significant uncertainty, a precautionary approach may be adopted.

However, the measures selected must nevertheless be based on a risk assessment that takes account of the available scientific information. In these circumstances the measures should be reviewed as soon as additional information becomes available. It is not acceptable to simply conclude that, because there is significant uncertainty, measures will be selected on the basis of a precautionary approach. The rationale for selecting measures must be made apparent. Each hazard or group of hazards will be dealt with separately using the following framework:

3.2.1.6. Risk Evaluation

If the risk estimate determined in the risk assessment is non-negligible, measures can be justified.

3.2.1.7. Option Evaluation

a) Identify possible options, including measures identified by international standard setting bodies, where they are available.
b) Evaluate the likelihood of the entry, exposure, establishment or spread of the hazard according to the option(s) that might be applied.

Select an appropriate option or combination of options that will achieve a likelihood of entry, exposure, establishment or spread that reduces the risk to an acceptable level.

The result of outlining the risk management options will be either that no measures are identified which are considered appropriate, or the selection of one or more management options that have been found to lower the risk associated with the hazard(s) to an acceptable level. These management options form the basis of regulations or requirements specified with an import health standard.

3.2.1.8. Review and Consultation

Peer review is a fundamental component of a risk analysis to ensure it is based on the most up-to-date and credible information available. Each analysis must be submitted to a peer review process involving appropriate staff within those government departments with applicable bio-security responsibilities, plus recognized and relevant experts from Bangladesh or overseas. The critique provided by the reviewers where appropriate, is incorporated into the analysis. If suggestions arising from the critique are not adopted the rationale must be fully explained and documented.

Once a risk analysis has been peer reviewed and the critiques addressed, the risk analysis is then published and released for public consultation. The period for public consultation is usually six weeks from the date of publication. All submissions received from stakeholders are analyzed and compiled into a review.

3.2.2. Initiation

This section provides information on the pest and pathway that is relevant to the analysis of bio-security risks and common to organisms or mealybug species potentially associated with the pathway and commodity. This chapter also provides information on climate and geography of the country of origin as well as Bangladesh for assessing the likelihood of establishment and spread of potential hazard organisms when enter and exposed to Bangladesh. Organism-specific information is provided in subsequent chapters.

3.2.2.1. Pest Description

C. capitata is a highly invasive species. It has a high dispersive ability, a very large host range and a tolerance of both natural and cultivated habitats over a comparatively wide temperature range. It has a high economic impact, affecting production, control costs and market access. It has successfully established in many parts of the world, often as a result of multiple introductions (Malacrida et al., 2007). Frequent incursions into North America require expensive eradication treatments and many countries maintain extensive monitoring networks.

3.2.2.2. Taxonomic position

Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Diptera
Family: Tephritidae
Genus: Ceratitis
Species: *Ceratitis capitata*

3.2.2.3. Risk of Introduction

The major risk is from the import of fruit containing larvae, either as part of cargo, or through the smuggling of fruit in airline passenger baggage or mail. For example, in New Zealand, Baker and Cowley (1991) recorded 7-33 interceptions of fruit flies per year in cargo and 10-28 per year in passenger baggage. Private individuals who successfully smuggle fruit are likely to discard it when they discover that it is rotten. This method of introduction has been suggested to account for the discovery of at least one fly in a trap in California every year (Foote *et al.,* 1993), although this notion has been strongly criticized by others that suggest the presence of a barely detectable, establish population (Papadopoulos *et al.,* 2013).
C. capitata is an EPPO A2 quarantine pest (OEPP/EPPO, 1981), and is also of quarantine significance throughout the world (CPPC, NAPPO, APPPC), especially for Japan and the USA. Its presence in Hawaii, but not in mainland USA, has contributed to its high international profile as a quarantine pest. It has reached all tropical and warm temperate land masses with the exception of Asia. Its presence, even as temporary adventives populations, can lead to severe additional constraints for export of fruits to uninfested areas in other continents. In this respect, *C. capitata* is one of the most significant quarantine pests for tropical or warm temperate areas in regions where it is not yet established. Worner (1988) used a climate-matching system, CLIMEX, to evaluate areas of potential establishment of *C. capitata* in New Zealand. The suitability of regions in Australia, Europe and South America has also been identified using CLIMEX (Vera *et al.,* 2002) and correlative bioclimatic methods (De Meyer *et al.,* 2007).

Consignments of fruits from countries where *C. capitata* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae.

3.2.2.4. Geographical Distribution

C. capitata is widespread in Africa and is endemic to most sub-Saharan countries. It was recorded from western Zambia by Munro (1953) and Namibia by Hancock *et al.* (2001). The lack of records or reports of 'restricted distributions' in many African countries is likely to reflect the lack of observations rather than absence. The spread to Europe, Egypt, the Middle East, the Malagasy subregion, Australia and the Americas is likely to be a result of accidental transportation during trade. Jafari and Sabzewari (1982) recorded *C. capitata* from the Mazandaran Province of Iran, where it was first detected in 1977. Kassim and Soilihi (2000) recorded it from the Comoros. The first records from the Amazon area of Brazil were in 1996 for Rondonia (Ronchi-Teles *et al.,* 1996) and in 1997 for Para (Gomes-Silva et al., 1998). The record of *C. capitata* in the Mariana Islands in CIE (1988) is incorrect. Reports of *C. capitata* from Suriname (e.g. Gasparich *et al.,* 1997) refer to mislabelled specimens originally from California. It has been recorded intermittently in the Ukraine between 1937 and 1966 (Fischer-olbrie and Busch-Petersen, 1989), in California since 1975, in Florida since 1929 and in Texas since 1966 (Gasparich *et al.,* 1997). It has been argued that, despite numerous eradication campaigns, *C. capitata* is now established and widespread in California as small, barely detectable populations (Papadopoulos *et al.,* 2013).

In Chile it was present from 1963 to 1995 (Diaz *et al.,* 1999). In New South Wales, Australia, it was first recorded in 1898 and had disappeared by 1948 (Orian and Moutia, 1960; Permkam and Hancock, 1995). In Queensland, Australia it was formerly present in the southeast and first recorded in 1909. It disappeared during the 1930s (Permkam and Hancock, 1995). Occasional outbreaks occur in South Australia. In Victoria, Australia it was first recorded in 1909 and had disappeared by the 1940s (Permkam and Hancock, 1995). It has been eradicated in New Zealand, but an outbreak occurred in 1996 (Holder *et al.,* 1977). In Jamaica, a *C. capitata* surveillance programme has been on-going since 2000 and has revealed no evidence that this pest occurs there (C Thomas, Chief Plant Quarantine Officer, Ministry of Agriculture, Kingston, Jamaica, personal communication, 2004).

C. capitata has been reported in Kaoma, Western Province and Chilanga-Lusaka, Zambia during a surveillance programme by ICIPE and APHIS (A Sakala, Plant Quarantine Service, Zambia: identification by Marc De Meyer, Royal Museum for Central Africa, Tervuren, Belgium).

A record of *C. capitata* in Hubei, China (Lu *et al.,* 2006; CABI/EPPO, 2015) published in previous versions of the Compendium is invalid. The paper by Lu *et al.* (2006) on which it is based refers to the Chinese citrus fly, *Bactrocera minax,* not *C. capitata*.

3.2.2.5. Morphological Identification

The Medfly has no near relatives in the Western Hemisphere. The adults are slightly smaller than a house fly and have picture wings typical of fruit flies. They can be distinguished fairly readily from any of the native fruit flies of the New World.

Egg: The egg is very slender, curved, 1 mm long, smooth and shiny white. The micropylar region is distinctly tubercular.

Figure 3.4: Eggs of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Photograph by Jeffery Lotz, Florida Department of Agriculture and Consumer Services-Division of Plant Industry; www.forestryimages.org.

Larva: Larva are white with a typical fruit fly larval shape, i.e. cylindrical maggot-shape, elongate, anterior end narrowed and somewhat recurved ventrally, with anterior mouth hooks, and flattened caudal end. The last instar is usually 7 to 9 mm in length, with eight ventral fusiform areas. The anterior buccal carinae are usually 9 to 10 in number. The anterior spiracles are usually nearly straight on dorsal edge of tubule row (often more straight than illustrated). There are usually 9 to 10 tubules, although there may be seven to 11.

Figure 3.5: Larva of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Head is to the left. Photograph by Jeffery Lotz, Florida Department of Agriculture and Consumer Services-Division of Plant Industry; www.forestryimages.org.

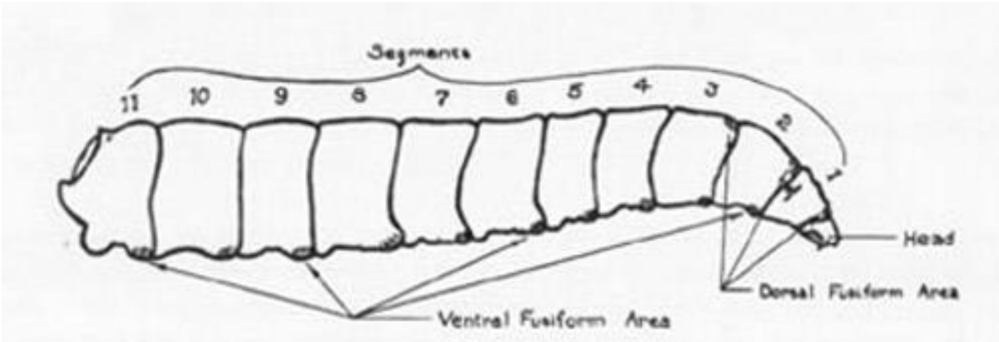


Figure 3.6: Lateral view of a mature larva of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Head is to the right. Graphic by Division of Plant Industry

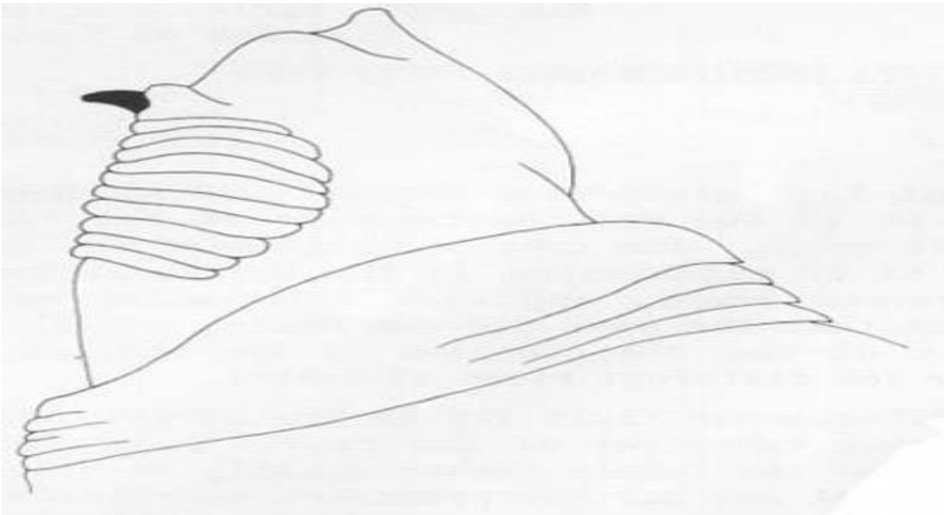


Figure 3.7: Head and buccal carinae of larva of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Graphic by Division of Plant Industry

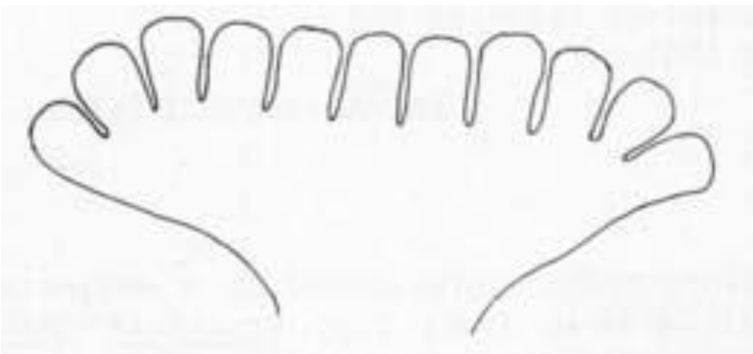


Figure 3.8: Anterior spiracles of larva

The cephalo-pharyngeal skeleton has a large convex mouth hook each side, approximately 2X hypostome in length. The hypostomium has prominent, rounded subhypostomium; post-hypostomial plates curved dorsally to the dorsal bridge, fused with sclerotized rays of central area of dorsal wing plate. The parastomium is prominent. The anterior of the dorsal bridge has a prominent sclerotized point. The dorsal wing plate is nearly as long as the pharyngeal plate. The median area is relatively unsclerotized. The pharyngeal plate is elongate, with prominent median hood and anterior sclerotized area.

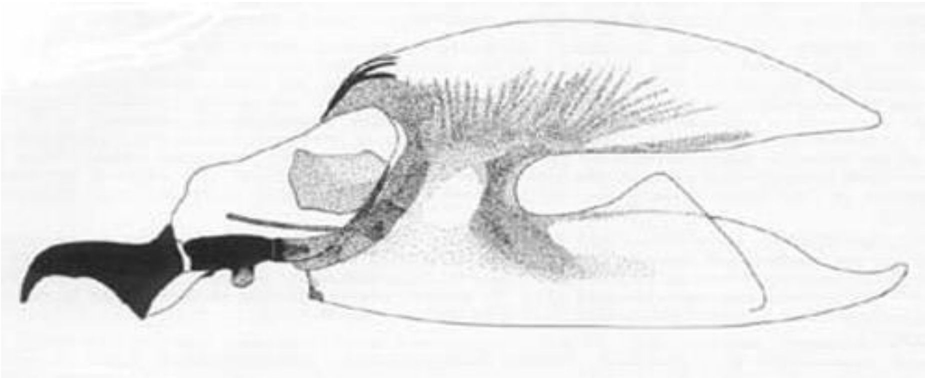


Figure 3.9: Larval cephalo-pharyngeal skeleton of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Graphic by Division of Plant Industry

The caudal end has bifurcate or paired dorsal papillules (D1 and D2) on small amount of relatively flat plate; intermediate papillules (I1-2) as a line of fused elevations on a very enlarged subspiracular tubercle, plus a remote I3 at approximately 45 degrees from I1-2; L1 on the median edge of the caudal end; V1 not prominent; posterior spiracles elongate (4.5 to 5X width), with dorsal and ventral spiracles angled away from relatively planar median spiracle; inter spiracular processes (hairs) usually not branched; anal lobe bifid or entire.

