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

Pest Risk Analysis (PRA) of Onion and Garlic in Bangladesh




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DTCL

Development Technical Consultants Pvt. Ltd (DTCL)

JB House, Plot-62, Road-14/1, Block-G, Niketon
Gulshan -1, Dhaka-1212, Bangladesh
Tel: 88-02-9856438, 9856439
Fax: 88-02-9840973
E-mail: info@dtcltd.org
Website: www.dtcltd.org

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PEST RISK ANALYSIS (PRA) OF ONION AND GARLIC IN BANGLADESH

Panel of Authors

Prof. Dr. Md. Razzab Ali	Team Leader
Dr. M. M. Amir Hossain	Entomologist
Prof. Dr. M. Salahuddin M. Chowdhury	Plant pathologist
Prof. Dr. Md. Abdul Karim	Agronomist
Dr. Bazlul Ameen Ahmad Mustafi	Economist

DTCL Management

Md. Habibur Rahman	Chief Coordinator, Study Team
Md. Mahabub Alam	Coordinator, Study Team

Reviewed by

Md. Ahsan Ullah	Consultant (PRA)

Submitted to

Strengthening Phytosanitary Capacity in Bangladesh (SPCB) Project
Plant Quarantine Wing, Department of Agricultural Extension
Khamarbari, Farmgate, Dhaka

Submitted by

Development Technical Consultants Pvt. Ltd. (DTCL)

JB House, Plot-62, Road-14/1, Block-G, Niketon
Gulsan-1, Dhaka-1212, Bangladesh.
Tel: 88-02-9856438, 9856439, Fax: 88-02-9840973
E-mail: info@dtcltd.org Website: www.dtcltd.org

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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 Onion and Garlic in Bangladesh"** according to the provision of contract agreement signed between SPCB-DAE and Development Technical Consultants Pvt. Ltd. (DTCL) on December 2016. The PRA study is a five month assignment commencing from 1 January 2017 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 onion and garlic 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 21 major onion and garlic growing districts of Bangladesh. The study covered the interview 5800 onion and garlic farmers. The key informant interviews were conducted with the extension personnel at field and head quarter level of DAE, officials of Plant Quarantine Centers at Sea and land ports; Entomologist and Plant Pathologist of BARI/BADC and Agricultural Universities. A total of 30 key personnel were interviewed using a semi-structured KII Checklist. The survey was also covered 21 FGDs each of which conducted in one district for qualitative data and visits of the onion and garlic fields under sampled districts. The consultants also reviewed secondary sources of information related to PRA of onion and garlic.

The study findings evidenced that a total of 36 pests of onion and garlic were recorded in Bangladesh, of which 7 insect pests, 1 mite pests, 16 species of pathogenic microorganisms and 12 weeds. The study also revealed that 23 pests of onion and garlic were identified as quarantine importance for Bangladesh that included 6 insects and 2 mite pests, 1 snail, 13 disease causing pathogen including 7 fungus, 2 bacteria, 1 nematode, 3 viruses and one weed that could be introduced into Bangladesh through importation of commercially produced onion and garlic. 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, out of twenty two (22) potential hazard organisms, 17 hazard organisms were identified with high risk potential, 2 identified with moderate risk potential and 2 with low risk rating and 1 uncertain species was found which likely to be associated with host plants during importation from exporting countries, but remained as uncertain hazards due to lack of detail information.. These mean that these pests pose unacceptable phytosanitary risk to Bangladesh's agriculture.

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

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

sd/-

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

PREFACE

This report intends to respond to the requirement of the client according to the provision of contract agreement signed between Project Director of Strengthening Phytosanitary Capacity in Bangladesh (SPCB) and the Development Technical Consultants Pvt. Ltd. (DTCL) for **"Conducting Pest Risk Analysis (PRA) of Onion and Garlic 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 five month assignment commencing from 1 January 2017 under the SPCB-DAE.

Consultancy services for "Conducting Pest Risk Analysis (PRA) of Onion and Garlic in Bangladesh" were 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 onion and garlic, 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.

Sd/-
Dr. M. M. Amir Hossain
Managing Director
Development Technical Consultants Pvt. Ltd. (DTCL).
Gulshan-1, Dhaka-1212, Bangladesh

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 Consultants Pvt. Ltd. (DTCL) to carry out the "**Pest Risk Analysis (PRA) of Onion and Garlic in Bangladesh"**. The report has been prepared based on the past five months (January 2017 to May 2017) activities of the survey study in 21 major onion and garlic 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 Dr. M. M. Amir Hossain, (Entomologist), Prof. Dr. M. Salahuddin M. Chowdhury (Plant Pathologist), Prof. Dr. Md. Abdul Karim (Agronomist), Dr. Bazlul Ameen Ahmad Mustafi (Economist) of the PRA study team.

The authors are grateful to all persons involved in the PRA study. Our special gratitude to Md. Golam Maruf, 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 co-operations, 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 Mohammad Mohsin, Director, PQW of DAE for his kind cooperation and suggestions during the study period. The active support and inspiration and cooperation of Dr. M. M. Amir Hossain, Managing Director, Development Technical Consultants Pvt. Ltd. (DTCL) are praise-worthy during the entire period of study.

Sd/-

Prof. Dr. Md. Razzab Ali
Team Leader

ACRONYMS

AEO	: Agricultural Extension Officer
BADC	: Bangladesh Agricultural Development Corporation
BARI	: Bangladesh Agricultural Research Institute
BBS	: Bangladesh Bureau of Statistics
BRRI	: Bangladesh Rice Research Institute
CABI	: Centre for Agriculture Bio-resources International
DAE	: Department of Agricultural Extension
DD	: Deputy Director
DPP	: Development Project Proforma
DTCL	: Development Technical Consultants Ltd.
EPPO	: European and Mediterranean Plant Protection Organization
FAO	: Food and Agricultural Organization
FGD	: Focus Group Discussion
FPC	: Finite Population Correction
HQ	: Headquarter
IPM	: Integrated Pest Management
IPPC	: International Plant Protection Convention
ISPM	: International Standard for Phytosanitary Measures
KII	: Key Informant Interview
LMOs	: Living Modified Organisms
Ltd.	: Limited
OEPP	: Organization for European and Mediterranean Plant Protection
PFA	: Pest Free Area
PFPP	: Pest Free Place of Production
PPW	: Plant Protection Wing
PQ	: Plant Quarantine
PQW	: Plant Quarantine Wing
PRA	: Pest Risk Analysis
QC	: Quarantine Centers
RMG	: Readymade Garments
RNQPs	: Regulated Non-Quarantine Pests
SPCB	: Strengthening Phytosanitary Capacity in Bangladesh Project
ToR	: Terms of References
USD	: United States Dollar
WTO	: World Trade Organization

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EXECUTIVE SUMMARY

The study "Pest Risk Analysis (PRA) of Onion and Garlic in Bangladesh" documents the pests of onion and garlic available in Bangladesh and the risks associated with the import pathway of onion and garlic from the exporting countries namely India, China, Thailand, Myanmar, Japan, Indonesia, and any other exporting countries of the world into Bangladesh.

The findings evidenced that the 36 pests of onion and garlic were recorded in Bangladesh, of which 7 insect pests;1 mite pest; 16 diseases causing pathogens among which 10 diseases were caused by fungi, 2 caused by bacteria, 3 caused by nematode and 1 diseases of onion and garlic was caused by viruse and 12 weeds. The insect pests of onion and garlic reported were black cutworm (*Agrotis ipsilon*), onion thrips (*Thrips tabaci*), chilli thrips (*Scirtothrips dorsalis*), melon thrips (*Thrips palmi*), lesser armyworm (*Spodoptera exigua),* wireworm (*Melanotus communis)* and aphid (*Tetranychus urticae*)*.* The mite pest of onion and garlic recorded in Bangladesh was two spotted spider mite (*Tetranychus urticae*). Among these insect pests of onion and garlic, thrips was the more damaging than other arthropod pests. The thrips was designated as major pest of onion and garlic and caused damage with high infestation intensity. The pest status of all other insect pests was minor significance and caused low level of infestation.

A total number of 17 species of disease causing pathogens for onion and garlic were reported in Bangladesh, among which 10 diseases were caused by fungi, 2 caused by bacteria, 3 caused by nematode and 1 diseases was caused by virus. The incidences of fungal diseases of onion and garlic reported in Bangladesh were purple blotch complex (*Alternaria porri* and *Stemphylium vesicarium*), black mould of onion (*Aspergillus niger*), grey mould-rot (*Botryotinia fuckeliana* and *Botrytis aclada*), leaf spot (*Colletotrichum dematium*), anthracnose (*Glomerella cingulata*), charcoal rot (*Macrophomina phaseolina*), cottony soft rot (*Sclerotinia sclerotiorum*), basal rot (*Fusarium oxysporum*) and rust of onion (*Puccinia allii*). Whereas, the incidences of bacterial diseases of onion and garlic recorded in Bangladesh were bacterial root rot (*Pectobacterium carotovorum subsp. Carotovorum)* and bacterial canker or blast (*Pseudomonas syringae* pv. *syringae*). The nemic diseases of onion and garlic were common spiral nematode (*Helicotylenchus dihystera*), Longidorids (*Longidorus Micoletzky*) and root rot nematode (*Meloidogyne* Spp.). The viral diseases of onion and garlic reported in Bangladesh were *Leek yellow stripe potyvirus* (LYSP). Among these diseases, the purple blotch of onion and garlic, black mould of onion and root rot were more damaging than others. While other diseases were reported as minor diseases of onion and garlic and caused damage with low infection intensity in Bangladesh.

A total number of 12 weeds were reported as the problems in the field of onion were in Bangladesh. In onion and garlic as reported was common chamomile (*Chamomilla recutita*), bermuda grass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-galli*), goose grass (*Eleusine indica*), hogweed (*Polygonum aviculare*), green foxtail (*Setaria viridis*), black nightshade (*Solanum nigrum*), and parthenium weed (*Parthenium hysterophorus*). The parthenium weed (*Parthenium hysterophorus*) was recorded and found in some restricted areas of Bangladesh such as Rajshahi, Natore, Pabna, Kustia, Jessore districts. These districts are nearly attached with the western border of Bangladesh and eastern border of West Bengal of India. It was also reported that the Parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading. As a newly introduced weed, though Parthenium caused damage with low infestation intensity, but it could cause severe damage and spread to other areas, if not controlled properly. Other eleven weeds were reported as minor weeds with low infestation intensity in onion and garlic fields.

Information on pests associated with onion and garlic in the exporting countries—India, China, Japan, Thailand, Taiwan, Vietnam, Philippines, Indonesia, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, Brazil and Chile—revealed that pests of quarantine importance exist. The study that included 6 insect pests, 2 mite pests, 1 snail,12 disease causing pathogens including 6 fungi, 2 bacteria, 1 nematode, and 3 viruses; and 1 weed. Without mitigation, these pests could be introduced into Bangladesh through importation of commercially produced onion and garlic. Pests of quarantine importance included insect pests namely the quarantine insect pests are Western flower thrips (*Frankliniella occidentalis*), pea leaf miner (*Liriomyza huidobrensis*), onion fly (*Delia antiqua*), serpentine leaf miner (*Liriomyza trifolii*), leek moth (*Acrolepiopsis assectella*) and vegetable weevil (*Listroderes costirostris*).The quarantine mite pests of onion and garlic for Bangladesh are dry bulb mite (*Aceria tulipae*), bulb mite (*Rhizoglyphus echinopus*). The quarantine snail of onion and garlic is common garden snail (*Cornu aspersum*)

Twelve (12) disease causing pathogens have been identified as quarantine pests of onion and garlic for Bangladesh. Among these, 6 quarantine fungi named neck rot of onion (*Botryotinia porri*), leaf blight of onion (*Botryotinia squamosa*), white rot (*Stromatinia cepivora*), onion smut (*Urocystis cepulae*), downy mildew of onion (*Peronospora destructor*) and pink root rot (*Pyrenochaeta terrestris*); 2 quarantine bacteria namely yellow disease phytoplasmas (*Candidatus Phytoplasma*) and crown gall *(Rhizobium radiobacter*); 1 species of nematode namely stubby root nematodes (*Trichodorus*spp); 3 viruses namely *Tomato black ring virus, Onion yellow dwarf, Iris yellow spot virus*. One species of quarantine weed has been identified for Bangladesh named Parthenium *weed (Parthenium hysterophorus).*

The consequences and potential/likelihood of introduction of each quarantine pest were assessed individually, and a risk rating estimated for each. The consequence and potential of introduction value was estimated assessing biology, host, distribution, hazard identification, risk assessment, consequence assessment, risk estimation and risk management of the pests: The two values were summed to estimate an overall Pest Risk Potential, which is an estimation of risk in the absence of mitigation.

Out of 23 quarantine pests associated with the pathway risk were assessed. Out of 22 potential hazard organisms, 17 hazard organisms were identified with high risk potential, 2 were moderate and 2 were low and 1 uncertain species was found which likely to be associated with host plants during importation from exporting countries, but *Pyrenochaeta terrestris* (pink root rot) remained as uncertain hazards due to lack of its detail information. 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 spices industry and specific phytosanitary measures are strongly recommended. While for moderate risk potential pest, specific phytosanitary measures may be necessary to reduce pest risk.

CHAPTER 1

SCOPE AND METHODOLOGY OF PEST RISK ANALYSIS

1.1. Background

Pest risk analysis (PRA) is the process used by NPPOs to provide technical justification for phytosanitary measures. PRA is defined by the IPPC as—the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it. The process requires a risk assessment to characterize the risk and risk management to determine appropriate measures.

The International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO) provides guidance for conducting pest risk analyses. The methods used to initiate, conduct, and report these pest risk analyses are consistent with guidelines provided by the FAO (IPPC, 1996a). Biological and phytosanitary terms (e.g., introduction, quarantine pest) conform to those outlined in International Standards for Phytosanitary Measures Publication No. 5, Glossary of Phytosanitary Terms (IPPC, 2002a).

Pest risk analysis provides the rationale for phytosanitary measures for a specified PRA area. It evaluates scientific evidence to determine whether an organism is a pest. If so, the analysis evaluates the probability of introduction and spread of the pest and the magnitude of potential economic consequences in a defined area, using biological or other scientific and economic evidence. If the risk is deemed unacceptable, the analysis may continue by suggesting management options that can reduce the risk to an acceptable level. Subsequently, pest risk management options may be used to establish phytosanitary regulations. For some organisms, it is known beforehand that they are pests, but for others, the question of whether or not they are pests should initially be resolved.

The pest risks posed by the introduction of organisms associated with a particular pathway, such as a commodity, should also be considered in a PRA. The commodity itself may not pose a pest risk but may harbour organisms that are pests. Lists of such organisms are compiled during the initiation stage. Specific organisms may then be analyzed individually, or in groups where individual species share common biological characteristics.Less commonly, the commodity itself may pose a pest risk. When deliberately introduced and established in intended habitats in new areas, organisms imported as commodities (such as plants for planting, biological control agents and other beneficial organisms, and living modified organisms (LMOs) may pose a risk of accidentally spreading to unintended habitats causing injury to plants or plant products. Such risks may also be analyzed using the PRA process.

The PRA process is applied to pests of cultivated plants and wild flora, in accordance with the scope of the IPPC. It does not cover the analysis of risks beyond the scope of the IPPC. Provisions of other international agreements may address risk assessment (e.g. the Convention on Biological Diversity and the Cartagena Protocol on Biosafety to that convention).

Bangladesh has been importing bulbs of onion and garlic as well as seeds from different exporting counties such as India, Thailand, China, Myanmar, Japan, Indonesia, or other counties of the world. Due to imports ofonion and garlicfrom 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. Moreover, Bangladesh is highly suitable for onion and garlic production due to its favorable climatic, topography and other conditions like labour cost and relatively low capital investment in contrast with high value addition. Therefore, the pathway risk analysis of onion and garlic from exporting countries to Bangladesh is essential. In this context, the Pest Risk Analysis (PRA) of onion and garlic in Bangladesh is indispensable. Thus, the assignment on PRA of onion and garlicin Bangladesh was undertaken aiming to identify pests and/or pathways of quarantine concernfor the onion and garlicgrown 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 find out the potential hazard organisms like insect and mite pests, diseases, weeds, and other pests associated with onion and garlic imported from different exporting countries such as India, China, Thailand, Myanmar, Indonesia or other exporting countries of onion and garlic into Bangladesh. 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) of Bangladesh to identify insect and mite pests, diseases, weeds, and other pests associated with onion and garlic and/or pathways of quarantine pests to be associated with the onion and garlic which brings along with them a certain risk of the introduction of insect and mite pests, diseases and other pests that are harmful to agriculture in Bangladesh. The consulting Firm is required to identify the pests, pathway/s, evaluate their risk, endangered areas, and risk management options etc.

According to the Terms and Reference (ToR) of the study, the consulting firm is required to listing of the major and minor pests of onion and garlic in Bangladesh and identify quarantine pests of onion and garlic for Bangladesh that follow the pathway(s) during importation, as well as to evaluate their risk, and finally to formulate the risk management options etc.

1.4. PRA Areas

The entire Bangladesh is considered as the PRA areas in this risk analysis. But the onion and garlic are not grown all over the country. Therefore, the major onion-garlic growing districts of Bangladesh are considered as the PRA area in this Pest Risk Analysis Process. Moreover, onion and garlic are imported through different Sea and Land ports which are located all regions of Bangladesh, which are also considered as PRA areas. However, survey on insect and mite pests, diseases, weeds and other hazard organisms was done in major onioin and garlic growing districts of Bangladesh as well as ports through which onion and garlic are being imported into Bangladesh.

1.5. Methodology of Pest Risk Analysis

PRA process includes three major stages such as Initiation, Pest Risk Assessment and Pest Risk Management as adapted from ISPM No.22 (2007). The following methods were sequentially followed to conduct PRA of onion and garlic.The process and methodology for undertaking import risk analyses are shown in the following figure.

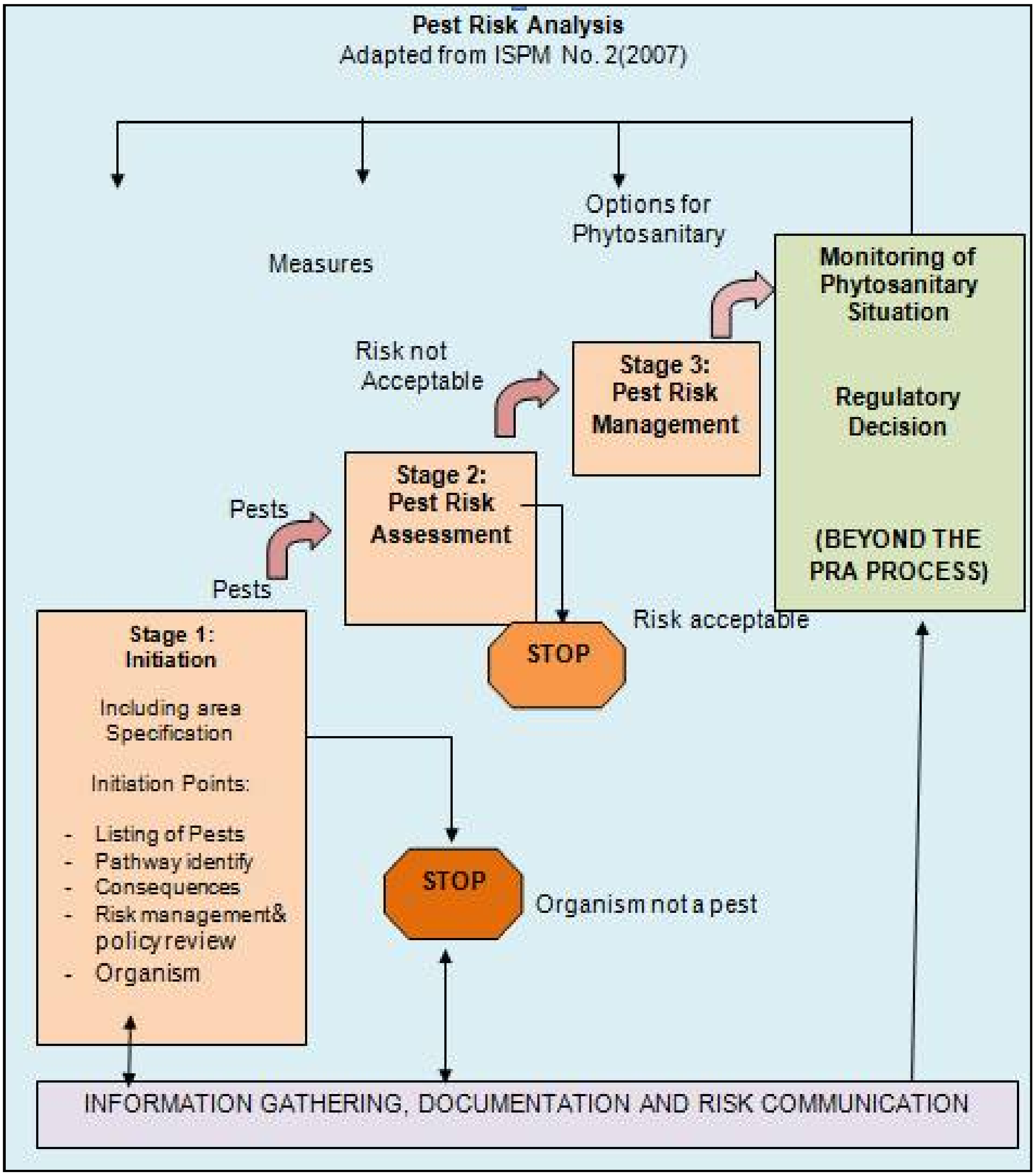


Figure 1: Schematic Diagram of Pest Risk Analysis

1.6. Methodology for data collection

Bangladesh till to date do not have any pest list of onion and garlic, so, to conduct PRA the study team first require an updated pest list of onion and garlic. Accordingly, the study team conducted a survey program through out the major growing districts of onion and garlic in Bangladesh and took help from the Universities and Research Institutes, Extentionists, relevant stakeholders and from CABI, EPPO to make a pest list of onion and garlic in Bangladesh. After completing the pest lists we have tried to asses the import risk of onion and garlic from the mentioned countries.

1.6.1. 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, weeds and other associated pests of onion and garlic, 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.

1.6.2. Field survey

The study survey was conducted with the direct interview of onion and garlic growers in 22 major onion and garlicgrowing 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 onion and garlic growers and through key informant interviews (KII) with extension personnel at field and headquarer level of DAE, Plant Quarantine Centres at the port of entry, Entomologist, Plant Pathologist and Agronomist of Bangladesh Agricultural Research Institute (BARI), Agricultural Universities and officials of BADC etc.

1.6.3. Secondary data collection and review

The current PRA related secondary data were collected and gathered from secondary sources such as journals, books, reports, proceedings, CD-ROM (CABI) search and others. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of onion and garlic available in the onion and garlic exporting counties namelyIndia, China, Thailand, Myanmar, Indonesia, Philippines, Vietnam, U.S.A, Australia, France, Germany, Italy, Netherlands, Brazil, Chille as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

1.6.4. Internet browsing

The PRA related information on pests of onion and garlic were also collected and gathered through internet browsing especially through websites of CAB International, EPPO Bulletin and different LAN based e-Journals namely TEEAL, HINARI, AGORA, OARE etc. The documents were then critically reviewed, synthesized in relation to identify the quarantine pests of onion and garlic available in the exporting counties of commodities as well as PRA related activities performed there. Ultimately, formulated all of these synthesized information based on the requirement of the current PRA.

1.6.5. Listing of pests of onion and garlic

There is no comprehensive list of onion and garlic pests in Bangladesh. Therefore, it is required to make a comprehensive list of insect and mite pests, diseases, weeds and other pests associated with onion and garlic in Bangladesh through primary and secondary data collection for conducting the pest risk analysis of onion and garlic. The insect and mite pests, diseases, weeds and other associated pests of onion and garlic were recorded and 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 onion and garlic in Bangladesh were also listed.

1.6.6. PRA location and study sampling

The survey study sas conducted in the 21 major onion and garlic 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 were selected under the 21 sampled distrcts, where 10 agricultural blocks were covered under each upazilla and 10 onion and garlic growingfarmers were interviewed in each block through pre-tested questionnaire. Thus, a total of 6000 growers/farmers were interviewed from all of 21 sampled districts. The focus group discussion (FGD) meeting was also conducted for each of 21 sampled districts with the participation of at least 10 onion and garlic growing 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 onion and garlic growing districts of Bangladesh

SN	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII
1	Faridpur	Sadar	10	100	1	1
		Nagarkanda	10	100		
		Bhanga	10	100		
2	Rajbari	Pansha	10	100	1	1
		Baliakandi	10	100		
		Kalukhali	10	100		
3	Madaripur	Shibchor	10	100	1	1
		Rajoir	10	100		
		Sadar	10	100		
4	Magura	Sreepur	10	100	1	1
		Sadar	10	100		
5	Shariatpur	Janghira	10	100	1	1
		Bedergonj	10	100		
6	Manikgonj	Shibaloy	10	100	1	1
		Horirampur	10	100		
		Sadar	10	100		
7	Sirajgonj	Tarash	10	100	1	1
		Sadar	10	100		
		Couhali	10	100		
		Kazipur	10	100		
8	Pabna	Chatmohor	10	100	1	1
		Sadar	10	100		
		Atghoria	10	100		
		Ishawadhi	10	100		
		Sathia	10	100		
		Sujanagar	10	100		
9	Natore	Gurudaspur	10	100	1	1
		Boroigram	10	100		
10	Dinajpur	Khanshama	10	100	1	1
		Chirirbandar	10	100		
11	Nilphamari	Sadar	10	100	1	1
		Kishoregonj	10	100		
12	Lalmonirhat	Hatibanda	10	100	1	1
		Sadar	10	100		
13	Chapainwabgonj	Shibgonj	10	100	1	1
		Sadar	10	100		
14	Jhenaidah	Coutcandpur	10	100	1	1
		Shoilakupa	10	100		
15	Noagaon	Atria	10	100	1	1
		Manda	10	100		
16	Rajshahi	Durgapur	10	100	1	1

SN	District	Upazilla	No. of Block	No. of Farmers	No. of FGD	KII
		Baghmara	10	100		
		Puthia	10	100		
17	Chuadanga	Damurhuda	10	100	1	1
		Sadar	10	100		
18	Kurigram	Roumari	10	100	1	1
		Ulipur	10	100		
		Nageshari	10	100		
		Bhurangamari	10	100		
		Sadar	10	100		
19	Gopalgonj	Mokshedpur	10	100	1	1
		Kasiani	10	100		
		Sadar	10	100		
20	Tangail	Bhuapur	10	100	1	1
		Sadar	10	100		
21	Joypurhat	Panchbibi	10	100	1	1
		Akkelpur	10	100		
		Sadar	10	100		
Total	**21**	**58**	**58**	**5800**	**21**	**21**

1.6.7. 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 21 major onion and garlic growing districts of Bangladesh through face to face interview with 5800onion and garlic growing farmers using a set of pre-designed and pre-tested questionnaire (**Appendix-1)** encompassing the relevant study indicators.

Focus Group Discussion (FGD) guidelines: For qualitative analysis, 21 FGD meetings were organized considering one FGD for each sampled districts with the participantion of at least 10 onion and garlic growing farmers for each. The FGD meetings were conducted using pre-designed FGD guidelines (**Appendix-2**).

Key Informant Interview (KII) checklists: The key informant interviews were conducted with the extension personnel of DAE, officials of Plant Quarantine Centres at Post of Entry; Entomologist and Plant Pathologist of BARI, Agricultural Universities, officials of BADC. A total of 30 key personnel were interviewed using a semi-structured KII Checklist (**Appendix 3-6)** encompassing the qualitative issues of the study.

Field visit/physical observation checklist: 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**.**

1.6.8. Interpretation of results

The collected information on pests of onion and garlic, their risk and management options were analyzed and interpreted. The most vulnerable stages of plant growth as well as parts of plants affected by the pests of onion and garlic were also determined based on both primary and secondary data. Finally, a checklist was prepared based on locally available pests of onion and garlic in Bangladesh as well as quarantine pests of onion and garlic recorded in exporting countries of onion and garlic into Bangladesh.

CHAPTER 2

METHODOLOGY OF RISK ANALYSIS

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

2.1. Undertaking of Pest Risk Analysis (PRA)

The study followed a systematic process of pest risk analysis framed as per ISPM No. 2. As per the 3 stages (I) Initiation (II) Pest Risk Assessment (III) Pest Risk Management, the study team evaluated the commodity and regulated articles and detection of pest for initiation stages.

PRA STAGE 1: INITIATION

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

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

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

PRA STAGE 2: PEST RISK ASSESSMENT

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

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

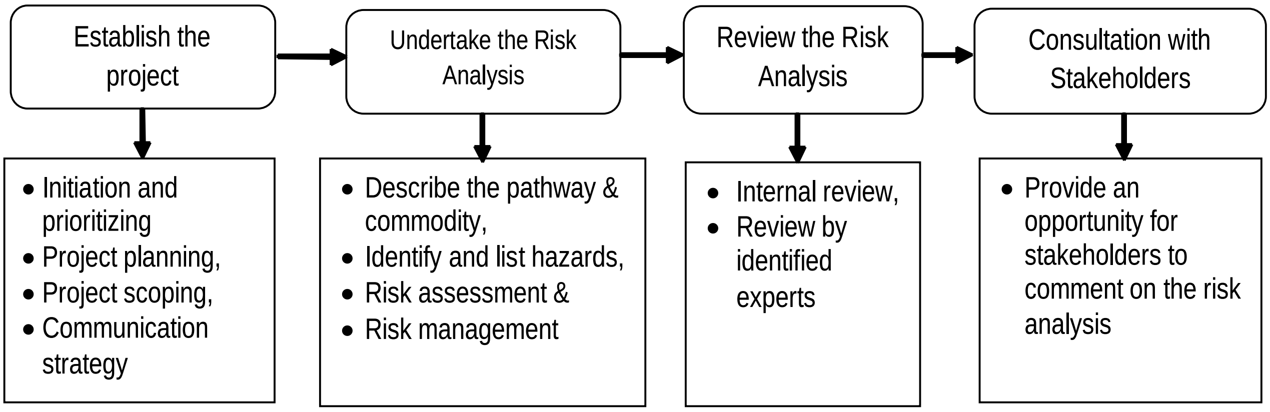
In most cases, these steps were applied sequentially in a PRA but it is not essential to follow a particular sequence. Pest risk assessment needs to be only as complex as is technically justified by the circumstances. This standard allows a specific PRA to be judged against the principles of necessity,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

PRA STAGE 3: PEST RISK MANAGEMENT

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

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

Figure 2: A summary of the risk analysis development process



2.2. Pathway Description

2.2.1. Import pathways of onion and garlic

For the purpose of this risk analysis, onion and garlic are presumed to be from anywhere in exporting countries such as India,China, Indonaessia, Japan, Thailand, Taiwan, Vietnamand Pakistan.

