PEST RISK ANALYSIS (PRA) OF BRINJAL IN BANGLADESH




Strengthening Phytosanitary Capacity in Bangladesh Project

Plant Quarantine Wing

Department of Agricultural Extension

Khamarbari, Farmgate, Dhaka-1205

JUNE 2016

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Pest Risk Analysis (PRA) of Brinjal in Bangladesh

Eusuf and Associates

South Avenue Tower (4th Floor, Bloack A)
7 Gulshan Avenue, Dhaka 1212, Bangladesh

TeL: +(880-2) 880-2-883-2149, 880-2-883-2169, Fax: +88-02-988-6431
E-mail: eusuf@connectbd.com, Website: http//www.eusuf.org

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PANEL OF AUTHORS

Kbd. SK. Hemayet Hossain

Mr. Mallik A-As-Saqui

Dr. Mohammad Hossain

Dr. Md. Anwar Hossain

Dr. Nizam Uddin Al Hossainy

Dr. Humyun Kabir

Reviewed by

Md. Ahsan Ullah

PRA Consultant

Strengthening Phytosanitary Capacity in Bangladesh Project

Plant Quarantine Wing

Department of Agricultural Extension

Khamarbari, Farmgate, Dhaka-1205

www.dae.gov.bd

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 Brinjal in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Eusuf and Associates on December 2015. The PRA study is a four-month assignment commencing from 1 February 2016 under the SPCB-DAE.

The overall objectives of this Pest Risk Analysis are to identify the pests and/or pathways of quarantine concern for a specified area of brinjal and evaluate their risk, to identify endangered areas, and if appropriate, to identify risk management options. To carry out the PRA study, the consulting firm conducted field investigations in 70 upazila under 24 major brinjal growing districts of Bangladesh. The study covered the interview 7000 brinjal growers; 140 field level officers and 24 Policy Level officers (Additional Deputy Director) of DAE, 48 seed dealers and 48 pesticide dealers. The survey was also conducted 24 FGDs (one in each district) for qualitative data and visits of the brinjal fields under sampled districts. The consultants also reviewed secondary sources of information related to PRA of brinjal.

The study findings evidenced that a total of 46 pests of brinjal were recorded in Bangladesh, of which 20 were arthropod pests, 18 species of pathogenic microorganisms and 8 weeds. The study also revealed that 14 pests of brinjal were identified as quarantine importance for Bangladesh that included 7 insect pests, 1 mite, 1 fungi, 2 nematodes, 2 viral diseases and 1 weed that could be introduced into Bangladesh through importation of commercially produced eggplants. The consultant team also conducted the risk assessment for each quarantine pest individually based on the consequences and potential of introduction of each quarantine pest and a risk rating was estimated for each. Based on the risk assessment and risk rating, all of 14 quarantine pests were identified as high risk rating. The findings also suggested the risk management options for the quarantine pests of brinjal 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 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, BARI, SCA, Agricultural Universities, research organizations and brinjal importer and exporters' associations 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 Secretary, Additional Secretary, DG (Seed Wing), Additional Secretary (Extension), Director General of DAE, Director (Plant Quarantine Wing) and other high officials under the Ministry of Agriculture for providing us valuable advice and guidance. I hope that the report certainly would contribute to enhance the exports and imports of brinjal.

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

PREFACE

This report intends to respond to the requirement of the client according to the provision of contract agreement signed between Project Director of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) and the Eusuf and Associates for **"Conducting Pest Risk Analysis (PRA) of Brinjal in Bangladesh"** under Plant Quarantine Wing (PQW), Department of Agricultural Extension (DAE), Ministry of Agriculture (MOA), Government of the Peoples Republic of Bangladesh. The PRA study is a four-month assignment commencing from 1 February 2016 under the SPCB-DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Brinjal in Bangladesh" were provided by the Eusuf and Associates, Bangladesh. The study team consists of five senior level experts including field and office level support staffs. The major objective of the study is to listing of major and minor pests of brinjal, identification of pests likely to be associated with pathway, identification of potential for entry, establishment and spread, identification of potential economic and environmental impact, identification of control measures and potential impacts of such measures, assessment of potential loss by the pests, preparation of report on risk analysis of the pests following the relevant ISPMs and make recommendation.

This report includes study design, sampling framework and data collection instruments, guidelines and checklists, details of survey and data collection method, data management and analysis and survey finding as well as the stages of PRA, risk assessment strategies of the pests likely to be associated with the commodity to be imported from the exporting countries and the risk management options as recommendations. The report had been reviewed and discussed thoroughly by the SPCB officials along with other experts and representatives through several discussion meetings. This report had been presented in the national level workshop for further comments and suggestions. The consultants finally revised and prepared this report of the PRA study based on comments and suggestions of the client and experts.

(Dr. Mohammed Eusuf Ali)
President
Eusuf and Associates
Gulshan-1, Dhaka

ACKNOWLEDGEMENTS

It is indeed a great honor for us that Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW) of Department of Agricultural Extension (DAE) has entrusted Eusuf and Associates to carry out the "**Conducting Pest Risk Analysis (PRA) of Brinjal in Bangladesh"**. The Draft Report has been prepared based on the past four months (January 2016 to May 2016) activities of the survey study in major 24 brinjal growing districts of Bangladesh as well as on the review of secondary documents. In the process of working on the setting indicators and sampling as well as for revising the questionnaires for the field survey and data collection, monitoring and supervision, data analysis and report writing, we have enjoyed the support of SPCB-PQW. The PRA report was prepared by a team of experts led by Kbd SK Hemayet Hosain (Study Director), Mr Mallik A-As-Saqui ITeam Leader), Dr. Mohammad Hossain, (Entomologist), Dr. Md. Anwar Hossain (Plant Pathologist), Dr. Nizam Uddin Al Hossainy (Agronomist), and Dr. Humyun Kabir (Agriculture Economist).

The authors are grateful to all persons involved in the PRA study. Our special gratitude to Md. Hamidur Rahman, Director General, DAE, Bangladesh, who provided his extended support and gave us an opportunity to meet Director of Plant Quarantine Wing (PQW) of DAE. Special thanks to Dr. Mohammad Ali, Project Director, Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project; Mr. Md. Ahsan Ullah, Consultant (PRA); Mrs. Marina Jebunehar, Senior Monitoring and Evaluation Officer, SPCB for their valuable cooperation, guidance and suggestions to the study team in line with the activities performed during study and report preparation. Our special grateful thanks are also given to Mr. Shoumen Saha, Director, PQW of DAE for his kind cooperation and suggestions during the study period. The active support of Dr. Mohammad Eusuf Ali, President, Eusuf and Associates are acknowledged with thanks.

____

(Kbd SK Hemayet Hossain)
Study Director

ACRONYMS

AEZ	AGRO-ECOLOGICAL ZONE
BADC	BANGLADESH AGRICULTURE DEVELOPMENT CORPORATION
BARI	BANGLADESH AGRICULTURAL RESEARCH INSTITUTE
BBS	BANGLADESH BUREAU OF STATISTICS
CABI	CENTER FOR AGRICULTURE AND BIOSCIENCE INTERNATIONAL
DAE	DEPARTMENT OF AGRICULTURAL EXTENSION
DG	DIRECTOR GENERAL
DR.	DOCTOR
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
NGO	NON-GOVERNMENT ORGANIZATION
NO.	NUMBER
NPPO	NATIONAL PLANT PROTECTION ORGANIZATION
^{o}C	DEGREE CELSIUS
PD	PROJECT DIRECTOR
PFA	PEST FREE AREA
PPW	PLANT PROTECTION WING
PQW	PLANT QUARANTINE WING
PRA	PEST RISK ANALYSIS
PVT.	PRIVATE
RH	RELATIVE HUMIDITY
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 Brinjal in Bangladesh” documents the pests of seeds and brinjal available in Bangladesh and the risks associated with the import pathway of fresh seeds and brinjal from the exporting countries named India, China, Thailand, Japan and Malaysia into Bangladesh.

The findings evidenced that the 20 arthropod pests including 19 insect and one mite pests, 16 disease causing microorganisms and 8 weeds likely to be associated with the seeds and brinjal in Bangladesh. The insect pests of brinjal/eggplants included the brinjal shoot and fruit borer (*Leucinodes orbonalis*), cut worm (*Agrotis* spp.), leaf roller (*Eublemma olivacea* Walker), cotton leaf worm (*Spodoptera litura*), cabbage caterpillar (*Helicoverpa armigera*), eggplant moth (*Neoleucinodes elegantalis*), jassid (*Amrasca biguttula biguttula*), cotton aphid (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci*), scale insect (*Aulacaspis* spp.), mealybug (*Coccidohystrix insolita*), potato psyllid (*Bactericera cockerelli*), lace bug (*Gargaphia solani*), epilachna beetle (*Epilachna vigintioctopunctata* and *Epilachna dodecastigma*), blister beetle (*Mylabris pustulata*), spotted cucumber beetle (*Diabrotica undecimpunctat*), thrips (*Thrips palmi* Karny), leaf miner (*Liriomyza sativae*). While the one mite of brinjal named two-spotted spider mite (*Tetranychus urticae* Koch). Among these insect and mite pests, leaf roller, jassid and epilachna beetle are more damaging than others. Of which, brinjal shoot and fruit borer caused damage eggplants with high infestation intensity. Whereas, the pest status of all other insect and mite pests were minor and caused damage with low infestation intensity

A total number of 18 species of disease causing pathogens of seeds and brinjal were reported in Bangladesh, among which 12 diseases were caused by fungi, 2 diseases were caused by bacteria, 2 caused by nematodes, one disease was caused by virus and one caused by Phytoplasma. The fungal diseases of seeds and brinjal reported in Bangladesh were early blight (*Alternaria tomatophilia*), cercospora leaf spot (*Cercospora melongenae*), colletotrichum fruit rot (*Colletotrichum melongenae*), anthracnose (*Colletotrichum coccodes*), phomopsis fruit rot (*Phomopsis vexans*), phytophthora blight (*Phytophthora capsici*), Verticillium wilt (*Verticillium* spp.), stem rot/damping off (*Fusarium solani*), root rot (*Pythium* spp.), damping off (*Rhizoctonia* spp.), powdery mildew (*Podosphaera pannosa*), downy mildew (*Peronospora sparsa*). While the bacterial diseases of eggplants recorded in Bangladesh were bacterial wilt of brinjal (*Ralstonia solanacearum*), bacterial soft rot (*Erwinia carotovora* subsp. *carotovora*). The nemic diseases of eggplants were root knot nematode caused by *Meloidogyne incognita* and *M. javanica*. The viral disease of eggplants recorded in Bangladesh was *Tomato leaf curl New Delhi virus* and the disease caused by Phytoplasma was little leaf of brinjal caused by *Candidatus Phytopasma solani* But the incidences of golder cyst nematode (*Globodera rostochiensis*), and pale cyst nematode (*Globodera pallida*) were not reported as the diseases of eggplants in Bangladesh. Among these diseases, the phomopsis fruit rot, bacterial wilt and damping off of seedlings were more damaging than others. Bacterial wilt of eggplant was major disease caused damage with medium severity. All of other diseases were reported as minor diseases in Bangladesh with low infection intensity.

A total number of 8 weeds as problem in the field of brinjal were reported in Bangladesh. The weeds were were bermuda grass (*Cynodon dactylon*), nutsedge (Cyperus esculentus), goosefoot (*Chenopodium album* L.), pigweed (Amaranthus acanthochiton), spiny pigweed (*Amaranthus spinosus*), blacknightshade (*Solanum nigrum*), horsenettle (*Solanum carolinense* L.), parthenium weed (*Parthenium hysterophorus*). The parthenium weed (*Parthenium hysterophorus*) was recorded and found only some restricted areas of Bangladesh named Rajshahi, Natore, Pabna, Kustia, Jessore districts. It was also reported that the parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading. As a newly introduced weed, though parthenium caused damage with low infestation intensity, but it could cause severe damage and spread to other areas, if not controlled properly. Other seven weeds were reported as minor weeds with low infestation intensity.

Information on pests associated with seeds and brinjal in the exporting countries—India, China, Thailand and Japan—reveals that pests of quarantine importance exist. The study also revealed 14 pests of quarantine importance that included 7 insect pests, one mite pest; 7 disease causing microorganisms included one fungus, two nematode, and two viruses; and while one quarantine weed. Without mitigation, these pests could be introduced into Bangladesh through importation of commercially produced eggplants. Pests of quarantine importance includes insect pests named Malaysian fruit fly (*Bactrocera latifrons*), serpentine leaf miner (*Liriomyza trifolii*), pea leaf miner (*Liriomyza huidobrensis*), silver leaf whitfly (*Bemisia tabaci (B biotype))*, vegetable weevil (*Listroderes costirostris*), Alfafa thrips (*Frankliniella occidentalis*), and cotton leaf worm (*Spodoptera littoralis*). The quarantine mite pest seeds and of brinjal for Bangladesh is red tomato spider mite (*Tetranychus evansi*). On the other hand, seven disease causing micro-organisms and viruses have been identified as quarantine pests of eggplants for Bangladesh. Among these quarantine diseases, one fungus named Phytopthora root rot (*Phytophthora megasperma*); two species of nematode named Golden cyst nematode (*Globodera rostochiensis*), and Pale cyst nematode (*Globodera pallid*); two viruses named *Tobaccor ringspot virus* and *Pepper veinal mottle virus*. One species of quarantine weed has been identified Bangladesh named *Parthenium weed (Parthenium hysterophorus).*

The consequences and potential/likelihood of introduction of each quarantine pest were assessed individually, and a risk rating estimated for each. The consequence and potential of introduction value was estimated assessing biology, host, 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 risk in the absence of mitigation.

Out of 14 quarantine pests associated with the pathway risk assessed, all of 14 quarantine pests were rated with high risk potential. These mean that these pests pose unacceptable phytosanitary risk to Bangladesh's agriculture. Visual inspection at ports-of-entry for high risk potential pests is insufficient to safeguard Bangladesh's eggplant industry and specific phytosanitary measures are strongly recommended. While for moderate risk potential pest, specific phytosanitary measures may be necessary to reduce pest risk.

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CHAPTER 1

RISK ANALYSIS BACKGROUND AND PROCESS

1.1. Background

Pest Risk Analysis provides the rationale for phytosanitary measures for a specified PRA area. It evaluates scientific evidence to determine whether an organism is 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, economic and environmental evidences. If the risk is deemed unacceptable, the analysis may continue by the suggestions of management options that can reduce the risk to an acceptable level. Subsequently, pest risk management options may be used to establish phytosanitary regulations.

Brinjal or eggplant (*Solanum melongena* L.) is the most common, popular and principal vegetables in Bangladesh and other parts of the world (Nonnecke, 1989). Brinjal is the second most important vegetables crops after brinjal in relation to its total production (Anon., 1996). This useful crop is grown all the year round in Bangladesh and covers 46558 ha with a production of 341000 tons (BBS, 2010) with about 25.4% of the total vegetable area of the country. Brinjal is grown all over areas and seasons of Bangladesh. But the brinjal is intensively grown in winter season in Jessore, Mymensingh, Narsingdi, Comilla, Savar, Bogra, Jamalpur, Dinajpur, Rajshahi districts of Bangladesh. In the year of 2010-11, the brinjal production was about 339874 metric tons with acreage of about 115018 ha of land (BBS, 2012).

More than 100 horticultural crops including brinjal are exported from Bangladesh. Export of fresh fruits and vegetables (FFVs) from Bangladesh increased from 9,000 tons in 1992-93 to 48428 tons in 2010-2011. The major export market comprises UK (46%), Italy (8%), other EU countries (3%) and Middle East countries (43%). More than 50 fresh fruits and vegetables are exported to UK alone**.** Exports are targeted for ethnic market. Besides, fresh fruits and vegetables, frozen products about 250-300 tons at a value of about 3 million US$ are exported for both ethnic and mainstream markets. Among the fresh vegetable and fruit items, brinjal stands sixth position. The United Kingdom and Middle East are the main export market of brinjal from Bangladesh. Simultaneously, the brinjal used for seed in Bangladesh mostly imported from the India as well as from other countries such as Thailand. But for the quarantine importance, importing countries need intensive study findings on the insect pests, diseases and other pests associated with brinjal in Bangladesh.

The introduction of insect pests, plant diseases, weeds and other pest associated with the commodity is brought about mainly during the accelerated agricultural development in different countries, when plants and plant materials were brought into, or sent out with little or no concern for the insect pests, diseases, weeds and other pests that were transported along with them. There are many instances of accidental introductions of insect pests and destructive diseases from one country to another. Extensive damages, often sudden in nature, have been caused not by indigenous pests, but with exotic ones introduced along with plants, plant parts or seeds in the normal channel of trade or individual interest. Instances may be cited of the introduction of grape *phylloxera (Phylloxera vitifolia*) from the U.S.A. to France which caused destruction of French vineyards; Mexican boll weevil (*Anthonomus grandis)* whose original home was in Mexico or Central America, round about 1892 entered the U.S.A. and later to various countries in the world, causing extensive damage to cotton; European corn borer (O*strinia nubilalis)* which reached North America probably through broom corn from Italy or Hungary and has since become a major pest there. Pink ball worm (*Pectinophora gossypiella*) considered to be one of the six most destructive insects of the world probably a native of India is now established as a highly destructive pest in nearly all cotton growing areas of the world. Downy mildew of grape

(*Plasmopara viticola*) introduced in France from the U.S.A. was responsible for the destruction of grape vines till the discovery of Bordeaux mixture. Blight disease of chestnut (*Endothia parasitica*) introduced into the U.S.A. from Europe completely wiped out chestnut plants.

Brinjal is susceptible to attack of various insects from seedling to fruiting stage. This crop is infested by 18 different insect species including brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee; epilachna beetle, *Epilachna vigintioctopunctata* Fab. and aphid, *Aphis gossypii* Glover. In Bangladesh, about eight insect species are considered as major pests causing damage to the crop (Biswas *et al*., 1992). Hill (1983) reported 50 insect pests cause damage to brinjal. Besides, Red spider mite (*Tetranychus urticae)* also causes damage to the brinjal leaf. A number of diseases also cause damage of flowers, fruits, leaves, seedlings, and twigs of brinjal. Among these the important diseases are the Early blight (*Alternaria tomatophilia*), Cercospora leaf spot (*Cercospora melongenae*), Colletotrichum fruit rot (*Colletotrichum melongenae*), Phomopsis fruit rot (*Phomopsis vexans*), Root-knot Nematodes (*Meloidogyne incognita*), Damping off of brinjal (*Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp.), etc. There are several weeds found in the field of brinjal in Bangladesh. The major weeds are *Cynodon dactylon, Cyperus rotundus, Echinochloa crusgalli, Elusine indica* etc.

Due to imports of eggplant seeds and or plant stocks with tropical and subtropical countries of the world, the possibility for introduction and establishment of quarantine pests along with the consignment of the commodity remains as threat. Therefore, the pathway risk analysis of brinjal from exporting countries to Bangladesh is essential. In this context, the Pest Risk Analysis (PRA) of brinjal in Bangladesh is indispensable. Thus, the assignment on Pest Risk Analysis (PRA) of brinjal in Bangladesh was undertaken aiming to identify pests and/or pathways of quarantine concern for the brinjal grown areas and evaluate their risk, to identify endangered areas, as well as to identify risk management options.

1.2. Scope of the Risk Analysis

The scope of this analysis is to findout the potential hazard organisms or diseases associated with brinjal seeds and planting materials imported from different exporting countries named India, China, Thailand, Japan. Risk in this context is defined as the likelihood of the occurrence and the likely magnitude of the consequences of an adverse event.

1.3. Objective of the PRA study

The overall objective of a Pest Risk Analysis by the SPCB Project is to support National Plant Protection Organization (NPPO) to identify pests 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 consulting Firm is required to identify the pests, pathway/s, evaluate their risk, endangered areas, and risk management options etc.

The **Specific Objectives** of the recruitment of a Pest Risk Analysis Consulting Firm are:

- Listing of major and minor pests mentioning plant parts affected
- Listing of regulated pests
- Identification and categorization of pests likely to be associated with a pathway
- Identification of potentials for entry, establishment and spread of regulated pests
- Identification of probability of survival during transport or storage & transfer of hosts
- Identification of probability of pest surviving existing pest management procedures
- Identification of availability of suitable hosts, alternate hosts and vectors in the PRA areas
- Identification of potential economic and environmental impacts

- Assessment of potential loss by the pests
- Identification of management options/system approach for control of regulated pests
- Preparation of report on risk analysis of the pests following the relevant ISPMs.

1.4. Methods of Data Colletion

The methodology for the present PRA study used system-wide approach, which involved wide-ranging and sequenced discussion with relavent stakeholders aiming to identify the insect pests, diseases and other associated pests of mangoes, their potential hazards, quarantine concern of the pests, their risk and management options. The study involved the use of (i) field survey through structured questionnaire, (ii) semi-structured interviews by means of focus group discussions (FGD), (iii) formal and non-formal interviews through Key Informant Interview (KII); (iv) collection of primary and secondary information, reviewing the available reports and (v) physical field visits to the sampled area.

1.4.1. Major Activities

Field survey

The study survey was conducted with the direct interview of farmers, field level DAE Officials, Seed Dealers/Traders and Pesticide Dealers/Traders in 24 major brinjal growing districts of Bangladesh for quantitative data aiming to identify insect pests, diseases, weeds and other pests, their status, damane severity, and management options; quarantine pests with their entry, establishment, risk and their management. The qualitative data were also collectected through focus group discussions (FGD) with farmers and through key informant interviews (KII) with extension personnel at field and headquarer level, Plant Quarantine Centres at Sea and land port, officials of Ministry of Agriculture, Entomologist and Plant Pathologist of Bangladesh Agricultural Research Institute (BARI), Agricultural Universities, and brinjal importers and Exporters.

Collection and Review of Secondary Documents

The current PRA related secondary data were collected and gathered from secondary sources such as journals, books, proceedings, CD-ROM search, internet browsing especially through websits of CAB International, EPPO Bulletin and others. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of brinjal available in the brinjal exporting counties such as India, China, Thailand and Japan as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

Listing of pests of brinjal

The insect pests, diseases, weeds and other associated pests of brinjal were identified through the field survey, focus group discussion, Key Informant Interview and direct field visit and prepared a list of insect pests, diseases, weeds and other associated pests of the target crops following the framework for pest risk analysis adopted by the IPPC in International Standard for Phytosanitary Measures (ISPMs) and other related ISPMs. The quarantine pests of brinjal in Bangladesh were also listed.

1.4.2. Study and Sampling Areas

The survey study sas conducted in 24 major brinjal growing districts of Bangladesh as selected by the client—Project Director, Stenghthening Phytosanitary Capacity in Bangladesh (SPCB) under Plant Quarantine Wing (PQW), DAE, Bangladesh. A total 71 upazilas were selected under the 24 sampled distrcts, where 10 agricultural blocks were covered under each upazilla and 10 brinjal farmers were interviewed in each block through pre-tested questionnaire. Thus, a total of 7000 farmers were interviewed from all of 24 sampled districts. Besides, local level officials of DAE, Pesticide Dealers and Seed Dealers were also interviewed for each district and upazilas through questionnaire. The district and upazila wise distribution of respondents is given below:

Table-1: Distribution of the respondents in major flower growing districts of Bangladesh

SN	District	Upazilla	No. of Block	No. of Farmers	Field level officer	Policy Level Officer	Pesticide Dealer	Seed dealer	No. of FGD
1	Norshingdi	Sadar	10	100	2	1	2	2	1
		Shibpur	10	100	2				
		Raipura	10	100	2				
		Monohordi	10	100	2				
		Belabo	10	100	2				
2	Manikgonj	Singair	10	100	2	1	2	2	1
		Saturia	10	100	2				
		Sadar	10	100	2				
3	Gazipur	Kaligonj	10	100	2	1	2	2	1
		Kapasia	10	100	2				
		Sadar	10	100	2				
		Kaliakoir	10	100	2				
4	Narayangonj	Soangaon	10	100	2	1	2	2	1
		Araihazar	10	100	2				
5	Comilla	Chandina	10	100	2	1	2	2	1
		Daudkandi	10	100	2				
		Burichong	10	100	2				
		Barura	10	100	2				
		Debiddar	10	100	2				
6	Chandpur	Sadar	10	100	2	1	2	2	1
		Hajigonj	10	100	2				
7	Jamalpur	Islampur	10	100	2	1	2	2	1
		Sadar	10	100	2				
		Sarishabari	10	100	2				
8	Mymensingh	Sadar	10	100	2	1	2	2	1
		Gafargaon	10	100	2				
9	Kishorgonj	Hosenpur	10	100	2	1	2	2	1
		Pakundia	10	100	2				
10	Tangail	Modhupur	10	100	2	1	2	2	1
		Ghatail	10	100	2				
		Dhanbari	10	100	2				
11	Sherpur	Sadar	10	100	2	1	2	2	1
		Nalitabari	10	100	2				
12	Chittagong	Potia	10	100	2	1	2	2	1
		Shitakunda	10	100	2				
		Mirershorai,	10	100	2				
		Fatikchari	10	100	2				
13	Bogra	Sadar	10	100	2	1	2	2	1
		Gabtoli	10	100	2				
		Shibgonj	10	100	2				
		Shajhanpur	10	100	2				
14	Pabna	Iswardi	10	100	2	1	2	2	1
		Atghoria	10	100	2				
15	Rajshahi	Poba	10	100	2	1	2	2	1
		Puthia	10	100	2				
		Durgapur	10	100	2				
16	Natore	Sadar	10	100	2	1	2	2	1
		Baghatipara	10	100	2				
17	Kustia	Sadar	10	100	2	1	2	2	1

SN	District	Upazilla	No. of Block	No. of Farmers	Field level officer	Policy Level Officer	Pesticide Dealer	Seed dealer	No. of FGD
		Doulatpur	10	100	2				
18	Jessore	Bagarpara	10	100	2	1	2	2	1
		Chougacha	10	100	2				
		Sadar	10	100	2				
		Keshobpur	10	100	2				
19	Chuadanga	Sadar	10	100	2	1	2	2	1
		Alamdanga	10	100	2				
20	Jhenidah	Kaligonj	10	100	2	1	2	2	1
		Court Chandpur	10	100	2				
		Shoilokupa	10	100	2				
		Harinakunda	10	100	2				
21	Magura	Sadar	10	100	2	1	2	2	1
		Mohammadpur	10	100	2				
22	Barisal	Uzirpur	10	100	2	1	2	2	1
		Babugonj	10	100	2				
23	Bhola	Sadar	10	100	2	1	2	2	1
		Daulotkhan	10	100	2				
24	Dhaka	Savar	10	100	2	1	2	2	1
		Dhamrai	10	100	2				
		Keranigonj	10	100	2				
Total=24		**70**	**700**	**7000**	**140**	**24**	**48**	**48**	**24**

1.4.3. Development of data collection tools

The most appropriate tools used in this field study are discussed below:

Field survey questionnaire: For quantitative analysis, the field survey was conducted in 24 major brinjal growing districts of Bangladesh through face to face interview with 7000 brinjal farmers using a questionnaire encompassing the relevant study indicators. The 24 policy level officer (Additional Deputy Director (PP)) and 140 field level officers of DAE, 48 Pesticides Dealers/Traders and 48 Seed Dealers/Traders were also interviwed through questionnaire (**Appendix-1-5)**.

Focus Group Discussion (FGD): For qualitative analysis, 24 FGD meetings were organized considering one FGD for each sampled districts with the participantion of at least 10 flower growers for each. The FGD meetings were conducted using pre-designed FGD guidelines (**Appendix-6**).

Field visit/physical observation: In addition, the expert team of the study physically visited the sampled districts of the study area aiming to observe the physical status of the insect pests, diseases and other associated pest problems in field condition**.**

1.5. Pests of brinjal recorded in Bangladesh

The study for "Conducting Pest Risk Analysis (PRA) of Brinjal in Bangladesh" was done in 24 major brinjal growing districts of Bangladesh. From the field survey and review of sectondary documents, the precise findings of the study in-line with the presence of insect and mite pests, diseases and weed pests have been presented below:

1.5.1. Insect and mite pests of brinjal

A total number of 20 athropod pests of eggplants were reported in Banlgadesh, among which 19 were insect pests and one was mite pest.

The incidences of insect pests of eggplants recorded in Bangladesh were brinjal shoot and fruit borer (*Leucinodes orbonalis*), cut worm (*Agrotis* spp.), leaf roller (*Eublemma olivacea* Walker), cotton leaf worm (*Spodoptera litura*), cabbage caterpillar (*Helicoverpa armigera*), eggplant moth (*Neoleucinodes elegantalis*), jassid (*Amrasca biguttula biguttula*), cotton aphid (*Aphis gossypii* Glover), whitefly (*Bemisia tabaci*), scale insect (*Aulacaspis* spp.), mealybug (*Coccidohystrix insolita*), potato psyllid (*Bactericera cockerelli*), lace bug (*Gargaphia solani*), epilachna beetle (*Epilachna vigintioctopunctata* and *Epilachna dodecastigma*), blister beetle (*Mylabris pustulata*), thrips (*Thrips palmi* Karny), leaf miner (*Liriomyza sativae*), and one mite named two-spotted spider mite (*Tetranychus urticae* Koch).

Among these insect and mite pests of eggplants, brinjal shoot and fruit borer, leaf roller, jassid and epilachna beetle are more damaging than others. Of which, brinjal shoot and fruit borer caused damage eggplants with high intensity. Whereas, the pest status of all other insect and mite pests were minor and caused damage eggplants with low infestation intensity.

1.5.2. Diseases of eggplants recorded in Bangladesh

A total number of 18 diseases of eggplants were reported in Bangladesh, among which 12 diseases caused by fungi, 2 diseases caused by bacteria, 2 diseases caused by nematode, 1 disease was caused by virus and one caused by Phytoplasma.

The incidences of fungal diseases of eggplants reported in Bangladesh were early blight (*Alternaria tomatophilia*), cercospora leaf spot (*Cercospora melongenae*), colletotrichum fruit rot (*Colletotrichum melongenae*), anthracnose (*Colletotrichum coccodes*), phomopsis fruit rot (*Phomopsis vexans*), phytophthora blight (*Phytophthora capsici*), Verticillium wilt (*Verticillium* spp.), stem rot/damping off (*Fusarium solani*), root rot (*Pythium* spp.), damping off (*Rhizoctonia* spp.), powdery mildew (*Podosphaera pannosa*), downy mildew (*Peronospora sparsa*),

The incidence of bacterial diseases of eggplants recorded in Bangladesh were bacterial wilt (*Ralstonia solanacearum*), bacterial soft rot (*Erwinia carotovora* subsp*. carotovora*). The nemic diseases of eggplants were root knot nematode caused by *Meloidogyne incognita* and *M. javanica*. The incidences of viral disease of eggplants recorded in Bangladesh was *Tomato leaf curl New Delhi virus* and the disease caused by Phytoplasma was little leaf of brinjal caused by *Candidatus Phytopasma solani* But the incidences of golder cyst nematode (*Globodera rostochiensis*), and pale cyst nematode (*Globodera pallida*) were not reported as the diseases of eggplants in Bangladesh. No Potyvirus and Nucleorhabdovirus were found in the seeds of brinjal as tested by reverse transcription-polymerase chain reaction (RT-PCR) in Bangladesh **(Appendix 6)**.

Among these diseases, the phomopsis fruit rot, bacterial wilt and damping off of seedlings were more damaging than others. Bacterial wilt of eggplant was major disease caused damage with medium severity. All of other diseases were reported as minor diseases in Bangladesh with low infection intensity. Most of the cases, the damage severity was controlled by the routine application of fungicides in field condition.

1.5.3. Weeds of eggplants recorded in Bangladesh

A total number of 8 weeds were reported as the problem in the field of eggplants in Bangladesh. The incidences of weeds in the field of eggplants as reported were bermuda grass (*Cynodon dactylon*), nutsedge (*Cyperus esculentus*), goosefoot (*Chenopodium album*

L.), pigweed (*Amaranthus acanthochiton*), spiny pigweed (*Amaranthus spinosus*), blacknightshade (*Solanum nigrum*), horsenettle (*Solanum carolinense* L.), parthenium weed (*Parthenium hysterophorus*) (Table 4). The parthenium weed (*Parthenium hysterophorus*) was recorded and found only some restricted areas of Bangladesh such as Rajshahi, Natore, Pabna, Kustia, Jessore districts. It was also reported that the parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading.