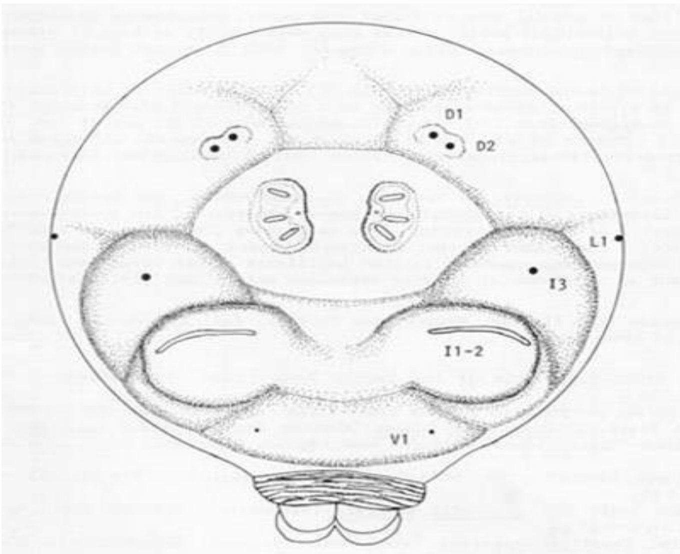


Figure 3.10: Caudal end of larva of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Graphic by Division of Plant Industry

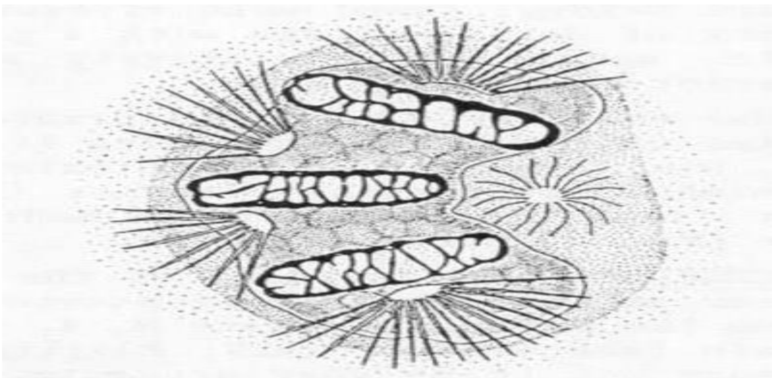


Figure 3.11: Posterior spriacles (left side) (after Phillips 1946) of a larva of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Graphic by Division of Plant Industry

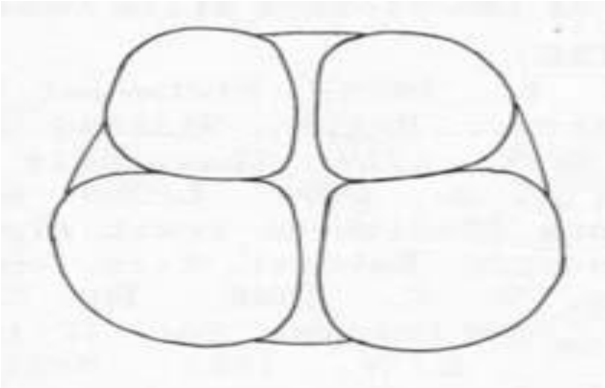


Figure 3.12: Anal lobes of larva

Larval Diagnosis: The primary diagnostic characters for Mediterranean fruit fly larvae involve the anterior spiracles, the buccal carinae, and the prominent subspiracular tubercles of the caudal end. The anterior spiracles have the tubule edge relatively straight dorsally and the tubule number usually is nine to 10, although it can be from seven to 11. The buccal carinae number nine to 10. The caudal end has two prominent subspiracular tubercles, each with a crescent of irregularly fused papillules (approximately equivalent to 11-2). The anal lobe is either bifid or entire. The pharyngeal skeleton is distinctive in overall configuration, particularly the enlarged sub-hypostomium of the hypostomium (posterior to each mouth hook). There is a heavily sclerotized dorsal bridge point at the anterior of the dorsal wing plate. The shape of the interior sclerotizations of the dorsal wing plate and the hood of the pharyngeal plate are also distinctive for the species.

The features of the larvae of *C. capitata*, as noted in the description, are variable to some degree as indicated. Most previous illustrations of the cephalo-pharyngeal skeleton of the species have not shown the pharyngeal plate hood, and details of the illustrations also vary among themselves (see Greene 1929, Phillips 1946). The figure of the cephalo-pharyngeal skeleton in Greene (1929) appears not to be very accurate. The supposed supernumerary lateral papillules of the caudal end, noted by Phillips (1946), are not usually evident in specimens or at most represent only slight plate elevations on the very lateral edge dorsal to L1.

Larvae examined came from verified samples from Florida, Hawaii, and Portugal (all are in the larval collection of the Museum of Entomology, Florida State Collection of Arthropods).

Pupa: The pupa is cylindrical, 4 to 4.3 mm long, dark reddish brown, and resembles a swollen grain of wheat.

Figure 3.13: Pupae of the Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Photograph by Jeffery Lotz, Florida Department of Agriculture and Consumer Services-Division of Plant Industry; www.forestryimage.org.

Figure 3.14: Pupal views.

Figure 3.15: An adult Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), emerging from a puparium. Head is to the left. Photograph by Anne-Sophie Roy, European and Mediterranean Plant Protection Organization; www.forestryimages.org.

Adult: The adult fly is 3.5 to 5 mm in length. The color is yellowish with brown tinge, especially on abdomen, legs, and some markings on wings. The lower corners of the face have white setae. Eyes are reddish purple (fluoresce green, turning blackish within 24 hours after death). Ocellar bristles are present. The male has a pair of bristles with enlarged spatulate tips next to the inner margins of the eyes. The thorax is creamy white to yellow with a characteristic pattern of black blotches. Light areas have very fine white bristles. Humeral bristles are present. Dorsocentral bristles are anterior of the halfway point between supraalar and acrostichal bristles. The scutellum is inflated and shiny black. The abdomen is oval with fine black bristles scattered on dorsal surface and two narrow transverse light bands on basal half.

Figure 3.16: The thorax of the adult Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), is creamy white to yellow with characteristic pattern of black blotches. The light areas have very fine white bristles. Photograph by Ken Walker, Museum Victoria, Melbourne, Australia; www.forestryimages.org.

Wings, usually held in a drooping position on live flies, are broad and hyaline with black, brown, and brownish yellow markings. There is a wide brownish yellow band across the middle of the wing. The apex of the wing's anal cell is elongate. There are dark streaks and spots in middle of wing cells in and anterior to anal cell.

Figure 3.17: Wing of the adult Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Wings are usually held in a drooping position on live flies, are broad and hyaline with black, brown, and brownish yellow markings. There is a wide brownish yellow band across middle of wing. Photograph by Ken Walker, Museum Victoria, Melbourne, Australia; www.forestryimages.org.

The males are easily separated from all other members of this family by the black pointed expansion at the apex of the anterior pair of orbital setae. The females can be separated from most other species by the characteristic yellow wing pattern and the apical half of the scutellum being entirely black (White and Elson-Harris 1994). The female's extended ovipositor is 1.2 mm long.

Figure 3.18: Dorsal view of adult male Mediterranean fruit fly, *Ceratitis Capitata* (Wiedemann). Photograph by Scott Bauer, USDA.

Figure 3.19: Lateral view of adult Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann). Photograph by Scott Bauer, USDA.

3.2.2.6. Life History and Habits

The length of time required for the Medfly to complete its life cycle under typical Florida summer weather conditions, and on which eradication schedules in Florida are based, is 21 to 30 days. A female Medfly will lay one to 10 eggs in an egg cavity 1 mm deep, may lay as many as 22 eggs per day, and may lay as many as 800 eggs during her lifetime (usually about 300). The number of eggs found at any time in the reproductive organs is no indication of the total number of eggs an individual female is capable of depositing, as new eggs are being formed continually throughout her adult life. Females usually die soon after they cease to oviposit.

Figure 3.20: Life cycle of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), from left to right: adult, pupa, larva and eggs. Photograph by USDA.

Eggs are deposited under the skin of fruit which is just beginning to ripen, often in an area where some break in the skin already has occurred. Several females may use the same deposition hole with 75 or more eggs clustered in one spot. When the eggs hatch, the larvae promptly begin eating, and at first tunnels are formed, but may keep close together in feeding until nearly full grown. Fruit in a hard or semi-ripe condition is better for oviposition than fully ripened fruit. Ripe fruit is likely to be more juicy, and such fruits often are associated with a high mortality of eggs and young larvae.

Females will not oviposit when temperatures drop below 60.8°F (16°C) except when exposed to sunlight for several hours. Development in egg, larval, and pupal stages stops at 50°F (10°C). Pupae carry the species through unfavorable conditions, such as lack of food, water, and temperature extremes. During warm weather eggs hatch in 1.5 to three days. The duration of the egg stage is considerably increased by lower temperatures.

Larvae pass through three instars. Larval life may be as short as six to 10 days when the mean temperatures average 77 to 79°F (25 to 26.1°C). The kind and condition of the fruit often influence the length of the larval stage. In citrus fruits, especially limes and lemons, it appears to be longer. Thus larvae require 14 to 26 days to reach maturity in a ripe lemon, as compared with 10 to 15 days in a green peach. Larvae leave the fruit in largest numbers at or just after daybreak and pupate in the soil or whatever is available.

Minimum duration of the pupal stage is six to 13 days when the mean temperature ranges from about 76 to 79°F (24.4 to 26.1°C). Back and Pemberton (1915) noted that this period may be increased to at least 19 days when the daily temperature means drop to about 69 to 71°F (20.6 to 21.7°C).

Adults emerge in largest numbers early in the morning during warm weather and emerge more sporadically during cool weather. They can fly short distances, but winds may carry them a mile or more away. Copulation may occur at any time throughout the day. Newly emerged adults are not sexually mature. Males often show sexual activity four days after emergence, and copulation has been observed five days after emergence. Both sexes are sexually active throughout the day. When the daily mean temperature averages from 76 to 78°F (24.4 to 25.6°C), most females are ready to mate from six to eight days after eclosion. Oviposition may take place as early as four to five days after emergence during very warm weather, but not for about 10 days when temperatures range between 68 to 72°F (20 to 22.2°C) (Back and Pemberton 1915).

Adults die within four days if they cannot obtain food. Usually about 50% of the flies die during the first two months after emergence. Some adults may survive up to six months or more under favorable conditions of food (fruit, honeydew, or plant sap), water, and cool temperatures. When host fruit is continuously available and weather conditions favorable for many months, successive generations will be large and continuous. Lack of fruit for three to four months reduces the population to a minimum.

3.2.2.7. Host Range

The Mediterranean fruit fly attacks more than 260 different fruits, flowers, vegetables, and nuts. Thin-skinned, ripe succulent fruits are preferred. Host preferences vary in different regions. Although several species of cucurbits have been recorded as hosts of the Medfly, they are considered to be very poor hosts. Some hosts have been recorded as Medfly hosts only under laboratory conditions and may not be attacked in the field. Knowledge of the hosts in one country often aids in correctly predicting those which are most likely to be infested in a newly infested country, but what may be a preferred host in one part of the world may be a poor host in another.

Table 3.1. List of major host of Medfly

Plant name	Family	Context
Anacardium occidentale (cashew nut)	Anacardiaceae	Other
Annona cherimola (cherimoya)	Annonaceae	Main
Annona reticulata (bullock's heart)	Annonaceae	Other
Annona squamosa (sugar apple)	Annonaceae	Other
Argania spinosa (argan tree)	Sapotaceae	Wild host
Artocarpus altilis (breadfruit)	Moraceae	Other
Averrhoa carambola (carambola)	Oxalidaceae	Unknown
Cananga odorata (perfume tree)	Annonaceae	Unknown
Capparis sepiaria (indian caper)	Capparaceae	Wild host
Capsicum annuum (bell pepper)	Solanaceae	Main
Capsicum frutescens (chilli)	Solanaceae	Other
Carica papaya (pawpaw)	Caricaceae	Other
Carissa macrocarpa (natal plum)	Apocynaceae	Wild host
Casimiroa edulis (white sapote)	Rutaceae	Other
Cinnamomum verum (cinnamon)	Lauraceae	Wild host
Citrus	Rutaceae	Main
Citrus aurantiifolia (lime)	Rutaceae	Other
Citrus aurantium (sour orange)	Rutaceae	Other
Citrus limetta (sweet lemon tree)	Rutaceae	Other
Citrus limon (lemon)	Rutaceae	Other
Clausena anisata (horsewood)	Rutaceae	Wild host
Coffea (coffee)	Rubiaceae	Main
Coffea arabica (arabica coffee)	Rubiaceae	Other
Cucumis (melons, cucuimbers, gerkins)	Cucurbitaceae	Other
Cucumis dipsaceus (hedgehog gourd)	Cucurbitaceae	Wild host
Cyphomandra betacea (tree tomato)	Solanaceae	Other
Dimocarpus longan (longan tree)	Sapindaceae	Other
Ficus carica (common fig)	Moraceae	Main
Hylocereus undatus (dragon fruit)	Cactaceae	Other
Juglans regia (walnut)	Juglandaceae	Other
Litchi chinensis (lichi)	Sapindaceae	Other
Malus domestica (apple)	Rosaceae	Main
Mangifera indica (mango)	Anacardiaceae	Other
Persea americana (avocado)	Lauraceae	Other
Phoenix dactylifera (date-palm)	Arecaceae	Other
Physalis peruviana (Cape gooseberry)	Solanaceae	Other
Pouteria viridis (green sapote)	Sapotaceae	Other
Prunus armeniaca (apricot)	Rosaceae	Other
Prunus domestica (plum)	Rosaceae	Other

Prunus persica (peach)	Rosaceae	Other
Psidium guajava (guava)	Myrtaceae	Main
Punica granatum (pomegranate)	Punicaceae	Other
Solanum lycopersicum (tomato)	Solanaceae	Other
Solanum mauritianum (tobacco tree)	Solanaceae	Wild host
Solanum melongena (aubergine)	Solanaceae	Other
Theobroma cacao (cocoa)	Sterculiaceae	Main
Vitis vinifera (grapevine)	Vitaceae	Other
Ximenia americana (Hog plum)	Olacaceae	Unknown
Ziziphus jujuba (common jujube)	Rhamnaceae	Other

Source: CABI (2015)

3.2.2.8. Nature of Damage

The damage to crops caused by Medfly result from 1) oviposition in fruit and soft tissues of vegetative plant parts, 2) feeding by the larvae, and 3) decomposition of plant tissue by invading secondary microorganisms.

Larval feeding damage in fruits is the most damaging. Mature attacked fruits may develop a water soaked appearance. Young fruits become distorted and usually drop. The larval tunnels provide entry points for bacteria and fungi that cause the fruit to rot. These maggots also attack young seedlings, succulent tap roots, and stems and buds of host plants.

