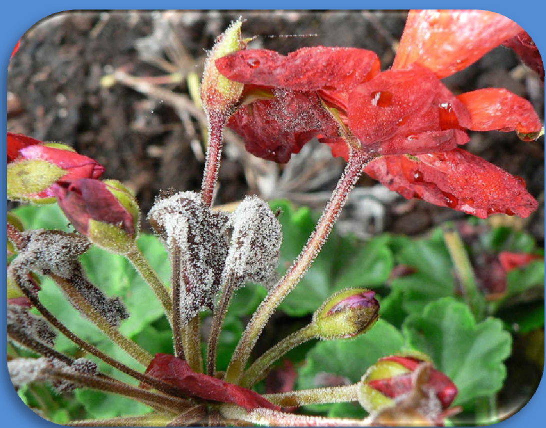
Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh



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 Cut flower and Foliages in Bangladesh

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FORWARD

The Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project under Plant Quarantine Wing (PQW), Department of Agricultural Extension (DAE), Ministry of Agriculture conducted the study for the "**Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Development Technical Consultants Pvt. Limited (DTCL) on 14 December 2015. The PRA study is a four-month assignment commencing from 10 January 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 cut flower and foliages 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 58 upazila under 23 major flower growing districts of Bangladesh. The study covered the interview 5800 flower growers; 23 FGDs each of which conducted in one district; conducted 55 KII and physical inspection and visits of the flower fields under sampled districts. The consultants also reviewed secondary sources of information related to PRA of cut flower and foliages.

The study findings evidenced that the 17 arthropod pests, 16 pathogenic microorganisms and 8 weeds likely to be associated with the flowers in Bangladesh. The study also revealed that pests of quarantine importance included 8 insect pests, 1 mite, 1 fungi, 1 bacteria, 2 nematodes and 3 viral disease and 1 weed of flowers that could be introduced into Bangladesh through importation of commercially produced cut flower and foliages. 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 17 quarantine pests were rated with high risk potential. The findings also suggested the risk management options for the quarantine pests of cut flower and foliages in line with the pre and post harvest management and phytosanitary measures.

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

I would like to congratulate study team for conducting the PRA study successfully and also the concerned SPCB professionals in making the total endeavor a success. I express my heartfelt thanks to the officials of DAE, Ministry of Agriculture, BARI, SCA, Agricultural Universities, research organizations and cut flower and foliages 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 cut flower and foliages.

(Dr. Mohammad Ali)

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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 Development Technical Consultants Pvt. Limited (DTCL) for **"Conducting Pest Risk Analysis (PRA) of Cut flower and Foliages 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 10 January 2016 under the SPCB-DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh" was provided by the Development Technical Consultants Pvt. Ltd. (DTCL), 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 cut flower and foliages, 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.

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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 Development Technical Consultant Pvt. Ltd. (DTCL) to carry out the "**Conducting Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh"**. This report has been prepared based on the past four months (January 2016 to May 2016) activities of the survey study in major 23 flower 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 principal author is Prof. Dr. Md. Razzab Ali, Team Leader with inputs from Prof. Dr. Md. Abdul Karim, Dr. M. M. Amir Hossain, Prof. Dr. M. Salahuddin M. Chowdhury and Dr. B. A. A. Mustafi of the PRA study team.

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. M. M. Amir Hossain, Managing Director of DTCL and Kbd. Md. Habibur Rahman, Survey Coordinator of the study and Executive Director of DTCL to coordinate the survey team during data collection and monitoring activities also acknowledged with thanks.

(Prof. Dr. Md. Razzab Ali)
Team Leader

ACRONYMS

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

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EXECUTIVE SUMMARY

The study “Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh” documents the pests of cut flowers available in Bangladesh and the risks associated with the import pathway of fresh cut flower and foliages from the exporting countries named India, China, Thailand, Japan and Malaysia into Bangladesh.

The findings evidenced that the fifteen arthropod pests including 14 insect and one mite pests, 16 disease causing microorganisms and 8 weeds were recorded as pests of flowers in Bangladesh. The insect pests flowers included the flower aphid (*Macrosiphum rosae*), whitefly (*Bemisia tabaci*), scale insect (*Aulacaspis rosae*), flower mealybug (*Pseudococcus* spp.), thrips (*Scirtothrips dorsalis*), leaf miner (*Liriomyza sativae* Blanchard), flower gall midge (*Cotarinia* spp.), june beetle (*Melolontha melolontha*), metallic flea beetle (*Altica* spp.), flower beetle (*Euphoria sepulcralis*), leaf eating beetle (*Macrodactylus subspinosus*), leaf eating bee (*Megachile* spp.), bristly rose slug/sawfly (*Cladius* spp.), tobacco caterpillar (*Spodoptera litura*), two-spotted spider mite (*Tetranychus urticae*). But the incidence of Japanese beetle (*Poppilla japonica*), and tortryx moth (*Lozotaenia forsterana*) were not reported by the farmers and other experts in Bangladesh. Among these insect and mite pests of flowers, aphid, thrips and tow spotted spider mite are more damaging than others. The pest status of all these insect and mite pests was minor and caused low level of infestation.

A total number of 16 diseases of flowers and foliages were reported by the farmers and experts of Bangladesh, among which 10 diseases were caused by fungi, 3 diseases were caused by bacteria, 1 caused by nematode and 2 diseases of flower and foliages were caused by viruses. The incidences of fungal diseases of flowers and foliages reported were black spot on rose leaf (*Diplocarpon rosae*), powdery mildew (*Podosphaera pannosa*), downy mildew (*Peronospora sparsa*), leaf rust (*Phragmidium mucronatum*), anthracnose (*Sphaceloma rosarum*), grey mold and leaf leaf blight of gladiolus (*Botrytis cineria*), verticilium wilt (*Verticillium dahlia*), sooty mold (*Alternaria* spp.), leaf & flower blight (*Botrytis cinerea),* root rot (*Pythium spp.), and* stem rot (*Fusarium solani)*. The incidence of bacterial diseases of flowers and foliages recorded in Bangladesh were crown gall of rose (*Agrobacterium tumefaciens*), bacterial leaf spot (*Pseudomonas syringae*), and bacteiral wilt of carnation (*Dickeya dianthicola*). The nemic disease of flowers and foliages was root knot nematode caused by *Meloidogyne* spp. The incidences of viral diseases of flowers and foliages reported were rose leaf curl disease caused by *Rose rosette virus* and rose leaf mosaic caused by *Rose yellow mosaic virus.* But the incidences of golder cyst nematode (*Globodera rostochiensis*), pale cyst nematode (*Globodera pallid*) and tuber and bulb nematode (*Ditylenchus destructor*) were not reported as the diseases of flowers and foliages in Bangladesh. Among these diseases, the anthracnose diseases on leaves and stems; botrytis leaf & flower blight of gladiolus and were more damaging than others. All of other diseases were reported as minor diseases for different kinds of flowers and foliages in Bangladesh with low infection intensity.

A total number of 8 weeds were reported as the problem in the field of flowers and foliages in Bangladesh. The incidences of weeds in the field of flowers and foliages as reported by the farmers 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 such as Rajshahi, Natore, Pabna, Kustia, Jessore districts. The stakeholders 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.

Information on pests associated with cut flower and foliages in the exporting countries-India, China, Thailand, Japan and Malaysia-reveals that pests of quarantine importance exist. The study also revealed 17 pests of quarantine importance that included 8 insect pests, one mite pest, 7 disease causing microorganisms including one fungus, one bacterium, two nematode, and three virus and viroid; and one weed. Without mitigation, these pests could be introduced into Bangladesh through importation of commercially produced fresh cut flower and foliages. Pests of quarantine importance included insect pests named Western flower thrips (*Frankliniella occidentalis*), Chrysanthemum leaf miner (*Liriomyza trifolii*), Pea leaf miner (*Liriomyza huidobrensis*), Cotton leaf worm (*Spodoptera littoralis*), Carnation tortrix moth (*Cacoecimorpha pronubana*), Red tiger moth (*Amsacta lactinea*), Japanese rose beetle (*Popilla japonica*), Tapioca scale insect (*Aonidomytilus albus*) and one mite pest named for Bagladesh is Red spider mite (*Tetranychus evansi*).

The quarantine pathogens of cut flower and foliages included one fungus named Phytopthora root rot (*Phytophthora megasperma*); one bacterium named Bacterial stem crack of carnation (*Burkholderia caryophylli*); two species of nematode named Golden cyst nematode (*Globodera rostochiensis*), and Pale cyst nematode (*Globodera pallid*); three viruses and viroids named Chrysanthemum stem necrosis virus (*Chrysanthemum stem necrosis tospovirus*), Tobacco ringspot virus (*Tobacco ringspot nepovirus*), Stunt of chrysanthemum (*Chrysanthemum stunt viroid*). The quarantine weed for Bangladesh included *Parthenium hysterophorus* L. (Parthenium weed).

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 18 quarantine pests associated with the pathway, the risk of all 18 potential pests was assessed and 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 flower industry and specific phytosanitary measures are strongly recommended, while for medium risk potential pest specific phytosanitary measures may be necessary to reduce pest risk.

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.

Today the trade of flowers is a promising trade and a number of florists have sprung up who sell flowers. No one could think of exporting Bangladeshi flowers even a few years ago. But this is a reality today and prosperous bonanza for tomorrow. In view of marketing prospect of flowers, a vast agricultural land has been turned into a flower growing area and the farmers are now in a position to make available any quantum of flowers for export according to the market requirements. In Bangladesh, the cultivation of flower for the purpose of commercial use was started in a large scale from the early 80's. Till then the traditional flower marketing system is increasing, many shops have been established, but the scenery of flower business is very poor. The substantial amount of flower cultivation is now still limited to the area of panishara and its adjacent places in Jessore (Hossain and Rahman, 1994). Before 1983, the space in front of the High Court Mazar was the venue for the flower trade. Now it has spread too many other specific areas of the Dhaka city.

In 1999 there were 530 flower shops in Dhaka city. At present the number of flower shops is more than a thousand throughout the country. Moreover, there are a good number of hawkers and none descript youngsters selling the flowers in different places of Dhaka and other big cities on temporary basis to maintain their livelihood. A good number of flower shops are also established in district towns. At least 26 business enterprises and 6 associations are directly engaged in growing and export of flowers in Bangladesh. This number has increased now days. Two decades have passed, but flower marketing cannot progress at expected rate. Many underdeveloped countries like Kenya earns more than 40 million US dollar from exporting flower. On the other hand, Bangladesh has huge potentiality to export flower besides domestic production and sales. Now the study will be developed for the purpose of drawing current condition, prospect and problem of flower marketing, On the other hand, Bangladesh has huge potentiality to export flower besides domestic production and sales. Based on prior research, it is found that there is huge potentiality in flower business in Bangladesh although several constraints are responsible to hinder the business. Now the study will be developed for the purpose of drawing current condition, prospect and problem of flower marketing in Bangladesh.

According to the Bangladesh Flower Growers and Exporters Association (BFA), around 10,000 hectares of land are under flower cultivation in our country. It was also reported that Jessore is the region which accounts for the maximum volume of flower cultivation. Tube rose, rose, orchid and marry gold are among the major flowers that make up Bangladesh's floral basket for exports.

Flowers are now cultivated in about 10 thousand hectares of land, mainly in the Godkhali Union of Zikorgasa Upzilla under Jessore district. About 4000 farmers produce mainly various types of Rose, Tube Rose, Gerbera, Gladiolus and some orchids. In Godkhali, the cultivation of flowers was started in 1983. Most of the tuberose and rose supplies come from Jhikargachha of Jessore and Savar of Dhaka, marry gold from Chuadanga and orchid from Mymensingh and Manikganj district. Cut flowers give three to four times' higher return than any other crop. Currently about 1,50,000 people are directly involved in Cut flower cultivation or business in Bangladesh.

Bangladesh is highly suitable for cut flower and foliage production due to its favorable climatic, topography and other conditions like labour cost and relatively low capital investment in contrast with high value addition. 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.

Due to imports of cut flower and foliages 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 cut flowers from exporting countries to Bangladesh is essential. In this context, the Pest Risk Analysis (PRA) of cut flower in Bangladesh is indispensable. Thus, the assignment on Pest Risk Analysis (PRA) of cut flower in Bangladesh was undertaken aiming to identify pests and/or pathways of quarantine concern for the cut flower and foliages 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 fresh cut flower and foliages imported from different exporting countries such as China, India, Japan, Thailand, Malaysia. 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. Methodology for data collection

1.4.1. Introduction

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 flowers, 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.

1.4.2. Major Activities for data collection

Field survey

The study survey was conducted with the direct interview of flower growers in 23 major 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 flower 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.

Secondary data collection and review

The current PRA related secondary data were collected and gathered from secondary sources such as journals, books, proceedings, CD-ROM (CABI) 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 flowers available in the flower exporting counties such as India, Japan, and Thailand 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 cut flower and foliages

The insect pests, diseases, weeds and other associated pests of cut flower and foliages 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 flower in Bangladesh were also listed.

1.4.3. PRA location and study sampling

The survey study sas conducted in the 23 major flower 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 58 upazilas (sub-district) were selected under the 23 sampled distrcts, where 10 agricultural blocks were covered under each upazilla and 10 flower growers/farmers were interviewed in each block through pre-tested questionnaire. Thus, a total of 5800 growers/farmers were interviewed from all of 23 sampled districts. The focus group discussion (FGD) meeting was also conducted for each of 23 sampled districts with the participation of at least 10 flower growers/farmers aiming to gather qualitative data. Besides, one officer designated as Additional Deputy Director (Plant Protection) for each district had also been interviewed through semi-structured key informant interview (KII) checklist. 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	Upazila	No. of Block	No. of Farmers	No. of FGD	KII
1	Dhaka	Savar	10	100	1	1
		Dhamrai	10	100		
		Keranigonj,	10	100		
		South City corporation	10	100		
		North city corporation	10	100		
2	Gazipur	Sadar,	10	100	1	1
		Kaligonj,	10	100		
		Sreepur	10	100		
		Kaliakoir	10	100		
		City corporation	10	100		
3	Manikgonj	Sadar	10	100	1	1
		Singair	10	100		
4	Narayangonj	Sonargaon	10	100	1	1
		Araihazar	10	100		
5	Tangail	Modhupur	10	100	1	1
		Sakhipur	10	100		
		Ghatail	10	100		
6	Mymensingh	Sadar	10	100	1	1
		Muktagacha	10	100		
7	Jamalpur	Sadar	10	100	1	1
8	Sherpur	Sadar	10	100	1	1
9	Cox's bazar	Sadar	10	100	1	1
		Chakaria	10	100		
10	Chittagong	City Corporation	10	100	1	1
		Sitakunda	10	100		
		Potia	10	100		
		Banshkhali	10	100		
		Anwara	10	100		

SN	District	Upazila	No. of Block	No. of Farmers	No. of FGD	KII
		Raujan	10	100		
11	Comilla	Chandina	10	100	1	1
		City Corporation	10	100		
		Burirchang	10	100		
12.	Jessore	Jhikorgacha	10	100	1	1
		Sarsha	10	100		
		Chougacha	10	100		
		Sadar	10	100		
		Keshobpur	10	100		
13.	Jhenaidah	Kaligonj	10	100	1	1
		Court Chandpur	10	100		
14	Chuadanga	Sadar	10	100	1	1
		Alamdanga	10	100		
15	Khulna	Fultala	10	100	1	1
		City Corporation	10	100		
16	Rajshahi	City Corporation	10	100	1	1
		Poba	10	100		
17	Natore	Sadar	10	100	1	1
		Baraigram	10	100		
18	Bogra	Shajhanpur	10	100	1	1
		Shibgonj	10	100		
19	Pabna	Ishwardi	10	100	1	1
		Atghoria	10	100		
20	Rangpur	City Corporation	10	100	1	1
		Gangachara	10	100		
21	Gaibandha	Sadar	10	100	1	1
		Gobindagonj	10	100		
22	Sylhet	City Corporation	10	100	1	1
23	Barisal	City Corporation	10	100	1	1
		Babugonj	10	100		
Total=23		**58**	**580**	**5800**	**23**	**23**

1.4.4. 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 23 major flower growing districts of Bangladesh through face to face interview with 5800 flower growers using a set of pre-designed and pre-tested questionnaire (**Appendix-1)** encompassing the relevant study indicators.

Focus Group Discussion (FGD): For qualitative analysis, 23 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-2**).

Key Informant Interview (KII): The key informant interviews were conducted with the extension personnel at field and headquarer level of DAE, officials of Plant Quarantine Centres at Sea and land ports; officials of Ministry of Agriculture; Entomologist and Plant Pathologist of BARI, Agricultural Universities. A total of 55 key personnel were interviewed using a semi-structured KII Checklist (**Appendix 3-5)** encompassing the qualitative issues of the study.

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**.**

1.4.6. Pests of cut flowers and foliages recorded in Bangladesh

The study for “Conducting Pest Risk Analysis (PRA) of Cut flower and Foliages in Bangladesh” was done in 23 major flower 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:

1.4.6.1. Insect and mite pests of cut flower and foliages

A total number of 16 insect pests and 1 mite pest of flowers were reported by the farmers and other stakeholders those attaced the flowers and foliages in fields.

The incidences of insect pests of flowers recorded were flower aphid (*Macrosiphum rosae*), whitefly (*Bemisia tabaci*), scale insect (*Aulacaspis rosae*), flower mealybug (*Pseudococcus* spp.), thrips (*Scirtothrips dorsalis*), leaf miner (*Liriomyza sativae* Blanchard), flower gall midge (*Cotarinia* spp.), june beetle (*Melolontha melolontha*), metallic flea beetle (*Altica* spp.), flower beetle (*Euphoria sepulcralis*), leaf eating beetle (*Macrodactylus subspinosus*), leaf eating bee (*Megachile* spp.), bristly rose slug/sawfly (*Cladius* spp.), tobacco caterpillar (*Spodoptera litura*), two-spotted spider mite (*Tetranychus urticae*) (Table 2). But the incidence of Japanese beetle (*Poppilla japonica*), and tortryx moth (*Lozotaenia forsterana*) were not reported by the farmers and other experts in Bangladesh.

Among these insect and mite pests of flowers, aphid, thrips and tow-spotted spider mite are more damaging than others. The pest status of all these insect and mite pests was minor and caused low level of infestation. Usually Bangladesh’s farmers always used chemical insecticides and acaricides through which these pests were suppressed in every season.

Table-2: Insect and mite pests of flowers, their status, plant parts affected and infestation severity

Sl. No.	Common Name	Scientific Name	Family	Order	Plant parts affected	Pest Status	Infestation Severity
1	Flower aphid	*Macrosiphum rosae*	Aphididae	Homoptera	Flower bud, leaf, twig	Minor	Medium
2	Whitefly	*Bemisia tabaci*	Aleurodidae	Homoptera	Leaf	Minor	Low
3	Scale insect	*Aulacaspis rosae*	Margarodidae	Homoptera	Stem	Minor	Low
4	Flower mealybug	*Pseudococcus* spp.	Pseudococcidae	Homoptera	Stem, leaf, twig, bud	Minor	Low
5	Thrips	*Scirtothrips dorsalis*	Thripidae	Thysanoptera	Flower, twig	Minor	Low
6	Leaf miner	*Liriomyza sativae* Blanchard	Agromyzidae	Diptera	Leaf	Minor	Low
7	Flower gall midge	*Cotarinia* spp.	Cecidomyiidae	Diptera	Flower bud	Minor	Low
8	June beetle	*Melolontha melolontha*	Melolonthidae	Coleoptera	Leaf, root	Minor	Low
9	Metallic flea beetle	*Altica* spp.	Chrysomelidae	Coleoptera	Leaf	Minor	Low
10	Flower beetle	*Euphoria sepulcralis*	Scarabaeidae	Coleoptera	Flower, leaf	Minor	-
11	Leaf eating beetle	*Macrodactylus subspinosus*	Scarabaeidae	Coleoptera	Leaf	Minor	Low
12	Japanese beetle	*Poppilla japonica*	Scarabaeidae	Coleoptera	Not recorded in Bangladesh		
13	Leaf eating bee	*Megachile* spp.	Megachilidae	Hymenoptera	Leaf	Minor	Low
14	Bristly rose slug/sawfly	*Cladius* spp.	Tenthredinidae	Hymenoptera	Stem, leaf sheath	Minor	
15	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera	Leaf, twig		
16	Tortryx moth	*Lozotaenia forsterana*	Tortricidae	Lepidoptera	Not recorded in Bangladesh		
17	Two-spotted spider mite	*Tetranychus urticae*	Tetranychidae	Acarina	Leaf, flower bud	Minor	Low

Pictures of some important insect and mite pests of cut flowers are presented below:

Plate-1: Aphids on rose flower bud (left) and orchid (right)

Plate-2: Aphids on gerbera flower (left) and chrysanthemum twig

Plate 3: Flower beetles on rose (left) and adult beetle (right)

Plate-4: June beetle on rose (left) and adult beetle (right)

Plate-5: Leaf miner infestation on marigold leaf (left) and adult (right)

Plate-6: Thrips on leaves of gladiolus (left & mid) and adult thrips (right)

Plate-7: Thrips on rose calyx (left) and damaged rose leaves by thrips (right)

Plate-8: Mealy bugs on marigold stalk (left) and marigold twigs (right)

Plate-9: Whitefly on orchid (left) and rose bud (right)

1.4.6.2. Diseases of flower and foliages recorded in Bangladesh

A total number of 16 diseases of flowers and foliages were reported by the farmers and experts of Bangladesh, among which 10 diseases were caused by fungi, 3 diseases were caused by bacteria, 1 caused by nematode and 2 diseases of flower and foliages were caused by viruses.

The incidences of fungal diseases of flowers and foliages reported were black spot on rose leaf (*Diplocarpon rosae*), powdery mildew (*Podosphaera pannosa*), downy mildew (*Peronospora sparsa*), leaf rust (*Phragmidium mucronatum*), anthracnose (*Sphaceloma rosarum*), grey mold and leaf leaf blight of gladiolus (*Botrytis cineria*), verticilium wilt (*Verticillium dahlia*), sooty mold (*Alternaria* spp.), leaf & flower blight (*Botrytis cinerea*), root rot (*Pythium* spp.), and stem rot (*Fusarium solani*) (Table 3).