To comply with existing Bangladesh import requirements for onion and garlic, the commodity would need to be prepared for export to Bangladesh by ensuring certain pests (insect & mite pests, diseases, weeds or any othe pests) are not associated with the product. Commodity would then be sea or land or air freighted to Bangladesh where it go to a holding facility before being distributed to dealers, distributors, markets, sellers and farmers for cultivation or users of the imported onion and garlic.

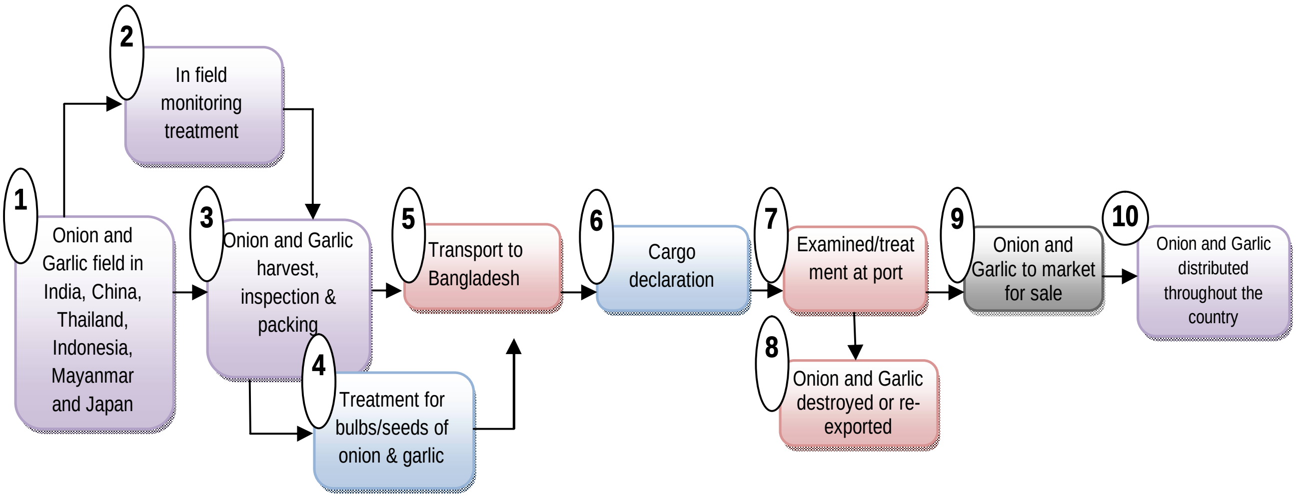
2.2.2. Pathway Description

- Onion and Garlic in India, China, Thailand, Indonasia, Japan, India, Pakistan are grown in the field;
- Monitoring of insect pests, diseases and other exotic pests is undertaken, with appropriate controls applied.
- Onion and Garlic are harvested, inspected and the best quality onion and garlic washed, pre-treated and packed in boxes.
- Post harvest disinfestations including are undertaken either before or during transport of the bulbs of Onion and Garlic and or seeds of Onion and Garlic Bangladesh.
- Transport to Bangladesh is by land, air or sea freighted.
- Each shipment must be accompanied by the appropriate certification, e.g. a phytosanitary certificate attesting to identity the tubers, any treatments completed, or other information required to help mitigate risks.
- Onion and garlic bulb and its seeds are examined at the border and or port of entry to ensure compliance.
- Any Onion and garlic and or onion and garlic seeds not complying with Bangladesh bio-security requirements (e.g. found harboring pest organisms) are either treated re-shipped or destroyed.
- Beside these, natural entry of some pests of onion and garlic may occure from other neighbouring country(ies) into Bangladesh. For example, dry bulb mite can transfer to long distance via aereial dispersal and can easily find their suitable hosts (Conijn *et al.,* 1996).
- Possibility of entry of pests of onion and garlic from exporting country(ies) into Bangladesh through transportation of commodities by escaping the phytosanitary inspection in the port of entry. For example, the eggs, larvae and pupae of leek moth may enter into Bangladesh through bulbs, tubers, corms, rhizoms, flowers,

inflorescences, leaves and stems by escaping the phytosanitary inspection during transportation. Because, the eggs and symptoms caused by this insect pest usually invisible when they present in croms, flowers, inflorescences, calyx etc.

- Onion and garlic and/or their seeds are stored/preserved before being distributed to market for sale.
- Dealers and sellers of onion and garlic stock and they are bought by consumers within the local area they are sold in.The linear pathway diagram of import risk of onion and garlic is furnished below:

Figure 3: Linear Pathway Diagram



2.3. Hazard Identification

The first step in this process is to identify organisms and diseases that could potentially be associated with the pathway in question, Onion and garlic from exporting countries. There are a number of limitations on the information that is available for the development of such a list of organisms or diseases. These limitations include:

- The information must be considered at least reasonably reliable and therefore be sourced from the scientific literature rather than the popular media or other such sources.
- Many organisms and diseases associated with a commodity will not have been identified in any scientific (or other) sources of information. This will vary depending on how well the commodity in question has been studied, which itself is most often a reflection of the commodities economic importance to a region or country.
- Many organisms have yet to be discovered or identified and as such may not be reported. Crous and Groenewald (2005) estimated that only 7% of the fungal species thought to exist are known to science.
- Organisms or diseases that are considered insignificant on the commodity in question may be under-reported, even though they may be significant for other commodities.

2.4. Risk Assessment of Potential Hazards

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

A risk assessment consists of four inter-related steps:

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

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

2.5. 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.

2.6. Risk Management Options

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 selected on the basis of a precautionary approach. The rationale for selecting measures must be made apparent.

Each hazard or group of hazards dealt with separately using the following framework:

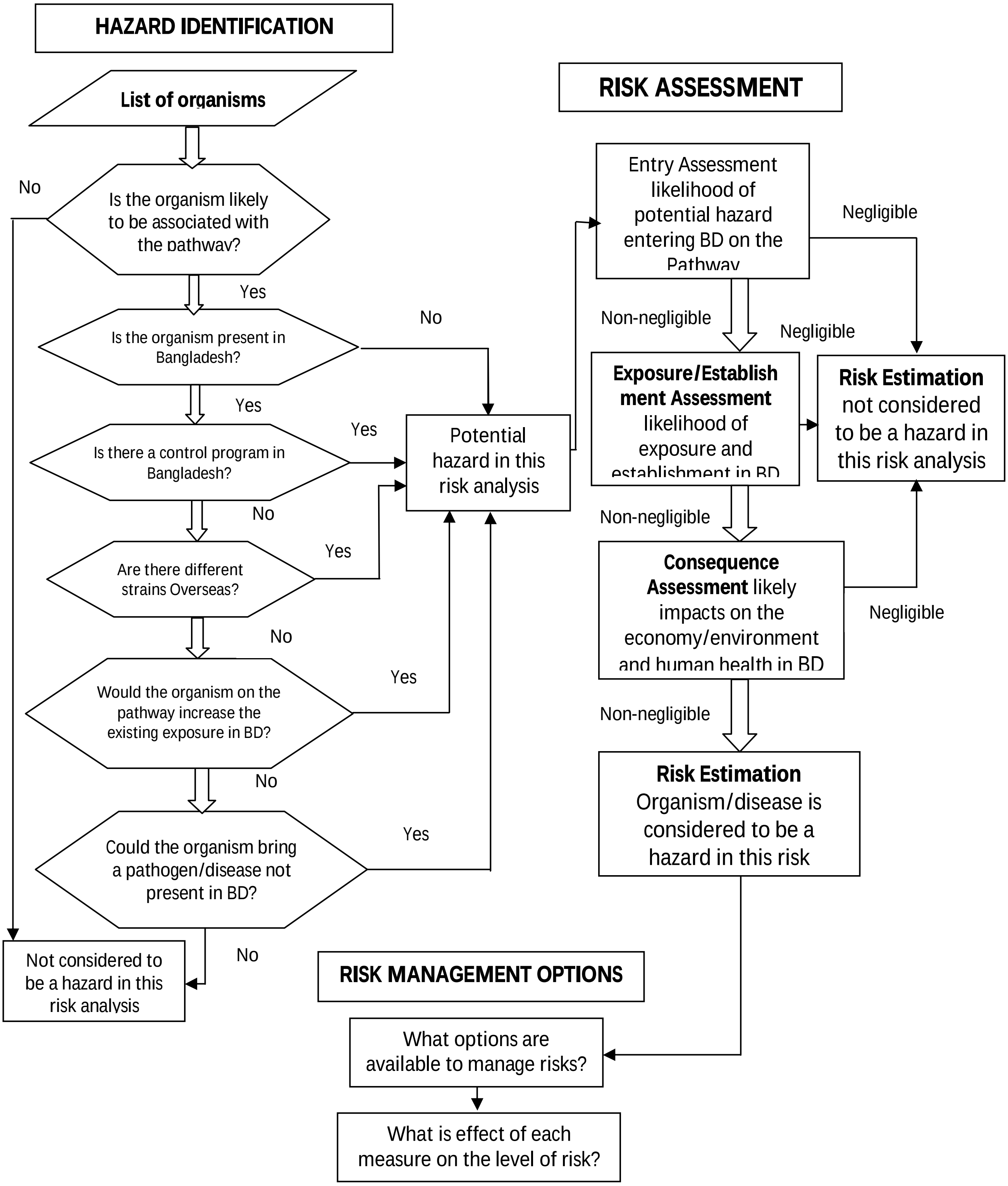
2.7. Risk Evaluation

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

2.8. 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, Pakistan, Japan, Thailand, Taiwan, Vietnam, Philippines and Indonesia) for onion and garlic bulb and seeds 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.

Figure 4. Diagram of the Risk Analysis Process:the three main aspects of analysis include hazard identification, risk assessment and risk management



2.9. 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.

2.10. References

Crous PW; Groenewald JZ (2005) Hosts, species and genotypes: opinions versus data. *Australasian Plant Pathology* 34: 463-470.

WRAP (2008) The food we waste. Waste & Resources Action Programme, Food Waste Report. Banbury, Oxon; pp 236. Available at http://www.wrap.org.uk/

DEFRA (2008) Basic Agricultural Statistics – Vegetable Section. Department for Environment, Food and Rural Affairs, UK. Available online: https://statistics.defra.gov.uk/esg/publications/bhs/2008/default.asp

CHAPTER 3

INITIATION

3.1. 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 onion and garlic. 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.

3.2. Commodity Description

3.2.1. General Description

Onion: Onion is believed to be indigenous to Asia and is thought to have originated in areas of Iran and West Pakistan. Onions were cultivated in the Middle East and India from as early as 320-2780 BC. The cultivation of onions in the new world is thought to have begun as early as 1629 (Databank and Evaluation Division- Jamaica Ministry of Agriculture & Fisheries, 2008).

Onion, *Allium cepa*, is an herbaceous biennial in the family Liliaceae grown for its edible bulb. The stem of the plant is a flattened disc at the base and the tubular leaves form a pseudostem where their sheaths overlap. The leaves are either erect or oblique and there are 3–8 per plant. The onion plant produces pink or white flowers clustered on stalks. The bulbs are formed just above the flattened stem of the plant by overlapping leaves. The bulb is made up of several layers, each corresponding to a leaf. They are are generally oval but shape can be variable and occur in clusters of 3–18 to a plant. The bulb is protected by a membrane which turns to a papery coat. Onion plants can reach a height of 50 cm (20 in) and are grown as annuals, harvested after one growing season. Onion may also be referred to by cultivar and these include red or purple onion, shallots and spring onions or scallions. The origin of the onion has not been conclusively determined although it is likely to be somewhere in South East Asia where the gene pool is most diverse.

Garlic: Garlic, *Allium sativum*, is a an herbaceous, annual, bulbous plant in the family Amaryllidaceae grown for its pungent, edible bulb of the same name. The garlic plant can either have a short, woody central stem (hardneck) or a softer pseudostem made up of overlapping leaf sheaths (softneck). Hardneck varieties produce a false flower stock which is termed a 'scape' and produce larger garlic cloves but in smaller numbers. Softneck garlic is the most popular variety of garlic grown in the US. The bulb can be up to 7 cm (2.8 in) in diameter and is made up of 1–15 cloves. The stem is very short and flattened and gives way to a pseudostem, The garlic plant can possess 6–12 flat, blade-like leaves which can stretch up to 50 cm (19.7 in) long. The plant can reach 60 cm (23.6 in) in height and is an annual, surviving only one growing season. Garlic is believed to originate from Asia.

3.2.2. Taxonomic position

A) Onion

Kingdom: Plantae
- Clade: Angiosperms
  - Clade: Monocots
    - Order: Asparagales
      - Family: Amaryllidaceae
        - Subfamily: Allioideae
          - Genus: Allium
            - Binomial name: *Allium cepa*

The **onion** (*Allium cepa* L., from Latin *cepa* "onion"), also known as the **bulb onion** or **common onion**, is a vegetable and is the most widely cultivated species of the genus *Allium*. A number of synonyms have appeared in its taxonomic history:

- *Allium cepa* var. *aggregatum* - G. Don
- *Allium cepa* var. *bulbiferum* - Regel
- *Allium cepa* var. *cepa* - Linnaeus
- *Allium cepa* var. *multiplicans* -L.H. Bailey
- *Allium cepa* var. *proliferum* - (Moench) Regel
- *Allium cepa* var. *solaninum* - Alef
- *Allium cepa* var. *viviparum* - (Metz) Mansf.

B) Garlic

Kingdom: Plantae
Clade: Angiosperms
Clade: Monocots
Order: Asparagales
Family: Amaryllidaceae
Subfamily: Allioideae
Genus: Allium
Binomial name:*Allium sativum*

3.2.3. History

Onion

Onions (*Allium cepa*) grew in Chinese gardens as early as 5000 years ago and they are referenced in some of the oldest Vedic writings from India. In Egypt, onions can be traced back to 3500 B.C. There is evidence that the Sumerians were growing onions as early as 2500 B.C

In Egypt, onions were considered to be an object of worship. The onion symbolized eternity to the Egyptians who buried onions along with their Pharaohs. The Egyptians saw eternal life in the anatomy of the onion because of its circle-within-a-circle structure. Paintings of onions appear on the inner walls of the pyramids and in the tombs of both the Old Kingdom and the New Kingdom. The onion is mentioned as a funeral offering, and depicted on the banquet tables of the great feasts “both large, peeled onions and slender, immature ones. They were shown upon the altars of the gods.

In India as early as the sixth century B.C., the famous medical treatise Charaka â€“ Sanhita celebrates the onion as medicine a diuretic, good for digestion, the heart, the eyes, and the joints.

Garlic

Garlic (*Allium sativum*) is an important spice crop belonging to the family Alliaceae along with onion, shallot and chives. Its folk medicinal use includes treatment of whooping cough, lung diseases, stomach complaints (as healing of ulcers of the intestines) and disorders resulting from child birth and as a specific for colds, sore eyes and ear-ache; Kostalova, (1982). Its ability to protect crop against a variety of fungal and bacterial diseases has been scientifically proven by researchers at the University of California in Berkley

Garlic was placed by the ancient Greeks (Theophrastus relates) on the piles of stones at cross-roads as a supper for Hecate, and according to Pliny garlic and onion were invocated as deities by the Egyptians at the taking of oaths.

It was largely consumed by the ancient Greeks and Romans, as we may read in Virgil's *Eclogues*. Horace, however, records his detestation of Garlic, the smell of which, even in his days (as much later in Shakespeare's time), was accounted a sign of vulgarity. He calls it 'more poisonous than hemlock,' and relates how he was made ill by eating it at the table of Maecenas. Among the ancient Greeks, persons who partook of it were not allowed to enter the temples of Cybele. Homer, however, tells us that it was to the virtues of the 'Yellow Garlic' that Ulysses owed his escape from being changed by Circe into a pig, like each of his companions.

Homer also makes Garlic part of the entertainment which Nestor served up to his guest Machaon.

There is a Mohammedan legend that:

> 'when Satan stepped out from the Garden of Eden after the fall of man, Garlick sprang up from the spot where he placed his left foot, and Onion from that where his right foot touched.'

There is a curious superstition in some parts of Europe, that if a morsel of the bulb be chewed by a man running a race it will prevent his competitors from getting ahead of him, and Hungarian jockeys will sometimes fasten a clove of Garlic to the bits of their horses in the belief that any other racers running close to those thus baited, will fall back the instant they smell the offensive odour.

3.2.5. Morphological characteristics

Allium sativum is a bulbous plant. It grows up to 1.2 m (4 ft) in height. Its hardiness is USDA Zone 8. It produces hermaphrodite flowers. It is pollinated by bees and other insects.

3.2.6. Onion and Garlic in Bangladesh

Agriculture is the largest employment sector in Bangladesh. As of 2016, it employs 46.5% of the total labor force and comprises 16% of the country's GDP. The performance of this sector has an overwhelming impact on major macroeconomic objectives like employment generation, poverty alleviation, human resources development and food security.

Spices are common item in food menus especially in Indian Sub-continent. International Standards Organization (ISO) listed 107 varieties of spices in the world. Spices are extensively used for nutritional merits, flavor, making food item tasty and delicious and preserving food. Traditionally, Bangladeshi food menus are spices dominated. The typical subsistence cropping system in Bangladesh was spices based. There are about 27 varieties of spices grown in Bangladesh (Spices Research Centre, 2005). Among them five major varieties of spice namely onion, garlic, chili, ginger and turmeric are common in Bangladesh cropping system. For food securities and policy support for rice culture, the areas under spices crops are gradually decreasing (Alam 2005). Beside these, increase in population as well as diverse ways of using spices lead to increase demand for spices.

3.2.7. Cultivation and Climatic requirements

The climate of Bangladesh is favorable for growing most of the vegetable crops specially onion and garlic.

1) Onions: Onions are best cultivated in fertile soils that are well-drained. Sandy loams are good as they are low in sulphur, while clayey soils usually have a high sulphur content and produce pungent bulbs. Onions require a high level of nutrients in the soil. Phosphorus is often present in sufficient quantities, but may be applied before planting because of its low level of availability in cold soils. Nitrogen and potash can be applied at regular intervals during the growing season, the last application of nitrogen being at least four weeks before harvesting. Bulbing onions are day-length sensitive; their bulbs begin growing only after the number of daylight hours has surpassed some minimal quantity. Onions may be grown from seed or from sets. Onion seeds are short-lived and fresh seeds germinate better. The seeds are sown thinly in shallow drills, thinning the plants in stages. In suitable climates, certain cultivars can be sown in late summer and autumn to overwinter in the ground and produce early crops the following year. Bulbing usually takes place after 12 to 18 weeks. The bulbs can be gathered when needed to eat fresh, but if they will be kept in storage, they should be harvested after the leaves have died back naturally. In dry weather, they can be left on the surface of the soil for a few days to dry out properly, and then they can be placed in nets, roped into strings, or laid in layers in shallow boxes. They should be stored in a well-ventilated, cool place such as a shed.

2) Garlic: The ground should be prepared in a similar manner as for the closely allied onion. The soil may be sandy, loam or clay, though Garlic flourishes best in a rich, moist, sandy soil. Dig over well, freeing the ground from all lumps and dig some lime into it. Tread firmly. Divide the bulbs into their component 'cloves' - each fair-sized bulb will divide into ten or twelve cloves - and with a dibber put in the cloves separately, about 2 inches deep and about 6 inches apart, leaving about 1 foot between the rows. It is well to give a dressing of soot. Garlic beds should be in a sunny spot. They must be kept thoroughly free from weeds and the soil gathered up round the roots.

3.2.8. Uses of onion and garlic

A) Onion

Historical use: The onion is easily propagated, transported, and stored. The ancient Egyptians revered the onion bulb, viewing its spherical shape and concentric rings as symbols of eternal life. Onions were even used in Egyptian burials, as evidenced by onion traces being found in the eye sockets of Ramesses IV. In ancient Greece, athletes ate large quantities of onion because it was believed to lighten the balance of the blood. Roman gladiators were rubbed down with onions to firm up their muscles. Doctors were known to prescribe onions to facilitate bowel movements and erections, and to relieve headaches, coughs, snakebite, and hair loss.

Culinary use: Onions are commonly chopped and used as an ingredient in various hearty warm dishes, and may also be used as a main ingredient in their own right, for example in French onion soup or onion chutney. They are very versatile and can be baked, boiled, braised, grilled, fried, roasted, sautéed, or eaten raw in salads. Their layered nature makes them easy to hollow out once cooked, facilitating stuffing them.

Onion types and products: Common onions are normally available in three colour varieties. Yellow or brown onions (called red in some European countries), are full-flavoured and are the onions of choice for everyday use. Yellow onions turn a rich, dark brown when caramelized and give French onion soup its sweet flavour.

Non-culinary uses: The pungent juice of onions has been used as a moth repellent and can be rubbed on the skin to prevent insect bites.

B) Garlic

Historical use: The use of garlic in China dates back to 2000 BC. It was consumed by ancient Greek and Roman soldiers, sailors, and rural classes (Virgil, Ecologues ii. 11), and, according to Pliny the Elder (Natural History xix. 32), by the African peasantry. Galen eulogized it as the "rustic's theriac" (cure-all).

Culinary use: Garlic is widely used around the world for its pungent flavor as a seasoning or condiment. The garlic plant's bulb is the most commonly used part of the plant. With the exception of the single clove types, garlic bulbs are normally divided into numerous fleshy sections called cloves. Garlic cloves are used for consumption (raw or cooked) or for medicinal purposes.

Other uses: The sticky juice within the bulb cloves is used as an adhesive in mending glass and porcelain. An environmentally benign garlic-derived polysulfide product is approved for use in the European Union (under Annex 1 of 91/414) and the UK as a nematicide and insecticide, including for use for control of cabbage root fly and red mite in poultry. Garlic along with cinnamon is used as a fish and meat preservative, and displays antimicrobial property at temperatures as high as 120 degree Celsius; the combination can also be used to preserve fried and deep fried foods, and in the future might be used in an inner layer of plastic

3.2.9. Pests of onion and garlic

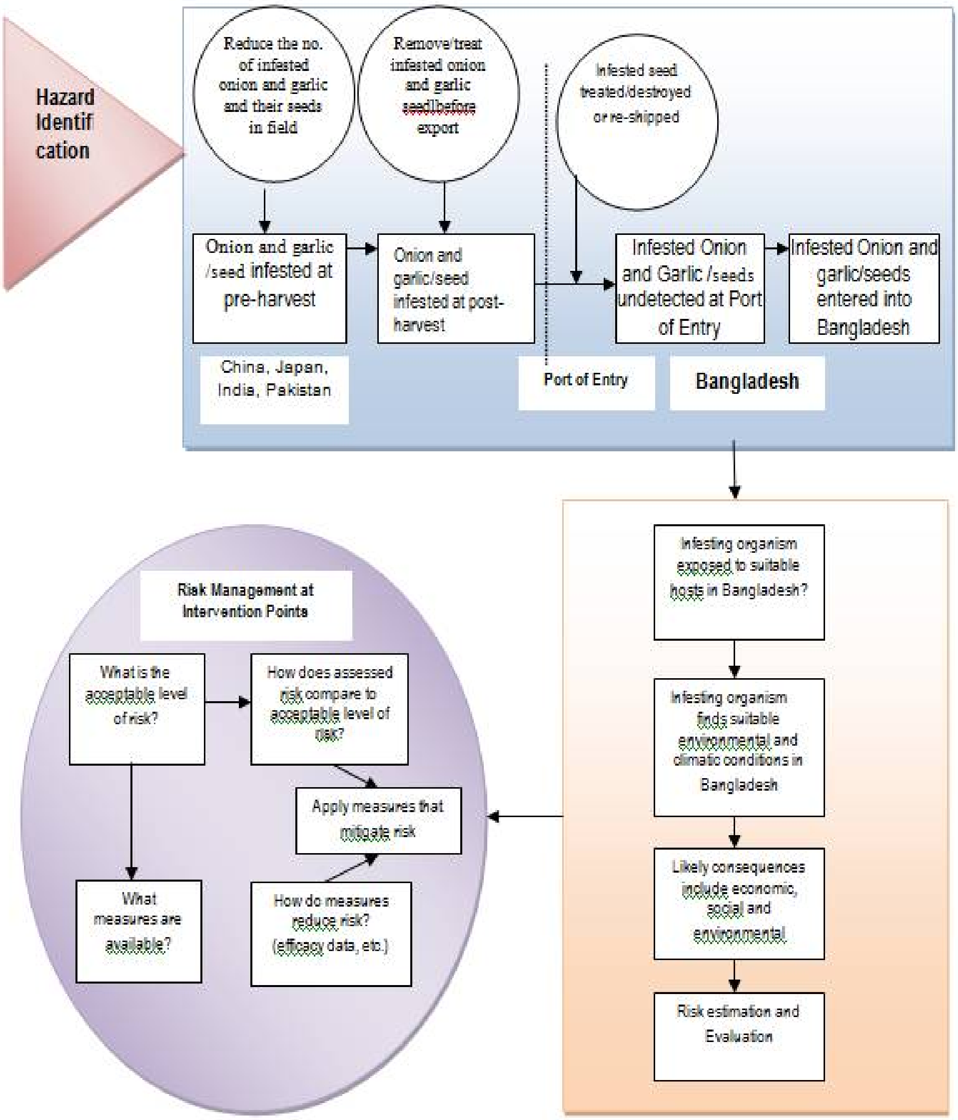
Insect and mite pests: Several insect pests attack onion and garlic. The major insect pests of onion and garlic in Bangladesh are black cutworm, thrips, lesser armyworm, wireworm, aphid etc. The mite pests of onion and garlic recorded in Bangladesh is two spotted spider mite.

Diseases: The diseases of onion and garlic commonly found in Bangladesh are purple blotch, black mould of onion, charcoal rot, cottony soft rot, basal rot, bacterial root rot, anthracnose, blast, leaf spot, wilt, root-lession, Longidorids, Leek yellow stripe potyvirus etc.

3.3. Description of the Import Pathway

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

Figure 5. Import pathway of onion and garlic



3.4.General Climate—Exporting Countries

3.4.1. India

General Climate: India's climate can be classified as a hot tropical country, except the northern states of Himachal Pradesh and Jammu & Kashmir in the north and Sikkim in the northeastern hills, which have a cooler, more continental influenced climate.

In most of India summer is very hot. It begins in April and continues till the beginning of October, when the monsoon rains start to fall. The heat peaks in June with temperatures in the northern plains and the west reach 45°C and more. The monsoons hit the country during this period too, beginning 1st of June when they are supposed to find the Kerala coast, moving further inland from day to day. Moisture laden trade winds sweep the country bringing heavy rains and thunderstorms; sometimes these monsoon rains can be very heavy, causing floodings and damage, especially along the big Rivers of India, Bramaputhra and Ganges.

The plains in the north and even the barren countryside of Rajasthan have a cold wave every year in December-January. Minimum temperatures could dip below 5°C but maximum temperatures usually do not fall lower than 12°C. In the northern high altitude areas of the northern mountains it snows through the winter and even summer months are only mildly warm.

Typhoons are usually not an danger, these tropical storms are quite seldom in India. The Typhoon Season is from August to November; the East coast of India has the highest Typhoon risk.

The Climate of India can be divided in different climate zones. The eastern part of India and the west coast can be classified as Aw climate, a hot, tropical climate with all months above 18°C and a dry period in the winter. The southern Tip of india can be classified as Am climate, a hot tropical Rainforest climate with monsoon rains and all months above 18°C. Central and Northwest India have a BSh climate, a dry Steppe climate with an annual average Temperature above 18°C. Finally, the northern mountainous areas can be classified as Cfa climate; a Temperated, humid climate with tha warmest month above 22°C (WeatherOnline, 2015a)

3.4.2. Thailand

Thailand's Climate can be described as tropical monsoonclimate. 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).

3.4.3. 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.

3.4.4. 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.

3.4.5. Indonesia

The main variable of **Indonesia's** climate is not temperature or air pressure, but rainfall. Split by the equator, Indonesia has an almost entirely tropical climate, with the coastal plains averaging 28°C, the inland and mountain areas averaging 26°C, and the higher mountain regions, 23°C. The area's relative humidity is quite high, and ranges.

The extreme variations in **rainfall** are linked with the monsoons. Generally speaking, there is a dry season (June to September), and a rainy season (December to March). Western and northern parts of Indonesia experience the most precipitation, since the north- and westward-moving monsoon clouds are heavy with moisture by the time they reach these more distant regions. Western Sumatra, Java, Bali, the interiors of Kalimantan, Sulawesi, and Irian Jaya are the most predictably damp regions of Indonesia, with rainfall measuring more than 2,000 millimeters per year.

3.4.6. Vietnam

Vietnam`s Climate can be divided a tropical and a temperate zone. 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. Regions located near the tropics and in the mountainous regions have a slightly cooler, more temperated climate.

The annual average **temperature** ranges from 22°C to 27°C year-round. There are almost no significant differences in temperature in the southern parts of Vietnam, while the northern regions can be quite cold in the winter. There are essentially four distinct seasons, which are most evident in the Northern provinces.