Among the eight weeds, the Parthenium was more damaging than other and caused damage in the whole season with low infestation intensity. As a newly introduced weed, though parthenium caused damage with low infestation intensity, but it could cause severe damage and spread to other areas, if not controlled properly. Other seven weeds were reported as minor weeds with low infestation intensity.

1.5.4. Management options for eggplants in Bangladesh

Insect and mite pest management: The most effective management practices commonly used by the farmers in Bangladesh against the insect pests of brinjal were spraying of insecticides followed by removal of infested plants from the field, seed treatment and use of balanced fertilizer. The use of pheromone traps against *Leucinodes orbonalis* was the most effective and eco-friendly management practice. The acaricides were also used for the controll of the infestation of mite.

Disease management: The most effective and commonly practiced management options against the diseases of eggplants were spraying of fungicides in the field, followed by removal of weeds and diseased plants/pruning of the diseased parts of the plants. Seed treatment was also the effective management of eggplant diseases. But the control of bacterial disease of brinjal was difficult.

Weeds management: The most effective and commonly practiced management options for weeds in the field of eggplants were weeding from the field, followed by removal of weeds during land preparation. Other options were earthing up at the base of plants and use of herbicides.

Table 2. Insect and mite pests of eggplants, their status, plant parts affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Plant parts affected	Pest status	Infestation severity
1	Brinjal shoot and fruit borer	*Leucinodes orbonalis*	Pyralidae	Lepidoptera	Flower bud, leaf, twig	Major	High
2	Cut worm	*Agrotis spp.*	Noctuidae	Lepidoptera	Seedlings	Minor	Low
3	Leaf roller	*Eublemma olivacea* Walker	Noctuidae	Lepidoptera	Leaf and twigs	Minor	Low-medium
4	Cotton leaf worm	*Spodoptera litura*	Noctuidae	Lepidoptera	Leaf, twigs	Minor	Low
5	Cabbage caterpillar	*Helicoverpa armigera*	Noctuidae	Lepidoptera	Fruits, leaf	Minor	Low
6	Eggplant moth	*Neoleucinodes elegantalis*	Crambidae	Lepidoptera	Fruits, flowers	Minor	Low
7	Jassid of brinjal	*Amrasca biguttula biguttula*	Cicadellidae	Homoptera	Leaf, flowers	Minor	Low
8	Aphid	*Aphis gossypii Glover*	Aphididae	Homoptera	Leaf, flower, twig	Minor	Low
9	Whitefly	*Bemisia tabaci*	Aleurodidae	Homoptera	Leaf, twig	Minor	Low
10	Scale insect	*Aulacaspis* spp.	Margarodidae	Homoptera	Stem	Minor	Low
11	Mealybug	*Coccidohystrix insolita*	Pseudococcidae	Homoptera	Stem, leaf, twig, bud	Minor	Low
12	Potato psyllid	*Bactericera cockerelli*	Triozidae	Hemiptera	Leaf, twig	Minor	Low
13	Lace bug	*Gargaphia solani*	Tingidae	Hemiptera	Leaf, twig	Minor	Low
14	Epilachna beetle	*Epilachna vigintioctopunctata*	Coccinellidae	Coleoptera	Leaf, twig	Minor	Low
15	Epilachna beetle	*Epilachna dodecastigma*	Coccinellidae	Coleoptera	Leaf, twig	Minor	Low
16	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera	Leaf, twig	Minor	Low
17	Thrips	*Thrips palmi* Karny	Thripidae	Thysanoptera	Leaf, flower, twig	Minor	Low
18	Leaf miner	*Liriomyza sativae*	Agromyzidae	Diptera	Leaf	Minor	Low
19	Two-spotted spider mite	*Tetranychus urticae* Koch	Tetranychidae	Acarina	Leaf, twig	Minor	Low

Table 3. Diseases of eggplants, their status, plant parts affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Plant parts affected	Pest status	Infestation severity
Causal organism: Fungi							
1	Early blight	*Alternaria tomatophilia*	Pleosporaceae	Pleosporales	Leaf, twig	Minor	Low
2	Cercospora leaf spot	*Cercospora melongenae*	Mycosphaerellaceae	Capnodiales	Leaf, fruits	Minor	Low
3	Colletotrichum fruit rot	*Colletotrichum melongenae*	Glomerellaceae	Glomerellales	Fruit, leaf, twig	Minor	Low
4	Anthracnose	*Colletotrichum coccodes*	Glomerellaceae	Glomerellales	Leaf, stem, twig, fruit	Minor	Low
5	Phomopsis fruit rot	*Phomopsis vexans*	Diaportaceae	Diaporthales	Fruit, leaf	Minor	Low
6	Phytophthora blight	*Phytophthora capsici*	Pythiaceae	Peronosporales	Leaf, twig, fruit	Minor	Low
7	Verticillium wilt	*Verticillium* spp.	Plectosphaerellaceae	Incertae sedis	Seedling, whole plant	Minor	Low
8	Stem rot/damping off	*Fusarium solani*.	Nectriaceae	Hypocreales	Seedling, stem	Minor	Low
9	Root rot	*Pythium* spp.	Nectriaceae	Hypocreales	Seedling, stem	Minor	Low
10	Damping off	*Rhizoctonia* spp.	Nectriaceae	Hypocreales	Seedling, stem	Minor	Low
11	Powdery mildew	*Podosphaera pannosa*	Erysiphaceae	Erysiphales	Flower, leaf	Minor	Low
12	Downy mildew	*Peronospora sparsa*	Peronosporaceae	Peronosporales	Leaf	Minor	Low
Causal organism: Bacteria							
13	Bacterial wilt	*Ralstonia solanacearum*	Ralstoniaceae	Burkholderiales	Seedling, whole plant	Major	Medium
14	Bacterial soft rot	*Erwinia carotovora* subsp. *carotovora*	*Enterobacteriaceae*	*Enterobacteriales*	Fruit	Minor	Low
Causal organism: Nematode							
15	Root knot nematode	*Meloidogyne javanica*	Heteroderidae	Tylenchida	Root, stem	Minor	Low
16	Root knot nematode	*Meloidogyne incognita*	Heteroderidae	Tylenchida	Root, stem	Minor	Low
17	Golder cyst nematode	*Globodera rostochiensis*	Heteroderidae	Tylenchida	Not recorded in Bangladesh		
18	Pale cyst nematode	*Globodera pallid*	Heteroderidae	Tylenchida	Not recorded in Bangladesh		
Virus							
19	Tomato leaf curl New Delhi virus	*Tomato leaf curl New Delhi virus*	Geminivirdae	Unassigned ssDNA	Leaf	Minor	Low
20	Potyvirus	*Potyvirus*	Potyviridae	Unassigned (+) ssRNA	Not found in Bangladesh through RT-PCR test		
21	Nucleorhabdovirus	*Nucleorhabdovirus*	Rhabdoviridae	Mononegavirales	Not found in Bangladesh through RT-PCR test		
Phytoplasma							
22	Little leaf of brinjal	*Candidatus Phytopasma solani*	Acholeplasmataceae	Acholeplasmatales	Leaf, twig	Minor	Low

Table 4. Weeds of eggplants, their status, plant stage affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Plant stage affected	Pest status	Infestation severity
1	Bermuda grass	*Cynodon dactylon*	Poacegae	Poales	Seedling-Vegetative	Minor	Low
2	Nutsedge	*Cyperus esculentus*	Cyperaceae	Poales		Minor	Low
3	Goosefoot	*Chenopodium album* L.	Chenopodioideae	Caryophyllales	Seedling-Vegetative	Minor	Low
4	Pigweed	*Amaranthus acanthochiton*	Amaranthaceae	Caryophyllales	Seedling-Vegetative	Minor	Low
5	Spiny pigweed	*Amaranthus spinosus*	Amaranthaceae	Caryophyllales	Seedling-Vegetative	Minor	Low
6	Blacknightshade	*Solanum nigrum*	Solanaceae	Solanales	Seedling-Vegetative	Minor	Low
7	Horsenettle	*Solanum carolinense* L.	Solanaceae	Solanales	Seedling-Vegetative	Minor	Low
8	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	Recorded in limited areas	Minor	Low

1.6. Pathway Risk Analysis Process and Methodology

The overall pest risk analysis (PRA) process includes undertaking pest risk analysis, risk assessment and identify risk management of the pests. The process and methodology of the PRA are described below:

1.6.1. Undertaking of Pest Risk Analysis (PRA)

The study followed 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 study team evaluated 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.

Steps of initiation stage: The initiation stage involves four steps:

- Step 1: Determination whether an organism is a pest
- Step 2: Defining the PRA area
- Step 3: Evaluating any previous PRA
- Step 4: Conclusion

PRA STAGE 2: PEST RISK ASSESSMENT

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

- Step 1: Pest categorization
- Step 2: Assessment of the probability of introduction, establishment and spread
- Step 3: Impacts
- Step 4: Overall assessment of risk
- Step 5: Uncertainty

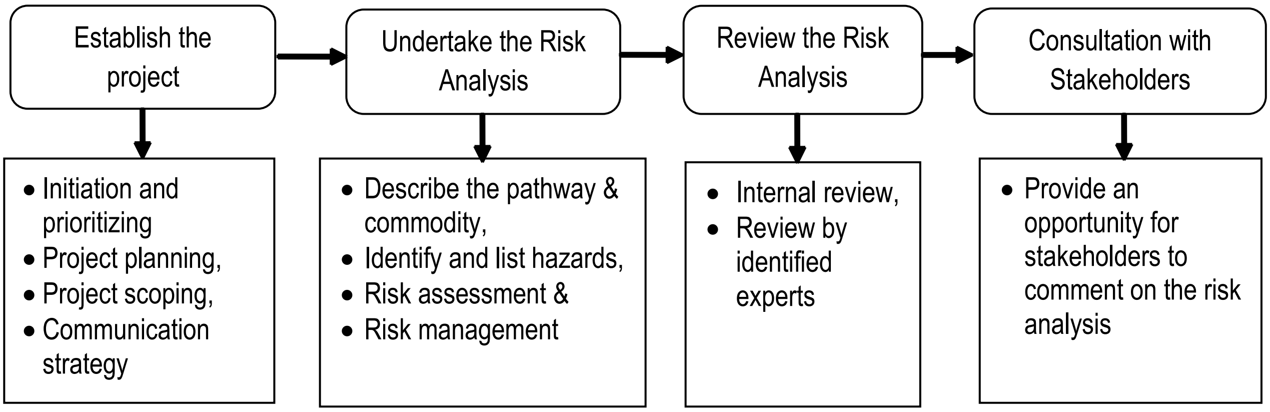
In most cases, these steps were applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity, 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.

The following briefly describes the Biosecurity process and methodology for undertaking pathway risk analyses. The risk analysis process leading to the final risk analysis document is summarized in Figure 1 below:

Figure 1: A summary of the risk analysis development process



1.7. Pathway Description

1.7.1. Import pathways of brinjal

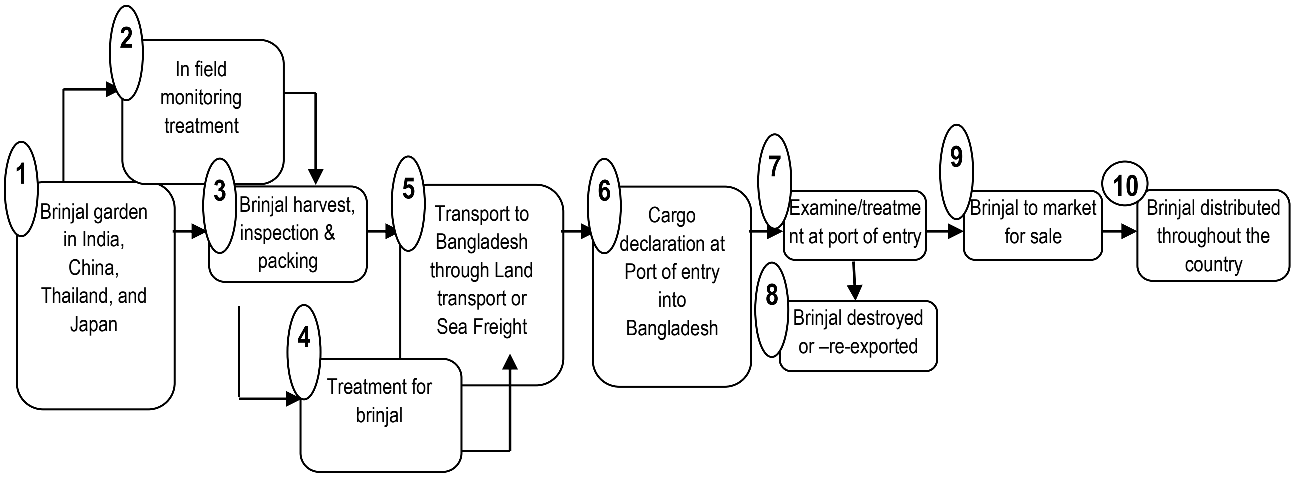
For the purpose of this risk analysis, brinajl are presumed to be from anywhere in exporting countries such as India, China, Japan, and Thailand.

To comply with existing Bangladesh import requirements for brinjal, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests (insect pests, diseases and weeds) 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 to dealers, distributors, markets, sellers and farmers for cultivation of the imported brinjal seeds, planting materials and or fruits.

1.7.2. Description

- Brinjal in India, China, Japan, and Thailand are being grown in the field, either as a single crop or beside other field or horticultural crops.
- Monitoring of the insect pests, disease and weed pests of brinjal is undertaken, with appropriate controls applied.
- Brinjal are being harvested, inspected and the best quality seeds, planting materials and or fruits pre-treated and packed in boxes.
- Post harvest disinfestations including fumigation or cold disinfestations are being undertaken either before or during transport of the brinjal and seeds to Bangladesh.
- Transport to Bangladesh is by air or sea.
- Each shipment must be accompanied by the appropriate certification, e.g. a phytosanitary certificate attesting to identity the brinjal, any treatments completed, or other information required to help mitigate risks.
- Brinjal is examined at the border to ensure compliance.
- Any brinjal not complying with Bangladesh biosecurity requirements (e.g. found harboring pest organisms) are either treated re-shipped or destroyed.
- Brinal and or seeds are stored before being distributed to market for sale.
- Dealers and sellers of brinjal seeds and or planting materials or fruits of brinjal stock and these are bought by users and or farmers within the local area these are sold in. The linear pathway diagram of import risk of brinjal is furnished below:

Figure 2: Linear Pathway Diagram

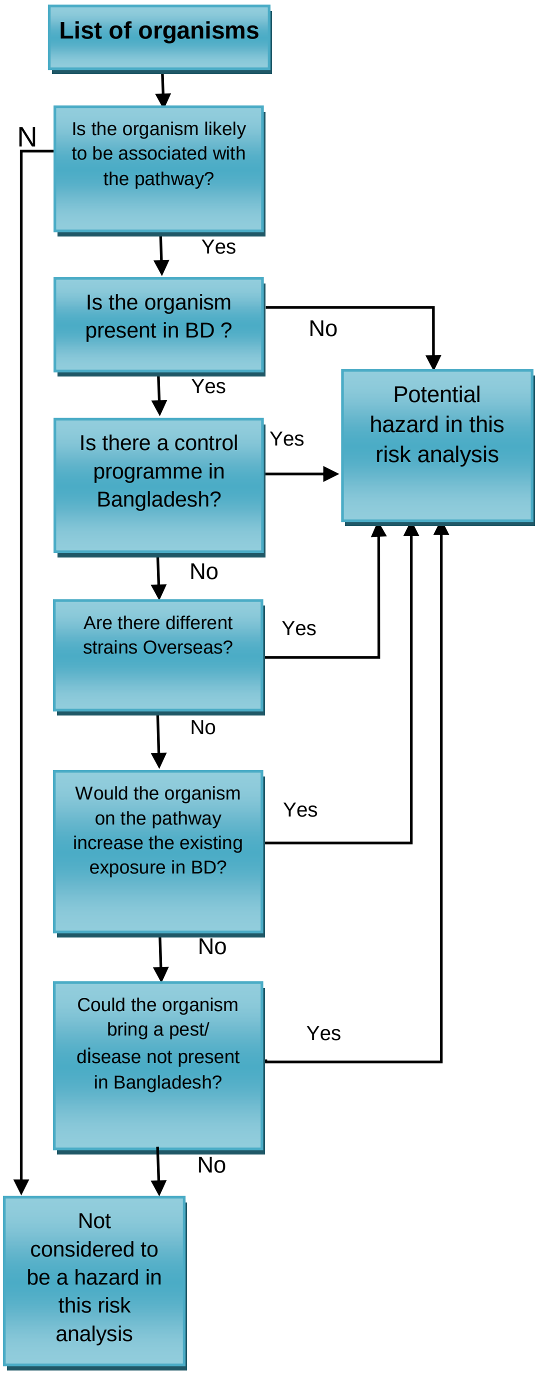


1.8. Hazard Identification

The first step for any risk assessment is to identify the hazard as the risk is related to hazard. Hazards are the unwanted insect pests, diseases (pathogen) or weeds of flowers and foliages which could be introduced into Bangladesh by risk goods, and are potentially capable of causing harm to brinjal production, must be identified. This process begins with the collection of information on insect pests, diseases (pathogen) or weed present in the country of origin. Such list is compared with the existing pests present in Bangladesh to prepare a list of exotic pests that might be associated with the commodity harmful for Bangladesh, if introduce.

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 pest or pathogen 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 which do not feed on it or specifically depend on that commodity in some other way are also included in the analysis. This is because there may be economic, environmental and human health consequences of these organisms entering and/or establishing. Diagrammatic representation of hazard identification is shown in Figure 3.

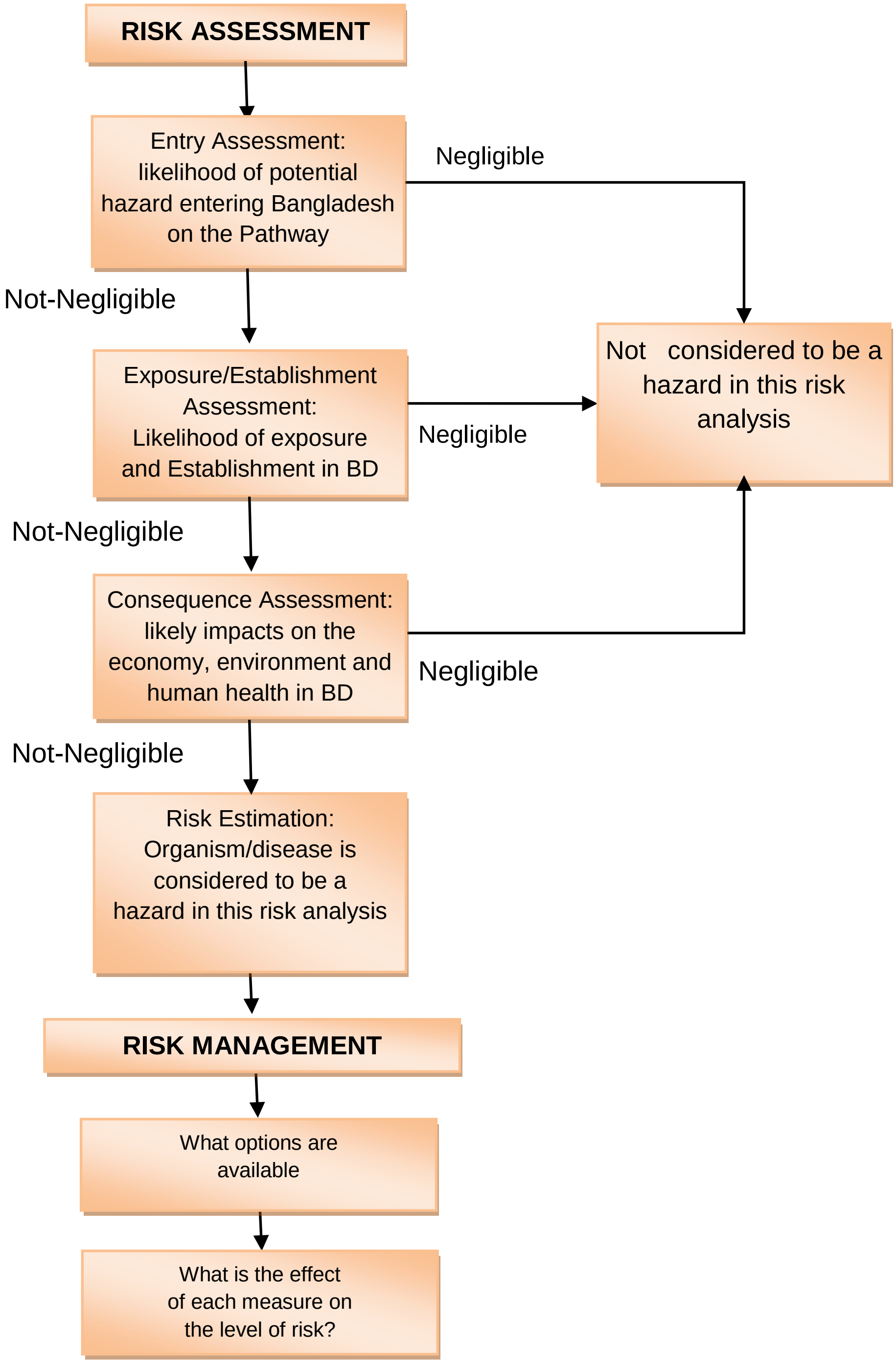
Figure 3: Diagrammatic representation of hazard identification



1.9. 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 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. Descriptors are used in assessing the likelihood of entry, exposure and establishment, and the economic, environmental, social and human health consequences. The approach taken in this Risk Analysis is to assume the commodity is imported without any risk management. In this risk analysis hazards have been grouped where appropriate to avoid unnecessary duplication of effort in the assessment stage of the project. Diagrammatic representation of risk assessment and risk management is shown in Figure 4.

Figure 4: Diagramatic representation of the process followed for risk assessment and management



1.10. 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 managing risk 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.

1.11. Analysis of Measures to Mitigate Biosecurity Risks

Risk management in the context of risk analysis is the process of identifying measures to effectively manage the risks posed by the hazard(s) associated with the commodity or organisms under consideration.

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:

1.12. Risk Evaluation

If the risk estimate determined in the risk assessment is significant, measures can be justified.

1.13. Option Evaluation

Measures that are expected to be effective against the hazard species are considered. A package of risk management measures is likely to be required to address the risk from all identified hazards. While there are currently six established pathways (India, China, Thailand, and Japan) for brinjal coming into Bangladesh, border interception for these pathways cannot be extrapolated to predict any possible level of slippage or efficacy of treatments. However, border interceptions can be used as evidence of hazard organism association with the commodity. Each new pathway must be regarded as unique, given differing pre and post harvest practices and treatment measures. Different pest species are associated with each pathway and measures therefore must be tailored to the individual organisms.

1.14. 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 biosecurity responsibilities, plus recognized and relevant experts fromBangladesh. The critique provided by the reviewers where appropriate, is incorporated into the analysis. If suggestions arising from the critique were not adopted the rationale must be fully explained and documented.

CHAPTER 2

IMPORT RISK ANALYSIS

2.1. Introduction

This chapter provides information on the commodity that is relevant to the analysis of biosecurity risks and common to all organisms or diseases potentially associated with the brinjal. It 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 Banladesh.

2.2. Commodity Description

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous crop of sub-tropics and tropics. The name brinjal is popular in Indian subcontinents and is derived from Arabic and Sanskrit whereasthe name eggplant has been derived from the shape of the fruit of some varieties, which are white and resemble in shape to chicken eggs. It is also called aubergine (French word) in Europe. The brinjal is of much importance in the warm areas of Far East, being grown extensively in India, Bangladesh, Pakistan, China and the Philippines. It is also popular in Egypt, France, Italy and United

States. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A number of cultivars are grown in India, consumer preference being dependent upon fruit color, size and shape.

Characteristics: The eggplant is a delicate perennial that often is cultivated as an annual. It grows 40 to 150 centimeters (16 to 57 inches) tall, with large coarsely lobed leaves that are 10 to 20 centimeters (4-8 inches) long and 5 to 10 centimeters (2-4 inches) broad. (Semi-) wild types can grow much larger, to 225 centimeters (7 feet) with large leaves over 30 centimeters (12 inches) long and 15 centimeters (6 inches) broad. The stem is often spiny. The flowers are white to purple, with a five-lobed corolla and yellow stamens. The fruit is fleshy, less than 3 centimeters in diameter on wild plants, but much larger in cultivated forms.

Cultivation: The mango is now cultivated in most frost-free tropical and warmer subtropical climates; almost half of the world's mangoes are cultivated in India alone, with the second-largest source being China (Jedele *et al.,* 2003; Rediff.com, 2004). Other cultivators include North America (in South Florida and California's Coachella Valley), South and Central America, the Caribbean, Hawai'i, south, west, and central Africa, Australia, China, Pakistan, Bangladesh, and Southeast Asia. Though India is the largest producer of mangoes, it accounts for less than 1% of the international mango trade; India consumes most of its own production.

Varieties: The most widely grown cultivated varieties in Europe and North America today are elongated ovoid, 12-25 centimeters long (4 1/2 to 9 inches) and 6-9 centimeters broad (2 to 4 inches) with a dark purple skin. A much wider range of shapes, sizes, and colors is grown in India and elsewhere in Asia. Larger varieties weighing up to a kilogram (2 pounds) grow in the region between the Ganges and Yamuna rivers, while smaller varieties are found elsewhere. Colors vary from white to yellow or green as well as reddish-purple and dark purple. Some cultivars have a color gradient, from white at the stem to bright pink to deep purple or even black. Green or purple cultivars with white striping also exist. Chinese eggplants are commonly shaped like a narrower, slightly pendulous cucumber and sometimes were called Japanese eggplants in North America.

Oval or elongated oval-shaped and black-skinned cultivars include 'Harris Special Hibush', 'Burpee Hybrid', 'Black Magic', 'Classic', 'Dusky', and 'Black Beauty'. Long, slim cultivars with purple-black skin include 'Little Fingers', 'Ichiban', 'Pingtung Long', and 'Tycoon'. Those with green skin include 'Louisiana Long Green' and 'Thai (Long) Green', while 'Dourga' is a white skin cultivar, and traditional, white-skinned, oval-shaped cultivars include 'Casper' and 'Easter Egg'.

Bicolored cultivars with a color gradient include 'Rosa Bianca', and 'Violetta di Firenze'.

Bicolored cultivars with striping include 'Listada de Gandia' and 'Udumalapet'. In some parts of India, miniature varieties of eggplants (most commonly called *Vengan*) are very popular.

In Bangladesh, Islampuri, Khat Khatia, Dohazari, Volanath and Singnath are some of the popular local varieties of brinjal.

Recently the Bangladesh agricultural research institute developed 5 varieties ie, Uttara, Shuktara (hybrid), Tarapuri (hybrid), Nayantara and Kazla. The variety grown in Gaffargaon area is famous for its size and taste.

Production: Production of eggplant is highly concentrated, with 90 percent of output coming from five countries in 2010. China is the top producer (58 percent of world output) and India is second (25 percent), followed by Egypt, Iran and Turkey. More than 4,000,000 acres (1,600,000 hectares) are devoted to the cultivation of eggplant in the world (Food And Agricultural Organization of United Nations 2010).

Consumption: The raw fruit can have a somewhat bitter taste, but becomes tender when cooked and develops a rich, complex flavor. Salting and then rinsing the sliced eggplant (known as "degorging") can soften and remove much of the bitterness. Some modern varieties do not need this treatment, as they are less bitter. The eggplant is capable of absorbing large amounts of cooking fats and sauces, allowing for very rich dishes, but the salting process will reduce the amount of oil absorbed. The fruit flesh is smooth; as in the related tomato, the numerous seeds are soft and edible along with the rest of the fruit. The thin skin is also edible, so that the eggplant need not be peeled.

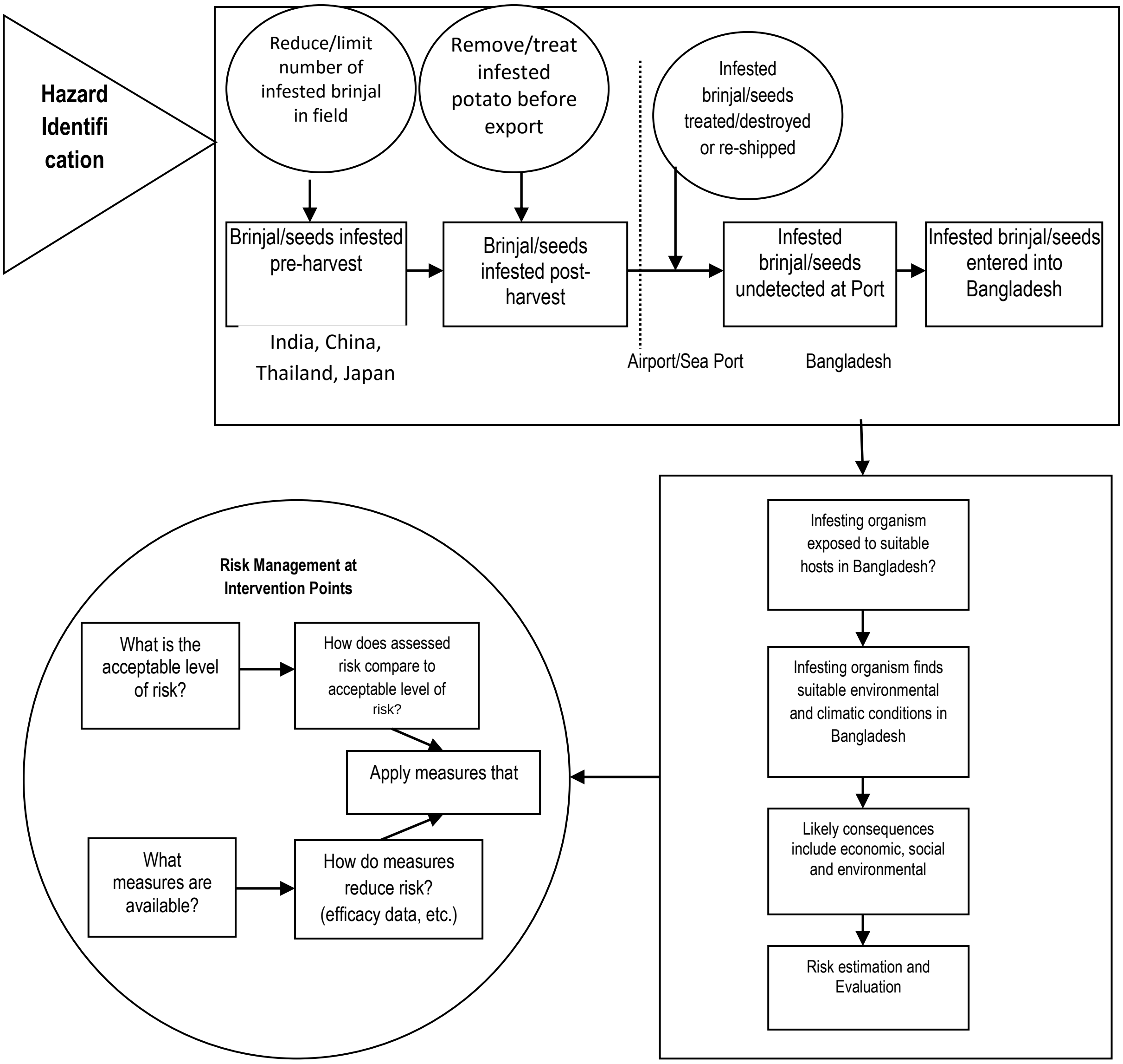
Insect pests: Brinjal is susceptible to attack of various insects from seedling to fruiting stage. This crop is infested by 18 different insect species including brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Guenee; epilachna beetle, *Epilachna vigintioctopunctata* Fab. and aphid, *Aphis gossypii* Glover. In Bangladesh, about eight insect species are considered as major pests causing damage to the crop (Biswas et al., 1992). Hill (1983) reported 50 insect pests cause damage to brinjal. The losses caused by these pests vary from season to season depending upon environmental factors as reported by Gangwar and Sachan (1986) and Patel et al. (1988). Various insect pests cause enormous losses to brinjal in every season and every year in Bangladesh (Alam, 1969). The yield loss caused by this pest has been estimated up to 67% in Bangladesh. Among them, brinjal shoot and fruit borer (BSFB), *Leucinodes orbonalis* Gueneeis one of the most destructive insect pest of brinjal in Bangladesh (Alam, 1969). The genus *Leucinodes* includes three species namely *Leucinodes orbonalis* Guenee, *Leucinodes diaphana* Hampson and *Leucinodes apicalis* Hampson (Alam et al., 1964).