The incidence of bacterial diseases of flowers and foliages recorded in Bangladesh were crown gall of rose (*Agrobacterium tumefaciens*), bacterial leaf spot (*Pseudomonas syringae*), and bacteiral wilt of carnation (*Dickeya dianthicola*). The nemic disease of flowers and foliages was root knot nematode caused by *Meloidogyne* spp. The incidences of viral diseases of flowers and foliages reported were rose leaf curl disease caused by *Rose rosette virus* and rose leaf mosaic caused by *Rose yellow mosaic virus.* But the incidences of golder cyst nematode (*Globodera rostochiensis*), pale cyst nematode (*Globodera pallid*) and tuber and bulb nematode (*Ditylenchus destructor*) were not reported as the diseases of flowers and foliages in Bangladesh.

Among these diseases, the anthracnose diseases on leaves and stems; botrytis leaf & flower blight of gladiolus and were more damaging than others. All of other diseases were reported as minor diseases for different kinds of flowers and foliages in Bangladesh with low infection intensity. Most of cases, the damage severity was controlled by the farmers through routine application of fungicides in the field of flowers.

1.4.6.3. Weeds of flowers and foliages recorded in Bangladesh

A total number of 8 weeds were reported as the problem in the field of flowers and foliages in Bangladesh. The incidences of weeds in the field of flowers and foliages as reported by the farmers 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. The stakeholders 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.

Table-3: Diseases of flowers, 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	Black spot on rose	*Diplocarpon rosae*	Dermateaceae	Helotiales	Rose leaf	Minor	Low
2	Powdery mildew	*Podosphaera pannosa*	Erysiphaceae	Erysiphales	Flower, leaf	Minor	Low
3	Downy mildew	*Peronospora sparsa*	Peronosporaceae	Peronosporales	Leaf	Minor	Low
4	Leaf rust	*Phragmidium mucronatum*	Phragmidiaceae	Uredinales	Stem, leaf	Minor	Low
5	Anthracnose	*Sphaceloma rosarum*	Elsinoaceae	Myriangiales	Stem, leaf, flower	Minor	Low
6	Grey mold, Leaf & flower blight	*Botrytis cineria*	Sclerotiniceae	Leotiomycetes	Gladiolus leaf, marigold flower	Major	Medium
7	Verticilium wilt	*Verticillium dahlia*	Plectosphaerellaceae	Incertae sedis	Stem, root	Minor	Low
8	Sooty mold	*Alternaria* spp.	Pleosporaceae	Pleosporales	Flower, bud	Minor	Low
9	Root rot	*Pythium* spp.	Pythiaceae	Pythiales	Root	Minor	Low
10	Stem rot	*Fusarium solani*	Nectriaceae	Sordariomycetes	Stem	Minor	Low
Causal organism: Bacteria							
11	Crown gall of rose	*Agrobacterium tumefaciens*	Rhizobiaceae	Rhizobiales	Rose stem base, root	Minor	Low
12	Bacterial leaf spot	*Pseudomonas syringae*	Pseudomonadaceae	Pseudomonadales	Leaf	Minor	Low
13	Bacteiral wilt of carnation	*Dickeya dianthicola*	Enterobacteriaceae	Enterobacteriales	Stem, root	Minor	Low
Causal organism: Nematode							
14	Root knot nematode	*Meloidogyne* spp.	Heteroderidae	Tylenchida	Root, stem	Minor	Low
15	Golder nematode	*Globodera rostochiensis*	Heteroderidae	Tylenchida	Not recorded in Bangladesh		
16	Pale nematode	*Globodera pallid*	Heteroderidae	Tylenchida	Not recorded in Bangladesh		
17	Tuber nematode	*Ditylenchus destructor*	Anguinidae	Tylenchida	Not recorded in Bangladesh		
Virus							
18	Rose leaf curl	*Rose rosette virus*	Unassigned (-ve) ssRNA	Unassigned (-ve)ssRNA	Leaf	Minor	Low
19	Rose leaf mosaic	*Rose yellow mosaic virus*	Potyviridae	Unassigned (+ve)ssRNA	Leaf	Minor	Low

Table-4: Weeds of flowers, 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	Medium
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	Medium

1.4.6.4. Management options for flower pests in Bangladesh

Management options for insect and mite pests: According to the responses provided by the farmers and other stakeholders, the most effective and commonly practiced management options against the insect pests of flowers and foliages were spraying of insecticides in the field of flowers followed by removal of infested plants from the field, seed treatment and use of balanced fertilizer. The acaricides were also used for the control of the infestation of mite especially for rose and marigold.

Management options for diseases: The most effective and commonly practiced management options against the diseases of flowers were spraying of fungicides in the field, followed by removal of weeds and diseased plants/pruning of the diseased parts of the plants. Farmers also reported that they treated the seeds before sowing seed to prevent the incidences of the diseases.

Management options for weeds: According to the responses by the stakeholders, the most effective and commonly practiced management options for weeds in the field of flowers were weeding from the field, followed by removal of weeds during land preparation, use of mulching, application of irrigation. Other options were earthing up at the base of plants and use of herbicides.

1.5. 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:

1.5.1. Possible ways of entry of quarantine pests into Banlgadesh

Bangladesh usually imported the cut flowers and foliages from from India through landports and from Thailand, China, Malaysia and Japan through air-freight. Therefore, there is a possibility to enter the flower pests into Bangladesh through the consignment of cut flowers and foliages during importation from these exporting countries, if imported without considering the standard phytosanitary system of Internation Standard Phytosanitary Measures (ISPM).

1.5.2. 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

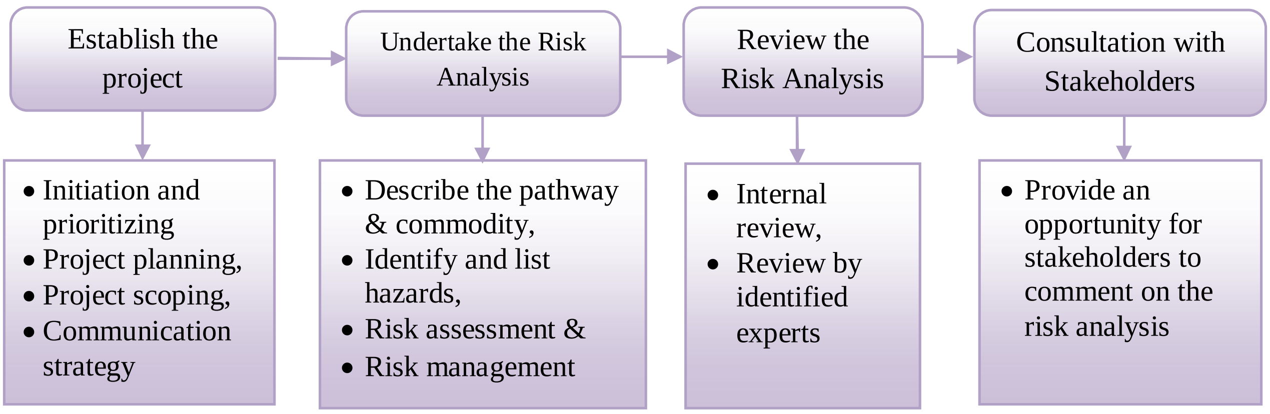
In most cases, these steps were applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity,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



1.6. Pathway Description

1.6.1. Import pathways of cut flower and foliages

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

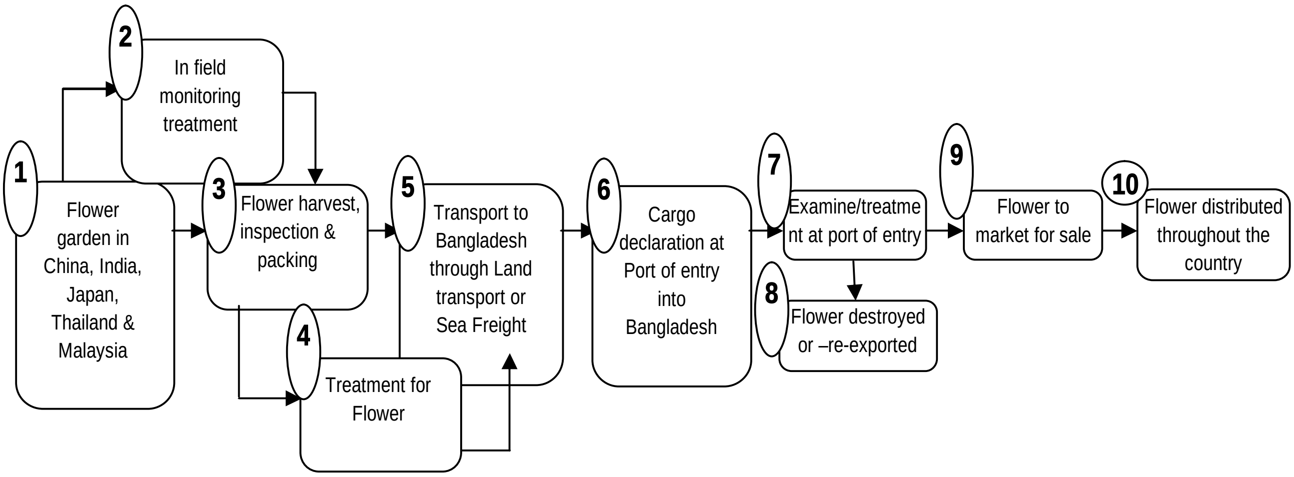
To comply with existing Bangladesh import requirements for cut flowers and foliage, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests (insect pests, diseases and weeds) are not associated with the product. Commodity would then be sea or land or air freighted to Bangladesh where it will go to a holding facility before being distributed to dealers, distributors, markets, sellers and farmers for cultivation of the imported cut flowers and ornamental foliages of plants and seeds.

1.6.2. Description

- Cut flowers in India, China, Japan, Thailand, Malaysia 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 cut flowers and foliages is undertaken, with appropriate controls applied.
- cut flowers and foliages are being harvested, inspected and the best quality flowers washed, pre-treated and packed in boxes.
- Post harvest disinfestations including fumigation or cold disinfestations are being undertaken either before or during transport of the cut flowers and foliages 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 cut flowers and foliages, any treatments completed, or other information required to help mitigate risks.
- Cut flowers and foliages is examined at the border to ensure compliance.
- Any cut flowers and foliages not complying with Bangladesh biosecurity requirements (e.g. found harboring pest organisms) are either treated re-shipped or destroyed.
- Cut flowers and foliages are stored before being distributed to market for sale.
- Dealers and sellers of cut flowers and foliages 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 flower pests is furnished below:

Figure-2: Linear Pathway Diagram

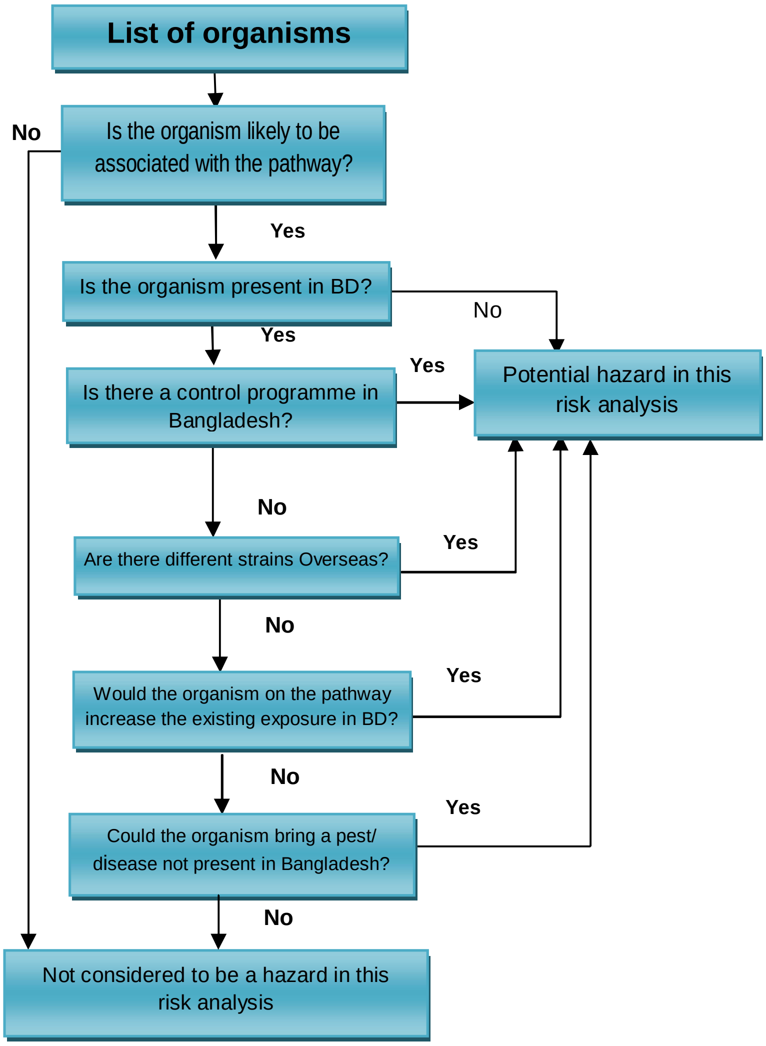


1.7. Hazard Identification

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 flower 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.

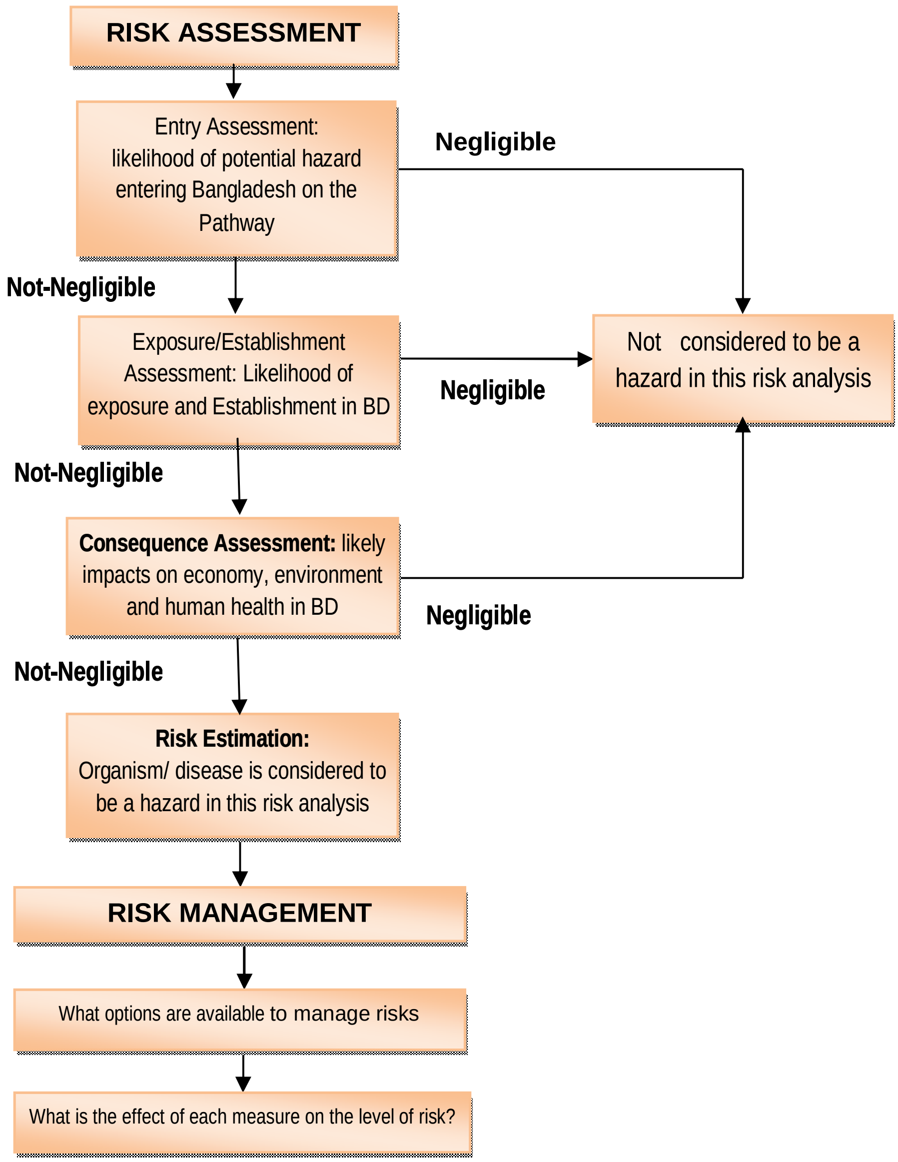
Figure 3: Diagrammatic representation of hazard identification



1.8. 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



1.9. 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.

1.10 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:

1.11. Risk Evaluation

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

1.12. 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, Japan, Malaysia) for cut flowers and foliages 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.

1.13. 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 cut flower and foliages. 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

2.2.1. Major cut flower crops grown in Bangladesh

Rose is the principal cut flower grown all over the country. These are used for offerings at places of worship, for the extraction of essential oils and also used in garlands. Gladiolus is the next most important cut flower crop in the country. Gladiolus is planted in a phased manner so that harvest can be done continuously. In some fields, old plants are left for bulb production; generally yellow, pink, red and dark red varieties are popular (Dahlani, 1997). Gerbera is also an important commercial cut flower in Bangladesh. In recent production of this flower is increasing. Tuberose, a very popular cut flower crop in Bangladesh, is grown mainly in Jessore. In Jessore, about 80 percent of total flower cultivated area is occupied by only tuberose. Both single land double flower varieties are equally popular.

Other main cut flower item is orchid. Its production is confined mainly in the Mymensingh and Savar. Among the traditional crops grown for loose flowers, the largest area is under marigold, grown all over the country. In most parts of the country only local varieties are grown in generations.
The major cut flowers and foliage preferably are Orchids, Rose, Gerbera, Tube rose, Gladiolus, Carnation, Lily, Chrysanthemum, Marigold.

Table-5: Name of cut flower and foliages grown in Bangladesh

Name of flowers	Scientific name	Family
Orchid	*Vanda teres, Aerides* spp.	Orchidaceae
Rose	*Rosa* spp.	Rosaceae
Tuberose	*Polianthes tuberose*	Asparagaceae
Gladiolus	*Gladiolus dalenii*	Iridaceae
Gerbera	*Gerbera jamesonii*	Asteraceae
Chrysanthemum	*Chrysanthemum indicum*	Asteraceae
Marigold	*Tagetes patula*	Asteraceae
Carnation	*Dianthus caryophyllus*	Caryophyllaceae
Lily	*Lilium candidum*	Liliaceae
Aster	*Aster* spp.	Asteraceae

Source: Ullah (1999) and Hoque (2002)

2.2.2. General features of major cut flowers

Orchid

The Orchidaceae are a diverse and widespread family of flowering plants, with blooms that are often colourful and often fragrant, commonly known as the orchid family. Along with the Asteraceae, they are one of the two largest families of flowering plants. The Orchidaceae have about 27,800 currently accepted species, distributed in about 880 genera (Stevens, 2001; WCSP, 2016). The largest genera are *Bulbophyllum* (2,000 species), *Epidendrum* (1,500 species), *Dendrobium* (1,400 species) and *Pleurothallis* (1,000 species). Moreover, since the introduction of tropical species into cultivation in the 19th century, horticulturists have produced more than 100,000 hybrids and cultivars.

Orchids are easily distinguished from other plants, as they share some very evident, shared derived characteristics, or "apomorphies". Among these are: bilateral symmetry of the flower (zygomorphism), many resupinate flowers, a nearly always highly modified petal (labellum), fused stamens and carpels, and extremely small seeds.

All orchids are perennial herbs that lack any permanent woody structure. They can grow according to two patterns:

- **Monopodial**: The stem grows from a single bud, leaves are added from the apex each year and the stem grows longer accordingly. The stem of orchids with a monopodial growth can reach several metres in length, as in *Vanda* and *Vanilla*.
- **Sympodial**: Sympodial orchids have a front (the newest growth) and a back (the oldest growth) (Nash and Frownie, 2008). The plant produces a series of adjacent shoots which grow to a certain size, bloom and then stop growing and are replaced. Sympodial orchids grow laterally rather than vertically, following the surface of their support. The growth continues by development of new leads, with their own leaves and roots, sprouting from or next to those of the previous year, as in *Cattleya*. While a new lead is developing, the rhizome may start its growth again from a so-called 'eye', an undeveloped bud, thereby branching. Sympodial orchids may have visible pseudobulbs joined by a *rhizome*, which creeps along the top or just beneath the soil.

Terrestrial orchids may be rhizomatous or form corms or tubers. The root caps of terrestrial orchids are smooth and white. Some sympodial terrestrial orchids, such as *Orchis* and *Ophrys*, have two subterranean tuberous roots. One is used as a food reserve for wintry periods, and provides for the development of the other one, from which visible growth develops. In warm and constantly humid climates, many terrestrial orchids do not need pseudobulbs

Epiphytic orchids, those that grow upon a support, have modified aerial roots that can sometimes be a few meters long. In the older parts of the roots, a modified spongy epidermis, called velamen, has the function to absorb humidity. It is made of dead cells and can have a silvery-grey, white or brown appearance. In some orchids, the velamen includes spongy and fibrous bodies near the passage cells, called tilosomes (Pillon & Chase, 2007).

The Orchidaceae are well known for the many structural variations in their flowers. Some orchids have single flowers, but most have a racemose inflorescence, sometimes with a large number of flowers. The flowering stem can be basal, that is, produced from the base of the tuber, like in *Cymbidium*, apical, meaning it grows from the apex of the main stem, like in *Cattleya*, or axillary, from the leaf axil, as in *Vanda*. As an apomorphy of the clade, orchid flowers are primitively zygomorphic (bilaterally symmetrical), although in some genera like *Mormodes*, *Ludisia*, and *Macodes*, this kind of symmetry may be difficult to notice.