There are two distinguishable seasons in the southern areas. The cold season occurs from November to April and the hot season from May to October. The northern parts of Vietnam have essentially four distinct seasons; it can be quite **cool** in the winter there, but very warm in summer. [http://www.weatheronline.co.uk/reports/climate/Vietnam.htm]

3.5. General Climate of Bangladesh

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

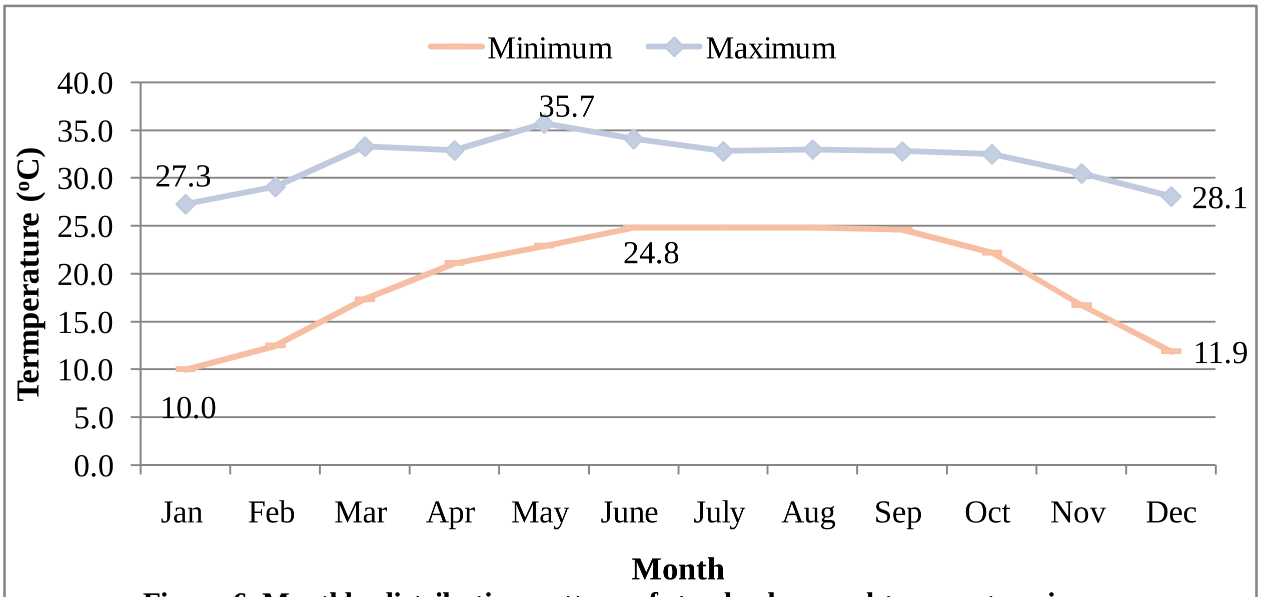


Figure 6. Monthly distribution pattern of standard normal temperature in Bangladesh, 1981-2012

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

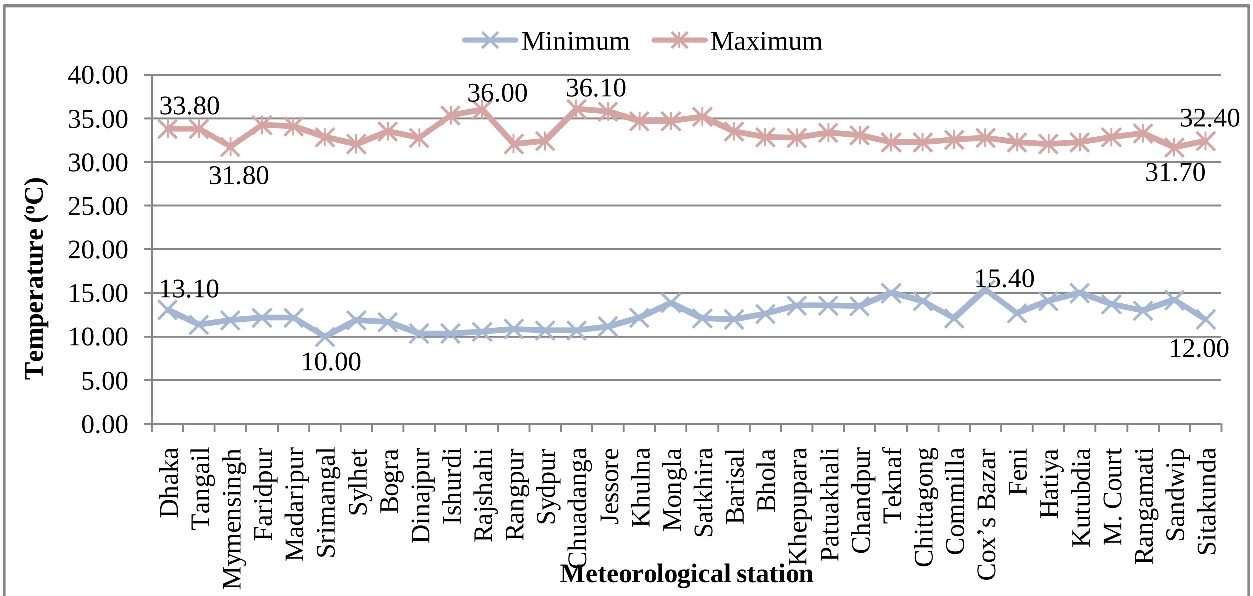


Figure 7. Location-wise distribution pattern of standard normal temperature in Bangladesh, 1981-2012

Source: BBS (2013)

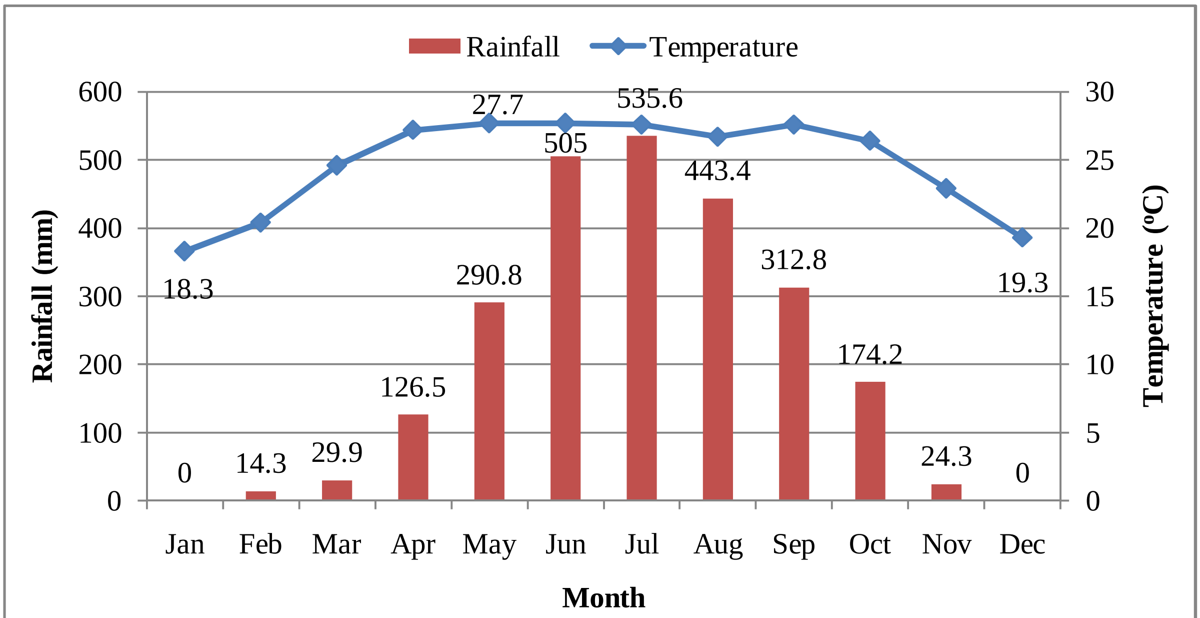


Figure 8. Average monthly Temperature and Rainfall for Bangladesh from 1960-1990

Source: World Bank Group (2015)

CHAPTER 4

HAZARD IDENTIFICATION

4.1. Introduction

This chapter outlines the potential hazards associated with onion and garlicin India, China, Japan, Thailand, Mayanmar, Vietnam, Philippines, Indonesia etc, and considerssome of the major risk characteristics of the commodity and its hazards.

An initial hazard list was made of all pests and pathogens associated with onion and garlic found in exporting countries.The Plant Quarantine Wing of theDepartment of Agricultural Extension (DAE) in Bangladesh list for pests of onion and garlic from these exporting countries was used as its basis, withvarious species added or excluded after considerations of association. This original list waslater refined to include only those organisms directly associated with onion and garlic and found tobe present in these exporting countries. Some hitch-hiker pests are included in the pest analyses where entryand establishment of a species into the country would cause potential economic,environmental or health consequences. The following a list of those organisms assessed anddiscarded as likely hazards based on biology, and lack of association with the commodity. Then all potential hazards and individual pest riskassessments and recommend measures where required.

4.2. Potential Hazard Groups

Pests and pathogens can be grouped in two main ways regarding their association with thecommodity. Under their taxonomic category, i.e. Hemiptera, Homoptera,Lepidoptera, Coleoptera, Acari, Fungi etc, orwithin the trophic role they play in their association, and whatstructures or part of the plants they attack, e.g. surface feeder, seed feeder, pathogen. In this risk analysis hazard organismsare grouped according to their general taxonomic category. Where a genus contains more thanone species, information on all species is contained within one pest risk assessment. Iforganisms 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

4.3. Interception of Pests on Onion and Garlic from Existing Pathways

In the past, there was no previous pest risk assessment on Onion and Garlic from any of the exporting countries including the India, China, Japan, Thailand, Mayanmar, Vietnam, Philippinesand Indonesia etc. As reported by the Plant Quarantine Wing (PQW) under Department of Agricultural Extension (DAE), Bangladesh, during inspection in port of entry of bulbs and seeds of onion and garlic from these exporting counties, not a pest had been intercepted yet today on the commodity imported into Bangladesh.

4.4. Review of earlier PRA

No PRA on Onion and Garlic had been done in Bangladesh earlier. However, damage assessment and other studies on insect pests, diseases or other pests associated with onion and garlic in Bangladesh and abroad helped to prepare this PRA report.

4.5. 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.

4.5.1 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 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.

4.5.2 Symptomless micro-organisms

Pests such as microbes and fungi infect onion and garlic before transit and may not produce symptomsmaking them apparent only when they reach a suitable climate to sporulate or reproduce.

Many fungi can infect onion and garlicafter arrival making it difficult to distinguish the origin ofsaprobes and pathogens without adequate identification. Consumers tend to throw awaymoulded onion and garlic rather than take it to a diagnostic laboratory so there is little data on post entryappearance of “invisible organisms”.

4.6 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 ofonion and garlic in India, China, Japan, Thailand, Mayanmar, Indonesia and other countries of onion and garlic 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 onion and garlicin the importing countries, and preferably, any information on incidence level in pests infested onion and garlic consignments or lots would be valuable.

Thus, the assessment of uncertainties and assumptions for each organism often covers similar areasof 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.

4.7. Assumptions and Uncertainties around hazard biology

- 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 have in a new environment, particularly if it has not become established as a pest elsewhere outside its natural range. Therefore, there 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.

4.8. Assumption and Uncertaintiesaround the Inspection Procedure

- There are distinct temperature requirements for optimum development and reproduction for the different biotype of pests like *Bemisia tabci B biotype* (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.

4.9. Assumption around Transit Time of Commodity on the Air Pathway

- An assumption is made around the time the fresh onion and garlic take to get from the field in India, China, Japan, Thailand, Mayanmar, Indonesia, Vietnam,Philippinesand other exporting countries to Bangladesh ready for wholesale if it is transported by Landport or Sea shipment.

4.10.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 onion and garlic 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 5

REVIEW OF MANAGEMENT OPTIONS

5.0 Risk management

For each organism classified as a potential quarantine pest, risk management identifies the options available for managing the risk. Feedback is sought from stakeholders on these options through consultations. The risk analysis is then finalized following consultations and will present options, refined if appropriate, for the phytosanitary measures to be considered. Measures are recommended to the Chief Plant Quarantine Officer for decision once the measures are deemed to be appropriate.

5.1 Risk Mitigation Options

5.1.1 Generally Applicable Phytosanitary Measures Options

The following phytosanitary options are generally applicable for pests potentially associated with imported goods.

Pest Free Areas (PFA)

The International Standards for Phytosanitary Measures (ISPM) No 4, Requirements for the establishment of pest free areas, describes the requirements for the establishment and use of PFAs as a risk management option. It is accepted that pests that have never been detected in, or that have been detected and eradicated from an area should not be considered present in an area if there have been sufficient opportunity for them to have been detected. When sufficient information is available to support a PFA declaration, this phytosanitary measure is usually considered to provide a very high level of protection.

Pest free place of production (PFPP)

ISPM 10 Requirements for the establishment of pest free places of production and pest free production sites) describes the requirements for the establishment and use of pest free places of production as a risk management option for meeting phytosanitary requirements for the import of plants. A pest free place of production is defined in the standard as a ―place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period

When sufficient information is available to support a PFPP declaration, this phytosanitary measure is usually considered to provide a high level of protection depending on the epidemiological characteristics of the pest under considerations.

5.1.2 Specific Phytosanitary Measures that may be Applicable to the Import of Onion and garlic from exporting countries

Pests associated with the crop can be reduced through the application of pesticides and fungicides as well as integrated pest management activities. Field inspections prior to harvesting can confirm that pest or disease rates are suitably low and, if combined with other phytosanitary measures such as processing or treatment, can ensure adequate levels of mitigation are achieved.

Integrated pest management (IPM) strategies to manage pest of concern in exporting countries could include:

1) Pre-Harvest Management

Cultural Control

1. Use pest free planting stock
2. Use of resistant or tolerant cultivar to reduce damage

3. Sanitation and farm hygiene; avoid the use of contaminated water.
4. Avoid dense planting of onions or planting near weeds and dense barriers because these help to maintain dew on the onion leaves which aids in disease infection and dissemination.
5. Remove un-harvested plant parts and decaying infected plant tissues
6. Destroy volunteer onion plants and crop debris as soon as the crop is harvested.

Chemical Control

1. Use of pesticides should be applied when appropriate

Insect, Mite and Diseases Pest Management of onion and garlic

Bradysia odoriphaga

- Basic Measures are justified and sufficient to manage the risk from *Bradysia odoriphaga*.
- Basic Measures will reduce the prevalence of *B. odoriphaga* in a consignment to a very low level and limit its potential to establish and spread in Bangladesh.
- Commercial production activities will reduce populations of B. odoriphaga in onion and garlic growing fields.
  a) *B. odoriphaga* damage onion and garlic roots and bulbs, which affects plant growth. Monitoring for plants displaying signs/symptoms of infestation during production will identify affected plants, resulting in pest controls being applied.
- Harvest activities and packing activities will reduce the likelihood of *B. odoriphaga* eggs being associated with bulbs at export.
  a) *B. odoriphaga* can lay eggs on onion and garlic leaves and in the soil. The specified commodity type 'commercially produced, harvested, cured bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no leaf material or soil associated with the imported fresh onion and garlic.
- *B. odoriphaga* are likely to be obvious during visual inspection.
  a) Adult *B. odoriphaga* are small (~2.5 mm long), dark, mosquito-like flies that are visually obvious against the golden brown of the cured onion bulb.
  b) Larvae are translucent with a black head and approximately 5 mm in size. Larvae tunnel into onion bulbs with bulb decay following wounding. The specified process for 'commercially produced' export grade bulbs (including grading to remove obviously damaged bulbs) means that infested and damaged bulbs will not be export-grade and therefore will be removed during grading and packaging.
  c) Eggs may be present on the axils of the remaining plant leaf material, however the eggs are yellowish-white and in contrast to the brown pseudostem making them visually obvious.
  d) The morphology of the onion means that *B. odoriphaga* may occur in between layers of the onion. However, during pre-export NPPO visual inspection some outer layers of the onion can be removed and any *B. odoriphaga* that were not detected and removed during production, harvest, grading and packing are likely to be detected.
  e) Detection of *B. odoriphaga* will require remedial action prior to export certification.

Liriomyza chinensis

- Basic Measures are justified and sufficient to manage the risk from *Liriomyza chinensis*.
- Basic Measures will reduce the prevalence of *L. chinensis* in a consignment to a very low level and limit its potential to establish and spread in Bangladesh.
- Commercial production will reduce populations of *L. chinensis* in onion growing fields.

  a) *L. chinensis* larvae make meandering tunnels under the surface of onion leaves; this damages and deforms the onion leaves. Monitoring for plants displaying signs/symptoms of infestation during production will identify affected plants, resulting in pest controls being applied.
- Harvest activities will reduce the likelihood of *L. chinensis* eggs being associated with bulbs at export.

  a) Eggs are laid into onion and garlic leaves. The specified commodity type 'commercially produced, harvested, cured *Allium cepa* bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no leaf material associated with the imported fresh onions and garlic. Packing activities will remove *L. chinensis* pupae not located within the onion.
- Packing activities will remove *L. chinensis* pupae not located within the onion and garlic.

  a) *L. chinensis* pupate in soil. The specified commodity type 'commercially produced, harvested, cured Allium cepa bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no leaf material associated with the imported fresh onion.
- *L. chinensis* are likely to be obvious during visual inspection.

  a) Adult L. chinensis are small (1-3 mm long), black and yellow leaf mining flies that have a characteristic yellow spot on their back. *L. chinensis* is visually obvious against the golden brown of the cured bulb.

  b) The morphology of the onion means that *L. chinensis* pupae may be concealed between the onion layers. However, during pre-export NPPO visual inspection some outer layers of the onion can be removed and any *L. chinensis* pupae that were not detected and removed during production, harvest, grading and packing are likely to be detected.

  c) Detection of *L. chinensis* will require remedial action prior to export certification.

Luperomorpha suturalis

- Basic Measures are justified and sufficient to manage the risk from *Luperomorpha suturalis*.
- Basic Measures will reduce the prevalence of *L. suturalis* in a consignment to a very low level and limit its potential to establish and spread in Bangladesh.
- Commercial production activities will reduce populations of *L. suturalis* in onion growing fields.

  a) Adult beetles eat leaves causing wormholes and notches; while the larvae damage fibrous roots and bulbs causing rotting, poor growth and withering and wilting of leaves. Monitoring for plants displaying signs/symptoms of infestation during production will identify affected plants, resulting in pest controls being applied.

- Harvest activities will reduce the likelihood of adult *L. suturalis* being associated with onion bulbs at export.

  a) Adults feed on green leaves, and onion leaves shrivel and brown prior to harvest. The specified commodity type 'commercially produced, harvested, cured Allium cepa bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no leaf material associated with the imported fresh onions.

- Packing activities will remove *L. suturalis* eggs.

  a) *L. suturalis* lay eggs in the soil. The specified commodity type 'commercially produced, harvested, cured Allium cepa bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no soil associated with the imported fresh onions.

- Packing activities would display signs of larval infestation in a bulb.

  a) Onions have the loose outer leaves removed during packhouse processes. Signs/symptoms of larval infestation would be more noticeable during grading and visual inspection.

- *L. suturalis* are likely to be obvious during visual inspection.

  a) *L. suturalis* larvae tunnel into onion bulbs. During visual pre-export NPPO inspection some additional layers of the onion can be removed, and larval tunnels are easily detectable.

  b) Detection of *L. suturalis* will require remedial action prior to export certification.

Alternaria palandui

- Basic Measures are justified and sufficient to manage the risk from *Alternaria palandui*.

- Basic Measures will reduce the prevalence of *A. palandui* in a consignment to a very low level and limit its potential to establish and spread in Bangladesh.

- Commercial production activities will reduce populations of the fungus *A. palandui* in onion growing fields.

  a) *A. palandui* causes lesions on leaf tissue in onions, with the leaves becoming blighted as the disease advances and the bulb decaying. Affected plants also fail to flower. Monitoring during production will identify affected plants, resulting in pest controls being applied to reduce the number of infected plants to a very low level.

- Harvest activities will reduce the likelihood of adult *A. palandui* being associated with onion bulbs.

  a) Diseased tissue (e.g. infected leaves and plant debris) contain conidia which disperse the pathogen. The specified commodity type 'commercially produced, harvested, cured *Allium cepa* bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no leaf material associated with the imported fresh onions.

- Packing activities will remove *A. palandui* spores.

  a) Spores of *A. palandui* could be present on the outer surface of the onions. Removal of the loose outer skins of onions as part of packaging activities means that there will be no loose outer skins presentl Production).

  b) Detection of *A. palandui* affected onion bulbs will require remedial action prior to export certification.

Delia antiqua

- Targeted Measures are required in addition to Basic Measures for *D. antiqua*.
- Targeted Measures will effectively manage risk from *D. antiqua* either by excluding them, reducing populations to a negligible level, limiting their potential for establishment in the Bangladesh environment, or removing or eliminating them from the pathway. Targeted Measures options include:

Pest Exclusion

- Pest freedom status either at the country, area or production site will effectively exclude *D. antiqua* from the pathway. The options for pest freedom are as per the international standards for phytosanitary measures (ISPMs):

a) Country freedom;

- Additional measures are not required where 'country freedom' status is recognised by Bangladesh for the export country.

b) Pest free area (PFA);

- PFAs managed as per ISPM 4: Pest free areas or based on historical absence as per ISPM 8: Determination of pest status in an area; and recognised as a PFA by MPI.

c) Pest free place of production (PFPP).

- PFPP managed in accordance with ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites and recognised by MPI.

Pest Reduction

- *D. antiqua* can be reduced to a negligible level through an effective systems approach. A systems approach is comprised of two or more independent measures. The following are considered suitable options as independent measures:

a) Pre-planting activities can reduce the incidence of *D. antiqua* during production. These options include:

- Crop rotation and breakdown of organic matter in soil – this limits the pest reservoirs at production sites
- Planting insecticide treated seed – this prevents *D. antiqua* from feeding on developing roots, young shoots and immature bulbs.
- A planting programme which is asynchronous to the *D. antiqua* lifecycle - the first generation of *D. antiqua* is the most injurious to onion plants and damage by later generations is less common as the developing bulb is difficult for larvae to penetrate.

b) In-field pest control measures can reduce the incidence of *D. antiqua* during production. These options include:

- The application of effective insecticides supported by official crop monitoring. Symptoms associated with *D. antiqua* attack include yellowing, wilting of onion leaves and often death of the plant.
- Monitoring activities are likely to detect an outbreak of *D. antiqua* at onion production sites, and effective insecticides can be applied to manage infestations.

c) Export eligibility:

- If *D. antiqua* is detected either during onion production, at post-harvest grading and packing, or at pre-export NPPO visual inspection, then the crop or consignment is ineligible for export unless an effective phytosanitary measure is applied.

Pantoea ananatis

- Targeted Measures are required in addition to Basic Measures for *P. ananatis.*
- Targeted Measures will effectively manage risk from *P. ananatis* either by excluding them or their vector (*Thrips tabaci*), reducing populations to a negligible level, limiting their potential for establishment in the Bangladesh environment, or removing or eliminating them from the pathway. Targeted Measures options include:

Pest Exclusion

- Pest freedom status either at the country, area or production site will effectively exclude *P. ananatis* from the pathway. The options for pest freedom are as per the international standards for phytosanitary measures (ISPMs):

a) Country freedom;

- Additional measures are not required where ‘country freedom’ status is recognised by Bangladesh for the export country.

b) Pest free area (PFA);

- PFAs managed as per ISPM 4: Pest free areas or, based on historical absence as per ISPM 8: Determination of pest status in an area; and recognised as a PFA by MPI.

c) Pest free place of production (PFPP);

- PFPP managed in accordance with ISPM 10: Requirements for the establishment of pest free places of production and pest free production sites and recognised by MPI.

Pest Removal or Elimination

- *P. ananatis* can be reduced to a negligible level through effective management of the disease and its vector. The vector Thrips tabaci is already present in Bangladesh. However, as *T. tabaci* is a potential vector of *Pantoea ananatis* a Targeted Measure is required if both these pests are present in the consignment. The following are considered suitable measures to manage P. ananatis:

a) Basic measures for vector (*T. tabaci*) management

i) Commercial production activities will reduce populations of *T. tabaci* in onion growing fields.

1. *T. tabaci* initially damage heart leaves, but outer leaves are damaged with high populations. Small silvery areas develop around feeding sites. Monitoring for plants displaying signs/symptoms of infestation during production will identify affected plants, resulting in pest controls being applied.

ii) Harvest activities will remove*T. tabaci.*

1. The presence of *T. tabaci* retards plant photosynthesis, resulting in small bulb size which are unlikely to meet export quality grade. Harvest activities includes ‘sorting of bulbs to remove extraneous matter (such as plant material and excess soil) and non-export quality produce’.

iii) Packing activities will remove *T. tabaci* pupae.

- *T. tabaci* pupae reside in the soil. The specified commodity type 'commercially produced, harvested, cured Allium cepa bulbs with skin, minimal root material attached and pseudostem trimmed within 15 mm of the bulb, clean and free from soil', means there will be no soil material associated with the imported fresh onions.

iv) *T. tabaci* are likely to be obvious during visual inspection.

a) *T. tabaci* eggs are white or translucent with the tip of the egg visible above the plant material.

b) The morphology of the onion means that *T. tabaci* larvae and adults may occur in between layers of the onion, or near the heart leaves. However, during pre-export NPPO visual inspection some outer layers of the onion can be removed and any *T. tabaci* that were not detected and removed during production, harvest, grading and packing are likely to be detected, with the use of 10 x magnification.

c) Detection of *T. tabaci* will require remedial action prior to export certification.

b) Export eligibility:

- Bulbs from infected production sites cannot be exported to Bangladesh.
- Production sites where *P. ananatis* is detected are not eligible to export to Bangladesh for the remainder of the season.

i) Monitoring for *P. ananatis* during onion production will identify disease presence and detect new outbreaks.

ii) The symptoms of *P. ananatis* infection in onion include the rapid death of the two centre above-ground leaves followed by rot of the centre of the bulb. Symptoms generally include white streaks with water-soaked margins running the length of the leaf.

2) Post-Harvest Management

- **Harvesting, Sanitization, Curing and Drying**

1. It is expected that large clumps or clods of soil and other foreign materials should be removed and badly affected or damaged produce discarded.
2. Onions must be sorted and only onions free from all impurities which may materially alter the appearance or eating quality should be sent to the exported consignment.
3. A standard sanitizing wash using sodium hypochlorite (NaClO) is recommended after the bulbs have been cleaned from soil and or decaying plant material to protect onion bulbs from bacterial or fungal infection during storage and transport
4. Visual inspection of bulbs for pests or symptoms of disease either immediately after harvesting or during processing for export should also be integrated into post-harvest management
5. It is important that no root material is left on the base of the bulb and the stalk at the top of the bulb is trimmed back to within a few millimetres of the bulb surface.
6. Onions must be mature, clean, firm, free from diseases, dry cured and free from bottle necks
7. Heat treatment using temperatures above 45^{o}C is suggested to reduce infestations by Peronospora destructor and Ditylenchus dipsaci.
8. In storage, it is important to maintain relative humidity between 65-70% with adequate air circulation at 0ºC (32ºF) to prevent splitting, sprouting and disease infestation.

3) Onion and garlic packaging

Good packaging for onion and garlic should meet the following criteria:

1. Strong enough to retain the required weight of onion and garlic under the conditions of transport and storage
2. Allow sufficient ventilation for the air around the bulbs to maintain relative humidity in the required range
3. In many circumstances, provide a means of displaying legally required and commercially necessary information.

4) Onion and garlic Storage

The objectives of onion and garlic storage are to extend the period of availability of crop, maintain optimum bulb quality and minimise losses from physical, physiological, and pathological agents.

1. Bulbs selected for storage should be firm and the neck dry and thin.
2. Skin colour should be typical of the cultivar.
3. Microbial infections such as *Aspergillus niger* occur during production of onion and garlic but these will only develop on the bulbs during storage where the storage environment is conducive for their growth.
4. Prior to storage, crop must be cleaned and graded, and all damaged or diseased bulbs removed. Careful harvest and pre-storage treatments with minimal mechanical loads are important to achieve a long storage period.
5. Storeroom temperature, relative humidity, and atmospheric composition affect the length of storage that can be achieved.

5) Fumigation

In keeping with, risk potential guidelines, specific phytosanitary measures are strongly recommended to provide sufficient phytosanitary security to Jamaica. With reference to the insect, Naupactus leucoloma which borrows internally in onion bulb; the USDA treatment manual (see section T101-q-2 of the treatment schedule for fruits, vegetables and nuts) provides a methyl bromide fumigation schedule for insects that are ―internal feeders‖ of onion and garlic bulbs.

Methyl bromide fumigation schedule for internal feeders (and leafminers) in onion bulbs.

Treatment: **T101-q-2 MB** at NAP—tarpaulin or chamber (extracted from treatment schedule for fruits, vegetables and nuts)

5.2. Risk management proposal

Phytosanitary measures to manage the risk of the regulated pests on the pathway include the use of pre-and post-harvest pest control activities, regulatory/official activities and phytosanitary inspection and certificate

Import Permit

Bangladesh plant quarantine import permit is required for the importation of onions from exporting countries

1) Pre-Harvest Activities

(i) In-field pest control

a) All registered farms implement pest management activities outlined in an integrated pest management (IPM) and monitoring programme.

b) An efficacious insecticide is applied if necessary, to manage the risk of *Nacpactus leucoloma* infestation. Application of an efficacious preventative fungicide for *Botryotina fuckeliana, Sclerotium cepivorum, Colletotrichum circinans, Peronospora destructor, Phytophthora cryptogea* and *Pythium irregular* is utilised. Records of control measures are retained

(ii) Monitoring

a) Production sites must be monitored by a SENASA personnel trained in detection and recognition of pathogens of concern to Bangladesh. Onion and garlic bulbs from production sites where disease symptoms are found are not eligible for export to Bangladesh.

2) Post-Harvest Activities

(i) **Cleaning**: Physical cleaning is expected to reduce the presence of regulated pests

a. Onion and garlic bulbs for export to Bangladesh must be cleaned, manicured and graded during processing at a plant quarantine authority registered packing house. Cleaning, manicuring and grading includes the removal of soil and foreign material, removal of fibrous roots leaving each onion bulb with minimal root material and the removal of the loose outer skin to ensure no soil remains.

b. Onion and garlic bulbs showing signs of damage, pest infestation, symptoms of disease, contamination or growth of sprouts or roots, are removed and labelled for disposal during the physical cleaning process.

(ii) **Visual Inspection and Remedial Action** is expected to reduce the presence of regulated pests

a) During the growing season and at the pre-harvest, plant quarantine authority crop inspection and monitoring activities should be conducted for arthropods or for signs and symptoms of disease associated with the above ground onion plant parts. Following harvest all onion and garlic bulbs are to be inspected for all life stages of regulated pests. Damaged bulbs may have noticeable secondary infection, arthropods or nematodes associated with them.

b) Detection of any regulated pest of concern to Bangladesh should result in the application of an appropriate treatment or exclusion of the onion and garlic lot from the Bangladeshi export pathway.

3) Regulatory/Official Activities

The following operational, phytosanitary maintenance and verification system ensures the proposed risk management measures have been met and are maintained.

(i) Farm registration

The designated NPPO for exporting countries registers all commercial farms. Only commercially produced onion and garlic bulbs from registered farms may be imported into Bangladesh. Registration is required to ensure approved production procedures are followed and provide product traceability along the export pathway.

(ii) Packing house/ storage facility registration

Exporting countries registers all packing and storage facilities processing onion bulbs for export to Jamaica verifying that packing and storage facilities are compliant with agreed packing house operations, and sanitation procedures. Packing house and storage facility registration is expected to limit the presence of hitchhiker pests and allow trace-back information in the event of non-compliance.