Diseases: A number of diseases also cause damage of flowers, fruits, leaves, seedlings, and twigs of brinjal. Among these, the important diseases are early blight (*Alternaria tomatophilia*), Cercospora leaf spot (*Cercospora melongenae*), Colletotrichum fruit rot (*Colletotrichum melongenae*), phomopsis fruit rot (*Phomopsis vexans*), root-knot Nematodes (*Meloidogyne incognita*), damping off of brinjal (*Fusarium* spp., *Pythium* spp., *Rhizoctonia* spp.), etc

2.3. Description of the Proposed Import Pathway

For the purpose of this risk analysis, brinjal are presumed to be from anywhere in India, China, Thailand, and Japan. To comply with existing Bangladesh import requirements for brinjal, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests are not associated with the product. Brinjal seeds, planting matersials and or fruits would then be sea or air freighted to Bangladesh where it will go to a holding facility before being distributed to dealers, distributors, markets, sellers and farmers for cultivation and uses of the imported brinjal seeds, planting matersials and or fruits. The proposed import pathway of brinjal and foliages indicating how the risk analysis process applied at the pathway level is given below:

Figure 5. Proposed import pathway of brinjal



2.4. Exporting Countries—Climate and Geography

2.4.1. India

India's climate can be classified as a hot tropical country, except the northern states of Himachal Pradesh and Jammu & Kashmir in the north and Sikkim in the northeastern hills, which have a cooler, more continental influenced climate. In most of India summer is very hot. It begins in April and continues till the beginning of October, when the monsoon rains start to fall. The heat peaks in June with temperatures in the northern plains and the west reach 45° C and more. The monsoons hit the country during this period too, beginning 1st of June when they are supposed to find the Kerala coast, moving further inland from day to day. Moisture laden trade winds sweep the country bringing heavy rains and thunderstorms; sometimes these monsoon rains can be very heavy, causing floodings and damage, especially along the big Rivers of India, Bramaputhra and Ganges. The plains in the north and even the barren countryside of Rajasthan have a cold wave every year in December-January. Minimum temperatures could dip below 5°C but maximum temperatures usually do not fall lower than 12°C. In the northern high altitude areas of the northern mountains it snows through the winter and even summer months are only mildly warm. Typhoons are usually not an danger, these tropical storms are quite seldom in India. The Typhoon Season is from August to November; the East coast of India has the highest Typhoon risk. The Climate of India can be divided in different climate zones. The eastern part of India and the west coast can be classified as Aw climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The southern Tip of india can be classified as Am climate, a hot tropical Rainforest climate with monsoon rains and all months above 18°C. Central and Northwest India have a BSh climate, a dry Steppe climate with an annual average Temperature above 18°C. Finally, the northern mountainous areas can be classified as Cfa climate; a Temperated, humid climate with tha warmest month above 22°C (WeatherOnline, 2015a)

2.4.2. Thailand

Thailand's Climate can be described as tropical monsoon climate. It is characterized by strong monsoon influences, has a considerable amount of sun, a high rate of rainfall, and high humidity that makes it sometimes feel quite uncomfortable.

The annual average temperature ranges from 22°C to 27°C year-round. There are two distinguishable seasons in Thailand, a dry period in the winter and a humid rain period in the summer. The Climate of Thailand can be classified as Aw climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The southern coast of Thailand has an Af climate, a hot, humid climate with all months above 18°C (WeatherOnline, 2015c).

2.4.3. China

China's extreme size means it has a great diversity of climates, but being located entirely in the northern hemisphere means its seasonal timings are broadly comparable to those in Europe and the US. The northeast experiences hot and dry summers and bitterly cold harsh winters, with temperatures known to reach as low as -20°C (-4°F). The north and central region has almost continual rainfall, temperate summers reaching 26°C (79°F) and cool winters when temperatures reach 0C (32°F). The southeast region has substantial rainfall, and can be humid, with semi-tropical summer. Temperatures have been known to reach over 40°C (104°F) although this is highly unusual, but during summer temperatures over 30°C (86°F) are the norm. Winters are mild, with lows of around 10°C (50°F) in January and February. Central, southern and western China are also susceptible to flooding, and the country is also periodically subject to seismic activity.

Early autumn around September and October, when temperatures are pleasant and rainfall is low, is generally seen as an optimum time to visit. Spring is also popular, for similar reasons, and the many tourists visit in March or April.

2.4.4. Japan

Japan is located at the northeastern edge of the Asian monsoon climate belt, which brings much rain to the country. The weather is under the dual influence of the Siberian weather system and the patterns of the southern Pacific; it is affected by the Japan Current (Kuroshio), a warm stream that flows from the southern Pacific along much of Japan's Pacific coast, producing a milder and more temperate climate than is found at comparable latitudes elsewhere. Northern Japan is affected by the Kuril Current (Oyashio), a cold stream flowing along the eastern coasts of Hokkaido and northern Honshu. The junction of the two currents is a bountiful fishing area. The Tsushima Current, an offshoot of the Japan Current, transports warm water northward into the Sea of Japan / East Sea.

Throughout the year, there is fairly high humidity, with average rainfall ranging by area from 100 cm to over 250 cm (39–98 in). Autumn weather is usually clear and bright. Winters tend to be warmer than in similar latitudes except in the north and west, where snowfalls are frequent and heavy. Spring is usually pleasant, and the summer hot and humid. There is a rainy season that moves from south to north during June and July.

Average temperature ranges from 17° C (63° F) in the southern portions to 9° C (48° F) in the extreme north. Hokkaido has long and severe winters with extensive snow, while the remainder of the country enjoys milder weather down to the southern regions, which are almost subtropical. The Ryukyus, although located in the temperate zone, are warmed by the Japan Current, giving them a subtropical climate. The typhoon season runs from May through October, and each year several storms usually sweep through the islands, often accompanied by high winds and heavy rains.

2.5. Bangladesh—Climate and Geography

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

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

CHAPTER 3

HAZARD IDENTIFICATION

3.1. Introduction

This chapter outlines the potential hazards associated with brinjal seeds, planting materials or fruits in India, China, Thailand, and Japan, and considers some of the major risk characteristics of the commodity and its hazards.

An initial hazard list was made of all pests and pathogens associated with brinjal seeds, planting materials or fruits found in India, China, Thailand, and Japan, The Plant Quarantine Wing of the Department of Agriculture Extension (DAE) in Bangladesh list for pests of brinjal from India, China, Thailand, and Japan was used as its basis, with various species added or excluded after considerations of association. This original list was later refined to include only those organisms directly associated with brinjal seeds, planting materials or fruits and found to be present in India, China, Thailand, and Japan. Some hitch-hiker pests are included in the pest analyses where entry and establishment of a species into the country would cause potential economic, environmental or health consequences. The following a list of those organisms assessed and discarded as likely hazards based on biology, and lack of association with the commodity. Then all potential hazards and individual pest risk assessments and recommend measures where required.

3.2. Potential Hazard Groups

Pests and pathogens can be grouped in two main ways regarding their association with the commodity. Under their taxonomic category, i.e. Lepidoptera, Coleoptera, Acari, Fungi etc, or within the trophic role they play in their association, and what structures or part of the flower plants they attack, e.g. surface feeder, seed feeder, pathogen. In this risk analysis hazard organisms are grouped according to their general taxonomic category. Where a genus contains more than one species, information on all species is contained within one pest risk assessment. If organisms that are hitch hikers or vectors this is noted in the individual pest risk assessment.

The following categories are used are as follows:

Insect pests
Mite pests
Fungi
Bacteria
Nematode
Virus
Weeds

3.3. Pests and Pathogens of brinjal in exporting countries

The most common pests and pathogens affecting brinjal seeds, planting materials or fruits found in India, China, Thailand, and Japan are shown in the following Table below. Among which several pests were identified as quarantine pests likely to be imported with unmitigated shipments of brinjal seeds, planting materials or fruits, possibly requiring phytosanitary measures to mitigate risk. Further analysis of these quarantine pests have been done in the following chapter with recommendation of phytosanitary measures.

Table 6. Pests likely to be associated with eggplant in the exporting countries, but not in Bangladesh

Sl. No.	Common name	Scientific name	Distribution in exporting countries	Plant parts likely to carry the pest	References
Arthropod					
Insect pests					
1	Malaysian fruit fly	*Bactrocera latifrons*	India, China, Japan, Malaysia	Fruit, stem	EPPO, 2015
2	Serpentine leaf miner	*Liriomyza trifolii*	India, China, Japan	Leaf, stem, flower	EPPO, 2014; CABI/EPPO, 1997; Minkenberg (1988
3	Pea leaf miner	*Liriomyza huidobrensis*	India, Thailand, Japan	Leaf, stem, flower	CABI/EPPO, 2002; EPPO, 2014
4	Silver leaf whitfly	*Bemisia tabaci (B biotype)*	India, China, Japan, Malaysia	Leaf, stem, flower	CABI & EPPO, 1999; EPPO, 2014
5	Vegetable weevil	*Listroderes costirostris*	Japan	Fruit, stem, plant stock	CABI & EPPO, 2000; EPPO, 2014; Morrone, 1993
6	Alfafa thrips	*Frankliniella occidentalis*	India, Thailand, China	Leaf, fruit, plant stock	EPPO, 2014; CABI/EPPO, 1999; Reitz et al., 2011; Zhang et al., 2003; Nakahara, 1997
7	Cotton leaf worm	*Spodoptera littoralis*	Japan, Pakistan, Indonesia	Stem, fruit,leaf, flower	CIE, 1967; CABI/EPPO, 1997; OEPP/EPPO, 1981
Mite pest					
8	Red tomato spider mite	*Tetranychus evansi*	Japan, Taiwan	Leaf, stem, cutting, flower	EPPO, 2006; CABI, 2015; EPPO, 2016
Disease causing organisms					
Fungi					
9	Phytopthora root rot	*Phytophthora megasperma*	Japan, Philippines	Leaf, stem, cutting,	CABI, 2006
Nematode					
10	Golden cyst nematode	*Globodera rostochiensis*	India, Japan, Pakistan, Sri Lanka	Tuber, bulb, corm	EPPO, 1997; CABI, 2007
11	Pale cyst nematode	*Globodera pallid*	India, Japan, Pakistan, Sri Lanka	Tuber, bulb, corm	EPPO, 1997; CABI, 2007
Virus					
12	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	India, China, Japan	Seed, leaf, cutting	EPPO, 2006
13	Pepper vein mottle virus	*Pepper veinal mottle virus*	India, Afganistan, Taiwan	Seed, cuttings	CABI,2007; Jagadeeshwar *et al*., 2005
Weeds					
14	Parthenium weed	*Parthenium hysterophorus*	Bangladesh (restricted areas), India, China, Japan	Seed, equipment	EPPO, 2014; CABI/EPPO, 1999

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3. 4. Organism Interception on Commodity from Existing Pathways

In the past, there was no previous pest risk assessment on brinjal from any of the exporting countries including the India, China, Thailand, and Japan. As reported by the Plant Quarantine Wing (PQW) under Department of Agriculture Extension (DAE), Bangladesh, during inspection in port of entry of brinjal seeds, planting materials or fruits from these exporting counties, not a pest had been intercepted yet today on the commodity imported into Bangladesh.

3.5. Other Risk Characteristics of the Commodity

Although many pests dealt with in this risk analysis have adequate information for assessment, we can not predict future or present risks that currently escape detection for a variety of reasons.

3.5.1 Unlisted Pests

These include pests that are not yet identified. With a trend towards decreasing use of chemical products in agriculture and further reliance on Integrated Pest Management strategies it is assumed that new pests will enter the system at some time in the future.

Prolonged use of large doses of pesticides and fertilizers can lead to previously non pest species becoming economically important through resistance to pest treatments. Any of these types of organism could initially appear in very small numbers associated with the commodity, and may not be identified as hazards before their impacts become noticeable.

3.5.2 Symptomless Micro-organisms

Pests such as microbes and fungi infect brinjal seeds, planting materials or fruits before transit and may not produce symptoms making them apparent only when they reach a suitable climate to sporulate or reproduce.

Many fungi can infect brinjal seeds, planting materials or fruits after arrival making it difficult to distinguish the origin of saprobes and pathogens without adequate identification. Consumers tend to throw away moulded eggplants rather than take it to a diagnostic laboratory so there is little data on post entry appearance of “invisible organisms”.

3.6 Assumptions and Uncertainties

The purpose of this section is to summarise 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 managing risk 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.

There is a major uncertainty concern regarding the prevalence of above mentioned high and moderate rated insect pests, diseases and weed of brinjal in India, China, Thailand, and Japan and other countries of brinjal export.

The assessment should have included information on export volumes and frequency to other countries, the average size of export lots, the number of lots found infested with pests of brinjal seeds, planting materials or fruits in the importing countries, and preferably, any information on incidence level in pests infested brinjal seeds, planting materials or fruits consignments or lots would be valuable.

Thus, the assessment of uncertainties and assumptions for each organism often covers similar areas of information or lack of information, with key factors or variables being relevant across different organism groups. The following sections outline these considerations. The uncertainties and assumptions are covered in these sections rather than individually in each pest risk assessment.

3.7. Assumptions and Uncertainties around hazard biology

- The species of mealybug (*Pseudococcus* spp.) are the well known hitch-hiker species, and has been associated with flowers in India, Thailand, China, and Japan. Currently there are no data demonstrating this association between this hitch-hiker pest and the pathway imported from these countries into Bangladesh. Interception data rather than biological information would be required to clarify this issue.
- The biology of insects that have been reared in the laboratory for several generations is often different to wild counterparts established in greenhouses or in field conditions (Mangan & Hallman 1998). Aspects such as life cycle, preovipositional period, fecundity and flight ability (Chambers 1977), as well as cold or heat tolerance can be influenced by the highly controlled laboratory environment. Laboratory reared insects may differ in their responses to environmental stress and exhibit tolerances that are exaggerated or reduced when compared with wild relatives.
- If a pest species occurs in Bangladesh often its full host range, or behaviour in the colonised environment remains patchy. It is difficult to predict how a species will behave in a new environment, particularly if it has not become established as a pest elsewhere outside its natural range. Therefore, there will be considerable uncertainty around the likelihood of an organism colonising new hosts or the consequences of its establishment and spread on the natural environment. Where indigenous plants are discussed as potential hosts this is extrapolated from the host range (at genus and family level) overseas and is not intended as a definitive list.

3.8. Assumption and Uncertainties Around the Inspection Produre

- There are distinct temperature requirements for optimum development and reproduction for the different biotype of pests like *Bemisia tabci* (Silver leaf whitefly). Therefore, the molecular data on race detection of the insect pests rather than occurrence of biological information would be required to clarify this issue.

3.9. Assumption Around Transit Time of Commodity on the Air Pathway

- An assumption is made around the time the brinjal seeds, planting materials or fruits take to get from the field in India, China, Thailand, and Japan to Bangladesh ready for wholesale if it is transported by Landport or Sea shipment.

3.10. Assumption Around Commodity Grown in Bangladesh

Section of PRA	Uncertainties	Further work that would reduce uncertainties
Taxonomy	None	-
Pathway	Presence of a pathway from imported produce to suitable protected environments, such as botanical gardens.	• Monitor all suitable protected environments which are near points of entry of infested produce. • Check reports of finds by other brinjal exporting countries
Distribution	None	-
Hosts	None	-
Establishment	Establishment potential under glasshouse in the PRA area.	Continue to monitor the literature for reports of establishment in protected environments.
Spread	Rate of potential spread in areas at risk within the PRA area	Continue to monitor the literature for reports on ability to spread.
Impact	Potential to cause damage in protected environments	Continue to monitor the literature for reports on damage caused in protected environments
Management	None	-

CHAPTER 4

REVIEW OF MANAGEMENT OPTIONS

4.1. Introduction

The following assessment of pre- and post-harvest practices reflects the current systems approach for risk management employed for commercially produced cut flowers. 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 cut flowers from exporting countries.

4.2. Pre-harvest Management Options

The in-field pest management practises for the production of brinjal are

a. Annual flooding of gardens to soil dwelling insects;
b. Pre-flowering pesticide treatments for arthropods and fungi above threshold levels;
c. Post-flowering pesticide treatments above threshold levels for specific pests such as aphids, whiteflies, mealy bugs, mites and anthracnose, blight etc;
d. Flower gardent hygiene which involves removal of fallen leaves and crop residues under a Good Agricultural Practise (GAP) scheme administered by Department of Agriculture Extension (DAE);

4.3. Post-Harvest Procedures

The procedure is to sorting/grading to remove damaged/overripe/infested/infected brinjal. The grading process is likely to remove flowers showing obvious signs of fungal and bacterial disease as well as the presence of aphids, mealybugs, scale insects, caterpillars etc.

4.4. Visual Inspection

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

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

A visual inspection at multiple points of the pathway provides opportunities to remove infested/infected flowers and is considered an appropriate risk management option for regulated organisms such as aphids, mealybugs and scale insects as they are easily detected on the surface of brinjal seeds, planting materials and or fruits.

4.5. 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.

4.6. General conditions for fresh fruit/vegetables for consumption

Eggplant includes fresh fruit/vegetables intended for comsumption and not for planting. For the purposes of this standard eggplant excludes roots or viable seeds.

- Only clean, inert/synthetic material may be used for the protection, packaging and shipping of fresh fruit/vegetables.
- A completed phytosanitary certificate issued by the exporting country's NPPO must accompany all consignments of fresh fruit and vegetables exported to Bangladesh.
- Where it has been determined through pest risk assessment that high impact pests are associated with a particular commodity more specific phytosanitary measures must be met.

4.7. Specific Conditions for eggplant

4.7.1. 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 cut flowers and foliages from which the eggplant and other planting materials were collected, have been treated.

Documentation

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

4.7.2. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all eggplant consignment 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 eggplants have:

i) been visually inspected in accordance with appropriate official procedures and found to be free from any regulated pests

AND,

ii) undergone appropriate pest control activities that are effective against: *Bemisia tabaci*

OR

iii) been sourced from a pest free area (verified by an official detection survey) free from a regulated pest(s).

AND

iv) undergone an agreed measure that is effective against associated fruit fly species of economic significance.

4.7.3. 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 eggplants 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 Banglasesh's current phytosanitary requirements".

AND

- have undergone appropriate pest control activities that are effective against those regulated high impact pests

AND;

- have been sources from an area free from those regulated high impact pests;

4.7.4. Transit requirements

The eggplants 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.

4.7.5. Inspection on arrival in Bangladesh

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

4.7.6. Testing for regulated pests

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

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

If regulated pests are intercepted/detected on the commodity, or associated packaging, the following actions will be 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 will be in accordance with the actions required by the relevant government department.

4.7.8. 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 will be given.

4.7.9. 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.

CHAPTER 5

POTENTIAL HAZARD ORGANISM: RISK ANALYSES

5.1. Introduction

The pest risk assessment was done with the aim to determine Bangladesh's phytosanitary measure regarding the eggplants imported from any eggplant exporting countries including India, China, Thailand, and Japan into Bangladesh.

5.2. Pest Categorization: Identification of Quarantine Pests Likely to Follow the Pathway

5.2.1. Pests of eggplants in the world

The pests associated with fresh cutflower and foliages in the world have been categorized and listed below based on their scientific name, taxonomic position, common name, infective phase, plant parts affected, geographical distribution and their quarantine status for Bangladesh.

Sixty two species of pests were recorded for eggplants in the world of which 26 species were insect pests and two species were mite pests; the species of disease causing fungi were 13, bacteria two, nematode four, and virus were five and Phytoplasma one species. Whereas eight species of weeds for eggplants were recorded.

Among Table 7 depicted the lists of pests associated with the eggplants in the world including in India, China, Thailand, Japan and the absence or presence of these pests in Bangladesh. Based on Table 7, any pest that meets all above criteria will be selected for further risk assessment (Table 8).

5.2.2. Quaratine pests of eggplants for Bangladesh

Fourteen species of quarantine pests of eggplants for Bangladesh had been identified, of those were present in India, China, Thailand, and or Japan, of these thirteen was not present in Bangladesh, but 1 species of weed present in exporting countries as well as in Bangladesh with distributed in restricted areas. Among these 14 species of pests, 7 were insect pests, one species was mite pest, one fungus, none of bacteria, nematode two species, virus three and weed was one species (Table 8).

The quarantine insect pests are Malaysian fruit fly (*Bactrocera latifrons*), serpentine leaf miner (*Liriomyza trifolii*), pea leaf miner (*Liriomyza huidobrensis*), silver leaf whitfly (*Bemisia tabaci (B biotype))*, vegetable weevil (*Listroderes costirostris*), Alfafa thrips (*Frankliniella occidentalis*), and cotton leaf worm (*Spodoptera littoralis*). The quarantine mite pest of brinjal for Bangladesh is red tomato spider mite (*Tetranychus evansi*) (Table 8).

On the other hand, seven disease causing micro-organisms and viruses have been identified as quarantine pests of eggplants for Bangladesh. Among these quarantine diseaes, one fungus named Phytopthora root rot (*Phytophthora megasperma*); two species of nematode named Golden cyst nematode (*Globodera rostochiensis*), and Pale cyst nematode (*Globodera pallid*); two viruses named *Tobaccor ringspot virus* and *Pepper veinal mottle virus* (Table 8).

One species of quarantine weed has been identified Bangladesh named Parthenium weed (*Parthenium hysterophorus*) (Table 8).

Table 7. Pests associated with eggplants in the world and identification of quarantine organisms

Sl. No.	Common name	Scientific name	Family	Order	Presence in Bangladesh	Qurantine status	Follow pathway
ARTHROPODS							
Insect pests							
1	Brinjal shoot and fruit borer	*Leucinodes orbonalis*	Pyralidae	Lepidoptera	Yes	No	Yes
2	Cut worm	*Agrotis spp.*	Noctuidae	Lepidoptera	Yes	No	Yes
3	Leaf roller	*Eublemma olivacea* Walker	Noctuidae	Lepidoptera	Yes	No	Yes
4	Cotton leaf worm	*Spodoptera litura*	Noctuidae	Lepidoptera	Yes	No	Yes
5	Cabbage caterpillar	*Helicoverpa armigera*	Noctuidae	Lepidoptera	Yes	No	Yes
6	Eggplant moth	*Neoleucinodes elegantalis*	Crambidae	Lepidoptera	Yes	No	Yes
7	Jassid of brinjal	*Amrasca biguttula biguttula*	Cicadellidae	Homoptera	Yes	No	Yes
8	Aphid	*Aphis gossypii Glover*	Aphididae	Homoptera	Yes	No	Yes
9	Whitefly	*Bemisia tabaci*	Aleurodidae	Homoptera	Yes	No	Yes
10	Silver leaf whitfly	*Bemisia tabaci (B biotype)*	Aleurodidae	Homoptera	No	Yes	Yes
11	Scale insect	*Aulacaspis* spp.	Margarodidae	Homoptera	Yes	No	Yes
12	Mealybug	*Coccidohystrix insolita*	Pseudococcidae	Homoptera	Yes	No	Yes
13	Potato psyllid	*Bactericera cockerelli*	Triozidae	Hemiptera	Yes	No	Yes
14	Lace bug	*Gargaphia solani*	Tingidae	Hemiptera	Yes	No	Yes
15	Epilachna beetle	*Epilachna vigintioctopunctata*	Coccinellidae	Coleoptera	Yes	No	Yes
16	Epilachna beetle	*Epilachna dodecastigma*	Coccinellidae	Coleoptera	Yes	No	Yes
17	Blister beetle	*Mylabris pustulata*	Meloidae	Coleoptera	Yes	No	Yes
18	Vegetable weevil	*Listroderes costirostris*	Curculionidae	Coleoptera	No	Yes	Yes
19	Thrips	*Thrips palmi* Karny	Thripidae	Thysanoptera	Yes	No	Yes
20	Vegetable leaf miner	*Liriomyza sativae*	Agromyzidae	Diptera	Yes	No	Yes
21	Serpentine leaf miner	*Liriomyza trifolii*	Agromyzidae	Diptera	No	Yes	Yes
22	Pea leaf miner	*Liriomyza huidobrensis*	Agromyzidae	Diptera	No	Yes	Yes
23	Malaysian fruit fly	*Bactrocera latifrons*	Tephritidae	Diptera	No	Yes	Yes
24	Alfafa thrips	*Frankliniella occidentalis*	Thripidae	Thysanoptera	No	Yes	Yes
25	Cotton leaf worm	*Spodoptera littoralis*	Noctuidae	Lepidoptera	No	Yes	Yes
Mite pests							
28	Two-spotted spider mite	*Tetranychus urticae*	Tetranychidae	Acarina	Yes	No	Yes
29	Tomato red spider mite	*Tetranychus evansi*	Tetranychidae	Acarina	No	Yes	Yes
DISEASES							
Causal organism: Fungi							
30	Early blight	*Alternaria tomatophilia*	Pleosporaceae	Pleosporales	Yes	No	Yes
31	Cercospora leaf spot	*Cercospora melongenae*	Mycosphaerellaceae	Capnodiales	Yes	No	Yes
32	Colletotrichum fruit rot	*Colletotrichum melongenae*	Glomerellaceae	Glomerellales	Yes	No	Yes

Sl. No.	Common name	Scientific name	Family	Order	Presence in Bangladesh	Qurantine status	Follow pathway
33	Anthracnose	*Colletotrichum coccodes*	Glomerellaceae	Glomerellales	Yes	No	Yes
34	Phomopsis fruit rot	*Phomopsis vexans*	Diaportaceae	Diaporthales	Yes	No	Yes
35	Phytophthora blight	*Phytophthora capsici*	Pythiaceae	Peronosporales	Yes	No	Yes
36	Verticillium wilt	*Verticillium* spp.	Plectosphaerellaceae	Incertae sedis	Yes	No	Yes
37	Stem rot/damping off	*Fusarium solani*.	Nectriaceae	Hypocreales	Yes	No	Yes
38	Root rot	*Pythium* spp.	Nectriaceae	Hypocreales	Yes	No	Yes
39	Damping off	*Rhizoctonia* spp.	Nectriaceae	Hypocreales	Yes	No	Yes
40	Powdery mildew	*Podosphaera pannosa*	Erysiphaceae	Erysiphales	Yes	No	Yes
41	Downy mildew	*Peronospora sparsa*	Peronosporaceae	Peronosporales	Yes	No	Yes
42	Phytopthora root rot	*Phytophthora megasperma*	Pythiaceae	Pythiales	No	Yes	Yes
Causal organism: Bacteria							
43	Bacterial wilt	*Ralstonia solanacearum*	Ralstoniaceae	Burkholderiales	Yes	No	Yes
44	Bacterial soft rot	*Erwinia carotovora* subsp. *carotovora*	*Enterobacteriaceae*	*Enterobacteriales*	Yes	No	Yes
Causal organism: Nematode							
45	Root knot nematode	*Meloidogyne javanica*	Heteroderidae	Tylenchida	Yes	No	Yes
46	Root knot nematode	*Meloidogyne incognita*	Heteroderidae	Tylenchida	Yes	No	Yes
47	Golder cyst nematode	*Globodera rostochiensis*	Heteroderidae	Tylenchida	No	Yes	Yes
48	Pale cyst nematode	*Globodera pallid*	Heteroderidae	Tylenchida	No	Yes	Yes
Virus and viroid							
49	Tomato leaf curl New Delhi virus	*Tomato leaf curl New Delhi virus*	Geminivirdae	Unassigned ssDNA	Yes	No	Yes
50	Potyvirus	*Potyvirus*	Potyviridae	Unassigned (+) ssRNA	No	Yes	Yes
51	Nucleorhabdovirus	*Nucleorhabdovirus*	Rhabdoviridae	Mononegavirales	No	Yes	Yes
52	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	*Secoviridae*	*Picornavirales*	No	Yes	Yes
53	Pepper vein mottle virus	*Pepper veinal mottle virus*	Potyviridae	Unassigned (+)ssRNA	No	Yes	Yes
Phytoplasma							
54	Little leaf of brinjal	*Candidatus Phytopasma solani*	Acholeplasmataceae	Acholeplasmatales	Yes	No	Yes
WEEDS							
55	Bermuda grass	*Cynodon dactylon*	Poacegae	Poales	Yes	No	Yes
56	Nutsedge	*Cyperus esculentus*	Cyperaceae	Poales	Yes	No	Yes
57	Goosefoot	*Chenopodium album* L.	Chenopodioideae	Caryophyllales	Yes	No	Yes
58	Pigweed	*Amaranthus acanthochiton*	Amaranthaceae	Caryophyllales	Yes	No	Yes
59	Spiny pigweed	*Amaranthus spinosus*	Amaranthaceae	Caryophyllales	Yes	No	Yes
60	Blacknightshade	*Solanum nigrum*	Solanaceae	Solanales	Yes	No	Yes
61	Horsenettle	*Solanum carolinense* L.	Solanaceae	Solanales	Yes	No	Yes
62	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	Yes (restricted areas	Yes	Yes

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Table 8. Quarantine pests for Bangladesh likely to be associated with eggplants imported from exporting countries selected for further analysis

Sl. No.	Common name	Scientific name	Family	Order
Arthropod				
Insect pests				
1	Malaysian fruit fly	*Bactrocera latifrons*	Tephritidae	Diptera
2	Serpentine leaf miner	*Liriomyza trifolii*	Agromyzidae	Diptera
3	Pea leaf miner	*Liriomyza huidobrensis*	Agromyzidae	Diptera
4	Silver leaf whitfly	*Bemisia tabaci (B biotype)*	Aleurodidae	Homoptera
5	Vegetable weevil	*Listroderes costirostris*	Thripidae	Thysanoptera
6	Alfafa thrips	*Frankliniella occidentalis*	Thripidae	Thysanoptera
7	Cotton leaf worm	*Spodoptera littoralis*	Noctuidae	Lepidoptera
Mite pest				
8	Red tomato spider mite	*Tetranychus evansi*	Tetranychidae	Acarina
Disease causing organisms				
Fungi				
9	Phytopthora root rot	*Phytophthora megasperma*	Pythiaceae	Pythiales
Nematode				
10	Golden cyst nematode	*Globodera rostochiensis*	Heteroderidae	Tylenchida
11	Pale cyst nematode	*Globodera pallid*	Heteroderidae	Tylenchida
Virus				
12	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	*Secoviridae*	*Picornavirales*
13	Pepper vein mottle virus	*Pepper veinal mottle virus*	Potyviridae	Unassigned (+)ssRNA
Weeds				
14	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales

5.3. Potential Hazard Organisms: Risk Analyses

The risk analysis of quarantine pests include the use of a developing or evolving process (PPQ, 2000; Orr et al., 1993), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1992; Orr et al., 1993). The risk assessment was done in accordance with International Plant Protection Convention (IPPC) and the International Standards for Phytosanitary Measures (ISPM 2 and ISPM 11). The risk analysis of quarantine pests of cut flower and foliages identified for Bangladesh has been analyzed details as follows:

INSECT PESTS

5.3.1.	**Malaysian fruit fly: *Bactrocera latifrons* (Hendel)**

5.3.1.1. Hazard Identification

Scientific name: *Bactrocera latifrons* (Hendel)

Synonyms:

*Chaetodacus antennalis (*Shiraki, 1933)
*Chaetodacus latifrons (*Hendel)
Dacus latifrons (Hendel)
*Dacus parvulus (*Hendel, 1912)

Common names: Malaysian fruit fly

Taxonomic tree

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

EPPO Code: DACULA.

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

5.3.1.2. Biology

Eggs (9-587 eggs) are laid below the skin of the host fruit. These hatch within a few days (mean 2.3) and the larvae feed for about a week (mean 8.5 days). Pupariation is in the soil under the host plant for little over a week (mean 10.2 days). Adults occur throughout the year and females begin oviposition after 6-17 days, and continue laying eggs for 6-117 days (Vargas and Nishida, 1985). Adult flight and the transport of infected fruit are the major means of movement and dispersal of *Bactrocera spp*. to previously uninfected areas. Many Bactrocera spp. can fly 50-100 km (Fletcher, 1989).