Rose

A rose is a woody perennial flowering plant of the genus *Rosa*, in the family Rosaceae, or the flower it bears. There are over a hundred species and thousands of cultivars. They form a group of plants that can be erect shrubs, climbing or trailing with stems that are often armed with sharp prickles. Flowers vary in size and shape and are usually large and showy, in colours ranging from white through yellows and reds. Most species are native to Asia, with smaller numbers native to Europe, North America, and northwestern Africa. Species, cultivars and hybrids are all widely grown for their beauty and often are fragrant. Roses have acquired cultural significance in many societies. Rose plants range in size from compact, miniature roses, to climbers that can reach seven meters in height. Different species hybridize easily, and this has been used in the development of the wide range of garden roses (Anon., 2016).

The leaves are borne alternately on the stem. In most species they are 5 to 15 centimetres (2.0 to 5.9 in) long, pinnate, with (3-) 5-9 (-13) leaflets and basal stipules; the leaflets usually have a serrated margin, and often a few small prickles on the underside of the stem. Most roses are deciduous but a few (particularly from South east Asia) are evergreen or nearly so. The flowers of most species have five petals, with the exception of *Rosa sericea*, which usually has only four. Each petal is divided into two distinct lobes and is usually white or pink, though in a few species yellow or red. Beneath the petals are five sepals (or in the case of some *Rosa sericea*, four). These may be long enough to be visible when viewed from above and appear as green points alternating with the rounded petals. There are multiple superior ovaries that develop into achenes (Mabberley, 1997).

Tuberose

Polianthes tuberosa, the tuberose, is a perennial plant related to the agaves, extracts of which are used as a note in perfumery. The common name derives from the Latin *tuberosa*, meaning swollen or tuberous in reference to its root system. *Polianthes* means "many flowers" in Greek. In Mexican Spanish, the flower is called *nardo* or *vara de San José*, which means "St. Joseph’s staff". This plant is called as rajanigandha in India, which means 'fragrant at night'. It is called kupaloke in Hawaiian (*Choy, 2011*).

The tuberose is a night-blooming plant native to Mexico, as is every other known species of *Polianthes* (Anonymous, 2016b). It grows in elongated spikes up to 45 cm (18 inch) long that produce clusters of fragrant waxy white flowers that bloom from the bottom towards the top of the spike. It has long, bright green leaves clustered at the base of the plant and smaller, clasping leaves along the stem. Epiphyllous adhesion of stamens is seen in the flower (Santra, 2016). Members of the closely related genus *Manfreda* are often called "tuberoses". In the Philippines, the plant is also known as *azucena*, and, while once associated with funerals, it is now used in floral arrangements for other occasions (Trujillo, 1968).

Gladiolus

Gladiolus (from Latin, the diminutive of *gladius*, a sword) is a genus of perennial cormous flowering plants in the iris family (Iridaceae) (Manning and Goldblatt, 2008). It is sometimes called the 'sword lily', but usually by its generic name (plural *gladioli*) (Anon., 2007). The genus occurs in Asia, Mediterranean Europe, South Africa, and tropical Africa. The center of diversity is in the Cape Floristic Region (Goldblatt and Manning. 1998). The genera *Acidanthera*, *Anomalesia*, *Homoglossum*, and *Oenostachys*, formerly considered distinct, are now included in *Gladiolus* (Goldblatt and De Vos, 1989).

The genus *Gladiolus* contains about 260 species, of which 250 are native to sub-Saharan Africa, mostly South Africa. About 10 species are native to Eurasia. There are 160 species of *Gladiolus* endemic in southern Africa and 76 in tropical Africa. The flowers of unmodified wild species vary from very small to perhaps 40 mm across, and inflorescences bearing anything from one to several flowers. The spectacular giant flower spikes in commerce are the products of centuries of hybridisation, selection, and perhaps more drastic manipulation.

Gladioli are half-hardy in temperate climates. They grow from rounded, symmetrical corms, that are enveloped in several layers of brownish, fibrous tunics. Their stems are generally unbranched, producing 1 to 9 narrow, sword-shaped, longitudinal grooved leaves, enclosed in a sheath. The lowest leaf is shortened to a cataphyll. The leaf blades can be plane or cruciform in cross section.

The flower spikes are large and one-sided, with secund, bisexual flowers, each subtended by 2 leathery, green bracts. The sepals and the petals are almost identical in appearance, and are termed tepals. They are united at their base into a tube-shaped structure. The dorsal tepal is the largest, arching over the three stamens. The outer three tepals are narrower. The perianth is funnel-shaped, with the stamens attached to its base. The style has three filiform, spoon-shaped branches, each expanding towards the apex. The ovary is 3-locular with oblong or globose capsules, containing many, winged brown, longitudinally dehiscent seeds. In their center must be noticeable the specific pellet-like structure which is the real seed without the fine coat. In some seeds this feature is wrinkled with black color. These seeds are unable to germinate. These flowers are variously colored, pink to reddish or light purple with white, contrasting markings, or white to cream or orange to red.

Gerbera

Gerbera, a genus of plants in the Asteraceae (daisy family). It was named in honour of German botanist and medical doctor Traugott Gerber (1710-1743) who travelled extensively in Russia and was a friend of Carl Linnaeus (Anon., 1995). Gerbera is native to tropical regions of South America, Africa and Asia. The first scientific description of a Gerbera was made by J. D. Hooker in Curtis's Botanical Magazine in 1889 when he described Gerbera jamesonii, a South African species also known as Transvaal daisy or Barberton Daisy. Gerbera is also commonly known as the African Daisy.

Gerbera species bear a large capitulum with striking, two-lipped ray florets in yellow, orange, white, pink or red colours. The capitulum, which has the appearance of a single flower, is actually composed of hundreds of individual flowers. The morphology of the flowers varies depending on their position in the capitulum. The flower heads can be as small as 7 cm in diameter or up to 12 cm.

Gerbera is very popular and widely used as a decorative garden plant or as cut flowers. The domesticated cultivars are mostly a result of a cross between *Gerbera jamesonii* and another South African species *Gerbera viridifolia* (Isabel Johnson, 2014). The cross is known as *Gerbera hybrida*. Thousands of cultivars exist. They vary greatly in shape and size. Colours include white, yellow, orange, red, and pink. The centre of the flower is sometimes black. Often the same flower can have petals of several different colours. *Gerbera* is also important commercially. It is the fifth most used cut flower in the world (after rose, carnation, chrysanthemum, and tulip). It is also used as a model organism in studying flower formation.

Gerbera contains naturally occurring coumarin derivatives. *Gerbera* is a tender perennial plant. It is attractive to bees, butterflies and/or birds, but resistant to deer. Their soil should be kept moist but not soaked.

Chrysanthemum

Chrysanthemums, sometimes called mums or chrysanths, are flowering plants of the genus *Chrysanthemum* in the family Asteraceae. They are native to Asia and northeastern Europe. Most species originate from East Asia and the center of diversity is in China (Liu *et al.*, 2012). There are countless horticultural varieties and cultivars.

Chrysanthemums were first cultivated in China as a flowering herb as far back as the 15th century BC. Over 500 cultivars had been recorded by the year 1630 (Zhu *et al.,* 2016). The plant is renowned as one of the Four Gentlemen in Chinese and East Asian art. The flower may have been brought to Japan in the eighth century AD, and the Emperor adopted the flower as his official seal. The "Festival of Happiness" in Japan celebrates the flower.

Wild *Chrysanthemum* taxa are herbaceous perennial plants or subshrubs. They have alternately arranged leaves divided into leaflets with toothed or occasionally smooth edges. The compound inflorescence is an array of several flower heads, or sometimes a solitary head. The head has a base covered in layers of phyllaries. The simple row of ray florets are white, yellow or red; many horticultural specimens have been bred to bear many rows of ray florets in a great variety of colors. The disc florets of wild taxa are yellow. This is also known as favorite flower for the month of November.

Marigold

Common marigold, plants in the genus *Tagetes.* Tagetes is a genus of annual or perennial, mostly herbaceous plants in the sunflower family (Asteraceae or Compositae. It was described as a genus by Linnaeus in 1753. The genus is native to North and South America, but some species have become naturalized around the world. One species, *T. minuta*, is considered a noxious invasive plant in some areas (Soule, 1996).

Tagetes species vary in size from 0.1 to 2.2 m tall. Most species have pinnate green leaves. Blooms naturally occur in golden, orange, yellow, and white colors, often with maroon highlights. Floral heads are typically (1-) to 4-6 cm diameter, generally with both ray florets and disc florets. In horticulture, they tend to be planted as annuals, although the perennial species are gaining popularity. Depending on the species, *Tagetes* species grow well in almost any sort of soil. Most horticultural selections grow best in soil with good drainage (Soule, 1993).

Marigolds are recorded as a food plant for some Lepidoptera caterpillars including the dot moth, and a nectar source for other butterflies. They are often part of butterfly gardening plantings. In the wild, many species are pollinated by beetles.

Carnation

Dianthus caryophyllus, carnation or clove pink, is a species of *Dianthus*. It is probably native to the Mediterranean region but its exact range is unknown due to extensive cultivation for the last 2,000 years (Blamey & Grey-Wilson, 1989; Huxley, 1992)

It is a herbaceous perennial plant growing to 80 cm tall. The leaves are glaucous greyish green to blue-green, slender, up to 15 cm long. The flowers are produced singly or up to five together in a cyme; they are 3–5 cm diameter, and sweetly scented; the original natural flower colour is bright pinkish-purple, but cultivars of other colours, including red, white, yellow and green, have been developed (Huxley, 1992)

Carnations require well-drained, neutral to slightly alkaline soil, and full sun. Numerous cultivars have been selected for garden planting (Huxley, 1992). Typical examples include 'Gina Porto', 'Helen', 'Laced Romeo', and 'Red Rocket'. Colombia is the largest carnation producer in the world.

Lily

Lilium is a genus of herbaceous flowering plants growing from bulbs, all with large prominent flowers. Lilies are a group of flowering plants which are important in culture and literature in much of the world. Most species are native to the temperate northern hemisphere, though their range extends into the northern subtropics. The range of lilies in the Old World extends across much of Europe, across most of Asia to Japan, south to India, and east to Indochina and the Philippines. In the New World they extend from southern Canada through much of the United States. They are commonly adapted to either woodland habitats, often montane, or sometimes to grassland habitats. A few can survive in marshland and epiphytes are known in tropical southeast Asia. In general they prefer moderately acidic or lime-free soils.

Lilies are tall perennials ranging in height from 2–6 ft (60–180 cm). They form naked or tunicless scaly underground bulbs which are their overwintering organs. In some North American species the base of the bulb develops into rhizomes, on which numerous small bulbs are found. Some species develop stolons. Most bulbs are deeply buried, but a few species form bulbs near the soil surface. Many species form stem-roots. With these, the bulb grows naturally at some depth in the soil, and each year the new stem puts out adventitious roots above the bulb as it emerges from the soil. These roots are in addition to the basal roots that develop at the base of the bulb.

Many species are widely grown in the garden in temperate and sub-tropical regions. They may also be grown as potted plants. Numerous ornamental hybrids have been developed. They can be used in herbaceous borders, woodland and shrub plantings, and as patio plants. Some lilies, especially *Lilium longiflorum*, form important cut flower crops. These may be forced for particular markets; for instance, *Lilium longiflorum* for the Easter trade, when it may be called the Easter lily. Lilies are usually planted as bulbs in the dormant season. They are best planted in a south-facing (northern hemisphere), slightly sloping aspect, in sun or part shade, at a depth 2½ times the height of the bulb (except *Lilium candidum* which should be planted at the surface). Most prefer a porous, loamy soil, and good drainage is essential. Most species bloom in July or August (northern hemisphere). The flowering periods of certain lily species begin in late spring, while others bloom in late summer or early autumn (Jefferson-Brown, 2008; Anon., 2010). They have contractile roots which pull the plant down to the correct depth, therefore it is better to plant them too shallowly than too deep. A soil pH of around 6.5 is generally safe. The soil should be well-drained, and plants must be kept watered during the growing season. Some plants have strong wiry stems, but those with heavy flower heads may need staking (EEB, 2016).

The flowers are large, often fragrant, and come in a range of colours including whites, yellows, oranges, pinks, reds and purples. Markings include spots and brush strokes. The plants are late spring- or summer-flowering. Flowers are borne in racemes or umbels at the tip of the stem, with six tepals spreading or reflexed, to give flowers varying from funnel shape to a "Turk's cap". The tepals are free from each other, and bear a nectary at the base of each flower. The ovary is 'superior', borne above the point of attachment of the anthers. The fruit is a three-celled capsule. Seeds ripen in late summer. They exhibit varying and sometimes complex germination patterns, many adapted to cool temperate climates.

Aster

Aster is a genus of flowering plants in the family Asteraceae. Its circumscription has been narrowed, and it now encompasses around 180 species, many species formerly in *Aster* are now in other genera of the tribe Astereae.

The genus *Aster* once contained nearly 600 species in Eurasia and North America, but after morphologic and molecular research on the genus during the 1990s, it was decided that the North American species are better treated in a series of other related genera. After this split there are roughly 180 species within the genus, all but one being confined to Eurasia. Many species and a variety of hybrids and varieties are popular as garden plants because of their attractive and colourful flowers.

Some pictures of important flowers are presented below:

Plate-10: Orchid

Plate-11: Rose

Plate-12: Gerbera

Plate-13: Tuberose

Plate-14: Gladiolus

Plate-15: Carnation

Plate-16: Lily

Plate-17: Chrysanthemum

Plate-18: Marigold

2.2.3. Production system of cutflowers

The production technology of flower in Bangladesh has not yet been developed well and needs to improve significantly to yield different variety of flowers. Open field is employed for the flower industry in most cases. Special production system viz. greenhouse is yet to be developed. In rare cases, small greenhouses are used for cultivation of orchids. But generally orchid production is not popular because of the high investment to build up controlled production systems. Irrigation is provided by overhead or surface watering in the summer time. In the rainy season, a cover for flowers is needed to avoid insect pests and diseases infestations. At different stages of growth different kinds of organic fertilizers are used.

The production-mix of flower varieties must be chosen in-line with the growing demand of each specific type of flower breed in the international market. A greenhouse environment should be used for hybrid variety rose productions. Leading flower exporting countries, such as Holland, uses variety of artificial lighting systems to ensure the optimum growth of the flowers. Furthermore, fertilizer grades also need to be in high-quality for ensuring the highest yield of variety of hybrid-flower production during a seasonal cycle.

2.2.4. Uses of cut flowers

A common use is for floristry, usually for decoration inside a house or building. Typically the cut flowers are placed in a vase. A number of similar types of decorations are used, especially in larger buildings and at events such as weddings. These are often decorated with additional foliage. In some cultures, a major use of cut flowers is for worship; this can be seen especially in south and Southeast Asia.

Sometimes the flowers are picked rather than cut, without any significant leaf or stem. Such flowers may be used for wearing in hair, or in a button-hole. Masses of flowers may be used for sprinkling, in a similar way to confetti.

Garlands (especially in south Asia), and wreaths (in Europe and the Americas) are major derived and value added products.

2.2.5. Marketing of cut flowers

Production areas are concentrated in the rural environments, but the consumption is concentrated in the cities. There is no organization or associated for marketing and distribution of cut flowers. There is substantial trade also in Chittagong and other big towns. There are around 2000 retail shops of flower in the country. Among these about 40 percent of retail shop are in Dhaka, while Chittagong and Sylhet having 25 percent and the remaining 10 percent are in other district towns (Mou, 2006).

2.2.7. Pests of cut flower and foliages

Insect pests: A number of insect pests have been reported damaging cut flower and foliages. Among these the important pests are aphid, rose flower beetle, Japanese beetle, june beetle, metallic flea beetle, cut worm, rose slug sawfly, leaf miner, tortrix moth, scale insect, thrips, mealy bug, white fly, red spider mites.

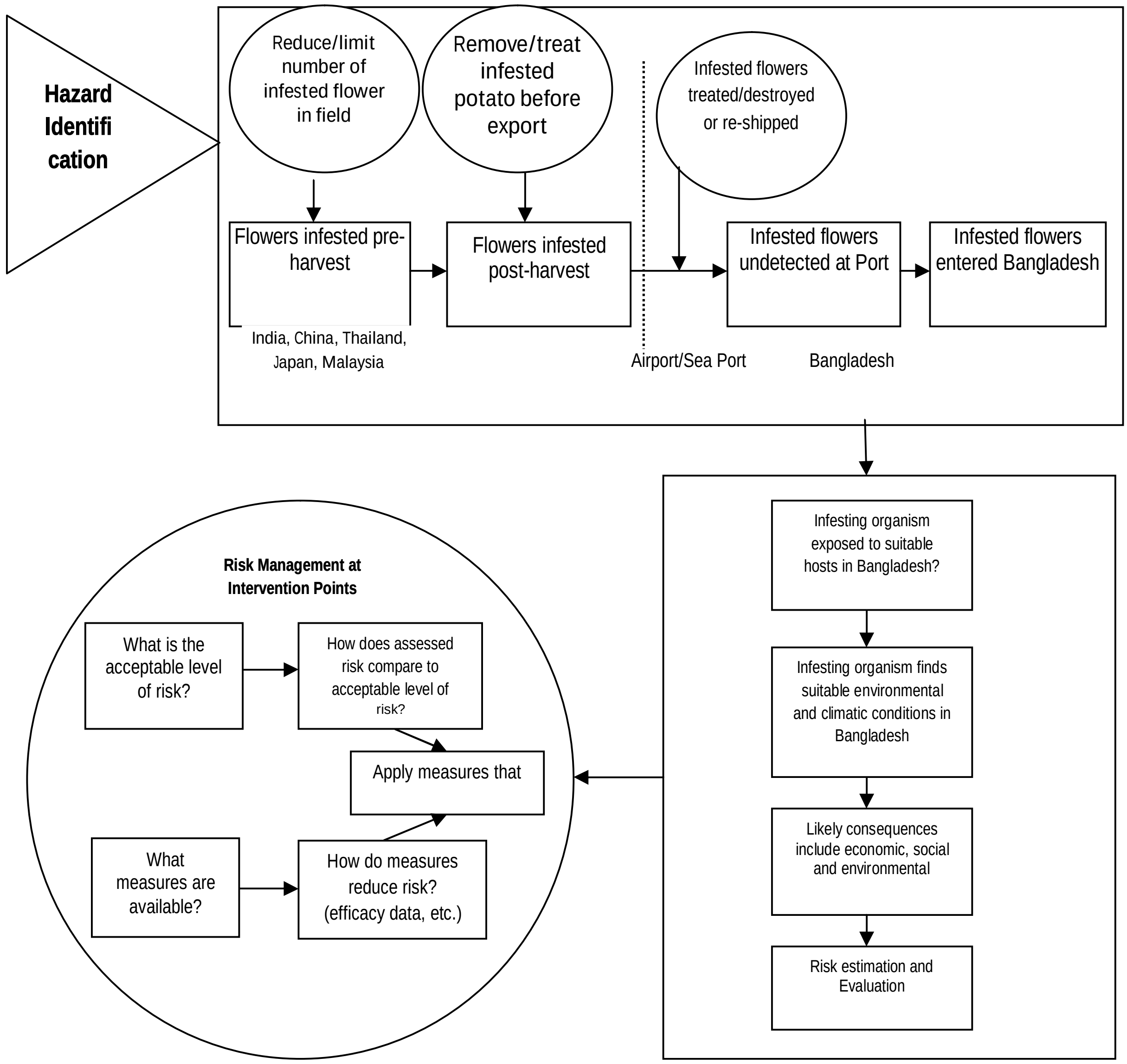
Diseases: Flowers are infected by arrange of diseases which can affect the quality of flowers as well as the yield and cost of production of the flowers. The type and severity of disease infection differs from season to season, category of flowers and between different regions. The most significant diseases of flowers are crown gall rot of rose (*Agrobacterium tumefaciens*), black Spot (*Diplocarpon rosae* syn. *marssonina rosae*), powdery mildew (*Podosphaera pannosa*), downy mildew (*Peronospora sparsa*), rust (*Phragmidium mucronatum*), anthracnose (*Sphaceloma rosarum*), grey mould (*Botrytis cineria*), Verticillium wilt (*Verticillium alboatrum* v. *dahlia*; *Fusarium* sp.), sooty moulds (*Alternaria* spp.), root knot (*Meloidogyne* spp.), rose leaf curl (*Rose leaf curl virus*), rose mosaic (*Rose mosaic virus*), rose rosette (*Rose rosette virus*), grey mould (*Botrytis cinerea*), black rot and collar rot (*Pythium ultimum*), leaf spot (*Alternaria* sp.; *Cercospora* sp.) etc.

Weeds: A number of weeds have been reported damaging cut flower and foliages namely durba grass, mutha grass, bathua grass, chota shema (barnyard grass), spiny pig weed, pig weed, black night shade, wild solanum, wild solanum, parthenium weeds etc.

2.3. Description of the Proposed Import Pathway

For the purpose of this risk analysis, cut flowers and foliages are presumed to be from anywhere in India, China, Thailand, Japan and Malaysia. To comply with existing Bangladesh import requirements for cut flowers, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests are not associated with the product. Cut flowers and foliages 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 cut flowers and foliages. The proposed import pathway of cut flowers and foliages indicating how the risk analysis process applied at the pathway level is given below:

Figure-5: Proposed import pathway of cut flowers and foliages



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.

Koeppen-Geiger classification: 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.

Koeppen-Geiger classification: 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.

2.4.5. Malaysia

Malaysia essentially observes tropical weather, without extremely high temperatures. Humidity however is a common feature; nights in Malaysia are fairly cool. Throughout the year, the average temperature ranges from 20°C to 30°C on an average. The main rainy season in the east runs between November and February, while August is the wettest period on the west coast. East Malaysia has heavy rains from November to February. While Peninsular Malaysia receives average rainfall of 2500 mm, East Malaysia thrives in 5080 mm of rain.

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 10.0°C to 15.40°C 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 31.80°C in Mymenshing district to 36.10°C in Chuadanga district.