(iii) Phytosanitary inspection and certification

All consignments must be sampled and visually inspected for pests prior to issuance of a phytosanitary certificate by the plant quarantine authority. When no pests or diseases are found and all requirements of the import have been met, a phytosanitary certificate should be issued.

a) Inspection on Arrival

- The Plant Quarantine Inspectors will check the accompanying documentation on arrival to confirm that it reconciles with the actual consignment.
- If regulated pests are intercepted or detected on the commodity, or associated with packaging, the following actions will be undertaken as appropriate:
  - Re-export (where possible) of the consignment at the importer‘s risk.
  - Destruction of the consignment at importers expense.
  - The suspension of trade, until the cause of the non-compliance is investigated, identified and rectified.

5.3. Application of phytosanitary measures

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

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

5.4. Pre-shipment requirements

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

5.4.2. Treatment of the consignment

The PQW of Bangladesh requires that the NPPO of the country of origin ensure that the onion and garlic from which the these were collected, have beentreated as specified by PQW of Bangladesh.

Documentation

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

5.5. Phytosanitary certification

A completed phytosanitary certificate issued by the NPPO of the country of origin must accompany all onion and garlicexported to Bangladesh.

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

The onion and garlichave:

i) been inspected in accordance with appropriate official procedures and found to be freeof 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 (inaccordance with the International Standards for Phytosanitary Measures; Requirementsfor the Establishment of Pest Free Areas, IPPC, FAO, Publication 4, 1996), free from aregulated pest(s).
iii) been sourced from a pest free place of production that is, as verified by pest surveillancemethods (in accordance with the International Standards for Phytosanitary Measures;Requirements for the Establishment of Pest Free Places of Production and Pest Free Production Sites, IPPC, FAO, Publication 10, 1996), free from a regulated pest(s).

AND;

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

5.6. 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 onion and garlic 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,

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

5.7. Transit requirements

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

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

5.8. Inspection on arrival in Bangladesh

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

5.9. Testing for regulated pests

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

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

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

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

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

5.11. 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 clearancegiven.

5.12. 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 otherphytosanitary requirements.

CHAPTER 6

IDENTIFICATION OF PESTS

6.1. Introduction

The pest risk assessment was done with the aim to determine Bangladesh's phytosanitary measure regarding theonion and garlicimported from anyexporting countries ofIndia, China, Thailand, Mayanmar, Indonesia, Japan, and other exporting countries into Bangladesh.

6.2. Pests of onion and garlic recorded in Bangladesh

The study for "Conducting Pest Risk Analysis (PRA) of onion and garlic in Bangladesh" was done in 22 major onion and garlic 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:

6.2.1. Insect and mite pests of onion and garlic

A total number of 8 arthropod pests of onion and garlic were recorded in Bangladesh. Among 8 arthropod pests, 7 were insect pests and 1 mite pest. The incidences of 7 insect pests of onion and garlic recorded in Bangladesh were black cutworm (*Agrotis ipsilon*)*,* onion thrips (*Thrips tabaci*), chilli thrips (*Scirtothrips dorsalis*), melon thrips (*Thrips palmi*), lesser armyworm (*Spodoptera exigua),* wireworm (*Melanotus communis)* and aphid (*Tetranychus urticae*)*.* The mite pest of onion and garlic recorded in Bangladesh was two spotted spider mite (*Tetranychus urticae*) (Table 2).

Among these insect pests of onion and garlic, thrips was the more damaging than other arthropod pests. The thrips was designated as major pest of onion and garlic and caused damage with high infestation intensity. The pest status of all other insect pests was minor significance and caused low level of infestation. Usually Bangladesh's farmers always used chemical insecticides through which these pests were suppressed in every season.

Table 2. Insect and mite pests of onion and garlic in Bangladesh, their status, plant parts affected and infestation severity

SN	Common Name	Scientific name	Family	Order	Host either onion or garlic or both	Plant parts affected	Pest status	Infestation severity
Insect pests								
01.	Black cutworm	*Agrotis ipsilon* (Hufnagel, 1766)	Noctuidae	Lepidoptera	Onion	Young seedling, Leaves (occasionally)	Minor	Low
02.	Onion thrips	*Thrips tabaci* Lindeman, 1889	Thripidae	Thysanoptera	Onion	Inforescence, leaves, stems (above ground)	Major	High
03.	Chilli thrips	*Scirtothrips dorsalis* Hood	Thripidae	Thysanoptera	Both	Whole plant	Minor	High
04.	Melon thrips	*Thrips palmi*	Thripidae	Thysanoptera	Onion	Whole plant	Minor	Medium
05	Lesser armyworm	*Spodoptera exigua (Hübner)*	Noctuidae	Lepidoptera	Garlic	Young seedling	Minor	Medium
06	Wireworm	*Melanotus communis*	Elateridae	Coleoptera	Both	Bulb	Minor	Low
07	Aphid	*Aphis* spp.	Aphididae	Homoptera	Both	Stem, Leaves, Inflorescence	Minor	Low
Mite pests								
08	Two spotted spider mite/ red spider mite	*Tetranychus urticae*	Tetranychidae	Acarina	Both	Leaves	Minor	Low

Some pictures of insect pests of onion and garlic are presented below:

Plate-1: Thrips of onion

Plate-2: Thrips infested onion plant

Plate-3: Adult onion fly

Plate-4: Onion bulb damaged by onion maggot

Plate-5: Onion leaf damaged by leaf miner

Plate-6: Larvae of onion leaf miner

Plate-7: Onion bulb affected by wireworms larvae

Plate-8: Leek moth pupa on onion stalk

6.2.2. Diseases of onion and garlic recorded in Bangladesh

A total number of 16 species of disease causing pathogens of onion and garlic were reported in Bangladesh, among which 10 diseases were caused by fungi, 2 caused by bacteria, 3 caused by nematode and 1 diseases of onion and garlic were caused by virus.

The incidences of fungal diseases of onion and garlic reported in Bangladesh were purple blotch complex (*Alternaria porri* and *Stemphylium vesicarium*), black mould of onion (*Aspergillus niger*), grey mould-rot (*Botryotinia fuckeliana* and *Botrytis aclada*), leaf spot (*Colletotrichum dematium*), anthracnose (*Glomerella cingulata*), charcoal rot (*Macrophomina phaseolina*), cottony soft rot (*Sclerotinia sclerotiorum*), basal rot (*Fusarium oxysporum*) and rust of onion (*Puccinia allii*) (Table 3).

The incidences of bacterial diseases of onion and garlic recorded in Bangladesh were bacterial root rot (*Pectobacterium carotovorum* subsp. *Carotovorum*) and bacterial canker or blast (*Pseudomonas syringae* pv. *syringae*). The nemic diseases of onion and garlic were common spiral nematode (*Helicotylenchus dihystera*), Longidorids (*Longidorus Micoletzky*) and root rot nematode (*Meloidogyne Spp*.). The viral disease of onion and garlic reported in Bangladesh were *Leek yellow stripe potyvirus* (LYSP) (Table 3).

Among these diseases, the purple blotch for onion and garlic, black mould of onion and root rot and blast were more damaging than others. But diseases were reported as minor diseases of onion and garlic and caused damage with low infection intensity in Bangladesh. Most of cases, the damage severity was controlled by the farmers through routine application of fungicides and other pesticides in the field of onion and garlic.

6.2.3. Weeds of onion and garlic recorded in Bangladesh

A total number of 12 weeds were reported as the problem in the field of onion and garlic in Bangladesh. The incidences of weeds in the field of onion and garlic were common chamomile (*Chamomilla recutita*), bermuda grass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-*

galli), goose grass (*Eleusine indica*), hogweed (*Polygonum aviculare*), green foxtail (*Setaria viridis*), black nightshade (*Solanum nigrum*), and parthenium weed (*Parthenium hysterophorus*). The parthenium weed (*Parthenium hysterophorus*) was recorded and found only in some restricted areas of Bangladesh namely Rajshahi, Natore, Pabna, Kustia, Jessore districts. These districts are nearly attached with the Western border of Bangladesh and Eastern border of West Bengall of India. It was also reported that the parthenium weed might be entered into Bangladesh through cross boundary pathway from India by the transportation system of border trading.

Among the twelve (12) weeds, the Parthenium grows in the whole season. 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 weeds were reported as minor weeds with low infestation intensity in the field onion and garlic. Basically Bangladeshi farmers controlled these weeds by weeding during intercultural operations of the field, thus these weeds remain as controlled condition except Parthenium.

Table 3. Diseases of onion and garlic in Bangladesh, their status, plant parts affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Host (onion or garlic)	Plant parts affected	Pest status	Infestation severity
Causal organism: Fungi								
01.	Purple blotch complex	*Alternaria porri (Ellis) Cif.* *Stemphylium vesicarium*	Pleosporaceae	Pleosporales	Both	Leaves, stem	Major	High
02.	Black mould of onion	*Aspergillus niger*	Trichocomaceae	Eurotiales	Both	Bulb	Minor	Low
03.	Grey mould-rot (Post harvest)	*Botryotinia fuckeliana* Whetzel [teleomorph]	Sclerotiniaceae	Helotiales	Onion	Bulb	Minor	Low
04.		*Botrytis aclada Fresen.*	Sclerotiniaceae	Helotiales	Onion	Bulb	Minor	Low
05.	Leaf spot	*Colletotrichum dematium* (Pers.) Grove	Glomerellaceae		Onion	Leaves	Minor	Low
06.	Anthracnose	*Glomerella cingulata* Spauld. & Schrenk	Glomerellaceae		Both	Leaves, Stem, Bulb	Main	High
07.	Charcoal rot	*Macrophomina phaseolina* (Tassi) Goid	Botryosphaeriaceae	Botryosphaeriales	Both	Whole plant	Main	Medium
08.	Cottony soft rot	*Sclerotinia sclerotiorum*	Sclerotiniaceae	Helotiales	Both	Stem, Inflorescence	Main	Low
09.	Basal rot	*Fusarium oxysporum*	Nectriaceae	Hypocreales	Garlic	Leaf, stem	Main	High
10	Rust of onion	*Puccinia allii*	Pucciniaceae	Pucciniales	Onion	Leaf, stem, bulb	Minor	Low
Causal organism: Bacteria								
11.	Bacterial root rot	*Pectobacterium carotovorum* subsp. *Carotovorum*	Enterobacteriaceae	Enterobacteriales	Onion	Tuber, root	Main	Low
12.	Bacterial canker or blast	*Pseudomonas syringae pv. Syringae* van Hall	Pseudomonadaceae	Pseudomonadales	Onion	Whole plant	Main	Low
Causal organism: Nematode								
13.	Common spiral nematode	*Helicotylenchus dihystera* (Cobb) Sher	Hoplolaimidae	Tylenchida	Onion	Root	Main	High
14.	Longidorids	*Longidorus Micoletzky* (Filipjev)	Longidoridae	Tylenchida	Onion	Root	Main	Medium
15.	Root knot nematode	*Meloidogyne* Spp.	Meloidogynidae	Tylenchida	Onion	Root	Main	Medium
Virus								
16	Leek yellow stripe poty virus	Leek yellow stripe virus	Potyviridae		Garlic	Leaf	Main	Low

Table 4. Weeds of onion and garlic in Bangladesh, their status, plant stage affected and infestation severity

Sl. No.	Common name	Scientific name	Family	Order	Host (onion or garlic)	Plant stage affected	Pest status	Infestation severity
01.	Common chamomile	*Chamomilla recutita (L.)* Rauschert	Asteraceae	Asterales	Onion	Vegetative	Minor	Low
02.	Bermuda grass	*Cynodon dactylon* (L.) Pers.	Poaceae	Cyperales	Onion	Throughout the growing season	Minor	Low
03.	Barnyard grass	*Echinochloa crus-galli* (L.) P.Beauv.	Poaceae	Cyperales	Onion	Throughout the growing season	Minor	Low
04.	Goose grass	*Eleusine indica* (L.) Gaertner	Poaceae	Cyperales	Onion	Throughout the growing season	Minor	Low
05.	Red tassel flower	*Emilia sonchifolia* (L.) DC. (1838)	Asteraceae	Asterales	Onion	Vegetative stage	Minor	Low
06.	Garden spurge	*Euphorbia hirta* L.	Euphorbiaceae	Euphorbiales	Onion	Vegetative stage	Minor	Low
07.	Hogweed	*Polygonum aviculare* L.	Polygonaceae	Polygonales	Onion	Vegetative stage	Minor	Low
08.	Marsh pepper	*Polygonum hydropiper* L.	Polygonaceae	Polygonales	Onion	Vegetative stage	Minor	Low
09.	Green foxtail	*Setaria viridis* (L.) Beauv.	Poaceae	Cyperales	Onion	Vegetative stage	Minor	Low
10.	Black nightshade	*Solanum nigrum* L.	Solanaceae	Solanales	Onion	Vegetative stage	Minor	Low
11.	Nettleleaf goosefoot	*Chenopodium murale* L.	Chenopodiaceae	Caryophyllales	Garlic	Vegetative stage	Minor	Low
12.	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	both	Recorded in limited areas	Minor	Medium

Some pictures of diseases of onion and garlic are presented below

Plate-9: Downy mildew on onion leaf

Plate-10: Purple blotch infected onion leaf

Plate-11: Bacterial soft rot infected onion

Plate-12: Root lesion nematode infected onion

Plate-13: Black mold affected onion

Plate-14: Neck rot affected onion

6.2.4. Management options for onion and garlic pests in Bangladesh

Insect and mite pest management: The most effective and commonly practiced management options against the insect pests of onion and garlic were spraying of insecticides in the field. Irrigation was done for controlling soil dwelling insect namely cutworm and removal of harmful insects and infested bulbs and parts of plants was also done. Few cases, especially for thrips sticky trap was used as well as hand picking was done for controlling armyworm.

Disease management: The most effective and commonly practiced management options against the diseases of onion and garlic were spraying of fungicides in the field, bulb treatment with fungicides for preventing bulb borne diseases, and removal of diseased plants or parts of plants. Other management practices for controlling diseases of onion and garlic were removal of weeds and spraying of insecticides in the onion and garlic fields for disease transmitting vector control.

Weed management: The most effective and commonly practiced management options for weeds in the field of onion and garlic were removal of weeds during land preparations and weeding during intercultural operations. Other options were earthing up at the base of plants, irrigation and use of herbicides.

6.3. Pests of Onion and Garlic in Exporting Countries

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

Fifty eight (58) species of pests were recorded for onion and garlicin the world including exporting countries into Bangladesh, of which 13 species were insect pests and 3 species were mite pests; 1 species was snail, the species of disease causing fungi were 17, bacteria 4, nematode 4, and virus & viroids were 4. On the other hand, 12 species of weeds for onion and garlic were recorded in the world.

Among Table 5 depicted the lists of pests associated with the onion and garlicthat also occured in the exporting coutries such as India, China, Thailand, Japan, Mayanmar, Indonesiaetc and the absence or presence of these pests in Bangladesh.

6.4. Quaratine pests of onion and garlic for Bangladesh

Twenty two (22) species of quarantine pests of onion and garlic for Bangladesh were identified those were recorded in India, China, Japan, Thailand, Mayanmar, Indonesia, and other countries of the world, but not in Bangladesh. Among these 22 species of quarantine pests, 6 were insect pests, 2 species were mite pests, 1 was snail, 6 fungi, 2 bacteria, 1 nematode species, 3 viruses and weed was one species (Table 6).

The quarantine insect pests are western flower thrips (*Frankliniella occidentalis*), pea leaf miner (*Liriomyza huidobrensis*), onion fly (*Delia antiqua*), serpentine leaf miner (*Liriomyza trifolii*), leek moth (*Acrolepiopsis assectella*) and vegetable weevil (*Listroderes costirostris*).The quarantine mite pests of onion and garlic for Bangladesh are dry bulb mite (*Aceria tulipae*) and bulb mite (*Rhizoglyphus echinopus*). The quarantine snail of onion and garlic is common garden snail (*Cornu aspersum*).

On the other hand, twelve (12) disease causing pathogens have been identified as quarantine pests of onion and garlic for Bangladesh. Among these, 7 quarantine fungus named neck rot of onion (*Botryotinia porri*), leaf blight of onion (*Botryotinia squamosa*), white rot (Stromatinia cepivora), onion smut (*Urocystis cepulae*), downy mildew of onion (*Peronospora destructor*), and pink root rot (*Pyrenochaeta terrestris*); 2 quarantine bacteria namely yellow disease phytoplasmas (*Candidatus Phytoplasma*) and crown gall *(Rhizobium radiobacter*); 1 species of nematode namely stubby root nematode (*Trichodorus* spp); 3 viruses namely*Tomato black ring virus,Onion yellow dwarf, Iris yellow spot virus*. 1 species of quarantine weed has been identified Bangladesh named Parthenium weed (*Parthenium hysterophorus*) (Table 6).

Table 5. Pests associated with onion and garlic in the world and identification of quarantine organisms

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
Arthropod pests							
A. Insect pests							
1	Onion thrips	*Thrips tabaci* Lindeman, 1889	Thripidae	Thysanoptera	Yes	No	CABI & EPPO, 1998
2	Chilli thrips	*Scirtothrips dorsalis* Hood	Thripidae	Thysanoptera	Yes	No	CABI, 2016
3	Melon thrips	*Thrips palmi*	Thripidae	Thysanoptera	Yes	No	CABI & EPPO, 1998; EPPO, 2014
4	Western flower thrips	*Frankliniella occidentalis* (Pergande)	Thripidae	Thysanoptera	No	Yes	EPPO, 2014; Kaomud & Tyagi Vikas Kumar, 2015;
5	Pea leaf miner	*Liriomyza huidobrensis* (Blanchard, 1926)	Agromyzidae	Diptera	No	Yes	CABI/EPPO, 2002;
6	Onion fly	*Delia antiqua* Meigen	Anthomyiidae	Diptera	No	Yes	EPPO, 2014;
7	Serpentine leafminer	*Liriomyza trifolii* Burgess	Agromyzidae	Diptera	No	Yes	EPPO, 2014; Gözel & Gözel, 2014; IPPC, 2009
8	Black cutworm	*Agrotis ipsilon* (Hufnagel, 1766)	Noctuidae	Lepidoptera	Yes	No	Islam *et al.*, 1991;
9	Lesser armyworm	*Spodoptera exigua* (Hübner)	Noctuidae	Lepidoptera	Yes	No	CABI, 2017
10	Leek moth	*Acrolepiopsis assectella*	Acrolepiidae	Lepidoptera	No	Yes	CABI, 2015; EPPO, 2014;
11	Vegetable weevil	*Listroderes costirostris* Schönherr	Curculionidae	Coleoptera	No	Yes	CABI & EPPO, 2000; EPPO, 2014
12	Wireworm	*Melanotus communis*	Elateridae	Coleoptera	Yes	No	EPPO, 2014
13	Aphid	*Aphis* spp.	Aphididae	Homoptera	Yes	No	EPPO, 2014
B. Mite pest							
14	Dry bulb mite	Aceria tulipae	Eriophyidae	Trombidiformes	No	Yes	CABI, 2015; Denizhan, 2012; Halliday & Knihinicki, 2004
15	Bulb mite (Post harvest)	*Rhizoglyphus echinopus* Fumouze & Robin	Acaridae	Sarcoptiformes	No	Yes	Al-Douri, 2000
16	Two spotted spider mite/ red spider mite	*Tetranychus urticae*	Tetranychidae	Acarina	Yes	No	Mir, 1990; IIE, 1996
Snail							
17	Common	*Cornu aspersum* Müller	Helicidae	Pulmonata	No	Yes	El-Wakil *et al.*, 2011;

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
	garden snail						CFIA, 2014
Diseases							
Causal organism: Fungi							
18	Black mould of onion (Post harvest)	*Aspergillus niger*	Trichocomaceae	Eurotiales	Yes	No	Rabbani *et al.*, 1986
19	Grey mould-rot (Post harvest)	*Botryotinia fuckeliana* Whetzel [teleomorph]	Sclerotiniaceae	Helotiales	Yes	No	CABI, 2017
20		*Botrytis aclada Fresen.*	Sclerotiniaceae	Helotiales	Yes	No	Wikipedia, 2017
21	Cottony soft rot	*Sclerotinia sclerotiorum*	Sclerotiniaceae	Helotiales	Yes	No	Prova *et al.*, 2014; Ahmed & Akhond, 2015; Rahman *et al.*, 2015
22	Neck rot of onion	*Botryotinia porri* (H.J.F. Beyma) Whetzel	Sclerotiniaceae	Helotiales	No	Yes	Zhang *et al.*, 2009;
23	Leaf blight of onion, neck rot of onion	*Botryotinia squamosa* Vienn.-Bourg. *Botryotinia allii* (Sawada) W. Yamam 1956	Sclerotiniaceae	Helotiales	No	Yes	CABI/EPPO, 2000; CABI/EPPO, 2007; EPPO, 2014
24	White rot	*Stromatinia cepivora*	Sclerotiniaceae	Helotiales	No	Yes	EPPO, 2014; Kim *et al.*, 2009;
25	Leaf spot	*Colletotrichum dematium* (Pers.) Grove	Glomerellaceae		Yes	No	CABI, 2017
26	Anthracnose	*Glomerella cingulata* Spauld. & Schrenk	Glomerellaceae		Yes	No	Mridha *et al.*, 1990
27	Charcoal rot	*Macrophomina phaseolina* (Tassi) Goid	Botryosphaeriaceae	Botryosphaeriales	Yes	No	CABI, 2016
28	Basal rot	*Fusarium oxysporum* Schlechtendahl	Nectriaceae	Hypocreales	Yes	No	CABI, 2017
29	Onion smut	*Urocystis cepulae* Frost	Urocystidaceae	Urocystidales	No	Yes	EPPO, 2014;
30	Downy mildew of onion	*Peronospora destructor* (Berk.)	Peronosporaceae	Peronosporales	No	Yes	Rochecouste, 1984; Fullerton *et al.*, 1986
31	Rust of onion	*Puccinia allii*	Pucciniaceae	Pucciniales	Yes	No	EPPO, 2014; Szabo *et al.*, 2013; Sansford *et al.*, 2015

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
32	Purple blotch	*Alternaria porri(Ellis) Cif.*	Pleosporaceae	Pleosporales	Yes	No	CABI, 2016
33	Onion leaf blight	*Stemphylium vesicarium*	Pleosporaceae	Pleosporales	No	Yes	Zhang & Zhang, 2002; EPPO, 2014; CABI/EPPO, 2006
34	Pink root rot	*Pyrenochaeta terrestris*		Pleosporales	No	Yes	Mishra et al., 2012
Causal organism: Bacteria							
35	Bacterial root rot	*Pectobacterium carotovorum subsp. carotovorum*	Enterobacteriaceae	Enterobacteriales	Yes	No	Hossain, 1994
36	Bacterial canker or blast	*Pseudomonas syringae pv. syringae* van Hall	Pseudomonadaceae	Pseudomonadales	Yes	No	Joyjit *et al.*, 2007; CABI/EPPO, 2012
37	Yellow disease phytoplasmas	*Candidatus Phytoplasma asteris*	Acholeplasmataceae	Acholeplasmatales	No	Yes	EPPO, 2014; Renu *et al.*, 2014; Kumar *et al.*, 2010;
38	Crown gall	*Rhizobium radiobacter*	Rhizobiaceae	Rhizobiales	No	Yes	EPPO, 2014; Ma & Wang, 1995;
Causal organism: Nematode							
39	Common spiral nematode	*Helicotylenchus dihystera* (Cobb) Sher	Hoplolaimidae	Tylenchida	Yes	No	Khan *et al.*, 2006; CABI/EPPO, 2010
40	Longidorids	*Longidorus Micoletzky* (Filipjev)	Longidoridae	Dorylaimida	Yes	No	Page *et al.*, 1979; Maqbool, 1992
41	Stubby root nematodes	*Trichodorus*	Trichodoridae	Triplonchida	No	Yes	Taylor & Brown, 1997
42	Root knot nematode	*Meloidogyne* Spp.	Meloidogynidae	Tylenchida	Yes	No	CABI/EPPO, 2001; EPPO, 2014
Virus							
43	Leek yellow stripe poty virus	Leek yellow stripe virus	Potyviridae		Yes	No	CABI, 2016
44	Ring spot of beet	*Tomato black ring virus*	Secoviridae	Picornavirales	No	Yes	CABI/EPPO, 2002; EPPO, 2014;
45	Iris yellow spot	Iris yellow spot virus Cortês *et al.* 1998	Bunyaviridae	Mononegavirales	No	Yes	Pawan & Poonam, 2013; EPPO, 2014; CABI/EPPO, 2014;
46	Onion yellow dwarf	Onion yellow dwarf virus	Potyviridae		No	Yes	Chen *et al.*, 2003; EPPO, 2014;
Weed							

SN	Common Name	Scientific name	Family	Order	Presence in Bangladesh	Quarantine status	References
47	Bermuda grass	*Cynodon dactylon* (L.) Pers.	Poaceae	Cyperales	Yes	No	Holm *et al.*, 1979
48	Barnyard grass	*Echinochloa crus-galli* (L.) P.Beauv.	Poaceae	Cyperales	Yes	No	USDA-ARS, 2014; Ali *et al.*, 1988
49	Goose grass	*Eleusine indica* (L.) Gaertner	Poaceae	Cyperales	Yes	No	Holm *et al.*, 1979
50	Red tassel flower	*Emilia sonchifolia* (L.) DC. (1838)	Asteraceae	Asterales	Yes	No	Holm *et al.*, 1997
51	Common chamomile	*Chamomilla recutita (L.)* Rauschert	Asteraceae	Asterales	Yes	No	CABI, 2015
52	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	No	Yes	Dale, 1981; Navie *et al.*, 1996; EPPO, 2014; Holm *et al.,* 1991
53	Garden spurge	*Euphorbia hirta* L.	Euphorbiaceae	Euphorbiales	Yes	No	Holm *et al.*, 1979
54	Hogweed	*Polygonum aviculare* L.	Polygonaceae	Polygonales	Yes	No	Holm *et al.*, 1997
55	Marsh pepper	*Polygonum hydropiper* L.	Polygonaceae	Polygonales	Yes	No	Holm *et al.*, 1997
56	Black nightshade	*Solanum nigrum* L.	Solanaceae	Solanales	Yes	No	CABI, 2015
57	Nettleleaf goosefoot	*Chenopodium murale* L.	Chenopodiaceae	Caryophyllales	Yes	No	Holm *et al.*, 1991
58	Green foxtail	*Setaria viridis* (L.) Beauv.	Poaceae	Cyperales	Yes	No	Holm *et al.*, 1979

Table 6. Quarantine pests for Bangladesh likely to be associated with onion and garlic imported from exporting countries

Sl. No.	Common name	Scientific name	Distribution to onion exporting countries	Plant parts likely to carry the pest	References
Arthropods					
Insect pests					
01.	Western flower thrips	*Frankliniella occidentalis* (Pergande)	China, India, Japan, Korea, Malaysia, Myanmar, Sri Lanka, Thailand, Turkey, USA, Brazil	Seed, human-assisted transport	EPPO, 2014; Kaomud & Tyagi Vikas Kumar, 2015; Gözel & Gözel, 2014;
02.	Pea leaf miner	*Liriomyza huidobrensis* (Blanchard, 1926)	China, India, Japan, Korea, Malaysia, Indonesia, Philippines, Sri Lanka, Thailand, Vietnam, Turkey, Brazil.	Infested leaf	CABI/EPPO, 2002; EPPO, 2014;
03.	Onion fly	*Delia antiqua* Meigen	China, India, Japan, Korea, Philippines, Turkey, USA, UK.	Bulbs, Leaves	EPPO, 2014; Pandey *et al.,* 2006;
04.	Serpentine leafminer	*Liriomyza trifolii* Burgess	China, India, Indonesia, Japan, Korea, Malaysia, Philippines, Thailand, Turkey, Vietnam, USA, Brazil, Chile.	Road/sea/ air transportation	EPPO, 2014; Baliadi & Tengkano, 2010; Gözel & Gözel, 2014; IPPC, 2009
05.	Leek moth	*Acrolepiopsis assectella*	Japan, USA, France, Germany, Italy, UK	Bulbs, Inflorescences	CABI, 2015; EPPO, 2014;
06.	Vegetable weevil	*Listroderes costirostris* Schönherr	Japan, Korea, Taiwan, USA, Brazil, Chile.	Shipping containers, human, vehicles	CABI & EPPO, 2000; EPPO, 2014;
Mite pest					
07.	Dry bulb mite	Aceria tulipae	India, Japan, Philippines, Thailand, Turkey, Vietnam, USA, Chile.	-	CABI, 2015; Monnet & Thibault, 2001; Halliday & Knihinicki, 2004
08.	Bulb mite (Post harvest)	*Rhizoglyphus echinopus* Fumouze & Robin	Japan, Korea, Taiwan, USA.	Bulb	Al-Douri, 2000
Snail					
09.	Common garden snail	*Cornu aspersum* Müller	China, Philippines, Thailand, Turkey, USA, Brazil.	food and skin care products, bulb,	El-Wakil *et al.,* 2011; Yildirim *et al.,* 2004; CFIA, 2014
Disease causing organisms					
Fungi					
10.	Neck rot of onion	*Botryotinia porri* (H.J.F. Beyma) Whetzel	China, Canada, USA, Chile.	Bulb, Seed	Zhang *et al.,* 2009; IPPC, 2006;
11.	Leaf blight of onion, neck rot of onion	*Botryotinia squamosa* Vienn.-Bourg. *Botryotinia allii* (Sawada) W. Yamam 1956	China, Japan, Korea, Canada, USA, Brazil.		CABI/EPPO, 2000; CABI/EPPO, 2007; EPPO, 2014
12.	White rot	*Stromatinia cepivora*	China, India, Japan, Korea, Philippines, Turkey, USA, Brazil, Chile	Bulb	EPPO, 2014; Kim *et al.,* 2009;
13.	Onion smut	*Urocystis cepulae*	China, India, Japan, Korea, Nepal,	Bulbs, Stems (above	EPPO, 2014;

Sl. No.	Common name	Scientific name	Distribution to onion exporting countries	Plant parts likely to carry the pest	References
		Frost	Pakistan, Philippines, Taiwan, Thailand, USA	ground)	
14.	Downy mildew of onion	*Peronospora destructor* (Berk.)	Afghanistan, China, India, Japan, Pakistan, Philippines, Thailand, USA, Brazil, Chile.	Leaf, stem	CMI, 1990; Gupta *et al.,* 1991; Sharma *et al.,* 1992;
15	Pink root rot	*Pyrenochaeta terrestris*	India, Israel, USA, Argentina, Australia,	Bulb, root	Mishra et al., 2012
Bacterial					
16.	Yellow disease phytoplasmas	*Candidatus Phytoplasma asteris*	China, India, Japan, Korea, Malaysia, Myanmar, Thailand, Turkey, USA, Brazil.	Bulb	EPPO, 2014; Baiswar *et al.,* 2010; Renu *et al.,* 2014; Kumar *et al.,* 2010; Nisbet *et al.,* 2014; Mollov *et al.,* 2014
17.	Crown gall	*Rhizobium radiobacter*	Afghanistan, China, India, Japan, Korea, Malaysia, Pakistan, Sri Lanka, Turkey, USA, Brazil, Chile.		EPPO, 2014; Ma & Wang, 1995; Sawada *et al.,* 1990;
Nematode					
18.	Stubby root nematodes	*Trichodorus*sp.	China, India, Japan, Korea, Pakistan, Taiwan, USA, Brazil.	Bulb, seedling	Decraemer, 1995; Maqbool & Nasira, 1995;
Virus and viroid					
19.	Ring spot of beet	*Tomato black ring virus*	India, Japan, France, UK	Vector	CABI/EPPO, 2002; EPPO, 2014;
20.	Iris yellow spot	*Iris yellow spot virus* Cortês et al. 1998	India, Indonesia, Japan, Pakistan, Sri Lanka, USA, Brazil, Chile.	Vector	Pawan & Poonam, 2013; EPPO, 2014; CABI/EPPO, 2014; Gawande *et al.,* 2014
21.	Onion yellow dwarf	*Onion yellow dwarf virus*	China, India, Indonesia, Japan, Thailand, Turkey, Vietnam, USA, Brazil, Chile.		Chen *et al.,* 2003; EPPO, 2014;
Weeds					
22.	Parthenium weed	*Parthenium hysterophorus*	India	Seed, equipment	

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CHAPTER 7

RISK ASSESSMENT

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 onion and garlic idenfied for Bangladesh has been analyzed details as follows:

7.A. ARTHROPOD: INSECT AND MITE PESTS

7.1.	Western flower thrips, *Frankliniella occidentalis* (Pergande)

7.1.1. 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]

7.1.2. 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).