In addition of physical damage, Medfly inflicts economic damage due to costs associated with quarantine and monitoring programs, limits on export from fly infested areas, and quarantine treatments of fruits from infested areas.

3.2.2.9. Growth Stages of Fruits Attacked and Symptoms

Usually fruits are attacked by the Medfly at fruiting stage, Post-harvest level of the fruits. Attacked fruit usually shows signs of oviposition punctures and there is laboratory evidence of fungal transmission (Cayol *et al.,* 1994). Very sweet fruits may produce sugary exudates.

3.2.2.10. Means of Movement and Dispersal

Natural Dispersal

The majority of mark-release-recapture studies on dispersal of *C. capitata* obtain recaptures no more than 1 km from the release site, although these results may represent limitations of the trapping array. There is evidence that *C. capitata* can fly at least 20 km (Fletcher, 1989).

Movement in Trade

The transport of infested fruits is the major means of movement and dispersal to previously uninfected areas. Some host fruits are only infested when ripe, and this has been the basis for an 'infestation-free quarantine procedure' for avocados exported from Hawaii to mainland USA. This was recently called into question when fruits still on the tree were found to be infested (Liquido *et al.*, 1995).

3.2.2.11. Impact

C. capitata is an important pest in Africa and has spread to almost every other continent to become the single most important pest species in its family. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In Mediterranean countries, it is particularly damaging to citrus and peach. It may also transmit fruit-rotting fungi (Cayol *et al.,*1994).

Damage to fruit crops is frequently high and may reach 100% (Fimiani, 1989; Fischer-Colbrie and Busch-Petersen, 1989). In Central America, losses to coffee crops were estimated at 5-

15% and the berries matured earlier and fell to the ground with reduced quality (Enkerlin *et al.,* 1989). As in areas where the fly is endemic, in outbreak conditions the economic impacts include reduced production, increased control costs and lost markets.

Environmental Impact

No impact of *C. capitata* on the natural environment or on other species has been observed, although the decline in populations of *Ceratitis catoirii* on Mauritius and Réunion may be due in part to competition from *C. capitata* (Duyck *et al.,* 2006).

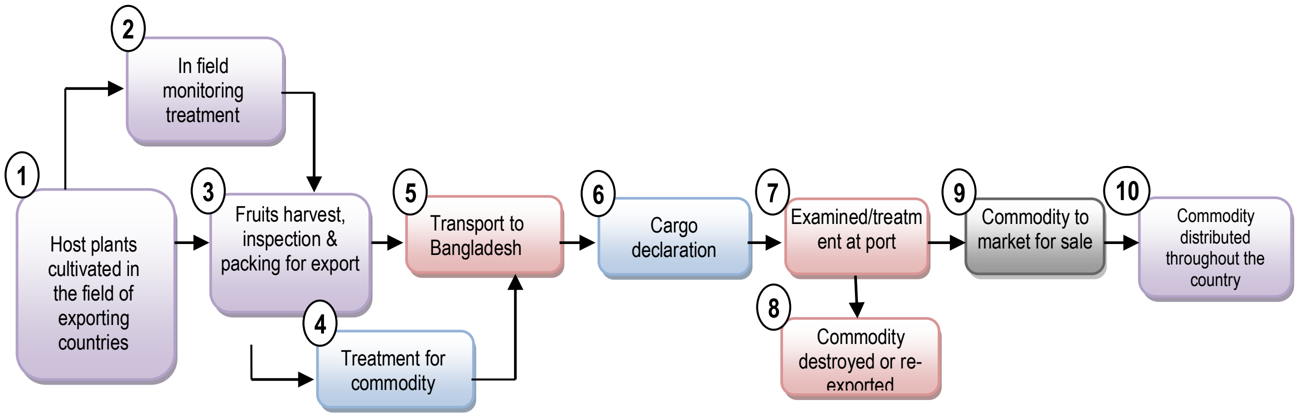
Social Impact

The social impact on fruit growers and their families caused by the presence or introduction of *C. capitata* is severe, mostly through reduced or lost income and increased costs of control. As a recognized and serious quarantine pest, loss of markets to producers in outbreak areas is also often severe.

3.2.3. Description of the Pathways of Medfly

For the purpose of this risk analysis, Medfly affected fruits are presumed to be imported or transported into Bagnaldesh from anywhere of exporting counties particularly Jordan, Cyprus, Lebanon, Saudi Arabia, Turkey, Algeria, Congo, Libya, USA, Brazil,Chile, Netherlands, Jamaicae and other countries of the world. To comply with existing Bangladesh import requirements for agricultural products/materials, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests are not associated with the product. Commodity would then be sea or land or air freighted to Bangladesh where it will go to a holding facility before being distributed the fruits to dealers, distributors, markets, sellers and farmers.

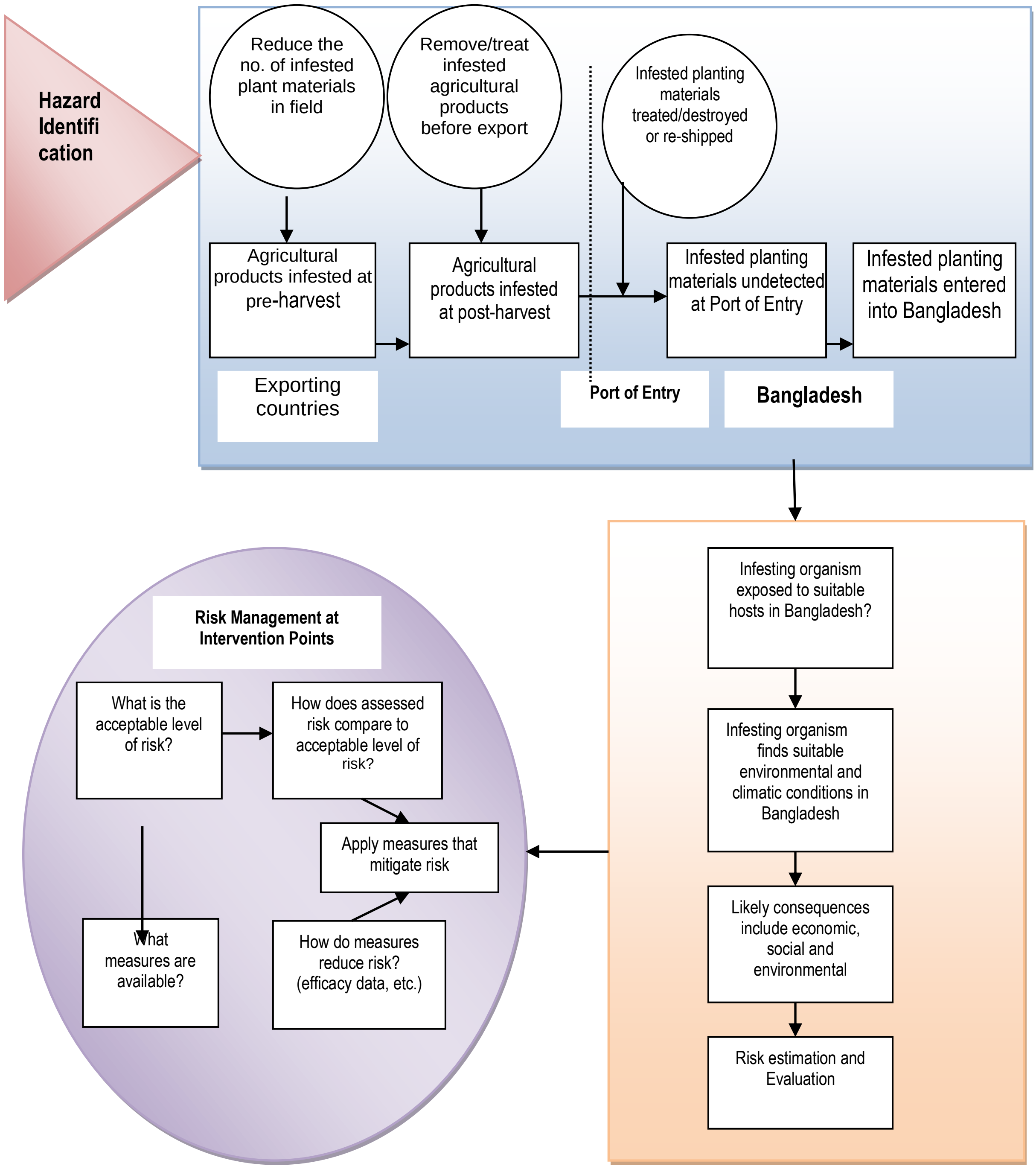
Figure-3.21: Linear Pathway Diagram to Check Medfly Infestation



- Fruits, and other agricultural commodities are grown in the field of exporting country(ies);
- Monitoring of Medfly and other exotic pests is undertaken, with appropriate controls applied.
- Fruits, vegetables and other agricultural productions or planting materials are harvested, inspected and the best quality fruits and vegetables washed, pre-treated and packed in boxes.
- Post harvest disinfestations including are undertaken either before or during transport of the fruits and vegetables to Bangladesh.
- Transport to Bangladesh is by land, air or sea freighted.
- Each shipment must be accompanied by the appropriate certification, e.g. a phytosanitary certificate attesting to identity the planting materials/products, any treatments completed, or other information required to help mitigate risks.

- Fruits, vegetables and other agricultural productions or planting materials are examined at the border and or port of entry to ensure compliance.
- Any fruit and or vegetable or other agricultural productions or planting materials not complying with Bangladesh biosecurity requirements (e.g. found harboring Medfly or any other pest organisms) are either treated re-shipped or destroyed.
- Fruits, vegetables and other agricultural commodities are stored before being distributed to market for sale.
- Dealers and sellers of fruits and vegetables stock and they are bought by consumers within the local area they are sold in.

Figure-3.22: Pathway and Likelihood of Entry Assessment of Medfly



3.2.4. Exporting Countries—General Climate

Jordan—General Climate

General Climate: Jordan has a hot, dry climate characterized by long, hot, dry summers and short, cool winters. The climate is influenced by Jordan's location between the subtropical aridity of the Arabian desert areas and the subtropical humidity of the eastern Mediterranean area. January is the coldest month, with temperatures from 5°C to 10°C, and August is the hottest month at 20°C to 35°C. Daily temperatures can be very hot, especially in the summer; on some days it can be 40°C or more, especially when the Shirocco, a hot, dry southe rly wind blows. These winds can sometimes be very strong and can cause Sandstorms.

About 70 percent of the average rainfall in the country falls between November and March; June through August are often rainless. Rainfall varies from season to season and from year to year. Precipitation is often concentrated in violent storms, causing erosion and local flooding, especially in the winter months.

Turkey—General Climate

Although Turkey is situated in a geographical location where climatic conditions are quite temperate, there are significant differences in climatic conditions from one region to the other. While the coastal regions enjoy milder climates, the inland Anatolia plateau experiences a dryer climate with hot summers and cold winters with limited rainfa ll.

In Istanbul and around the sea of Marmara (Marmara region) the climate is moderate (winter 5°C and summer 25°C); in winter the temperature can drop below zero. In Western Anatolia (Aegean region) there is a mild, pleasant Mediterranean influenced climate with average temperatures of 9°C in winter and 29°C in summer. On the southern coast of Anatolia (Mediterranean region) the same climate can be found. The climate of the Anatolian Plateau (Central Anatolian region) is a steppe climate, with a great temperature difference between day and night. Rainfall is low and there is more snow in the winter. The average temperature is about 23°C in summer and -2°C in winter.

Cyprus—General Climate

Cyprus enjoys an intense Mediterranean climate, with long dry summers from mid–May to mid–October, and mild winters from December to February, which are separated by short autumn and spring seasons. Summer is a season of high temperatures with cloudless skies, but the sea breeze creates a pleasant atmosphere in the coastal areas. Isolated thunder showers are possible mainly over the mountains during early afternoons. Winters are mild with rain and snow on Troodos Mountains (usually starting before Christmas).

The island enjoys abundant sunshine, and even in December and January, there is an average of six hours of bright sunshine per day, whilst over the six 'summer' months, there is an average of 11.5 hours of bright sunshine per day.

Temperatures and Weather Conditions

Daily temperatures during the hottest months of July and August range between 30° C on the central plain, and 24° C on the Troodos Mountains. The average maximum temperatures for these two months range between 38° C and 27° C. In January, the coolest month, the indicative daily temperature is 10° C on the central plain, and 3° C on the higher parts of the Troodos Mountains, while the average minimum temperatures are 5° C and 0° C.

Lebanon—General Climate

Lebanon has a Mediterranean climate characterized by long, hot, dry summers and short, cool, rainy winters. The climate is determined by Lebanons's location between the subtropical aridity of the African continent and the subtropical humidity of the eastern Mediterranean area. January is the coldest month, with temperatures from 5°C to 10°C, and August is the hottest month at 18°C to 38°C. Daily temperatures can be very hot, especially in the summer; on some day it can be 40°C or more, especially when the Shirocco, a hot, dry southerly wind blows. These winds can sometimes be very strong and can cause Sandstorms.

About 70 percent of the average rainfall in the country falls between November and March; June through August are often rainless. Rainfall varies from season to season and from year to year. Precipitation is often concentrated in violent storms, causing erosion and local flooding, especially

Algeria—General Climate

Northern Algeria lies within the temperate zone, and its climate is similar to that of other Mediterranean countries, although the diversity of the relief provides sharp contrasts in temperature. The coastal region has a pleasant climate, with winter temperatures averaging from 10° to 12° C (50° to 54° F) and average summer temperatures ranging from 24° to 26° C (75° to 79° F). Rainfall in this region is abundant—38 to 69 cm (15 to 27 in) per year, and up to 100 cm (40 in) in the eastern part—except in the area around Oran (Ouahran), where mountains form a barrier against rain-carrying winds. When heavy rains fall (often more than 3.8 cm/1.5 in within 24 hours), they flood large areas and then evaporate so quickly that they are of little help in cultivation.

Farther inland, the climate changes; winters average 4° to 6° C (39° to 43° F), with considerable frost and occasional snow on the massifs; summers average 26° to 28° C (79° to 82° F). In this region, prevailing winds are westerly and northerly in winter and easterly and northeasterly in summer, resulting in a general increase in precipitation from September to December and a decrease from January to August; there is little or no rainfall in the summer months.

In the Sahara Desert, temperatures range from –10° to 34° C (14° to 93° F), with extreme highs of 49° C (120° F). There are daily variations of more than 44° C (80° F). Winds are frequent and violent. Rainfall is irregular and unevenly distributed.

Congo—General Climate

The country’s tropical climate is characterized by heavy precipitation and high temperatures and humidity. The Equator crosses the country just north of Liranga. In the north a dry season extends from November through March and a rainy season from April through October, whereas in the south the reverse is true. On both sides of the Equator, however, local climates exist with two dry and two wet seasons.