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

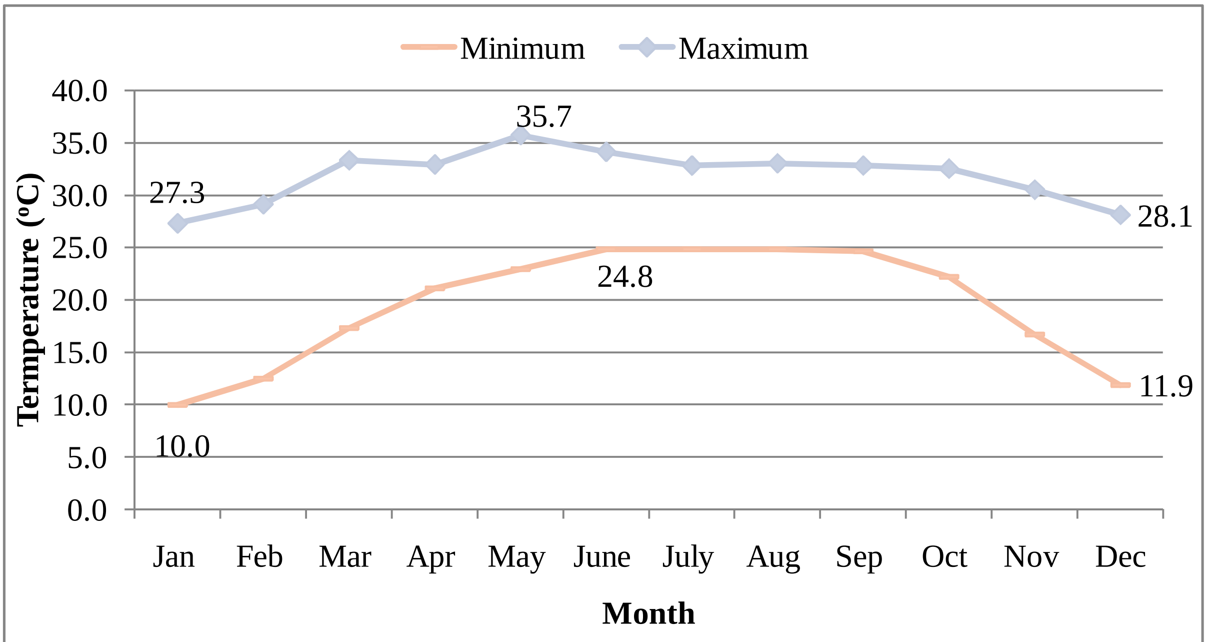


Figure-6: Monthly distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

Köppen climate classification

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

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

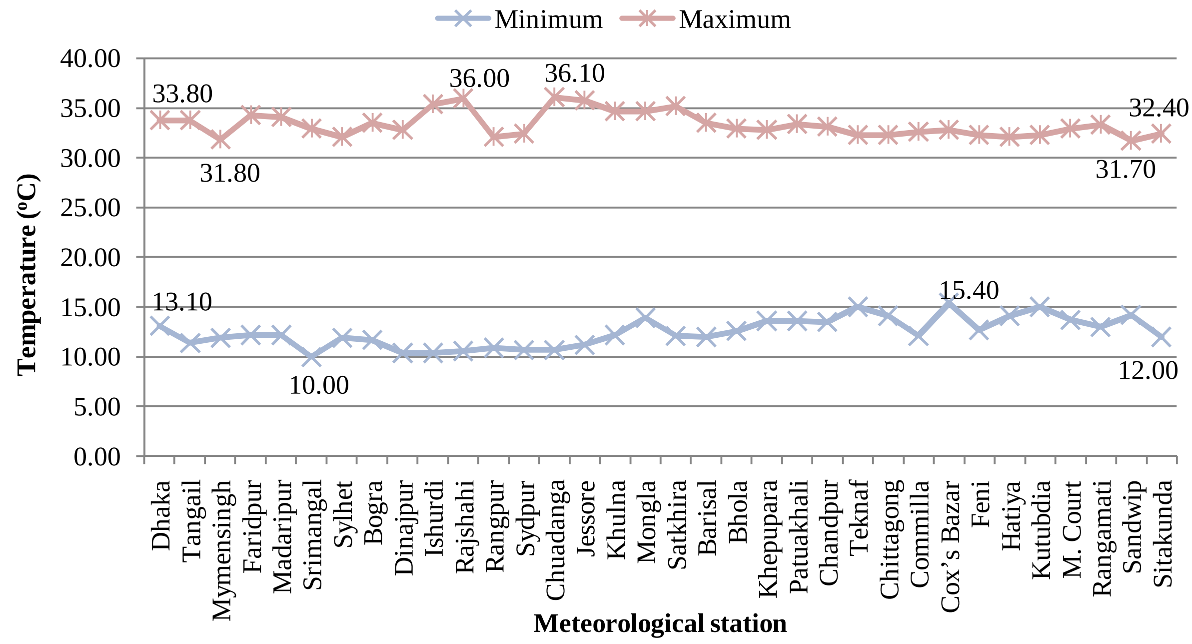


Figure 7. Location-wise distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

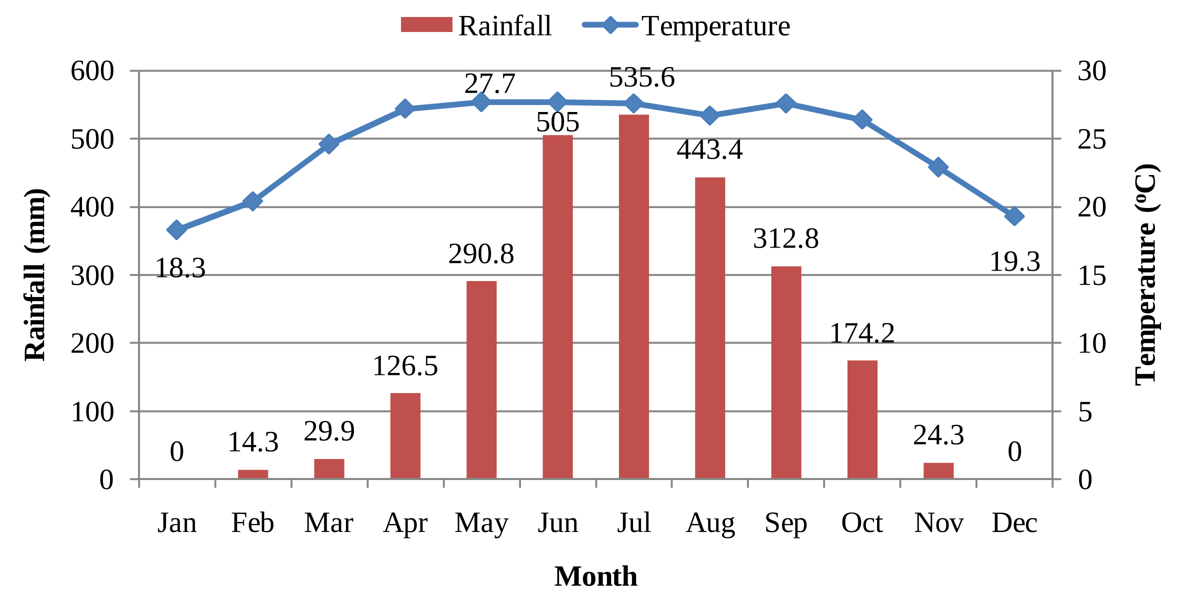


Figure -8: Average monthly Temperature and Rainfall for Bangladesh from 1960-1990

Source: World Bank Group (2015)

CHAPTER 3

HAZARD IDENTIFICATION

3.1. Introduction

This chapter outlines the potential hazards associated with cut flowers and foliages in India, China, Thailand, Japan and Malaysia, 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 cut flowers and foliages found in India, China, Thailand, Japan and Malaysia. The Plant Quarantine Wing of the Department of Agricultural Extension (DAE) in Bangladesh list for pests of flowers from India, China, Thailand, Japan and Malaysia 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 cut flowers and foliages and found to be present in India, China, Thailand, Japan and Malaysia. 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 cut flowers and foliages in exporting countries

The most common pests and pathogens affecting cut flowers and foliages found in India, China, Thailand, Japan and Malaysia are shown in the following Table below. Among which several pests were identified as quarantine pests likely to be imported with unmitigated shipments of cut flowers and foliages, 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 cut flowers and foliages in the exporting countries

Sl. No.	Common name	Scientific name	Distribution to flower exporting countries	Plant parts likely to carry the pest	References
Arthropods					
Insect pests					
1	Western flower thrips	*Frankliniella occidentalis*	India, Thailand, China, Japan, Sri Lanka	Flower, stem, leaf	CABI/EPPO, 1999; EPPO, 2014
2	Chrysanthemum leaf miner	*Liriomyza trifolii*	India, China, Japan, Taiwan	Leaf, stem, flower	EPPO, 2014; CABI/EPPO, 1997; Minkenberg (1988
3	Pea leaf miner	*Liriomyza huidobrensis*	India, Thailand, Japan, Taiwan	Leaf, stem, flower	CABI/EPPO, 2002; EPPO, 2014
4	Cotton leaf worm	*Spodoptera littoralis*	Japan, Pakistan, Indonesia	Stem, leaf, flower	CIE, 1967; CABI/EPPO, 1997; OEPP/EPPO, 1981
5	Carnation tortrix moth	*Cacoecimorpha pronubana*	Japan, Turkey, Azerbaijan	Leaf, stem, flower	Carter, 1984; EPPO, 2014; CABI/EPPO, 2014
6	Red tiger moth	*Amsacta lactinea*	India, China, Thailan, Malaysia	Leaf, stem, flower	CABI, 2011; BAPHIQ, 2007; TARI, 2009
7	Japanese rose beetle	*Popilla japonica*	India, China, Japan	Leaf, cutting, flower	CABI, 2004; EPPO, 2014; EPPO, 2016; CIE, 1978
8	Tapioca scale insect	*Aonidomytilus albus*	India, China, Thailand, Malaysia,	Leaf, stem, cutting, flower	EPPO, 2014; Tao, 1999; Sankaran et al., 1984
Mite pest					
9	Red spider mite	*Tetranychus evansi*	Japan, Taiwan	Leaf, stem, cutting, flower	CABI, 2015; EPPO, 2016
Disease causing organisms					
Fungi					
10	Phytopthora root rot	*Phytophthora megasperma*	Japan, Philippines	Leaf, stem, cutting,	CABI, 2006;
Bacterial					
11	Bacterial stem crack of carnation	*Burkholderia caryophylli*	India, China, Japan	Leaf, stem, cutting, flower	EPPO/CABI, 1996
Nematode					

Sl. No.	Common name	Scientific name	Distribution to flower exporting countries	Plant parts likely to carry the pest	References
12	Golden cyst nematode	*Globodera rostochiensis*	India, Japan, Pakistan, Sri Lanka	Tuber, bulb, corm	EPPO, 1997; CABI, 2007
13	Pale cyst nematode	*Globodera pallid*	India, Japan, Pakistan, Sri Lanka	Tuber, bulb, corm	EPPO, 1997; CABI, 2007
Virus and viroid					
14	Chrysanthemum stem necrosis virus	*Chrysanthemum stem necrosis tospovirus*	Netherlands, Brazil	Seed, leaf,cutting, flower	EPPO, 2006; CABI, 2007
15	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	India, China, Japan	Seed, leaf, cutting, flower	EPPO, 2006
16	Stunt of chrysanthemum	Chrysanthemum stunt viroid	India, China, Japan	Seed, leaf, cutting, flower	CABI, 2007
Weeds					
17	Parthenium weed	*Parthenium hysterophorus*	India	Seed, equipment	Jayachandra, 1971

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3. 4. Organism Interception on Commodity from Existing Pathways

In the past, there was no previous pest risk assessment on cut flowers and foliages from any of the exporting countries including the India, China, Thailand, Japan and Malaysia. As reported by the Plant Quarantine Wing (PQW) under Department of Agricultural Extension (DAE), Bangladesh, during inspection in port of entry of cut flowers and foliages 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 flowers and foliages 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 flowers and foliages after arrival making it difficult to distinguish the origin of saprobes and pathogens without adequate identification. Consumers tend to throw away moulded flowers and foliages 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 cut flowers and foliages in India, China, Thailand, Japan, Malaysia and other countries of flower 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 cut flowers and foliages in the importing countries, and preferably, any information on incidence level in pests infested cut flowers and foliages 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.

3.6.1. 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, Japan and Malaysia.

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.

3.6.2. 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.

3.6.3 Assumption Around Transit Time of Commodity on the Air Pathway

- An assumption is made around the time the fresh flowers and foliages take to get from the field in India, China, Thailand, Japan and Malaysia to Bangladesh ready for wholesale if it is transported by Landport or Sea shipment.

3.6.4. Assumption around Commodity Growon 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 flower 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 flowers are in brief:

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

4.3. Post-Harvest Procedures

The procedure is to sorting/grading to remove damaged/overripe/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, 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 flowers and foliages and cuttings of flower plants.

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 cut flowers and branches

- Cut flowers and branches include fresh parts of plants intended for decorative use and not for planting. For the purposes of this standard cut flowers and branches excludes roots or viable seeds.
- Only inert/synthetic material may be used for the protection, packaging and shipping materials of cut flowers and branches.
- Cut flowers and branches shall not be shipped or contained in free-standing water.

4.7. Specific Management options

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 cut flowers and branches were collected, have been treated as specified by PQW of Bangladesh.

Documentation

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

4.7.2. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all cut flowers and foliages 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 cut flowers and foliages have:

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

AND, ONE OR MORE OF THE FOLLOWING;

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

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

iv) undergone methyl bromide fumigation, within 5 days of shipment the consignment, at a approved temperature/dosage/duration combination, under vacuum (88 kPa), gradually returning to atmospheric pressure by the end of the period. The Ministry of Agriculture and Forestry of New Zealand approved a rate of fumigation at 10-14^{o}C temperature with a initial dose of methyl bromide @ 50gm^{-3} for 3 hours exposure time or at 15-25^{o}C temperature with a initial dose of methyl bromide @ 50gm^{-3} for 2 hours exposure time or at >25^{o}C temperature with a initial dose of methyl bromide @ 32gm^{-3} for 1 hours exposure time

v) undergone full immersion in water held at more than 50^{O}C (120^{O}F) for not less than 14 minutes, within 5 days of shipment the consignment.

vi) undergone full exposure to vapour heat for not less than 1 hour at more than 46.6^{O}C (116^{O}F) and 90 to 98% relative humidity, within 5 days of shipment the consignment.

vii) been sprayed to run off (on all above-ground plant parts) with a approved fungicide and insecticide combination, 14 days AND 5 days prior to harvesting the foliage for export to Bangladesh.

Ministry of Agriculture and Forestry (MAF) of New Zealand approved fungicide and insecticide combinations include:

a) Benomyl and Methomyl, or
b) Captan and Cypermethrin, or
c) Thiram and Cypermethrin.

AND;

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

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 cut flowers and foliages 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, ONE OR MORE OF THE FOLLOWING;

- sourced from a pest free area that is, as verified by pest surveillance methods, free from______ **(named regulated pest(s))** _____.
- sourced from a pest free place of production that is, as verified by pest surveillance methods, free from ______ **(named regulated pest(s))** _____.
- fumigated with methyl bromide within 5 days of shipping at __________ **(Temperature /Initial dosage/Exposure time)** _____, and under vacuum (88 kPa) gradually returning to atmospheric pressure by the end of the fumigation period.
- treated by hot-water immersion for ____ **(Exposure time)** ___ at a minimum of ___ **(Temperature)** __, within 5 days of shipping.
- treated with vapour heat for ______ **(Exposure time)** ______ at _____ **(Temperature)** ____ and ___ **(% Relative humidity)** _____, within 5 days of shipping.
- harvested from plants that have been sprayed with __________ **(Active ingredient and dosage rate)** _____, 14 and 5 days prior to harvesting for export to Bangladesh.

AND;

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

4.7.4. Transit requirements

The cut flowers and foliages 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.

PQW of Bangladesh requires, with 95% confidence, that not more than 0.5% of the units in a consignment are infested with visually detectable regulated pests. To achieve this, PQW will sample and inspect 600 units with an acceptance level of zero infested units (or equivalent), from the (homogeneous) lot.

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 ANALYSIS

5.1. Introduction

The pest risk assessment was done with the aim to determine Bangladesh's phytosanitary measure regarding the cut fllowers and foliages imported from any flower exporting countries viz. India, China, Thailand, Japan, Malaysia into Bangladesh.

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

5.2.1. Pests of cut flowers and foliages 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.

Fifty one species of pests were recorded for cut flower and foliages in the world of which 17 species were insect pests and two species were mite pests; the species of disease causing fungi were eleven, bacteria four, nematode four, and virus & viroids were five. On the other hand, eight species of weeds for cut flowers and foliages were recorded in the world.

Among Table 7 depicted the lists of pests associated with the cut flowers and foliages that also occur in India, China, Thailand, Japan and Bangladesh 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 cut flowers and foliages for Bangladesh

Seventeen species of quarantine pests of cut flower and foliages for Bangladesh were identified those were present in India, China, Thailand, Japan and Malaysia, but not in Bangladesh. Among these 17 species of pests, eight were insect pests, one species was mite pests, one fungus, one bacteria, nematode two species, virus/viroid three and weed was one species (Table 8).

The quarantine insect pests are Western flower thrips (*Frankliniella occidentalis*), Chrysanthemum leaf miner (*Liriomyza trifolii*), Pea leaf miner (*Liriomyza huidobrensis*), Cotton leaf worm (*Spodoptera littoralis*), Carnation tortrix moth (*Cacoecimorpha pronubana*), Red tiger moth (*Amsacta lactinea*), Japanese rose beetle (*Popilla japonica*), Tapioca scale insect (*Aonidomytilus albus*). The quarantine mite pest of cut flowers and foliages for Bangladesh is two-spotted spider mite (*Tetranychus evansi*) (Table 8).

On the other hand, seven disease causing micro-organisms and viruses have been identified as quarantine pests of cutflowers and foliages for Bangladesh. Among these, one quarantine fungus named Phytopthora root rot (*Phytophthora megasperma*); one bacterium named Bacterial stem crack of carnation (*Burkholderia caryophylli*); two species of nematode named Golden cyst nematode (*Globodera rostochiensis*), and Pale cyst nematode (*Globodera pallid*); three viruses and viroids named Chrysanthemum stem necrosis virus (*Chrysanthemum stem necrosis tospovirus*), Tobacco ringspot virus (*Tobacco ringspot nepovirus*), Stunt of chrysanthemum (*Chrysanthemum stunt viroid*) (Table 8).

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

Table-7: Pests associated with cut flower and foliages in the world and identification of quarantine organisms

Sl. No.	Common Name	Scientific Name	Family	Order	Present in Bangladesh	Qurantine status	Follow pathway
ARTHROPODS							
Insect pests							
1	Flower aphid	*Macrosiphum rosae*	Aphididae	Homoptera	Yes	No	Yes
2	Whitefly	*Bemisia tabaci*	Aleurodidae	Homoptera	Yes	No	Yes
	Silver whitefly (B biotyipe)	*Bemisia tabaci B biotype*	Aleurodidae	Homoptera	No	Yes	Yes
3	Scale insect	*Aulacaspis rosae*	Margarodidae	Homoptera	Yes	No	Yes
4	Flower mealybug	*Pseudococcus* spp.	Pseudococcidae	Homoptera	Yes	No	Yes
	Tapioca scale insect	*Aonidomytilus albus*	Diaspididae	Homoptera	No	Yes	Yes
5	Thrips	*Scirtothrips dorsalis*	Thripidae	Thysanoptera	Yes	No	Yes
	Western flower thrips	*Frankliniella occidentalis*	Thripidae	Thysanoptera	No	Yes	Yes
6	Leaf miner	*Liriomyza sativae*	Agromyzidae	Diptera	Yes	No	Yes
	Chrysanthemum leaf miner	*Liriomyza trifolii*	Agromyzidae	Diptera	No	Yes	Yes
	Pea leaf miner	*Liriomyza huidobrensis*	Agromyzidae	Diptera			
7	Flower gall midge	*Cotarinia* spp.	Cecidomyiidae	Diptera	Yes	No	Yes
8	June beetle	*Melolontha melolontha*	Melolonthidae	Coleoptera	Yes	No	Yes
9	Metallic flea beetle	*Altica* spp.	Chrysomelidae	Coleoptera	Yes	No	Yes
10	Flower beetle	*Euphoria sepulcralis*	Scarabaeidae	Coleoptera	Yes	No	Yes
11	Leaf eating beetle	*Macrodactylus subspinosus*	Scarabaeidae	Coleoptera	Yes	No	Yes
12	Japanese beetle	*Poppilla japonica*	Scarabaeidae	Coleoptera	No	Yes	Yes
13	Leaf eating bee	*Megachile* spp.	Megachilidae	Hymenoptera	Yes	No	Yes
14	Bristly rose slug/sawfly	*Cladius* spp.	Tenthredinidae	Hymenoptera	Yes	No	Yes
15	Tobacco caterpillar	*Spodoptera litura*	Noctuidae	Lepidoptera	Yes	No	Yes
	Cotton leaf worm	*Spodoptera littoralis*	Noctuidae	Lepidoptera	No	Yes	Yes
16	Carnation tortryx moth	*Lozotaenia forsterana*	Tortricidae	Lepidoptera	No	Yes	Yes
17	Red tiger moth	*Amsacta lactinea*	Arctiidae	Lepidoptera	No	Yes	Yes
Mite pests							
18	Two-spotted spider mite	*Tetranychus urticae*	Tetranychidae	Acarina	Yes	No	Yes
19	Red spider mite	*Tetranychus evansi*	Tetranychidae	Acarina	No	Yes	Yes