7.1.3. 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, **onion and garlic,** cabbage, wild radish, wild mustard, sugarbeet, melon, 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.

7.1.4. 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).

7.1.5. 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 onion and garlic in Asia including **China, India, Thailand**, **Japan** [EPPO, 2014; CABI/EPPO, 1999] from where onion and garlic are imported to Bangladesh.
- can become established in Bangladesh through imports of the onion and garlic. 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 onion and garlic bulb and/or nursery stock [EPPO, 2016].
- *Frankliniella occidentalis* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.1.6. Determine likelihood of pest establishing in Bangladesh 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, • 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. Secondly, Onion and garlic is packed in sac and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with highrisk 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 bulb, 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* reproduce continuously, with up to 15 generations in a year being recorded under glass (Bryan and Smith, 1956; Lublinkhof and Foster, 1977). Development and reproductive rates are temperature dependent. The total life cycle from egg to egg has been recorded as 44.1, 22.4, 18.2 and 15 days at 15, 20, 25 and 30°C. Each female lays typically between 20 and 40 eggs during its life. At 15°C, pre-oviposition time is longer (10.4 days) than at higher temperatures of 20 or 30°C (2-4 days). However, because of faster development times, greater population growth rates are seen at temperatures of 30^{o}C (Gaum *et al.,* 1994).	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its host(s) are not common in Bangladesh and climate is not similar to places it is established	Low

7.1.7. Determine the Consequence establishment of this pest in Bangladesh

Table 8. 2 – Which of these descriptions best fit of this pest?

Description	Consequence potential
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 onion and garlic as well as other crops in Bangladesh still free from the pest. • This is a fairly serious pest of several important field crops, vegetables, onion and garlic, flowers 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. • 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.*	**Yes and High**

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

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

Establishment Potential X Consequence Potential = Risk

Table 8.3 – Calculating risk rating

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

Calculated Risk Rating – High

7.1.9. Risk Management Measures

- Avoid importation of onion and garlic 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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7.2:	Serpentine leaf miner, *Liriomyza trifolii* (Burgess)

7.2.1. Hazard identification

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

Synonyms: *Agromyza phaseolunata* Frost, 1943
Liriomyza huidobpensls
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]

7.2.2. 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.

7.2.3. Hosts

a. Major hosts: The main host of *L. trifolii includes cucurbits such* cucumbers, melons, watermelons(Stegmaier (1968)*,* Ageratum*,* Aster, marigold, Callistephus, safflower, *Chrysanthemum morifolium,* Dahlia, Gerbera *(barbeton daisy),* sunflower, carnation, gypsophila *(baby's breath),* Zinnia, salvia (sage), **garlic**,**onion,** Begunia, groundnut, lettuce, Chinese cabbage, spinach, ornamental gourd, 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, onionetc.

7.2.4. 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.

7.2.5. 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 onion and garlic and other vegetables 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 many vegetables and onion and garlic are imported to Bangladesh.
- can become established in Bangladesh through imports of the onion and garlic. 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. Onion and garlic 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.

7.2.6. Determine likelihood of pest establishing in Bangladesh 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. • 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.	HIGH

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

- Female flies puncture the leaves of the host plants causing wounds which serve as sites for feeding or oviposition (Parrella *et al.,* 1981). Eggs are inserted just below the leaf surface. *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). Eggs hatch in 2-5 days according to temperature. Harris and Tate (1933) give 4-7 days at 24°C. Many eggs may be laid on a single leaf. The duration of larval development also depends on temperature and probably host plant.
- In case of onion and garlic, either seeds or bulbs of onion and garlic are imported from the exporting countries into Bangladesh. The transport, storage and transfer duration for import of onion and garlic from exporting countries to our country is about 20 days. Therefore, the possibility of survival of this pest is less during transport of the onion and garlic. But high possibility for transportation of plant stocks particularly bulbs and seeds.

c. Does the pathway appear good for this pest to enter Bangladesh and establish? - No,

- Internationally, *L. trifolii*is liable to be carried on any plants for planting or nursery stocks and ornamental flowers, which are the main means of dispersal of this pest [EPPO, 2016]. But there is no possibility of this pest to appear on the bulbs.

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* 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, **c**ucumbers**,** garlic, leeks, lettuces, lucerne, marrows, melons**, onions** and **garlic**, 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	**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 Bangladesh and establish, and • Its host(s) are not common in Bangladesh and climate is not similar to places it is established	Low

7.2.7. 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. • *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** and **garlic**, peas, *Phaseolus coccineus*, *P. lunatus*, *P. vulgaris*, potatoes, spinach, tomatoes, *Tropaeolum* spp., *Vigna* spp., watermelons (Stegmaier, 1968). • 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 onion and garlic as well as other crops in Bangladesh still free from the pest. • This is a **fairly serious pest** of several important vegetables, onion and garlic bulbs, 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). • Vegetable losses in the USA are also considerable. For example, losses for celery were estimated at US$ 9 million in 1980 (Spencer, 1982). It was noted, however, that damage to celery during the first 2 months of the 3-month growing season was insignificant and largely cosmetic, whereas considerable yield loss resulted from pest presence during the final month (Foster *et al.,* 1988). 1.5 million larval mines per hectare were recorded from	**Yes and High**

<table>
<tr><td>onions in Iowa (Harris et al., 1933).
• 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).
• L. trifolii is also known to be a vector of plant viruses (Zitter et al., 1980).
c. Environmental Impact
• L. trifolii has developed resistance to most commonly used insecticides that were recommended for its control before 1990 (Parella et al., 1984; Nuessly and Webb, 2013), including carbamates, organophosphates, pyrethroids, avermectins, spinosyns and moulting disruptors, such as cyromazina (Hernandez, 2009).
• The development of resistance to insecticides could trigger repeated changing of different insecticides that creates toxic and harmful impact to the environment and human health.</td><td></td></tr>
<tr><td>• Not as above or below</td><td>Moderate</td></tr>
<tr><td>• This is a not likely to be an important pest of common crops grown in Bangladesh.</td><td>Low</td></tr>
</table>

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

Establishment Potential X Consequence Potential = Risk

Table 9.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.2.9. Risk Management Measures

- Avoid importation of onion and garlic and other susceptible crops from countries, where this pest is available.
- *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, onion and garlic,* 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 ohion and garlic importation.

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7.3	Pea leaf miner, *Liriomyza huidobrensis* (Blanchard)

7.1. Hazard Identification

Scientific Name: *Liriomyza huidobrensis* (Blanchard)

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

Common names: Pea leaf miner,
South American leaf miner

Taxonomic tree

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

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

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

7.2. 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.

7.10.3. 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.

7.10.4. 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.

7.5. 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 onion and garlic 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 onion and garlic and other major vegetables and susceptible crops are imported to Bangladesh.
- can become established in Bangladesh through imports of the onion and garic. 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. Onion and garlic 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.

7.6. Determine likelihood of pest establishing in Bangladesh 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 • 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. Possibility of survival of this pest during transport, storage and transfer of commodity?—Yes** • Female flies puncture the leaves of the host plants causing wounds which serve as sites for feeding or oviposition (Parrella *et al.,* 1981). In California, *L. huidobrensis* completes its life-cycle in 17-30 days during the summer	**Moderate**

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. • In case of onion and garlic, either transport of seeds or bulbs of onion and garlic are imported from the exporting countries into Bangladesh is about 20 days. Therefore, the possibility of survival of this pest is high during transport of the onion and garlic. But high possibility for transportation of plant stocks particularly leaves, bulbs of any plants. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - No,** • Internationally, *L. huidobrensis*is liable to be carried on any plants for planting or and nursery stocks, which are the main means of dispersal of this pest [EPPO, 2016]. But there is no possibility of this pest to appear on the bulbs. **c. 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 (*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	**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 Bangladesh and establish, and • Its host(s) are not common in Bangladesh and climate is not similar to places it is established	Low

7.7. Determine the Consequence establishment of this pest in Bangladesh

Table 10. 2. – Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • *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* is of quarantine significance for Bangladesh. Its introduction and rapid spread to many countries, and the problems presented by its presence in flowers, leaves and other crops including onion and garlic, illustrate clearly the serious nature of this pest and the potential threat to the onion and garlic as well as other crops in Bangladesh still free from the pest. • This is a **fairly serious pest** of several important vegetables, flowers and other crops for Bangladesh. **b. Economic Impact and Yield Loss** • *L. huidobrensis* is a serious pest of potato, vegetables and ornamental plants in the field and glasshouses in many parts of the world (Lange *et al.,* 1957). In South America, it is a key pest of potato. In Europe and Mediterranean regions, *L. huidobrensis* is already a major pest of chrysanthemums, Primula spp., Verbena, lettuces (OEPP/EPPO, 1994), Phaseolus vulgaris, cucumbers, celery and *Cucurbita pepo* (ADAS, 1991). • Although it initially proved to be a much more serious pest than *L. trifolii* in Israel (Weintraub and Horowitz, 1995), it has since come under natural biological control and is only occasionally a pest (Weintraub, 2001b). • 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 (Parrella and Bethke, 1984). 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. **c. Environmental Impact** • Some insecticides, particularly abamectin (Weintraub and Horowitz, 1998; Weintraub 2001; Hidrayani *et al,* 2005), the growth regulator cyromazine (Veire, 1991; Staay, 1992; Leuprecht, 1993; Weintraub and Horowitz, 1998;	**Yes and High**

Weintraub 2001) and spinosad (Weintraub and Mujica, 2006) provide effective control against larvae because these insecticides are translaminar, but leaf miner resistance can sometimes make control of adults difficult (Parrella *et al.,* 1984; Macdonald, 1991). • The development of resistance to insecticides could trigger repeated changing of different insecticides that creates toxic and harmful impact to the environment and human health.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 10.3. – Calculation of risk rating

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

Calculated Risk Rating – High

7.9. Risk Management Measures

- Avoid importation of onion and garlic 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, onion, garlic, *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 onion and garlic and for vegetables with leaves.

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7.4. Onion fly, *Delia antiqua* Meigen

7.4.1. Hazard identification

Scientific Name: *Delia antiqua* Meigen

Synonyms:

Anthomyia antiqua
Hylemya ceparum
Leptohylemyia antiqua
Phorbia antiqua Meigen

Common names: Onion maggot

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Uniramia
Class: Insecta
Order: Diptera
Family: Anthomyiidae
Genus: Delia
Species: *Delia antiqua*

EPPO Code: HYLEAN.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2015; EPPO, 2016]

7.4.2. Biology

Adult onion flies emerge from overwintered pupae from May onwards and deposit eggs at the neck on young leaves or in the soil adjacent to host plants. The eggs hatch within a few days and each female can produce more than 200 eggs. The white, legless and headless maggots can move from one plant to another through the soil to complete development. They reach 10mm long when fully grown which takes about three weeks. They pupate in the soil, unlike allium leaf miner which pupates within the foliage. The next generation of flies emerges after two to three weeks and there can be three generations a year.

7.4.3. Hosts

Delia antiqua is considered a specialist phytophagous species. Its host range is restricted to plants belonging to the genus Allium. The onion fly was only observed on cultivated Allium. Leek (*A. porrum*) and **onion (*A. cepa*)** are the main host plants but attacks are also

observed on **garlic (*A. sativum*),** shallot (*A. cepa* var *aggregatum*) and chives (*A. fistulosum* and *A. schoenoprasum*).
The vegetative and seedling stages are most widely affected. Stored onions and garlic are also damaged.

7.4.4. Distribution

The onion fly is found in North America, Western Europe, Russia, Central Asia, China, Japan, and Korea, but is absent from deserts. In the far north of its range, it has one generation per year, but further south, two, three, or four generations may occur in one year.
Africa: Egypt
Asia: China (Hebei, Heilongjiang, Jilin, Liaoning), **India** (Jammu and Kashmir, Uttar Pradesh), Iran, Israel, **Japan** (Hokkaido, Honshu, Kyushu, Shikoku), Kazakhstan, Korea, Mongolia, Philippines and Turkey (Wang & Ren, 2004; Pandey *et al.,* 2006; EPPO, 2014),
Europe: Austria, Belarus, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France Germany, Greece, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Rassian Federation, Serbia, Slovakia, Spain, Sweden, Switzerland and United Kingdom (EPPO, 2014),
North America: Canada (British Columbia, New Brunswick, Ontario, Prince Edward Island, and Quebec; first found in 1993), United States (EPPO, 2014).
South America: Brazil, Colombia

7.4.5. Hazard Identification Conclusion

Considering the facts that *Delia antiqua* -

- is not known to be present in Bangladesh [EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of onion in Asia including China, India, **Japan**, Kazakistan, Korea, Philippines and Turkey [EPPO, 2014] from where seeds and bulbs are imported to Bangladesh.
- *Delia antiqua* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 11.1 – Which of these descriptions best fit of this pest?

Description	Establishment Potential
a. **Has this pest been established in several new countries in recent years-Yes**, • *Delia antiqua* has been recorded in **India**, **Japan**, Kazakistan**, Egypt, Canada, Greece,** Russian federation, Serbia and United Kingdom (EPPO, 2014). • The presence of *Delia antiqua* has been confirmed **China, Iran**, Philippines, USA, Austria, Belgium, Denmark, Germany, France, Hungary, Poland and Spain (EPPO, 2014). **b. Posibility of survival during transport, storage and transfer? Yes** • The onion seeds and bulbs are transported from Japan, Germany, Canada, USA, Russian federation and UK 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. *Delia antiqua* enters diapause at the beginning of September when the ground temperature is below 15°C. Therefore, this pest is rated with high risk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,**	**YES and HIGH**

• The eggs, larvae and pupae may be enter into imported countries through bulbs, tubers, corns, rhizomes, stems, shoots and branches. • The onion and garlic seed and bulbs are imported into Bangladesh mainly from Japan, India, Germany, Canada, USA, and UK. *Delia antiqua* is a common problem in such countries. The So, the pathway appear good for this pest to entire in Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the onion and garlic. *Delia antiqua* was mainly known as a pest of onion in tropical and subtropical countries. *Delia antiqua* host range is restricted to plants belonging to the genus *Allium* which is mostly common in Bangladesh. • The lifespan depends on the temperature, 45 days at 15°C and 17 days at 25-30°C.These climatic requirements for growth and development of *Delia antiqua* is more or less similar with the climatic condition of **Bangladesh**.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.4.7. Determine the Consequence establishment of this pest in Bangladesh

Table 11.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • Until recently, *Delia antiqua* can establish on host plant of *Allium* genus plants. And the host range (onion, garlic, leek, Welsh onion and chives) is available in Bangladesh. • *Delia antiqua* has been known as a minor pest of onion and garlic crops in the warmer parts of the world and, until recently, has been easily controlled by insecticides. • The establishment of this pest in Canada has resulted in economic losses to garlic, leek, and onion growers, especially organic growers in eastern Ontario and southern Quebec (EPPO, 2014). • The number of onion fly in a population depends on climatic conditions. The population increases with successive generations and damage is more important in summer and at the beginning of autumn than in the spring • This is a fairly serious pest of onion and garlic for Bangladesh. **b. Economic impact and yield loss** • *Delia antiqua* In France, damage can reach >70% in Brittany (Rahn, 1982b), and 60-80% on leek and 40-50% on onion in Vaucluse (Nepveu and Hoffman, 1950). **c. Environmental Impact** • Food and Agriculture Organization (FAOSTAT 2002) showed that a temperature increase of 3^{o}C, paired with a 10% increase in rainfall, would lead to about 4% more cultivable rainfed land. The cultivable land in developed countries would increase by 25% whereas it would decrease by	**Yes and High**

11% in developing countries, which clearly indicates the uneven distribution of climate benefits. During the height of the breeding season, the insect can be transported easily from place to place through the shipment of green vegetables and root crops, either on the plants or secluded in shipping containers. Repeated observations have demonstrated that the pest may be accidentally transported by persons or vehicles (High, 1939), This invariably leads to an increase in the use of insecticides as *Delia antiqua* 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

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

Establishment Potential X Consequence Potential = Risk

Table 11.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.4.9. Risk Management Measures

- Avoid importation of bulbs and seeds from countries, where this pest is available.
- In countries where *Delia antiqua* is not already present, the enforcement of strict phytosanitary regulations as required for *Delia antiqua* , may help to reduce the risk of this leek moth 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, 2014). Particular attention is needed for consignments from countries where certain *Delia antiqua* are present.

7.4.10. References

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OEPP/EPPO (2014) EPPO Standards PP 1/135 (4), PP 1/214 (3), PP 1/224 (2), PP 1/241 (2), PP 1/242 (2), PP 1/243 (2), PP 1/248 (2), PP 1/257 (2), PP 1/283 (1), PP 1/284 (1) in this issue of the EPPO Bulletin.

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7.5. Leek moth, *Acrolepiopsis assectella* Zeller

7.5.1. Hazard identification

Scientific Name: *Acrolepiopsis assectella* Zeller

Synonyms:

Acrolepia assectella Zeller
Acrolepia betulella Herrich-Schaffer
Acrolepia vigieliella Duponchel
Roeslerstammia betulella Herrich-Schaffer

Common names: Leek moth

Taxonomic tree

- Domain: Eukaryota
  - Kingdom: Metazoa
    - Phylum: Arthropoda
      - Subphylum: Uniramia
        - Class: Insecta
          - Order: Lepidoptera
            - Family: Plutellidae
              - Subfamily: Plutellinae
                - Genus: Acrolepiopsis
                  - Species: *Acrolepiopsis assectella*

EPPO Code: ACROAS.

Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2015; EPPO, 2016]

7.5.2. Biology

A female generally lays between 100 and 120 eggs during her 1-week life, a maximum of about 400 eggs has been observed. Eggs are white, elliptical, ca 0.3 x 0.2 mm, laid singly on the leaves of Allium plants and, after a wandering period, first instar larvae (ca 1 mm long) penetrate into the green leaves where they bore galleries. Third, fourth and fifth instars bore into the central yellow leaves of the leek and produce the most severe damage. The pupa is 7-8 mm long, its colour varies from weak yellow after pupal moulting to brown before adult emergence. Males and females 8- 9 mm long, with a wing span reaching ca 15 to 16 mm, are similar although the females are generally a little bigger. The general colour is grey-brown with a typical white triangle in the middle of the posterior edge of the fore wings. Adults emerge from pupae fixed on to Allium leaves by the cocoon. They are active at night

and remain still during the day. The first night after emergence the female releases a sex pheromone that attracts males. Mating takes place in the second half of the night and lasts about 1 h. Females normally mate once only but males are able to mate two or three times during their lifespan, but only once a night. Development time is temperature dependent. At 25°C, eggs hatch after 3-4 days. Larval development takes 2 weeks, pupal development 1 week and adults can survive 7-10 days.
Migration has not been observed in the leek moth. An adult diapause, which is initiated by low temperatures and short photoperiods during larval instars, allows the adults to overwinter and survive for 4-6 months (Abo-Ghalia and Thibout, 1982). This diapause decreases female fecundity. According to latitude, *A. assectella* completes various generations a year. In northern and central Europe, only two generations were observed. In southern Europe four to five generations, and in Algeria up to eight overlapping generations, have been observed.

7.5.3. Hosts

A. assectella is considered a specialist phytophagous species. Its host range is restricted to plants belonging to the genus Allium. The leek moth was only observed on cultivated Allium. Leek *(A. porrum)* and **onion*(A. cepa)*** are the main host plants but attacks are also observed on **garlic*(A. sativum)*** and chives (*A. fistulosum* and *A. schoenoprasum*). In 1910, Picard noted possible damage on cultivated ornamental Asphodelus and Hemerocalis.
The vegetative and flowering stages are most widely affected, but the seedling stage is sometimes affected in nurseries. Stored onions and garlic are also damaged.

7.1.4. Distribution

This species is found throughout Europe (USDA, 1960). It was mistakenly reported from Hawaii.
Africa: Algeria,
Asia: Japan, Kazakhstan, Kyrgyzstan, Mongolia, and Russia (EPPO, 2012),
Europe: Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France (including Corsica), Germany, Greece, Hungary, Italy (including Sardinia and Sicily), Latvia, Lithuania, Luxembourg, Macedonia, the Netherlands, Norway, Poland, Portugal, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, and former Yugoslavia (reviewed in Garland, 2002; EPPO, 2012),
North America: Canada (Ontario, Prince Edward Island, and Quebec; first found in 1993), United States (New York) (Mason *et al.,* 2011).

7.5.5. Hazard Identification Conclusion

Considering the facts that *Acrolepiopsis assectella*-

- is not known to be present in Bangladesh [EPPO, 2014; CABI/EPPO, 2007];
- is potentially economic important to Bangladesh because it is an important pest of onion in Asia including **Japan**, Kazakhstan, Kyrgyzstan, Azerbaijan [EPPO, 2014; CABI/EPPO, 2007] from where seeds, and bulbs are imported to Bangladesh.
- *Acrolepiopsis assectella*is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 12.1 – 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**, • *Acrolepiopsis assectella*has been recorded in **Japan, Canada** and Russian federation (EPPO, 2014; CABI/EPPO, 2007).	

• The presence of *Acrolepiopsis assectella* has been confirmed Algeria, USA (New York), Austria, Belgium, Germany, France, Hungary, Poland, Spain and UK (EPPO, 2014; CABI/EPPO, 2007. **b. Posibility of survival during transport, storage and transfer? Yes** • The onion seeds and bulbs are transported from Japan, Germany, Canada, USA, Russian federation and UK 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 about 20 days. So, the insects or eggs or larvae can survive within this time. The storage condition is more or less favorable for its survival. Therefore, this pest is rated with highrisk potential. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • The onion is imported into Bangladesh manily from Japan, Germany, Canada, USA, Russian federation and UK. *Acrolepiopsis assectella*is a common problem in such countries. Eggs, larvae, pupae may enter into our country through bulbs, tubers, corms, rhizomes, flowers, inflorescences, leaves and stems. The pest and sympots usually invisible when they present in flowers, inflorescence, cones and calyx. So, the pathway appear good for this pest to entire in Bangladesh. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the onion and garlic. *Acrolepiopsis assectella* was mainly known as a pest of onion in tropical and subtropical countries. *Acrolepiopsis assectella* host range is restricted to plants belonging to the genus *Allium* which is mostly common in Bangladesh. Development time is temperature dependent. At 25°C, eggs hatch after 3-4 days. Larval development takes 2 weeks, pupal development 1 week and adults can survive 7-10 days. According to latitude, *A. assectella* completes various generations a year. In northern and central Europe, only two generations were observed. In southern Europe four to five generations, and in Algeria up to eight overlapping generations, have been observed. • These climatic requirements for growth and development of *A. assectella*is more or less similar with the climatic condition of **Bangladesh**.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.5.7. Determine the Consequence establishment of this pest in Bangladesh

Table 12.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Until recently, *A. assectella*can establish on host plant of *Allium* genus plants. And most of the host range (onion, garlic, leek, Welsh onion and chives) . Most of them are available in Bangladesh. • *A. assectella* has been known as a minor pest of onion and garlic crops in	**Yes and High**

the warmer parts of the world and, until recently, has been easily controlled by insecticides. It can sometimes be a serious pest in continental Europe (Agassiz, 1996). Areas with several generations per year can have up to 40% infestation in host crops while areas with one to two generations per year can have minor economic damage caused by sporadic populations (Allen *et al.,* 2008). • The establishment of this pest in Canada has resulted in economic losses to garlic, leek, and onion growers, especially organic growers in eastern Ontario and southern Quebec (Mason *et al.,* 2011). • The number of leek moths in a population depends on climatic conditions. The population increases with successive generations and damage is more important in summer and at the beginning of autumn than in the spring. • This is a fairly serious pest of onion and garlic for Bangladesh. **b. Economic impact and yield loss** • *A. assectella*is a moth present throughout Europe. It is also found in some Asian countries and has been introduced to parts of Canada. The larvae of *A. assectella* feed on cultivated *Allium* species, primarily leek (*A. porrum*) and onion **(*A. cepa*),** but also garlic **(*A. sativum*)** and chives (*A. fistulosum* and *A. schoenoprasum*). • In France, damage can reach >70% in Brittany (Rahn, 1982b), and 60-80% on leek and 40-50% on onion in Vaucluse (Nepveu and Hoffman, 1950). • *A. assectella* can cause damage to several species in the Allium family, including leeks and onions by mining and feeding in the foliage and bulbs of the host plants. *A. assectella* can also prevent seed formation by feeding on the seed stalk (USDA, 1960). • It can sometimes be a serious pest in continental Europe (Agassiz, 1996). Areas with several generations per year can have up to 40% infestation in host crops while areas with one to two generations per year can have minor economic damage caused by sporadic populations (Allen *et al.,* 2008) **c. Environmental Impact** • According to latitude, *A. assectella* completes various generations a year. A single individual is capable of establishing the species in any new area where climatic conditions are favourable (Lovell, 1932). During the height of the breeding season, the weevil can be transported easily from place to place through the shipment of green vegetables and root crops, either on the plants or secluded in shipping containers. Repeated observations have demonstrated that the pest may be accidentally transported by persons or vehicles (High, 1939), This invariably leads to an increase in the use of insecticides as *A. assectella* 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

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

Establishment Potential X Consequence Potential = Risk

Table 12.3 – Calculation of risk rating

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

High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.5.9. Risk Management Measures

- Avoid importation of bulbs and seeds from countries, where this pest is available.
- In countries where *A. assectella* is not already present, the enforcement of strict phytosanitary regulations as required for *A. assectella*, may help to reduce the risk of this leek moth 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 *A. assectella* are present.

7.5.10. References

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OEPP/EPPO (2014) EPPO Standards PP 1/135 (4), PP 1/214 (3), PP 1/224 (2), PP 1/241 (2), PP 1/242 (2), PP 1/243 (2), PP 1/248 (2), PP 1/257 (2), PP 1/283 (1), PP 1/284 (1) in this issue of the EPPO Bulletin.

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7.6.	Vegetable weevil; ***Listroderes costirostris*** **Schönherr**

7.6.1. Hazard Identification

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

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

Taxonomic tree

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

EPPO Code:LISTCO.

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

7.6.2. Biology

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

7.7. Hosts

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

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

7.6.4. Distribution

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

7.6.5. Hazard identification conclusion

Considering the facts that *Listroderes costirostris* -

- is not known to be present in Bangladesh [CABI & EPPO, 2000; EPPO, 2014];
- is potentially economic important to Bangladesh because it is an important pest of vegetables in Asia including Iarael, **Japan** [CABI & EPPO, 2000; EPPO, 2014,] Taiwan from where vegetables are imported to Bangladesh.
- can become established in Bangladesh through imports of the onion and garlic. 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, bulb (High 1939). The major method of long distance dispersal for this pest is via transportation of infested seed and nursery stock [EPPO, 2016]
- *Listroderes costirostris* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

7.6.6. Determine likelihood of pest establishing in Bangladesh 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,** • *Listroderes costirostris* is distributed in many Asian countries including Israel (Friedman, 2009; EPPO, 2014), Japan (Morrone, 1993; CABI & EPPO, 2000; EPPO, 2014), Taiwan (Hsu & Chiang,	

1983;), Korea (Morimoto, 1992; CABI & EPPO, 2000; EPPO, 2014). • High (1939) reported serious economic damage to vegetable crops in the ten USA States where the pest was established in 1930. Growers in Mississippi, USA, reported losses as high as 90%, with common losses ranging from 40 to 70%. During 1933, the estimated crop losses for tomatoes alone ranged from 5 to 70% of the total crop value. Entire plantings of turnips, carrots, cabbages, mustard and spinach can be destroyed or seriously injured during the early stages of growth by this weevil. Practically all vegetable growers in the region adjacent to the Gulf of Mexico, USA, have suffered crop losses due to *L. costirostris* damage *(High, 1939).* **b. Posibility of survival during transport, storage and transfer of this pest? Yes** • The onion and garlic bulbs are transported from Japan, Thailand, Taiwan, India, Indonesia, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, Brazil, and Chile to Bangladesh mainly by Airfreight, and or Landport.Therefore, the period of time taken for shipment through these transportation pathways from the exporting countries to Bangladesh is very short. Within this period the eggs and larvae of vegetable wevill can easily survive on fruit surfaces of bulbs. Because, Egg incubation period ranged from 15 to 33 days when the average daily temperature was 12.8-24.4°C. During the spring and autumn most of the eggs under observation hatched within 15-20 days after deposition. Secondly, fruit is packed in sac and stored in normal conditions. So the pests could survive during transporting process. Therefore, this pest is rated with **High** risk potential. As *L. costirostris* reproduces parthenogenetically, a single individual is capable of establishing the species in any new area where climatic conditions are favourable (Lovell, 1932). During the height of the breeding season, the weevil can be transported easily from place to place through the shipment of green vegetables and root crops, either on the plants or secluded in shipping containers. Repeated observations have demonstrated that the pest may be accidentally transported by persons or vehicles (High, 1939), although *L. costirostris* is not included on any quarantine lists for any country. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Internationally, *Listroderes costirostris* is liable to be carried on any plants for planting or on bulb, 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** • *Listroderes costirostris* is a remarkably polyphagous species with 87plant species from 20 families being recorded as hosts. The host range of *Listroderes costirostris* is *Solanum melongena* (aubergine), *Solanum lycopersicum* (tomato), potato, grapevine orchid, safflower, Chrysanthemum morifolium, roses,Gerbera, gypsophila, Zinnia, Begunia, Poinsettia, balsam. amaranth, carrot, lettuce, cabbage, wild radish, wild mustard, melon, sugarbeet,	**YES and HIGH**

cucumber, pea, peach, apple, apricot, ***Allium cepa* (onion)** etc.As long as environmental conditions are favourable,	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter your country and establish, and • Its host(s) are not common in your country and your climate is not similar to places it is established	Low

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

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

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

Establishment Potential X Consequence Potential = Risk

Table 13.3 – 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

7.6.9. Possible Risk Management Measures

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

7.6.10. References

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7.7.	Dry bulb mite, *Aceria tulipae* (Keifer, 1938)

7.7.1. Hazard identification

Scientific Name: *Aceria tulipae* (Keifer, 1938)
Synonyms:*Eriophyes tulipae* Keifer, 1938

Common names: Garlic mite;
Onion mite;
Wheat curl mite

Taxonomic tree

- Domain: Eukaryota
  - Kingdom: Metazoa
    - Phylum: Arthropoda
      - Subphylum: Chelicerata
        - Class: Arachnida
          - Subclass: Acari
            - Superorder: Acariformes
              - Suborder: Prostigmata

Family: Eriophyidae
Genus: Aceria
Species: *Aceria tulipae*

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

7.7.2. Biology

The mite has a vermiform body ranging from 200-250µm length. The dorsal side is covered with a shield (37-39 µm) which bears a longitudinal striation as well a pair of long posterior-directed, divergent dorsal setae near the posterior edge. The two pairs of legs have distinctive claw-like structures located terminally on the tarsi, with seven pairs of rays.