Annual precipitation is abundant throughout the country, but seasonal and regional variations are important. Precipitation averages more than 48 inches (1,200 mm) annually but often surpasses 80 inches (2,000 mm).

Temperatures are relatively stable, with little variation between seasons. More variation occurs between day and night, when the difference between the highs and lows averages about 27 °F (15 °C). Over most of the country, annual average temperatures range between the high 60s and low 80s F (low and high 20s C), although in the south the cooling effect of the Benguela Current may produce temperatures as low as the mid-50s F (low 10s C). The average daily humidity is about 80 percent.

Libya—General Climate

Within Libya five different climatic zones have been recognized, but the dominant climatic influences are Mediterranean and Saharan. Both the Mediterranean Sea and the desert affect Libya's climate. In winter, the weather is cool with some rain on the coast and in the desert the temperature can drop to sub-freezing at night.

The Sahara is very dry and hot in summer and cool and dry in winter. Less than 2 percent of the national territory receives enough rainfall for settled agriculture. Temperatures in the summer can reach 50 degrees Celsius (122° Fahrenheit) during the day but more commonly are around 40°C (104°F). Night temperatures can vary from 30 to 40°C (86-104°F). If don't like the heat then the best time for visiting the Sahara is from October to April, at this time average temperatures range from 15 to 30°C (59-86°F) during the day and from 5 to 20°C (41-68°F) at night.

This is most likely in January or February and rarely lasts long. Often after the rains the desert comes to life with flowers and this generally happens in late February or March.

The Netherlands—General Climate

The Netherlands have a temperate maritime climate influenced by the North Sea and Atlantic Ocean, with cool summers and moderate winters. Daytime temperatures variy from 2°C-6°C in the winter and 17°C-20°C in the summer.

Since the country is small there is little variation in climate from region to region, although the marine influences are less inland. Rainfall is distributed throughout the year with a dryer period from April to September.

Especially in fall and winter strong atlantic low-pressure systems can bring gales and uncomfortable weather. Sometimes easterly winds can cause a more continental type of weather, warm and dry in the summer, but cold and clear in the winter with temperatures sometimes far below zero. The Netherlands is a flat country and has often breezy conditions, although more in the winter than in the summer, and more among the coastal areas than inland.

Koeppen-Geiger classification: The climate of The Netherlands can be classified as **Cfb** Climate; a warm temperated humid climate with the warmest month lower than 22°C over average and four or more months above 10°C over average.

United States of America—General Climate

The climate of the United States varies due to differences in latitude, and a range of geographic features, including mountains and deserts. West of the 100th meridian, much of the US is semi-arid to arid, even desert in the far southwestern US. East of the 100th meridian, the climate is humid continental in the northern areas (locations above 40 north latitude), to humid temperate in the central and middle Atlantic coast regions, to humid subtropical in the Gulf and south Atlantic regions. The southern tip of Florida is tropical. The climate along the coast of California is Mediterranean, while upper West Coast areas in coastal Oregon and Washington are cool temperate oceanic. The state of Alaska, on the northwestern corner of the North American continent, is largely subarctic, but with a cool oceanic climate in the southeast (Alaska Panhandle), southwestern peninsula and Aleutian Islands, and a polar climate in the north. The archipelago state of Hawaii, in the middle of the Pacific Ocean, is tropical, with rainfall concentrated in the cooler season (November to March).

As in most land masses located in the middle and lower-middle latitudes, the primary drivers of weather in the contiguous United States are the seasonal change in the solar angle, the migration north/south of the subtropical highs, and the seasonal change in the position of the polar jet stream. In the Northern Hemisphere summer, the "Bermuda High" over the subtropical Atlantic Ocean typically sends warm, humid air over the eastern, southern and central United States - resulting in southerly airflow, warm to hot temperatures, high humidity and occasional thunderstorm activity. In summer, high pressure over the north-central Pacific typically results in northwesterly airflow, stable conditions and cool to mild conditions along most of the immediate Pacific coast, from Washington state to San Diego, CA. In the Northern Hemisphere winter, the subtropical highs retreat southward. The polar jet stream (and associated conflict zone between cold, dry air masses from Canada and warm, moist air masses from the Gulf of Mexico) drops further southward into the United States - bringing major rain, ice and snow events, and much more variable, and sometimes dramatically colder, temperatures. Areas in the extreme southern US (Florida, the Gulf Coast, the Desert Southwest, and southern California) however, often have more stable weather, as the polar jet stream's impact does not usually reach that far south.

In the cold season (generally November to March), most precipitation occurs in conjunction with organized low-pressure systems and associated fronts, especially in the east-central, eastern and southeastern states. Average winter-season precipitation is especially heavy in Tennessee, Kentucky and the northern Gulf Coast states, and coastal North Atlantic districts. In the summer, storms are much more localized, with short-duration thunderstorms common in many areas east of the 100th meridian. In the warm season, storm systems affecting a large area are less frequent, and weather conditions are more solar controlled, with the greatest chance for thunderstorm and severe weather activity during peak heating hours, mostly between 3 PM and 9 PM local time. From May to August especially, often-overnight mesoscale-convective-system (MCS) thunderstorm complexes, usually associated with frontal activity, can deliver significant to flooding rainfall amounts from the Dakotas/Nebraska eastward across Iowa/Minnesota to the Great Lakes states. From late summer into fall (mostly August to October), tropical cyclones sometimes approach or cross the Gulf and south Atlantic states, bringing high winds, heavy rainfall, and storm surges (often topped with battering waves) to coastal areas. More rarely, tropical cyclones can affect the mid-Atlantic and Northeastern states, such as with the "Long Island Express" hurricane in September 1938, and Superstorm Sandy in October 2012.

Brazil—General Climate

The **climate of Brazil** varies considerably mostly from tropical north (the equator traverses the mouth of the Amazon) to temperate zones south of the Tropic of Capricorn (23°26' S latitude). Temperatures below the equator are high, averaging above 25 °C (77 °F), but not reaching the summer extremes of up to 40 °C (104 °F) in the temperate zones. There is little seasonal variation near the equator, although at times it can get cool enough to need to wear a jacket, especially in the rain. Average temperatures below the Capricorn Tropic are mild, ranging from 13 °C (55 °F) to 22 °C (72 °F).

At the country's other extreme, there are frosts south of the Tropic of Capricorn and during the winter (June–September), and in some years there are snowfalls on the high plateau and mountainous areas of some regions. Snow falls in the mountains of the states of Rio Grande do Sul, Santa Catarina, and Paraná and it is possible but very rare in the states of São Paulo, Rio de Janeiro, Minas Gerais, and Espírito Santo. The cities of Belo Horizonte and Brasília have moderate temperatures, usually between 15 and 30 °C (59 and 86 °F), because of their elevation of approximately 1,000 metres (3,281 ft). Rio de Janeiro, Recife, and Salvador on the coast have warm climates, with average temperatures of each month ranging from 23 to 27 °C (73 to 81 °F), but enjoy constant trade winds. The cities of São Paulo, Curitiba, Florianópolis and Porto Alegre have a subtropical climate similar to that of southern United States, and temperatures can fall below freezing in winter.

Precipitation levels vary widely. Most of Brazil has moderate rainfall of between 1,000 and 1,500 mm (39 and 59 in) a year, with most of the rain falling in the summer (between December and April) south of the Equator. The Amazon region is notoriously humid, with rainfall generally more than 2,000 mm (79 in) per year and reaching as high as 3,000 mm (118 in) in parts of the western Amazon and near Belém. It is less widely known that, despite high annual precipitation, the Amazon rain forest has a three- to five-month dry season, the timing of which varies according to location north or south of the equator.

High and relatively regular levels of precipitation in the Amazon contrast sharply with the dryness of the semiarid Northeast, where rainfall is highly erratic and there are severe droughts in cycles averaging seven years. The Northeast is the driest part of the country. The region also constitutes the hottest part of Brazil, where during the dry season between May and November, temperatures of more than 38 °C (100 °F) have been recorded. However, the sertão, a region of semidesert vegetation used primarily for low-density ranching, turns green when there is rain. Most of the Center-West has 1,500 to 2,000 mm (59 to 79 in) of rain per year, with a pronounced dry season in the middle of the year, while the South and most of the East is without a distinct dry season.

Bangladesh—General Climate

Bangladesh has a subtropical monsoon climate characterized by wide seasonal variations in rainfall, high temperatures and humidity. There are three distinct seasons in Bangladesh: a hot, humid summer from March to June; a cool, rainy monsoon season from June to October; and a cool, dry winter from October to March. In general, maximum summer temperatures range between 30°C and 40°C. April is the warmest month in most parts of the country. January is the coldest month, when the average temperature for most of the country is about 10°C. http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

The minimum termperature in different locations of the country ranges from 10.0ºC to 15.40ºC and lowest recorded Srimangal under Habiganj district and highest recorded in Cox's Bazar district on the bank of Bay of Bengal. The maximum normal temperature in different locations of the country ranges from 31.80ºC in Mymenshing district to 36.10ºC in Chuadanga district.

Heavy **rainfall** is characteristic of Bangladesh. Most rains occur during the monsoon (June-September) and little in winter (November-February). With the exception of the relatively dry western region of Rajshahi, where the annual rainfall is about 1600 mm, most parts of the country receive at least 2000 mm of rainfall per year. Because of its location just south of the foothills of the Himalayas, where monsoon winds turn west and northwest, the regions in northeastern Bangladesh receives the greatest average precipitation, sometimes over 4000 mm per year. About 80 percent of Bangladesh's rain falls during the monsoon season (WeatherOnline, 2015). http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

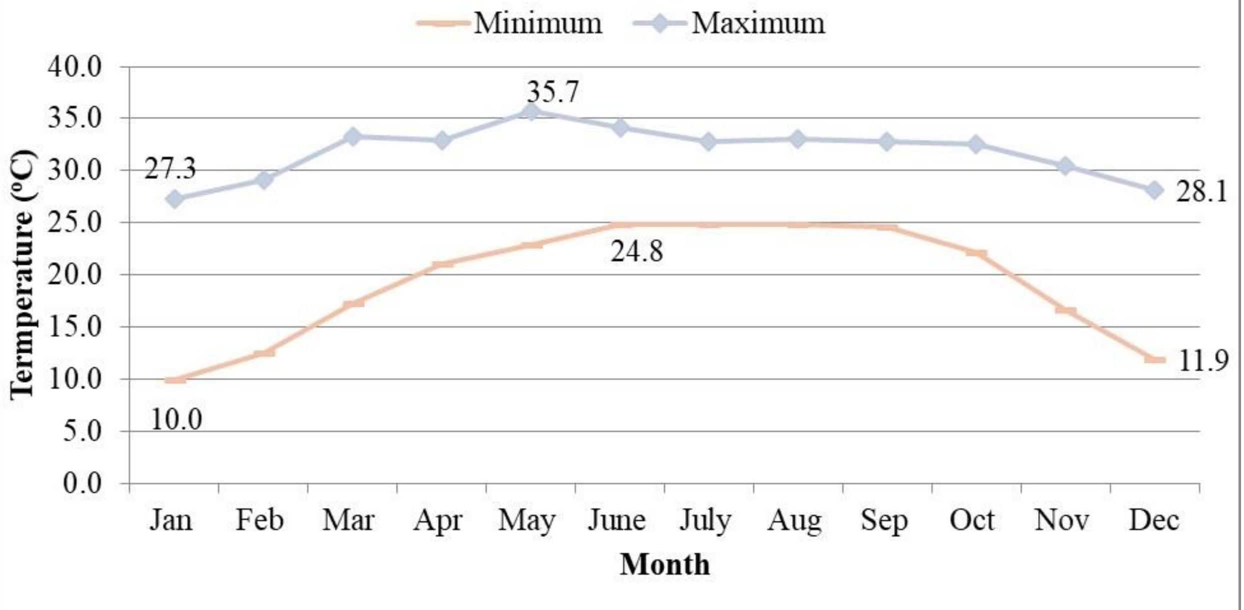


Figure 23. Monthly distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

Köppen climate classification

The Climate of Bangladesh can be divided in different climate zones. The central and southern part can be classified as **Aw** climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The northern mountainous areas can be classified as **Cwa** climate; a Temperated, humid climate with the warmest month above 22°C and a dry period in the winter (Arnfield, 2014).

http://www.weatheronline.co.uk/reports/climate/Bangladesh.htm

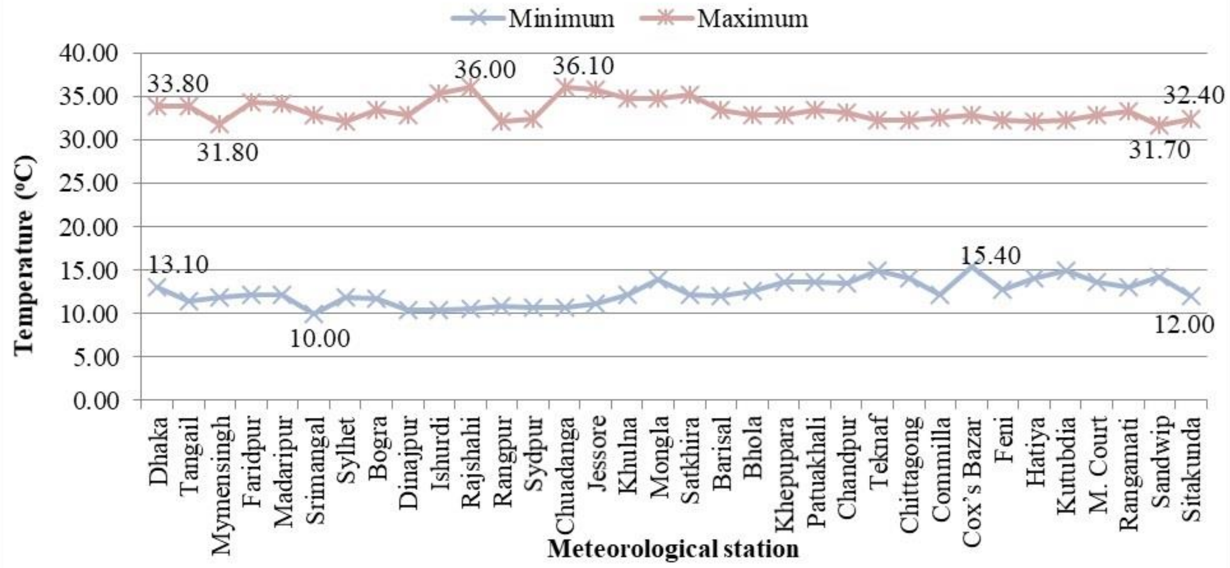


Figure 24. Location-wise distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