5. 3.1.3. Hosts

B. latifrons is a pest of fruit and vegetable species, mainly belonging to Solanaceae and to a lesser extent to Cucurbitaceae, such as: *Capsicum annuum, C. chinense, C. frutescens, Physalis peruviana, Solanum aethiopicum, S. lycopersicum, S. melongena, S. torvum* -

Cucumis sativus, C. melo, Cucurbita maxima, Citrullus lanatus, Lagenaria siceraria, Momordica charantia. A recent review has also identified more than 50 plant species (in 14 plant families) on which field infestations by *B. latifrons* have been recorded (e.g. *Citrus aurantifolia* (Rutaceae), *Dimocarpus longan* (Sapindaceae), *Passiflora foetida* (Passifloraceae), *Psidium guajava* (Myrtaceae), *Punica granatum* (Lytraceae)).

5. 3.1.4. Distribution

B. latifrons has a predominantly south and south-east Asian distribution. Waterhouse (1993) records this species from Indonesia, although no area is specified. Given that this species has been found in Sabah and **West Malaysia** it may at least be expected in Kalimantan and Sumatra. In Africa, *B. latifrons* has only been recorded from Tanzania and Kenya. Its occurance in other parts of Africa is currently unknown (Meyer et al., 2007). This species was recently introduced to Hawaii and was first discovered there in 1983 (Liquido et al., 1994). *B. latifrons* originates from Asia but its range has expanded through introductions into Africa (Kenya and Tanzania, first found in 2007 and 2006 respectively) and the islands of Hawaii (US, first found in Honolulu in 1983) and Yonaguni (Okinawa prefecture, Ryukyu Archipelago, **Japan,** first found in 1984).

EPPO region: Absent.

Africa: Kenya, Tanzania.

Asia: Brunei Darussalam, **China** (Fujian, Guangdong, Guangxi, Hainan, Xianggang (Hong Kong), Yunnan), **India** (Karnataka, Kerala, Himachal Pradesh, Tamil Nadu, West Bengal), Indonesia (Kalimantan, Sulawesi), **Japan** (Ryukyu), Laos, Malaysia (Sabah, West), Myanmar, **Pakistan**, Singapore, Sri Lanka, **Taiwan, Thailand, Vietnam**.

North America: USA (Hawaii only). Isolated outbreaks have been reported occasionally from California, but have been eradicated.

5. 3.1.5. Hazard identification conclusion

Considering the facts that *B. latifrons* -

- is not known to be present in Bangladesh [CABI/EPPO, 2015];
- is potentially economic important to Bangladesh because it is an important pest of Solanaceae and Cucurbitaceae in Asia including China, India, Thailand, **Japan** [CABI/EPPO, 2015] from where brinjal seeds are imported to Bangladesh.
- can become established in Bangladesh through imports of the eggplants. Some of the major host plants of *B. latifrons*, such as tomato, aubergine, sweet pepper, cucumber, melons and other cucurbits are widely grown in the Asia region, in both field and protected conditions. Economic damage has been reported from countries where *B. latifrons* occurs.
- At 14 or 15 °C, more than 30 % of females survived for 90 days. Time required to kill 95 % of *B. latifrons* at 8 °C was estimated to be 13 days; at 10 °C, 29 days; and at 12 °C, 38 days for females, and 8, 17, and 24 days at the same above temperatures, respectively, for males, suggesting low cold tolerance of this species. The females survive at cold temperatures better than males.
- According to the EPPO study on pest risks associated with the import of brinjal, the climatic similarity between the area where *B. latifrons* occurs and Bangladesh region is same. As experience has shown that control and eradication of fruit flies is complex and costly, the introduction of *B. latifrons* in Bangladesh should be avoided.
- *B. latifrons* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5. 3.1.6. Determine likelihood of pest establishing in Bangladesh via this pathway

Table 1.1 – 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, • This pest has been established in many Asian countries. The introduction of this pest in India was first reported in 2014; Japan in 2014, China in 2014; Thailand in 2014, Sri-lanka in 2014. b. **Posibility of survival during transport, storage and transfer of this pest? Yes** • The brinjal seeds and fruits are transported from India, China, Japan, Thailand, Taiwan and Vietnam to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and larva of fruitfly can easily survive within the fruit of eggplant. Becauase eggs (9-587 eggs) are laid below the skin of the host fruit. These hatch within at few days (mean 2.3) and the larvae feed for about a week (mean 8.5 days). Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - 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. Larvae have been found in peppers sent by mail from Hawaii to California (Foote et al., 1993). **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *B. latifrons* is a remarkably polyphagous species with 50 plant species from 14 families being recorded as hosts. The host range of *B. latifrons* is the fruits *Capsicum annuum, C. chinense, C. frutescens, Physalis peruviana, Solanum aethiopicum, S. lycopersicum, S. melongena, S. torvum - Cucumis sativus, C. melo, Cucurbita maxima, Citrullus lanatus, Lagenaria siceraria, Momordica charantia* (EPPO, 2016), which are mostly common in Bangladesh. • Adult flight is the main means of natural spread. No data is specifically given for flying distances of *B. latifrons*, but several Bactrocera spp. have been reported to fly 50-100 km. Over long distances, movement and trade of fruit and vegetables can transport the pest. In the EPPO region, B. latifrons has been intercepted several times in imported fruits and vegetables from Asia, thus showing that the pest has pathways to enter the region.	**YES and HIGH**

• 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5. 3.1.7. Determine the Consequence establishment of this pest in Bangladesh

Table 1.2 – Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. **Is this a serious pest of Bangladesh? - Yes.** • *B. latifrons* is a remarkably polyphagous species with 50 plant species from 14 families being recorded as hosts. The host range of *B. latifrons* is the fruits *Capsicum annuum, C. chinense, C. frutescens, Physalis peruviana, Solanum aethiopicum, S. lycopersicum, S. melongena, S. torvum - Cucumis sativus, C. melo, Cucurbita maxima, Citrullus lanatus, Lagenaria siceraria, Momordica charantia* (EPPO, 2016), which are mostly common in Bangladesh. • *B. latifrons* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in field crops, illustrate clearly the serious nature of this pest and the potential threat to the field crops as well as other horticultural crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important field crops for Bangladesh. **b. Economic impact and yield loss** • When the eggs hatch, the rotten fruit tissues make it easier for the larvae to feed inside the fruit, resulting in a soft, mushy mess. The puncture and feeding galleries made by developing larvae also provide entry points for pathogens to infect, develop and increase the fruit decay. From a quantitative point of view, the damage is caused by larvae at the second and especially third instar stages, by the removal of the significant proportion of the pulp which consequently results in reduction in the yield and quality of the harvestable fruits. Generally, the fruit falls to the ground as, or just before the maggots pupate and emerge as adult to continue the cycle (Ekesi and Billah, 2006). **c. Environmental impact** • The introduction of Malaysian fruitefly within new areas brings along the possibility of insecticide resistance genes. This invariably leads to an increase in the use of insecticides as fruitfly control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment. • The *B. latifrons d*oes not respond to methyl eugenol, only responds to Alpha-oinol+cade oil (Lati-Lure). Therefore, it introduction triggers the use of more chemical insecticides which directly causes environmental	**Yes and High**

hazards. • The invasion of alien species can cause extensive economic and ecological damage, with unpredictable negative effects on native populations. Alien species' impact on environm ent is believed to be second only to habitat destruction. Invasive species can alter succession patterns, mutualistic relationships, community dynamics, ecosystem functions and resource distributions. Invasive species that cause extinction of native species will ultimately reduce local and global species diversity (Lyon and Miller, 2000).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5. 3.1.8. Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 1.3 – Calculating 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

5. 3.1.9. Risk Management Measures

- Avoid importation of fruits and vegetables from countries, where this pest is available.
- Many countries, such as the mainland USA, forbid the import of susceptible fruit without strict post-harvest 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). However, recent research has indicated that *B. latifrons* is more heat tolerant than other species (Jang *et al*., 1999). 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.
- 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 well before the fruit is attacked. Little information is available on the attack time for most fruits but few Bactrocera spp. attack prior to ripening.

- Although cover sprays of entire crops are sometimes used, the use of bait sprays is both more economical and more environmentally acceptable. 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.

- This species is not attracted to either cue lure or methyl eugenol. Field monitoring is by sampling susceptible fruits for larvae. In Hawaii a new lure chemical is being developed (White and Liquido, 1995).

5. 3.1.10. References

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5.3.2.	**Serpentine leaf miner: *Liriomyza trifolii* (Burgess)**

5.3.2.1. Hazard identification

Scientific Name: *Liriomyza trifolii* Burgess in Comstock, 1880

Synonyms: *Agromyza phaseolunata* Frost, 1943
Liriomyza alliivora Frick, 1955
Liriomyza alliovora Frick, 1955
Liriomyza phaseolunata (Frost, 1943)
Oscinis trifolii Burgess in Comstock, 1880

Common names: Serpentine leaf miner
Chrysanthemum leaf miner

Taxonomic tree

Phylum: Arthropoda
Subphylum: Mandibulata
Class: Insecta
Order: Diptera
Family: Agromyzidae
Genus: *Liriomyza*
Species: *Liriomyza trifolii*

EPPO Code: LIRITR. This pest has been included in EPPO A2 list: No. 131

Bangladesh status: Not present in Bangladesh [EPPO, 2014; CABI/EPPO, 1997]

5. 3.2.2. Biology

Peak emergence of adults occurs before midday (McGregor, 1914). Males usually emerge before females. Mating takes place from 24 h after emergence and a single mating is sufficient to fertilize all eggs laid. Female flies puncture the leaves of the host plants causing wounds which serve as sites for feeding or oviposition. Feeding punctures cause the destruction of a larger number of cells and are more clearly visible to the naked eye. About 15% of punctures made by *L. trifolii* contain viable eggs (Parrella et *al*., 1981). Eggs are inserted just below the leaf surface. The number of eggs laid varies according to temperature and host plant. *L. trifolii* females each laid 25 eggs in celery at 15°C and 400 eggs at temperatures around 30°C. One female of *L. trifolii* laid 493 eggs in peas (Poe, 1981) and another laid 639 eggs in chrysanthemums (cv. Fandango).

The life-cycle is probably continuous throughout the year. There is a noticeable first generation which reaches a peak in April (Spencer, 1973). On celery *L. trifolii* completes its life-cycle (oviposition to adult emergence) in 12 days at 35°C, 26 days at 20°C, and 54 days at 15°C (Leibee, 1982). On chrysanthemums the life-cycle is completed in 24 days at 20°C but on *Vigna sinensis* and *Phaseolus lunatus* it takes only 20 days at this temperature (Poe, 1981). Adults of *L. trifolii* live between 15 and 30 days. On average, females live longer than males.

5. 3.2.3. Hosts

a. Major hosts: The main host of *L. trifolii* includes aubergine, Chinese cabbage, spinach, ornamental gourd, cucurbits, beans, soyabean, common bean, cow pea, okra, cotton, tomato Ageratum, Aster, marigold, Callistephus, safflower, *Chrysanthemum morifolium*, Dahlia, Gerbera (barbeton daisy), sunflower, carnation, gypsophila (baby's breath), Zinnia, salvia (sage), garlic, Begunia, groundnut, lettuce etc.

b. Minor hosts: The minor or other hosts of this pest include pumpkin, bottle gourd, loofah, castor bean, *Chrysanthemum indicum,* faba bean, onion, Goosefoot, citrullus, etc.

5. 3.2.4. Distribution

L. trifolii has not yet been reported from many countries where it is actually present. It is generally recognized that all the countries bordering the Mediterranean have *L. trifolii* in varying degrees and that it occurs in all mainland states of the USA. *L. trifolii* has been recorded from the Juan Fernandez Islands (an offshore territory of Chile; Martinez and Etienne, 2002; EPPO, 2009). The record for Argentina has been changed to 'Absent, unreliable record' as Martinez and Etienne (2002) and EPPO (2006) are based on Burgess (in Comstock, 1880 (1879)) and there have been no other reports of the pest in Argentina. *L. trifolii* is a quarantine pest for Argentina (SENASA, personal communication, 2008).

L. trifolii originates in North America and spread to other parts of the world in the 1960-1980s and in India, it was first reported in 1991 (EPPO, 2014). A detailed review of its spread is given in Minkenberg (1988).

- **EPPO region**: First detected in 1976. Now present in Austria, Belgium, Bulgaria, Cyprus, Egypt, France, Greece, Ireland, Israel, Italy, Lebanon, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain (including Canary Islands), Switzerland, Turkey, Yugoslavia. Eradicated in the Czech Republic, Denmark, Finland, Germany, Hungary, Norway, Sweden, UK.
- **Asia**: Cyprus, **India** (Andhra Pradesh), Israel, **Japan** (Honshu), Korea Republic, Lebanon, Philippines, **Taiwan**, Turkey (EPPO, 2014), **China** (CABI, 1997).
- **Africa**: Egypt, Ethiopia, Kenya, Mauritius, Nigeria, Réunion, Senegal, South Africa, Tanzania, Tunisia.
- **North America**: Canada (Alberta, Nova Scotia, Ontario, Quebec), Mexico (unconfirmed), USA (outside in New Mexico, California, most eastern states from Florida northward to New Jersey, Wisconsin and Iowa; under glass in other southern states).
- **Central America and Caribbean**: Bahamas, Barbados, Costa Rica, Cuba, Dominican Republic, Guadeloupe, Guatemala, Martinique, Trinidad and Tobago.
- **South America**: Brazil, Colombia, French Guiana, Guyana, Peru, Venezuela.
- **Oceania**: American Samoa, Guam, Micronesia, Northern Mariana Islands, Samoa, Tonga.

5. 3.2.5. Hazard Identification Conclusion

Considering the facts that *Liriomyza trifolii* (Burgess) -

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 1997];
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including India, China, Thailand (absent, unreliable record), **Japan**, Sri Lanka, Lebanon, Philippines, Cyprus, Israel, Turkey, Taiwan, [EPPO, 2014; CABI/EPPO, 1997] from where flowers are imported to Bangladesh.
- can become established in Bangladesh through imports of the vegetable seeds, nursery stock, flowers and foliages. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, because one female of *L. trifolii* can lay 493 eggs in peas (Poe, 1981) and another laid 639 eggs in chrysanthemums and larvae develop within the leaf surface. Dispersal over long distances is on planting material of host species. Cut flowers can also present a danger as a means of dispersal; it should be noted, for example, that the vase life of chrysanthemums is sufficient to allow completion of the life-cycle of the pest. [EPPO, 2016].
- *L. trifolii* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5. 3.2.6. Determine likelihood of pest establishing in tour country via this pathway

Table 2.1 – 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, • This pest has been established in many Asian countries. The introduction of this pest in India was first reported in 1991; Turkey in 1985, Tunisia in 1992, introduced in Kenya in 1976, now present in many Asian countries including Japan, Korea, the Republic, Thailand (absent, unreliable record) and China. • *L. trifolii* originates in North America and spread to other parts of the world in the 1960-1980s. • In EPPO region, this pest has been first detected in 1976. Now present in Austria, Belgium, Bulgaria, Cyprus, Egypt, France, Greece, Ireland, Israel, Italy, Lebanon, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain (including Canary Islands), Switzerland, Turkey, Yugoslavia. Eradicated in the Czech Republic, Denmark, Finland, Germany, Hungary, Norway, Sweden, UK. **b. Posibility of survival during transport? Yes** • The brinjal seeds and fruits are transported from India, China, Japan, Thailand, Taiwan and Vietnam to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and larva of serpentine leaf miner can easily survive within the fruit and planting materials of eggplant. • On celery *L. trifolii* completes its life-cycle (oviposition to adult emergence) in 12 days at 35°C, 26 days at 20°C, and 54 days at 15°C	**YES and HIGH**

(Leibee, 1982). On the life-cycle is completed in 24 days at 20°C but on Vigna sinensis and Phaseolus lunatus it takes only 20 days at this temperature (Poe, 1981). Adults of *L. trifolii* live between 15 and 30 days. Secondly, fruit/planting material is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *L. trifolii* is liable to be carried on any plants for planting or on cut flowers and foliages, and nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *L. trifolii* has been recorded from 25 families with preference shown for the Asteraceae, including the following important crops: *Brassica chinensis*, *Capsicum annuum*, celery, Chinese cabbages, cotton, cucumbers, garlic, leeks, lettuces, lucerne, marrows, melons, onions, peas, *Phaseolus coccineus*, *P. lunatus*, *P. vulgaris*, potatoes, spinach, tomatoes, *Tropaeolum* spp., *Vigna* spp., watermelons, *Aster* spp., chrysanthemums, *Dahlia* spp., *Dianthus* spp., *Gerbera* spp., *Gypsophila* spp., *Lathyrus* spp., *Zinnia* spp., beetroots, *Bidens* spp., (Stegmaier (1968). which are mostly common in Bangladesh. • On celery *L. trifolii* completes its life-cycle (oviposition to adult emergence) in 12 days at 35°C, 26 days at 20°C, and 54 days at 15°C (Leibee, 1982). On chrysanthemums the life-cycle is completed in 24 days at 20°C but on *Vigna sinensis* and *Phaseolus lunatus* it takes only 20 days at this temperature (Poe, 1981). *L. trifolii* females each laid 25 eggs in celery at 15°C and 400 eggs at temperatures around 30°C. One female of *L. trifolii* laid 493 eggs in peas (Poe, 1981) and another laid 639 eggs in chrysanthemums (cv. Fandango). • The duration of larval development also varies with temperature and host plant but is generally 4-7 days at mean temperatures above 24°C (Harris & Tate, 1933). Adult emergence of *Liriomyza* species occurs 7-14 days after pupariation, at temperatures between 20 and 30°C (Leibee, 1982). At low temperatures emergence is delayed. In the laboratory *L. trifolii* survived cold storage at 4.5°C for 8 weeks (Miller, 1978). • In the southern USA, the life-cycle is probably continuous throughout the year. There is a noticeable first generation which reaches a peak in April (Spencer, 1973). In southern Florida, *L. trifolii* has two or three complete generations followed by a number of incomplete, overlapping generations (Spencer, 1973). • These climatic requirements for growth and development of *L. trifolii* are 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 your country	Low

and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	

5. 3.2.7. Determine the Consequence establishment of this pest in Bangladesh

Table 2.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • *L. trifolii* is a remarkably polyphagous species and has been recorded from 25 families with preference shown for the Solanaceous,cucurbitaceous and Asteraceae, including the following important crops: Brinjal, *Capsicum annuum*, celery, Chinese cabbages, cotton, cucumbers, garlic, leeks, lettuces, lucerne, marrows, melons, onions, peas, *Phaseolus coccineus*, *P. lunatus*, *P. vulgaris*, potatoes, spinach, tomatoes, *Tropaeolum* spp., *Vigna* spp., watermelons, *Aster* spp., chrysanthemums, *Dahlia* spp., *Dianthus* spp., *Gerbera* spp., *Gypsophila* spp., *Lathyrus* spp., *Zinnia* spp., beetroots, *Bidens* spp., *Brassica chinensis* (Stegmaier, 1968). • This species is now the major pest of chrysanthemums in North America (D'Aguilar & Martinez, 1979). Vegetable losses in the USA are also considerable, for example losses for celery were estimated at US$ 9 million in 1980 (Spencer, 1982). *L. trifolii* is also known to be a vector of plant viruses (Zitter *et al*., 1980). • *L. trifolii* is already a serious pest of chrysanthemums in those countries in the EPPO region where it is established. It is apparently not capable of overwintering outdoors in northern Europe. • Damage is caused by larvae mining into leaves and petioles. The photosynthetic ability of the plants is often greatly reduced as the chlorophyll-containing cells are destroyed. Severely infested leaves may fall, exposing plant stems to wind action, and flower buds and developing fruit to scald (Musgrave *et al*., 1975). The presence of unsightly larval mines and adult punctures in the leaf palisade of ornamental plants can further reduce crop value (Smith *et al*., 1962; Musgrave *et al*., 1975). • *L. trifolii* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in flowers and other crops, illustrate clearly the serious nature of this pest and the potential threat to the flower and foliages as well as other crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important vegetables and other crops for Bangladesh. **b. Economic impact and yield loss** • The main damage is caused by larvae who mining the leaves of the brinjal plant and should not be confused by other mining insects as *Ceuthorrhynchus suturalis* or *Phytobia cepae*. Young seeding are most susceptible for insects pests and feeding by larvae. Older plants more readily tolerate attacks by this pest. However, if the infestation is severe and many larvae are feeding on the same leaf, photosynthetic capacity is reduced, thus causing a slowing in development of the plant and in later stadium also bulb formation. • The first larval stage of the vegetable leafminer burrows into the mesophyl tissue. The second stage also feeds in the mesophyl tissue, which reduce	**Yes and High**

photosynthetic capacity. The third stage larva concentrates its feeding towards the upper leaf surface. When it is mature, it cuts a longitudinal slit in the leaf and leaves to pupate on the leaf surface or on the ground. • Moreover, there are effective control methods and therefore the economic impacts is not high. Only when young seedlings are attacked, plants can be die and led to harvest losses. Because these young plants died in the early growing season, risk on contamination on matured bulbs is low. **c. Environmental Impact** • Damage is caused by *L. trifolii* larvae mining into leaves and petiole. The photosynthetic ability of the plants is often greatly reduced as the chlorophyll-containing cells are destroyed. Severely infested leaves may fall, exposing plant stems to wind action, and flower buds and developing fruit to scald (Musgrave *et al.,* 1975). The presence of unsightly larval mines and adult punctures caused by *L. trifolii* in the leaf palisade of ornamental plants, such as chrysanthemums, can further reduce plant value (Smith *et al.,* 1962; Musgrave *et al.,* 1975). In young plants and seedlings, *L. trifolii* mining may cause considerable delay in plant development, even leading to plant loss. The level of damage depends on many factors, including climate suitability, host resistance, crop distribution, growing conditions, control methods in place and the degree of infestation (EFSA, 2012). • This invariably leads to an increase in the use of insecticides as leaf miner control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 2.3 – Calculating 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

5.2.9. Risk Management Measures

- Avoid importation of vegetables seeds, nursery stock, flowers and foliages from countries, where this pest is available.

- In chrysanthemum cuttings, *L. trifolii* survives cold storage at 1.7°C for at least 10 days. Newly laid eggs of *L. trifolii* in chrysanthemums survived for up to 3 weeks in cold storage at 0°C (Webb & Smith, 1970). Eggs incubated for 36-48 h were killed after 1 week under the same conditions (Webb & Smith, 1970). All stages of larvae were killed after 1-2 weeks at 0°C (Webb & Smith, 1970). These authors, therefore, proposed that chrysanthemum cuttings should be maintained under normal glasshouse conditions for 3-4 days after lifting to allow eggs to hatch. Subsequent storage of the plants at 0°C for 1-2 weeks should then kill off the larvae.

- Gamma irradiation of eggs and first larval stages at doses of 40-50 Gy provided effective control (Yathom *et al*., 1991), but lower doses were ineffective.

- EPPO (OEPP/EPPO, 1990) recommends that planting material (except seeds) of celery, *Cucumis*, lettuces and tomatoes, brinjal and material (except seeds and pot plants) of *Capsicum*, carnations, chrysanthemums, *Gerbera*, *Gypsophila* and *Senecio hybridus* from countries where the pest occurs must either have been inspected at least every month during the previous 3 months and found free from the pests, or have been treated by a recommended method. It is left optional as to whether countries make the same requirements for pot plants of the second group of plants mentioned above.

- A phytosanitary certificate may be required for vegetables especially brinjal seeds, cut flowers and for with leaves.

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5.3.3.	Pea leaf miner: *Liriomyza huidobrensis* (Blanchard)

5.3.3.1 Hazard Identification

Scientific Name: *Liriomyza huidobrensis* (Blanchard)

Synonyms: *Agromyza huidobrensis* Blanchard
Liriomyza cucumifoliae Blanchard
Liriomyza langei Frick
Liriomyza dianthi Frick

Common names: Pea leaf miner,
South American leaf miner

Taxonomic tree

Phylum: Arthropoda
Subphylum: Mandibulata
Class: Insecta
Order: Diptera
Family: Agromyzidae
Genus: *Liriomyza*
Species: *Liriomyza huidobrensis*

EPPO Code: LIRIHU. This pest has been included in EPPO A2 list: No. 152

Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2002; EPPO, 2014].

5.3.2. Biology

Males usually emerge before females. Mating takes place from 24 h after emergence and a single mating is sufficient to fertilize all eggs laid. Female flies puncture the leaves of the host plants causing wounds which serve as sites for feeding or oviposition. Feeding punctures cause the destruction of a larger number of cells and are more clearly visible to the naked eye. About 15% of punctures made by *L. trifolii* and *L. sativae* contain viable eggs (Parrella *et al*., 1981). The life-cycle is probably continuous throughout the year. There is a noticeable first generation which reaches a peak in April (Spencer, 1973). In California*, L. huidobrensis* completes its life-cycle in 17-30 days during the summer and in 50-65 days during the winter (Lange et al., 1957). Adults of Liriomyza spp. live, on average, between 15 and 30 days, and females generally live longer than males.

5.3.3. Hosts

a. **Major hosts:** The main host of *L. huidobrensis* includes, tomato, aubergine, potato, Celery, lettuce, marigold, gypsophila (baby's breath), ornamental gourd, common bean, pea, onion, garlic etc.

b. **Minor hosts:** The minor or other hosts of this pest include Amaranthus, Aster, gerbera, marigold, zinnia, spinach, melon, cucumber, faba bean, bell pepper, petuniaetc.

5.3.4. Distribution

L. huidobrensis originates in Central and South America and was absent from other continents until the 1980s. It was first detected in the EPPO region in 1987 in the Netherlands where it was found on glasshouse lettuces; it is presumed to have been imported directly from South America. It has since spread considerably in the EPPO region, but remains absent from a significant number of countries, in particular in central and eastern Europe.

- **EPPO region**: Austria, Belgium, Cyprus, Czech Republic, France (Trouvé *et al*., 1991), Israel, Italy (Suss, 1991; including Sicily), Malta, Netherlands, Portugal, Spain (including Canary Islands), UK (England, Northern Ireland, Scotland). *L. huidobrensis* has been intercepted, or has occurred and been eradicated, in Denmark, Finland, Germany (Leuprecht, 1991), Ireland and Sweden.
- **Asia**: Cyprus, India (Uttar Pradesh), Israel, Thailand.
- **Africa**: Mauritius, Réunion.
- **North America**: Mexico (unconfirmed), USA (California, Hawaii and in glasshouses in Florida and Virginia).
- **Central America and Caribbean**: Belize, Costa Rica, Dominican Republic, El Salvador, Guadeloupe, Guatemala, Honduras, Nicaragua, Panama.
- **South America**: Argentina, Brazil (Matto Grosso, São Paulo), Chile, Colombia, Peru, Venezuela.
- **Oceania**: Australia.

5.3.5. Hazard Identification Conclusion

Considering the facts that *Liriomyza huidobrensis* -

- is not known to be present in Bangladesh [CABI/EPPO, 2002; EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages Asia including China (restricted distribution), India (restricted distribution), Thailand, **Japan (**restricted distribution), Sri Lanka, Cyprus, Israel, Lebanon, Philippines, Taiwan, [CABI/EPPO, 2002; EPPO, 2014] from where vegetables seeds especially brinjal seeds and nursery stocks imported to Bangladesh.
- can become established in Bangladesh through imports of the brinjal seeds and nursery stocks. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, Female flies of *L. huidobrensis* puncture the leaves of the host plants causing wounds which serve as sites for feeding or oviposition and eggs are inserted into the epidermis and mesophyll layer of the leaf (Poe, 1981). Adult flies are capable of limited flight. Dispersal over long distances is on planting material of host species. Vegetables can also present a danger as a means of dispersal; it should be noted, for example, that the vase life of chrysanthemums is sufficient to allow completion of the life-cycle of the pest [EPPO, 2016].
- *L. huidobrensis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.6. Determine likelihood of pest establishing in tour country via this pathway.

Table 3.1 – 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, This pest has been established in many Asian countries. The introduction of this pest in India was first reported in 1994; Indonesia in 1994 (Mujica & Cisneros, 1997), Thailand in 1994; Taiwan in 1991; Cyprus in 1994; Finland in 1997; Ireland in 1997; Italy in 1991; Turkey in 1985, Netherlands in 1989; Slovenia in 1999 (CABI/EPPO, 2002; EPPO, 2014). Now present	**YES and HIGH**

in many Asian countries including Japan, China etc.

b. Posibility of survival during transport, storage and transfer of this pest? Yes

- The cucurbit seeds and fruits are transported from India, Japan, Thailand, Taiwan, Vietnam, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, Brazil, and Chile to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and catterpiller of leaf miner can easily survive with seeds and other planting materials. Because, In California, *L. huidobrensis* completes its life-cycle in 17-30 days during the summer and in 50-65 days during the winter (Lange *et al.,* 1957). Adults of Liriomyza spp. live, on average, between 15 and 30 days, and females generally live longer than males. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High risk potential.

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

- Internationally, *L. huidobrensis* is liable to be carried on any plants for planting or on vegetable seeds especially brinjal seeds and nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016].