7.7. Hosts

Aceria tulipae has hosts in the families Alliaceae and Liliaceae. These include Allium species such as *A. ampeloprasum* (leek), *A. ascalonicum* (shallot), ***A. cepa*** **(onion),** ***A. sativum*** **(garlic),***A. schoenoprasum* (chives), and Tulipa (tulip). *Allium chinense* (rakkyo) is a secondary host (MacLeod, 2007).

7.7.4. Distribution

Asia: Georgia, **India** (Tamil Nadu), Indonesia, **Japan**, Philippines, **Thailand**, Turkey, Vietnam.
Africa: Egypt, South Africa, Tanzania
North America: USA (California).
Central America and Caribbean: Cuba.
South America: Brazill, Chile, Venezuela.
Oceania: Australia, Fiji, New Zealand.
Europe: France, Hangary, Italy, Poland, Russian Federation, Spain.

7.7.5. Hazard Identification Conclusion

Considering the facts that *Aceria tulipae* -

- 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.
- The mite can be established in the protected environments of Allium storage facilities. The mite requires high humidity to thrive. The eggs, nymphs and adults are able to survive in bulbs for extended periods in storage, and are the main source of infestation of the annually cultivated crops, where this pest is present (MacLeod, 2007). Chemical treatment in the field is inadequate since bulbs would be difficult to access. The risk of mites surviving postharvest treatment is therefore high.
- *Aceria tulipae* is a **quarantine pest** for Bangladesh and considered to be a **potential hazard organism** in this risk analysis.

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

Table 14.1 – Which of these descriptions best fit of this pest?

Description	**Establishment Potential**
a. **Has this pest been established in several new countries in recent years-Yes**, • Establishment of *Aceria tulipae* has been recorded in recent years in Turkey, Vietnam, Hungary and Australia. **b. Posibility of survival during transport, storage and transfer? Yes**	

• Eggs, nymphs and adults of this mite are able to survive in the bulbs for extended periods both in the soil over winter and in storage. • If infested bulbs were planted out the mite could transfer to suitable hosts via aerial dispersal, as is common amongst other eriophyids, although Conijn *et al.,* (1996) indicate that the spread of this mite outdoors is limited. If *A. tulipae* was carried into onion stores, they could survive and transfer to other bulbs (MacLeod, 2007). **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • The mite is very small and difficult to see with the naked eye. Identification with certainty requires examining properly cleared and slide-mounted specimens under high magnification. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the onion and garlic. *Aceria tulipae*was mainly known as a pest of onion in tropical and subtropical countries. *Aceria tulipae* host range is restricted to plants belonging to the genus *Allium* which is mostly common in Bangladesh. • Based on the current known distribution of *A. tulipae*, the mite is likely to be able to establish outdoors in Jamaica. Infested bulbs planted in Jamaica could support *A. tulipae*. The mite show optimum development at 25^{o}C, which coincide with the temperatures in Jamaica year round. • These climatic requirements for growth and development of *Aceria tulipae* are more or less similar with the climatic condition of **Bangladesh**.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.7.7. 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. • *Aceria tulipae has hosts in the families Alliaceae and Liliaceae*. These include Allium species such as *A. ampeloprasum* (leek), *A. ascalonicum* (shallot), ***A. cepa* (onion), *A. sativum* (garlic),***A. schoenoprasum* (chives), and Tulipa (tulip). *Allium chinense* (rakkyo) is a secondary host (MacLeod, 2007). • This is a fairly serious pest of several important vegetables, onion and garlic and other crops for Bangladesh. **b. Economic impact and yield loss** • *A. tulipae* feeds on the foliage of hosts and between the layers in bulbs.Feeding causes stunting, twisting, curling and discoloration of foliage and scarification and drying of bulb tissue. • There is scant information quantifying the impact of this pest. However, what data there is, suggests that when bulbs are severely infested, losses could be significant, for example approximately 30% losses have	**Yes and High**

been reported from onions. In field trials, Larrain (1986) measured yield losses of 23% in garlic due to A. tulipae. • The mite can transmit Onion Mite- borne Latent virus and Shallot Mite borne Latent virus. Vectoring these viruses would not significantly increase any impact resulting from feeding damage caused by the mite since virus symptoms and damage resulting from mite feeding is very similar (MacLeod, 2007). **c. Environmental Impact** • *Aceria tulipae* has hosts in the families Alliaceae and Liliaceae. Control of *A. tulipae* has focused on treatment of bulbs with chemicals or low temperatures to attempt to eradicate mite infestations prior to storage or planting. 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

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

Establishment Potential X Consequence Potential = Risk

Table 14.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.7.9. Risk Management Measures

- Avoid importation of vegetables, onion and garlic from countries, where this pest is available.
- In countries where *A. tulipae* is not already present, the enforcement of strict phytosanitary regulations as required for *A. tulipae*, may help to reduce the risk of this mite becoming established.

7.7.10. References

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7.8.	Bulb mite, ***Rhizoglyphus echinopus*** **Fumouze & Robin**

7.8.1. Hazard identification

Scientific Name: *Rhizoglyphus echinopus* Fumouze & Robin
Synonyms:
Rhizoglyphus hyacinthi
Rhizoglyphus spinitarsus
Common names: Potato root mite;
Tulip mite
Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Arthropoda
Subphylum: Chelicerata
Class: Arachnida
Subclass: Acari
Superorder: Acariformes
Order: Astigmata
Family: Acaridae
Genus: Rhizoglyphus
Species: *Rhizoglyphus echinopus*
EPPO Code:RHIGEC.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2015]

7.8.2. Biology

Bulb mites are 1/50 to 1/25 in. (0.5 to 0.9 mm) in length, shiny white to translucent with two brown spots on the body, and smooth with short, red-orange legs. Females laying up to 100 white, elliptical eggs during their lifespan. The life cycle takes approximately 40 days to complete. Bulb mites may be less active during the winter months; however, they don't undergo diapause (a kind of dormancy), and all life stages may be present throughout the growing season. Bulb mites may be moved in and between greenhouses by workers or growing medium.

7.8.3. Hosts

Rhizoglyphus echinopushas hosts in the families Araliaceae *and Liliaceae*.These include Allium species such as ***A. cepa*** **(onion),** ***A. sativum*** **(garlic**) and another host plant is *Panax ginseng* (Asiatic ginseng) (CABI, 2010).

7.8.4. Distribution

Asia*: Iraq, Japan, Korea, Taiwan.*
North America: *USA (Texas).*
Oceania: *New Zealand.*
Europe: *Hangary, Spain.*

7.8.5. Hazard Identification Conclusion

Considering the facts that *Rhizoglyphus echinopus-*

- is not known to be present in Bangladesh [CABI, 2010];
- is potentially economic important to Bangladesh because it is an important pest of onion and garlic in Asia including **Japan**, Iraq, Korea, Taiwan, [Al-Douri, 2000] from where bulb and seed are imported to Bangladesh.
- *R. echinopus* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 15.1 – 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, • Establishment of *Rhizoglyphus echinopus*has been recorded in recent years in Iraq, Japan and Korea. • Rhizoglyphus echinopus also present in USA (Texas), Hungary, Spain (CABI, 2010). **b. Posibility of survival during transport, storage and transfer? Yes** • Adults live longer at lower temperatures (up to 121 days) and males tend to live twice as long as females. The hypopal stage attaches to insects visiting the bulbs and may be carried to other bulbs. Hypopi do not feed (no head), and they are resistant to starvation and desiccation during adverse conditions. The transport duration of onion and garlic from exporting countries to Bangladesh is about 20 days. So, the transport duration is favourable for its survival and the storage condition is also favourable for its survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • The mite is very small and difficult to see with the naked eye. Identification with certainty requires examining properly cleared and slide-mounted specimens under high magnification. • Besides their direct feeding, bulb mites are a threat because they carry pathogenic fungi. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • This pest can become establish in Bangladesh through imports of the onion and garlic. was mainly known as a pest of onion in tropical and subtropical countries. *Rhizoglyphus echinopus* host range is restricted to plants belonging to the genus *Allium* which is mostly common in Bangladesh. • These mites can survive at 35°C, but they cannot lay eggs at that temperature. On the other hand these mites cannot develop at temperatures below 11.8°C. The length of development is greatly dependent on temperature, relative humidity (100 percent is best), and available food. • These climatic requirements for growth and development of *Rhizoglyphus echinopus* are more or less similar with the climatic condition of **Bangladesh**.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.8.7. Determine the Consequence establishment of this pest in Bangladesh

Table 15.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? –Yes • This pest can become establish in Bangladesh through imports of the onion and garlic. *Rhizoglyphus echinopus* was mainly known as a pest of onion in tropical and subtropical countries. *Rhizoglyphus echinopus* host range is restricted to plants belonging to the genus Allium which is mostly common in Bangladesh. **b. Economic impact and yield loss** • *Rhizoglyphus echinopus* is an important pests attacking bulbs, corms and tubers of a variety of crops (e.g. onions, garlic and other vegetables) and ornamentals (lily and other flowers) in greenhouses and in the field worldwide. • Bulb mite is a storage pest of onion and garlic. It causes great economic losses of onion and garlic at the time of storage. But due to lack of accurate information of yield losses of onion and garlic at the time of storage, we can't provide the actual yield losses information. **c. Environmental Impact** • Management of bulb mites is complicated by their short generation time, high reproductive potential, broad food niche, interactions with other pests and pathogens, and unique adaptations for dispersal. Historically, control of these acarine pests has relied on the use of synthetic miticides and insecticides, but this option is now limited due to documented resistance and withdrawal of registration of some products. Alternative control strategies, including cultural and biological control, have shown limited success, but need to be further developed and implemented. • Due to use of different miticide and insecticide different adverse effect are seen in the environment like destruction of natural control system, effent on wild life, aquatic life, even on birds.	**Low**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 15.3 – Calculation of risk rating

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

Calculated Risk Rating – Moderate

7.8.9. Risk Management Measures

- Avoid importation of 0nion and garlic from countries, where this pest is available.
- In countries where *R. echinopus*is not already present, the enforcement of strict phytosanitary regulations as required for *R. echinopus*, may help to reduce the risk of this bulb mite 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 *R. echinopus*-listed viruses are present.

7.8.10. References

Al-Douri Z, 2000. Notes on some mites under certain field crops in central Iraq. Bulletin of the Iraq Natural History Museum, 9(2):5-8.

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7.9.	Common garden snail, *Cornu aspersum* Müller

7.9.1. Hazard identification

Scientific Name: *Cornu aspersum* Müller
Synonyms:
Cornu copiae Born, 1778
Helix aspera
Helix rufescens
Common names: Brown garden snail;
Brown snail;
European brown snail
Taxonomic tree
Domain: Eukaryota
Kingdom: Metazoa
Phylum: Mollusca
Class: Gastropoda
Subclass: Pulmonata
Order: Stylommatophora
Suborder: Sigmurethra
Superfamily: Helicoidea
Family: Helicidae
Genus: Cornu
Species: *Cornu aspersum*
EPPO Code:HELXAS.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2016]

7.9.2. Biology

C. aspersum is a large-sized land snail, with a shell generally globular but sometimes more conical (higher spired) and rather thin in the common form when compared to other Helicinae. Adult shells (4½ to 5 slightly convex whorls) measure 28-45 mm in diameter, 25-35 mm in height (Kerney and Cameron, 1979). The shell ground colour is from yellowish to pale brown. The head and foot are 5-10 cm long when extended, yellowish-grey to greenish-black, often with a pale line along the back from the base of the tentacles to the shell. Specimens with soft parts entirely dark are occasionally observed. Eggs are laid in clutches in hollows up to 7 cm below the soil surface dug out by the snail and covered with earth. Clutches vary in number of eggs from about 40 to 100 that are clustered together and joined by a sticky, colourless mucus. They are roundish-oval in shape, roughly 4.25 mm long by 4 mm wide. Newly-hatched juvenile shells, which are fragile and translucent, lack any pattern of shell bands and flecks. However, as they grow the shells rapidly become coloured. The shell colour and pattern polymorphism is better observed in young individuals because the periostracum tends to become darker in adults. Old individuals are easily recognized because some parts of the periostracum become worn, exposing the underlying calcified shell. In natural populations, formation of a reflected lip round the shell aperture indicates sexual maturity and the end of somatic growth. Two juvenile classes are distinguished by snail farmers for practical reasons (Daguzan, 1982), based on shell diameter (D), i.e. first stage juveniles with D < 22 mm and second stage juveniles with D > 22 mm.

7.9.3. Hosts

C. aspersum is a polyphagous grazer with a large diet spectrum. In its natural habitat, it feeds on wild plants such as *Urtica dioica* or *Hedera helix*, which are also used for shelter. In human-disturbed habitats, a wide range of crops and ornamental plants are reported as hosts: these include vegetables, cereals, flowers and shrubs (Godan, 1983; Dekle and Fasulo, 2001). In particular, it causes serious damage in citrus groves and vineyards. It will feed on both living and dead or senescent plant material. Main host plant families are Actinidiaceae, Liliaceae, Chenopodiaceae, Brassicaceae, Solanaceae, Rutaceae, Rosaceae, Asteraceae, Lauraceae, Fabaceae, Grossularaceae and Poaceae (CABI, 2016).

7.9.4. Distribution

- **Asia**: China (Hebel), Israel, Philippines, Saudi Arabia, Syria, Thailand, Turkey.
- **Africa:**Egypt, Morocco, South Africa, Spain, Zimbabwe.
- **North America:**Canada (British Columbia, Nova Scotia), USA.
- **South America:** Argentina, Brazil, Chile, Venezuela.
- **Oceania:**Australia, New Zealand.
- **Europe:** Belgium, Cyprus, France, Germany, Hangary, Itali, Poland, Spain, UK.

7.1.5. Hazard Identification Conclusion

Considering the facts that *C. aspersum*-

- is not known to be present in Bangladesh [CABI, 2016];
- In Asia, a branch of the Chinese Academy of Sciences introduced the species to China from France in the early 1980s (W Wang, Pharmacom Corporation, Iowa, USA, personal communication, 2009). Around the middle of the 1990s, a company in northern China commercialized the technology of snail farming and management in Hebei Province. The 'meat' was mainly used as food at Chinese dining tables. From 2008, a US-based biotech company started to extract and purify the functional contents of the snail for skincare products and medical applications.
- *C. aspersum* is a polyphagous grazer with a large diet spectrum. In its natural habitat, it feeds on wild plants such as Urtica dioica or Hedera helix, which are also used for shelter. In human-disturbed habitats, a wide range of crops and ornamental plants are reported as hosts: these include vegetables, cereals, flowers and shrubs (Godan, 1983; Dekle and Fasulo, 2001). In particular, it causes serious damage in citrus groves and vineyards. It will feed on both living and dead or senescent plant material. The Host Plants/Plants Affected table does not cover all plants that C. aspersum will feed on, as the list is so extensive but aims to provide an insight to the well-known species affected
- *C. aspersum* is a quarantine plant pest in various states in the USA (Arizona, California, Louisiana, Oregon, South Carolina and Washington) and in Canada.
- *C. aspersum* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

7.9.6. Determine likelihood of pest establishing in Bangladesh 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, • Establishment of *C. aspersum* has been recorded in recent years in China, Saudi Arabia, Uzbekistan, Egypt, Zimbabwe, Canada, Colombia, Austria and Hungary. • *C. aspersum also present in USA (Texas), Uk, Germany, Brazil, Chile, Spain, Australia and New Zealand (CABI, 2016).* **b. Posibility of survival during transport, storage and transfer? Yes** • Overwintering in *C. aspersum* lasts more than 7 months in Scotland (Crook, 1980), 6 months in Wales (Bailey, 1981), approximately 5 months in northwestern France (Lorvelec and Daguzan, 1990) and 4 months in northwestern Spain (Iglesias *et al.,* 1996). • During dormancy, snails bury in the soil or crawl into crevices among rocks, retire into their shells and produce a calcareous and mucous epiphragm sealing the shell aperture (Barnhart, 1983). Their metabolic rate is depressed to 5-30% of its normal value (Herreid, 1977; Barnhart and MacMahon, 1987; Storey and Storey, 1990; Brooks and Storey, 1997): oxygen consumption, water exchange, heart rate, neural activity and patterns of protein synthesis and activation are modified (Machin, 1966, 1972; Riddle, 1983; Barnhart and MacMahon, 1987; Bailey and Lazaridou-Dimitriadou, 1991; Biannic *et al.,* 1994; Brooks and Storey, 1995, 1997; Feneglio *et al.,*1997; Pakay *et al.,* 2002). A moderately enhanced cold hardiness is related to hibernation, allowing the snails to bear temperatures as low as c. –5°C (Ansart *et al.,* 2001). However, young individuals seem unable to really hibernate and thus exhibit higher mortality during overwintering (Charrier, 1980; Biannic, 1995). **c. Does the pathway appear good for this pest to enter Bangladesh and establish? - Yes,** • Nowadays, the western lineage of *C. aspersum* has become a typically anthropochorous form widespread throughout the world in many regions having Mediterranean, temperate and even subtropical climates. • Besidethis the host range is available in Bangladesh for establishment of *C. aspersum*. • Adults and larger juveniles are likely to be visible among the host material or attached to the transporting containers. They may also be hidden in protected locations, sealed into their shells to avoid desiccation. Check the undersides of containers and their rims. Small snails and eggs in soil could be difficult to find. *C. aspersum* hides in crevices and will overwinter in stony ground. • Inspections are best carried out under wet, warm and dark conditions. Under bright, dry conditions it is necessary to throughly search dark, sheltered areas where the humidity is elevated, such as under low-growing plants or debris. The snails may bury themselves in loose soil or other matter, so the only way to be reasonably sure an area is not infested is to make repeated surveys over a long period of time. • *C. aspersum*, in common with other pulmonate invaders, has been widely distributed throughout the world by human activities. • Some bird species, seems to be an efficient vector for the passive dispersal of *C. aspersum*.	**YES and HIGH**

d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– No • *C. aspersum* is a generalist species, found in a large range of habitats and climates, from Mediterranean to temperate, oceanic and tropical (Chevallier, 1977). • Activity necessitates a temperature of between 7 and 28°C and an elevated humidity of 75-90% (Daguzan, 1980). If conditions are unfavourable, adult snails are able to remain dormant for several months. However, they cannot withstand long periods of frost (Ansart *et al.,* 2002). Eggs are particularly sensitive to dehydration (Machin, 1975; Riddle, 1983) and cold temperatures (Le Calvé, 1995; Ansart *et al.,* 2007), such that in temperate regions egg deposition occurs only in spring and autumn (Madec and Daguzan, 1993). • Habitats are also highly variable, but the snails preferentially choose microhabitats with greater light intensity and structural complexity, offering more dormancy retreats and better protection against predators, and reject dimly lit microhabitats with smooth substrates (Perea *et al.,* 2007). As the availability of calcium is critical for shell construction, richness in calcium is often suggested as an important criterion for microhabitat selection (e.g. Crowell, 1973). • In culture, crowding rapidly and persistently affects growth of juveniles, with accumulation of slime and faecal matter suggested as having a negative effect on individuals (Cowie and Cain, 1983; Lucarz and Gomot, 1985; Jess and Marks, 1995).	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.9.7. 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. Is this a serious pest of Bangladesh? - Yes. • Main host plant families are Actinidiaceae, Liliaceae, Chenopodiaceae, Brassicaceae, Solanaceae, Rutaceae, Rosaceae, Asteraceae, Lauraceae, Fabaceae, Grossularaceae and Poaceae (CABI, 2016). **b. Economic impact and yield loss** • *C. aspersum* can cause serious losses to various ornamental plants and crops such as cabbage, lettuce, tomato, citrus, avocado, grapevines and other fruits and vegetables. It can especially be a problem following wet winters and springs. • In the citrus orchards of California, infestation can reach as high as 1000 individuals per tree. In high-rainfall years, fruit losses are often in the order of 40-50% and sometimes reach 90-100% (Sakovich, 2002). • In South African viticultural regions, *C. aspersum* causes crop losses up to 25%. Moreover, active animals leave mucous trails on the developing grapes, reducing their aesthetic appearance and rendering table grapes unsuitable for export markets (Sanderson and Sirgel, 2002). • In Australia, a significant increase in the level of snail (*C. aspersum* and *Theba pisana*) contamination in dried grapes has been	**Yes and High**

observed since the late 1980s, leading to penalties imposed on growers delivering contaminated products. Infestations of 50-70 *C. aspersum* per vine have been recorded (Sanderson and Sirgel, 2002). • In the USA and New Zealand, *C. aspersum* creates problems in commercial kiwifruit fields. Fruits with snail damage (up to 35% of kiwifruit harvested) prior to harvest have significantly more *Botrytis cinerea* grey mould than fruits without damage (Michailides and Elmer, 2000). Moreover, slime trails deposited on fruits stimulate the germination of *B. cinerea*. • As a consequence, molluscicide usage has increased 70-fold since the early 1970s. In the UK, 4800 tonnes (250 tonnes of active ingredient) were being applied each year at a cost of nearly £10 million, and Spanish farmers were spending £5 million each year on molluscicides (Garthwaite and Thomas, 1996). **c. Environmental Impact** • There are few studies on the impacts of *C. aspersum* in its natural habitat, as it is essentially a pest in human-disturbed habitats. However, in New Zealand (Barker and Watts, 2002), it is particularly abundant in indigenous ecosystems and potentially constitutes a threat through: - selective feeding, which can modify the structure of plant communities; - substantial deposit of mucus and faecal material, leading to increasing bacterial and fungal biomass, and hence increased decomposition rates (Theenhaus and Scheu, 1996); - introduction of new parasites associated with the snails, such as the mite *Riccardoella limacum*, which could infect indigenous species; acting as a new food resource for mammalian and avian predators. • It has also been suggested that terrestrial gastropods may influence metal fluxes through soil ecosystems, simply by their preferential selection of certain types of food (Dallinger *et al.,* 2001). In general, terrestrial gastropods are important in nutrient cycling and plant litter decomposition (Meyer *et al.,* 2011, 2013)	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 16.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.9.9. Risk Management Measures

- Avoid importation of 0nion and garlic from countries, where this pest is available.
- In countries where *C. aspersum*is not already present, the enforcement of strict phytosanitary regulations as required *C. aspersum*, may help to reduce the risk of this bulb mite 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).

7.9.10. References

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7.10.	Neck rot of onion, ***Botryotinia porri*** (H.J.F. Beyma) Whetzel

7.10.1. Hazard identification

Scientific Name: *Botryotinia porri* (H.J.F. Beyma) Whetzel
Synonyms:
Botrytis porri N.F. Buchw. [anamorph] N.F. Buchw.
Sclerotinia porri H.J.F. Beyma
Common names: Neck rot of onion
Botrytis rot of garlic;
Botrytis rot of leek;
Seedling damping-off of onion

Taxonomic tree

Domain: Eukaryota
Kingdom: Fungi
Phylum: Ascomycota
Subphylum: Pezizomycotina
Class: Leotiomycetes
Subclass: Leotiomycetidae
Order: Helotiales
Family: Sclerotiniaceae
Genus: Botryotinia
Species: *Botryotinia porri*
EPPO Code:BOTTPO.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2011]

7.10.2. Biology

The life cycle of *B. porri* follows the typical pattern of the group. Survival is mainly as sclerotia in the soil. The fungus may possibly also survive in host debris. Formation of apothecia is a normal stage in the life cycle, but sclerotia can also give rise to conidia directly. The relative importance of ascospores and conidia in primary infection is not known. *B. porri* is favoured by cool moist conditions, which allow the dispersal of conidia in the early part of the growing season and thus the possibility of epidemic spread. The disease does not progress when conditions become warm and dry. Irrigation also favours infection. Post-harvest damage arises from the spread of lesions formed in the field. In stored leeks, the fungus does not spread at storage temperatures of -1 to 0°C, but lesions expand at 5°C or above.

7.10.3. Hosts

B. porri has only been recorded on leek and garlic in the field, but Presly (1985) was able to infect onions in the laboratory (CABI, 2011).

7.10.4. Distribution

- **Asia**: China (Hebel), Iran.
- **North America:**Canada (Quebec), USA.
- **South America:** Chile, Venezuela.
- **Oceania:**Australia, New Zealand.
- **Europe:** Germany, Hangary, UK.

7.10.5. Hazard Identification Conclusion

Considering the facts that *B. porri*-

- is not known to be present in Bangladesh [CABI, 2016];
- In Asia, *B. porri* is present in China (Only one state named Hebel) and Iran.
- *B. porri* also present in Canada, USA (California, Nevada, Oregon, and Washington), Chile, Germany, UK, Australia and New Zewaland.
- *B. porri* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

7.10.6. 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, • Establishment of *B. porri*has been recorded in recent years in China, Canada, Chile and Germany. **b. Posibility of survival during transport, storage and transfer? Yes** • *B. porri* is favoured by cool moist conditions, which allow the dispersal of conidia in the early part of the growing season and thus the possibility of epidemic spread. The disease does not progress when conditions become warm and dry. Irrigation also favours infection. The storage temperature and humidity is also favourable for its survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • Crowe *et al.* (1995) mention that there are unconfirmed reports that *B. porri* may be seed-borne. Since *B. porri* does not apparently infect the above-ground parts of the plant, and is not known to produce the kind of latent infection which characterizes the seed-borne *B. allii,* such seed-borne transmission seems implausible. • *B. porri* may be spread by planting material (bulbs of garlic, possibly young seedlings of leek). Internationally, it could also be introduced into new areas with garlic bulbs or leeks for consumption, although it is relatively unlikely that diseased material should enter international trade because of its obvious poor quality. • The fungus spreads by wind or rain dispersal of ascospores and conidia. **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 *B. porri* is limited but available in Bangladesh. Leek, onion and garlic are the main host for *B. porri.*	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate

• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.10.7. 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. • The host range of *B. porri* is limited but available in Bangladesh. Leek, onion and garlic are the main host for *B. porri.* **b. Economic impact and yield loss** • *B. porri* causes a neck rot of leek and garlic, which may cause the whole aboveground parts of the plant to die. Typical Botrytis conidia form on the neck of the bulbs, followed by sclerotia. In garlic, the rot may spread to the whole of the bulb during the growing season, with abundant production of sclerotia. In leek, plants are decayed in store. **c. Environmental Impact** • Due to introduction of this fungus into different countries where they estabilished, different type of chemical fungicide is used to mitigate its infection. As a result different type negative effect have been shown in the environment like development of bio-type, resistence, resurgence, upset, destruction of natual control system etc.	**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

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

Establishment Potential X Consequence Potential = Risk

Table17.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.10.9. Risk Management Measures

- Avoid importation of 0nion and garlic from countries, where this pest is available.
- In countries where *B. porri* is not already present, the enforcement of strict phytosanitary regulations as required *B. porri*, may help to reduce the risk of this bulb mite 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).

7.10.10. References

Crowe F, Mohan SK, Schwartz HF, 1995. Botrytis rot of garlic. In: Schwartz HF, Mohan SK, eds. Compendium of Onion and Garlic Diseases. St Paul, USA: American Phytopathological Society, 19-20.

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7.11.	Leaf blight of onion, *Botryotinia squamosa* Vienn.-Bourg

7.11.1. Hazard identification

Scientific Name: *Botryotinia squamosa* Vienn.-Bourg

Synonyms:

Botrytis squamosa J.C. Walker [anamorph] J.C. Walker.
Sclerotinia squamosa (Vienn.-Bourg.) Dennis

Common names: Leaf blight of onion
Neck rot of onion;
Small sclerotial neck rot

Taxonomic tree

Domain: Eukaryota
Kingdom: Fungi
Phylum: Ascomycota
Subphylum: Pezizomycotina
Class: Leotiomycetes
Subclass: Leotiomycetidae
Order: Helotiales
Family: Sclerotiniaceae
Genus: *Botryotinia*
Species: *Botryotinia squamosa*

EPPO Code:SCLESQ.