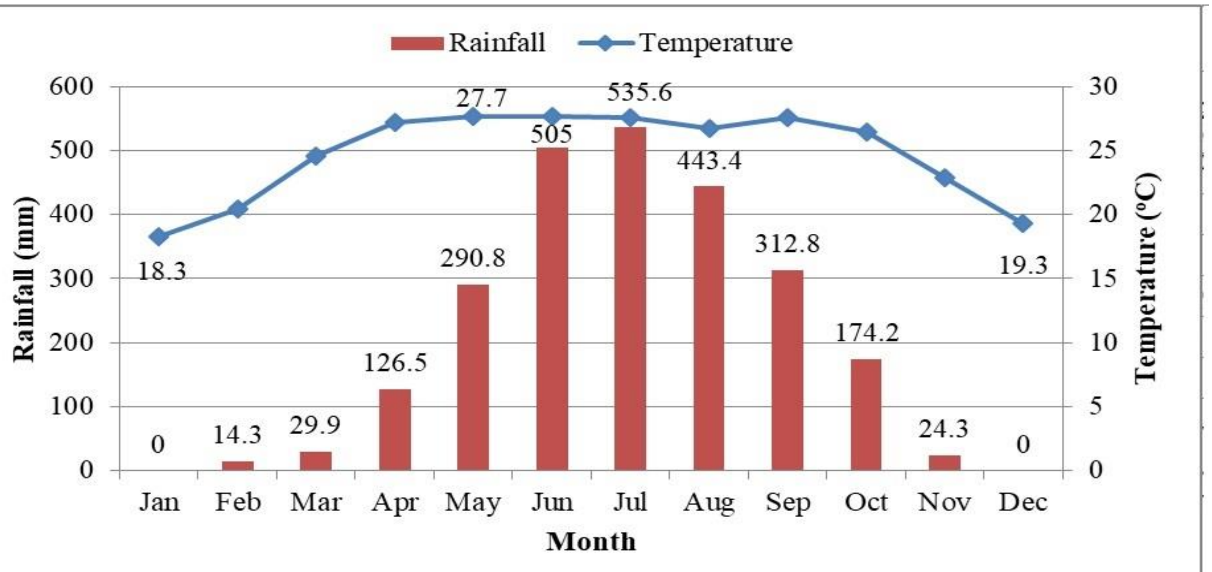


Figure 25. Average monthly Temperature and Rainfall for Bangladesh from 1960-1990

Source: World Bank Group (2015)

CHAPTER IV

RISK ASSESSMENT

C. capitata is an EPPO A2 quarantine pest (OEPP/EPPO, 1981), and is also of quarantine significance throughout the world (CPPC, NAPPO, APPPC) and especially for Japan and the USA. Its presence in Hawaii, but not in mainland USA, has contributed to its high international profile as a quarantine pest. In the EPPO region, *C. capitata* has reached the limits of its natural distribution and does not appear likely to establish in any major new areas (but possibly around the Black Sea). However, its presence even as temporary adventive populations could lead to severe additional constraints for export of fruits to uninfested areas in other continents. In this respect, *C. capitata* is one of the most significant quarantine pests for the EPPO region. For this reasons the quarantine risk assessment of medfly has been analyzed details as follows:

4.1. Hazard identification

Scientific Name: *Ceratitis capitata* (Wiedemann)
Synonyms:

Ceratitis citriperda MacLeay
Ceratitis hispanica De Brême
Pardalaspis asparagi Bezzi
Tephritis capitata Wiedemann

Common names: Mediterranean fruit fly, medfly (English)

4.2. Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Diptera
Family: Tephritidae
Genus: Ceratitis
Species: *Ceratitis capitata*

EPPO Code: CERTCA
EPPO A2 list No: 105

Bangladesh status: Not present in Bangladesh [EPPO, 2014; CABI/EPPO, 2015]

4.3. Biology

Eggs of *C. capitata* are laid below the skin of the host fruit. They hatch within 2-4 days (up to 16-18 days in cool weather) and the larvae feed for another 6-11 days (at 13-28°C). Pupariation is in the soil under the host plant and adults emerge after 6-11 days (24-26°C; longer in cool conditions) and adults live for up to 2 months (field-caged) (Christenson & Foote, 1960). *C. capitata* will not in practice survive sub-zero winter temperatures; it is well named Mediterranean, for the area in which it survives in the EPPO region is precisely that (virtually coinciding with where Citrus is grown). Worner (1988) uses the climate-matching system to evaluate the areas of potential establishment of *C. capitata* in New Zealand.

4.4. Detection and Identification

Symptoms

Attacked fruit usually shows signs of oviposition punctures.

Morphology

C. capitata, like other *Ceratitis spp*., has banded wings, and a swollen scutellum which is marked yellow and black. The pattern of grey flecks in the basal wing cells distinguishes *Ceratitis spp.* from most other genera of tephritids. Recently, DNA probes have been proposed as a practical means of discriminating between all life stages of the three main tephritids present in Hawaii (*C. capitata, Bactrocera cucurbitae* and *B. dorsalis*) (Haymer *et al.,* 1994).

Larva

Described by Hardy (1949), Orian & Moutia (1960), Sabatino (1974), Berg (1979), Heppner (1985), Smith (1989), White & Elson-Harris (1992). Electrophoretic methodshave been tried out to distinguish larvae of *B. tryoni* from those of *C. capitata* (Dadour *et al.,* 1992).

Adult

Colour: Wing bands and general body colour yellow; scutellum entirely black in apical half, with a sinuate yellow line across it sub-basally; costal band starting beyond the endof vein R1, and separated from discal crossband by a hyaline area at the end of R1.

Head: Male anterior pair of orbital setae modified into spatulate appendages, with a sharp apex to the spatulate section, which is black.

Thorax: Male mid-tibia without stout setae arranged in such a way as to give a feathered appearance. Wing length 4-6 mm.

Fortunately the males of this most serious of tephritid pests have a unique feature. The head of the male bears a pair of spatulate appendages which have sharp-pointed ends and the colour of the spatulate sections is black. Related species in subgenus *Ceratitis*, such as *C. malgassa*, have blunt spatulate appendages with a white spatulate section. The males also lack the feathered mid-tibia that characterizes most species of subgenus *Pterandrus*.

Detection and inspection methods

C. capitata can be monitored by traps baited with male lures. As in other tested species belonging to the subgenus *Ceratitis*, males are attracted to trimedlure and terpinyl acetate, but not methyl eugenol. Ceralure is a new potent and persistent attractant for *C. capitata* (Avery *et al.,* 1994). The responses to baits of 16 *Ceratitis* species were tabulated by Hancock (1987). Trimedlure (t-butyl-4(or 5)-chloro-2-methyl cyclohexane carboxylate) is the most widely used lure for *C. capitata*. The history of trimedlure development and the problems of isolating the best of the eight possible isomers are discussed by Cunningham (1989a). The lure is usually placed on a cottonwool wick suspended in the middle of a plastic trap that has small openings at both ends; Drew (1982) describes the Steiner trap. Lure can either be mixed with an insecticide or a piece of paper dipped in dichlorvos can be placed in the trap. Traps are usually placed in fruit trees at a height of about 2 m above ground and should be emptied regularly as it is possible to catch hundreds of flies in a single trap left for just a few days, although the lure may remain effective for a few weeks. A review of the biological aspects of male lures is presented by Cunningham (1989a) and the use of lures is described more fully by Drew (1982). A trapping system used to monitor for possible introductions of *C. capitata* into New Zealand has been described by Somerfield (1989).

4.5. Hosts

C. capitata is a highly polyphagous species whose larvae develop in a very wide range of unrelated fruits. On Hawaii (USA), 60 out of 196 fruit species examined over the years 1949-85 were at least once found as hosts of *C. capitata*; the two most important hosts were coffee (*Coffea arabica*) and *Solanum pseudocapsicum* (Liquido *et al.,* 1989). In the EPPO region, important hosts include apples (*Malus pumila*), avocados *(Persea americana*), Citrus, figs (*Ficus carica*), kiwifruits (*Actinidia deliciosa*), mangoes (*Mangifera indica*), medlars (*Mespilus germanica*), pears (*Pyrus communis*), *Prunus* spp. (especially peaches, *P. persica*), in fact practically all the tree fruit crops. It has also been recorded from wild hosts belonging to a large number of families.

Major hosts: *Annona cherimola* (cherimoya); *Capsicum annuum* (bell pepper); Coffea; *Ficus carica* (common fig); *Malus domestica* (apple); Prunus (stone fruit); *Prunus salicina* (Japanese plum); Citrus; *Psidium guajava* (guava) and *Theobroma cacao* (cocoa).

Minor hosts: *Averrhoa bilimbi* (bilimbi); *Averrhoa carambola* (carambola); *Capsicum frutescens* (chilli); *Carica papaya* (pawpaw); *Cinnamomum verum* (cinnamon); *Citrus aurantiifolia* (lime); *Citrus aurantium* (sour orange); *Citrus limetta* (sweet lemon tree); *Citrus limon* (lemon); *Cucumis* (melons, cucuimbers, gerkins); *Mangifera indica* (mango); *Punica granatum* (pomegranate); *Solanum lycopersicum* (tomato); *Solanum melongena* (aubergine) and *Ziziphus jujuba* (common jujube).

4.6. Distribution

C. capitata originates in tropical Africa, from where it has spread to the Mediterranean area and to parts of Central and South America.

EPPO region: Southern part of the EPPO region, i.e. Albania, Algeria, Croatia (Kovacevic, 1965), Cyprus, Egypt, France (very limited distribution in south only; Cayol & Causse, 1993), Greece (including Crete), Hungary (found but not established), Israel, Italy, Lebanon, Libya, Malta, Morocco, Portugal (including Azores and Madeira), Russia (southern, found but not established), Slovenia, Spain (including Balearic and Canary Islands), Switzerland (limited distribution), Syria, Tunisia, Turkey, Ukraine (outbreaks in the south eradicated). Records in northern or central Europe (Austria, Belgium, Bulgaria, Czech Republic, Germany, Hungary, Luxemburg, Netherland, Sweden, UK) refer to interceptions or short-lived adventive populations only (Karpati, 1983; Fischer-Colbrie & Busch-Petersen, 1989).

Asia: Afghanistan (unconfirmed), Cyprus, India (single quarantine interception; Kapoor, 1989), Israel, Jordan, Lebanon, Saudi Arabia, Syria, Turkey, Yemen.

Africa: Algeria, Angola, Benin, Burkina Faso, Burundi, Botswana, Cameroon, Cape Verde Islands, Congo, Côte d'Ivoire, Egypt, Ethiopia, Gabon, Ghana, Guinea, Kenya, Liberia, Libya, Madagascar (also the related species C. malgassa), Malawi, Mali, Mauritius, Morocco, Mozambique, Niger, Nigeria, Réunion, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, St. Helena, Sudan, Tanzania, Togo, Tunisia, Uganda, Zaire, Zimbabwe. Karpati (1983) lists some other African countries but does not give the source of his data.

North America: Bermuda (eradicated). USA (only Hawaii); introduced and eradicated several times in California during 1980s and 1990s; introduced, eradicated and still absent in Florida and Texas (Cunningham, 1989b; Lorraine & Chambers, 1989). Eradicated from Mexico.

Central America and Caribbean: Belize (eradicated), Costa Rica, El Salvador, Guatemala, Honduras, Jamaica, Netherlands Antilles, Nicaragua, Panama. The related species C. malgassa, from Madagascar, was at one time established in Puerto Rico (Steyskal, 1982).
South America: Argentina (locally), Bolivia, Brazil (Espirito Santo, Goias, Minas Gerais, Paraná, Rio Grande do Sul, São Paulo), Chile (extreme north only, declared eradicated in 1996), Colombia, Ecuador, Paraguay, Peru, Suriname, Uruguay, Venezuela.

Oceania: Australia (found but not established in New South Wales, limited distribution in Western Australia), Northern Mariana Islands.

EU: Present.

4.7. Hazard Identification Conclusion

Considering the facts that *C. capitata*-

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 2016];
- *C. capitata* is a highly invasive species. It has a high dispersive ability, a very large host range and a tolerance of both natural and cultivated habitats over a comparatively wide

temperature range. It has a high economic impact, affecting production, control costs and market access. It has successfully established in many parts of the world, often as a result of multiple introductions (Malacrida *et al.,* 2007).

- will be potentially economic important to Bangladesh because it is a major pest of several crops like tea, citrus, orchids, mango, papawa etc which are also important crops in our country.
- The degree of polyphagy of *C. capitata*its numerous economically important host-plants, and the rapid escalation of international trade in fresh plant material and produce, mean that this species presents a high risk of introduction.
- ***C. capitata*** is an important pest in Africa and has spread to almost every other continent to become the single most important pest species in the family. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In Mediterranean countries, it is particularly damaging on citrus and peaches. It also transmits fruit-rotting fungi (Cayol *et al.*, 1994).
- *C. capitata* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

4.7.1. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 4.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. Has this pest been established in several new countries in recent years? Yes, • Original from tropical Africa, *C. capitata* widely spread to the Mediterranean Basin, Southern Europe and most tropical and subtropical regions throughout the world (Malacrida *et al.,* 2007; EPPO, 2013). This species was also reported to be present in countries neighboring to Romania, such as Serbia (Glavendekic *et al.,* 2005), Hungary (Bodor *et al.,* 2011) and Bulgaria (Staneva, 2006). The extensive studies found in recent literature, that evaluated the potential of the geographic distribution of *C. capitata* in climate-based scenarios, estimated that it poses great abilities to penetrate into zones with wide climatic regimes, outside of its current distribution in Europe (Baini *et al.,* 2009; Vera *et al.,* 2002, De Meyer *et al.,* 2008). This species is native to both the Ethiopian and Palearctic regions, and introduced populations have since been discovered in all of the biogeographic regions. The pest already established in many countries from where a varietal fruits are imported every year. These countries are Jordan (EPPO, 2014; CABI/EPPO, 2015); Lebanon (EPPO, 2014; CABI/EPPO, 2015); Saudi Arabia (EPPO, 2014; CABI/EPPO, 2015); Syria (Ali *et. al.,* 2015); Turkey (Fimiani,1989); Cameroon (EPPO, 2014; CABI/EPPO, 2015); Congo (EPPO, 2014; CABI/EPPO, 2015); Egypt (EPPO, 2014; CABI/EPPO, 2015) etc. **b. Possibility of survival during transport, storage and transfer? Yes** • The eggs of *C. capitata* are laid below the skin of the host fruit. They hatch within 2-4 days (up to 16-18 days in cool weather) and the larvae feed for another 6-11 days (at 13-28°C). Pupariation is in the soil under the host	**YES and HIGH**

plant, the adults emerge after 6-11 days (24-26°C; longer in cool conditions) (Christenson and Foote, 1960), and after adult emergence, ovarian development at 25°C takes 5 days (Duyck and Quilici, 2002). The thermal constant for development from egg to adult is 260°D (Duyck and Quilici, 2002). Christenson and Foote (1960) report that adult *C. capitata* live for up to 2 months (field-caged). The transport, storage and transfer duration of fruits is about 20 days and the storage temperature for fruits is about 15-20^0C in our country, so the duration and as well as the storage condition is favorable for its survival.