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

- Fourteen families of plants have been recorded as hosts of *L. huidobrensis*, without a clear preference for any particular family. *L. huidobrensis* has been reported from aubergines (*Solanum melongena*), beets (*Beta vulgaris*), *Capsicum annuum*, celery (*Apium graveolens*), cucumbers (*Cucumis sativus*), faba beans (*Vicia faba*), garlic (*Allium sativum*), *Lathyrus* spp., lettuces (*Lactuca sativa*), lucerne (*Medicago sativa*), melons (*Cucumis melo*), onions (*Allium cepa*), peas (*Pisum sativum*), *Phaseolus vulgaris*, potatoes (*Solanum tuberosum*), *Amaranthus* spp., *Aster* spp., chrysanthemums (*Dendranthema morifolium*), *Dahlia* spp., *Dianthus* spp., *Gypsophila* spp., *Zinnia* spp., hemp (*Cannabis sativa*), *Primula* spp., radishes (*Raphanus sativus*), spinach (*Spinacia oleracea*), tomatoes (*Lycopersicon esculentum*), *Tropaeolum* spp., and *Verbena* spp., which are mostly common in **Bangladesh**.
- In the southern USA, the life-cycle is probably continuous throughout the year. There is a noticeable first generation which reaches a peak in April (Spencer, 1973). In California, *L. huidobrensis* completes its life-cycle in 17-30 days during the summer and in 50-65 days during the winter (Lange *et al*., 1957). The duration of larval development also varies with temperature and host plant but is generally 4-7 days at mean temperatures above 24°C (Harris & Tate, 1933). Reductions in population levels of *L. huidobrensis* occurred in California (USA) when the daily maximum temperature rose to 40°C (Lange *et al*., 1957).
- These climatic requirements for growth and development of *L. huidobrensis* are 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.7. Determine the Consequence establishment of this pest in Bangladesh

Table3. 2. – Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • *L. huidobrensis* is a remarkably polyphagous species and has been recorded from 14 families without a clear preference for any particular family including the following important crops: Fourteen families of plants have been recorded as hosts of *L. huidobrensis*, without a clear preference for any particular family. aubergines (*Solanum melongena*), beets (*Beta vulgaris*), *Capsicum annuum*, celery (*Apium graveolens*), cucumbers (*Cucumis sativus*), faba beans (*Vicia faba*), garlic (*Allium sativum*), *Lathyrus* spp., lettuces (*Lactuca sativa*), lucerne (*Medicago sativa*), melons (*Cucumis melo*), onions (*Allium cepa*), peas (*Pisum sativum*), *Phaseolus vulgaris*, potatoes (*Solanum tuberosum*), *Primula* spp., radishes (*Raphanus sativus*), spinach (*Spinacia oleracea*), tomatoes (*Lycopersicon esculentum*),*L. huidobrensis* has been reported from *Amaranthus* spp., *Aster* spp., chrysanthemums (*Dendranthema morifolium*), *Dahlia* spp., *Dianthus* spp., *Gypsophila* spp., *Zinnia* spp., hemp (*Cannabis sativa*), *Tropaeolum* spp., and *Verbena* spp. (Spencer, 1990). • *L. huidobrensis* has the potential to become a major pest of a wide variety of field crops and horticultural crops grown under glass and as protected crops in the EPPO region. This species could also cause damage to these crops grown in the open in the warmer parts of the region. • *L. huidobrensis* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in vegetables especially brinjal and other crops, illustrate clearly the serious nature of this pest and the potential threat to the flower and foliages as well as other crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important vegetables especially brinjal seeds and other crops for Bangladesh. **b. Economic impact and yield loss** • This species damages a range of glasshouse ornamentals and also attacks vegetable crops (Lange *et al.,* 1957). In South America, it is a key pest of potato. In the EPPO region, *L. huidobrensis* is already a major pest of chrysanthemums, Primula, Verbena, lettuces (OEPP/EPPO, 1994), Phaseolus, cucumbers, celery and Cucurbita pepo (ADAS, 1991). Treatments for chrysanthemums are recommended if 50 larvae are found in a random sample of the upper two-thirds of ten stems (Spencer, 1982). Since it has spread to Mediterranean countries, it has appeared on outdoor crops (e.g. lettuce and beet; Echevarria *et al.,* 1994). It has proved a much more serious pest than *L. trifolii* (Weintraub & Horowitz, 1995). Damage is caused by larvae mining into leaves and petioles. The photosynthetic ability	**Yes and High**

of the plants is often greatly reduced as the chlorophyll-containing cells are destroyed. Severely infested leaves may fall, exposing plant stems to wind action, and flower buds and developing fruit to scald (Musgrave *et al.,* 1975). The presence of unsightly larval mines and adult punctures in the leaf palisade of ornamental plants can further reduce crop value (Smith *et al.,* 1962; Musgrave *et al.,* 1975). In young plants and seedlings, mining may cause considerable delay in plant development leading to plant loss. All of these can affect the yield and quality of a crop and thus its market value. **c. Environmental Impact** • The appearance of the leaf miner within new areas is in most cases, the result of movement of infested plant material. The movement and establishment of leaf miner populations through this route bring along the possibility of insecticide resistance genes. Some insecticides, particularly pyrethroids (abamectin) and also cyromazine (Van der Staay, 1992; Leuprecht, 1993), are effective, but leaf miner resistance can sometimes make control difficult (Parrella *et al.,* 1984; Macdonald, 1991). This invariably leads to an increase in the use of insecticides as leaf miner control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 3.3. – Calculating 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

5.3.9. Risk Management Measures

- Avoid importation of flowers and foliages from countries, where this pest is available.
- All stages are killed within a few weeks by cold storage at 0°C. Newly laid eggs are, however, the most resistant stage and it is recommended that cuttings of infested ornamental plants be maintained under normal glasshouse conditions for 3-4 days after lifting, to allow eggs to hatch. Subsequent storage of the plants at 0°C for 1-2 weeks should then kill off the larvae of leaf miner species (Webb & Smith, 1970).
- To avoid the introduction of *L. huidobrensis* (and the other leaf miner species, including *L. sativae* and *Amauromyza maculosa*; EPPO/CABI, 1996), EPPO (OEPP/EPPO, 1990) recommends that propagating material (except seeds) of *Capsicum*, carnations, celery, chrysanthemums, *Cucumis*, *Gerbera*, *Gypsophila*, lettuces, *Senecio hybridus* and tomatoes from countries where the pests occur must have been inspected at least every month during the previous 3 months and found free from the pests.
- A phytosanitary certificate may be required for brinjal seeds, nursery stock and vegetables with leaves.

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5.3.4.	**Silver leaf whitefly: *Bemisia tabaci (B biotype)***

5.3.1.1. Hazard identification

Scientific Name: *Bemisia tabaci (B biotype) (*Gennadius, 1889)

Synonyms:

Bemisia argentifolii Bellows,
Perring, Gill & Hendrick, 1994
Bemisia tabaci B

Common names: Silver whitefly,
Poinsettia whitefly;
Tobacco whitefly, B biotype

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Hemiptera
Suborder: Sternorrhyncha
Superfamily: Aleyrodoidea
Family: Aleyrodidae
Genus: *Bemisia*
Species: *Bemisia tabaci* (*B biotype*)

EPPO Code: BEMIAR. This pest has been included in EPPO A2 list: No. 178

Bangladesh status: Not present in Bangladesh [EPPO, 2014; CABI/EPPO, 1999]

5.3.1.2. Biology

Eggs are laid usually in circular groups, on the underside of leaves, with the broad end touching the surface and the long axis perpendicular to the leaf. They are anchored by a pedicel which is inserted into a fine slit made by the female in the tissues, and not into stomata, as in the case of many other aleyrodids. Eggs are whitish when first laid but gradually turn brown. Hatching occurs after 5-9 days at 30°C but, like many other developmental rates, this depends very much on host species, temperature and humidity. On hatching, the first instar, or "crawler", is flat, oval and scale-like. This first instar is the only larval stage of this insect which is mobile. It moves from the egg site to a suitable feeding location on the lower surface of the leaf where its legs are lost in the ensueing moult and the larva becomes sessile. It does not therefore move again throughout the remaining nymphal stages. The first three nymphal stages last 2-4 days each (this could however vary with temperature). The fourth nymphal stage is called the 'puparium', and is about 0.7 mm long and lasts about 6 days; it is within the latter period of this stage that the metamorphosis to adult occurs. The adult emerges through a "T"-shaped rupture in the skin of the puparium and spreads its wings for several minutes before beginning to powder itself with a waxy secretion from glands on the abdomen. Copulation begins 12-20 h after emergence and takes place several times throughout the life of the adult. The life span of the female could extend to 60 days. The life of the male is generally much shorter, being between 9 and 17 days. Each female lays up to 160 eggs during her lifetime, although the B biotype has been shown to lay twice as many, and each group of eggs is laid in an arc around the female. Eleven to fifteen generations can occur within one year.

5.3.1.3. Hosts

B. tabaci was mainly known as a pest of field crops in tropical and subtropical countries: cassava *(Manihot esculenta)*, cotton *(Gossypium)*, sweet potatoes *(Ipomoea batatas)*, tobacco *(Nicotiana)* and tomatoes *(Lycopersicon esculentum)*. Its host plant range within any particular region was small, yet *B. tabaci* had a composite range of around 300 plant species within 63 families (Mound & Halsey, 1978). With the evolution of the highly polyphagous B biotype, *B. tabaci* has now become a pest of glasshouse crops in many parts of the world, especially Capsicum, **courgettes *(Cucurbita pepo)***, **cucumbers *(Cucumis sativus)***, Hibiscus, Gerbera, Gloxinia, lettuces (*Lactuca sativa*), poinsettia (*Euphorbia pulcherrima*) and tomatoes (*Lycopersicon esculentum*). *B. tabaci* moves readily from one host species to another and is estimated as having a host range of around 600 species (Asteraceae, Brassicaceae, Convolvulaceae, **Cucurbitaceae**, Euphorbiaceae, Fabaceae, Malvaceae, Solanaceae, etc.).

5.3.1.4. Distribution

- ***EPPO region**:* Present and widespread in the field in Algeria, Cyprus, France (South), Greece, Israel, Italy, Libya, Portugal, Spain, Turkey and Ukraine (CABI & EPPO, 1999; EPPO, 2014).
- ***Asia**:* Afghanistan, Bhutan, China *(*He et al., 2008), Cyprus, Hong Kong, Israel, India (Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jammu and Kashmir, Kerala, Karnataka, Maharashtra, Meghalaya, Madhya Pradesh, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal) *(*CABI & EPPO, 1999; EPPO, 2014), Indonesia, Iran, Iraq, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Thailand, Yemen. The B biotype has been recorded in Cyprus, India, Israel, Japan and Yemen.
- **Africa:** Algeria, Angola, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Morocco, Mozambique, Nigeria *(*Brown et al., 1995a; EPPO, 2014; CABI/Bedford et al., 1994a).
- **North America:** Bermuda, Canada, Mexico, USA. The *B biotype* is confirmed in Mexico and USA (southern states, Hawaii, New York).
- **Central America and Caribbean:** Antigua and Barbuda, Barbados, Belize, Costa Rica, Cuba, Dominica, Dominican Republic, Trinidad and Tobago. The B biotype has been recorded in Central America and the Caribbean Basin.
- **South America:** Argentina, Brazill.
- **Oceania:** Australia, Fiji, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Tuvalu. The B biotype is present in Australia.
- EU: Present.

5.3.1.5. Hazard Identification Conclusion

Considering the facts that *Bemisia tabaci B biotype*-

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 1999];
- is potentially economic important to Bangladesh because it is an important pest of field crops and flowers in Asia including China, India, Thailand, **Japan**, Sri Lanka, Cyprus, Israel, Turkey, Lebanon, Philippines, Taiwan, [EPPO, 2014; CABI/EPPO, 1999] from where many vegetables, seeds, vegetable parts and flowers are imported to Bangladesh.
- EPPO (OEPP/EPPO, 1989) has listed *B. tabaci* as an A2 quarantine pest, and it is also a quarantine pest for CPPC. The risk to the EPPO region is primarily to the glasshouse industry in northern countries, and mainly concerns the B biotype (though it is difficult in practice to confirm this in specific cases). Since its recent introduction to several of these countries, the pest has proved particularly difficult to combat because of its polyphagy, its resistance to many insecticides and its disruption of biological control programmes (Della Giustina et al., 1989). Very few countries remain free from B. tabaci, illustrating the difficulty of preventing its movement in international trade.
- *Bemisia tabaci (B biotype)* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 1.1 – Which of these descriptions best fit of this pest?

<table>
<tr><th>Description</th><th>Establishment Potential</th></tr>
<tr><td>a. Has this pest been established in several new countries in recent years-Yes,
• First reports of a newly evolved biotype of B. tabaci, the B biotype, appeared in the mid-1980s (Brown et al., 1995b). Commonly referred to as the silverleaf whitefly or poinsettia strain, the B biotype has been shown to be highly polyphagous and almost twice as fecund as previously recorded strains and has been documented as being a separate species, B. argentifolii (Bellows et al., 1994).
• The B biotype has been recorded in Cyprus, India, Israel, Japan and Yemen (EPPO, 2014).
• The presence of the B biotype has been confirmed in Cyprus, France (South) (Villevieille & Lecoq, 1992), Israel, Italy, Spain and in the glasshouse infestations of northern Europe (e.g. Netherlands).
b. Posibility of survival during transport, storage and transfer of this pest? Yes
• The cucurbit seeds and fruits are transported from India, China, Japan, Thailand, Taiwan, Vietnam, Philippines, Indonesia, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, Brazil, and Chile to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and crawlers of whitefly can easily survive on fruit surfaces of cucurbits. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High (3) risk potential.</td><td>YES and HIGH</td></tr>
</table>

c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes, • The cucurbits are imported into Bangladesh manily from India, China, Japan, Thailand. *B. tabaci* B biotype is a common problem in such countries. So, the pathway appear good for this pest to entire in Bangladesh. Adults of *B. tabaci* do not fly very efficiently but, once airborne, they can be transported quite large distances by the wind. All stages of the pest are liable to be carried on planting material and cucurbits of host species. The international trade in poinsettia is considered to have been a major means of dissemination within the EPPO region of the B biotype of *B. tabaci*. **c. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the vegetables, seeds, vegetable parts and flowers. *B. tabaci* was mainly known as a pest of field crops in tropical and subtropical countries. *B. tabaci* had a composite range of around 300 plant species within 63 families. *B. tabaci* moves readily from one host species to another and is estimated as having a host range of around 600 species (Asteraceae, Brassicaceae, Convolvulaceae, **Cucurbitaceae**, Euphorbiaceae, Fabaceae, Malvaceae, Solanaceae, etc.) which are mostly common in Bangladesh. • The development time of this insect from egg to adult may range from 15-70 days dependent upon temperature and plant host. Development occurs in temperatures ranging from 50 to 89.6ºF (10 to 32ºC). 80.6ºF (27ºC) appears to be the optimal temperature for development. Under control conditions on cotton, the pest completes its development in 17 days at 86ºF (30ºC) On the contentinal U.S. development from egg to adult under field conditions varies with the season; development variesfrom 25 to 50 days. Very little seasonal difference occurs in Hawaii. Overlapping whitefly generations occur throughout the year. • These climatic requirements for growth and development of *Bemisia tabaci* are 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.1.7. Determine the Consequence establishment of this pest in Bangladesh

Table 1.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Until recently, *B. tabaci* was mainly known as a pest of field crops in tropical and subtropical countries: cassava *(Manihot esculenta),* cotton *(Gossypium),* sweet potatoes *(Ipomoea batatas),* tobacco *(Nicotiana)* and tomatoes *(Lycopersicon esculentum).* Its host plant range within any	**Yes and High**

particular region was small, yet *B. tabaci* had a composite range of around 300 plant species within 63 families (Mound & Halsey, 1978). With the evolution of the highly polyphagous **B biotype**, *B. tabaci* has now become a pest of glasshouse crops in many parts of the world, especially *Capsicum,* **courgettes *(Cucurbita pepo),* cucumbers *(Cucumis sativus)*,** Hibiscus, Gerbera, Gloxinia, lettuces *(Lactuca sativa),* poinsettia *(Euphorbia pulcherrima)* and tomatoes *(Lycopersicon esculentum).* • *B. tabaci* has been known as a minor pest of cotton and other tropical or semi-tropical crops in the warmer parts of the world and, until recently, has been easily controlled by insecticides. In the southern states of the USA in 1991, however, it was estimated to have caused combined losses of 500 million USD to the winter vegetable crops (Perring et al., 1993) through feeding damage and plant virus transmission. *B. tabaci* is also a serious pest in glasshouses in North America and Europe. • The larvae of the B biotype of *B. tabaci* are unique in their ability to cause phytotoxic responses to many plant and crop species. These include a severe silvering of courgette leaves, white stems in pumpkin, white streaking in leafy brassica crops, uneven ripening of tomato fruits, reduced growth, yellowing and stem blanching in lettuce and kai choy (*Brassica campestris*) and yellow veining in carrots and Lonicera (Bedford et al., 1994a, 1994b). • *B. tabaci* B biotype is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries and the problems presented by its presence in vegetables, flowers and other crops, illustrate clearly the serious nature of this pest and the potential threat to thevegetables cucurbits as well as other crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important vegetables, flower and other crops for Bangladesh. **b. Economic impact and yield loss** • The B biotype of *B. tabaci* can have a serious impact on the production of certain field crops as well as a wide range of protected horticultural crops. In the majority of cases, this is due to viruses that the whitefly transmits between susceptible crops or acquires from indigenous host reservoirs. • The B biotype is also able to induce a phytotoxic response from a number of plant species that could cause yield loss or reduced quality produce. This includes squash silver leaf (Bedford et al., 1994), pumpkin white stem (Costa and Brown, 1991), white streaking of cole crops (Brown et al., 1992), reduced growth and stem blanching of kai choy (Costa et al., 1993) and uneven ripening of tomato (Maynard and Cantliffe, 1989). All of these can affect the yield and quality of a crop and thus its market value. • In 1991, the B biotype alone caused an estimated $500 million loss to the 1991 winter harvest in California, USA, mainly through virus damage. However, in other areas of the world where the B biotype has appeared, it is found alongside an indigenous non-B biotype, so it is extremely difficult to determine specific economic damage. For example, the B biotype is found alongside the K biotype in Pakistan where both biotypes transmit a disease of cotton, Cotton leaf curl virus. Around 2 million tonnes of cotton are grown in Pakistan and between 30 and 40% crop losses can be expected through whitefly-transmitted viruses based on figures in the mid 1990s. An estimate of 2.4 billion dollars damage was caused by the virus	

between 1993 and 1994 (Bhatti and Soomro 1996). In 1994, the cotton virus spread to India as did a whitefly-transmitted virus of tomato, Tomato leaf curl virus (Colvin et al. 2002), which caused a number of complete crop failures. This tomato virus was then reported to have spread to potato (Gard et al., 2001). Again the B biotype was present within the epidemics although indigenous biotypes G, H and I were also recorded from India, so specific damage attributed to B biotypes alone, could not be calculated. • Within Israel around the Mediterranean Basin, North Africa and on the Canary Islands the B biotype is present alongside the indigenous Q biotype. As seen in Pakistan, it is impossible to calculate the economic impact of the B biotype alone in these areas. The economic impact of more recent appearances of the B biotype within Africa, South and Central America and Australasia currently remains unknown. A European network for the exchange of research ideas into whitefly-related problems exists and can be accessed at www.whitefly.org (EWSN, 1999). **c. Environmental Impact** • The appearance of the B biotype within new areas is in most cases, the result of movement of infested plant material. The movement and establishment of B biotype populations through this route bring along the possibility of insecticide resistance genes. This invariably leads to an increase in the use of insecticides as whitefly control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table1.3 – Calculating 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

5.3.1.9. Risk Management Measures

- Avoid importation of vegetables, cucurbits from countries, where this pest is available.
- In countries where *B. tabaci* biotype B is not already present, the enforcement of strict phytosanitary regulations as required for *B. tabaci*, may help to reduce the risk of this whitefly becoming established.
- Because of the difficulty of detecting low levels of infestation in consignments, it is best to ensure that the place of production is free from the pest (OEPP/EPPO, 1990). Particular attention is needed for consignments from countries where certain *B. tabaci*-listed viruses, now on the EPPO A1 or A2 quarantine lists, are present. These viruses are also transmitted by the B biotype.

5.3.1.10. References

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5.3.5.	Vegetable weevil: *Listroderes costirostris* Schönherr

5.3.5.1. Hazard Identification

Scientific name: *Listroderes costirostris* Schönherr

Synonyms: *Desiantha nociva* French
Listroderes difficilis Germain
Listroderes hypocritus Hustache
Listroderes lugubris Germain
Listroderes obliquus Klug
Listroderes paranensis Hustache
Listroderes vicinus Hustache

Common names: Vegetable weevil;
Australian tomato weevil;
Brown vegetable weevil;
Buff-colored tomato weevil;
Carrot weevil;
Dirt-colored weevil;
Turnip weevil

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Coleoptera
Family: Curculionidae
Genus: *Listroderes*
Species: *Listroderes costirostris*

EPPO Code: LISTCO.

Bangladesh status: Not present in Bangladesh [CABI & EPPO, 2000; EPPO, 2014]

5.3.5.2. Biology

Most of these notes are taken from High (1939) who described the life history of the pest in southern USA. L. costirostris deposits its eggs on plants or in nearby soil. The crowns of host plants are the preferred locations when ample moisture is present. After depositing the eggs on the leaves and stems, the weevil attaches them to the leaves by a glutinous secretion exuded at the time of oviposition. In the soil, the weevil constructs a small pocket with its ovipositor before depositing the eggs. The eggs are usually deposited singly, although masses of two to eight or more eggs are sometimes found. Weevils depositing only unfertilized eggs often oviposit in masses. Immediately after hatching, the larvae begin feeding on the buds of the host plants, or on the undersides of leaves close to the buds. Later in their development they feed on all the foliage parts, and on root crops, such as turnips and carrots, they often feed on the roots, causing severe damage. The larval period under laboratory conditions varies greatly according to temperature and moisture, averaging approximately 35 days. Larvae are found in the field from the last week of October until mid-May of the following year, occurring in greatest abundance during December, January and February.

5.3.5.3. Hosts

a. Major hosts: The main host of *Listroderes costirostris* includes *Solanum melongena* (aubergine), Solanum lycopersicum (tomato), potato, grapevine orchid, safflower, *Chrysanthemum morifolium,* roses, Gerbera, gypsophila, Zinnia, Begunia, Poinsettia, balsam. amaranth, carrot, lettuce, cabbage, wild radish, wild mustard, melon, sugarbeet, cucumber, pea, peach, apple, apricot, *Allium cepa* (onion) etc.

b. Minor hosts: The minor or other hosts of this pest include pumpkin, *Chrysanthemum indicum,* pistachio etc.

5.3.5.4. Distribution

- **EPPO region:** Present and widespread in the field in France, Greece, Israel, Italy, Libya, Portugal, Spain, Turkey and Ukraine (CABI & EPPO, 2000; EPPO, 2014).
- **Asia:** *Listroderes costirostris* is distributed in many Asian countries including Israel (Friedman, 2009; EPPO, 2014), **Japan** (Morrone, 1993; CABI & EPPO, 2000; EPPO, 2014), Taiwan (Hsu & Chiang, 1983;), Korea (Morimoto, 1992; CABI & EPPO, 2000; EPPO, 2014).
- **Africa:** Central African Republic, Morocco, Nigeria (Balachowsky, 1963; CABI & EPPO, 2000; EPPO, 2014).
- **North America:** USA (southern states, Hawaii, New York,Oregon, South Carolina, Texas, Viriginia)(High, 1939; O'Brien & Wibmer, 1982; CABI & EPPO, 2000; EPPO, 2014).
- **Central America and Caribbean:** Antigua and Barbuda, Barbados, Belize, Costa Rica, Cuba, Dominica, Dominican Republic, Trinidad and Tobago. The B biotype has been recorded in Central America and the Caribbean Basin.
- **South America:** Argentina, Brazill,Bolivia,Venezuela (CIE, 1964; CABI & EPPO, 2000; EPPO, 2014).
- **Oceania:** Australia, Fiji, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Tuvalu. The B biotype is present in Australia.
- **EU:** Present.

5.3.5.5. Hazard identification conclusion

Considering the facts that *Listroderes costirostris* -

- is not known to be present in Bangladesh [CABI & EPPO, 2000; EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of vegetables in Asia including Iarael, **Japan** [CABI & EPPO, 2000; EPPO, 2014,] Taiwan from where vegetables are imported to Bangladesh.
- can become established in Bangladesh through imports of the brinjal seeds. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, because the eggs are laid in leaves, flower structures or fruit (High 1939). The major method of long distance dispersal for this pest is via transportation of infested seed and nursery stock [EPPO, 2016]
- *Listroderes costirostris* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 5.1 – 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,** • *Listroderes costirostris* is distributed in many Asian countries including Israel (Friedman, 2009; EPPO, 2014), Japan (Morrone, 1993; CABI & EPPO, 2000; EPPO, 2014), Taiwan (Hsu & Chiang, 1983;), Korea (Morimoto, 1992; CABI & EPPO, 2000; EPPO, 2014). • High (1939) reported serious economic damage to vegetable crops in the ten USA States where the pest was established in 1930. Growers in Mississippi, USA, reported losses as high as 90%, with common losses ranging from 40 to 70%. During 1933, the estimated crop losses for tomatoes alone ranged from 5 to 70% of the total crop value. Entire plantings of turnips, carrots, cabbages, mustard and spinach can be destroyed or seriously injured during the early stages of growth by this weevil. Practically all vegetable growers in the region adjacent to the Gulf of Mexico, USA, have suffered crop losses due to L. costirostris damage (High, 1939). **b. Posibility of survival during transport, storage and transfer of this pest? Yes** • Egg incubation period of this pest ranged from 15 to 33 days when the average daily temperature was 12.8-24.4°C. During the spring and autumn most of the eggs under observation hatched within 15-20 days after deposition. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with **High** risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *Listroderes costirostris* is liable to be carried on any plants for planting or on brinjal seeds, and nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. • As *L. costirostris* reproduces parthenogenetically, a single individual is capable of establishing the species in any new area where climatic conditions are favourable (Lovell, 1932). During the height of the breeding season, the weevil can be transported easily from place to place through the shipment of green vegetables and root crops, either on the plants or secluded in shipping containers. Repeated observations have demonstrated that the pest may be accidentally transported by persons or vehicles (High, 1939), although *L. costirostris* is not included on any quarantine lists for any country. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *Listroderes costirostris* is a remarkably polyphagous species with 87plant species from 20 families being recorded as hosts. The host range of *Listroderes costirostris* is *Solanum melongena* (aubergine), *Solanum lycopersicum* (tomato), potato, grapevine orchid, safflower,	**YES and HIGH**

Chrysanthemum morifolium, roses, Gerbera, gypsophila, Zinnia, Begunia, Poinsettia, balsam. amaranth, carrot, lettuce, cabbage, wild radish, wild mustard, melon, sugarbeet, cucumber, pea, peach, apple, apricot, *Allium cepa* (onion) etc. As long as environmental conditions are favourable,	
• 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.5.7. Determine the Consequence establishment of this pest in Bangladesh

Table 5.2 – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *Listroderes costirostris* is a remarkably polyphagous species with 87 plant species from 20 families being recorded as hosts The host range of Listroderes costirostris is Solanum melongena (aubergine), Solanum lycopersicum (tomato), potato, grapevine orchid, safflower, Chrysanthemum morifolium, roses,Gerbera, gypsophila, Zinnia, Begunia, Poinsettia, balsam. amaranth, carrot, lettuce, cabbage, wild radish, wild mustard, melon, sugarbeet, cucumber, pea, peach, apple, apricot, Allium cepa (onion) etc. As long as environmental conditions are favourable. • *Listroderes costirostris* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in vegetables, flowers and other crops, illustrate clearly the serious nature of this pest and the potential threat to the field crops as well as horticultural crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important vegetables, flower and other crops for Bangladesh. **b. Economic impact and yield loss** • The primary injury by larvae is caused when they devour the buds of the host plants, stunting them, followed by foliage attack, with the exception of the main stems and larger veins. The loss of the leaves not only interferes with the normal functioning of the plants, but affects the market value of the crops, for example, in southern USA, the leaves of turnips have a greater market value than the roots. Even when the infestation is not severe enough to cause noticeable injury, the mere presence of the larvae lowers the market value of the crops (High, 1939). • High (1939) reported serious economic damage to vegetable crops in the ten USA States where the pest was established in 1930. Growers in Mississippi, USA, reported losses as high as 90%, with common losses ranging from 40 to 70%. During 1933, the estimated crop losses for tomatoes alone ranged from 5 to 70% of the total crop value. Entire plantings of turnips, carrots, cabbages, mustard and spinach can be	**Yes and High**

destroyed or seriously injured during the early stages of growth by this weevil. Practically all vegetable growers in the region adjacent to the Gulf of Mexico, USA, have suffered crop losses due to L. costirostris damage (High, 1939). **c. Environmental Impact** • The appearance of the vegetable weevil within new areas is in most cases, the result of movement of infested plant material. As *L. costirostris* reproduces parthenogenetically, a single individual is capable of establishing the species in any new area where climatic conditions are favourable (Lovell, 1932). During the height of the breeding season, the weevil can be transported easily from place to place through the shipment of green vegetables and root crops, either on the plants or secluded in shipping containers. Repeated observations have demonstrated that the pest may be accidentally transported by persons or vehicles (High, 1939), This invariably leads to an increase in the use of insecticides as *L. costirostris* control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table5.3 – Calculating 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

5.3.5.9. Risk Management Measures

- Avoid importation of vegetables especially brinjal, tomato etc and planting materials like seeds, nursery stock from countries, where this pest is available.
- Treatment should begin when 5% or more of small, newly set plants (within 3 weeks after transplanting) are killed or injured. Vegetable weevil larvae in tobacco plant beds can be controlled using acephate insecticides.
- In addition, resistance of this pest has developed to certain pesticides. Accordingly, the only safe measure is to ensure that the place of production is free from the pest by appropriate inspection (OEPP/EPPO, 1990).

5.3.5.10. References

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5.3.6. Alfalfa thrips: *Frankliniella occidentalis* (Pergande)

5.3.6.1. Hazard Identification

Scientific name: *Frankliniella occidentalis* (Pergande)

Synonyms: *Frankliniella californica* (Moulton)
Frankliniella helianthi (Moulton)
Frankliniella moultoni Hood
Frankliniella trehernei Morgan

Common names: Alfalfa thrips (English)
Western flower thrips,

Taxonomic tree

Phylum: Arthropoda
Subphylum: Mandibulata
Class: Insecta
Order: Thysanoptera
Family: Thripidae
Genus: *Frankliniella*
Species: *Frankliniella occidentalis*

EPPO Code: FRANOC. This pest has been included in EPPO A2 list: No. 177

Bangladesh status: Not present in Bangladesh [EPPO, 2014; CABI/EPPO, 1999]

5.3.6.2. Biology

F. occidentalis reproduces throughout the year producing as many as 12-15 generations per year. The total life-cycle from egg to egg at 15, 20, 25 and 30°C is 44.1, 22.4, 18.2 and 15 days, respectively. Each female lays between 20 and 40 eggs. Pre-oviposition time is 10.4 days at 15°C and 2-4 days at both 20 and 30°C; highest reproductive rate (95.5 hatched eggs/female) is at 20°C. The eggs are inserted in the parenchyma cells of leaves, flower parts and fruits, and hatch in about 4 days at 27°C. This period is lengthened to 13 days at 15°C. The eggs are susceptible to desiccation, and high mortality at this stage is not uncommon. Adult thrips have been observed entering closed chrysanthemum buds, presumably to lay eggs, a behavior pattern which makes control very difficult (Bryan & Smith, 1956; Lublinkhof & Foster, 1977).

5.3.6.3. Hosts

c. **Major hosts:** The main host of *F. occidentalis* includes tomato, aubergine, potato, grapevine orchid, safflower, *Chrysanthemum morifolium,* roses, Gerbera, gypsophila, Zinnia, Begunia, Poinsettia, balsam. amaranth, carrot, lettuce, cabbage, wild radish, wild mustard, melon, sugarbeet, cucumber, pea, peach, apple, apricot, etc.

d. **Minor hosts:** The minor or other hosts of this pest include pumpkin, *Chrysanthemum indicum,* pistachio etc.

5.3.6.4. Distribution

F. occidentalis is distributed in many Asian countries including India (CABI/EPPO, 1999; EPPO, 2014; Kaomud & Tyagi Vikas Kumar, 2015), Thailand, Sri Lanka (CABI/EPPO, 1999; EPPO, 2014), Japan (Nakahara, 1997; CABI/EPPO, 1999; EPPO, 2014), China (EPPO, 2014; Reitz et al., 2011; Zhang et al., 2003), Iran (EPPO, 2014).

F. occidentalis is naturally abundant in many field crops throughout western North America from southern California (and presumably Mexico) into Canada. In the late 1970s and 1980s, it spread across the USA and Canada. It reached the Netherlands in 1983 and then spread outwards across Europe (Kirk and Terry, 2003). This sudden explosion remains unexplained but is possibly the result of some undetected genetic change in a population on a crop under intensive cultivation and insecticide treatment (Immaraju et al., 1992). Having become well established in Europe and Israel, it spread to the highlands of eastern Africa and subsequently entered New Zealand in 1992 and Australia in 1993. In Australia it has spread around Sydney, Adelaide and Brisbane, but in Western Australia summer temperatures that routinely exceed 40°C may be limiting its spread to the vicinity of Perth. It is present in southern Brazil (Monteiro et al., 1995), and also in the Cameron Highlands of Peninsular Malaysia (Fauziah and Saharan, 1991), and it is becoming more common in tropical lowland countries. In Costa Rica and Colombia, although abundant in screen houses where chrysanthemums are grown, it remains rare outside on native plants or crops, whereas in Guatemala it has been reported as a pest of field-grown crops. In Florida, USA, it can be abundant in crop fields but becomes progressively less abundant away from crop areas, presumably because of competition from native thrips and predation (Reitz et al., 2006; Paini et al., 2007, 2008; Northfield et al., 2008).

5.3.6.5. Hazard identification conclusion

Considering the facts that *Frankliniella occidentalis* -

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 1999];
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China, India, Thailand, **Japan** [EPPO, 2014; CABI/EPPO, 1999] from where flowers are imported to Bangladesh.