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

7.11.2. Biology

Initial symptoms of the disease are small elliptical white to straw coloured lesions of 1-5 mm diameter, which mostly occur on the side of the leaf exposed to sunlight. Each lesion is usually surrounded by a greenish-white halo that appears water-soaked. A lengthways sunken slit often occurs in the centre of the lesion. The older leaves are the most susceptible and they typically wilt and blight within 5-12 days of infection and lesion formation. The pathogen in some instances can infect the outer tissues of the bulb, causing a disease known as small sclerotial neck rot. As mentioned earlier, the pathogen makes sclerotia that overwinter in the field debris (infected leaves, bulbs) and cull piles and germinate in the spring. As a result of this germination, conidiophores arise that produce conidia (anamorphic phase). Apothecia also arise out of the sclerotia and release ascospores (teleomorphic phase) although these are not a very significant source of primary inoculum for infection. The sclerotia are capable of continuous and prolonged production of conidia thus resulting in a huge amount of primary inoculum. The conidia and ascospores then go on to produce primary infection on leaves causing leaf blights. Conidia are produced in the necrotic tissues that act as sources of dissemination and secondary inoculum. Towards maturity, Sclerotia are produced in the leaves and necks of infected bulbs (blackened appearance) that overwinter and germinate the following spring. Sclerotia can survive up to 21 months at a depth greater than 15 cm from the soil surface.

7.11.3. Hosts

B. squamosa is found in Aliaceaefamily like onion, garlic and leek.

7.11.4. Distribution

- **Asia**: China (Hebel, Hong kong),Japan, Korea.
- **North America:**Canada, USA.
- **South America:**Brazil, Peru.
- **Oceania:**Australia, New Zealand.
- **Europe:**France, Germany, Italy, Poland, UK.

7.11.5. Hazard Identification Conclusion

Considering the facts that *B. squamosa*-

- is not known to be present in Bangladesh [CABI, 2015];
- In Asia, *B. squamosa* is present in China (Hebel and Hong kong), Japan and Korea.
- *B. squamosa* also present in Canada, USA, Brazil, France, UK, Australia and New Zewaland.
- *B. squamosa* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 18.1 – 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, • Establishment of *B. squamosa* has been recorded in recent years in China, Japan, Korea, Canada, USA, Argentina, Germany, UK, Australia, New Zealand. **b. Posibility of survival during transport, storage and transfer? Yes** • The conidia and ascospores go on to produce primary infection on leaves causing leaf blights. Conidia are produced in the necrotic tissues that act as sources of dissemination and secondary inoculum. Towards maturity, Sclerotia are produced in the leaves and necks of infected bulbs (blackened appearance) that overwinter and germinate the following spring. Sclerotia can survive up to 21 months at a depth greater than 15 cm from the soil surface. So, the sclerotia may survive during transport, because the maximum time for onion and garlic transportation from exporting countries to our country is about 20 days, which is favourable for its survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • The pathogen makes sclerotia that overwinter in the field debris (infected leaves, bulbs) and cull piles and germinate in the spring. As a result of this germination, conidiophores arise that produce conidia (anamorphic phase). • So, this pathogen may enter into our country from exporting countries where this pathogen is already estabilished through infected bulbs. **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 *B. squamosa*is limited but available in Bangladesh.	**YES and HIGH**

Leek, onion and garlic are the main host for *B. squamosa.*	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.11.7. Determine the Consequence establishment of this pest in Bangladesh

Table 18.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • The host range of *B. squamosa*is limited but available in Bangladesh. Leek, onion and garlic are the main host for *B. squamosa.* • If this pests enter into our country through infected bulbs it become a serious pest of Bangladesh. **b. Economic impact and yield loss** • Older leaves are more susceptible to lesion formation and blighting. Under favourable environmental conditions (high rainfall, extended periods of leaf wetness, high relative humidity, and moderately warm temperatures, between 12 and 25°C), leaf blight can result in significant reductions of onion bulb growth and yield. **c. Environmental Impact** • Due to estabilishment of this pathogen, different harmful fungicides are used to control the pathogen, causes different harmful effect on 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

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

Establishment Potential X Consequence Potential = Risk

Table18.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.11.9. Risk Management Measures

- Avoid importation of onion and garlic from countries, where this pest is available.
- In countries where *B. squamosal* is not already present, the enforcement of strict phytosanitary regulations as required *B. squamosa*, may help to reduce the risk of this bulb mite 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).

7.11.10. References

CABI/EPPO, 2015. Botryotinia squamosa. Distribution Maps of Plant Diseases, No. 164. Wallingford, UK: CAB International.
Delahaut, K., and Stevenson, W. 2004. Onion disorders: Botrytis leaf blight, leaf fleck, and neck rot. A3803 University of Wisconsin Extension publication http://learningstore.uwex.edu/assets/pdfs/A3803.pdf
Lacy, M.L., and Lorbeer, J.W. 2008. Neck rot. In: Compendium of onion diseases. Second edition. Schwartz, H.F. and Mohan, S.K. (eds.) APS Press, St. Paul, MN.

7.12.	White rot of onion and garlic, *Stromatinia cepivora* (Berk.) Whetzel [anamorph] (Berk.) Whetzel

7.12.1. Hazard identification

Scientific Name: *Stromatinia cepivora* (Berk.) Whetzel [anamorph] (Berk.) Whetzel
Synonyms:
Sclerotium cepivorum Berk.
Stromatinia cepivorum (Berk.) Whetzel [teleomorph] (Berk.) Whetzel

Common names
White rot of onion and garlic;
Bulb rot of onion.

Taxonomic tree

Domain: Eukaryota
Kingdom: Fungi
Phylum: Ascomycota
Subphylum: Pezizomycotina
Class: Leotiomycetes
Subclass: Leotiomycetidae
Order: Helotiales
Family: Sclerotiniaceae
Genus: *Stromatinia*
Species: *Stromatinia cepivora*

EPPO Code: SCLOCE.

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

7.12.2. Biology

This fungus forms black, near-spherical sclerotia that are 200-500 µm in diameter. It can also form large sclerotial bodies of irregular shape with lengths varying between 0.5 and 1.5 cm (6). The sclerotia can be found on the mycelium. The infective sclerotia remain viable in the soil for many years and are stimulated to germinate by the presence of a susceptible crop. Sclerotium cepivorum is the asexual reproductive form of Stromatinia cepivora and is a plant pathogen, causing white rot in Allium species, particularly onions, leeks, and garlic. On a worldwide basis, white rot is probably the most serious threat to Allium crop production of any disease. This is a soil borne fungus and affects susceptible crops planted in infected soil containing sclerotia. The sclerotia that are developed in the life cycle can be spread to other fields by unsuccessful sanitation practices.The sclerotia can remain viable in the soil for years and germinate with a susceptible host to cause disease. The pathogen grows in moist cold temperatures. So, in the right conditions, pathogenic activity increases as the root systems develop. The White Rot pathogen is dependent upon temperature. Environmental conditions influence the germination with it favoring cooler weather (50-70 F). If there is high soil moisture present, germination and infection will be favored. However, the sclerotia and fungal growth are inhibited above 70 F. With the pathogen favoring cool wet summers, irrigation can be also be a problem in spreading the disease from an infected field to a clean field. Therefore, this pathogen is of great concern to growers experiencing cool wet summers.

7.12.3. Hosts

S. cepivorum is a pest primarily of the Allium species (CABI, 2006).

7.12.4. Distribution

- **Asia**: China, India (Delhi and Uttar Pradesh), Iran, Israel, Japan, Korea, Philippines, Turkey (EPPO, 2014; CMI, 1990).
- **Africa**: Egypt, South Africa (EPPO, 2014; CMI, 1990).
- **North America:** Canada, Mexico, USA (EPPO, 2014; CMI, 1990).
- **South America:** Argentina, Brazil, Chile (EPPO, 2014; CMI, 1990).
- **Oceania:** Australia, New Zealand (EPPO, 2014; CMI, 1990).
- **Europe:** Cyprus, France, Germany, Italy, Spain, UK (EPPO, 2014; CMI, 1990).

7.12.5. Hazard Identification Conclusion

Considering the facts that -

- is not known to be present in Bangladesh [CABI, 2015];
- On a worldwide basis, Allium white rot is probably the most serious threat to Allium crop production of any disease
- It is present in almost all Allium-producing regions of the world. While some regions have been able to continue production despite infestation, the disease has never been completely successfully managed anywhere.
- *S. cepivorum* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 19.1 – 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 • In Asia, *S. cepivorum*has been introduced in Korea and Turkey, (EPPPO, 2014). • In another trading countries like Costa Rica, Guyana, Hungery, Poland, Russian Fedaration and Siberiait also has been introduced (EPPPO, 2014). b. **Posibility of survival during transport, storage and transfer? Yes** • If bulbs infected by *S. cepivorum* survive long enough to be placed into storage, the pathogen may continue to decay the bulbs if there is high humidity and low temperatures. If the bulbs are stored under dry conditions then the disease may not spread but bulbs infected in the field will continue to decay (Cherry, 2008) This means that bulb curing won‘t inhibit fungal growth if prior infection occurred in the field and storage at 0^{o}C and between 65-70% humidity, as is reported by Argentina, will further encourage multiplication. The possibility of surviving postharvest treatment will be therefore be high.	**YES and HIGH**

<table>
<tr><td>

- Temperature relationships for *S. cepivorum* sclerotial germination vary according to the temperature history of the sclerotia. Once sclerotia germinate and infect plants/plant part, time for symptom development decreases with increasing temperature. Infection symptoms took five times as long to be seen at 6°C as at 24°C (CABI, 2006).
- The transport duration of onion and garlic from exporting countries to our country is about 20 days. So, the duaration is favourable for its survival. Beside this, the storage temperature and humidity is also favourable for its growth, development and survival.

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

- In commercial crops, the first signs of the disease may appear as a small patch more yellow than the surrounding onions, which could be mistaken for nutrient deficiency (CPC, 2006). The signs of the disease may be masked by other conditions as well as by the natural colour of the bulb which may also be white.
- Hyphae and sclerotia may present in or on bulbs, tubers, rhizomes, roots and stems.
- As, we import the onion and garlic from different countries where this diseases is already estabilished. So, there is a great possibility to enter this pathogen in our country through bulb and/or tubers.

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

- Unless the imported onion intended for consumption is used as planting stock, the fungus is not expected to be transferred and affect local production. Its survival is also limited as it requires an optimum temperature of 10 -20 °C. The growth of this fungus is restricted by higher temperatures, which is seen year round in Jamaica.
- The fungus is favoured by cool weather and survives in the soil as small, round structures known as sclerotia. These sclerotia can survive in the soil for decades. The sclerotia that form on the decaying host will lay dormant until a host plant's root exudates stimulate germination specifically root exudates that are unique to Allium spp. Cool weather is also needed for germination of sclerotia and hyphal growth. Jamaica only experience short bouts of seasonal cool temperatures which are intricate in the fungus growth and development, potential dispersal is therefore low.
- So, the development, growth and survival may occur in our country in winter season.

</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 Bangladesh and establish, and
• Its hosts are not common in Bangladesh and climate is not similar to places it is established.</td><td>Low</td></tr>
</table>

7.12.7. Determine the Consequence establishment of this pest in Bangladesh

Table 19.2: Which of these descriptions best fit of this pest?

Description	Consequence potential

a. Is this a serious pest of Bangladesh? - Yes. • This is serious disease for plants of the allium family. The soil borne fungus can persist in the soil for many years. This disease is present in all allium-producing regions making it a threat in the allium production industry and a worldwide disease. **b. Economic impact and yield loss** • On a worldwide basis, Allium white rot is probably the most serious threat to Allium crop production of any disease (CABI, 2006). • It has been found in the United States 10 times with the first in 1918 in Oregon and the latest in 2014 in an onion field. Onions and garlic are economically important vegetables in the world. S. cepivora is one of the most destructive diseases carrying high loss in onion and garlic. Once land has been infested, it is considered not suitable for garlic or onion production for up to 40 or more years. • In a number of regions, the disease has been responsible for the complete collapse of the Allium production industry (Cherry online). • The pathogen cause losses from 1 to 100% and has caused great damage in diverse regions of Europe, Asia, Africa, North, Central, and South America, Australia and New Zealand (Ulacio-Osario *et. al* 2006). **c. Environmental Impact** • Temperature relationships for sclerotial germination vary according to the temperature history of the sclerotia and the isolate under study (Gerbrandy, 1992). The fungus infects plants in the Allium genus, which includes onion, garlic, and leeks. The disease can occur in any location where Allium spp. are grown, as long as part of the crop growth occurs during a cool season. Cool weather is also needed for germination of sclerotia and hyphal growth. • Sclerotia of *S. cepivorum* are stimulated to germinate specifically by root exudates of the genus Allium and the natural host range is limited to this genus. Chemical treatment is among the more effective short-term solutions to Allium white rot, but cannot be relied upon in the long term. Biological and using resistant varities would have to be employed. • The use of excessive chemical fungicide may harm to our environment in many ways like distruction of natural control system, development of bio type, resistence, resurgence and secondary pest outbreak.	**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

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

Establishment Potential X Consequence Potential = Risk

Table19.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.12.9. Risk Management Measures

- Avoid importation of onion and garlic from countries, where this pest is available.
- In countries where *S. cepivorum*is not already present, the enforcement of strict phytosanitary regulations as required *S. cepivorum*, may help to reduce the risk of this bulb mite 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).

7.12.10. References

CAB International, 2006. Crop Protection Compendium, 2006 Edition. Wallingford, UK: CAB International.

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

Gerbrandy SJ, 1992. Effects of different temperature treatments on dormancy of sclerotia of ten isolates of Sclerotium cepivorum. Netherlands Journal of Plant Pathology, 98(5):269-276

Michelle M. Moyer. 2015. Diseases of garlic: various pests. The Plant Disease Diagnostic Clinic. http://www.plantclinic.cornell.edu

The Department of Agriculture and Markets Nov. 10, 2011 press release regarding this pest at: http:// www.agriculture.ny.gov/AD/release.asp?ReleaseID=1984

7.13.	Onion smut, ***Urocystis cepulae*** Frost

7.13.1. Hazard identification

Scientific Name: *Urocystis cepulae* Frost

Synonyms:

Tuburcinia cepulae (Frost) Liro.
Urocystis colchici var. *cepulae* (Schltdl.) Rabenh. Cooke
Urocystis magica Pass.

Common names: Onion smut, Leek smut

Taxonomic tree

Domain: Eukaryota
Kingdom: Fungi
Phylum: Basidiomycota
Subphylum: Ustilaginomycotina
Class: Ustilaginomycetes
Order: Urocystidiales
Family: Urocystidaceae
Genus: Urocystis
Species: *Urocystis cepulae*

EPPO Code: UROCCE.

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

7.13.2. Biology

Sori as pustules in leaves and bulbs, often confluent, initially covered by the epidermis which ruptures to expose the dusty blackish brown mass of spore balls. Spore balls globose to ovoid, composed of 1 or 2 central spores and a continuous to discontinuous layer of peripheral sterile cells. Spores globose, subglobose, ovoid to slightly irregular, 13–16 (–19) × 10.5–13.5 µm diam., medium to dark reddish brown. Sterile cells globose, ovoid to irregular, 5–10 µm diam., light yellowish brown. Spore germination resulting in a hemispherical or short-cylindrical aseptate basidium from which 4–8 septate branching hyphae arise. First symptoms are observed at the cotyledonary stage as dark, thickened areas which break open during further leaf development, showing characteristic dark spore masses. Plants may be killed in 3-5 weeks. Surviving plants show short, distorted leaves bearing lesions throughout their length. Bulb development is poor. The spores are spread by wind, rainfall, soil particles and plant residues. There is no seed transmission, but spore balls could ocuur as contaminants of onion seeds samples. The optimum infection temperature is 13-22^{0}C. A cool (13-22^{o}C) and wet spring increases the incidence of smut infection, because the onion seedlings grow slowly and the flag leaf is in the soil for a longer period. Similarly, planting onion seeds too deep will also make them more likely to be infected. Smut spores (teliospores) survive in the soil for about 15-20 years, and even long crop rotations may not reduce disease incidence very effectively. Seed treatments with fungicides can reduce losses to the disease and growing onions from onions sets avoids the disease. The disease is spread when contaminated soil or set onions are transferred to smut-free areas.

7.13.3. Hosts

U. cepulae host plants are onion and garlic.

7.13.4. Distribution

- **Asia**: China, India (Jammu and Kasmir and Karnmataka), Iran, Japan, Korea, Nepal, Pakistan, Philippines, Thailand.
- **North America:** Canada, USA.
- **South America:** Chile, Peru.
- **Oceania:** Australia, New Zealand.
- **Europe:** France, Germany, Italy, poland, UK.

7.13.5. Hazard Identification Conclusion

Considering the facts that *U. cepulae*-

- is not known to be present in Bangladesh [CABI, 2015];
- In Asia, *U. cepulae*is present in China, India, Iraq, Japan, Korea, Nepal, Pakistan, Philippines and Thailand.
- *U. cepulae* also present in Canada, USA, France, Germany, UK, Australia and New Zewaland.
- The disease can affect 70-90% of seedlings and 40% of mature bulbs and reduce yields by 70% (McDonald et al., 1996; McDonald and Janse, 1997).
- *U. cepulae* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 20.1 – 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, • Establishment of *U. cepulae*has been recorded in Asia, Africa, North	

America, South America, Europe and Oceania. • In Asia, *U. cepulae* has been established recent years in China, India, Japan, Korea, Nepal, Pakistan, Philippines and Thailand from which countries Onion and Garlic are imported in Bangladesh (EPPO, 2014). • *U. cepulae* has also been established in many countries from where onion and garlic are imported in Bangladesh like Germany, Canada, Australia, New Zealand, Chile and France (EPPO, 2014). **b. Posibility of survival during transport, storage and transfer? Yes** • *U. cepulae* fungus can over-winter as resting spores in the soil for several years. • The spores are spread by wind, rainfall, soil particles and plant residues. There is no seed transmission, but spore balls could occur as contaminants of onion seeds samples. The optimum infection temperature is 13-22^{0}C. • So, the pathogen may enter into our country from onion seed exporting countries, where this pathogen is already estabilished. • The transport duration and storage condition is also favourable for its survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • The pathway for *U. cepulae* to enter Bangladesgh is appear good for the neighboring seed treading countries. • *U*Spread of the fungus occurs through infected onion sets, transplants and when spores are transported by wind, equipment and water. Onion seedlings are susceptible to infection from just after germination until they reach the first true leaf stage. As each new leaf emerges it goes through a growth phase where it is susceptible to infection. After that growth phase, infection does not occur. **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 *U. cepulae*is limited but available in Bangladesh. Onion and garlic are the main host for *U. cepulae.*	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.13.7. Determine the Consequence establishment of this pest in Bangladesh

Table 20.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • It is a serious pest of onion and garlic, which are important field crops in our country.	**Yes and High**

b. Economic impact and yield loss • Infected seedlings often die within six weeks of emergence. Dark areas can be seen first on cotyledons soon after their emergence from soil. On older plants raised, blister-like lesions can occur near the base of the scales, and large lesions cause leaves to curve downward. Streaks may develop within the leaves, leaf sheaths and bulbs. Mature lesions contain a black, powdery mass of spores. Infected plants are stunted as infection progresses inward from leaf to leaf. • Onion smut is of sporadic occurrence and generally of minor importance in terms of yields or financial returns (Locke and McBurney, 1995; F Crowe, Central Oregon Agricultural Centre, Madras, USA, personal communication, 1997). • The disease can affect 70-90% of seedlings and 40% of mature bulbs and reduce yields by 70% (McDonald et al., 1996; McDonald and Janse, 1997). • The reasons for site to site variations in smut incidence are not understood. Even minor outbreaks of smut can have far-reaching consequences: following reports of smut in the Marshlands area, onion exports from Canterbury, New Zealand, were suspended, starting again in 1989 (Harrow, 1970a; Grant, 1990; Jermyn *et al.,* 1993). Onion smut does not affect bulbs in store but may increase their susceptibility to other diseases. **c. Environmental Impact** • There are no effective chemical treatments to control or prevent U. cepulae infection during the growing season. So, farmers ues different type of fungicides to control it, which has direct negative effect on our environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table20.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.13.9. Risk Management Measures

- Avoid importation of onion and garlic from countries, where this pest is available.

- In countries where *U. cepulae*is not already present, the enforcement of strict phytosanitary regulations as required *U. cepulae*, may help to reduce the risk of this bulb mite 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).

7.13.10. References

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

J. C. WALKER and F. L. WELLMAN. 1926. Relation of temperature to spore germination and growth of *Urocystis cepula.J. Agril. Res.* Vol. XXXII, No. 2: 133-146.

JONES, E. S. 1923. Influence of temperature, moisture, and oxygen on spore germination of *ustilago avenae. Jour. Agr. Research* 24: 577-591, illus.

WALKER, J. C, and JONESJ L. R. 1921. Relation of soil temperature and other factors to onion smut infection. *Jour. Agr. Research* 22: 235-262, illus.

7.14.	Downy mildew of onion, *Peronospora destructor* (Berk.) Casp. ex Berk

7.14.1. Hazard identification

Scientific Name: *Peronospora destructor* (Berk.) Casp. ex Berk
Synonyms:

Peronospora schleideni Unger.

Common names: Downy mildew of onion

Taxonomic tree

Domain: Eukaryota
Kingdom: Chromista
Phylum: Oomycota
Class: Oomycetes
Order: Peronosporales
Family: Peronosporaceae
Genus: Peronospora
Species: *Peronospora destructor*

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

7.14.2. Biology

The downy mildew fungus can rest in perennial varieties and in infected onion bulbs left in the field and in cull piles. Resting sexual spores (oospores) may persist in the soil to infect seedling onions planted the following season. During the onion growing season the fungus produces spores (conidia) that are carried by wind to infect new onion plants. Spores are produced on nights with high humidity and moderate temperatures (4-25° C) with an optimum temperature for sporulation of 13° C. The spores mature early in the morning and are dispersed during the day. They remain viable for about 4 days. For germination the spores require free water and the optimal temperatures 7-16° C. Rain is not needed for infection when dew occurs continuously during the night and morning.
After the fungus is established, it completes its life cycle in 11 to 15 days. New spores infect new plants or leaves. As the upper portion of the onion leaf is killed, the fungus can infect the next lower part of the leaf. The entire leaf may thus become infected and die. During favorable environmental conditions the infection may result in a severe epidemic. During dry

weather, the spores usually disappear and the number of lesions declines. However, the disease cycle recommences when wet, cool weather recurs.

7.14.3. Hosts

Onion, garlic and other plants of the allium family.

7.14.4. Distribution

- **Asia**: Afghanistan, China, India (Haryana, Himachal Pradesh, Indian Punjab, Jammu and Kasmir and Maharastra), Iran, Iraq, Japan,Pakistan, Philippines, Saudi Arabia, Thailand, Turkey.
- **Africa**:Egypt, South Africa, Zimbabwe.
- **North America:**Canada, USA.
- **South America:**Argentina, Brazil, Chile, Peru.
- **Oceania:**Australia, New Zealand.
- **Europe:**Cyprus, France, Germany, Hungary, Italy, poland, Rassian Federation, Spain, UK.

7.1.5. Hazard Identification Conclusion

Considering the facts that *P. destructor*-

- is not known to be present in Bangladesh [CABI, 2015];
- In Asia, *P. destructor* is present in Afghanistan, China, India, Iraq, Iran, Japan, Pakistan, Philippines, Saudi Arabia, Turkey and Thailand.
- *P. destructor* also present in Argentina, Brazil, Chile, Canada, USA, France, Germany, UK, Russian Federation, Australia and New Zewaland.
- Downy mildew is considered an important disease in several countries. *P. destructor* can cause severe yield losses if weather conditions stay within a favourable range for each of the disease stages. Therefore, control of downy mildew is always necessary to guarantee crop health: good management of cultural factors alone is not sufficient (Palti, 1989; Lorbeer *et al*., 1997).
- *P. destructor* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 21.1 – 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-No **b. Posibility of survival during transport, storage and transfer? Yes** • *P. destructor*can service under low temperature during transport. • Mainly bulbs are the main vector for hyphae and spores of *P. destructor.* • Spores are produced on nights with high humidity and moderate temperatures (4-25° C) with an optimum temperature for sporulation of 13° C. The spores mature early in the morning and are dispersed during the day. They remain viable for about 4 days. For germination the spores require free water and the optimal temperatures 7-16° C. After the fungus is established, it completes its life cycle in 11 to 15 days. • So, the total life cycle from spore production to maturity the time duration is around 20 days. But the transport duration is about 20 days. So, this pathogen may survive during this time. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes**	**Moderate**

• The pathway for *P. destructor* to enter Bangladesh is appear good for the neighboring treading countries. • *P. destructor* is transported through bulb of onion and garlic. **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 *P. destructor* is limited but available in Bangladesh. Onion and garlic are the main host for *P. destructor.*	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.14.7. Determine the Consequence establishment of this pest in Bangladesh

Table 21.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - No. **b. Economic impact and yield loss** • Downy mildew seldom kills onion plants, but bulb growth may be reduced. Bulb tissue, especially the neck, may become spongy and the bulb may lack keeping quality. This disease is one of the most destructive of onion seed production world-wide (Rueda and Shelton, 1995). • Downy mildew is considered an important disease in several countries. The high number of countries that have studied the various aspects of P. destructor, in particular disease control (see Control), demonstrates this. However, precise data about the percentage of diseased crops and yield losses are not available. **c. Environmental Impact** • Control is by crop rotation (at least 3 years between successive onion crops), use of healthy bulbs for planting (heat treatment has been used to eliminate the pathogen from bulbs), fungicide treatment of the bulbs for planting, and fungicide sprays of the foliage if downy mildew infection is nevertheless observed. • Due to lack of infection we can’t provide any specific information about their effect on environment.	**Low**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 21.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating
High	High	High
High	Moderate	High

Moderate	High	High
High	Low	Moderate
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	**Low**	**Low**
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – Low

7.14.9. Risk Management Measures

- Avoid importation of onion and garlic from countries, where this pest is available.
- In countries where *P. destructor*is not already present, the enforcement of strict phytosanitary regulations as required *P. destructor*, may help to reduce the risk of this bulb mite 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).

7.14.10. References

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7.15.	Yellow disease phytoplasmas, *Candidatus Phytoplasma asteris*

7.15.1. Hazard identification

Scientific Name: *Candidatus Phytoplasma asteris*
Synonyms:
Anemone virescence.
Aconitum proliferation;
Symphytum proliferation

Common names: Yellow disease phytoplasmas;
Aster yellows phytoplasmas;
Tomato big bud phytoplasma.

Taxonomic tree

Domain: Bacteria
Phylum: Firmicutes
Class: Mollicutes
Order: Acholeplasmatales
Family: Acholeplasmataceae
Genus: *Phytoplasma*
Species: *Candidatus Phytoplasma asteris*

EPPO Code:PHYP01.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2015]

7.15.2. Biology

Ultrastructural aspects of AY group phytoplasmas in sieve tube elements of diseased plants have been studied by several researchers using transmission and scanning electron microscope observations (Hirumi and Maramorosch, 1973; Haggis and Sinha, 1978; Marcone *et al.,* 1995; Marcone and Ragozzino, 1996; Fránová and Šimková, 2009; Fránová *et al.,* 2009). The phytoplasma bodies varied in size and shape. They showed a very high polymorphism, appearing in round, ovoid, encurved and elongated forms. Octopus-like structures, as well as budding, dimpled- and dumbbell-shaped forms were also observed. The size of spherical forms ranged from 100 to 800 nm and filamentous bodies were up to 2600 nm in length. However, the morphological variations observed most probably represented various developmental stages of phytoplasmas and they cannot be considered as distinctive characteristics.Mollicutes are prokaryotes that have small genomes (530 to 1350 kbp), lack a cell wall, are pleomorphic, and have a low G + C content (23-29 mol%). Phytoplasmas belong to the class Mollicutes and are the proposed causative agents of diseases in several hundred plant species (McCoy *et al.,* 1989).

7.16.3. Hosts

AY group phytoplasmas appear to have a wide host range. The vast majority of strains in the AY group infect herbaceous dicotyledonous plant hosts. However, a number of strains that belong to subgroups 16SrI-A, 16SrI-B and 16SrI-C are capable of infecting monocotyledonous plants (e.g., maize, **onion**, gladiolus, oat, wheat and grass). Some strains in subgroups 16SrI-A, 16SrI-B, 16SrI-D, 16SrI-E, 16SrI-F and 16SrI-Q can induce disease in woody plants (e.g., grey dogwood, sandalwood, blueberry, mulberry, peach, cherry, olive, grapevine and paulownia

7.15.4. Distribution

- **Asia**: China, India (Delhi, Meghalaya and Uttar Pradesh), Indonesia, Iran, Israel, Japan, Korea, Malaysia, Myanmar, Thailand, Turkey.
- **Africa**:South Africa.
- **North America:**Canada, USA.
- **South America:** Argentina, Brazil, Peru.
- **Oceania:**Australia.
- **Europe:**Belgium, France, Germany, Hungary, Italy, Poland, Rassian Federation, Spain, UK.