c. Does the pathway appear good for this pest to enter Bangladesh and establishment and spread? - Yes,

- The major risk is from the import of fruit containing larvae, either as part of cargo, or through the smuggling of fruit in airline passenger baggage or mail. For example, in New Zealand, Baker and Cowley (1991) recorded 7-33 interceptions of fruit flies per year in cargo and 10-28 per year in passenger baggage. Private individuals who successfully smuggle fruit are likely to discard it when they discover that it is rotten. This method of introduction has been suggested to account for the discovery of at least one fly in a trap in California every year (Foote et al., 1993), although this notion has been strongly criticized by others that suggest the presence of a barely detectable, establish population (Papadopoulos *et al.,* 2013). Transportation of fresh fruit by air (either commercially, or incidentally by travelers) has greatly increased the risk of accidental introduction of this species into other parts of the world, and strong efforts are made to prevent its spread. (Copeland, *et al.*, 2002; Dekker and Messing, 2005; Thomas, *et al.,* 2001).
- **Natural Dispersal:** The majority of mark-release-recapture studies on dispersal of *C. capitata* obtain recaptures no more than 1 km from the release site, although these results may represent limitations of the trapping array. There is evidence that *C. capitata* can fly at least 20 km (Fletcher, 1989).
- **Movement in Trade:** The transport of infested fruits is the major means of movement and dispersal to previously uninfested areas. Some host fruits are only infested when ripe, and this has been the basis for an 'infestation-free quarantine procedure' for avocados exported from Hawaii to mainland USA. This was recently called into question when fruits still on the tree were found to be infested (Liquido *et al.,* 1995).

d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes

- *C. capitata* is an extremely polyphagous species, more than 350 cultivated and wild fruit and vegetable species having been recorded as host plants for it (Thomas *et al.,* 2001). Among these, the fruit crops of high commercial importance as plums (*Prunus spp*.), peaches (*P. persica*), apricots (*P. armeniaca*), cherries (*P. cerasi*), apples (*Malus domestica*), pears (*Pyrus communis*), mandarins (*Citrus reticulata*), oranges (*Citrus sinensis*), lemons (*Citrus limon*), grapefruits (*Citrus paradisi*), figs (*Ficus carica*), persimmon (*Diospyros kaki*), jujube (*Ziziphus jujuba*), *Psidium guajava* (guava), kiwifruits

(*Actinidia deliciosa*), *Capsicum frutescens* (chilli); *Carica papaya* (pawpaw), *Mangifera indica* (mango); *Punica granatum* (pomegranate); *Solanum lycopersicum* (tomato); *Solanum melongena* (aubergine) are also included. • Host range of *C. capitata* are very common in Bangladesh. • *C. capitata* lives in Mediterranean climates, which tends to coincide with where Citrus is grown). Although it is able to tolerate low temperatures, its northward expansion in Europe appears to have been prevented by the cold winters. The lower developmental temperature for larvae is 10.2°C (Duyck & Quilici, 2002). Adult activity is reduced or suspended at higher temperatures around 30°C, when the flies seek out cooler areas (Cayol, 1996). In the absence of behavioural thermoregulation, the lower and upper temperatures that permit coordinated movement of adults are within the range of 5.4–6.6°C and 42.4–43.0°C, respectively. • So, the climatic requirements for growth and development of *C. capitata,* is more or less similar with the climatic condition of **Bangladesh**.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

4.7.2. Determine the Consequence establishment of this pest in Bangladesh

Table 4.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - No. • It is not still established in Bangladesh. It is confirmed by the present study because no *C. capitata* is captured by the trap putted throughout the country. But it will become a serious pest for our country after its establishment. **b. Economic impact and yield loss** • *C. capitata* is an important pest in Africa and has spread to almost every other continent to become the single most important pest species in its family. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In Mediterranean countries, it is particularly damaging to citrus and peach. It may also transmit fruit-rotting fungi (Cayol *et al.,* 1994). • Damage to fruit crops is frequently high and may reach 100% (Fimiani, 1989; Fischer-Colbrie and Busch-Petersen, 1989). In Central America, losses to coffee crops were estimated at 5-15% and the berries matured earlier and fell to the ground with reduced quality (Enkerlin *et al.,* 1989). As in areas where the fly is endemic, in outbreak conditions the economic impacts include reduced production, increased control costs and lost markets.	**Yes and Moderate**

• Fruit-growers and their governments around the world spend millions of dollars a year trying to control this pest and prevent it from spreading to new locations. ("Common Pests of Summer Fruit in Western Australia", 2003; International Atomic Energy Agency, 2003; Mau and Kessing, 1992). • Serious economic damage is caused by this insect in Tunisia; in mixed fruit cultivation crop losses can be from 80 to 100% (Jerraya, 2003). Citrus is the most affected host crop, with direct annual losses attributed to *C. capitata* of up to 38% of annual income from Tunisian citrusproduction (Driouchi, 1990; Lebdi Grissa, 2010). **c. Environmental Impact** • No impact of *C. capitata* on the natural environment or on other species has been observed, although the decline in populations of *Ceratitis catoirii* on Mauritius and Réunion may be due in part to competition from *C. capitata* (Duyck *et al.,* 2006). • Moreover use of this chemical insecticide for controlling the pest may harm to the environment and destroying the natural control system in the field. **d. Social Impact** • The social impact on fruit growers and their families caused by the presence or introduction of *C. capitata* is severe, mostly through reduced or lost income and increased costs of control. As a recognized and serious quarantine pest, loss of markets to producers in outbreak areas is also often severe.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

4.7.3. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 4.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	**Moderate**	**High**
Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

4.7.4. Risk Management Measures

- Avoid importation of infested fruits from those countries, where this pest is available.
- Consignments of fruits from countries where *C. capitata* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae.
- EPPO recommends (OEPP/EPPO, 1990) that fruits of *Citrus* or *Prunus* should have been treated by an appropriate method, e.g. in transit by cold treatment (e.g. 10, 11, 12, 14, 15 days at 0.0, 0.6, 1.1, 1.7 or 2.2°C, respectively,) or, for certain types of fruits, by vapour heat (e.g. keeping at 44°C for 8 h) (USDA, 1994), forced hot-air (Armstrong *et al*., 1995) or hot water treatment (Sharp & Picho-Martinez, 1989).
- Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf-life, although treatment schedules are available for specific cases (e.g. 32 g/m3 for 2-4 h; USDA, 1994).
- Irradiation has been proposed as disinfestation method (Ohta *et al.,* 1989).
- A combination of methyl bromide fumigation and cold treatment is also recommended against *C. capitata*.
- Wrapping fruits in shrinkwrap film has been investigated as a possible method of disinfesting fruits (Jang, 1990).

4.7.5. References

Armstrong, J.W.; Hu, B.K.S.; Brown, S.A. (1995) Single-temperature forced hot-air quarantine treatment to control fruit flies (Diptera: Tephritidae) in papaya. *J. Econo. Entomo.* 88, 678-682.

Avery, J.W.; Chambers, D.L.; Cunningham, R.T.; Leonhardt, B.A. (1994) Use of ceralure and trimedlure in Mediterranean fruit fly mass-trapping tests. *J. Entomol. Sci.* 29, 543-556.

Baini, L.I., Jun, M.A., Xuenan, H.U., Haijun, L., Runjie, Z. (2009). Potential Geographical Distributions of the Fruit Flies *Ceratitis capitata, Ceratitis cosyra*, and *Ceratitis rosa* in China. *J. Econo. Entomol*, 102 (**5**), 1781-1790.

Bateman, M.A. (1982) Chemical methods for suppression or eradication of fruit fly populations. In: Economic fruit flies of the South Pacific Region (Ed. by Drew, R.A.I.; Hooper, G.H.S.; Bateman, M.A.), pp. 115-128. 2nd edition. Queensland Department of Primary Industries, Brisbane, Australia.

Berg, G.H. (1979) Pictorial key to fruit fly larvae of the family Tephritidae. OIRSA, San Salvador, El Salvador.

Carey, J.R. (1992) The Mediterranean fruit fly in California: taking stock. California Agriculture 46, 12-17.

Cayol, J.P.; Causse, R. (1993) Mediterranean fruit fly *Ceratitis capitata* back in Southern France. *J. Applied Entomol.* 116, 94-100.

Cayol, J.P.; Causse, R.; Louis, C.; Barthes, J. (1994) Medfly *Ceratitis capitata* as a rot vector in laboratory conditions. Journal of Applied Entomology 117, 338-343.

Christenson, L.D.; Foote, R.H. (1960) Biology of fruit flies. Annual Review of Entomology 5, 171-192.

CIE (1988) Distribution Maps of Pests, Series A No. 1 (revised). CAB International, Wallingford, UK.

Cireasa, V., Rosu, F., Ursache, C. (1984). *Ziziphus jujube* Mill. a promising new fruit. In Lucrari Stiintifice Institutul Agronomic „Ion Ionescu de la Brad" Horticultura, 1983-1984, 27-28.

Copeland, R., R. Wharton, Q. Luke, M. Meyer. 2002. Indigenous Hosts of *Ceratitis capitata* (Diptera:Tephritidae) in Kenya. Annals of the Entomological Society of America, 95/6: 672-694. Accessed November 12, 2005 at http:// www. bioone. org/ bioone/? request=getdocument & issn=0013-8746& volume=095& issue=06& page=0672.

Cunningham, R.T. (1989a) Biology and physiology; parapheromones. In: World crop pests 3(A). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 221-230. Elsevier, Amsterdam, Netherlands.

Cunningham, R.T. (1989b) Population detection and assessment; population detection. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 169-173. Elsevier, Amsterdam, Netherlands.

Cunningham, R.T. (1989c) Control; insecticides; male annihilation. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 345-351. Elsevier, Amsterdam, Netherlands.

Dadour, I.R.; Yeates, D.K.; Postle, A.C. (1992) Two rapid diagnostic techniques for distinguishing Mediterranean fruit fly from *Bactrocera tryoni*. *J. Econo. Entomol.* 85, 208-211.

De Meyer, M., Robertson, M. P., Peterson, A. T., Mansell, M. W. (2008). Ecological niches and potential geographical distributions of Mediterranean fruit fly (*Ceratitis capitata*) and Natal fruit fly (*Ceratitis rosa*). *J. Biogeo*, 35(**2**), 270–281.

Dekker, L., R. Messing. 2005. "Introduction to Managing Fruit Flies in Hawai'i" (On-line). http://www.extento. hawaii.edu . Accessed November 12, 2005 at http:// www. extento. hawaii. edu/ kbase/ reports/ fruit_pest. htm.

Drew, R.A.I. (1982) Fruit fly collecting. In: Economic fruit flies of the South Pacific Region (Ed. by Drew, R.A.I.; Hooper, G.H.S.; Bateman, M.A.), pp. 129-139. 2nd edition. Queensland Department of Primary Industries, Brisbane, Australia.

EPPO (2013) PQR - EPPO database on quarantine pests (available online). http://www.eppo.int

Fischer-Colbrie, P.; Busch-Petersen, E. (1989) Pest status; temperate Europe and west Asia. In: World crop pests 3(A). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 91-99. Elsevier, Amsterdam, Netherlands.

Fletcher, B.S. (1989) Ecology; movements of tephritid fruit flies. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 209-219. Elsevier, Amsterdam, Netherlands.

Gilmore, J.E. (1989) Control; sterile insect technique (SIT); overview. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 353-363. Elsevier, Amsterdam, Netherlands.

González, R.H. (1978) Introduction and spread of agricultural pests in Latin America: analysis and prospects. FAO Plant Protection Bulletin 26, 41-52.

Hancock, D.L. (1987) Notes on some African Ceratitinae (Diptera: Tephritidae), with special reference to the Zimbabwean fauna. Transactions of the Zimbabwe Scientific Association 63, 47-57.

Hardy, D.E. (1949) Studies in Hawaiian fruit flies. Proceedings of the Entomological Society of Washington 51, 181-205.

Haymer, D.S.; Tanaka, T.; Teramae, C. (1994) DNA probes can be used to discriminate between tephritid species at all stages of the life cycle. *J. Econo. Entomol.* 87, 741-746.

Heppner, J.B. (1985) Larvae of fruit flies. II. *Ceratitis capitata* (Mediterranean fruit fly) (Diptera: Tephritidae). Entomology Circular, Division of Plant Industry, Florida Department of Agriculture and Consumer Services No. 273, pp. 1-2.

Jang, E.B. (1990) Fruit fly disinfestation of tropical fruits using semipermeable shrinkwrap film. Acta Horticulturae No. 269, 453-458.

Kapoor, V.C. (1989) Pest status; Indian sub-continent. In: World crop pests 3(A). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 59-62. Elsevier, Amsterdam, Netherlands.

Karpati, J.F. (1983) The Mediterranean fruit fly (its importance, detection and control). FAO, Rome, Italy.

Kovacevic, Z. (1965) [Remarks on the population movements of the Mediterranean fruit fly on the Yugoslavian Adriatic coast]. Anzeiger für Schädlingskunde 38, 151-153.

Liquido, N.J.; Chan, H.T., Jr.; McQuate, G.T. (1995) Hawaiian tephritid fruit flies (Diptera): integrity of the infestation-free quarantine procedure for 'Sharwil' avocado. *J. Econ. Entomol.* 88, 85-96.

Liquido, N.J.; Cunningham, R.T.; Nakagawa, S. (1989) Host plants of Mediterranean fruit fly on the island of Hawaii (1949-1985 survey). *J. Econ. Entomol.* 83, 1863-1878.

Lorraine, H.; Chambers, D.L. (1989) Control; eradication of exotic species: recent experiences in California. In: World crop pests 3(**B**). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 399-410. Elsevier, Amsterdam, Netherlands.

Malacrida, A.R., Gomulski, L.M., Bonizzoni, M., Bertin, S., Gasperi, G. & Guglielmino, C.R. (2007). Globalization and fruit fly invasion and expansion: the medfly paradigm. Genetica, 131(**1**), 1-9.

Mitchell, W.C.; Saul, S.H. (1990) Current control methods for the Mediterranean fruit fly, *Ceratitis capitata*, and their application in the USA. Review of Agricultural Entomology 78, 923-940.

Niccoli, A.; Sacchetti, P.; Lupi, E. (1991) [Observations on the capture of *Ceratitis capitata* in peach orchards in Tuscany]. Redia 74, 641-658.