- can become established in Bangladesh through imports of the brinjal seeds. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, because the eggs are laid in leaves, flower structures or fruit (Childers and Achor, 1995). The major method of long distance dispersal for this pest is via transportation of infested seed and nursery stock [EPPO, 2016].
- *Frankliniella occidentalis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 6.1 – 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, • This pest has been established in many Asian countries. The introduction of this pest in India was first reported in 2015; Japan in 1990, the Republic of Korea in 1993; Sri Lanka in 1996, Israel in 2003). • *Frankliniella occidentalis* is highly polyphagous, breeding on many field and horticultural crops that are transported around the world. The international movement of plant material has fostered the rapid spread of the species throughout the world and many populations are now highly resistant to various insecticides. It is considered likely that the development of resistance in the late 1970s is the factor that triggered the worldwide spread and establishment of this species (Kirk and Terry, 2003). **b. Posibility of survival of this pest during transport, storage and transfer? - Yes** • The total life-cycle of Alfalfa thrips, *F. occidentalis* from egg to adult at 15, 20, 25 and 30°C is 44.1, 22.4, 18.2 and 15 days, respectively. The eggs are inserted in the parenchyma cells of leaves, flower parts and fruits, and hatch in about 4 days at 27°C. This period is lengthened to 13 days at 15°C (Bryan & Smith, 1956; Lublinkhof & Foster, 1977). Therefore, the period of time taken for shipment through transportation pathways from the exporting countries to Bangladesh is sufficient enough for survival. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with high risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *F. occidentalis* is liable to be carried on any plants for planting or on brinjal seeds, and nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *F. occidentalis* is a remarkably polyphagous species with 244 plant species from 62 families being recorded as hosts. The host range of *F.*	**YES** **and** **HIGH**

occidentalis is tomatoes, *Capsicum*, Cucurbitaceae and strawberries, *Beta*, carrots, cotton, grapefruits, grapes, onions, flowers of roses, carnations, *Gladiolus*, chrysanthemums, *Gerbera*, sweet peas, plums, peas, *Phaseolus*, safflower (EPPO, 2016), which are mostly common in Bangladesh. • As long as environmental conditions are favourable, *F. occidentalis* will reproduce continuously, with up to 15 generations in a year being recorded under glass (Bryan and Smith, 1956; Lublinkhof and Foster, 1977). Development and reproductive rates are temperature dependent. The total life cycle from egg to egg has been recorded as 44.1, 22.4, 18.2 and 15 days at 15, 20, 25 and 30°C. Each female lays typically between 20 and 40 eggs during its life. At 15°C, pre-oviposition time is longer (10.4 days) than at higher temperatures of 20 or 30°C (2-4 days). However, because of faster development times, greater population growth rates are seen at temperatures of 30°C (Gaum et al., 1994).	
• 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.6.7. Determine the Consequence establishment of this pest in Bangladesh

Table 6.2 – Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • *F. occidentalis* is a remarkably polyphagous species with 244 plant species from 62 families being recorded as hosts. In the USA, the host range of *F. occidentalis* is brinjal, tomatoes, *Capsicum*, Cucurbitaceae and strawberries. *Beta*, carrots, cotton, grapefruits, grapes, onions, flowers of roses, carnations, *Gladiolus*, sweet peas, apricots, peaches and nectarines, plums, peas, *Phaseolus*, *Purshia tridentata*, safflower. In Europe, this pest is most commonly on brinjal, tomatoes, chrysanthemums, *Gerbera*, roses and *Saintpaulia* [EPPO, 2016]. • *F. occidentalis* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in vegetables, flowers and other crops, illustrate clearly the serious nature of this pest and the potential threat to the field crops as well as horticultural crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important vegetables, flower and other crops for Bangladesh. **b. Economic Impact and Yield Loss** • *F. occidentalis* attacks the flowers and foliage of a great number of crops. As well as feeding on plant fluids with their sucking mouthparts, *F. occidentalis* also eats the pollen and nectar of many plants, and the	**Yes and High**

spreading of pollen during this feeding result in pollination and premature senescence - which can be a serious problem with certain ornamental crops such as *Saintpaulia*. • *F. occidentalis* is a very important pest of ornamental flower crops as it takes only a few individuals to scarthe marketable portion of the crop, the flower and reduces the aesthetic quality of the crop. • *F. occidentalis* also attacks vegetables under glass and the decline in cucumber production in British Columbia (Canada) is attributed mainly to the spread of this pest. For example, in 1985, *F. occidentalis* was estimated to have caused a 20% yield loss in the glasshouse cucumber crop. • In California (USA), *F. occidentalis* also causes damage outdoors, on lucerne (by larval feeding on flowers and young pods) and on fruit trees (by scarring and silvering the surface of the fruit, especially in *Prunus*). Nursery stock of fruit trees and roses is also damaged, the terminal buds being killed or weakened. A range of other crops in North America is damaged by this pest to a greater or lesser extent. • *F. occidentalis* may affect most fruiting vegetables with the exception of tomatoes. Problems are most severe on cucumbers where the blossoms can be reduced or so extensively damaged that no fruit is produced. The cucumber fruits often show severe distortion. • *F. occidentalis* has been associated with outbreaks of tomato spotted wilt virus (TSWV) on tomatoes in Ontario (Canada). The symptoms of this disease include stunting, distortion and mosaic mottling of leaves, and clearing of leaf veins and fruit. TSWV causes severe loss (50-90%) of lettuces in Hawaii (USA), particularly in the major vegetable-growing area of Kula. Twenty-five weed species found in Kula serve as reservoirs for *F. occidentalis*, 17 of which may harbour TSWV. In lettuce fields there is a high correlation between thrips populations and TSWV incidence. In Louisiana (USA) the incidence of TSWV in tomato, pepper and tobacco crops has increased dramatically since about 1978. The infection can reach 60% in commercial fields and 100% in gardens. It is thought that the expanded geographical range of *F. occidentalis* into Louisiana is responsible for the increase of TSWV. However, it has also been suggested that the role of *F. occidentalis* as the vector of the virus in California has been over-emphasized, and that *Thrips tabaci* is probably more important. **c. Environmental Impact** • *F. occidentalis* represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment. • Chemical control is important and widely practised, but is often constrained by the secretive habits of *F. occidentalis*, and because populations have been found to develop resistance quickly. For example, MacDonald (1995) demonstrated 30-fold differences in susceptibility to Malathion among populations of *F. occidentalis* in the remarkably small area of the southern half of England. A disturbing practice is mixing insecticides into 'cocktails' to obtain short-term control enhancement when one insecticide loses efficacy, because of the added risk of longer term resistance that this brings. The nature of quick resistance	

development of this pest against insecticides also triggers further changing of new chemical insecticides that also enhance harmful impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 6.3 – Calculating 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

5.3.6.9. Risk Management Measures

- Avoid importation of flowers and foliages from countries, where this pest is available.
- Treatments against *F. occidentalis* on plants in transit are unlikely to be entirely successful because of the ability of the pest to secrete itself in small crevices and tightly closed plant parts, because the eggs are protected by the epidermis of the host, and because of the subterranean habit of certain stages (Zhang *et al.,* 2004).
- In addition, resistance of this pest has developed to certain pesticides. Accordingly, the only safe measure is to ensure that the place of production is free from the pest by appropriate inspection (OEPP/EPPO, 1990).

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5.3.7.	**Tobacco caterpillar: *Spodoptera littoralis*** (Boisduval)

5.3.7.1 Hazard Identification

Scientific Name: *Spodoptera littoralis* (Boisduval)

Synonyms: *Hadena littoralis* Boisduval

Noctua gossypii

Prodenia littoralis (Boisduval)

Prodenia litura Fabricius sensu auctorum

Prodenia retina (Freyer)

Prodenia testaceoides Guenee

Common names: Tobacco caterpillar;
Tomato caterpillar
Egyptian cotton leafworm;
Egyptian cotton worm;
Mediterranean brocade moth;
Mediterranean climbing cutworm;
Mediterranean climbing cutworm;

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Noctuidae
Genus: *Spodoptera*
Species: *Spodoptera littoralis*

EPPO Code: PRODLI. This pest has been included in EPPO A2 list: No. 42

Bangladesh status: Not present in Bangladesh [CIE, 1967; EPPO, 2014].

5.3.7.2. Biology

Between 2 and 5 days after emergence, females lay 1000-2000 eggs in egg masses of 100-300 on the lower leaf surface of the host plant (Miyahara *et al*., 1971). The masses are covered by hair-like scales from the end of the insect's abdomen. Fecundity is adversely affected by high temperature and low humidity (about 960 eggs laid at 30°C and 90% RH and 145 eggs at 35°C and 30% RH). Newly laid eggs of one strain of *S. littoralis* were reported to survive exposure to 1°C for 8 days.

The eggs hatch in about 4 days in warm conditions, or up to 11-12 days in winter. The larvae pass through six instars in 15-23 days at 25-26°C.. The young larvae (first to third instar) feed in groups, leaving the opposite epidermis of the leaf intact. Later, the (4th to 6th instar) larvae disperse and spend the day in the ground under the host plant, feeding at night and early in the morning.

The pupal period is spent in earthen cells in the soil and lasts about 11-13 days at 25°C. Longevity of adults is about 4-10 days, being reduced by high temperature and low humidity. Thus, the life cycle can be completed in about 5 weeks. The development thresholds and thermal requirements of S. litura have been specified by Rao et al. (1989). For more information, see Bishara (1934), Schmutterer (1969), Salama *et al.* (1970), Cayrol (1972), Nasr (1973), Baker & Miller (1974), Shutova & Cheknonadskikh (1974), Cunningham & Broadley (1975).

5.3.6.3. Hosts

a. **Major hosts:** The main crop species attacked by *S. lituralis* in the tropics are vegetables (aubergines, *Brassica oleracea*, *B. oleracea* var. *capitata*, Capsicum, pea, radish, carot, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes, Vigna etc.) *Colocasia esculenta*, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco,.
b. **Minor hosts:** The minor or other hosts include ornamentals such as china aster (*Callisterphus chinensis*), chrysanthemum (*Chrysanthemum indicum*), Gerbera, sunflower, carnation etc, wild plants, weeds and shade trees (e.g. *Leucaena leucocephala*, the shade tree of cocoa plantations in Indonesia).

5.3.7.4. Distribution

EPPO region: Widespread in Algeria, Cyprus, Egypt, Israel, Libya, Malta, Morocco, Spain; locally established in Greece, Italy, Portugal, Tunisia; found but not established in Denmark, Finland, France, Germany, Netherlands, UK (England). It was also reported from Lebanon, Syria and Turkey.

Asia: Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen, Pakistan, Japan, Indonesia.

Africa: Algeria, Angola, Benin, Burkina Faso, Burundi, Botswana, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Egypt, Equatorial Guinea, Eritrea, Gambia, Ghana, Guinea, Kenya, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Réunion, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, St. Helena, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zaire, Zambia, Zimbabwe.

EU: Present.

5.3.7.5. Hazard Identification Conclusion

Considering the facts that *S. littoralis* -

- is not known to be present in Bangladesh [CIE, 1967; EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages Asia including Bahrain, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Oman, Pakistan, Saudi Arabia, Syria, Turkey, United Arab Emirates, Yemen [CIE, 1967a; EPPO, 2014] and Japan (Nakasuji, 1976) from where flowers are imported to Bangladesh.
- can become established in Bangladesh through imports of the flowers and foliages. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, because this pest has high reproductive potential, high dispersal ability for long distance and high survivability at adverse environment, the risk rating for establishment potential is high**.**
- *Spodoptera littoralis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.7.6. Determine likelihood of pest establishing in tour country via this pathway.

Table 7.1. – 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, • This pest has been established in many Asian countries including Bahrain, Iran, Iraq, Jordan, Lebanon, Oman, Saudi Arabia, Turkey, United Arab Emirates, Yemen (EPPO, 2016), Pakistan, Japan, Indonesia. The introduction of another species *S. litura* into the UK was on aquatic plants imported from Singapore (Aitkenhead *et al*., 1974). *S. littoralis* has been trapped outside its normal range in Europe (Hachler, 1986), presumably as a result of entry on imported commodities. • EPPO has listed *S. littoralis* as an A2 quarantine pest (OEPP/EPPO, 1981). CPPC, NAPPO and OIRSA also consider this species of quarantine significance. *S. littoralis* is already fairly widespread in Mediterranean countries. **c. Posibility of survival during transport, storage and transfer of this pest? Yes** • The brinjal fruits, seeds and other planting materials are transported from China, Japan, Thailand, Taiwan, Vietnam, Indonesia, U.S.A, Australia, etc to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and catterpillers of tomato catterpillers can easily survive on fruit surfaces of brinjal. The eggs hatch in about 4 days in warm conditions, or up to 11-12 days in winter. The larvae pass through six instars in 15-23 days at 25-26°C. At lower temperatures, for example *S. littoralis* on glasshouse chrysanthemums in Europe, larvae often go through an extra instar, and maturation may take up to 3 months. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with **High** risk potential.	**YES and HIGH**

c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes, • Commerce appears to be the most likely pathway for introduction. Eggs or larvae are carried on imported plants, cut flowers and edible crops. Adult moths have also occasionally been recorded as immigrants presumed to have originated from Mediterranean Europe or northern Africa (Eight records to 2010). • Internationally, *S. littoralis* is liable to be carried on any plants for planting materials such as brinjal seeds, nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *S. littoralis* species is totally polyphagous (Brown & Dewhurst, 1975; Holloway, 1989). The host range of this pest species covers at least 87 species of economic importance (Salama et al., 1970). Among the main crop species attacked by *S. lituralis* in the tropics are vegetables (aubergines, *Brassica oleracea*, *B. oleracea* var. *capitata*, Capsicum, pea, radish, carot, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes, Vigna etc.), *Colocasia esculenta*, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco. Other hosts include ornamentals such as china aster (*Callisterphus chinensis*), chrysanthemum (*Chrysanthemum indicum*), Gerbera, sunflower, carnation etc, wild plants, weeds and shade trees (e.g. *Leucaena leucocephala*, the shade tree of cocoa plantations in Indonesia), among these hosts many of them mostly common in **Bangladesh**. • Adult females lay 1000-2000 eggs in egg masses of 100-300 on the lower leaf surface of the host plant (Miyahara *et al*., 1971). Newly laid eggs of one strain of *S. littoralis* were reported to survive exposure to 1°C for 8 days. Partially developed eggs survived longer than newly laid ones under equivalent conditions. • The larvae pass through six instars in 15-23 days at 25-26°C. At lower temperatures, for example *S. littoralis* on glasshouse chrysanthemums in Europe, larvae often go through an extra instar, and maturation may take up to 3 months. The pupal period is spent in earthen cells in the soil and lasts about 11-13 days at 25°C. Longevity of adults is about 4-10 days, being reduced by high temperature and low humidity. Thus, the life cycle can be completed in about 5 weeks. In Japan (Nakasuji, 1976), four generations develop between May and October, while in the humid tropics there may be eight annual generations. In the seasonal tropics, several generations develop during the rainy season, while the dry season is survived in the pupal stage. • These climatic requirements for growth and development of *S. littoralis* are 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.7.7. Determine the Consequence establishment of this pest in Bangladesh

Table 7.2. – Which of these descriptions best fit of this pest?

Description	Consequence potential is:
a. Is this a serious pest of Bangladesh? - Yes. • *S. littoralis* is an extremely serious pest, the larvae of which can defoliate many economically important crops within its subtropical and tropical range all the year round. On cotton, the pest may cause considerable damage by feeding on the leaves, fruiting points, flower buds and, occasionally, also on bolls. When groundnuts are infested, larvae select primarily the young folded leaves for feeding but, in severe attacks, leaves of any age are stripped off. Sometimes, even the ripening kernels in the pods in the soil may be attacked. Pods of cowpeas and the seeds they contain are also often badly damaged. In tomatoes, larvae bore into the fruit which is thus rendered unsuitable for consumption. Numerous other crops are attacked, mainly on their leaves. • In Europe, damage due to *S. littoralis* was minimal until about 1937. In 1949, there was a catastrophic larval population explosion in southern Spain. The main crops affected were lucerne, potatoes and other vegetable crops. At present, this noctuid is of great economic importance in Cyprus, Israel, Malta, Morocco and Spain. In Italy, it is especially important on protected crops of ornamentals and vegetables (Inserra & Calabretta, 1985; Nucifora, 1985). In Greece, *S. littoralis* causes slight damage in Crete on lucerne and *Trifolium* only. • Larval penetration into maturing cotton bolls causes considerable damage as well as introducing bacterial and fungal rot agents that cause secondary damage. • *S. littoralis* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in flowers and other crops, illustrate clearly the serious nature of this pest and the potential threat to the flower and foliages as well as other crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important flower and other crops for Bangladesh. **b. Economic impact and yield loss** • *S. littoralis* is one of the most destructive agricultural lepidopterous pests within its subtropical and tropical range. It can attack numerous economically important crops all the year round. On cotton, the pest may cause considerable damage by feeding on the leaves, fruiting points, flower buds and, occasionally, also on bolls. When groundnuts are infested, larvae select primarily the young folded leaves for feeding but, in severe attacks, leaves of any age are stripped off. Sometimes, even the ripening kernels in the pods in the soil may be attacked. Pods of cowpeas and the seeds they contain are also often badly damaged. In tomatoes, larvae bore into the fruit which is thus rendered unsuitable for consumption. Numerous other crops are attacked, mainly on their leaves. In Europe, damage due to *S. littoralis* was minimal until about 1937. In 1949, there was a catastrophic larval population explosion in southern Spain. The main crops affected were lucerne, potatoes and other vegetable crops. At present, this noctuid is of great economic importance in Cyprus, Israel, Malta, Morocco and Spain (but not in the north, e.g. Cataluña). In Italy, it is especially important on protected crops of	**Yes and High**

ornamentals and vegetables (Inserra & Calabretta, 1985; Nucifora, 1985). In Greece, S. littoralis causes slight damage in Crete on lucerne and Trifolium only. **c. Environmental Impact** • The appearance of the *S. littoralis* within new areas is in most cases, the result of movement of infested plant material. The movement and establishment of *S. littoralis* populations through this route bring along the possibility of insecticide resistance genes. This invariably leads to an increase in the use of insecticides as *S. littoralis* control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table7.3. – Calculating 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

5.3.7.9. Risk Management Measures

- Avoid importation of plantilng materials such as brinjal seeds and nursery stocks from countries, where this pest is available.
- For planting material, EPPO recommends (OEPP/EPPO, 1990) absence of the pests from the place of production during the last 3 months, or treatment of the consignment. For brinjal, pre-export inspection is considered sufficient.
- Cold storage of brinjal seeds nursery stocks for at least 10 days at a temperature not exceeding 1.7°C will kill all stages of *S. littoralis*, and presumably also *S. litura*, but may damage the plants. Storage at slightly higher temperatures or shorter durations does not eradicate *S. littoralis*, but differences in response to cold have been observed both between strains and within developmental stages of the pest (Powell & Gostick, 1971; Miller, 1976). The standard treatment now used in the UK is cold storage for 2-4 days at less than 1.7°C, followed by methyl bromide fumigation at 15-20°C with a CTP of 54 g h m^3 (Mortimer & Powell, 1988). This has been adopted as an EPPO quarantine

procedure (OEPP/EPPO, 1984). Irradiation has been investigated as a treatment for brinjal seeds (Navon *et al.*, 1988).

- For cut chrysanthemum flowers, Wang & Lin (1984) suggest enclosing buds in perforated polythene bags to exclude the pest and dipping the cut stems in insecticide solutions.
- A phytosanitary certificate may be required for vegetables seeds especially brinjal, nursery stocks and for vegetables with leaves.

5.3.7.10. References

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5.3.8. Red spider mite: *Tetranychus evansi*

5.3.8.1 Hazard Identification

Scientific name: *Tetranychus evansi* Baker & Pritchard, 1960

Synonyms: No synonyms recorded, but *Tetranychus takafujii* Ehara & Ohashi, 2002, is suspected to be the same species.

Common names: Red tomato spider-mite, red spider mite

Cassava stem mussel scale; white mussel scale

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Class: Arachnida
Order: Acarina
Family: Tetranychidae
Genus: *Tetranychus*
Species: *Tetranychus evansi*

EPPO Code: TETREV. This pest has been included in EPPO A2 list: No. 349

Bangladesh status: Not present in Bangladesh [EPPO, 2016].

5.3.8.2 Biology

Arrhenotokous parthenogenesis is the rule for Tetranychid mites. Unfertilised eggs develop into haploid males while diploid females are produced biparentally from fertilized eggs. The sex-ratio is about 70% females.

Tetranychus evansi reproduction is continuous throughout the year. No diapause has been observed even in the coldest parts of its distribution area nor for *T. takafujii* in Tokyo Bay (Ohashi *et al.*, 2003). This could limit the distribution to areas with moderately cold winters.

Qureshi *et al.* (1969), Moraes & McMurtry (1987) and Bonato (1999) have studied the life-history of the mite. The theoretical minimal growing temperature varies from 10.3°C to 13.7°C depending on authors and stages. The optimal temperature is 34°C and the maximal 38°C. The duration of development from egg to adult ranges from 46 days at 15°C to 8-13 days at 25°C and 6 days at 35°C. The number of eggs laid by females varies from 80 with extreme low and high temperatures to a range of 120-250, depending on the authors, for optimal temperatures. This mite has one of the highest rates of population increase among *Tetranychus* species (~0.4) which leads to heavily infested plants at the end of a favourable growing season. This phenomenon causes spectacular outbreaks and high mite populations can kill host plants. Dispersal behaviour is associated with outbreaks, in which mites form large aggregates at the top of the infested plants and are blown with the wind.

5.3.8.3 Hosts

T. evansi is polyphagous. It has been reported on 31 plant families (Spider Mites Web Database, Migeon & Dorkeld, 2007). Major hosts are within the *Solanaceae.*

Cultivated hosts

The primary cultivated solanaceous hosts are tomato (*Lycopersicon esculentum*) (Silva, 1954; Migeon, 2007), aubergine (*Solanum melongena*) (Moraes *et al.*, 1987a; Leite *et al.*, 2003), potato (*S. tuberosum*) (Escudero & Ferragut, 2005), tobacco (*Nicotiana tabacum*) (Blair, 1989) and to a lesser degree peppers and chillies (*Capsicum annuum*) (Silva, 1954). Bean (*Phaseolus vulgaris*) is a cultivated non-solanaceous host (Gutierrez & Etienne, 1986).

The EWG regarded the following crops as secondary, or minor, hosts since there are very few records in the literature of *T. evansi* occurring on them, *Abelmoschus esculentus* (Tuttle *et al.* 1977), beetroot (*Beta vulgaris*) (Aucejo *et al.*, 2003), *Phacelia* sp. (Qureshi *et al.* 1969), cotton (*Gossypium hirsutum*) (Wene, 1956), castor bean (*Ricinus communis*) (Ho *et al.* 2004), peanuts (*Arachis hypogea* and *A. prostrata*) (Moutia 1958, Chiavegato & Reis 1969, Feres & Hirose 1986), sweet potato (*Ipomea batatas*) (Moutia, 1958), watermelon (*Citrullus lanatus* (Ferragut, pers. comm. 2007), and *Rosa* spp. (Qureshi *et al.* 1969).

Weeds

The preferred host for *T. evansi* is the widespread weed *Solanum nigrum* (Migeon, 2007). Other weed hosts include *Amaranthus blitoides*, *Chenopodium* spp. (El Jaouani, 1988), *Convolvulus arvensis*, *Conyza* spp., *Diplotaxis erucoides*, *Hordeum murinum, Lavatera trimestris*, *Sonchus* spp. (Ferragut & Escudero, 1999; Aucejo, Foo, Gimeno, *et al.*, 2003). INRA Spider Mites Web database (Migeon & Dorkeld, 2007) provides a more extensive lists of hosts / plants on which *T. evansi* has been recorded.

5.3.8.4 Geographical distribution

T. evansi is suspected to originate from South America. It has been unintentionally introduced to other parts of the world.
Because the pest can easily be confused with other *Tetranychus* species, there is uncertainty on the pest distribution, e.g. it could be present on crops but considered to be another *Tetranychus* species, or present but disregarded on non-crop plants. The geographic distribution of *T. evansi* is given below:

EPPO region: France (Pyrénées-Orientales, Alpes Maritimes, Var), Greece (EPPO, 2007), Israel (EPPO, 2006a), Italy (Liguria, EPPO 2006b), Jordan (Palevsky, pers. comm. 2007), Portugal (from Algarve to Lisbon including Madeira), Spain (Canary Islands, Baleares Islands, along the Mediterranean coast, Atlantic coast of Andalusia).

Asia: Israel (EPPO, 2006), Jordan (Palevsky, pers. comm. 2007), Taiwan (including Kinmen and Lienchang Islands). If *T. takafujii* is shown to be a synonym of *T. evansi*, then the pest would also be known to occur in Japan (EPPO, 2006).

Africa: Democratic Republic of Congo, Congo, Gambia, Kenya, Malawi, Mauritius (including Rodrigues island), Morocco, Mozambique, Namibia, Niger (pers. comm. Migeon, 2007), Reunion Island, Senegal, Seychelles, Somalia, South Africa, Tunisia, Zambia, Zimbabwe. Detections of *T. evansi* on consignments of plant products from Gambia, suggest that *T. evansi* may also be present in Gambia (MacLeod, pers. comm. 2007).

North America: USA (Arizona, California, Florida, Texas, Hawaii).

Central America and Caribbean: Puerto Rico, Virgin Islands

South America: Brazil, Argentina

Oceania: Hawaii (USA).

5.3.8.5 Hazard Identification Conclusion

Considering the facts that *T. evansi*

- is not known to be present in Bangladesh [EPPO, 2006].
- is potentially economic important to Bangladesh because it is an important pest of Solanaceous crops in Asia including Japan, Taiwan (EPPO, 2006) from where vegetable seeds especially brinjal seeds and nursery stocks are imported to Bangladesh.
- Local movement is mainly linked to wind currents. In international trade, *T. evansi* may be carried on Solanaceous plants for planting (except tubers and seeds) and this is the hypothesis used to explain the introduction of the pest e.g. in Africa. The mites are less likely to infest fruits, these only present a risk where peduncles are present (aubergines, vine tomatoes, fresh beans, and to a lesser degree, chillies and peppers).
- *T. evansi* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.8.6 Determine likelihood of pest establishing in tour country via this pathway

Table 8.1 – 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, • *T. evansi* is suspected to originate from South America. It has been unintentionally introduced to other parts of the world. However, this pest is widely distributed in many Asian countries including Japan, Taiwan (CABI, 2015). • *T. evansi* is a tropical species of New World origin. There is no mention in the literature of the history of its spread, but it has undoubtedly reached countries outside the New World as a result of human transport of infested planting materials. **b. Posibility of survival during transport, storage and transfer?—Yes** • The mites are less likely to infest fruits, these only present a risk where peduncles are present (cucurbits, aubergines, vine, tomatoes, fresh beans, and to a lesser degree, chillies and peppers). • The duration of development from egg to adult ranges from 46 days at 15°C to 8-13 days at 25°C and 6 days at 35°C. Within this period the eggs and mites can easily survive on fruit surfaces of cucurbits. Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *T. evansi* is liable to be carried on any plants for planting materials such as seeds, nursery stocks of brinjal, which are the main means of dispersal of this pest [EPPO, 2006]. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The preferred host (*S. nigrum*) and at least three major cultivated hosts (aubergines, tomatoes and potatoes) and rose are widely distributed in many Asian countries including Japan, China, Thailand, India (CABI, 2015), among of these are common in **Bangladesh**. • *T. evansi* is a warmth-loving pest. A study by Bonato (1999) showed that the optimal temperature for population growth is 34°C. The shortest developmental time (6.3 days) occurs at 36°C. At 25°C, the life cycle is completed in 13.5 days. • These climatic requirements for growth and development of *T. evansi* are more or less similar with the climatic condition during summer season of **Bangladesh**.	**YES and HIGH**
• 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.8.7 Determine the Consequence establishment of this pest in Bangladesh

Table 8.2 – Which of these descriptions best fit of this pest?

<table>
<tr><td>Description</td><td>Consequence potential is:</td></tr>
<tr><td>

a. Is this a serious pest of Bangladesh? - Yes.

- If infested plants for planting are introduced in protected cultivation where no plant protection products are used, *T. evansi* has the potential to cause economic damage although we do not know about the susceptibility of cultivars used.
- In African countries where *T. evansi* is established, it has been reported as a serious pest in particular of tomato. Of the thirteen known spider mite species on Reunion, *T. evansi* is one of the most destructive pests on crops (Gutierrez & Etienne, 1986). In Southern Africa *T. evansi* is considered as the most important dry season acarine pest of tomatoes (Fiaboe, 2007). Severe damage is also recorded on aubergine (Migeon, pers. comm. 2007). Infested tomato plants turn yellow, green then brown. Plants generally show a bleached yellow-orange or russeted appearance. Infested plants may be killed very rapidly (Jeppson *et al.*, 1975). In Zimbabwe, up to 90% yield losses have been recorded from field trials. However, it should be noted that with improved use of plant protection products, the damage on crops could be significantly reduced (Knapp *et al* 2003).
- This is a fairly serious pest of several important field crops for Bangladesh.

b. Economic Impact and Yield Loss

- *Tetranychus evansi* is regarded as an important pest of tomato and other solanaceous crops. In East and South Africa it has been considered the most important dry season pest of tomatoes (Knapp, 2002) since it was first recorded in 1979 and yield losses are noted. In Western Africa, it damages tomatoes and aubergines (Duverney & Ngueye-Ndiaye, 2005).
- *Tetranychus evansi* is one of four species of red spider mites causing damage in vegetable crops in eastern Spain (Escudero and Ferragut, 2005), although there is no specific data on economic impact caused by *T. evansi* alone (Ferragut, pers. com. 2007). In Spain, damage has only been recorded in outdoor crops such as aubergine, potato and tomato (Ferragut, pers com. 2007) the same situation occurs in Israel on aubergine and potato.
- The most severe damage in Israel occurs on aubergine (Palevsky pers. com. 2007). Few outbreaks are recorded under protected conditions, even in areas where the pest is present outdoors on weeds.
- An outbreak in organic farming production unit was detected in southern France on tomato in protected cultivation in October 2007 (Migeon, pers. com. 2007). This illustrates the potential of the pest to cause damage in protected organic farming cultivation.

c. Environmental Impact

- Acaricides are commonly used against *T. evansi* and other spider mites on Solanaceous crops. Mite populations have developed resistance, in particular in Zimbabwe during the 1980s but current use of non organo-phosphorous acaricides is effective at controlling populations although it does not allow integrated crop protection or organic production.

</td><td>

Yes

and

High

</td></tr>
</table>

• The pesticide resistance invariably leads to an increase in the use of insecticides as whitefly control becomes increasingly more difficult. This in turn can produce an ever increasing spiral in the levels of insecticide resistance and insecticide use, having a direct impact on the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5.3.8.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 8.3 – Calculating 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

5.3.8.9 Risk Management Measures

a. Measures related to consignments:

- **Visual inspection:** Visual detection of mites is possible but confusion with other mites (such as *T. urticae (syn. cinnabarinus), T. turkestani, T. ludeni, T. neocaledonicus, T. lombardini)* is possible. Mites and eggs in low numbers would be difficult to detect.
- **Treatment of the consignment:** Chemical treatments (combining treatments targeting adults and eggs) may be recommended, but their efficacy has to be verified by inspection.

b. Measures related to the crop or to places of production

- Pest Free Area for *T. evansi*
- Pest Free Place of Production:
  (i) Mites are expected to spread more than five kilometres.
  (ii) Having a five km buffer zone free from host plants is not a realistic option but a place of production freedom should consist in:
    - Isolation: no other host plants in the immediate vicinity of the place of production (minimum 5 m recommended by Clark, 2001)
    - Hygienic measures to prevent the pest to enter the greenhouse.

- Treatment of the crop during the production (the active ingredients which have resulted in more than 90% of mortality in adult females are: hexythiazox, propargite, dicofol, acrinatrin, fenbutatin oxide, dicofol+hexythiazox, fenpyroximate and dicofol.)
- Two inspections of the consignment prior to export

c. Other possible measures

- Surveillance in the importing country was not considered as a possible measure.

5.3.8.10 References

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5.3.9. Phytophthora root rot: *Phytophthora megasperma*

5.3.9.1 Hazard Identification

Scientific Name: *Phytophthora megasperma* Drechsler

Synonyms: *Phytophthora fragariae* var. *fragariae*
Phytophthora fragariae var. *rubi*

Common names: Phytophthora root rot,
Red core disease,
Red stele disease

Taxonomic tree

Domain: Eukaryota
Phylum: Heterokontophyta
Class: Oomycetes
Order: Pythiales
Family: Pythiaceae
Genus: *Phytophthora*
Species: *Phytophthora megasperma*

EPPO Code: PHYTDR

Bangladesh status: Not present in Bangladesh [CABI, 2006]

5.3.9.2 Biology

The fungus survives in crop debris in the soil, principally as oospores. Oospores germinate and form sporangia especially in spring. The temperature optima for oospore germination and production, determined in laboratory experiments, are 27°C and 18-23°C, respectively (Schechter & Gray, 1987). After flooding or heavy rainfall, sporangia release zoospores. Zoospores, moving in soil water on crop residues, are attracted by host roots, encyst, germinate and penetrate the roots without forming an appressorium (Odermatt et al., 1988).