Sl. No.	Common Name	Scientific Name	Family	Order	Present in Bangladesh	Qurantine status	Follow pathway
DISEASES							
Causal organism: Fungi							
20	Black spot on rose	*Diplocarpon rosae*	Dermateaceae	Helotiales	Yes	No	Yes
21	Powdery mildew	*Podosphaera pannosa*	Erysiphaceae	Erysiphales	Yes	No	Yes
22	Downy mildew	*Peronospora sparsa*	Peronosporaceae	Peronosporales	Yes	No	Yes
23	Phytopthora root rot	*Phytophthora megasperma*	Peronosporaceae	Peronosporales	No	Yes	Yes
24	Leaf rust	*Phragmidium mucronatum*	Phragmidiaceae	Uredinales	Yes	No	Yes
25	Anthracnose	*Sphaceloma rosarum*	Elsinoaceae	Myriangiales	Yes	No	Yes
26	Grey mold, leaf & flower blight	*Botrytis cineria*	Sclerotiniceae	Leotiomycetes	Yes	No	Yes
27	Verticilium wilt	*Verticillium dahlia*	Plectosphaerellaceae	Incertae sedis	Yes	No	Yes
28	Sooty mold	*Alternaria* spp.	Pleosporaceae	Pleosporales	Yes	No	Yes
29	Root rot	*Pythium* spp.	Pythiaceae	Pythiales	Yes	No	Yes
30	Stem rot	*Fusarium solani*	Nectriaceae	Sordariomycetes	Yes	No	Yes
Causal organism: Bacteria							
31	Crown gall of rose	*Agrobacterium tumefaciens*	Rhizobiaceae	Rhizobiales	Yes	No	Yes
32	Bacterial leaf spot	*Pseudomonas syringae*	Pseudomonadaceae	Pseudomonadales	Yes	No	Yes
33	Bacteiral wilt of carnation	*Dickeya dianthicola*	Enterobacteriaceae	Enterobacteriales	Yes	No	Yes
34	Bacterial stem crack of carnation	*Burkholderia caryophylli*	Burkholderiaceae	Burkholderiales	No	Yes	Yes
Causal organism: Nematode							
35	Root knot nematode	*Meloidogyne* spp.	Heteroderidae	Tylenchida	Yes	No	Yes
36	Golder cyst nematode	*Globodera rostochiensis*	Heteroderidae	Tylenchida	No	Yes	Yes
37	Pale cyst nematode	*Globodera pallid*	Heteroderidae	Tylenchida	No	Yes	Yes
38	Tuber nematode	*Ditylenchus destructor*	Anguinidae	Tylenchida	No	Yes	Yes
Virus and viroid							
39	Rose leaf curl	*Rose rosette virus*	Unassigned (-ve) ssRNA	Unassigned (-ve)ssRNA	Yes	No	Yes
40	Rose leaf mosaic	*Rose yellow mosaic virus*	Potyviridae	Unassigned (+ve)ssRNA	Yes	No	Yes
41	Chrysanthemum stem necrosis virus	*Chrysanthemum stem necrosis tospovirus*	Bunyaviridae	Unassigned (-ve)ssRNA	No	Yes	Yes

Sl. No.	Common Name	Scientific Name	Family	Order	Present in Bangladesh	Qurantine status	Follow pathway
42	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	*Secoviridae*	*Picornavirales*	No	Yes	Yes
43	Stunt of chrysanthemum	Chrysanthemum stunt viroid	Pospiviroidae	Group: Viroids	No	Yes	Yes
WEEDS							
44	Bermuda grass	*Cynodon dactylon*	Poacegae	Poales	Yes	No	Yes
45	Nutsedge	*Cyperus esculentus*	Cyperaceae	Poales	Yes	No	Yes
46	Goosefoot	*Chenopodium album* L.	Chenopodioideae	Caryophyllales	Yes	No	Yes
47	Pigweed	*Amaranthus acanthochiton*	Amaranthaceae	Caryophyllales	Yes	No	Yes
48	Spiny pigweed	*Amaranthus spinosus*	Amaranthaceae	Caryophyllales	Yes	No	Yes
49	Blacknightshade	*Solanum nigrum*	Solanaceae	Solanales	Yes	No	Yes
50	Horsenettle	*Solanum carolinense* L.	Solanaceae	Solanales	Yes	No	Yes
51	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	No	Yes	Yes

Table-8: Quarantine pests for Bangladesh likely to be associated with cut flower and foliages imported from flower exporting countries selected for further analysis

Sl. No.	Common name	Scientific Name	Distribution to flower exporting countries	Plant parts likely to carry the pest	References
Arthropods					
Insect pests					
1	Western flower thrips	*Frankliniella occidentalis*	India, Thailand, China, Japan, Sri Lanka	Flower, stem, leaf	CABI/EPPO, 1999; EPPO, 2014
2	Chrysanthemum leaf miner	*Liriomyza trifolii*	India, China, Japan, Taiwan	Leaf, stem, flower	EPPO, 2014; CABI/EPPO, 1997; Minkenberg (1988
3	Pea leaf miner	*Liriomyza huidobrensis*	India, Thailand, Japan, Taiwan	Leaf, stem, flower	CABI/EPPO, 2002; EPPO, 2014
4	Cotton leaf worm	*Spodoptera littoralis*	Japan, Pakistan, Indonesia	Stem, leaf, flower	CIE, 1967; CABI/EPPO, 1997; OEPP/EPPO, 1981
5	Carnation tortrix moth	*Cacoecimorpha pronubana*	Japan, Turkey, Azerbaijan	Leaf, stem, flower	Carter, 1984; EPPO, 2014; CABI/EPPO, 2014
6	Red tiger moth	*Amsacta lactinea*	India, China, Thailan, Malaysia	Leaf, stem, flower	CABI, 2011; BAPHIQ, 2007; TARI, 2009
7	Japanese rose beetle	*Popilla japonica*	India, China, Japan	Leaf, cutting, flower	CABI, 2004; EPPO, 2014; EPPO, 2016; CIE, 1978
8	Tapioca scale insect	*Aonidomytilus albus*	India, China, Thailand, Malaysia,	Leaf, stem, cutting, flower	EPPO, 2014; Tao, 1999; Sankaran et al., 1984
Mite pest					
9	Red spider mite	*Tetranychus evansi*	Japan, Taiwan	Leaf, stem, cutting, flower	CABI, 2015; EPPO, 2016
Disease causing organisms					
Fungi					
10	Phytopthora root rot	*Phytophthora megasperma*	Japan, Philippines	Leaf, stem, cutting,	CABI, 2006;
Bacterial					
11	Bacterial stem crack of carnation	*Burkholderia caryophylli*	India, China, Japan	Leaf, stem, cutting, flower	EPPO/CABI, 1996
Nematode					
12	Golden cyst nematode	*Globodera rostochiensis*	India, Japan, Pakistan, Sri	Tuber, bulb, corm	EPPO, 1997; CABI, 2007

Sl. No.	Common name	Scientific Name	Distribution to flower exporting countries	Plant parts likely to carry the pest	References
			Lanka		
13	Pale cyst nematode	*Globodera pallid*	India, Japan, Pakistan, Sri Lanka	Tuber, bulb, corm	EPPO, 1997; CABI, 2007
Virus and viroid					
14	Chrysanthemum stem necrosis virus	*Chrysanthemum stem necrosis tospovirus*	Netherlands, Brazil	Seed, leaf,cutting, flower	EPPO, 2006; CABI, 2007
15	Tobacco ringspot virus	*Tobacco ringspot nepovirus*	India, China, Japan	Seed, leaf, cutting, flower	EPPO, 2006
16	Stunt of chrysanthemum	*Chrysanthemum stunt viroid*	India, China, Japan	Seed, leaf, cutting, flower	CABI, 2007
Weeds					
17	Parthenium weed	*Parthenium hysterophorus*			

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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 flowers and foliages idenfied for Bangladesh has been analyzed details as follows:

ARTHROPOD: INSECT PESTS

Pest-5.3.1:	Western flower thrips: *Frankliniella occidentalis* (Pergande)

5.3.1.1. Hazard Identification

Scientific name: *Frankliniella occidentalis* (Pergande)

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

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

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]

5.3.1.2. 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).

5.3.1.3. Hosts

a. **Major hosts:** The main host of *F. occidentalis includes 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, tomato, aubergine, potato, grapevine etc.*

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

5.3.1.4. 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 wild flowers 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).

5.3.1.5. 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 flowers and foliages. 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 flower and foliages 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.

5.3.1.6. 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 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 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 during transport, storage and transfer of this pest? - 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. 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 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** • *F. occidentalis* is a remarkably polyphagous species with 244 plant species from 62 families being recorded as hosts. The host range of *F. occidentalis* is flowers of roses, carnations, *Gladiolus*, chrysanthemums, *Gerbera*, sweet peas, plums, peas, tomatoes, *Capsicum*, Cucurbitaceae and strawberries, *Beta*, carrots, cotton, grapefruits, grapes, onions, *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	**YES and HIGH**

Description	Establishment Potential
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^{o}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 Bangladesh 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. • *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 flowers of roses, carnations, *Gladiolus*, sweet peas, apricots, peaches and nectarines, plums, peas, tomatoes, *Capsicum*, Cucurbitaceae and strawberries. *Beta*, carrots, cotton, grapefruits, grapes, onions, *Phaseolus*, *Purshia tridentata*, safflower. In Europe, this pest is most commonly on 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 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** • *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 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.	**Yes and High**

• 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-3.3: Calculating risk

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 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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Pest-5.3.2:	**Chrysanthemum 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: Chrysanthemum leaf miner
Serpentine 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* Ageratum*, Aster, marigold, Callistephus, safflower, Chrysanthemum morifolium, Dahlia, Gerbera (barbeton daisy), sunflower, carnation, gypsophila (baby's breath), Zinnia, salvia (sage), garlic, Begunia, groundnut, lettuce, Chinese cabbage, spinach, ornamental gourd, cucurbits, beans, soyabean, common bean, cow pea, okra, cotton, tomato, aubergine etc.*

b. Minor hosts: The minor or other hosts of this pest include Goosefoot, citrullus, pumpkin, *bottle gourd, loofah, castor bean, Chrysanthemum indicum,* faba bean, onion 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 China, India, Thailand (absent, unreliable record), **Japan**, Sri Lanka, Cyprus, Israel, Turkey, Lebanon, Philippines, Taiwan, [EPPO, 2014; CABI/EPPO, 1997] 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 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, storage and transfer of this pest? Yes** • 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 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. • The cutflowers 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 Chrysanthemum leaf miner can easily survive within the flowers, leaves and planting materials of cutflowers. Secondly, the transport conditions are more or less same with the environmental condition required for it's survive. 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: *Aster*	**YES and HIGH**

spp., chrysanthemums, *Dahlia* spp., *Dianthus* spp., *Gerbera* spp., *Gypsophila* spp., *Lathyrus* spp., *Zinnia* spp., beetroots, *Bidens* spp., *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 (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 and establish, and • Its host(s) are not common in Bangladesh and your climate is not similar to places it is established	Low

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 Asteraceae, including the following important crops: *Aster* spp., chrysanthemums, *Dahlia* spp., *Dianthus* spp., *Gerbera* spp., *Gypsophila* spp., *Lathyrus* spp., *Zinnia* spp., beetroots, *Bidens* spp., *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.,	**Yes and High**

watermelons (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 flower and other crops for Bangladesh. **b. Economic impact and yield loss** • *L. trifolii* is an economically important key pest of both ornamental crops (Bogran, 2006) and vegetables (Cheri, 2012). • In Kenya, chrysanthemums were grown commercially before 1976, but *L. trifolii* was thought to have been introduced in contaminated cuttings from Florida (USA) in 1976, at a large propagating nursery at Masongaleni. By 1979 the nursery was closed, but the establishment of the pest in local wild hosts, and the dissemination of cuttings from the nursery to other parts of the country as well as abroad, has added *L. trifolii* to the other pests of East Africa. It has caused considerable crop losses and loss of overseas markets due to quarantine requirements (IPPC Secretariat, 2005). • L. trifolii is also known to be a vector of plant viruses (Zitter *et al.,* 1980). **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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-2.3: Calculate risk

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

5.3.2.9. Risk Management Measures

- Avoid importation of 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, 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 cut flowers and for vegetables with leaves.

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Pest-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: Serpentine leaf miner,
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].

5.3.3.2. 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.

5.3.3.3. Hosts

a. **Major hosts:** The main host of *L. huidobrensis includes 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, *petunia, tomato, aubergine, potato,* etc.

5.3.3.4. 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**: India (Uttar Pradesh), Thailand, **Japan (**restricted distribution), Sri Lanka, Cyprus, Israel, Lebanon, Philippines, Taiwan, [CABI/EPPO, 2002; EPPO, 2014]
- **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.

5.3.3.5. 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 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, 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. 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. huidobrensis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table-3.1: Which of these descriptions best fit of this pest?

<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,

- 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 in many Asian countries including Japan, China etc.

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

- The cutflowers and others planting materials 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 flowers 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. On the other hand the environmental requirements required for the pests survival, are more or less same with the transport condition. 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 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

- 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 *Amaranthus* spp., *Aster* spp., chrysanthemums (*Dendranthema morifolium*), *Dahlia* spp., *Dianthus* spp., *Gypsophila* spp., *Zinnia* spp., hemp (*Cannabis sativa*), 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

</td><td>

YES and HIGH

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

(*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 Bangladesh and your climate is not similar to places it is established	Low

5.3.3.7. Determine the <u>Consequence</u> establishment of this pest in Bangladesh

Table-3.2: 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. *L. huidobrensis* has been reported from *Amaranthus* spp., *Aster* spp., chrysanthemums (*Dendranthema morifolium*), *Dahlia* spp., *Dianthus* spp., *Gypsophila* spp., *Zinnia* spp., hemp (*Cannabis sativa*), 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*), *Tropaeolum* spp., and *Verbena* spp. (Spencer, 1990). • *L. huidobrensis* has the potential to become a major pest of a wide variety of ornamental or vegetable 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	**Yes and High**

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** • 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 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-5.3: Calculate risk

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

5.3.3.9. 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 cut flowers and for vegetables with leaves.

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Pest-5.3.4:	Cotton Leafworm: ***Spodoptera littoralis*** (Boisduval)

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

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].

5.3.4.2. 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).

5.3.4.3. Hosts

a. Major hosts: The main crop species attacked by *S. lituralis* in the tropics are *Colocasia esculenta*, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco, vegetables (aubergines, *Brassica oleracea*, *B. oleracea* var. *capitata*, Capsicum, pea, radish, carot, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes, Vigna etc.).

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).

5.3.4.4. 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.

5.3.4.5. 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.

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

Table- 4.1: Which of these descriptions best fit of this pest?

Description	**Establishment Potential is:**
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	**YES and HIGH**

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. **b. Posibility of survival of this pest during transport, storage and transfer? 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 or planting materials such as cut flowers, nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *S. littoralis* 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** • *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 *Colocasia esculenta*, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco, vegetables (aubergines, *Brassica oleracea*, *B. oleracea* var. *capitata*, Capsicum, pea, radish, carot, cucurbit vegetables, Phaseolus, potatoes, sweet potatoes, Vigna etc.). 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 Bangladesh and your climate is not similar to places it is established	Low

5.3.4.7. Determine the Consequence establishment of this pest in Bangladesh

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

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - 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.	**Yes and High**

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 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table -4.3: Calculate risk

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

5.3.4.9. Risk Management Measures

- Avoid importation of flowers and foliages 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 cut flowers, pre-export inspection is considered sufficient.
- Cold storage of chrysanthemum and carnation cuttings 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 cut flowers (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 cut flowers and for vegetables with leaves.

5.3.4.10. References

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Pest-5.3.5:	Carnation Tortrix moth/Caterpillar: *Cacoecimorpha pronubana* Hübner

5.3.5.1 Hazard Identification

Scientific Name: *Cacoecimorpha pronubana* Hübner

Synonyms: *Cacoecia pronubana* Hübner
Cacoecimorpha ambustana Hübner
Cacoecimorpha hermineana Duponchel
Cacoecimorpha insolatana Lucas
Tortrix pronubana Hübner

Common names: Carnation tortrix moth;
European carnation tortrix;
Mediteranean carnation tortrix;
Mediterranean carnation leafroller

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Lepidoptera
Family: Tortricidae
Genus: *Cacoecimorpha*
Species: *Cacoecimorpha pronubana*

EPPO Code: TORTPR. This pest has been included in EPPO A2 list: No. 104

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

5.3.5.2. Biology

The large-bodied females cannot fly easily and only males are normally active. Egg laying occurs in batches, beginning 3-4 h after copulation, and is spaced out over several days. Eggs are laid on smooth surfaces, especially glass, the first batch, usually of 150-250 eggs, being the most important. Each female can lay up to 700 eggs (average 430).

Eggs hatch after 8-51 days. The larvae emerge within a few seconds and, being positively phototactic, quickly move or are carried in wind to the young growing points or flowers. Here, they spin silk around two to three terminal leaves or petals, and feed on the upper surface, so making numerous holes; the parenchyma may be mined. By the end of the third larval instar, the whole leaf is attacked and surrounded by a dense silken mass.

Hatching to pupation (seven larval instars) takes 19-70 days, and pupation itself 10-15 days. Longevity of imagoes is about 11-12 days for females and 14-18 for males; males, in particular, are strongly attracted to light. Temperature thresholds for copulation, egg laying and hatching are 10.5, 12-13 and 14°C, respectively. Pupae cannot survive 2 h at -4°C, and are therefore of no importance in overwintering. At average temperatures of 15 and 30°C, the complete life cycle takes 123-147 and 28-44 days, respectively. Humidity is an important factor; larvae can develop at 10-15% RH; 40-70% RH is optimum but, above 90% RH, larval and pupal mortality is increased. For more information, see Fisher (1924), Bestango (1955), Balachowsky (1966).

5.3.5.3. Hosts

a. Major hosts: The principa host species attacked by *C. pronubana* is only the Carnations.

b. Minor hosts: The other ornamental hosts include: *Acacia*, *Acer*, *Chrysanthemum*, *Coriaria*, *Coronilla*, *Euphorbia*, *Ilex*, *Jasminum*, *Laurus*, *Mahonia*, *Pelargonium*, *Populus*, *Rhododendron*, *Rosa*, *Syringa*.

- Fruit crop hosts include: *Citrus*, *Malus*, *Olea*, *Prunus*, *Rubus*.
- Vegetable hosts include: *Brassica* spp., carrots, peas, potatoes, tomatoes, *Trifolium* and *Vicia*.

5.3.5.4. Distribution

C. pronubana is indigenous to the Mediterranean region.

- **EPPO region**: Albania, Algeria, France, Germany (intercepted only), Greece, Ireland, Italy, Libya, Luxembourg, Malta, Morocco, Netherlands, Poland (unconfirmed), Portugal, Slovenia, Spain, Switzerland, Tunisia, UK (including Guernsey and Jersey), Yugoslavia.
- **Asia:** Japan (Carter, 1984; EPPO, 2014; CABI/EPPO, 2014) and other Asian countries such as Azerbaijan (Maharramova, 2011; CABI/EPPO, 2014), Israel (Wysoki, 1989; EPPO, 2014; CABI/EPPO, 2014) and Turkey (Kaçar & Ulusoy, 2008; EPPO, 2014; CABI/EPPO, 2014).
- **Africa**: Algeria, Libya, Morocco, Tunisia and South Africa (few records).
- **North America**: USA (Oregon only).
- **EU**: Present.

5.3.5.5. Hazard Identification Conclusion

Considering the facts that *C. pronubana* -

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 2014].
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages Asia Japan (Carter, 1984; EPPO, 2014; CABI/EPPO, 2014) and other Asian countries such as Azerbaijan (Maharramova, 2011; CABI/EPPO, 2014), Israel (Wysoki, 1989; EPPO, 2014; CABI/EPPO, 2014) and Turkey (Kaçar & Ulusoy, 2008; EPPO, 2014; CABI/EPPO, 2014) 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 on carnation cuttings the terminal and axial leaves and buds are enclosed in silk and eaten, becoming typically crooked; this is usually more serious in spring, whereas on carnation flowers the buds are penetrated by the larvae; petals may be joined by larval silk, thus hampering opening and giving flowers a characteristic swollen appearance. In some cases, it may not be apparent that flowers are infested (EPPO, 2016a). This pest has high reproductive potential and high possibility to long distance transport through planting materials, the risk rating for establishment potential is high**..**
- *C. pronubana* 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 tour country 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, • This pest has been established in many Asian countries including	

Description	Establishment Potential
Japan, Azerbaijan, Turkey, Uzbekistan (absent, no pest record) (EPPO, 2014). • *C. pronubana* is indigenous to the Mediterranean region. *C. pronubana* was previously considered a quarantine pest for Israel (D Opatowski, Plant Protection and Inspection Services (PPIS), Israel, personal communication, April, 2006). b. **Posibility of survival of this pest during transport, storage and transfer? Yes** • The cutflowers and other planting materials are transported from India, Japan, Thailand, Taiwan, Vietnam, U.S.A, Australia 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 carnation moth can easily survive with cut flowers and other planting materials. Because, Temperature thresholds for copulation, egg laying and hatching are 10.5, 12-13 and 14°C, respectively. Pupae cannot survive 2 h at -4°C, and are therefore of no importance in overwintering. At average temperatures of 15 and 30°C, the complete life cycle takes 123-147 and 28-44 days, respectively. On the other hand the environmental requirement for it's growth and survival are more or less same with the temperature of transport condition. 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, *C. pronubana* 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** • The principal host is carnations. Other ornamental hosts include: *Acacia*, *Acer*, *Chrysanthemum*, *Coriaria*, *Coronilla*, *Euphorbia*, *Ilex*, *Jasminum*, *Laurus*, *Mahonia*, *Pelargonium*, *Populus*, *Rhododendron*, *Rosa*, *Syringa*. Fruit crop hosts include: *Citrus*, *Malus*, *Olea*, *Prunus and Rubus*. Vegetable hosts include: *Brassica* spp., carrots, peas, potatoes, tomatoes, *Trifolium* and *Vicia*., (CABI, 2016), among which mostly common in **Bangladesh**. • Temperature thresholds for egg laying and hatching are 12-13 and 14°C, respectively. Pupae cannot survive 2 h at -4°C, and are therefore of no importance in overwintering. At average temperatures of 15 and 30°C, the complete life cycle takes 123-147 and 28-44 days, respectively. Humidity is an important factor; larvae can develop at 10-15% RH; 40-70% RH is optimum but, above 90% RH, larval and pupal mortality is increased (Fisher, 1924; Bestango, 1955; Balachowsky, 1966). • These climatic requirements for growth and development of *C. pronubana* are more or less similar with the climatic condition of	**YES and HIGH**

Description	Establishment Potential
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 Bangladesh 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-7.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • In spite of the polyphagous nature of this insect, serious damage is confined mainly to carnation crops in the Mediterranean area, where losses have been reported since the 1920s. • In France, around Nice, 25-35% of carnations were affected in 1972-1973, and losses in consignments for export were valued at about 100 000 F. In Morocco, *C. pronubana* was first found in 1933, on citrus, but it was not until 20 years later that it developed into a widespread pest on this crop, the larvae destroying foliage and damaging fruit. • In Algeria, it is found mainly on lemons, but is not considered a serious pest. In Italy (Sicily) surveys reported *C. pronubana* mainly on olives, weeds and roses but not on lemons (Inserra *et al.*, 1987; Siscaro *et al.*, 1988). In northern countries (e.g. Poland), *C. pronubana* is important in glasshouses. • This is a fairly serious pest of several important other crops rather than flowers for Bangladesh. **b. Economic impact and yield loss** • In spite of the polyphagous nature of this insect, serious damage is confined mainly to carnation crops in the Mediterranean area, where losses have been reported since the 1920s. • In France, around Nice, 25-35% of carnations were affected in 1972-1973, and losses in consignments for export were valued at about 100,000 F. In Morocco, *C. pronubana* was first found in 1933, on citrus, but it was not until 20 years later that it developed into a widespread pest on this crop, the larvae destroying foliage and damaging fruit. • In Algeria, it is found mainly on lemons, but is not considered a serious pest. In Italy (Sicily) surveys reported C. pronubana mainly on olives, weeds and roses but not on lemons (Inserra et al., 1987; Siscaro et al., 1988). In northern countries (for example, Poland), C. pronubana is important in glasshouses. **c. Environmental Impact** • *C. pronubana* 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.	**Yes and High**

Description	Consequence potential
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-5.3: Calculate risk

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

5.3.5.3.7. Risk Management Measures

- Avoid importation of flowers and foliages from countries, where this pest is available.
- EPPO recommends (OEPP/EPPO, 1990) that, in countries where *C. pronubana* occurs, nursery inspections should be carried out during the growing season prior to dispatch.
- A phytosanitary certificate may be required for cut flowers and for vegetables with leaves.