OEPP/EPPO (1981) Data sheets on quarantine organisms No. 105, *Ceratitis capitata*. Bulletin OEPP/EPPO Bulletin 11 (**1**).

OEPP/EPPO (1990) Specific quarantine requirements. EPPO Technical Documents No. 1008.

Ohta, A.T.; Kaneshiro, K.Y.; Kurihara, J.S.; Kanegawa, K.M.; Nagamine, L.R. (1989) Gamma radiation and cold treatments for the disinfestation of the Mediterranean fruit fly in California-grown oranges and lemons. Pacific Science 43, 17-26

Orian, A.J.E.; Moutia, L.A. (1960) Fruit flies (Trypetidae) of economic importance in Mauritius. Revue Agricole et Sucrière de l'Ile Maurice 39, 142-150.

Roessler, Y. (1989) Control; insecticides; insecticidal bait and cover sprays. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 329-336. Elsevier, Amsterdam, Netherlands.

Roessler, Y.; Chen, C. (1994) The Mediterranean fruit fly, *Ceratitis capitata*, a major pest of citrus in Israel, its regulation and control. Bulletin OEPP/EPPO Bulletin 24, 813-816.

Sabatino, A. (1974) Distinctive morphological characters of the larvae of *Dacus oleae*, *Ceratitis capitata, Rhagoletis cerasi*. *Entomologica* 10, 109-116.

Schwarz, A.J.; Liedo, J.P.; Hendrichs, J.P. (1989) Control; sterile insect technique (SIT); current programme in Mexico. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 375-386. Elsevier, Amsterdam, Netherlands.

Sharp JL, Picho-Martinez H, 1989. Hot-water quarantine treatment to control fruit flies in mangoes imported into the United States from Peru. *J. Econo. Entomol.*, 83(**5**):1940-1943 (/isc/abstract/19911154790)

Sharp, J.L.; Picho-Martinez, H. (1989) Hot-water quarantine treatment to control fruit flies in mangoes imported into the United States from Peru. Journal of Economic Entomology 83, 1940-1943.

Smith, K.G.V. (1989) An introduction to the immature stages of British flies; Diptera larvae, with notes on eggs, puparia and pupae. Handbooks for the identification of British insects 10 (**14**), 280 pp. Royal Entomological Society of London, London, UK.

Somerfield, K.G. (1989) Establishment of fruit fly surveillance trapping in New Zealand. New Zealand Entomologist No. 12, 79-81.

Stancic, J. (1986) [Development of chemical control of the Mediterranean fruit fly of citrus in Algeria]. Annales de l'Institut National Agronomique El Harrach 10, 67-73.

Steyskal, G.C. (1982) A second species of *Ceratitis* (Diptera: Tephritidae) adventive in the New World. Proceedings of the Entomological Society of Washington 84, 165-166.

USDA (1994) Treatment manual. USDA/APHIS, Frederick, USA.

Vargas, R.I. (1989) Rearing; mass production of tephritid fruit flies. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 141-151. Elsevier, Amsterdam, Netherlands.

Vera, M.T., Rodriguez, R., Segura, D.F., Cladera, J.L., Sutherst R.W. (2002). Potential geographical distribution of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera:Tephritidae), with emphasis on Argentina and Australia. *Environ. Entomol.* 31(**6**), 1009-1022.

Wharton, R.H. (1989) Control; classical biological control of fruit-infesting Tephritidae. In: World crop pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. by Robinson, A.S.; Hooper, G.), pp. 303-313. Elsevier, Amsterdam, Netherlands.

White, I.M.; Elson-Harris, M.M. (1992) Fruit flies of economic significance, their identification and bionomics. CAB International, Wallingford, UK.

Worner, S.P. (1988) Ecoclimatic assessment of potential establishment of exotic pests. *J. Econo. Entomol.* 81, 973-983.

CHAPTER V

REVIEW OF MANAGEMENT OPTIONS

5.1. Introduction

The following assessment of pre-harvest and post-harvest practices reflects the current systems approach for risk management employed for Medflythat attack on commercially produced fruits/agricultural crops/plants. It is proposed that these practices combined with specific post-harvest treatment (such as fumigation and other requirements e.g. phytosanitary inspection) are used to manage the risks to importing countries posed by regulated organisms associated with the importation of fruits/agricultural crops/plants from exporting countries. The management options for Medflyof fruits/agricultural crops have been reviewed and presented below:

5.2. Management Strategies for Med fly

Controlling this pest remains a significant problem when considering the level and abundance of associated fruit damage and the difficulty in implementing effective control interventions. Worldwide, control measures against *C. capitata* are based on the establishment of an integrated pest management (IPM) program using several techniques, including insecticides (Primo-Millo *et al.,* 2003; Magaña *et al*., 2007), mass trapping (Katsoyannos *et al.,* 1999 b; Navarro-Llopis *et al.,* 2008), the sterile insect technique (Katsoyannos *et al.,* 1999 a; Hendrichs et al., 2002) and also biological control using parasitoids (Montoya *et al.,* 2005). Management of mealybug involves the following tactics:

5.2.1. Regulatory Control

- Many countries, such as the mainland USA, forbid the import of susceptible fruit without strict postharvest treatment having been applied by the exporter.
- This may involve fumigation, heat treatment (hot vapour or hot water), cold treatments, insecticidal dipping, or irradiation (Armstrong and Couey, 1989). For example, EPPO recommends (OEPP/EPPO, 1990) that fruits of Citrus or Prunus should have been treated by an appropriate method, for example, in transit by cold treatment (e.g. 10, 11, 12, 14, 15 days at 0.0, 0.6, 1.1, 1.7 or 2.2°C, respectively) or, for certain types of fruits, by vapour heat (e.g. 44°C for 8 h) (USDA, 1994), forced hot-air (Armstrong et al., 1995) or hot-water treatment (Sharp and Picho-Martinez, 1989).
- Irradiation is not accepted in most countries and many have now banned methyl bromide fumigation.
- Heat treatment tends to reduce the shelf life of most fruits and so the most effective method of regulatory control is to preferentially restrict imports of a given fruit to areas free of fruit fly attack.

5.2.2. Cultural Control and Sanitary Methods

- One of the most effective control techniques against fruit flies in general is to wrap fruit, either in newspaper, a paper bag, or in the case of long/thin fruits, a polythene sleeve.
- This is a simple physical barrier to oviposition but it has to be applied before the stage at which the fruit is attacked.
- When detected, it is important to gather all fallen and infected host fruits, and destroy them.

5.2.3. Chemical Control

- Although cover sprays of entire crops are sometimes used, the use of bait sprays is both more economical and more environmentally acceptable (Stancic, 1986; Roessler and Chen, 1994).
- A bait spray consists of a suitable insecticide (e.g. Malathion) mixed with a protein bait. Both males and females of fruit flies are attracted to protein sources emanating ammonia and so insecticides can be applied to just a few spots in an orchard and the flies will be attracted to these spots.
- The protein most widely used is hydrolysed protein, but some supplies of this are acid hydrolysed and so highly phytotoxic.
- Smith and Nannan (1988) have developed a system using autolysed protein; in Malaysia this has been developed into a very effective commercial product derived from brewery waste (developed for *Bactrocera* spp.).

5.2.4. Sterile Insect Technique

- The sterile insect technique (SIT) requires the release of millions of sterile flies into the wild population so that there is a strong likelihood of wild females mating with sterile males (Gilmore, 1989).
- SIT has been used against *C. capitata* in Argentina, Australia, Brazil, Costa Rica, Italy, Israel, Jordan, Mexico, Nicaragua, Palestine, Peru, Portugal, Spain, South Africa, Tunisia and the USA (California and Hawaii) (Klassen and Curtis, 2005).
- The largest of these programmes (Programa Moscamed) is being carried out in southern Mexico and is designed to stop the fly spreading north, and ultimately to eradicate it from Central America (Schwarz *et al.,* 1989).
- SIT depends on the ability to mass-rear millions of sterile flies and Vargas (1989) reviewed the required procedures.
- Chemosterilisation of wild females and males with lufenuron, an insect growth regulator, shows promise for the suppression of *C. capitata*.
- Females fed lufenuron or that have mated with lufenuron-fed males can reduce or prevent egg hatching (Casaña-Giner *et al.,* 1999).
- Field trials in which lufenuron was mixed with food-based attractants have demonstrated the effectiveness of this technique (Navarro-Llopis *et al.,* 2004; 2007; 2010).

5.2.5. Phermone Trapping

- Male annihilation utilizes the attraction of males to chemical lures (see Detection Methods) and this technique has been applied in Hawaii where it did have some impact on population size (Cunningham, 1989b).
- Mass trapping of females and males using densely-spaced baited traps is being used extensively in the Mediterranean region (Navarro-Llopis *et al.,* 2008).

5.2.6. Biological Control

- Biological control has been tried against *C. capitata,* but introduced parasitoids have had little impact (Wharton, 1989).
- *C. capitata* is susceptible to a range of entomopathogenic fungi and nematodes (see Natural Enemies), usually with larval and adult mortality being higher than that of pupae. Commercial formulations applications that include these pathogens or parasites are being developed and may prove useful in control of *C. capitata.*

5.3. Phytosanitary measures

5.3.1. Post-Harvest Procedures

The procedure is to sorting/grading to remove damaged/overripe/infested/infected fruits by med fly. The grading process is likely to remove fruits showing obvious signs of fungal and bacterial disease as well as the presence of larvae and eggs of med fly.

5.3.2. Visual Inspection

Visual inspection of fruit occurs at several points during the routine production and post-harvest pathway for fruits. These include:

- In-field monitoring during the growing season
- Harvesting
- Post-harvesting sorting and grading
- Packaging fruits for treatment
- Packaging of fruits for export
- Visual phytosanitary inspection

A visual inspection at multiple points of the pathway provides opportunities to remove infested/infected fruits and is considered an appropriate risk management option for regulated organism.

5.3.3. Application of phytosanitary measures

A number of different phytosanitary measures may be applied to pests based on the outcome of an import or pest risk analysis. Required measures may include:

- Surveillance for pest freedom;
- Testing prior to export for regulated pests which cannot be readily detected by inspection (e.g. viruses on propagating material);
- Specific pre-shipment pest control activities to be undertaken by the supply contracting party;
- The application of a pre-shipment treatment;
- Inspection of the export consignment;
- Treatment on arrival in Bangladesh.

5.3.4. Phytosanitary Measures

Consignments of fruits from countries where *C. capitata* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae.

- EPPO recommends (OEPP/EPPO, 1990) that fruits of Citrus or Prunus should have been treated by an appropriate method, e.g. in transit by cold treatment (e.g. 10, 11, 12, 14, 15 days at 0.0, 0.6, 1.1, 1.7 or 2.2°C, respectively,) or, for certain types of fruits, by vapour heat (e.g. keeping at 44°C for 8 h) (USDA, 1994), forced hot-air (Armstrong et al., 1995) or hot water treatment (Sharp & Picho-Martinez, 1989).
- Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf-life, although treatment schedules are available for specific cases (e.g. 32 g/m3 for 2-4 h; USDA, 1994).
- Irradiation has been proposed as disinfestation method (Ohta et al., 1989). A combination of methyl bromide fumigation and cold treatment is also recommended against C. capitata. Wrapping fruits in shrinkwrap film has been investigated as a possible method of disinfesting fruits (Jang, 1990).

5.3.5. Pre-shipment requirements

Inspection of the consignment: Bangladesh requires that the NPPO of the country of origin sample and inspect the consignment according to official procedures for all the visually detectable regulated pests specified by Plant Quarantine Wing (PQW) of the Departemnt of Agiculture Extension of Bangladesh.

Treatment of the consignment

The PQW of Bangladesh requires that the NPPO of the country of origin ensure that the fruits from which the fruits were collected, have been treated as specified by PQW of Bangladesh.

Documentation

- Bilateral quarantine arrangement: Required.
- Phytosanitary certificate: Required.
- Import permit/Authorisation to import: Required.

5.3.6. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all fruits exported to Bangladesh.

Before a phytosanitary certificate is to be issued, the NPPO of the country of origin must be satisfied that the following activities required by Ministry of Agiculture of Bangladesh have been undertaken.

The fruits have:

i) been inspected in accordance with appropriate official procedures and found to be free of any visually detectable regulated pests specified by PQW of Bangladesh.

AND, ONE OR MORE OF THE FOLLOWING;

ii) been sourced from a pest free area that is, as verified by pest surveillance methods (in accordance with the International Standards for Phytosanitary Measures; Requirements for the Establishment of Pest Free Areas, IPPC, FAO, Publication 4, 1996), free from a regulated pest(s).

iii) been sourced from a pest free place of production that is, as verified by pest surveillance methods (in accordance with the International Standards for Phytosanitary Measures; Requirements for the Establishment of Pest Free Places of Production and Pest Free Production Sites, IPPC, FAO, Publication 10, 1996), free from a regulated pest(s).

AND;

iv) been devitalised (rendered non-propagable) using an effective devitalisation treatment or process.

5.3.7. Additional declarations to the phytosanitary certificate

If satisfied that the pre-shipment activities have been undertaken, the NPPO of the country of origin must confirm this by providing the following additional declarations to the phytosanitary certificate:

"The fruits in this consignment have been:

- inspected according to appropriate official procedures and are considered to be free from the regulated pests specified by Plant Quarantine Wing under Department of Agriculture of Bangladesh, and to conform with Bangladesh's current phytosanitary requirements".

AND,

- subjected to an effective devitalisation treatment [details of treatment must be included on the phytosanitary certificate] rendering the consignment non-propagatable."

5.3.8. Transit requirements

The cucurbits must be packed and shipped in a manner to prevent infestation and/or contamination by regulated pests.

Where a consignment is split or has its packaging changed while in another country (or countries) *en route* to Bangladesh, a "Re-export Certificate" is required. Where a consignment is held under bond as a result of the need to change conveyances and is kept in the original shipping container, a "Re-export Certificate" is not required.

5.3.9. Inspection on arrival in Bangladesh

Plant Quarantine Wing of DAE, Bangladesh will check the accompanying documentation on arrival to confirm that it reconciles with the actual consignment.

5.3.10. Testing for regulated pests

PQW of DAE of Bangladesh may, on the specific request of the Director, PQW, test the consignment for regulated pests.

5.3.11. Actions undertaken on the interception/detection of organisms/contaminants

If regulated pests are intercepted/detected on the commodity, or associated packaging, the following actions undertaken as appropriate (depending on the pest identified):

- Treatment (where possible) at the discretion of the Director, PQW of Bangladesh;
- Reshipment of the consignment;
- Destruction of the consignment;
- The suspension of trade, until the cause of the non-compliance is investigated, identified and rectified to the satisfaction of PQW of DAE of Bangladesh.

Actions for the interception/detection of regulated non-plant `pests in accordance with the actions required by the relevant government department.