Lateral roots are destroyed and the whole plant may be killed at the seedling stage. Older plants are attacked more slowly, the fungus spreading gradually from the taproot up the stem to the lower branches. Leaves may be infected directly from soil splashed onto their surface. Pods and seeds are not normally infected, although the fungus has been reported from seeds.

The disease is favoured by high soil moisture and rainfall, and is most severe on heavy soils. Tightly compacted soil also increases the incidence of *P. megasperma* f.sp. *glycines* (Moots et al., 1988). Most root damage occurs under cool conditions (15°C). Under warm, dry conditions, plants recover by replacing the lateral roots destroyed by the fungus.

5.3.9.3 Hosts

Phytophthora megasperma has been recorded to attack multiple species in multiple families including: **Solanaceae** (tomato, potato, eggplant), **Brassicaceae** (cabbage, cauliflower), **Liliaceae** (asparagus), **Apiaceae** (carrot), **Rutaceae** (lemon, grape fruit), **Asteraceae** (sunflower), **Poaceae** (rice, sugar cane), **Sterculiaceae** (cacao), **Cucurbitaceae** (cucumber), **Caryophyllaceae** (carnation, *Dianthus caryophyllus*), **Lauraceae** (avocado) Malvaceae (hollyhock, *Alcea rosea*), **Rosaceae** (apple, apricot, cherry, plum, peach, strawberry and rose) (CABI, 2006).

5.3.9.4 Distribution

Phytophthora megasperma is found in Australia, New Zealand, United States, France, Greece, Ireland, Italy, Spain, United Kingdom, Scotland.

Asia: *P. megasperma* widespread in Japan, Philippines. (http://zipcodezoo.com/Chromista/P/Phytophthora_medicaginis.asp, (CABI, 2006).

5.3.9.5 Hazard Identification Conclusion

Considering the facts that *Phytophthora megasperma* -

- is not known to be present in Bangladesh.
- is potentially economic important to Bangladesh because it is an important pest of vegetables like tomato, potato, eggplant etc in Asia including Japan from where planting materials iike seeds, nursery stocks and others are imported to Bangladesh.
- There is no evidence that *Phytophthora megasperma* is seed borne (Richardson, 1979). It can be introduced in diseased nursery stock, so nursery hygiene is essential. Zoospores can be passively spread long distances in irrigation water, or in drainage ditches (Ribeiro and Linderman, 1991).
- *Phytophthora megasperma* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.9.6 Determine likelihood of pest establishing in tour country via this pathway

Table 13.1. – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. This pest has established in several new countries in recent years?— Yes • This disease is widely established in Japan and Philippines. *P. megasperma* f.sp. glycines was formerly considered to be an A1 quarantine pest for EPPO (OEPP/EPPO, 1989), but was transferred to the EPPO A2 list in 1992 due to its recent appearance within the EPPO region. There is every reason to suppose that it could establish itself widely and cause losses in the Euro-Mediterranean region. **b. Posibility of survival during transport, storage and transfer of this pest? Yes** • The fungus survives in crop debris in the soil, principally as oospores (Schechter & Gray, 1987). After flooding or heavy rainfall, sporangia release	**YES and HIGH**

zoospores. Zoospores, moving in soil water on crop residues, are attracted by host roots, encyst, germinate and penetrate the roots without forming an appressorium (Odermatt et al., 1988). • Lateral roots are destroyed and the whole plant may be killed at the seedling stage. Older plants are attacked more slowly, the fungus spreading gradually from the taproot up the stem to the lower branches. Leaves may be infected directly from soil splashed onto their surface. Fruits and seeds are not normally infected, although the fungus has been reported from seeds (Moots et al., 1988). Most root damage occurs under cool conditions (15°C). Therefore, the oospores can also survive during transportation of plants or seeds. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? Yes** • The natural spread of the pathogen is very slow and over extremely short distances. The main path of distribution is by means of infected cuttings which may be obtained from infected but symptomless mother plants. • By itself, the fungus has low dispersal potential. It is liable to be moved as oospores in debris accompanying seeds, or possibly in seeds. Bangladesh imports vegetable seeds from many exporting countries including Japan. Therefore, seed transmission appears to be of high significance in Bangladesh; it may be supposed that the risk is virtually high with low-quality seed. d. **Are the host(s) of this pest fairly common in Bangladesh and the climate is similar to places it established? – Yes** • *Phytophthora megasperma* has been recorded to attack multiple species in multiple families including: Solanaceae (tomato, potato, eggplant), Brassicaceae (cabbage, cauliflower), Liliaceae (asparagus), Apiaceae (carrot), Rutaceae (lemon, grape fruit), Asteraceae (sunflower), Poaceae (rice, sugar cane), Sterculiaceae (cacao), Cucurbitaceae (cucumber), Caryophyllaceae (carnation, *Dianthus caryophyllus*), Lauraceae (avocado) Malvaceae (hollyhock, *Alcea rosea*), Rosaceae (apple, apricot, cherry, plum, peach, strawberry and rose) (CABI, 2006). Many of these hosts are fairly common in Bangladesh. • The fungus survives in crop debris in the soil, principally as oospores. Oospores germinate and form sporangia especially in spring. The temperature optima for oospore germination and production, determined in laboratory experiments, are 27°C and 18-23°C, respectively (Schechter & Gray, 1987). After flooding or heavy rainfall, sporangia release zoospores. Zoospores, moving in soil water on crop residues, are attracted by host roots, encyst, germinate and penetrate the roots without forming an appressorium (Odermatt et al., 1988). • These climatic requirements for proper growth and development of this fungus also more or less similar with the climatic conditions 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.9.7 Determine the Consequence establishment of this pest in Bangladesh

Table 9.2 – Which of these descriptions best fit of this pest?

<table>
<tr><th>Description</th><th>Consequence potential</th></tr>
<tr><td>a. Is this a serious pest of Bangladesh? - Yes.
• This is a serious pest of Bangladesh. In the USA, P. megasperma f.sp. glycines causes severe losses of soyabean plants (Schmitthenner, 1989). Yield losses may reach 50% in susceptible cultivars. The disease can be avoided by planting in well drained fertile soils under warm conditions. Oospores survive for long periods in the soil, so sites where the disease has occurred should preferably be avoided.
• This is a fairly serious pest of several important flower and other crops for Bangladesh.
b. Economic impact and yield loss
• Generally, Phytophthora megasperma is one of the less aggressive species of Phytophthora, and causes debilitation rather than substantial plant death (CABI, 2006).
c. Environment Impact
• Soil water management techniques, particularly those that minimize prolonged periods of flooding (Wilcox and Mircetich, 1985b), are regarded as one of the most effective ways of managing all diseases caused by P. megasperma.
• The Oomycete-active fungicides have the capacity to slow disease development, but they will not eradicate P. megasperma from the soil.</td><td>Yes and High</td></tr>
<tr><td>• Not as above or below</td><td>Moderate</td></tr>
<tr><td>• This is a not likely to be an important pest of common crops grown in your country.</td><td>Low</td></tr>
</table>

5.3.9.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 9.3 – Calculating 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

5.3.9.9 Phytosanitary Measures

- Only good-quality clean seed should be imported (OEPP/EPPO, 1990).
- Normal precautions taken against truly seed borne pathogens of soyabeans should be more than adequate to protect against the low risk of introduction with soil.

5.3.9.10 References

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5.3.10.	Golden cyst nematode: *Globodera rostochiensis*

5.3.10.1. Hazard Identification

Scientific name: *Globodera rostochiensis*

Synonyms: *Heterodera rostochiensis* Wollenweber

Common names: Yellow potato cyst nematode,
Golden potato cyst nematode,
Golden nematode

Taxonomic tree

Kingdom: Animalia
Phylum: Nematoda
Class: Secernentea
Order: Tytenchida
Family: Heteroderiidae
Genus: *Globodera*
Species: *Globodera rostochiensis*

EPPO Code: HETDRO. This pest has been included in EPPO A2 list: No. 125

Bangladesh status: Not present in Bangladesh EPPO, 1997; CABI, 2007 []

5.3.10.2 Biology

Second-stage juveniles hatch, under stimulus from host root exudates, from eggs within cysts in the soil, and invade the roots. Each individual nematode feeds on a group of cells in the pericycle, cortex or endodermis, transforming them into a syncytium or transfer cell. The nematode remains here for the rest of its development, as it passes through two more juvenile stages to become either male or female. Females swell and break through the root surface but remain attached. They are fertilized by the vermiform, actively moving males. After copulation the males die and the females remain on the roots while eggs develop within them. Females are white when they protrude from the root surface but those of *G. rostochiensis* later pass through a golden yellow phase lasting 4-6 weeks. When the females are fully mature they die and their skin hardens and turns brown to become a protective cover (the cyst) around the eggs within. There are, on average, 500 eggs per cyst. At this point they generally drop from the surface of the root into the soil, where the eggs can either hatch immediately to attack the crop or remain dormant to act as a source of inoculum for future crops. Cysts can remain infective for many years in the absence of solanaceous hosts (Stelter, 1971; Stone, 1973b; Jones & Jones, 1974).

5.3.10.3 Hosts

Potatoes are by far the most important host crop. Tomatoes and aubergines are also attacked. Other *Solanum* spp. and their hybrids can also act as hosts.

The species of *Globodera* have several different pathotypes (Kort, 1974). The pathotypes are characterized by their ability to multiply on certain tuberous *Solanum* clones and hybrids used in breeding. Five pathotypes are recognized within *G. rostochiensis* (Ro1-Ro5 international notation).

5.3.10.4 Geographical distribution

The centre of origin of the two species is in the Andes Mountains in South America from where they were introduced to Europe with potatoes, probably in the mid-19th century. From there, they were spread with seed potatoes to other areas. The present distribution covers temperate zones down to sea level and in the tropics at higher altitudes. In these areas, distribution is linked with that of the potato crop.

- ***Globodera rostochiensis***

EPPO region: Albania, Algeria, Austria, Belarus, Belgium, Bulgaria, Czech Republic, Cyprus, Denmark, Egypt, Estonia, Faroe Islands, Finland, France, Germany, Greece (including Crete), Hungary (one locality only), Iceland, Ireland, Latvia, Lebanon, Libya, Lithuania, Luxembourg, Malta, Morocco, Netherlands, Norway, Poland, Portugal (including Madeira; unconfirmed in Azores), Spain (including Canary Islands), Russia (Central Russia, Eastern Siberia, Far East, Northern Russia, Southern Russia, Western Siberia), Slovakia, Sweden, Switzerland, Tunisia, UK (England, Channel Islands), Ukraine, Yugoslavia (unconfirmed). Found in Israel on only two occasions in 1954 and 1965 in a small area in the Sharon region, and was successfully eradicated.

Asia: Cyprus, India (Kerala, Tamil Nadu), Japan (Hokkaido), Lebanon, Pakistan, Philippines, Sri Lanka, Tajikistan, Russia (Eastern Siberia, Far East, Western Siberia).

Africa: Algeria, Egypt, Libya, Morocco (intercepted only), Sierra Leone, South Africa, Tunisia.

North America: Canada (Newfoundland, British Columbia Vancouver Island only), Mexico, USA (New York; eradicated in Delaware).

Central America and Caribbean: Costa Rica, Panama.

South America: Throughout the high Andean region: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru, Venezuela. More southerly in range than *G. pallida*.

Oceania: Australia (two outbreaks, one in Western Australia in 1986, the other in Victoria in 1991; both are subject to official eradication programmes), New Zealand, Norfolk Island.

EU: Present.

5.3.10.5 Hazard Identification Conclusion

Considering the facts that *G. rostochiensis*

- is not known to be present in Bangladesh [EPPO, 1997; CABI, 2007].
- is potentially economic important to Bangladesh because these are the important pest of tomatoes, brinjal and potatoes in Asia including India, Japan, Pakistan, Sri Lanka (EPPO, 2006) from where both vegetables and planting materials such as seeds, nursery stocks and others above mentioned agricultural crops are imported to Bangladesh.
- This nematode has no natural means of dispersal, and can only move the short distances travelled by juveniles attracted towards roots in the soil. They are spread into new areas as cysts on, in order of importance, seed potatoes, nursery stock, soil, flower bulbs, potatoes for consumption or processing. The last named are only important if there is a risk of their being planted or if care is not taken with disposal of waste soil.
- *G. rostochiensis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.10.6 Determine likelihood of pest establishing in tour country via this pathway

Table 10.1. – 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, • Golden cyst nematode is A2 quarantine pests for EPPO (OEPP/EPPO, 1978; 1981). It has also have quarantine significance for APPPC and NAPPO. In addition, *G. rostochiensis* is a quarantine pest for CPPC and IAPSC. • The nematodes are already established in most or all areas in the EPPO region that are important for the cultivation of potatoes for consumption or the production of starch; therefore, regular attention to control is needed in such areas. Where domestic legislative measures are in force, import regulations are justified to ensure comparable standards for imported material. It is essential that areas of seed potato production be kept as free as possible from these nematodes. **b. Posibility of survival during transport, storage and transfer? Yes** • In general, the cyst nematodes can survive in any environment where potatoes can be grown. A period of 38-48 days (depending on soil temperature) is required for a complete life cycle of the potato cyst nematodes (Chitwood and Buhrer, 1945). • Cyst nematode eggs can remain dormant and viable within the cyst for 30 years (Winslow and Willis, 1972). After mating, each female produces approximately 500 eggs (Stone, 1973b). Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests	**YES and HIGH**

could survive during transporting process. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *G. rostochiensis* is liable to be carried on tomatoes, brinjal and potatoes for planting, which are the main means of dispersal of this pest [EPPO, 2006]. • Golden cyst nematode eggs can remain dormant and viable within the cyst for 30 years (Winslow and Willis, 1972). After mating, each female produces approximately 500 eggs (Stone, 1973b). **c. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established? – Yes** • The preferred tomatoes, potatoes and aubergines are three major cultivated hosts (aubergines, tomatoes and potatoes) widely distributed in many Asian countries including Japan, China, Thailand, India (CABI, 2015), and these crops are also common in **Bangladesh**. • The optimum temperature for the hatch of *G. rostochiensis* is about 15°C (Evans, 1968). • These climatic requirements for growth and development of *G. rostochiensis* are more or less similar with the climatic condition during summer season 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.10.7 Determine the Consequence establishment of this pest in Bangladesh

Table 10.2.– Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Golden cyst nematodes are major pests of the potato crop in cool-temperate areas. This is particularly the case when, because of the pathotypes present, no resistant cultivars are available for planting. This situation is, at present, more serious in the case of *G. rostochiensis* because of the lack of commercially available potato cultivars having resistance to this species. • The amount of damage, particularly in relation to the weight of tubers produced, is closely related to the number of nematode eggs per unit of soil. It has been estimated that approximately 2 t/ha of potatoes are lost for every 20 eggs/g soil (Brown, 1969). Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation of potatoes. • This is a fairly serious pest of several important other crops rather than flowers for Bangladesh.	**Yes and High**

b. Economic impact and yield loss • Crop losses induced by the golden nematode range 20-70% (Greco, 1988). It has been estimated that approximately 2 t/ha of potatoes are lost for every 20 eggs/g soil (Brown, 1969). Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation of potatoes. • In Chile, yield losses of 20, 50 and 90% were obtained with population densities of 9, 28 and 128 eggs/g soil (Moreno *et al.*, 1984; Greco and Moreno, 1992). Rhizoctonia and other fungal diseases associated with nematode feeding may also contribute to the yield loss. In Canada, *Globodera rostochiensis* was found in Newfoundland in 1962 and 800,000$Can /year has been spent on control and research of golden cyst nematode (Miller, 1986). • Besides that, affected plants suffer tubers are smaller (CABI, 2006). This means it effects on quality of potato tubers as well as seed potatoes. Control on golden cyst nematode, *Globodera rostochiensis* is major by soil fumigants but fumigant nematicides are toxic and expensive (Mazin, 1991). • Moreover, golden cyst nematode (*Globodera rostochiensis*) is quarantine pest for EPPO, APPPC, NAPPO (OEPP/EPPO, 1978; 1981). Therefore, the presence of the potato cyst nematodes in potato growing areas prevents the export of potatoes to international markets due to the restrictions imposed by many countries against this pest. • Based on these Economic Impacts, the Potato cyst nematodes could become established in Bangladesh with **High Risk** potential. **c. Environmental Impact** • Introduction of *Globodera rostochiensis* into Bangladesh is likely to initiate chemical, because it is a serious pest of economically important crops. • The fumigation to control this nematode may also harm to the beneficial organisms available to the soils. • This species has the potential to attack plants (Solanum) that are main crop in Bangladesh. As a large chemical will be used for it's controlling. Therefore, it can impacts on ecological system.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5.3.10.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 10.3. – Calculating 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

5.3.10.9 Risk Management Measures

- Measures to prevent the introduction of the nematodes to areas where they are not already established include soil sampling surveys and regulations concerning movement of brinjal seeds, nursery stock, flower bulbs and soil. These apply nationally as well as internationally (CEC, 1969).
- Consignments of potato tubers, rooted plants and bulbs from countries where the nematodes occur may be examined to check amounts of adhering soil, if any, or to take samples of soil for laboratory examination.
- Additional safeguards during transit of consignments could be washing of tubers and flower bulbs to remove soil, although it should be noted that cysts can remain embedded in tubers, especially in the eyes. Alternatively, tubers may be dipped in dilute sodium hypochlorite solution (Wood & Foot, 1975).
- The EPPO specific quarantine requirements (OEPP/EPPO, 1990) for these nematodes require that the field in which seed potatoes or rooted plants being imported were grown was inspected by taking soil samples according to an EPPO-recommended method (OEPP/EPPO, 1991) and found free from viable cysts of both species. The sampling must have been performed after harvest and after removal of the previous potato crop.

5.3.10.10 References

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5.3.11.	Pale cyst nematode: *Globodera pallida*

5.3.11.1. Hazard Identification

Scientific name: *Globodera pollida* (Stone) Behrens

Synonyms: *Heterodera pallida* Stone
Heterodera rostochiensis Wollenweber *in partim*

Common names: White potato cyst nematode,
Pale potato cyst nematode

Taxonomic tree

Kingdom: Animalia
Phylum: Nematoda
Class: Secernentea
Order: Tytenchida
Family: Heteroderiidae
Genus: *Globodera*
Species: *Globodera pallida*

EPPO Code: HETDRO. This pest has been included in EPPO A2 list: No. 124

Bangladesh status: Not present in Bangladesh [EPPO, 1997; CABI, 2007].

5.3.11.2 Biology

Second-stage juveniles hatch, under stimulus from host root exudates, from eggs within cysts in the soil, and invade the roots. Each individual nematode feeds on a group of cells in the pericycle, cortex or endodermis, transforming them into a syncytium or transfer cell. The nematode remains here for the rest of its development, as it passes through two more juvenile stages to become either male or female. Females swell and break through the root surface but remain attached. They are fertilized by the vermiform, actively moving males. After copulation the males die and the females remain on the roots while eggs develop within them. Females are white when they protrude from the root surface and those of *G. pallida* remain so. When the females are fully mature they die and their skin hardens and turns brown to become a protective cover (the cyst) around the eggs within. There are, on average, 500 eggs per cyst. At this point they generally drop from the surface of the root into the soil, where the eggs can either hatch immediately to attack the crop or remain dormant to act as a source of inoculum for future crops. Cysts can remain infective for many years in the absence of solanaceous hosts (Stelter, 1971; Stone, 1973b; Jones & Jones, 1974).

5.3.11.3 Hosts

Potatoes are by far the most important host crop. Tomatoes and aubergines are also attacked. Other *Solanum* spp. and their hybrids can also act as hosts.

Both species of *Globodera* have several different pathotypes (Kort, 1974). The pathotypes are characterized by their ability to multiply on certain tuberous *Solanum* clones and hybrids used in breeding. Three pathotypes are recognized within *G. pallida* (Pa1-Pa3) (Kort *et al*., 1977).

5.3.11.4 Geographical distribution

The centre of origin of the two species is in the Andes Mountains in South America from where they were introduced to Europe with potatoes, probably in the mid-19th century. From there, they were spread with seed potatoes to other areas. The present distribution covers temperate zones down to sea level and in the tropics at higher altitudes. In these areas, distribution is linked with that of the potato crop.

EPPO region: Algeria, Austria, Belgium, Cyprus, Faroe Islands, France, Germany, Greece (Crete only), Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal (mainland), Russia (unconfirmed in European Russia), Slovakia, Spain (including Canary Islands), Sweden, Switzerland, Tunisia, UK (England, Scotland, Channel Islands), Yugoslavia.

Asia: Cyprus, India (Himachal Pradesh, Kerala, Tamil Nadu), Pakistan.

Africa: Algeria, Tunisia, South Africa.

North America: Canada (Newfoundland).

Central America and Caribbean: Panama.

South America: Throughout the high Andean region. Argentina, Bolivia, Chile, Colombia, Ecuador, Peru, Venezuela.

Oceania: New Zealand.

EU: Present.

5.3.11.5 Hazard Identification Conclusion

Considering the facts that *G. pallida*

- is not known to be present in Bangladesh [EPPO, 1997; CABI, 2007].
- is potentially economic important to Bangladesh because these are the important pest of tomatoes, brinjal and potatoes, but not of flowers in Asia including India, Japan, Pakistan, Sri Lanka (EPPO, 2006) from where both field crops and horticultural crops and their planting materials like seeds, nursery stocks etc are imported to Bangladesh.
- This nematode has no natural means of dispersal, and can only move the short distances travelled by juveniles attracted towards roots in the soil. They are spread into new areas as cysts on, in order of importance, seed potatoes, nursery stock, soil, flower bulbs, potatoes for consumption or processing. The last named are only important if
- *G. pallida* are the **quarantine pests** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.11.6 Determine likelihood of pest establishing in tour country via this pathway

Table 11.1. – 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, • Both species of potato cyst nematode are A2 quarantine pests for EPPO (OEPP/EPPO, 1978; 1981). They are also of quarantine significance for APPPC and NAPPO. In addition, *G. pallida* is a quarantine pest for CPPC and IAPSC. • The nematodes are already established in most or all areas in the EPPO region that are important for the cultivation of potatoes for consumption or the production of starch; therefore, regular attention to control is needed in such areas. Where domestic legislative measures are in force, import regulations are justified to ensure comparable standards for imported material. It is essential that areas of seed potato production be kept as free as possible from these nematodes. **b. Posibility of survival during transport, storage and transfer of this pest? Yes** • In general, the cyst nematodes will survive in any environment where potatoes can be grown. A period of 38-48 days (depending on soil temperature) is required for a complete life cycle of the potato cyst nematodes (Chitwood and Buhrer, 1945). • Cyst nematode eggs can remain dormant and viable within the cyst for 30 years (Winslow and Willis, 1972). After mating, each female produces approximately 500 eggs (Stone, 1973b). Secondly, fruit is packed in wrapping (wooden boxes) and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with High (3) risk potential **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *G. pallida* is liable to be carried on tomatoes, brinjal and potatoes for planting, which are the main means of dispersal of this pest [EPPO, 2006]. • Potato cyst nematode eggs can remain dormant and viable within the cyst for 30 years (Winslow and Willis, 1972). After mating, each female produces approximately 500 eggs (Stone, 1973b). **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The preferred tomatoes, potatoes and aubergines are three major cultivated hosts (aubergines, tomatoes and potatoes) widely distributed in many Asian countries including Japan, China, Thailand, India (CABI, 2015), and these crops are also common in **Bangladesh**. • The optimum temperature for the hatch of *G. pallida* is about 15°C (Evans, 1968). • These climatic requirements for growth and development of *G. pallida* are more or less similar with the climatic condition during summer season of **Bangladesh**.	**YES and HIGH**

• 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.11.7 Determine the Consequence establishment of this pest in Bangladesh

Table 11.2.– Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Yellow cyst nematode is the major pest of the potato crop in cool-temperate areas. This is particularly the case when, because of the pathotypes present, no resistant cultivars are available for planting. This situation is, at present, more serious in the case of *G. pallida* because of the lack of commercially available potato cultivars having resistance to this species. • The amount of damage, particularly in relation to the weight of tubers produced, is closely related to the number of nematode eggs per unit of soil. It has been estimated that approximately 2 t/ha of potatoes are lost for every 20 eggs/g soil (Brown, 1969). Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation of potatoes. • This is a fairly serious pest of several important other crops rather than flowers for Bangladesh. **b. Economic impact and yield loss** • Crop losses induced by the golden nematode range 20-70% (Greco, 1988). It has been estimated that approximately 2 t/ha of potatoes are lost for every 20 eggs/g soil (Brown, 1969). Up to 80% of the crop can be lost when nematode populations are raised to very high levels by repeated cultivation of potatoes. • In Chile, yield losses of 20, 50 and 90% were obtained with population densities of 9, 28 and 128 eggs/g soil (Moreno et al., 1984; Greco and Moreno, 1992). Rhizoctonia and other fungal diseases associated with nematode feeding may also contribute to the yield loss. In Canada, Globodera rostochiensis was found in Newfoundland in 1962 and 800,000$Can /year has been spent on control and research of golden cyst nematode (Miller, 1986). • Besides that, affected plants suffer tubers are smaller (CABI, 2006). This means it effects on quality of potato tubers as well as seed potatoes. Control on golden cyst nematode, Globodera rostochiensis is major by soil fumigants but fumigant nematicides are toxic and expensive (Mazin, 1991). • Moreover, golden cyst nematode (Globodera rostochiensis) is quarantine pest for EPPO, APPPC, NAPPO (OEPP/EPPO, 1978; 1981). Therefore, the presence of the potato cyst nematodes in potato growing areas prevents the export of potatoes to international markets due to the restrictions imposed by many countries against this pest. • Based on these Economic Impacts, the Potato cyst nematodes could	**Yes and High**

become established in Bangladesh with High Risk potential. **c. Environmental Impact** • Introduction of *Globodera rostochiensis* into Bangladesh is likely to initiate chemical, because it is a serious pest of economically important crops. • The fumigation to control this nematode may also harm to the beneficial organisms available to the soils. • This species has the potential to attack plants (Solanum) that are main crop in Bangladesh. As a large chemical will be used for it's controlling. Therefore, it can impacts on ecological system.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5.3.11.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 11.3. – Calculating 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

5.3.11.9 Risk Management Measures

- Measures to prevent the introduction of the nematodes to areas where they are not already established include soil sampling surveys and regulations concerning movement of seed potatoes, nursery stock, flower bulbs and soil. These apply nationally as well as internationally (CEC, 1969).

- Consignments of potato tubers, rooted plants and bulbs from countries where the nematodes occur may be examined to check amounts of adhering soil, if any, or to take samples of soil for laboratory examination.

- Additional safeguards during transit of consignments could be washing of tubers and flower bulbs to remove soil, although it should be noted that cysts can remain embedded in tubers, especially in the eyes. Alternatively, tubers may be dipped in dilute sodium hypochlorite solution (Wood & Foot, 1975).

- The EPPO specific quarantine requirements (OEPP/EPPO, 1990) for these nematodes require that the field in which seed potatoes or rooted plants being imported were grown was inspected by taking soil samples according to an EPPO-recommended method (OEPP/EPPO, 1991) and found free from viable cysts of both species. The sampling must have been performed after harvest and after removal of the previous potato crop.

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5.3.12.	***Tobacco ringspot nepovirus***

5.3.12.1 Hazard Identification

Preferred Name: *Tobacco ringspot nepovirus*

Synonyms: *Tobacco ringspot No. 1 Nicotiana virus 12*

Common names: Tobacco ring spot virus (TRSV)
Ring spot (in tobacco and various hosts),
Bud blight (in soyabean),
Necrotic ring spot,
Pemberton disease (in blueberry),
Necrosis (in anemone) (English)

Taxonomic tree

Group : Group IV ((+)ssRNA)
Order : Picornavirales
Family : Secoviridae
Subfamily: Comovirinae
Genus : *Nepovirus*
Species : *Tobacco ringspot virus*

EPPO Code: TORSXX. This pest has been included in EPPO A2 list: No. 228
Bangladesh status: Not present in Bangladesh [CABI, 2007]

5.3.12.2 Biology

In its native range, TRSV is transmitted by the nematode *Xiphinema americanum*, which in the part of North America concerned is most probably *X. americanum sensu stricto*, and also *X. rivesi* (Brown & Trudgill, 1989; EPPO/CABI, 1996c). The virus is acquired within 24 h and is transmitted by both adult and larval stages (Stace-Smith, 1985). The nematode can transmit to many different host species, at high efficiency (Douthit & McGuire, 1978). A number of other vectors have been suggested: *Thrips tabaci* and *Melanoplus differentialis* (a grasshopper) for the disease on soyabeans, *Tetranychus* spp. (mite), *Epitrix hirtipennis* (flea beetle) and aphids. The virus is readily transmitted mechanically to herbaceous hosts.

5.3.12.3 Hosts

Major hosts: Tobacco, aubergines (*Solanum melongena*), soyabeans, grapevine and *Vaccinium* spp. (blueberry), especially *V. corymbosum* and Cucurbitaceae.

Minor hosts: Herbaceous ornamentals (*Anemone*, *Gladiolus*, *Iris*, *Narcissus*, *Pelargonium*), *Anemone*, apples (*Malus pumila*), blackberries (*Rubus fruticosus*), *Capsicum*, cherries (*Prunus avium*), *Cornus*, *Fraxinus*, *Gladiolus*, grapes (*Vitis vinifera*), *Iris*, *Lupinus*, *Mentha*, *Narcissus pseudonarcissus*, pawpaws (*Carica papaya*), *Pelargonium*, *Petunia*, *Sambucus* and various weeds.

5.3.12.4 Geographical distribution

Austria, Belgium, Bulgaria, Czech Republic, Denmark, France, Germany, Greece, Hungary, Italy, Lithuania, Morocco, Netherlands, Poland, Romania, Russia, Spain, Switzerland, UK, Ukraine, Yugoslavia, **China**, Georgia, **India**, Indonesia, Iran, **Japan**, Kyrgyzstan, Russia, Sri Lanka, **Taiwan**, Malawi, Morocco, Nigeria, Zaire, Canada, Mexico, USA, Cuba, Dominican Republic, Brazil, Uruguay, Australia New Zealand, Papua New Guinea (EPPO, 2006).

5.3.12.5 Hazard Identification Conclusion

Considering the facts that *Tobacco ringspot virus* -

- is not known to be present in Bangladesh.
- is potentially economic important to Bangladesh because it is an important pest of vegetable in Asia including **China, India (Tamil Nadu), Japan** from where seed of eggplants are imported into Bangladesh.
- Long-range dispersal in trade is in host plants and parts of plants, including seeds; accompanying soil may harbour infective seeds and the nematode vector.
- *Tobacco ringspot virus* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.12.6 Determine likelihood of pest establishing in tour country via this pathway.