5.3.5.3.8. References

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Pest-5.3.6:	**Red tiger moth: *Amsacta lactinea* Cramer**

5.3.6.1 Hazard Identification

Scientific Name: *Amsacta lactinea* Cramer 1777

Synonyms: *Estigmene lactinea*

Common name: Red tiger moth

Taxonomic tree

Kingdom: Animalia
- Phylum: Arthropoda
  - Class: Insecta
    - Order: Lepidoptera
      - Superfamily: Noctuoidea
        - Family: Arctiidae
          - Genus: Amsacta
            - Species: *Amsacta lactinea*

Bangladesh status: Not present in Bangladesh [CABI, 2011].

5.3.6.2. Biology

Females of a similar species, *A. moorei*, may lay 500-1900 eggs during their life spans (CABI, 2011). After eclosion, early instar larvae feed gregariously. Later instars spread throughout the field (CABI, 2011). Adults of *A. moorei* are poor fliers, but they are strongly attracted to artificial light-especially males (CABI, 2011). For *A. lactinea* raised in the laboratory on maize, the incubation period ranged from 3 to 4 days, the total larval period from 24.8±1.3 to 31±1 days, and the total life cycle ranged from 35.8±2.3 days in the 1st generation (beginning of July to end of August) to 252±4 days in the 3rd generation (mid-October to end of June) (Yazdani et al., n.d.). Hence, *A. lactinea* may have several generations per year.

5.3.6.3. Hosts

a. Major hosts: The main host of *A. lactinea* orchid *Oncidium* sp., *Arachis* sp., *Helianthus annuus*, *Leucaena leucocephala*, *Phaseolus* sp., *Glycine* sp., *Camelia sinensis* and *Gossypium* sp. *etc.*

b. Minor hosts: The minor or other hosts of this pest include *Ligustrum sinennsis*, *Oriza* sp., *Phragmites australis*, *Ocimun basilicum*, and *Sapium sebiferum* etc.

5.3.6.4. Distribution

A. lactinea is distributed over several subtropical and tropical countries including China, India, Korea, Laos, Malaysia, Myanmar, Taiwan, Thailand, Vietnam (CABI, 2011).

5.3.6.5. Hazard Identification Conclusion

Considering the facts that *A. lactinea* -

- is not known to be present in Bangladesh [CABI, 2011].
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China, India, Korea, Laos, Malaysia, Myanmar, Taiwan, Thailand, Vietnam (CABI, 2011) from where flowers are imported to Bangladesh.
- Damage caused by early instars of *Amsacta lactinea* is easily detected as chlorophyll-free, whitish leaves, with the network of veins intact and larvae can easily live on the undersurface of leaves. The eggs are laid in grouped rows of 6-22 eggs, which makes their detection easier (CABI, 2011). Imported plants could also be placed in warm, indoor sites (such as greenhouses or shops) where the pests may proliferate. Bournier, (1986) suggested that rapid, long-distance dispersal is facilitated by wind and aircraft transport of infested plant materials. The flowers and foliages are imported from other countries through airfreight. Therefore, *A. lactinea* can easily enter in Bangladesh and establish.

- *Amsacta lactinea* 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 tour country 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 including India, Korea, Laos, Malaysia, Myanmar, Taiwan, Thailand, Vietnam (CABI, 2011). **b. Posibility of survival of this pest during transport, storage and transfer? No** • We found little information about dispersal potential for this species. But according to the information the climatic condition required for it's growth and survival are more or less similar with the transport conditions. So the pests could survive during transporting process. Therefore, this pest is rated with medium risk potential.	HIGH

Description	Establishment Potential
c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes, • Internationally, *A. lactinea* 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** • The host range of *A. lactinea* is very wide. It feeds on virtually all cultivated and wild vegetation. Some affected host are orchid *Oncidium* sp. (Orchidaceae) (BAPHIQ, 2007; TARI, 2009), *Arachis* sp. (Peanut Crop Germplasm Committee, 2003), *Leucaena leucocephala* (Wu et al., 2007), *Phaseolus* sp., (Sharma and Ramamurthy, n.d.), *Glycine* sp. (Jayappa *et al*., n.d.), *Camelia sinensis* (Banerjee, 1987), *Gossypium* sp. (Gentry, 1965), *Ligustrum sinennsis* (Zhang et al., 2008), *Oriza* sp. (Maxwell-Lefroy, 1907; Gentry, 1965), *Phragmites australis* (Wen et al., 2007; Maxwell-Lefroy, 1907; Gentry, 1965), *Helianthus annuus* (IKISAN, 2009), *Ocimun basilicum* (Wen et al., 2007), and *Sapium sebiferum* (TARI, 2009). The numbers of plants attacked belong to the families Asteraceae, Euphorbiaceae, Fabaceae, Lamiaceae, Malvaceae, Oleaceae, Orchidaceae, Poaceae, Rosaceae, and Theaceae. • This species is distributed over several subtropical and tropical countries including China, India, Korea, Laos, Malaysia, Myanmar, Taiwan, Thailand, Vietnam (CABI, 2011). These places correspond to almost all of 30 Agro-Ecological Zones (AEZ) of Bangladesh. Based on this distribution, we estimate that this pest species can become establish into different AEZ of Bangladesh	
• NOT AS ABOVE OR BELOW	**Yes & 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 Bangladesh 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. • *Amsacta lactinea* may not be of significant impact on the ornamental production under greenhouse conditions, but if introduced on field crops it could cause damage and economic losses. Seedlings of certain crops (e.g., clusterbean, *Cyamopsis tetragonolobus*) are completely killed because the larvae feed on the soft stem rather than on leaves (CABI, 2011). • If introduced, this pest could lower the yield of several crops of economic	**Yes and High**

Description	Consequence potential
importance and may cause plant mortality, but damages depend upon the type of crop and the growth stage affected. • Little information has been found about dispersal potential for this species. Females of a similar species, *A. moorei*, may lay 500-1900 eggs during their life spans (CABI, 2011). After eclosion, early instar larvae feed gregariously. Later instars spread throughout the field (CABI, 2011). Adults of *A. moorei* are poor fliers, but they are strongly attracted to artificial light–especially males (CABI, 2011). For *A. lactinea* raised in the laboratory on maize, the incubation period ranged from 3 to 4 days, the total larval period from 24.8±1.3 to 31±1 days, and the total life cycle ranged from 35.8±2.3 days in the 1st generation (beginning of July to end of August) to 252±4 days in the 3rd generation (mid-October to end of June) (Yazdani et al., n.d.). Hence, *A. lactinea* may have several generations per year. • *A. lactinea* 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** • *Amsacta lactinea* may not be of significant impact on the ornamental **production** under greenhouse conditions, but if introduced on field crops it could cause damage and economic losses, e.g., the Peanut Crop Germplasm Committee (2003) rated the economic impact for this pest in peanuts growing areas as medium. Damage caused by a larva from a similar *Amsacta sp*. differs from crop to crop. Seedlings of certain crops e.g., clusterbean Cyamopsis tetragonolobus are completely killed because the larvae feed on the soft stem rather than on leaves (CABI, 2011). Other crops, such as pearl millet (Pennisetum glaucum**)** mostly survive damage. If introduced, this pest could lower the yield of several crops of economic importance and may cause plant mortality, but damages depend upon the type of crop and the growth stage affected. Controlling this pest will increase production costs. The risk rating for the Economic Impact of this pest is High. **c. Environment Impact** • Hosts include species of Helianthus (IKISAN, 2009). This genus includes one endangered species, *H. schweinitzii*, and one threatened species, *H. paradoxus*, in the continental United States (50 CFR§17.12, 2005). Outbreaks would likely trigger increased chemical control programs. The risk rating for the Environmental Impact of this pest is High	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	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

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.
- To avoid the introduction of *A. lactinea* recommends that propagating material of Orchid other crops 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 cut flowers and for vegetables with leaves.

5.3.6.10. References

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Pest-5.3.7:	**Japanese Rose Beetle: *Popillia japonica* Newman**

5.3.7.1 Hazard Identification

Preferred Scientific Name: *Popillia japonica* Newman

Common names: Japanese beetle (English)

Taxonomic tree

- Domain: Eukaryota
  - Kingdom: Metazoa
    - Phylum: Arthropoda
      - Subphylum: Uniramia
        - Class: Insecta
          - Order: Coleoptera
            - Family: Scarabaeidae
              - Genus: *Popillia*
                - Species: *Popillia japonica*

EPPO Code: POPIJA. This pest has been included in EPPO A2 list: No. 40

Bangladesh status: Not present in Bangladesh [CABI, 2004; EPPO, 2014; EPPO, 2016].

5.3.7.2. Biology

P. japonica overwinters as a larva (usually 3rd instar) in a cell, about 15-30 cm deep in the soil. In the spring, when the soil temperature exceeds 10°C, the larvae resume feeding on plant roots at about 5 cm depth. Pupation usually occurs after a few weeks' feeding and the beetles emerge in late May to early July, depending on latitude. The average life of the adults is 30-45 days and the eggs are laid in the soil. After hatching from the eggs, the larvae feed in the soil. Normally, there is one generation per year but, at the northern edge of its range, a few individuals may need 2 years to complete the life cycle.

5.3.7.3. Hosts

a. Major hosts: The main host of *P. japonica includes Acer* (maples), *Asparagus officinalis* (asparagus), *Glycine max* (soybean), *Malus* (ornamental species apple), *Prunus* (stone fruit including plums, peaches etc), *Rheum hybridum* (rhubarb), *Rosa* (roses), *Rubus* (blackberry, raspberry), *Tilia* (limes), *Ulmus* (elms), *Vitis* (grapes), *Zea mays* (corn). *etc.*

b. Minor hosts: The minor or other hosts of this pest include *Aesculus* (buckeyes), *Althaea* (hollyhocks), *Betula* (birches), *Castanea* (chestnuts), *Hibiscus* (rosemallows), *Juglans nigra* (American walnut), *Platanus* (planes), *Populus* (poplars), *Salix* (willow), *Sassafras albidum* (common sassafras), *Sorbus americana* (American mountain ash), turf grasses. etc.

5.3.7.4. Distribution

P. japonica originates from northeastern Asia where it is native in northern China, Japan and in the Far East of Russia. It was introduced into North America and has become a more serious pest in the USA than in its area of origin (Balachowsky, 1962; USDA, 1975). The worldwide distribution has been presented below:

- **EPPO region**: Absent, except for one island in the Azores (Portugal), where the pest has spread from a USA air base; Russia (Far East).
- **Asia**: China (northeast; unconfirmed), Hong Kong, India (unconfirmed dubious record from northern India), Japan (including Hokkaido), Korea Democratic People's Republic (unconfirmed), Korea Republic (unconfirmed), Russia (only Far Eastern parts, Kurile Islands).
- **North America**: Canada (Nova Scotia, Ontario, Quebec; under eradication), USA (all states of eastern seaboard, and many other states east of the Rocky Mountains; California).
- **EU**: Absent.

5.3.7.5. Hazard Identification Conclusion

Considering the facts that *P. japonica* -

- is not known to be present in Bangladesh [EPPO, 2014; EPPO, 2016].
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China (northeast; unconfirmed), Hong Kong, India (unconfirmed dubious record from northern India), Japan (including Hokkaido), Korea Democratic People's Republic (unconfirmed), Korea Republic (unconfirmed), Russia (only Far Eastern parts, Kurile Islands). [CIE, 1978; EPPO, 2016; CABI 2004; Fleming, 1972a] from where flowers are imported to Bangladesh.

- The adults disperse locally by flight. In international trade, *P. japonica* adults have been intercepted on agricultural produce, on packaging and on ships and aircraft.

Larvae may be transported in soil around the roots of plants for planting [EPPO, 2016].

- *P. japonica* 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 India, China, Korea, Japan etc. • Outside of its native Japan, *Popillia japonica* is found in China, Russia, Portugal, Canada and the USA (CABI 2004). • Since the first detection in the United States in a nursery near Riverton, New Jersey in 1916, it has spread to many states east of the Mississippi River (except Florida), as well as parts of Wisconsin, Minnesota, Iowa, Missouri, Nebraska, Kansas, Arkansas and Oklahoma. Despite regulatory efforts, by 2002 it had become established in at least 30 states (status map). Of the states in the southern region, climatological studies predict that it will establish in all states bordering the Gulf of Mexico (Johnson and Lyon 1991). **b. Posibility of survival of this pest during transport, storage and transfer? Yes** • In international trade, *P. japonica* adults have been intercepted on agricultural produce, on packaging and on ships and aircraft. Larvae may be transported in soil around the roots of plants for planting. • Temperature and particularly soil moisture are the main factors limiting potential spread of the beetle into new areas. According to Fleming (1972a), the Japanese beetle is adapted to regions were the mean soil temperature is between 17.5 and 27.5^{0}C during the summer, and above -9.4^{0}C in the winter. • So, we can say that the climatic conditions required of *P. japonica* for growth and survival are more or less same with the storage condition. • 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, larvae and adult of *P. japonica* can easily survive within the root soil, leaves or flowers. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *P. japonica* 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**	**YES and HIGH**

climate is similar to places it is established?– Yes • More than 300 species of plants in 79 plant families are known to be host to Japanese beetle. o The beetles are particularly attracted to certain species of Aceraceae, Anacardiaceae, Betulaceae, Clethraceae, Ericaceae, Fagaceae, Gramineae, Hippocastanaceae, Juglandaceae, Lauraceae, Leguminosae, Liliaceae, Lythraceae, Malvaceae, Onagraceae, Platanaceae, Polygonaceae, Rosaceae, Salicaceae, Tiliaceae, Ulmaceae and Vitaceae (Fleming, 1972). o Some of the better-known hosts (CABI 2004) of this pest include species of: *Acer*, *Aesculus*, *Betula*, *Castanea*, *Glycine*, *Juglans*, *Malus*, *Platanus*, *Populus*, *Prunus*, *Rosa*, *Rubus*, *Salix*, *Tilia*, *Ulmus* and *Vitis,* among which many of these are available in Bangladesh. In Japan, the host range appears to be smaller than in North America (Fleming (1972b), • Temperature and particularly soil moisture are the main factors limiting potential spread of the beetle into new areas. According to Fleming (1972a), the Japanese beetle is adapted to regions were the mean soil temperature is between 17.5 and 27.5^{o}C during the summer, and above -9.4^{o}C in the winter. In addition, precipitation must be adequate and rather uniformly distributed throughout the year, averaging at least 25 cm during the summer. The distribution in Japan may be influenced by other species of *Popillia*, or other scarabs, competing for limited resources. • These climatic requirements for growth and development of *P. japonica* 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 Bangladesh 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**
a. Is this a serious pest of Bangladesh? - Yes. • *P. japonica* is a remarkably polyphagous species and has been recorded from 79 families with preference of hosts including the following important crops: *Acer*, *Aesculus*, *Betula*, *Castanea*, *Glycine*, *Juglans*, *Malus*, *Platanus*, *Populus*, *Prunus*, *Rosa*, *Rubus*, *Salix*, *Tilia*, *Ulmus* and *Vitis* (CABI, 2004). • *P. japonica* is rated so serious a pest in North America that many millions of US dollars have been spent in limiting its spread. It is less of a pest in Japan. • The adult beetles feed on foliage, flowers and fruits. The adults are gregarious and many beetles collect together on a single plant, so	**Yes and High**

Description	Consequence potential
individual plants or trees may be completely defoliated, while adjacent ones remain virtually undamaged. The beetles eat out holes between the leaf veins, skeletonizing the leaves. Feeding on flowers, especially roses, can cause loss of blooms. Maize is the field crop most seriously damaged in North America. The beetles cut off the maturing silk, preventing pollination; this results in malformed kernels and reduced yield. Beetles are also found in fields of soyabeans, clover and lucerne. • The natural habitat of the larvae is permanent pasture, where their feeding weakens growth and reduces resistance to drought. Most damage to other crops occurs where they follow grass, but the larvae can cause serious damage to strawberry plants and in nursery beds. • *P. japonica* 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** • *P. japonica* is the single most destructive insect pest on golf courses, lawns and pastures, and on herbaceous and woody landscape plants in the eastern USA (Tashiro, 1987; Potter, 1998; Vittum *et al.,* 1999). A decade ago it was estimated that more than $460 million is spent each year to control the grubs and adults, and about $156 million in renovating or replacing damaged turf or ornamental plants (USDA/APHIS, 2000). Damage to tree fruits, small fruits, maize, and soybeans is also significant. In addition, many millions of US dollars, and considerable quantities of pesticides, are also lost trying to limit the beetle's spread by nursery stock and aeroplanes in North America. The Japanese beetle has never been a major pest in Japan, and has not caused extensive damage up to this point in the Azores. Costs connected with quarantine concerns are likely to increase greatly with the discovery of the beetle on San Miguel Island, USA. **c. Environmental Impact** • This species has the potential to attack many major field crops, vegetables and cut flowers in Bangladesh. As a large chemical will be used for it's controlling. Therefore, it can impacts on ecological system. • *P. japonica* 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-7.3: Calculate risk

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. Possible Risk Management Measures

- Removal of soil from roots of nursery stock should also remove larvae. If necessary, soil may be fumigated or treated with insecticide. Beetles are usually eliminated from fruit by commercial grading, and further routine treatment of plants and produce is not usually practicable.
- EPPO suggests that countries may prohibit the importation of plants with roots from countries where *P. japonica* occurs. If they are imported, consignments should have close attention from inspection services, and this should extend to the packing materials.
- To prevent the introduction of larvae, EPPO recommends (OEPP/EPPO, 1990) that these consignments should have been planted in inorganic growing medium or in a growing medium which was treated by an EPPO-approved procedure, and kept under conditions which prevent re-infestation.
- A phytosanitary certificate may be required for cut flowers and for vegetables with leaves.

5.3.7.10. References

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Pest-5.3.8:	**Tapioca Scale: *Aonidomytilus albus* (Cockerell, 1893)**

5.3.8.1 Hazard Identification

Scientific Name: *Aonidomytilus albus* (Cockerell, 1893)

Synonyms:
Coccomytilus dispar (Vayssière) Takahashi, 1935
Lepidosaphes alba (Cockerell) Fernald, 1903
Lepidosaphes cockerelliana Kirkaldy, 1904
Lepidosaphes dispar
Mytilaspis (Coccomytilus) dispar Vayssière, 1914
Mytilaspis albus Cockerell, 1893
Mytilococcus dispar (Vayssière) Lindinger, 1943

Common names: Cassava scale;
Cassava stem mussel scale;
White mussel scale

Taxonomic tree

- Domain: Eukaryota
  - Kingdom: Metazoa
    - Phylum: Arthropoda
      - Subphylum: Uniramia
        - Class: Insecta
          - Order: Homoptera
            - Suborder: Sternorrhyncha
              - Superfamily: Coccoidea
                - Family: Diaspididae
                  - Genus: *Aonidomytilus*
                    - Species: *Aonidomytilus albus*

EPPO Code: AONMAL. This pest has been included in EPPO A2 list: No. 40

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

5.3.8.2. Biology

Adult female A. albus feed throughout their lives and, once adult, live for several months. The adult male lacks mouthparts, so cannot feed and lives only a few days.

The eggs hatch in 3-4 days; in 20-25 days the immature stages are fully grown (Lal and Pillai, 1981). The first-instar crawlers are the primary dispersal stage and walk to new areas of the plant or are dispersed by wind or animal contact. Mortality due to abiotic factors is high in this stage. There are two immature instars in the female and four in the male (including non-feeding pre-pupal and pupal stages). Reproduction is sexual. The sessile females mate with winged males, and begin to lay eggs approximately 2 days after reaching maturity (Anantanarayanan et al., 1957).

5.3.8.3. Hosts

a. **Major hosts:** The main crop species attacked by *A. albus* in the tropics are only the Mahihot and Cassava.

b. **Minor hosts:** The minor or other hosts include Chrysanthemum (daisy), *Rosa chinensis* (roses), *Salvia* sp. (sage), *Croton bonplandianus*, *Jatropha gossypiifolia* (bellyache bush), *Malvastrum americanum* (spiked malvastrum (Australia)), *Mangifera indica* (mango), Solanum (nightshade), *Turnera ulmifolia* (west Indian holly), *Carica papaya* (papaw).