5.3.12. Biosecurity clearance

If regulated pests are not detected, or are successfully treated following interception/detection, and there is no evidence to suggest the plant material is propagatable, biosecurity clearance given.

5.3.13. Feedback on non-compliance

The NPPO will be informed by the Director, Plant Quarantine Wing of Bangladesh, of the interception (and treatment) of any regulated pests, “unlisted” pests, or non-compliance with other phytosanitary requirements.

5.4. References

Armstrong JW, Couey HM, 1989. Control; fruit disinfestation; fumigation, heat and cold. In: Robinson AS, Hooper G, eds. Fruit Flies; their Biology, Natural Enemies and Control. World Crop Pests. Amsterdam, Netherlands: Elsevier, 3(**B**):411-424

Armstrong JW, Hu BKS, Brown SA, 1995. Single-temperature forced hot-air quarantine treatment to control fruit flies (Diptera: Tephritidae) in papaya. *J. Econ. Entomol*., 88(**3**):678-682 (/isc/abstract/19951109012)

Casaña-Giner V, Gandía-Balaguer A, Mengod-Puerta C, Primo-Millo J, Primo-Yúfera E, 1999. Insect growth regulators as chemosterilants for *Ceratitis capitata* (Diptera: Tephritidae). *J. Econ. Entomol*., 92 (**2**):303-308 (/isc/abstract/19991106671)

Cunningham RT, 1989. Control; insecticides; male annihilation. In: Robinson AS, Hooper G, eds. Fruit Flies; Their Biology, Natural Enemies and Control. World Crop Pests 3(**B**):345-351. Amsterdam, Netherlands: Elsevier

Gilmore JE, 1989. Control; sterile insect technique (SIT); overview. In: Robinson AS, Hooper G, eds. Fruit Flies; Their Biology, Natural Enemies and Control. World Crop Pests 3(**B**). Amsterdam, Netherlands: Elsevier, 353-363

Klassen K, Curtis CF, 2005. History of the sterile insect technique. Principles and Practice in Area Wide Integrated Pest Management. In: Sterile Insect Technique. Principles and Practice in Area Wide Integrated Pest Management [ed. by Dyck, V. A. \Hendrichs, J. \Robinson, A.]., Netherlands: IAEA, Springer, 3-36

Navarro-Llopis V, Alfaro F, Domínguez J, Sanchis J, Primo J, 2008. Evaluation of traps and lures for mass trapping of Mediterranean fruit fly in citrus groves. *J. Econ. Entomol.*, 101(**1**):126131.http://www.bioone.org/doi/abs/10.1603/00220493%282008%29101%5B126%3AEOTALF%5D2.0.CO%3B2(/isc/abstract/20093307708)

Navarro-Llopis V, Domínguez-Ruiz J, Zarzo M, Alfaro C, Primo J, 2010. Mediterranean fruit fly suppression using chemosterilants for area-wide integrated pest management. Pest Management Science, 66(**5**):511-519. http://www.interscience.wiley.com/pestmanagementscience (/isc/abstract/20103151152)

Navarro-Llopis V, Sanchis J, Primo-Millo J, Primo-Yúfera E, 2007. Chemosterilants as control agents of *Ceratitis capitata* (Diptera: Tephritidae) in field trials. Bulletin of Entomological Research, 97(**4**):359-368. http://journals.cambridge.org/action/displayJournal?jid=ber (/isc/abstract/20073185880)

Navarro-Llopis V, Sanchis-Cabanes J, Ayala I, Casaña-Giner V, Primo-Yúfera E, 2004. Efficacy of lufenuron as chemosterilant against Ceratitis capitata in field trials. Pest Management Science, 60(**9**):914-920. http://www.interscience.wiley.com/pestmanagementscience (/isc/abstract/20043150142)

Roessler Y, Chen C, 1994. The Mediterranean fruit fly, *Ceratitis capitata*, a major pest of citrus in Israel, its regulation and control. Bulletin OEPP/EPPO, 24:813-816

Schwarz AJ, Liedo JP, Hendrichs JP, 1989. Control; sterile insect technique (SIT); current programme in Mexico. In: Robinson AS, Hooper G, eds. Fruit Flies; Their Biology, Natural Enemies and Control. World Crop Pests 3(**B**):375-386. Amsterdam, Netherlands: Elsevier

Sharp JL, Picho-Martinez H, 1989. Hot-water quarantine treatment to control fruit flies in mangoes imported into the United States from Peru. *J. Econ. Entomol*., 83(**5**):1940-1943 (/isc/abstract/19911154790)

Smith D, Nannan L, 1988. Yeast autolysate bait sprays for control of Queensland fruit fly on passionfruit in Queensland. Queensland *J. Agri. Ani. Sci.*, 45(**2**):169-177 (/isc/abstract/19901144999)

Stancic J, 1986. Development of chemical control of the Mediterranean fruit fly of citrus in Algeria (*Ceratitis capitata* Wied.). Annales de l'Institut National Agronomique El-Harrach, 10(**1**):67-73 (/isc/abstract/19880350289)

USDA, 1994. Treatment manual. Frederick, USA: USDA/APHIS

Vargas RI, 1989. Rearing; mass production of tephritid fruit flies. In: Robinson AS, Hooper G, eds. Fruit Flies; Their Biology, Natural Enemies and Control. World Crop Pests 3(**B**):141-151. Amsterdam, Netherlands: Elsevier

Wharton RH, 1989. Control; classical biological control of fruit-infesting Tephritidae, In: Robinson AS, Hooper G, eds. Fruit Flies; their Biology, Natural Enemies and Control. World Crop Pests 3(B). Amsterdam, Netherlands: Elsevier, 303-313.

CHAPTER VI

PHYTOSANITARY REQUIREMENTS

6.1. Phytosanitary Requirements for Importation of Fresh Fruits

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests assessed to pose an unacceptable level of risk to Bangladesh via the importation of fresh fruits commercially produced from Jordan, Cyprus, Lebanon, Saudi Arabia, Turkey, Algeria, Congo, Libya, USA, Brazil,Chile, Netherlands, Jamaicae or any other countries of fruits export (i.e. produced under standard cultivation, harvesting and packing activities). Plant Quarantine Wing of Bangladesh will consider the risk management measures proposed below is commensurate with the identified risks.

6.1.1. Requirements for Registered Export Establishments

i. Inspections, pre-shipment cold disinfestation, fumigation and irradiation treatments for quarantine pests must be conducted within registered export establishments.
ii. Export establishments are audited annually by the department and are required to have documented standard operating procedures (SOP) covering traceability and product security for each treatments.
iii. Export establishments involved in the export of fruits to Bangladesh must be registered with the department prior to commencement of export.
iv. Inspection of fruit from recognized Mediterranean fruit fly free areas, must be conducted in a registered export establishment located within the same pest free area.
v. Export establishment details for those establishments that have exported to Bangladesh under this protocol must be provided to PPD on request.

6.1.2. Management Measures for Pests of Concern

Growers participating in export trade from exporting countries undertake standard commercial infield controls ensuring appropriate pest management for produce destined for export. Verification that appropriate in-field measures have been effective is undertaken as part of export inspection.

6.1.3. Management Measures for Mediterranean fruit fly

- **Mediterranean fruit fly pest free area**

Fruit originating from areas recognized as being free from Mediterranean fruit fly (*Ceratitis capitata*), which complies with International Standards for Phytosanitary Measures (ISPM) 4 and 26 are not required to undergo mandatory disinfestation treatment. The department will notify PPD should outbreaks of Mediterranean fruit fly occur.

- **Areas not free from Mediterranean fruit fly**

Fruit originating from areas not free from Mediterranean fruit fly, must be subjected to one of the following treatments:

A. Cold disinfestation treatment

Fruit must be subjected to the following cold disinfestation treatment schedules. For fruit originating in areas where Mediterranean fruit fly is present:

Fruit pulp temperature	Exposure period
3^0C or below	20 days or more

Or

B. Irradiation treatment

Fruit must be subjected to irradiation treatment at a minimum absorbed dose of 400 Gray for Hemiptera (*Aspidiotus nerii* Bouché; *Hemiberlesia lataniae* (Signoret); *Isotenes miserana* (Walker); *Lepidosaphes gloverii* Packard; *Pseudococcus viburni* Signoret) and fruit flies of the family Tephritidae as per ISPM 18

Or

C. Methyl bromide fumigation treatment

Fruit must be subjected to treatment at the following rate:

Temperature	Dosage rate (gram/cu.m)	Exposure period (hour)
20^0C or greater	32 g/m^3	2

The loading ratio should not excessed 50% of the chamber volume.

6.2. Requirements for Cold Disinfestation Treatment

6.2.1. Cold disinfestation treatment can be performed pre-shipment or in-transit.

- The in-transit treatment may be carried out partly as a pre-shipment treatment started in exporting countries and completed in-transit.
- In the event of a treatment failure in-transit, treatment may be completed on arrival.

6.2.2. Pre-shipment cold disinfestation treatment and in-transit cold disinfestation treatment are assessed on fruit temperature sensors only.

6.2.3. Pre-shipment cold disinfestation treatment

- Treatment conducted prior to shipment must be supervised by the department in a cold disinfestation treatment facility registered with the department. Fruit intended for export to Bangladesh may be treated concurrently with fruits destined for other markets.
- If a consignment of fruits is to undergo pre-shipment cold disinfestation treatment, the department must ensure compliance with conditions specified in Attachment 2.

6.2.4. In-Transit Cold Disinfestation Treatment

- In-transit cold disinfestation treatment refers to cold disinfestation treatment conducted in-transit.
- In-transit cold disinfestation treatment in shipping containers may be commenced on-shore and completed in-transit or completed at destination.
- Fruits must be pre-cooled until fruits pulp temperature is at or below the target treatment temperature prior to initiation of the cold disinfestation treatment.
- If a consignment of fruit is to undergo in-transit cold disinfestation treatment, the department must ensure compliance with conditions specified in Attachment 3. A certificate of calibration for in-transit cold disinfestation treatment must accompany every consignment.

6.3. Requirements for Irradiation Treatment

- Irradiation treatment must be conducted in an irradiation facility registered as an export establishment with the department.
- The application of the irradiation treatment must be carried out in accordance with the relevant ISPMs. The following irradiation doses are approved for the treatment of orange fruit:
  - Minimum absorbed dose of 400 Gray for plant pests of the class Insecta except pupae and adults of the order Lepidoptera.
  - The maximum absorbed dose for fruits must not exceed 1 Kilogray as per the Food Standards Code (FSC) requirements
- If a consignment of fruits is to undergo irradiation treatment, the department must ensure compliance with conditions specified in Attachment 4.

6.4. Requirements for Packing and Labeling

- Packing material may be made of corrugated fiber-board, polystyrene, plastic or wooden crates that can be manufactured either from recycled material or virgin material. Where cartons are used, they must be clean and new.
- Fruits must be packed in containers which are free from soil, sand and contaminating plant materials e.g. leaves, twigs, plant debris or other potential carriers of quarantine pests.

- Fruits subjected to pre-shipment cold disinfestation treatment, fumigation or irradiation treatment and exported by sea or air freight must be packed in such a way to ensure product security is maintained.
- Fruits transported or treated in-transit in secure self-refrigerated shipping containers are exempt from the requirements.
- Each pallet must have necessary information to facilitate traceability. The following information must appear on each pallet, in English, as a minimum requirement.

All consignments other than those subject to irradiation

- "FOR BANGLADESH"
- Country of origin
- Name of exporting company
- Name of fruit (common name)
- Export establishment registration number

Irradiated consignments

- "FOR BANGLADESH"
- Country of origin
- Name of exporting company
- Name of fruit (common name)
- Export establishment registration number
- "Treated with ionising irradiation" or "Irradiated (food)"
- (Optional) Food irradiation symbol to be displayed near the name of fruit as follows:

All consignments destined to Bangladesh using solid wood packing material must comply with ISPM 15.

6.5. Export Inspection

Before fruits are certified for export to Bangladesh, the department must be satisfied that the following processes required by PPD have been undertaken.

- Fruits have been inspected by a departmental inspector or an officer authorised by the department in accordance with appropriate official procedures (aligned with ISPM 23 and 31) and found to be free from quarantine pests specified in Attachment 1; and
- Fruit that have originated from areas not recognised as Mediterranean fruit fly free have undergone one of the management measures for quarantine pests as specified in section 7; and
- Fruit are free from soil, sand and contaminating plant materials e.g. leaves, twigs, plant debris or other potential carriers of quarantine pests.

6.6. Phytosanitary Certification

A phytosanitary certificate issued by the department is required. The original copy must accompany each consignment and including additional declarations.

6.7. Treatment information

A. Cold disinfestation treatment

- If the consignment is subjected to pre-shipment cold disinfestation treatment, treatment temperature and period (number of consecutive days) must be inserted in the Treatment section of the phytosanitary certificate.
- If the consignment is subjected to in-transit cold disinfestation treatment, the original copy of the certificate of calibration for in-transit cold disinfestation treatment must accompany the phytosanitary certificate.

B. Irradiation treatment

- If the consignment is subjected to irradiation treatment, then the phytosanitary certificate must include the irradiation rate in the Treatment section of the phytosanitary certificate.

C. Fumigation treatment

- If the consignment is subjected to fumigation treatment, then the phytosanitary certificate must include the fumigation rate in the Treatment section of the phytosanitary certificate.

D. For sea freight the container and seal numbers must be recorded on the phytosanitary certificate.

6.8. On-arrival Inspection

In the case of live quarantine pests of concern to Bangladesh as listed in Attachment 1 being found during import inspection, the following measures may be taken.

Fruit that has been subjected to cold disinfestation treatment

(1) Mediterranean fruit flies

1.1) If any live Mediterranean fruit flies (any life stage) are found, the infested consignment must be re-exported or destroyed at the importer's expense. PPD will immediately notify the department of the interception.

1.2) The department shall immediately investigate the cause of such incidence and propose corrective actions. In the case a suspension of trade has been applied, the suspension will be lifted when the cause of non-compliance has been clarified and corrective actions have been implemented to the satisfaction of PPD.

(2) If any live quarantine pests other than Mediterranean fruit flies are found, the consignment shall be treated according to Bangladeshi phytosanitary legislation.

Fruit that has been subjected to irradiation treatment.

(1) If any live fruit flies (any life stage) are found, the consignment shall be released and PPD will immediately notify the department of the interception.

(2) If other live quarantine pests listed in Attachment 1, except pupae and adults of the order Lepidoptera, are found in a consignment treated at 400 Gray, the consignment shall be released and PPD will immediately notify the department of the interception.

6.9. Audit of Export Procedures

In the event of a suspension of trade, PPD may audit export certification procedures in Australia prior to a decision being taken on resumption of trade.

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