Table 12.1 Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. This pest has established in several new countries in recent years, and Yes. • TRSV has its origin in central and eastern North America, and first observed in tobacco fields in Virginia and describled in 1927 (Fromme & Priode, 1927.), but there are now scattered records from many countries around the world, most of which are probably associated with material exported from North America. • Recently, TRSV is identified as quarantine pathogen in Europe (EPPO/CABI 1992) and Czech Republic in 2011, **b. Posibility of survival during transport, storage and transfer of this pest? Yes** • Long-range dispersal in trade is in host plants and parts of plants, including seeds; accompanying soil may harbour infective seeds and the nematode vector. • TRSV is readily transmissible by sap inoculation and naturally transmitted by the nematode *Xiphinema americanum* and other closely related *Xiphinema* spp. (Lamberti & Bleve-Zacheo 1979). • TRSV is transmitted by pollen (Card et al. 2007) and also transmissible by seed at least in twelve species of crop and weed hosts; the frequency of transmission ranges from 3% in *Cucumis melo* to 100% in *Glycine max* (Murant 1983). **c. Does the pathway appear good for this pest to enter Bangladesh and establish? Yes** • TRSV has a wide host range, including both woody and herbaceous plants. The virus occurs both in annual and perennial crops, fruit trees, ornamentals, and various weeds (Stace-Smith1985) in nature. • In tobacco, TRSV causes ring and line patterns on the foliage and stunting (Gooding, 1991). In cucurbits, leaves are mottled and stunted, and fruits are deformed (Sinclair & Walker, 1956). • In soyabean, plants are most severely affected when they are infected young (less than 5 weeks old or from seed), the virus spreading systemically in the plant (Demski & Kuhn, 1989). The terminal bud is curved to form a crook (bud blight), and other buds become brown, necrotic	**YES and HIGH**

and brittle. Brown streaks can be seen in the pith of stems and branches, and occasionally on petioles and leaf veins. Leaflets are dwarfed and rolled. Pods develop poorly and late. • Grapevine shows symptoms of decline, exactly as with ToRSV, i.e. new growth is weak and sparse, internodes are shortened, leaves are small and distorted, and plants are stunted. Berries are sparse and develop unevenly (Gonsalves, 1988). • *Vaccinium corymbosum* shows stem dieback and stunting. On a susceptible cultivar such as Pemberton, leaves are deformed and somewhat thickened, become chlorotic and show necrotic spots, and may drop giving a shothole or tattered effect (Ramsdell, 1987). • In cherry, in which the disease has only ever been seen in a few individual trees, young leaves show irregular chlorotic blotching over the whole leaf blade, and the leaf margins are deformed and lobed. These symptoms are seen in scattered leaves throughout the crown. Fruits mature late on infected trees (Stace-Smith & Hansen, 1974). • Long-range dispersal in trade is in host plants and parts of plants, including seeds; accompanying soil may harbour infective seeds and the nematode vector. **d. Its host(s) are fairly common in Bangladesh and the climate is similar to places it is established – Yes** • The common hosts of this virus are Tobacco, soyabeans, grapevine and *Vaccinium* spp., especially *V. corymbosum* and Cucurbitaceae. The other hosts of this virus are the herbaceous ornamentals including *Anemone*, *Gladiolus*, *Iris*, *Narcissus*, *Pelargonium* etc; *Petunia*, *Mentha*, *Carica papaya* and various weeds. These hosts are common in Bangladesh. • The climatic conditions of India, Japan, China, Taiwan, Indonesia, where this pest is available are more or less similar with Bangladesh. There a possibility to establish this pest in 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.12.7 Determine the Consequence establishment of this pest in Bangladesh

Table12. 2. – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this is a serious pest of Bangladesh? Yes • The only really serious disease caused by TRSV is bud blight of soyabean in USA (Demski & Kuhn, 1989), which can involve serious damage to plants, yield losses of 25-100%, and poor seed quality. Although described on tobacco and widespread on this crop in the USA, TRSV causes only minor damage (Gooding, 1991). The same applies on cucurbits (Sinclair & Walker, 1956), and on a number of ornamentals. • TRSV causes blueberry necrotic ringspot disease of susceptible cultivars of *Vaccinium corymbosum*. Infected bushes show a slow but steady decline in	**Yes and High**

productivity (Ramsdell, 1978). TRSV is much more important in *Vaccinium* than ToRSV (Ramsdell, 1987). • TRSV has been recorded in a few individual cherry trees, and rather more often from ornamental *Prunus* spp. (*P. serrulata*, *P. incisa*, *P. serrula*) (Uyemoto *et al*., 1977). • It has been recorded once from apple (Lana *et al*., 1983), once from *Rubus fruticosus* and also from wild *Rubus* spp. in North Carolina (USA) (Stace-Smith, 1987). With the exception of *Vaccinium* and *Vitis*, TRSV has very minor impact on fruit crops, the records on some species being no more than scientific curiosities of no practical importance. • This is a fairly serious pest of several important vegetables and other crops for Bangladesh. **b. Economic impact and yield loss** • The rapid spread of TomRSV in grapes in New York has led to a serious decline, particularly of the cultivar Cascade (Siebel 13053) (Uyemoto, 1975). In Oregon, fruit from TomRSV-infected raspberry canes weighed 21% less individually than from healthy canes, and the yield was more than halved, since TomRSV has a particularly adverse effect on drupelet set of certain cultivars (Daubeny et al., 1975; Freeman et al., 1975). • Seed transmission has been reported in several hosts, such as *Cucumis sativus* and *Glycine max* (up to 100% in the latter, in which it is the main form of transmission). It probably occurs to some extent in most hosts (Stace-Smith, 1985). • In addition, fruit quality is reduced, the fruits being crumbly and therefore unmarketable (Mircetich, 1973). The progressive decline in raspberries is such that, by the third year of infection, up to 80% of fruiting canes may be killed. The virus is of some economic importance in those EPPO countries where it occurs. An isolate of TomRSV from Pelargonium in the UK (probably imported from the USA) caused severe symptoms on several glasshouse crops; thus, the virus presents a serious threat to the glasshouse industry, especially where salad and ornamental crops are grown together. • It is possible that European *Xiphinema* species, such as *X. pachtaicum*, which is widespread in the EPPO region, could transmit the virus. This species has a wide host range, including many hosts of TomRSV. However, there are no reports of transmission experiments with *X. pachtaicum* and TomRSV. In North America, *X. rivesi* has been implicated as a vector of TomRSV; although present in Europe, it has a very limited host range and would not probably play a significant role in virus distribution. **c. Environmental Impact** • Control of TomRSV in established in plantings of fruit tree or berry crops is difficult. The use of resistant cultivars (e.g. for grapes) and the use of healthy planting material can reduce the disease. In addition, it is necessary to achieve good control of weeds. • *TomRSV* represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5.3.12.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 12.3. – Calculating 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

5.3.12.9 Possible Phytosanitary Measures

- Planting material of should be derived from certification schemes guaranteeing freedom from TRSV (OEPP/EPPO, 1991).
- Seeds should be free from TRSV.

5.3.12.10 References

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5.3.13.	***Pepper veinal mottle virus***

5.3.13.1 Hazard Identification

Preferred Name: *Pepper veinal mottle virus*
Synonyms: *Pepper veinal mottle potyvirus*
Common names: PVMV

Taxonomic tree

Domain: Virus
Group: "Positive sense ssRNA viruses"
Group: "RNA viruses"
Family: Potyviridae
Genus: Potyvirus
Species: Pepper veinal mottle virus

EPPO Code: PVMV00.

Bangladesh status: Not present in Bangladesh [CABI, 2016].

5.3.13.2. Biology

Pepper veinal mottle potyviruses, a new potyvirus with distinctive properties was found widely distributed in Shewa and Welega provinces. The virus, tentatively designated Ethiopian pepper mottle potyvirus, had filamentous particles c. 700-750 nm in length. It had an unusually narrow experimental host range, and was nonpersistently transmitted by *Myzus persicae. Pepper veinal mottle virus (PVMV)*, a previously undescribed virus widespread in *Capsicum annuum* and *C. frutescens* in the Eastern Region of Ghana, is acquired and inoculated in 2 min feeding periods by aphids (*Myzus persicae* and *Aphis gossypii*); it is transmissible by inoculation of sap to eleven of fifteen Solanaceae and to five of forty-six other species within three of seventeen other families. The virus was propagated in

Nicotiana clevelandii and *Petunia hybrida*, and assayed in *Chenopodium quinoa, C. amaranticolor* and *C. murale*

5.3.13.3. Hosts

a. **Major hosts:** The main crop species attacked by *Pepper veinal mottle, are Abelmoschus esculentus* (okra), *Solanum melongena (aubergine), Capsicum annuum* (bell pepper), *Capsicum frutescens* (chilli), *Datura metel* (Hindu datura), *Nicotiana tabacum* (tobacco), *Solanum lycopersicum* (tomato), *Solanum nigrum* (black nightshade).
b. **Minor hosts:** The minor or other hosts include ornamentals such as china aster (*Callisterphus chinensis*), chrysanthemum (*Chrysanthemum indicum*), Gerbera, sunflower, carnation etc, wild plants, weeds and shade trees (e.g. *Leucaena leucocephala*, the shade tree of cocoa plantations in Indonesia).

5.3.13.4. Distribution

Asia: Afghanistan (Lal & Singh, 1988), **India** (Andhra Pradesh, Karnataka) (Jagadeeshwar *et al*., 2005, Nagaraju, & Reddy, 1980; Bidari & Reddy, 1983; Nagaraju, & Reddy, 1981; Gowda & Reddy, 1985; Gowda & Reddy, 1989; Bidari & Reddy, 1989; Bidari & Reddy, 1990; Prasad Rao et al., 1980), **Taiwan** (Cheng et al., 2009).

Africa: Benin, Burkina Faso, Cameroon, Cape Verde, Côte d'Ivoire, Egypt, Equatorial Guinea, Eritrea, Gambia, Ghana, Kenya, Libya, Nigeria, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Togo (Brunt et al., 1978; Lamptey, 1978; Brunt & Kenten, 1972) .

EU: Absent.

5.3.13.5. Hazard Identification Conclusion

Considering the facts that *Pepper veinal mottle virus* -

- is not known to be present in Bangladesh [CABI,2016];
- is potentially economic important to Bangladesh because it is an important pest of various vegetables like tomato, okra, chilli etc in Asia including Afganistan, India, Taiwan (Bidari & Reddy, 1990), from where flowers are imported to Bangladesh.
- can become established in Bangladesh through imports of such vegetables and planting materials like seeds, nursery stocks and others. It has capability to cause direct economic and ecological damage to many valuable cultivated crops, because this pest has high reproductive potential, high dispersal ability for long distance and high survivability at adverse environment, the risk rating for establishment potential is high**.**
- *Pepper veinal mottle virus* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.13.6. Determine likelihood of pest establishing in tour country via this pathway.

Table 13.1.– 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, • This pest has been established in many Asian countries including Afganistan, India, Taiwan (Bidari & Reddy, 1990) • CPPC, NAPPO and OIRSA also consider this species of quarantine significance. *Pepper veinal mottle* is already fairly widespread in Asian, Mediterranean and African countries.	**YES and HIGH**

B. Posibility of survival during transport, storage and transfer of this pest? Yes • The brinjal seeds and fruits are transported from India, China, Japan, Thailand, Taiwan and Vietnam to Bangladesh mainly by Airfreight, and or Landport. Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. It is transmissible by inoculation of sap to eleven of fifteen Solanaceae and to five of forty-six other species within three of seventeen other families. The virus was propagated in *Nicotiana clevelandii* and *Petunia hybrida*, and assayed in *Chenopodium quinoa, C. amaranticolor* and *C. murale.* Internationally, *Pepper veinal mottle virus* is liable to be carried on any plant parts like flowers, inflorescences, cones, calyx,fruits, leaves, roots, seedlings, stems etc for planting and nursery stocks, which are the main means of dispersal of this pest the pests could survive during transporting process. Therefore, this pest is rated with High risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *Pepper veinal mottle virus* is liable to be carried on any plant parts like flowers, inflorescences, cones, calyx,fruits, leaves, roots, seedlings, stems etc for planting and nursery stocks, which are the main means of dispersal of this pest [CABI, 2016]. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *Pepper veinal mottle virus* species is totally polyphagous The main crop species attacked by *Pepper veinal mottle*, are *Abelmoschus esculentus* (okra), *Solanum melongena* (aubergine), *Capsicum annuum* (bell pepper), *Capsicum frutescens* (chilli), *Datura metel* (Hindu datura), *Nicotiana tabacum* (tobacco), *Solanum lycopersicum* (tomato), *Solanum nigrum* (black nightshade) among these hosts many of them mostly common in **Bangladesh**. • 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.13.7. Determine the Consequence establishment of this pest in Bangladesh

Table 13.2. – Which of these descriptions best fit of this pest?

Description	Consequence potential is:
a. Is this a serious pest of Bangladesh? - Yes. • *The main crop species attacked by Pepper veinal mottle, are Abelmoschus esculentus* (okra)*, Solanum melongena* (aubergine)*, Capsicum annuum* (bell pepper)*, Capsicum frutescens* (chilli)*, Datura metel* (Hindu datura)*, Nicotiana tabacum* (tobacco)*, Solanum*	Yes and High

lycopersicum (tomato), *Solanum nigrum* (black nightshade). Most of the main vegetables in Bangladesh and this virus are capable to damage at any growing stage. So it is an extremely serious pest for Bangladesh. **b. Economic impact and yield loss** • PMMV causes considerable yield losses (ca 20-30%) in field-grown and protected infected pepper crops as well as causing significant loss of quality of fruits (e.g., Conti and Marte, 1983; Marte and Wetter, 1986; Alonso et al., 1989). In addition, rogueing of infected and adjacent plants to minimize secondary spread of infection in protected crops also results in greatly reduced potential yields. Even the mild strain used for cross protection in Italy has some debilitating effect on protected plants (Cartia *et al.,* 1985). None of several attenuated strains of PMMoV failed to confer significant levels of cross-protection in Japan (Tsuda *et al.,* 2007). • Total infection can occur in field-grown crops resulting in greatly reduced yields of marketable fruit (Conti and Marte, 1983; Marte and Wetter, 1986) **c. Environmental Impact** • PMMV represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment.	
• Not as above or below	**Moderate**
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table13.3. – Calculating 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

5.3.13.9. Risk Management Measures

- Avoid importation of flowers and foliages from countries, where this disease is available. Disease-free seeds should be used.

5.3.13.10. References

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5.3.14.	Parthenium weed: *Parthenium hysterophorus*

5.3.14.1 Hazard Identification

Scientific name: *Parthenium hysterophorus* L.
Synonyms: *Parthenium hysterophorus* var. *lyratum* A.Gray
Argyrochaeta bipinnatifida Cav.
Argyrochaeta parviflora Cav.
Echetrosis pentasperma Phil.
Parthenium glomeratum Rollins,
Parthenium lobatum Buckley,
Parthenium pinnatifidum Stokes,
Villanova bipinnatifida Ortega

Common names: Parthenium weed, bitter weed, bitter-broom, bitterweed, carrot grass, congress grass, false camomile, false ragweed, feverfew, parthenium, parthenium weed, ragweed, ragweed parthenium, Santa Maria, Santa Maria feverfew, white top, whitehead, whitetop

Taxonomic tree

Kingdom: Plantae
Order: Ateriales
Family: Asteraceae
Genus: *Parthnium*
Species: *Parthenium hysterophorus*

EPPO Code: PTNHY. This pest has been included in EPPO A2 list: No. 383

Bangladesh status: Present in restricted areas of Bangladesh possibly introduced from India.

5.3.14.2 Biology

P. hysterophorus reproduces only by seeds and is known to be highly prolific, as a single plant produces 15 000 seeds on average and up to 100 000 seeds (GISD Database, Global Invasive Species Database, 2010). Seed viability is high, 85% or higher (Navie et al., 1998). Buried seeds have been found to last longer than seeds on the soil surface, and a significant proportion can still germinate after 8–10 years. Freshly produced seeds demonstrate a degree of dormancy (up to several months) (Navie et al., 1998). In addition, the species is an opportunistic germinator. Seeds can germinate at any time of the year provided moisture is available but they require bare soil to do so (Parsons & Cuthbertson, 1992). The plant flowers 4 – 8 weeks after germination and flowering continue until drought or frost kills the plant. Under favourable conditions, 2 – 3 life cycles can be completed per year (Fatimah & Ahmad, 2009).

5.3.14.3 Hosts or habitats

- *P. hysterophorus* grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie*et al*. 1996a).
- According to the Corine Land Cover nomenclature, the following habitats are invaded: arable land, permanent crops (e.g. vineyards, fruit tree and berry plantations, olive),

pastures, riverbanks / canalsides (dry river beds), road and rail networks and associated land, other artificial surfaces (wastelands).

- In Australia, the main impact of *P. hysterophorus* has been in the pastoral region of Queensland, where it replaces forage plants, thereby reducing the carrying capacity for grazing animals (Haseler, 1976; Chippendale and Panetta, 1994). Serious encroachment and replacement of pasture grasses has also been reported in India (Jayachandra, 1971) and in Ethiopia (Tamado, 2001; Taye, 2002).
- *P. hysterophorus* is now being reported from India as a serious problem in cotton, groundnuts, potatoes and sorghum, as well as in more traditional crops such as okra (*Abelmoschus esculentus*), brinjal (*Solanum melongena*), chickpea and sesame (Kohli and Rani, 1994), and is also proving to be problematic in a range of orchard crops, including cashew, coconut, guava, mango and papaya (Tripathi et al., 1991; Mahadevappa, 1997).
- Similar infestations of sugarcane and sunflower plantations have recently been noted in Australia (Parsons and Cuthbertson, 1992; Navie et al., 1996). In Ethiopia, parthenium weed was observed to grow in maize, sorghum, cotton, finger millet (*Eleusine coracana*), haricot bean (*Phaseolus vulgaris*), tef (*Eragrostis tef*), vegetables (potato, tomato, onion, carrot) and fruit orchards (citrus, mango, papaya and banana) (Taye, 2002). In Pakistan, the weed has been reported from number of crops, including wheat, rice, sugarcane, sorghum, maize, squash, gourd and water melon (Shabbir 2006; Shabbir et al. 2011; Anwar et al. 2012).

5.3.14.4 Geographical distribution

Native distribution

P. hysterophorus is native to the area bordering the Gulf of Mexico, and has spread throughout southern USA, the Caribbean and Brazil.

- **North America**: Bermuda, Mexico, USA (Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Hawaii, Illinois, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Mississippi, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Texas, Virginia).
- **Central America and Caribbean**: Belize, Costa Rica, Cuba, Dominican Republic, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Puerto Rico, Saint Barthelemy, Republic of Panama, Trinidad, Trinidad and Tobago.
- **South America**: Argentina, Bolivia, Brazil, Chile, Ecuador, French Guiana, Guyana, Peru, Paraguay, Suriname, Uruguay, Venezuela.

Exotic distribution

- **EPPO region**: Israel.
- **Africa:** Comores, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Mauritius, Mauritius, Mayotte, Mozambique, Reunion, Seychelles, Somalia,South Africa, Swaziland, Tanzania, Uganda and Zimbabwe.
- **Asia:** Bangladesh,Bhutan, China (south of country), India, Oman and Yemen, Israel, Nepal, Pakistan, Sri Lanka, Japan, Republic of Korea, Taiwan and Vietnam.
- **Oceania:** Australia (Queensland, New South Wales, Northern Territory, Western Australia), French Polynesia, several Pacific islands including Bermuda, New Caledonia, Vanuatu and Christmas island.

5.3.14.5 Hazard identification conclusion

Considering the facts that *P. hysterophorus* -

- is not known to be present in all areas of Bangladesh;
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China, India, Nepal, Pakistan, **Japan** [EPPO, 2014; CABI/EPPO, 1999] from where agricultural crops and flowers are imported to Bangladesh.
- can become established in Bangladesh through the transportation of agricultural equipment and imports of the agricultural planting materials including flowers and foliages.
- *Parthenium hysterophorus* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

5.3.14.6 Determine likelihood of pest establishing in Bangladesh via this pathway

Table 14.1. – 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, • The genus *Parthenium* contains 15 species, all native to North and South America. *P. hysterophorus* has a native range in the subtropical regions of North to South America. It is thought that the species originated in the region surrounding the Gulf of Mexico, including southern USA, or in central South America (Dale, 1981; Navie et al., 1996), but is now widespread in North and South America and the Caribbean, and Fournet and Hammerton (1991) indicate that it occurs in 'probably all islands' of the Lesser Antilles. • Since its accidental introduction into Australia and India in the 1950s, probably as a contaminant of grain or pasture seeds, it has achieved major weed status in those countries. It was first recorded in southern Africa in 1880 but was not reported as a common weed in parts of that region until the mid-1980s following extensive flooding on the east coast (McConnachie et al., 2011). Recent reports of the weed from other countries indicate that its geographic range continues to increase. • Because *P. hysterophorus* has shown invasive behaviour where it has been introduced elsewhere in the world and has a highly restricted distribution in the EPPO region, it can be considered an emerging invader in the EPPO region (EPPO, 2012). **b. Posibility of survival during transport, storage and transfer? Yes** • *P. hysterophorus* reproduces only by seeds and is known to be highly prolific, as a single plant produces 15000 seeds on average and up to 100000 seeds (GISD Database, Global Invasive Species Database, 2010). Seed viability is high, 85% or higher (Navie et al., 1998). Buried seeds have been found to last longer than seeds on the soil surface, and a significant proportion can still germinate after 8–10 years. Freshly produced seeds demonstrate a degree of dormancy (up to several	**YES and HIGH**

months) (Navie et al., 1998). In addition, the species is an opportunistic germinator. Seeds can germinate at any time of the year provided moisture is available but they require bare soil to do so (Parsons & Cuthbertson, 1992). Therefore, the seeds of this weed can survive during transport, storage and transfer of the commodity. c. **Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Entries as a contaminant of agricultural produce and machinery have historically been important pathways for the introduction of *P. hysterophorus* in new regions. • **Contaminant of used machinery:** *P. hysterophorus* can enter new territories as a contaminant of used machinery, either as seeds, e.g. lodged on the radiators and grills of automobiles, or as seeds in soil attached to machinery, such as harvesters, road construction and maintenance machinery, military equipment and other vehicles. Vehicles and harvesters may circulate quite frequently across EPPO countries. The release of seeds of *P. hysterophorus* from the vehicles on the roads networks may facilitate its transfer to other unintended habitats connected by roads. • **Contaminant of grain:** *P. hysterophorus* was accidentally introduced into Israel in 1980 most likely through import of contaminated grains from the USA for fishponds (Dafni& Heller 1982). Wheat and other cereals were reported for the introduction of *P. hysterophorus* in India (Sushilkumar&Varshney, 2010), and sorghum is also reported to be infested in Ethiopia (Tamado*et al*., 2002). • **Contaminant of seed:** - Pasture seeds (grass) from Texas into central Queensland (Everist, 1976), as well as in Egypt from Texas in the 1960s (Boulos& El-Hadidi, 1984); - Cereal seed from the United States in Africa, Asia and Oceania (Bhomik&Sarkar, 2005); - Soybean seed from the USA in the Shandong Province in China in 2004 (Li & Gao, 2012). **d.Are the host(s) and habitats of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *P. hysterophorus* grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie*et al*. 1996a). • *P. hysterophorus* is now being reported from India as a serious problem in cotton, groundnuts, potatoes and sorghum, as well as in more traditional crops such as okra (*Abelmoschus esculentus*), brinjal (*Solanum melongena*), chickpea and sesame (Kohli and Rani, 1994), and is also	

proving to be problematic in a range of orchard crops, including cashew, coconut, guava, mango and papaya (Tripathi et al., 1991; Mahadevappa, 1997). • Where climatic conditions are appropriate (e.g. Mediterranean area, Black Sea, Eastern Asia, the warmest temperate area) there are numerous suitable habitats. Consequently, for these areas, the probability of establishment is high with low uncertainty. • Therefore, the hosts and habitats as well as climatic requirements for this weeds are mostly common in 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 your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

5.3.14.7 Determine the Consequence establishment of this pest in Bangladesh

Table 14.2 – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *P.hysterophorus*is a major pestinpastures and crops in its exotic range, and has major detrimental impact on human and animal health through allergies and dermatitis. • If introduced in the area of potential establishment, eradication or containment would be unlikely to be successful due to its high reproductive potential and high spread capacity through human activities. • This is a **fairly serious pest** of several important crops and human health rather than flowers for Bangladesh. **b. Economic impact and yield loss** • The main impact of parthenium weed on crops relates to its allelopathic properties. The water soluble phenolics; caffeic acid, ferulic acid, vanicillic acid, anisic acid and fumaric acid; and sesquiterpene lactones, mainly parthenin and/or hymenin, occur in all parts of the plant and significantly inhibit the germination and subsequent growth of a wide variety of crops including pasture grasses, cereals, vegetables, other weeds and tree species (Navie *et al.,* 1996; Evans, 1997a). • Few critical assessments of yield losses have been made, although it has been determined that almost 30% grain loss can occur in irrigated sorghum in India (Channappagoudar *et al.,* 1990). As *Parthenium* pollen is also allelopathic (Kanchan and Jayachandra, 1980), heavy deposits on nearby crop plants may result in failure of seed set, and losses of up to 40% have been reported in maize yield in India (Towers *et al.,* 1977). In eastern Ethiopia, parthenium weed is the second most frequent weed after *Digitaria*	**Yes and High**

abyssinica (Tamado and Milberg, 2000) and sorghum grain yield was reduced from 40 to 97% depending on the year and location (Tamado, 2001). • Although *P. hysterophorus* is not yet considered to be a major crop weed in Australia (Navie *et al.,* 1996), it has started to spread into sorghum, sugarcane and sunflower growing areas and negatively affect yields (Parsons and Cuthbertson, 1992). Also, Chippendale and Panetta (1994) estimate that cultivation costs may be doubled since the prepared ground has to be re-worked to eliminate the emergent parthenium weed seedlings. **c. Environmental Impact** • Parthenium weed lacks predators, and cattle and livestock usually do not feed on it. As a result, the food chain is disturbed and the trophic structure changes, leading to an ecological imbalance in the invaded area. • It causes a prolonged toxic effect to the soil environment – for instance, Kanchan and Jayachandra (1981) reported that the leachates from parthenium weed have an inhibitory effect on nitrogen fixing and nitrifyingbacteria. Parthenium weed is also an environmental weed that can cause irreversible habitat changes in native grasslands, woodlands, river banks and floodplains in both India and Australia (Jayachandra 1971; McFadyen, 1992; Evans, 1997a; Kumar and Rohatgi, 1999). • Parthenium weed, due to its allelopathic potential, replaces dominant flora and suppresses natural vegetation in a wide range of habitats and thus becomes a big threat to biodiversity. Batish et al. (2005) recorded 39 plant types in a *Parthenium*-free area, but only 14 were present in an infested area, and very little or sometimes no vegetation can be seen in some *Parthenium*-dominated areas (Kohli, 1992). Wherever it invades, it forms a territory of its own, replacing indigenous grasses and weeds which are supposedly useful for the grazing animals (De and Mukhopadhyay, 1983). Parthenium weed has an adverse effect on a variety of natural herbs which are the basis of traditional systems of medicines for the treatment of several diseases in various parts of the world (Mahadevappa *et al.,* 2001; Shabbir and Bajwa, 2006).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

5.3.14.8 Calculating the Risk of this Pest via this pathway for Bangladesh

Establishment Potential X Consequence Potential = Risk

Table 14.3 – Calculating 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

5.3.14.9 Risk Management Measures

a. Contaminant of used machinery

- Cleaning or disinfection of machinery/vehicles in combination with internal surveillance and/or eradication or containment campaign.

b. Contaminant of grain: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme
- Import under special licence/permit and specified restrictions (for grain which is aimed to be crushed or transformed).

c. Contaminant of seeds: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment of the crop, testing of the commodity, internal surveillance and/or eradication or containment campaign.
- Certification scheme for seeds.

d. Contaminant of growing media adherent to plants for planting: Measures related to the crop or to places of production:

- Pest-free area
- Pest-free place of production/production site consist in the following combination of measures: visual inspection at the place of production, specified treatment, growing in glasshouses and in sterilized soil, internal surveillance and/or eradication or containment campaign.
- Certification scheme for plants for planting
- Removal of the growing medium from plants for planting.

e. Contaminant of travelers (tourists, migrants, etc.) and their clothes, shoes and luggage

Systems approach:

- Publicity to enhance public awareness on pest risks
- Internal surveillance and/or eradication or containment campaign.

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5.4. Conclusion: Pest Risk Potential and Pests Requiring Phytosanitary Measures

The Pest Risk Assessment (PRA) is based on the International Standard for Phytosanitary Measures No 11 (2004) and the PRA scheme developed by CAB Internation (2007) and EPPO (European and Mediterranean Plant Protection Organization) (1997).

From the quantitatively risk analysts of quarantine pests likely to be associated and follow the eggplants pathway to Bangladesh from India, China, Thailand, and Japan and other exporting countries, the among 14 potential hazard organisms, all of these hazard organisms were identified with high risk potential.

The overall pest risk potential ratings of 14 quarantine pests of brinjal for Bangladesh have been included in the following Table:

Table 9: The Overall Pest Risk Potential Rating

Sl. No.	Potential Hazard Organism	Common name	Family	Order	Pest Risk Potential
Insect					
1	Malaysian fruit fly	*Bactrocera latifrons*	Tephritidae	Diptera	**High**
2	Serpentine leaf miner	*Liriomyza trifolii*	Agromyzidae	Diptera	**High**
3	Pea leaf miner	*Liriomyza huidobrensis*	Agromyzidae	Diptera	**High**
4	Silver leaf whitfly	*Bemisia tabaci (B biotype)*	Aleurodidae	Homoptera	**High**
5	Vegetable weevil	*Listroderes costirostris*	Thripidae	Thysanoptera	**High**
6	Alfafa thrips	*Frankliniella occidentalis*	Thripidae	Thysanoptera	**High**
7	Cotton leaf worm	*Spodoptera littoralis*	Noctuidae	Lepidoptera	**High**
Mite					
8	*Tetranychus evansi*	Red tomato spider mite	Tetranychidae	Acarina	**High**
Fungus					
9	*Phytophthora megasperma*	Phytopthora root rot	Peronosporaceae	Peronosporales	**High**
Nematode					
10	*Globodera rostochiensis*	Golden cyst nematode	Heteroderidae	Tylenchida	**High**
11	*Globodera pallid*	Pale cyst nematode	Heteroderidae	Tylenchida	**High**
Virus					
12	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	*Secoviridae*	*Picornavirales*	**High**
13	Pepper vein mottle virus	*Pepper veinal mottle virus*	Potyviridae	Unassigned (+)ssRNA	**High**
Weed					
14	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	**High**

CHAPTER 6

RISK MANAGEMENT

6.1. Risk Management Options and Phytosanitary Procedures

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 commercially produced brinjal from India, China, Thailand and Japan or any other countries of flower export (i.e. produced under standard cultivation, harvesting and packing activities). Plant Quarantine Wing of Bangladesh considers that the risk management measures proposed below is commensurate with the identified risks.

6.1.1. Pre-harvest Management Options

The in-field pest management practises for the production of flowers are in brief:

- Pre-flowering pesticide treatments for arthropods and fungi above threshold levels;
- Post-flowering pesticide treatments above threshold levels for specific pests;
- Flower gardent hygiene which involves removal of fallen leaves and crop residues under a Good Agricultural Practise (GAP);

6.1.2. Post-Harvest Procedures

The procedure is to sorting/grading to remove damaged/infested/infected flowers. The grading process is likely to remove flowers showing obvious signs of fungal and bacterial disease as well as the presence of aphids, mealybugs, scale insects, leaf miner, caterpillars etc.

6.1.3. Visual Inspection

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

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

6.1.4. 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.

6.1.5. Pre-shipment requirements

Inspection of the consignment: Inspection of the consignment according to official procedures for all the visually detectable regulated pests specified by Plant Quarantine Wing (PQW) of the Department of Agriculture Extension of Bangladesh.

Treatment of the consignment

The eggplants from which these would be collected, should be treated as specified by PQW of Bangladesh.

Documentation

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

6.1.6. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all eggplant consignment 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 eggplants have:

v) been visually inspected in accordance with appropriate official procedures and found to be free from any regulated pests

AND,

vi) undergone appropriate pest control activities that are effective against: *Bemisia tabaci*

OR

vii) been sourced from a pest free area (verified by an official detection survey) free from a regulated pest(s).

AND

viii) undergone an agreed measure that is effective against associated fruit fly species of economic significance

6.1.7. 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 eggplants 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 Banglasesh’s current phytosanitary requirements”.

AND

- have undergone appropriate pest control activities that are effective against those regulated high impact pests

AND;

- have been sources from an area free from those regulated high impact pests;

6.1.8. Transit requirements

The eggplants 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.

6.1.9. Inspection on arrival in Bangladesh

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

6.1.10. Testing for regulated pests

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

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

If regulated pests are intercepted/detected on the commodity, or associated packaging, the following actions will be 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 will be in accordance with the actions required by the relevant government department.

6.1.12. 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 will be given.

6.1.13. 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.

6.2. Risk Management Conclusions

All the pests assessed requires mitigative measures, however, due to the diverse nature of these pests, it is unlikely that a single mitigative measure will be adequate to reduce the risk to acceptable levels. Consequently, a combination of measures is being suggested as a feasible approach.