5.3.8.4.Geographical distribution

- **Asia:** China (Tao, 1999), India (Sankaran *et al.*, 1984; APPPC, 1987; EPPO, 2014), Sri Lanka (Williams & Williams, 1988; EPPO, 2014), Thailand (Wongkobrat, 1988; Waterhouse, 1993; APPPC, 1987), Indonesia, Malaysia (Takahashi, 1942; EPPO, 2014), Taiwan.
- **Africa:** Angola, Cape Verde, Congo, Gambia, Ghana, Kenya, Liberia, Madagascar, Malawi, Mauritius, Mozambique, Nigeria, Senegal, Somalia, Tanzania, Uganda, Zambia (CABI, 2016).
- **North America:** Mexico, USA (CABI, 2016).
- **Central America and Caribbean:** Antigua and Barbuda, Bahamas, Barbados, British Virgin Islands, Cuba, Dominica, Dominican Republic, Grenada, Guadeloupe, Haiti, Honduras, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago, US Virgin Islands (CABI, 2016).
- **South America:** Argentina, Brazil, Colombia, French Guiana, Guyana, Peru, Suriname (CABI, 2016).

5.3.8.5. Hazard Identification Conclusion

Considering the facts that *A. albus* -

- is not known to be present in Bangladesh [EPPO, 2014].
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including Bahrain, China, India, Indonesia, Malaysia, Thailand, Sri Lanka, Taiwan (EPPO, 2014; Tao, 1999) from where flowers are imported to Bangladesh.
- The first-instar crawlers are the dispersal stage and move across quite short distances to new parts of the host-plant or to adjacent plants. Dispersal over longer distances is only possible with the assistance of wind or animals/humans (CABI, 2015). Dispersal of the sessile adults and immature stages between countries occurs through human transport of infested plant material, mainly on planting sticks rather than on stored tubers (CABI, 2015). Because this pest has high dispersal potential for long distance, the risk rating for establishment potential is high**.**

- *A. albus* 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,	

<table>
<tr><th>Description</th><th>Establishment Potential</th></tr>
<tr><td>

- This pest has been established in many Asian countries including Bahrain, China, India, Indonesia, Malaysia, Thailand, Sri Lanka, Taiwan (EPPO, 2014; Tao, 1999).
- *A. albus* 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 sticks of cassava.

b. Posibility of survival of this pest during transport? Yes

- Transport of infested planting sticks of cassava, and stored cassava, is the main risk of transporting *A. albus* to new territory. Transport of infested material through fields planted with cassava also risks spread of the infestation, as crawlers may drop (or be blown) off the harvested material onto uninfested plants still in the field.
- Dry conditions may make plants more susceptible to attack, and favour dispersal of the crawlers, which are vulnerable to drowning and being swept off the host in heavy rain and high winds.
- Dispersal of the sessile adults and immature stages between countries occurs through human transport of infested plant material, mainly on planting sticks rather than on stored tubers. 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, *A. albus* 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

- The preferred hosts of *A. albus* are species of *Manihot esculenta* (cassava), but this insect has been recorded feeding on a variety of hosts such as Chrysanthemum (daisy), *Rosa chinensis* (roses), *Salvia* sp. (sage), *Croton bonplandianus*, *Jatropha gossypiifolia* (bellyache bush), *Malvastrum americanum* (spiked malvastrum (Australia)), *Mangifera indica* (mango), Solanum (nightshade), *Turnera ulmifolia* (west Indian holly), *Carica papaya* (papaw), (CABI, 2015), among which mostly common in **Bangladesh**.
- These climatic requirements for growth and development of *A. albus* are more or less similar with the climatic condition of **Bangladesh**.

</td><td>YES
and
HIGH</td></tr>
<tr><td>• NOT AS ABOVE OR BELOW</td><td>Moderate</td></tr>
<tr><td>• 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 Bangladesh and your climate is not similar to places it is established</td><td>Low</td></tr>
</table>

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?

Description	**Consequence potential is:**
a. Is this a serious pest of **Bangladesh? - Yes**. • *A. albus* is a more or less serious pest of cassava in East and West Africa, Argentina, Brazil, Colombia, India, Madagascar, Mexico, Taiwan, Thailand, West Indies and USA (Florida) (Simmonds, 1960; Subramaniam et al., 1977; Anon., 1978; Vargas et al., 1978; Lal and Pillai, 1981; Wongkobrat, 1988). In Brazil, this species is a pest on *Manihot* and *Solanum* spp. (Foldi, 1988), and was regarded with potential pest status on Manihot spp. (source of Ceara rubber) by Bastos et al. (1979). It can cause serious damage locally in Kenya (Bruijn and Guthrie, 1982). Severe attacks on cassava cuttings kept for planting can lead to losses (Lal and Pillai, 1981; Chua and Wood, 1990); it is a field pest less often (Lal and Pillai, 1981). • This is a fairly serious pest of several important other crops rather than flowers for Bangladesh. **b.Economic impact and yield loss** o *A. albus* is only an occasional problem in the field; most often, it is a pest of cassava stems stored for later planting. Infested cuttings often do not root, and use of infested cuttings at planting can result in rooting failure of up to 80% (Lal and Pillai, 1981). Heavy infestation causes desiccation of the stems; in the field, this causes them to become thin and weak, and to break in the wind; death of the plant may result. Breakage of stems leads to profuse branching, and infested plants often appear bushy. The severity of attack becomes worse in drought conditions, aggravating drought stress (Lal and Pillai, 1981). • *A. albus* is a more or less serious pest of cassava in East and West Africa, Argentina, Brazil, Colombia, India, Madagascar, Mexico, Taiwan, Thailand, West Indies and USA (Florida) (Simmonds, 1960; Subramaniam et al., 1977; Anon., 1978; Vargas et al., 1978; Lal and Pillai, 1981; Wongkobrat, 1988). In Brazil, this species is a pest on Manihot and Solanum spp. (Foldi, 1988), and was regarded with potential pest status on Manihot spp. (source of Ceara rubber) by Bastos et al. (1979). It can cause serious damage locally in Kenya (Bruijn and Guthrie, 1982). Severe attacks on cassava cuttings kept for planting can lead to losses (Lal and Pillai, 1981; Chua and Wood, 1990); it is a field pest less often (Lal and Pillai, 1981). **c. Environmental Impact** • *A. albus* 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.	**Yes and High**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	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: Calculate risk

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

- Avoid importation of flowers and foliages 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 cut flowers, pre-export inspection is considered sufficient.
- Planting sticks of cassava, and stored cassava, should be thoroughly inspected for *A. albus* scales before export, as there is a risk of their dissemination on such material (Lozano et al., 1977). Imported planting material of cassava should also be thoroughly inspected before planting and treated if necessary, to kill any scale insects present.
- A phytosanitary certificate may be required for cut flowers and for vegetables with leaves.

5.3.8.10. References

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Pest-5.3.9:	**Silver leaf whitefly, *Bemisia tabaci (B biotype)***

5.3.9.1. 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]

5.3.9.2. 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.

5.3.9.3. 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.).

5.3.9.4. 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.*

5.3.9.5. Hazard Identification Conclusion

Considering the facts that *Bemisia tabaci* (Gennadius, 1889) -

- 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.

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

Table-9.1: 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**, • 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 of this pest during transport, storage and transfer? Yes** • The cutflowers are transported from India, China, Japan, Thailand, Taiwan, 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 crawlers of whitefly can easily survive on cutflowers, leaves and other planting material. On the other hand the temperature and other climatic condition required for it's growth and survival are more or less same with the transport condition. 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,** • Most of the vegetables, planting materials and flowers in Bangladesh are imported from India, Thailand, Japan and Europe countries. *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 cut flowers 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*. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • can become established 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,	**YES and HIGH**

Description	Establishment Potential
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 89.6°F (10 to 32°C). 80.6ûF (27°C) appears to be the optimal temperature for development. Under control conditions on cotton, the pest completes its development in 17 days at 86°F (30°C). In 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 Bangladesh 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?

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 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	**Yes and High**

Description	Consequence potential
(*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 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, 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	

Description	Consequence potential
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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-11.3: Calculate risk

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. Risk Management Measures

- Avoid importation of vegetables, flowers and foliages 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.

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ARTHROPOD: MITE PESTS

Pest-5.3.10:	Red spider mite: *Tetranychus evansi*

5.3.10.1 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 (English)
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].

5.3.10.2 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 neither 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.

5.3.10.3 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.

5.3.10.4 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).

5.3.10.5 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 flowers and foliages in Asia including Japan, Taiwan (EPPO, 2006) from where flowers 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.

5.3.10.6 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, • *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).	**YES and HIGH**

Description	Establishment Potential
• *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 of this pest during transport? Yes** • The mites are less likely to infest fruits, flowers and other planting material these only present a risk where peduncles are present (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 immature stage of mites can easily survive on flowers and foliages. On the other hand the temperature and other climatic conditions required for it's growth and survival are more or less similar similar with the transport condition. 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 or on roses, and nursery stocks, 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**.	
• 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 Bangladesh and your climate is not similar to places it is established	Low

5.3.10.7 Determine the <u>Consequence</u> 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. • 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 other crops rather than flowers for Bangladesh. **b. Economic impact and yield loss** • *Tetranychus evansi* is regarded as an important pest of cutflowers, 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. In some situations, the use of acaricides may be the explanation as to why *T. evansi* does not establish in protected conditions. In infested EPPO countries *T. evansi* can kill *Solanum nigrum* but such damage has not been noted on other host plants. 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** • *T. evansi* represents a potential threat to many crops. The establishment	**Yes and High**

Description	Consequence potential
of it could trigger chemical control programs by using different insecticides that are toxic and harmful to the environment. • 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. • The appearance of the *T. evansi* within new areas is in most cases, the result of movement of infested plant material. The movement and establishment of *T. evansi* 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 Bangladesh.	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: Calculate risk

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 Possible 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.

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DISEASE CAUSING PATHOGEN: FUNGI

Pest-5.3.11:	**Phytophthora root rot: *Phytophthora megasperma***

5.3.11.1 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]

5.3.11.2 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.

5.3.11.3 Hosts

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

5.3.11.4 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).

5.3.11.5 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 flowers and foliages in Asia including Japan from where flowers 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.

5.3.11.6 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. **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. *glycine* was formerly considered to be an A1 quarantine pest for EPPO (OEPP/EPPO, 1989), but was transferred to	**YES and HIGH**

<table>
<tr><th>Description</th><th>Establishment Potential</th></tr>
<tr><td>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 of this pest during transport, storage and transfer? Yes
• The fungus survives in crop debris in the soil, principally as oospores (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. 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 flowers and foliages or seeds.
b. 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 flower seeds from many flower 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. Theoretically, the fungus might be introduced with soil from infested fields.
c. Its host(s) are fairly common in Bangladesh and the climate is similar to places it is established – Yes
• Phytophthora megasperma has been recorded to attack multiple species in multiple families including: Liliaceae (asparagus), Brassicaceae (cabbage, cauliflower), Apiaceae (carrot), Solanaceae (tomato, potato, eggplant), Rosaceae (apple, apricot, cherry, plum, peach, strawberry and rose), Rutaceae (lemon, grape fruit), Asteraceae (sunflower), Poaceae (rice, sugar cane), Sterculiaceae (cacao), Cucurbitaceae (cucumber), Caryophyllaceae (carnation, Dianthus caryophyllus), Lauraceae (avocado) Malvaceae (hollyhock, Alcea rosea) (CABI, 2006).</td><td></td></tr>
<tr><td>• NOT AS ABOVE OR BELOW</td><td>Moderate</td></tr>
<tr><td>• 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 Bangladesh and your climate is not similar to places it is established</td><td>Low</td></tr>
</table>

5.3.11.7 Determine the Consequence establishment of this pest in Bangladesh

Table-13.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
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. • *Phytophthora megasperma* 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.	High
• Not as above or below	**Yes and Moderate**
• This is a **not** likely to be an important pest of common crops grown in Bangladesh	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: Calculate risk

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

- 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.

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DISEASE CAUSING PATHOGEN: BACTERIA

Pest-5.3.12:	**Bacterial stem crack of carnation: *Burkholderia caryophylli***

5.3.12.1 Hazard Identification

Scientific Name: *Burkholderia caryophylli* (Burkholder)

Synonyms: *Phytomonas caryophylli* Burkholder
Pseudomonas caryophylli (Burkholder)

Common names: Bacterial stem crack of carnation
Bacterial wilt of carnation
Carnation: bacterial stem crack;
Carnation: bacterial wilt

Taxonomic tree

Domain: Bacteria
Phylum: Proteobacteria
Class: Betaproteobacteria
Order: Burkholderiales
Family: Burkholderiaceae
Genus: *Burkholderia*
Species: *Burkholderia caryophylli*

EPPO Code: PSDMCA. This pest has been included in EPPO A2 list: No. 55

Bangladesh status: Not present in Bangladesh [EPPO/CABI, 1996]

5.3.12.2 Biology

The bacterium can only enter plants through wounds, and subsequently colonizes the vascular system of the stem and roots. The primary infection source is infected cuttings taken from mother plants with a latent infection. Bacteria can pass from one cutting to another in the water of the propagating bed or, if the cuttings are held in water, before planting out. The observed slow, scattered spread of the disease indicates that spread occurs only from one root system to another. Bacterial slime is exposed when stems crack and this inoculum may be transferred from one plant to another. Temperatures over 20°C accelerate bacterial growth and therefore symptom expression, while at low temperatures infected plants may show no symptoms. For more information, see Dowson (1929), Burkholder (1942), Dimock (1950), Hellmers (1958), Garibaldi (1967).

5.3.12.3 Hosts

Major hosts: Carnation

Minor hosts: *Dianthus barbatus* and *D. allwoodii* can be infected through artificial inoculation. In Florida (USA) and Japan, *Limonium sinuatum* is also reported to be infected (Jones & Engelhard, 1984; Nishiyama *et al.*, 1988).

5.3.12.4 Geographical distribution

Hungary, Israel, Italy, Norway, Poland, Slovakia, Sweden, Yugoslavia. Found in the past but not established in Denmark, France, Germany, Ireland, Netherlands and the UK. Also found in China, India, Israel, Japan, Taiwan, USA, Argentina, Brazil and Uruguay EPPO/CABI (1996).

5.3.12.5 Hazard Identification Conclusion

Considering the facts that *Burkholderia caryophylli* -

- is not known to be present in Bangladesh.
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asia including China (Jilin; unconfirmed), India, Israel, Japan (Shikoku), Taiwan from where flowers are imported to Bangladesh.
- 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.
- *Burkholderia caryophylli* 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, (Yes).** Many Asian countries including in China, India, Japan, Taiwan, as well as in USA, Argentina, Brazil and Uruguay EPPO/CABI (1996).	YES and HIGH

Description	Establishment Potential
b. Posibility of survival of this pest during transport, storage and transfer? Yes • The bacterium can only enter plants through wounds, and subsequently colonizes the vascular system of the stem and roots. Temperatures over 20°C accelerate bacterial growth and therefore symptom expression, while at low temperatures infected plants may show no symptoms. So, the pathogen may easily survive during storage, transport and transfer. **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. • Roots of infected plants, once wilting occurs, are more or less rotten, the plants being easily pulled out of the soil and, on cutting, roots show discontinuous brown spots which distinguish the disease from that caused by *Phialophora cinerescens* which leaves the roots apparently symptomless (EPPO/CABI, 1996a). • The symptoms of the plant included soft rot, wilting and necrosis (Chun and Jones, 2001). It also causes wilt, stem crack and stem rot (Coenye and Vandamme, 2003). • 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. • Its host(s) are fairly common in Bangladesh and the climate is similar to places it is established – Yes	
• 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 Bangladesh 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

Table14.2. – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • This is a serious pest of **Bangladesh**. Symptoms may take 2-3 years to manifest themselves, particularly when cuttings are mildly infected and maintained at relatively low temperatures. Foliage becomes greyish-green, later yellowing and wilting and then death may occur. At soil temperatures below about 17°C, a rapid multiplication of cells leads to tension around the vessels and longitudinal, internodal stem cracks appear, usually at the base of the plant, and later develop into deep cankers. At 20-25°C, cankers are more rare and wilting is the common	High

Description	Consequence potential
symptom. Roots of infected plants, once wilting occurs, are more or less rotten, the plants being easily pulled out of the soil and, on cutting, roots show discontinuous brown spots. • This is a fairly serious pest of several important flower and other crops for Bangladesh. **b. Economic impact and yield loss** • *B. caryophylli* has caused serious damage in the USA since its first report in 1940. Only minor losses occur in Europe and the Mediterranean region at present (EPPO/CABI, 1996c). **c. Environmental Impact** • Introduction of *B. caryophylli* into Bangladesh is likely to initiate chemical, because it is a serious pest of economically important cutflowers. • This species has the potential to attack many cutflowers and major field crops 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	**Yes and Moderate**
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	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: Calculate risk

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

5.3.12.9. Possible Risk Management Measures

Cuttings should be taken from separately grown mother plants derived from biologically tested, healthy cuttings. Disease-free mother plants should be used and rooting beds and soil should be fumigated.

5.3.12.10 References

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DISEASE CAUSING PATHOGEN: NEMATODE

Pest-5.3.13:	***Cyst nematode: Globodera rostochiensis* and *Globodera pallida***

5.3.13.1 Hazard Identification

- ***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 []

- ***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].

5.3.13.2 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, 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).

5.3.13.3 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. Five pathotypes are recognized within *G. rostochiensis* (Ro1-Ro5 international notation) and three in *G. pallida* (Pa1-Pa3) (Kort *et al*., 1977).

5.3.13.4 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.

- ***Globodera pallida***

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. More northerly in range than *G. rostochiensis*.

Oceania: New Zealand.

EU: Present.

5.3.13.5 Hazard Identification Conclusion

Considering the facts that *G. rostochiensis* and *G. pallida*

- are not known to be present in Bangladesh [EPPO, 1997; CABI, 2007].
- are 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 flowers and other above mentioned agricultural crops and their planting materials are imported to Bangladesh.
- These nematodes have 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* and *G. pallida* are the **quarantine pests** 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, • 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. rostochiensis* is a quarantine pest for CPPC and IAPSC. • The nematodes are already established in most or all areas in the	**YES and HIGH**

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 of this pest during transport, storage and transfer? Yes** • The cyst nematodes are dispersed with soil debris and plant material contaminated by the cysts and by infected or contaminated cutflowers, planting materials. (http://nematode.unl.edu/pest6.htm). • In general, the cyst nematodes will survive in any environment where cutflowers and potatoes can be grown. A period of 38-48 days (depending on soil temperature) is required for a complete life cycle of the 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). 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 reproductive organ of nematode can easily survive on cutflowers. **b. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *G. rostochiensis* and *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). **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* and *G. pallida* are about 15°C (Evans, 1968). • These climatic requirements for growth and development of *G. rostochiensis* and *G. pallida* 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 Bangladesh and your climate is not similar to places it is established	Low

5.3.13.7 Determine the <u>Consequence</u> establishment of this pest in Bangladesh

Table-13.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Potato 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. 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 become established in Bangladesh with High Risk potential. **c. Environmental Impact** • Introduction of Globodera rostochiensis into Bangladesh is likely to initiate	**Yes and High**

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 that are main crop including cutflowers 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table -13.3: Calculate risk

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

- 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.

5.3.13.10 References

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VIRUS AND VIROID

Pest-5.3.14:	*Chrysanthemum stem necrosis tospovirus*

5.3.14.1 Hazard Identification

Preferred Name: *Chrysanthemum stem necrosis tospovirus*

Common name: CSNV (acronym)

Synonyms: *Tomato spotted wilt virus* (TSWV)

Taxonomic tree

Domain: Virus
- Group: RNA viruses
  - Order: Mononegavirales
  - Family: Bunyaviridae
    - Genus: *Tospovirus*
      - Species: *Chrysanthemum stem necrosis tospovirus*

EPPO Code: CSNV00. This pest has been included in EPPO A1 action list: No. 313

Bangladesh status: Not present in Bangladesh [EPPO, 2006; CABI, 2007]

5.3.14.2 Biology

CSNV is transmitted and spread in nature by insects of the family Thripidae (Thysanoptera) in a persistent manner. *Frankliniella occidentalis* and *Frankliniella schultzei*, but not Thrips tabaci, are vectors of CSNV. *F. occidentalis* and *F. schultzei* have been used experimentally to transmit CSNV from Datura stramonium to leaf discs of petunia. *F. schultzei* transmits tospoviruses with great efficiency and has been proposed as an important vector of CSNV in Brazil.

5.3.14.3 Hosts

CSNV occurs on florists' chrysanthemum *Dendranthema x grandiflorum* and tomato (*Lycopersicon esculentum*). In the Netherlands, CSNV has been isolated from the chrysanthemum cultivars 'Cocarde', 'Fiji', 'Majoor Bosshardt', Reagan', 'Spider', 'Tiger', 'Tigerrag' and 'Vyking' (Verhoeven *et al*., 1996). In the UK, CSNV has been isolated from the chrysanthemum cultivars 'Fiji' and 'Calabria' (Mumford *et al*., 2003). There is a record of CSNV in one sample of *Gerbera* (Ravinkar *et al*., 2004).

5.3.14.4 Geographical distribution

Distributed in the Netherlands, Slovenia, UK, South America: Brazil (Sao Paulo, Minas Gerais).

5.3.14.5 Hazard Identification Conclusion

Considering the facts that CSNV -

- is not known to be present in Bangladesh [EPPO, 2016].
- is potentially economic important to Bangladesh because it is an important pest of flowers and Pest can be introduced by infected plants for planting of tomato and chrysanthemum and by viruliferous thrips (*Frankliniella occidentalis*, *F. schultzei*). [EPPO, 2016].

- CSNV 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 tour country via this pathway.

Table-14.1: 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 virus is not present in Asian countries, but the CSNV is transmitted and spread in nature by insects of the family Thripidae (Thysanoptera) in a persistent manner. *Frankliniella occidentalis* and *Frankliniella schultzei*, but not Thrips tabaci, are vectors of CSNV. *F. occidentalis* and *F. schultzei* have been used experimentally to transmit CSNV from Datura stramonium to leaf discs of petunia. *F. schultzei* transmits tospoviruses with great efficiency and has been proposed as an important vector of CSNV in Brazil. • In the Netherlands, CSNV has been isolated from the chrysanthemum cultivars 'Cocarde', 'Fiji', 'Majoor Bosshardt', Reagan', 'Spider', 'Tiger', 'Tigerrag' and 'Vyking' (Verhoeven *et al*., 1996). In the UK, CSNV has been isolated from the chrysanthemum cultivars 'Fiji' and 'Calabria' (Mumford *et al*., 2003). There is a record of CSNV in one sample of *Gerbera* (Ravinkar *et al*., 2004). **b. Posibility of survival of this pest during transport, storage and transfer? Yes** • CSNV moves only in its thrips vectors which can spread it between plants, fields or glasshouses in infested areas. In international trade, the virus could be carried long distances in cuttings and other vegetative plants for planting. • CSNV occurs on florists' chrysanthemum *Dendranthema x grandiflorum* and tomato (*Lycopersicon esculentum*). *Frankliniella occidentalis* and *Frankliniella schultzei*, but not Thrips tabaci, are vectors of CSNV. Therefore, this virus can survive within the body of vector during transportation, storage and transfer of cut flowers and foliages. b. **Does the pathway appear good for this pest to enter Bangladesh and establish? Yes** • Pest can be introduced through infected plants for planting of tomato and chrysanthemum and by viruliferous thrips (*Frankliniella occidentalis*, *F. schultzei*) CSNV spreads locally by thrips vectors. It is expected to become widespread and important (Bezerra *et al*., 1999). • The vectors can spread the virus between plants, fields or glasshouses in infested areas. In international trade, the virus can be carried over long distances in cuttings and other vegetative plants for planting or with plants infested with the vector. CSNV is known to have spread to the Netherlands in chrysanthemum cuttings imported from Brazil (Verhoeven *et al.,* 1996) as well as to the UK (Mumford *et al*., 2003) by the same route.	**Yes and HIGH**

• Because of this virus is not present in the countries including Japan, India, China, India, Thailand from where Bangladesh imports cut flowers and planting materials; therefore, this pest can not follow the pathway. **d. Are the hosts of this pest fairly common in Bangladesh and the climate is similar to places it is established – Yes** • On chrysanthemum, CSNV causes symptoms which are similar to those of TSWV. In the Netherlands, they were described as mild or severe necrotic streaks on the stem, wilting of leaves and stems, and chlorotic or necrotic spots and rings on some leaves. However, symptoms of CSNV are more severe and can result in complete necrosis of the stem resulting in wilting of sections of plants (Verhoeven *et al*., 1996). In Brazil, symptoms were described as necrotic lesions surrounded by yellow areas on leaves followed by necrosis on stems, peduncles and floral receptacles (Duarte *et al*., 1995). At the British outbreak, symptoms included distinct dark stem lesions with some leaf necrosis (Mumford *et al*., 2003). • On inoculated tomato cultivars 'Moneymaker', 'Pronto' and 'Trust', systemic symptoms have been described as chlorotic and necrotic lesions, chlorosis, rugosity and severe growth reduction, although not all inoculated plants developed symptoms (Verhoeven *et al*., 1996). • In the Netherlands, CSNV has been isolated from the chrysanthemum cultivars 'Cocarde', 'Fiji', 'Majoor Bosshardt', 'Reagan', 'Spider', 'Tiger', 'Tigerrag' and 'Vyking' (Verhoeven *et al* .,1996). In the UK, CSNV has been isolated from the chrysanthemum cultivars 'Fiji' and 'Calabria' (Mumford *et al* .,2003). There is a record of CSNV in one sample of *Gerbera* (Ravinkar *et al* ., 2003). • In artificial inoculation studies, CSNV induced symptoms on a large number of test plants (Duarte *et al*., 1995; Verhoeven *et al*., 1996; Bezerra *et al*., 1999). Other artificial hosts of CSNV identified in experiments are aubergine, cucumber and lettuce, bean, cowpea, pea and courgette (Bezerra *et al*., 1999), capsicum (Verhoeven *et al* ., 1996) and tobacco (Duarte *et al*., 1995; Verhoeven *et al* ., 1996).	
• 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 Bangladesh and your climate is not similar to places it is established	**Yes & 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. • CSNV poses a significant threat to chrysanthemum and tomato crops in those parts of the EPPO region where its known vector *F. occidentalis* is present and widespread. • CSNV causes a more severe disease on chrysanthemum than TSWV. In addition, *F. schultzei*, which is the major vector in Brazil (Bezerra *et al*., 1999), is present in glasshouses in the Netherlands and Belgium and has been reported in various southern countries of the EPPO region. The two geographically isolated outbreaks of CSNV in the Netherlands and the UK were both related to imported chrysanthemum cuttings from Brazil, which shows that there is a pathway for introduction (though no such direct pathway exists at the moment for tomato). • CSNV also poses a threat to tomato cultivation under glass. Another danger is that, because symptoms of CSNV closely resemble those caused by TSWV, they could easily be mistaken by the growers for this virus in nurseries that already have a TSWV problem. Although isolated outbreaks of CSNV can be eradicated (this has been achieved successfully in the Netherlands and in UK), it is desirable to avoid any further introductions. • This virus is a serious pest of Bangladesh. **b. Economic impact and yield loss** • In Brazil, CSNV is growing in economic importance as it continues to spread to new geographical areas since 1997. It is expected to become widespread and important (Bezerra *et al.,* 1999). Losses due to CSNV are difficult to determine as damage to chrysanthemum and tomato in Brazil due to CSNV has not been quantified. CSNV is now frequently detected on tomato, but had not reached epidemic proportions. • No specific data is available on losses in tomato as there are apparently 3 tospovirus species present on this host in Brazil and their effects differ from region to region. However, experimental work suggests that CSNV could kill tomato plants in a few days. Tomato and chrysanthemum are crops of major economic importance. It could be expected to be substantial. In addition, it can be noted that the eradication campaign has already cost the Netherlands 25–30 000 EUR. The cost of the British campaign against CSNV has not yet been calculated. **c. Environmental Impact** • Control of the disease is essentially targeted at eliminating or excluding the thrips vectors. Thrips are generally difficult to control with chemicals. They are very small and hard to detect; the prepupal and pupal stages survive in the soil and are difficult to treat. They have a high fecundity, which would hamper eradication in glasshouses. Resistance to the major classes of insecticides has also been reported in thrips. Resistance to insecticides is persistent (Lewis, 1997). • CSNV represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different pesticides that	**Yes and High**

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 Bangladesh.	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: Calculate risk

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

- Control of insect vector.
- Eradication of isolated outbreaks can be achieved by destruction of affected hosts and of the vector(s).

5.3.14.10 References

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Pest-5.3.15:	Tobacco ringspot nepovirus

5.3.15.1 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

5.3.15.2 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., *Epitrix hirtipennis* and aphids. The virus is readily transmitted mechanically to herbaceous hosts.

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).

5.3.15.3 Hosts

Major hosts: Tobacco, soyabeans, grapevine and *Vaccinium* spp., especially *V. corymbosum* and Cucurbitaceae.

Minor hosts: Herbaceous ornamentals (*Anemone*, *Gladiolus*, *Iris*, *Narcissus*, *Pelargonium*), *Anemone*, apples (*Malus pumila*), aubergines (*Solanum melongena*), 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.

5.3.15.4 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).

5.3.15.5 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 flowers and foliages in Asia including China, India (Tamil Nadu), Japan from where flowers are imported to 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.

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

Table-15.1: 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 • TRSV has its origin in central and eastern North America, but there are now scattered records from many countries around the world, most of which are probably associated with material exported from North America. Since the virus mostly does not cause striking symptoms or spread rapidly, it is difficult to determine from the published literature whether TRSV has established in the various countries in which it has been detected. **b. Posibility of survival of this pest during transport, storage and transfer? 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. • 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). A number of other vectors have been suggested: *Thrips tabaci* and *Melanoplus differentialis* (a grasshopper) for the disease on soyabeans, *Tetranychus* spp., *Epitrix hirtipennis* and aphids. Therefore, this virus can survive within the vectors during transport, storage and transfer its hosts. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? Yes** • Long-range dispersal in trade is in host plants and parts of plants,	**YES and HIGH**

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 Bangladesh and your climate is not similar to places it is established	Low

5.3.15.7 Determine the Consequence establishment of this pest in Bangladesh

Table-17. 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. • On woody fruit crops, TRSV has a certain impact on grapevines in northeastern USA, causing a decline. *Vitis vinifera* is most readily affected, but is relatively little grown in that area compared with interspecific hybrids which are less affected (Gonsalves, 1988). TRSV causes blueberry necrotic ringspot disease of susceptible cultivars of *Vaccinium corymbosum*. Infected bushes show a slow but steady decline in 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). • 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 flower and other crops for Bangladesh.	**Yes and High**

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). • 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. **c. Environmental Impact** • Control of TomRSV in established 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 pesticides 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table -15.3: Calculate risk

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

5.3.15.9 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.

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Pest-5.3.16:	***Chrysanthemum stunt viroid***

5.3.16.1 Hazard Identification

Preferred Name: *Chrysanthemum stunt viroid*

Synonyms: *Chrysanthemum stunt mottle virus*

Common names: Chrysanthemum stunt viroid (CSVd)

Stunt or measles of chrysanthemum

Taxonomic tree

Group: Viroids
Family: Pospiviroidae
Genus: Pospiviroid
Species: Chrysanthemum stunt viroid

EPPO Code: CHSXXX. This pest has been included in EPPO A2 list: No. 313

Bangladesh status: Not present in Bangladesh [CABI, 2007]

5.3.16.2 Biology

Initially, the lack of a suitable assay host was a major limitation in determining the nature of the causal agent. However, the disease agent is now known to be viroid in nature, consisting of an uncoated, low-molecular-weight RNA (Diener & Lawson, 1973). CSVd is closely related to potato spindle tuber viroid and cucumber pale fruit viroid. These three viroids have a similar experimental host range and symptomatology, as well as an identical electrophoretic mobility of their RNA bands (Kryczynski & Paduch-Cichal, 1987).

CSVd is easily transmitted by mechanical means and also by Cuscuta sp. Experiments in Poland showed that it can be seed- and pollen-transmitted in artificially infected tomato (Kryczynski et al., 1988).

The viroid appears unusually heat-stable (the thermal inactivation point being between 90 and 100°C) and infectivity is retained in extracts treated with alcohol. In dried tissue, the viroid remains infectious for at least 2 years and it can withstand freezing in vitro for at least 1 year.

5.3.16.3 Hosts

The main hosts of CSVd are florists' chrysanthemums (*Dendranthema morifolium*) and related ornamentals including *Chrysanthemum prealtum*, *D. indicum* and *Tanacetum parthenium*. Susceptibility varies between cultivars, but generally all-the-year-round cultivars are more susceptible.

Many other Asteraceae can be infected experimentally, such as: *Achillea* spp., *Ambrosia trifida*, *Anthemis tinctoria*, *Centaurea cyanus*, other *Chrysanthemum* spp., *Dahlia pinnata*, *Echinacea purpurea*, *Emilia javanica*, *Gynura aurantiaca*, *Heliopsis pitcheriana*, *Liatris pycnostachya*, *Senecio* spp., *Tanacetum* spp., *Venidium fastuosum* and *Zinnia elegans*. Of 39 species and cultivars found to be susceptible, only seven developed discernible symptoms.

5.3.16.4 Geographical distribution

EPPO region: Austria (found but not established), Belgium, Czech Republic, Denmark, France, Germany, Hungary (unconfirmed), Italy (including Sicily), Netherlands, Norway, Poland, Sweden, UK.

Asia: China (Jiangsu), India (Assam, Uttar Pradesh), Japan.

Africa: South Africa.

North America: Canada (Alberta, Nova Scotia, Ontario), USA (Kansas, Michigan, New York, Pennsylvania).

South America: Brazil (São Paulo).

Oceania: Australia (South Australia), New Zealand.

EU: Present.

5.3.16.5 Hazard Identification Conclusion

Considering the facts that CSVd -

- is not known to be present in Bangladesh [CABI, 2007; EPPO, 1997].
- is potentially economic important to Bangladesh because it is an important pest of flowers and foliages in Asian countries including Japan, India, China etc from where flowers are imported to Bangladesh.
- The major method of long distance international spread of the viroid is most unlikely by natural means, but can result from transplant of infected chrysanthemum plants and cuttings; there is also the possibility that the viroid is present in plant material of other species. CSVd is easily transmitted by *Cuscuta* sp. reported by Keller (1953) but not confirmed by Hollings & Stone (1973). Experiments in Poland showed that it can be seed- and pollen-transmitted in artificially infected tomato (Kryczynski *et al.*, 1988).

- CSVd is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table -16.1: 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 established in many Asian countries including China, India, and Japan. **b. Posibility of survival of this pest during transport, storage and transfer? Yes** • International spread of the viroid is most unlikely by natural means, but can result from transplant of infected chrysanthemum plants and cuttings; there is also the possibility that the viroid is present in plant material of other species. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? Yes** • CSVd is easily by natural means, but can result from transplant of infected chrysanthemum plants and cuttings; there is also the possibility that the viroid is present in plant material of other species, also transmitted by mechanical means and by *Cuscuta* sp. Experiments in Poland showed that it can be seed- and pollen-transmitted in artificially infected tomato (Kryczynski *et al.*, 1988). • Plants infected the previous summer produce far fewer laterals the following spring. Leaves are reduced in number and size; a striking crinkle symptom is found in cvs Blanche and Yellow Garza, the leaf surface being wavy or crumpled with associated yellowish-green patches. Stems become very brittle and break easily where they branch. *Tanacetum parthenium* cv. Matricaria Golden Ball may show a dwarfing with associated pale leaves	**YES and HIGH**

and shortened, crowded inflorescences. • *Chrysanthemum prealtum* may develop rosetting. **d. Are the host(s) of this pest fairly common in Bangladesh and the climate is similar to places it is established? Yes** • The common hosts of this virus are chrysanthemum and other related ornamentals and these hosts are common in Bangladesh. • The climatic conditions of India, Japan, China, 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 Bangladesh and your climate is not similar to places it is established	Low

5.3.16.7 Determine the Consequence establishment of this pest in Bangladesh

Table -16.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. This is a serious pest of Bangladesh. Yes • Plants infected thethis viroid produce far fewer laterals in chrysanthemum. Leaves are reduced in number and size; a striking crinkle symptom is found in cvs Blanche and Yellow Garza, the leaf surface being wavy or crumpled with associated yellowish-green patches. Stems become very brittle and break easily where they branch. *Tanacetum parthenium* cv. Matricaria Golden Ball may show a dwarfing with associated pale leaves and shortened, crowded inflorescences. • This is a fairly serious pest of several important flower and other crops for Bangladesh. **b. Economic impact and yield loss** • Chrysanthemum stunt was first recognized in the USA, in a disastrous epidemic in 1947. It is a serious disease; in the year of infection, plant height may be reduced by 55% and, if cuttings from such plants are used, reductions in height of over 90% may result the following year. Moreover, within 2 years, the number of cuttings which can be produced from infected mother plants may be reduced by 90%. The induction of early flowering has serious consequences for producers of pot plants. **c. Environmental Impact** • Chrysanthemum stunt viriod represents a potential threat to many crops. The establishment of it could trigger chemical control programs by using different pesticides that are toxic and harmful to the environment.	**Yes and High**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-16.3: Calculate risk

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

5.3.16.9 Possible Phytosanitary Measures

- Use of viroid-free propagation material.
- Good plant hygiene measures (e.g. use of disposable blades and gloves when taking cuttings, removal of dead material etc) can help to limit spread (Horst & Nelson, 1997).

5.3.16.10 References

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Pest-5.3.17:	Parthenium weed: *Parthenium hysterophorus*

5.3.17.1 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
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.

5.3.17.2 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).

5.3.17.3 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).

5.3.17.4 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.

Exoticdistribution

- **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.

5.3.17.5 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.

5.3.17.6 Determine likelihood of pest establishing in Bangladesh via this pathway

Table -17.1: 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, • *Parthenium hysterophorus* (Asteraceae) is an annual plant (or short-lived perennial under certain growth conditions) native to the subtropics of North and South America. The plant has been introduced accidentally to Australia, and to many countries in Africa, Asia and the Pacific where it is considered invasive. • It has also been recorded in Egypt (Boulos& El-Hadidi, 1984), but information on its exact situation in this country is lacking.The species is recorded as casual in Belgium (Verloove, 2006) and Poland (Mirek*et al*., 2002). • 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. *P. hysterophorus* has been determined as a priority for Pest Risk Analysis according to the EPPO Prioritization process for invasive alien plants (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 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.	**YES and HIGH**

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) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • 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. • The distribution and abundance of *P. hysterophorus* may be affected markedly by land use, since it favours open habitats subject to a relatively high frequency of disturbance (Navie*et al*., 1996a; Dale, 1981).	
• 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 Bangladesh and your climate is not similar to places it is established	Low

5.3.17.7 Determine the Consequence establishment of this pest in Bangladesh

Table-17.2: 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	**Yes and 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 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 Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table-17.3: Calculating risk

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

5.3.17.9 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.

5.3.17.10 References

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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 fresh cut flowers and foliage pathway to Bangladesh from India, China, Thailand, Japan and Malaysia and other exporting countries, the among 18 potential hazard organisms, all of 18 hazard organisms were identified with high risk potential.

The overall pest risk potential ratings of 18 quarantine pests of cut flowers and foliages 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	*Frankliniella occidentalis*	Western flower thrips	Thripidae	Homoptera	**High**
2	*Liriomyza trifolii*	Chrysanthemum leaf miner	Agromyzidae	Diptera	**High**
3	*Liriomyza huidobrensis*	Pea leaf miner	Agromyzidae	Diptera	**High**
4	*Spodoptera littoralis*	Cotton leaf worm	Noctuidae	Lepidoptera	**High**

Sl. No.	Potential Hazard Organism	Common name	Family	Order	Pest Risk Potential
5	*Cacoecimorpha pronubana*	Carnation tortrix moth	Tortricidae	Lepidoptera	**High**
6	*Amsacta lactinea*	Red tiger moth	Arctiidae	Lepidoptera	**High**
7	*Popilla japonica*	Japanese rose beetle	Scarabaeidae	Coleoptera	**High**
8	*Aonidomytilus albus*	Tapioca scale insect	Diaspididae	Homoptera	**High**
9	*Bemisia tabaci (B biotype)*	Silver leaf whitefly	Aleurodidae	Homoptera	**High**
Mite					
10	*Tetranychus evansi*	Red spider mite	Tetranychidae	Acarina	**High**
Fungus					
11	*Phytophthora megasperma*	Phytopthora root rot	Peronosporaceae	Peronosporales	**High**
Bacteria					
12	*Burkholderia caryophylli*	Bacterial stem crack of carnation	Burkholderiaceae	Burkholderiales	**High**
Nematode					
13	*Globodera rostochiensis*	Golden cyst nematode	Heteroderidae	Tylenchida	**High**
14	*Globodera pallida*	Pale cyst nematode	Heteroderidae	Tylenchida	**High**
Virus and viroid					
15	*Chrysanthemum stem necrosis tospovirus*	Chrysanthemum stem necrosis virus	Bunyaviridae	Unassigned (-ve)ssRNA	**High**
16	*Tobacco ringspot nepovirus*	Tobacco ringspot virus	*Secoviridae*	*Picornavirales*	**High**
17	*Chrysanthemum stunt viroid*	Stunt of chrysanthemum	Pospiviroidae	Group: Viroids	**High**
Weed					
18	*Parthenium hysterophorus*	Parthenium weed	Asteraceae	Asterales	**High**

CHAPTER 5

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 cut flower and foliages from India, China, Thailand, Japan and Malaysia 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 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

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 Agricultural Extension of Bangladesh.

Treatment of the consignment

The cut flower and foliages from which the cut flowers and branches were 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 with all cut flower and foliages 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 cut flowers and foliages have:

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

AND, ONE OR MORE OF THE FOLLOWING;

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

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

xii) undergone methyl bromide fumigation, within 5 days of shipment the consignment, at a approved temperature/dosage/duration combination, under vacuum (88 kPa), gradually returning to atmospheric pressure by the end of the period. The Ministry of Agriculture and Forestry of New Zealand approved a rate of fumigation at 10-14^{o}C temperature with a initial dose of methyl bromide @ 50gm^{-3} for 3 hours exposure time or at 15-25^{o}C temperature with a initial dose of methyl bromide @ 50gm^{-3} for 2 hours exposure time or at >25^{o}C temperature with a initial dose of methyl bromide @ 32gm^{-3} for 1 hours exposure time

xiii) undergone full immersion in water held at more than 50^{O}C (120^{O}F) for not less than 14 minutes, within 5 days of shipment the consignment.

xiv) undergone full exposure to vapour heat for not less than 1 hour at more than 46.6^{O}C (116^{O}F) and 90 to 98% relative humidity, within 5 days of shipment the consignment.

xv) been sprayed to run off (on all above-ground plant parts) with a approved fungicide and insecticide combination, 14 days AND 5 days prior to harvesting the foliage for export to Bangladesh.

Ministry of Agriculture and Forestry (MAF) of New Zealand approved fungicide and insecticide combinations include:

d) Benomyl and Methomyl, or
e) Captan and Cypermethrin, or
f) Thiram and Cypermethrin.

AND;

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

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 cut flowers and foliages 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 (PQW) under the Department of Agricultural Extension (DAE) of Bangladesh, and to conform with Bangladesh's current phytosanitary requirements".

AND, ONE OR MORE OF THE FOLLOWING;

- sourced from a pest free area that is, as verified by pest surveillance methods, free from______ **(named regulated pest(s))** ______
- sourced from a pest free place of production that is, as verified by pest surveillance methods, free from ______ **(named regulated pest(s))** ______
- fumigated with methyl bromide within 5 days of shipping at __________ **(Temperature /Initial dosage/Exposure time)** _____, and under vacuum (88 kPa) gradually returning to atmospheric pressure by the end of the fumigation period.
- treated by hot-water immersion for ____ **(Exposure time)** ___ at a minimum of ___ **(Temperature)** __, within 5 days of shipping.
- treated with vapour heat for ______ **(Exposure time)** ______ at _____ **(Temperature)** ____ and ___ **(% Relative humidity)** _____, within 5 days of shipping.
- harvested from plants that have been sprayed with __________ **(Active ingredient and dosage rate)** _____, 14 and 5 days prior to harvesting for export to Bangladesh.

AND;

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

6.1.8. Transit requirements

The cut flowers and foliages 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 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.