7.15.5. Hazard Identification Conclusion

Considering the facts that *Candidatus Phytoplasma asteris*-

- is not known to be present in Bangladesh [CABI, 2017];
- AY group phytoplasmas are not listed as quarantine pests by EPPO. However, they are of quarantine significance for the Inter-African Phytosanitary Commission.
- *Candidatus Phytoplasma* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 23.1 – 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 • In Asia, *Candidatus Phytoplasma asteris*has been introduced in	

Indonesia, Iran, Korea Lebanon, Myanmar and Turkey, (EPPPO, 2017). • In other trading countries like South Africa, Bermuda, Cuba, Argentina, Colombia, Hungery, Portjugal, Russian Fedaration and Australia it also has been introduced (EPPPO, 2014). **b. Posibility of survival during transport, storage and transfer? Yes** • The transport duration, storage environment is favourable for this pathogen survival and growth. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • The only confirmed vectors of 'Ca. *Phytoplasma australiense'* are *Zeoliarus (Oliarus) atkinsoni* and *Zeoliarus oppositus* (Liefting *et al.,* 1997; Beever *et al.,* 2008). • Spread through infected plants for planting, such as nursery stock and cuttings, is also possible (CABI, 2011). This phytoplasma pathogen is not known to be seedborne. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • 'Ca. P. australiense' is considered an imminent threat that could be introduced into the United States with imported leaves, stems, and roots of infected plants (NPAG, 2007). This phytoplasma has a relatively wide host range. Particular emphasis should be placed in areas that grow alfalfa, grapes, papaya, pawpaw, potato, strawberry, and sweet gum (Liquid amber) trees.	**Moderate**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.15.7. Determine the Consequence establishment of this pest in Bangladesh

Table 23.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • Because most of the major hosts of this pathogen are very common in Bangladesh and the environmental condition also similar for its survival, growth and development. So, this become a serious pest in Bangladesh if estabilished. **b. Economic impact and yield loss** • Diseases caused by *'Ca. P. australiense'* impact economically important food and ornamental crops. Researchers have documented vineyard losses as high as 13%. Severely affected grape vines can produce up to 54% less fruit than healthy grape vines (CABI, 2007; NPAG, 2007). Papaya dieback is responsible for annual plant losses of 10% and up to 100% during epiphytotics (epidemic among plants of a single kind over a wide area) in central and southern Queensland plantations (Glennie and Chapman, 1976; Guthrie *et al.,* 1998). Australian lucerne yellows has caused a reduction in seed yield, which has led to the cutting or plowing-under of seed crops, resulting in estimated losses of $7 million annually	**Yes and High**

(Pilkington *et al.,* 1999). • The economic impact that '*Ca. P. australiense'* could have on new host *Solanum tuberosum* is potentially significant. The total economic value of New Zealand's potato industry in 2011 was estimated to be $382 million NZD ($300 million USD), with about a quarter of that coming from exports (Potatoes New Zealand, n.d.). **c. Environmental Impact** • While there are no species of Malus native to New Zealand, the Malus genus is a member of the Rosaceae family which includes around two dozen native species in the genera Rubus, Acena, Potenteilla and Geum (Allan 1982). Symptoms of disease caused by ApSL, namely localised leaf necrosis or shoot poliferation, while being of potential concern in commercial production are less likely to be of such significance in natural ecosystems. Naturalised introduced host species of the fruit trees in the urban environment might be affected by ApSL lowering fruit yield or quality. These social impacts, while being significant on there own, are of less significance given the wide number of pests and diseases already associated with these hosts in New Zealand. • The potential environmental impact of ApSL in New Zealand should therefore be considered to have a low likelihood of being low.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 23.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.15.9. Risk Management Measures

- No phytosanitary measures required if the non-negligible level of risk is considered acceptable.
- Pest free place of production (PFPP) is identified for importing onion and garlic from other importing countries.

7.15.10 References

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7.16. Gall, *Rhizobium rhizogenes* (Riker et al. 1930) Young et al. 2001

7.16.1. Hazard identification`

Scientific Name: *Rhizobium rhizogenes* (Riker et al. 1930) Young et al. 2001
Synonyms:

Agrobacterium radiobacter (Beijerinck & van Delden 1902) Conn 1942.
Agrobacterium rhizogenes (Riker *et al.* 1930) Conn 1942*;*
Bacterium rhizogenes (Riker *et al*. 1930);
Erwinia rhizogenes (Riker *et al*. 1930) Dowson 1957;
Phytomonas rhizogenes (Riker *et al*. 1930)

Common names: Gall;
Bacterial stem gall;
Crown knot;
Root gall; root knot;
Rosaceae crown gall.

Taxonomic tree

Domain: Bacteria
Phylum: Proteobacteria
Class: Alphaproteobacteria
Order: Rhizobiales
Family: Rhizobiaceae
Genus: *Rhizobium*
Species: *Rhizobium rhizogenes*

EPPO Code:AGRBRH.

Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2017]

7.16.2. Biology

Pathogenic strains of *R. rhizogenes* are capable of inducing hairy root growth on their hosts. When a plant is wounded it releases compounds which are sensed by the bacterium in the soil. *R. rhizogenes*is attracted towards the plant wound and it can transfer its DNA into the host cell via transfer of a portion of the root-inducing (Ri) plasmid. The transferred DNA (T-DNA) is integrated into the plant cell genome. After integration the plant produces an abundance of growth hormones and opines which are beneficial for growth of *R. rhizogenes*. It is thought that the virulence genes of *R. rhizogenes* are activated by the lignin forming compounds in some plant cell walls (Gafni and Levy, 2005).

Galls also occur on lateral roots and above ground on stems, canes and vines. On some woody species, such as cottonwood and willow, galls are common on stems above ground. Types of plants affected include shrubs, ornamental flowering trees, fruit trees (temperate to tropical), tubers, vines, tobacco, annuals, gymnosperms, etc. In temperate zones, symptoms appear with the onset of warm temperatures in May or June and can increase rapidly in size and number. Galls first appear as small, callus-like outgrowths within 2-4 weeks of infection when temperatures are at or above 20°C. At first the galls cannot be distinguished from wound callus, but galls usually develop more rapidly than callus, producing white to tannish-coloured, more-or-less spherical galls.

7.16.3. Hosts

The plant families Solanaceae, Rosaceae, Fabaceae, Crassulaceae, Caesalpinaceae, Brassicaceae, Polygonaceae, and Asteraceae are susceptible to hairy root caused by *R. rhizogenes*. Laboratory experiments have shown that many plants can serve as hosts including monocots and primitive dicots (Porter and Flores, 19991). Hosts which are phenol accumulators tend to be more sensitive to infection by *R. rhizogenes* (De Cleene and De Ley, 1981). *R. rhizogenes* has a world-wide distribution but it cannot grow above 30°C in culture.

Major host: *Allium cepa* (onion), *Beta vulgaris* var. *saccharifera* (sugarbeet), *Brassica nigra* (black mustard), *Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *italica* (broccoli), *Brassica rapa* subsp. *rapa* (turnip), *Cajanus cajan* (pigeon pea), Calendula (marigolds), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita maxima* (giant pumpkin), *Mangifera indica* (mango), *Pisum sativum* (pea), *Rosa chinensis* (China rose) etc.

7.16.4. Distribution

- **Asia**: China,Japan,Malaysia, Taiwan.
- **Africa**:South Africa, Spain.
- **North America:**Canada, USA.
- **South America:** Brazil.
- **Oceania:**Australia.
- **Europe:** Belgium, France, Italy, Rassian Federation, Spain.

7.16.5. Hazard Identification Conclusion

Considering the facts that *Rhizobium rhizogenes is-*

- It is not known to be present in Bangladesh [CABI, 2017];
- Infectious hairy root disease is caused by Rhizobium rhizogenes and it occurs on many dicotyledonous plants.
- Most of the hosts are common in Bangladesh and the pathogen is already estabilished in countries from where we import onion and garlic into our country.
- *Rhizobium rhizogenes* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 24.1 – 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 • *R. rhizogenes*has been introduced in Bulgeria, France, Italy, Spain (EPPO, 2014). This pathogen is already estabilished in different Asain countries like China, Japan, Malaysia, Taiwan from mainly we import onion and garlic into our country. **b. Posibility of survival during transport, storage and transfer? Yes** • *R. rhizogenes c*an survive under low temperature and it is suitable for his growth and development which is maintain at the time of transport. • *R. rhizogenes* is not seed born disease, so that it can disperse associated with bulb, vegetable, other plant materials. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • This pathogen may transfer by bulb from one country into another. The climatic condition of Bangaldesh is more or less similar with those countries where this pathogen is already estabilished. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • The major hosts of *R. rhizogenes* are onion, sugarbeet, black mustard, cabbages, cauliflower, turnip. Pigeon pea, marigolds, melon, cucumber, mango, pea, china rose. So, the pathogen attack many vegetables, field crops, fruits, flowers and ornamental crops which are major crops and fruits in our country. • Optimum growth of *R. rhizogenes* occurs at pH above 4 and 20-28°C which is present in Bangladesh.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.16.7. Determine the Consequence establishment of this pest in Bangladesh

Table 24.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? –Yes • The plant families Solanaceae, Rosaceae, Fabaceae, Crassulaceae, Caesalpinaceae, Brassicaceae, Polygonaceae, and Asteraceae are susceptible to hairy root caused by *R. rhizogenes*. • The major hosts of *R. rhizogenes* are onion, sugarbeet, black mustard, cabbages, cauliflower, turnip. Pigeon pea, marigolds, melon, cucumber, mango, pea, china rose. So, the pathogen attack many vegetables, field	**Yes and High**

crops, fruits, flowers and ornamental crops which are major crops and fruits in our country. • Almost all the crops are important in our country, and all the crops are widely cultivated in almost all the part of our country. • So, if the pest estabilished into our country it become a serious pest. **b. Economic impact and yield loss** • *R. rhizogenes*is characterized by very interesting and important interactions with plants. The species contains strains which are economically important as plant pathogens. • Plants with crown gall disease are primarily a problem for nurserymen who grow woody plants and shrubs for landscapes and fruit production. Losses in the USA amount to millions of dollars annually from the culling of diseased nursery trees. Infected nursery plants may subsequelty have reduced vigour through root damage, but thiss has never been accurately quantified. Production also can be reduced for landscape plants such as rose and poplar and for fruit trees, grapevines, caneberries and chrysanthemums (Moore, 1980; Schroth *et al.,* 1988; Misic *et al.,* 1990; Nesme *et al.,* 1990). • Plants are damaged most by crown gall when they become infected the first year after out-planting. Severely galled young plants are weakened, stunted, unproductive and occasionally die due to girdling and/or development of an inferior root system (Htay and Kerr, 1974). **c. Environmental Impact** • *R. rhizogenes*have the capacity to causes great economic losses and greatly damaged to the crops. So the farmers use different type of pesticide to control it, resulting distruction of natural control system and development of resistence, resurgence and secondary pest outbreak.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table24.3 – Calculation of risk rating

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

Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.16.9. Risk Management Measures

- No phytosanitary measures required if the non-negligible level of risk is considered acceptable.
- Pest free place of production (PFPP) is identified for importing onion and garlic from other importing countries.

7.16.10. References

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7.17. Stubby root nematodes, *Trichodorus* spp.

7.17.1. Hazard identification

Scientific Name: *Trichodorus*
Common names: Stubby root nematodes;
Paratrichodorids;
Trichodorids.

Taxonomic tree

Domain: Eukaryota
Kingdom: Metazoa
Phylum: Nematoda
Family: Trichodoridae
Genus: *Trichodorus*

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

7.17.2. Biology

Plant-parasitic nematodes range from 250 um to 12 mm in length, averaging 1 mm, to about 15-35 um in width. While large for a plant-parasitic nematode (about 1/16 inch long), *Trichodorus obtusus* is still small enough that it can be seen only with the aid of a microscope. Stubby-root nematodes are plant-parasitic nematodes in the Triplonchida, an order characterized by having a six-layer cuticle (body covering). Stubby-root nematodes are unique among plant-parasitic nematodes because they have an onchiostyle, a curved, solid stylet or spear they use in feeding.All other plant-parasitic nematodes have straight, hollow stylets. Stubby-root nematodes use their onchiostyle like a dagger to puncture holes in plant cells. The stubby root nematode then secretes from its mouth (stoma) salivary material into the punctured cell. After mating, female *Trichodorus obtusus* lay eggs that remain in soil until they hatch as second-stage juveniles. Stubby-root nematodes are obligate plant-parasites, meaning they must feed on plants in order to survive and reproduce. Once it locates a root and starts feeding, the juvenile nematode will molt 3 times before it becomes an egg-laying adult.

7.17. Hosts

Known hosts of *Trichodorus obtusus* are: bermudagrass (*Cynodon* spp.), St. Augustinegrass (*Stenotaphrum secundatum*), zoysia grass (*Zoysia* spp.), and tomato (*Lycopersicon esculetum*). It has been associated with; big bluestem (*Andropogon gerardii*), sideoats grama (*Bouteloua curtipendula*), eucalyptus (*Eucalyptus* sp.), Kentucky bluegrass (*Poa pretensis*), rhododendron (*Rhododendron* sp.), saw palmetto (*Sabal palmetto*), **Onion and garlic,** potato (*Solanum tuberosum*), littleleaf linden (*Tilia cordata*), sweetbay magnolia (*Magnolia virginiana*), sorghum-sudangrss (*Sorghum bicolor* x *S. arundinaceum*) and seashore paspalum (*Paspalum vaginatum*).

7.17.4. Distribution

- **Asia**: Afghanistan, China, India, Indonesia, Iran, Israel, Japan, Korea, Pakistan, Saudi Arabia, Taiwan, Turkey.
- **Africa**: Egypt, Kenya, South Africa, Spain.
- **North America:** Canada, USA.
- **South America:** Argentina, Brazil, Chile, Peru.
- **Oceania:** Australia, New Zealand.
- **Europe:** Belgium, Denmark, France, Germany, Hungary, Italy, Poland, Rassian Federation, Spain, UK.

7.17.5. Hazard Identification Conclusion

Considering the facts that Trichodorus-

- It is not known to be present in Bangladesh [CABI, 2014];
- *Trichodorus* has present in Asian countries like Afghanistan, China, India, Japan, Korea, Indonesia, Pakistan, Saudi Arabia and Turkey from which onion and garlic are imported in Bangladesh.
- *Trichodorus* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 25.1 – 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- No **b. Posibility of survival during transport, storage and transfer? Yes** • *Trichodorus*can survive under low temperature as cyst formation which is maintain at the time of transport. • The ability of nematodes to form environmentally resistant stages makes their dissemination even easier, since dried nematodes can be blown with the wind or plant debris over large geographical regions. • *Trichodorusis not seed born nematode, so that it can disperse*	**Low**

associated with bulb, vegetable, and other plant materials. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • The movement of water during floods and irrigation can disperse nematodes over long distances. • Likewise the movement of nematode infected plants, seeds, and bulbs can give nematodes international tickets to travel the world. • Even migrating birds are suspected to be able to carry nematodes along their flight paths, assisting the nematodes in their quest for new homes. • Essentially any process that moves soil or plant tissue has the ability to disperse plant nematodes, making them difficult plant pathogens to quarantine. **d. Are the host(s) of this fairly common in Bangladesh and the climate is similar to places it is established?– no** • Most of the hosts are not common in our country except onion and garlic, potato	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	**Low**

7.1.7. Determine the Consequence establishment of this pest in Bangladesh

Table 25.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - No. **b. Economic impact and yield loss** • *Trichodorus obtusus* is very damaging on turfgrasses. In Florida it is one of the most common nematode problems diagnosed on St. Augustinegrass lawns. By damaging the turf root system it makes the turf more prone to environmental stresses and may lead to increased use of water and fertilizer inputs. It also makes turf less competitive with weeds and may lead to increased herbicide usage. **c. Environmental Impact** • Nematode survival is not impacted only by biotic factors, but also by abiotic ones such as temperature and water availability. The onset of winter or the drying of the soil can be disastrous for a nematode. Interestingly, many nematodes are well adapted to abiotic stress and are capable of cryptobiosis (hidden life): the ability to enter a state of suspended metabolic activity during unfavorable environmental conditions (drying, heat, cold). While not all nematode are capable of cryptobiosis, the ones that are can often survive for years in a cryptobiotic state awaiting favorable conditions that will trigger their revival. The ability of nematodes to undergo cryptobiosis is one reason some nematode species are very difficult to eradicate from a field. • Nematicides are available for use on golf courses, sod farms, cemeteries, athletic fields, and industrial grounds. However, no effective nematicides are currently available for use on residential lawns.	**Yes and Moderate**
• Not as above or below	**Moderate**
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table25.3 – Calculation of risk rating

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

Calculated Risk Rating – Low

7.17.9. Risk Management Measures

- No phytosanitary measures required if the non-negligible level of risk is considered acceptable.
- Pest free place of production (PFPP) is identified for importing onion and garlic from other importing countries.

7.17.10. References

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7.18.	Ring spot of beet, Tomato black ring virus

7.18.1. Hazard identification

Scientific Name: Tomato black ring virus
Other scientific Names: *Potato bouquet virus*
Beet ring spot virus
Tomato black ring nepovirus
Common names: Ring spot of beet;
Black ring of tomato;
Ring spot of bean;
Ring spot of lettuce;
Yellow vein of celery.

Taxonomic tree
Domain: Virus
Group: "Positive sense ssRNA viruses"
Group: "RNA viruses"
Order: Picornavirales
Family: Secoviridae
Subfamily: Comovirinae
Genus: Nepovirus
Species: *Tomato black ring virus*
EPPO Code:TBRV00. EPPO list is A2/102.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2014]

7.18.2. Biology

The two types of RNA present in TBRV are both genomic RNA species and are necessary for infectivity (Randles *et al.,* 1977). Isometric particles c. 28 nm in diameter with hexagonal outlines. In purified preparations particles exist as three sedimenting components with sedimentation coefficients (S20,w) of c. 55S, 97S and 121S, termed T, M and B, respectively. All particles consist of 60 protein subunits each of molecular weight c. 57 000 but, whereas T particles are nucleic acid-free protein shells, M and B particles contain linear ssRNA with molecular weight of 1.7 x 106 and 2.7 x 106, respectively (Murant, 1970; Murant *et al.,* 1973). Some virus isolates contain in addition a satellite RNA of molecular weight c. 0.5 x 106. Several different satellites have been described for different TBRV isolates (Fritsch *et al.,* 1984).

7.18.3. Hosts

TBRV infects a wide range of herbaceous and woody monocotyledonous and dicotyledonous species including many that are important crop plants such as Vitis vinifera, tree fruit and small fruit species, sugarbeet, potatoes and many vegetables (e.g. species of **Alliums**, Beta, Brassica, Lactuca, Lycopersicon, Phaseolus) and ornamentals; it has also been found infecting some forest tree and shrub species. All these crop hosts of TBRV and many wild plants hosts occur widely throughout the EPPO region. In practice, the only important hosts are Rubus, Ribes, Fragaria and some Prunus spp. (especially peaches).

7.18.4. Distribution

EPPO region: Widespread in France. Also reported from Denmark (unconfirmed), Finland, Germany, Greece, Hungary, Ireland, Italy (unconfirmed), Netherlands, Moldova, Norway, Poland, Romania, Russia (European), Sweden, Turkey, UK (England, Scotland) and Yugoslavia.
Asia: India (Andhra Pradesh, Karnataka, Tamil Nadu), Japan (both probably infected imported material), Turkey.
Africa: Kenya (intercepted only).
North America: Canada (Ontario; probably infected imported material), USA (intercepted only). **South America**: Brazil (intercepted only).
EU: Present.

7.18.5. Hazard Identification Conclusion

Considering the facts that *TBRV* -

- It is not known to be present in Bangladesh [CABI, 2014];
- TBRVhas present in Asian countries like China, India, Japan and Turkey from which onion and garlic are imported in Bangladesh.
- TBRV is transmitted by its nematode vectors over short distances only. In international trade, only movement of infected planting material would be important. The significant host plants are not moved as seeds.
- *TBRV* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 26.1 – 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 • TBRV has been established worldwide in recent years. • Among them Asian and Europian countries are present in high risk zone. **b. Posibility of survival during transport, storage and transfer? Yes** • The duration of transport, storage and transfer is suitable for it survival because the onion and garlic bulbs transport duration from exporting countries is about 20 days which is favourable for its survival and the storage temperature is more or similar for its growth, survival and development**.** **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • TBRV is transmitted by its nematode vectors over short distances only. In international trade, only movement of infected planting material would be important. The significant host plants are not moved as seeds. • The virus is also transmitted through seeds of infected plants, often with a high frequency, especially in some crop species and weeds (Lister & Murant, 1967). This enables the virus to be dispersed over a wide area. • Additionally, the virus can be dispersed by transport of soil containing TBRV-infected nematodes and/or TBRV-infected seed. In perennial plants, virus may be distributed in material vegetatively propagated from infected plants **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 TBRV in Bangladesh is available. • And the environmental condition also suitable for growth and development of TBRV.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.18.7. Determine the Consequence establishment of this pest in Bangladesh

Table 26.2: Which of these descriptions best fit of this pest?

Description	Consequence potential
a. Is this a serious pest of Bangladesh? - Yes. • TBRV infects a wide range of herbaceous and woody monocotyledonous and dicotyledonous species including many that are important crop plants such as *Vitis vinifera*, tree fruit and small fruit species, sugarbeet, potatoes and many vegetables (e.g. species of Allium, Beta, Brassica, Lactuca, Lycopersicon, Phaseolus) and ornamentals; it has also been found infecting some forest tree and shrub species. • So, if the pathogen enters in our country it became a serious pest for our crops.	**Yes and High**

b. Economic impact and yield loss • TBRV can cause severe disease in some raspberry, strawberry and peach cultivars in some localities but the incidence of such infections is often small. Yield loss in crops is difficult to quantify but, although significant in some cultivars of some crops, it is probably of only local importance. **c. Environmental Impact** • Nematode survival is not impacted only by biotic factors, but also by abiotic ones such as temperature and water availability. The onset of winter or the drying of the soil can be disastrous for a nematode. Interestingly, many nematodes are well adapted to abiotic stress and are capable of cryptobiosis (hidden life): the ability to enter a state of suspended metabolic activity during unfavorable environmental conditions (drying, heat, cold). While not all nematode are capable of cryptobiosis, the ones that are can often survive for years in a cryptobiotic state awaiting favorable conditions that will trigger their revival. The ability of nematodes to undergo cryptobiosis is one reason some nematode species are very difficult to eradicate from a field.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table26.3 – Calculation of risk rating

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

Calculated Risk Rating – High

7.18.9. Risk Management Measures

- Vegetative planting material of Fragaria, Ribes, Rubus and peach (*Prunus persica*) should be derived from parent stock tested and found to be free from the virus. Ideally, material should be washed thoroughly to remove adhering soil particles and possible nematodes.
- EPPO recommends a suitable certification scheme for fruit trees (OEPP/EPPO, 1991/1992) and is developing schemes for Ribes, Rubus and strawberries.

7.18.10. References

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7.19. Iris yellow spot, Iris yellow spot virus Cortês *et al.* 1998

7.19.1. Hazard identification

Scientific Name: Iris yellow spot virus Cortês *et al.,* 1998
Common names: Iris yellow spot;
Lisianthus leaf necrosis;
Straw bleaching on onion.
Taxonomic tree
Domain: Virus
Group: "Negative sense ssRNA viruses"
Group: "RNA viruses"
Order: Mononegavirales
Family: Bunyaviridae
Genus: Tospovirus
Species: *Iris yellow spot virus*

EPPO Code:IYSV00.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2017]

7.19.2. Biology

IYSV is a vectored virus, so two organisms are involved in the initiation and spread of the disease. This datasheet focuses on the virus. Tospoviruses are usually transmitted by a large number of thrips species; however, IYSV is only transmitted by onion thrips (Thrips tabaci). IYSV is transmitted by both larvae and adult thrips, but only the larvae can acquire the virus from infected plants. Virus transmission is persistent and once a thrips has acquired the virus, it can transmit it for the remainder of its lifetime. IYSV is likely to overwinter from one season to the next in volunteer onions or weeds found among or around crops. Emerging thrips spread the virus from infected to healthy hosts whilst feeding. The disease has the potential to spread rapidly in fields with large numbers of viruliferous thrips. The distribution of infected plants in the field is associated with feeding activity by the vector. In many cases, the damage is first noticed at the field edges, in areas of stressed plants, or in locations with thin plant stands. The virus is not seedborne nor does it survive in the soil (Gent *et al.,* 2006; Pappu *et al.,* 2009).

7.19.3. Hosts

IYSV has a relatively restricted host range. Edible A*llium* crops including **onion (bulb and seed crops), garlic**, chive, shallots, leeks and some cut flower/potted ornamental species including *Alstroemeria*, chrysanthemum, iris and lisianthus are the most economically important crops affected by IYSV. Wild *Allium* species and ornamental alliums are also potentially at risk. A range of weed species (*Datura stramonium*, *Nicotiana* spp. and *Amaranthus retroflexus*) can also act as reservoirs. Six species have been mechanically inoculated in experimental host range trials (*Chenopodium amaranticolor*, *C. quinoa*, *Datura stramonium*, *Nicotiana benthamiana*, *N. rustica* and *Gomphrena globosa*). There is no evidence that these species are infected in the wild. Ben Moussa *et al.* (2005) reported infection of another three members of the Solanaceae (capsicums, potatoes and tomatoes) but it is unclear if these are natural hosts or were artificially inoculated.

Major hosts: *Allium cepa* (onion) and *A. porrum* (leek). The virus has occasionally been found on *Alstroemeria*, *Eustoma grandiflorum (lisianthus), Iris hollandica*, *Lilium* hybrids and *Hippeastrum*. IYSV has also been detected on a weed species, *Atriplex micrantha* (Chenopodiaceae). The experimental host range is narrow (*Nicotiana benthamiana*, *Datura stramonium*).

7.19.4. Distribution

EPPO region: France (on leek, onion, garlic and chives, but no economic damage observed), Germany (found on onion in 2007, under eradication), Greece (found in 2008 in onion crops), Israel, Italy (in 2007 on onion crops in Emilia-Romagna, Veneto, then also found in Piemonte), Netherlands (incidental findings on onion, leek, *Eustoma, Iris* and *Alstroemeria*), Serbia (in 2007 in 1 onion seed crop), Slovenia (reported in 2002 on leek, onion and weeds), Spain (on leek and onion), United Kingdom (found on glasshouse *Eustoma* in 2007, under eradication).
Asia: India, Iran, Japan.
Africa: Egypt, Réunion, South Africa.
North America: Canada (found on onion in Ontario), USA (first in 2001 on onion in Colorado, now also found in Arizona, California, Georgia, Hawaii, Idaho, Nevada, New Mexico, New York, Oregon, Texas, Utah, Washington).
Central America: Guatemala.
South America: Brazil, Chile, Peru, Uruguay.
Oceania: Australia (New South Wales, Western Australia, Victoria), New Zealand (probably widespread but with low economic impact).

7.19.5. Hazard Identification Conclusion

Considering the facts that *IYSV* -

- It is not known to be present in Bangladesh [CABI, 2014];
- IYSV has present in Asian countries like India, Indonesia, Japan, Pakistan and Sri Lanka from which onion and garlic are imported in Bangladesh.
- Iris yellow spot represents an immediate and serious threat to sustainable and productive onion cropping systems around the world, and the recent detection of this disease in numerous onion-producing countries demonstrates that the disease is spreading rapidly in a range of environments.
- *IYSV* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 27.1 – 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 • IYSV has been established worldwide in recent years (21 century). • Among them Asian and Europian countries are present in high risk zone. **b. Posibility of survival during transport, storage and transfer? Yes** • IYSV is only vectored by thrips, *Thrips tabaci*, so movement and dispersal is linked to both the movement of infected plants and the dispersal of the vector. • The virus also perpetuates itself and overwinters in weed species in or near protected crops. • Iris yellow spot represents an immediate and serious threat to sustainable and productive onion cropping systems around the world, and the recent detection of this disease in numerous onion-producing countries demonstrates that the disease is spreading rapidly in a range of environments. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • IYSV is only vectored by thrips, *Thrips tabaci*, so movement and dispersal is linked to both the movement of infected plants and the dispersal of the vector. The virus also perpetuates itself and overwinters in weed species in or near protected crops. • *Frankliniella fusca* can also transmit IYSV, but at alower efficiency than *T. tabaci* (Srinivasan *et al.,* 2012). • IYSV is not seedborne. • The thrips vector (*Thrips tabaci*) is widespread. More data is needed on the epidemiology of the disease and its host range (can other important monocotyledonous crops be infected) **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 IYSV in Bangladesh is available. • And the environmental condition also suitable for growth and development of IYSV.	**YES and HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.19.7. Determine the Consequence establishment of this pest in Bangladesh

Table 27.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? –Yes • IYSV is only vectored by thrips, Thrips tabaci, so movement and dispersal is linked to both the movement of infected plants and the dispersal of the vector. • The vector is already present in our country and a serious pest. • The host plants are also major crops in our country. So, if the pathogen	**Yes and High**

estabilished in our country became a serious pest for our crops. **b. Economic impact and yield loss** • Tospoviruses are agriculturally important because they cause severe economic damage to various vegetable and ornamental crops and are transmitted by thrips in a circulative and propagative manner. • The economic impact of IYSV can be important in onion crops. The loss of an entire crop has been reported in Brazil (Pozzer *et al.,* 1999), Israel (Kritzman *et al.,* 2001), some states in the USA (e.g., Oregon, Idaho and Texas) (Mohan and Moyer, 2004; Crowe and Pappu, 2005; Miller *et al.,* 2006), Spain (Córdoba-Sellés *et al.,* 2005) and the Netherlands (Mavric and Ravnikar, 2001). • The incidence of IYSV in onion often reaches up to 60% in Israel (Kritzman *et al.,* 2001), and in Slovenia over 90% of an onion crop was infected by the virus but there was no record of yield loss (Mavric and Ravnikar, 2001). • In Spain, the impact on onion production was considered potentially devastating by Córdoba-Sellés et al. (2005). In the Netherlands 50-90% of iris plants became infected with IYSV. The projected economic impact of IYSV in the western USA could reach 60-90 million dollars (for 10-15% yield loss), in addition to environmental and economic costs due to additional pesticide sprays for thrips control estimated at 7.5-12.5 million dollars (for three to five sprays on 48,500 hectares/year) (Gent *et al.,* 2006). • Gent et al. (2004) reported a rapid expansion of iris yellow spot in onion in Colorado, USA, with an increase from 6 to 73% of the surveyed fields being infected. **c. Environmental Impact** • Iris yellow spot represents an immediate and serious threat to sustainable and productive onion cropping systems around the world, and the recent detection of this disease in numerous onion-producing countries demonstrates that the disease is spreading rapidly in a range of environments. • To control the vector different types of chemical insecticides is used, which are harmful for our environment.	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 27.3 – Calculation of risk rating

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

Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – High

7.19.9. Risk Management Measures

- Iris yellow spot represents an immediate and serious threat to sustainable and productive onion cropping systems around the world, and the recent detection of this disease in numerous onion-producing countries demonstrates that the disease is spreading rapidly in a range of environments.
- Avoid importation of bulbs and seeds from countries, where this pest is available.
- In countries where *IYSV* is not already present, the enforcement of strict phytosanitary regulations as required for *IYSV*, may help to reduce the risk of this leek moth 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 *IYSV* are present.

7.19.10. References

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7.20.	Onion yellow dwarf, Onion yellow dwarf virus

7.20.1. Hazard identification

Scientific Name: Onion yellow dwarf virus

Common names: Onion yellow dwarf;
Allium virus 1;
Garlic mosaic virus
Garlic yellow streak virus
Garlic yellow stripe virus
Marmor cepae
Onion yellow dwarf potyvirus.

Taxonomic tree
Domain: Virus
Group: "Positive sense ssRNA viruses"
Group: "RNA viruses"
Family: Potyviridae
Genus: Potyvirus
Species: *Onion yellow dwarf virus*

EPPO Code:OYDV00.
Bangladesh status: Not present in Bangladesh [CABI/EPPO, 2016]

7.20.2. Biology

The viruses that cause OYD are typically 25-28nm in diameter and hexagonal in outline (Figure 8). They are composed of two proteins (a major coat protein and a minor "readthrough" protein) that encapsulate the single-stranded ribonucleic acid (ssRNA) genome. This RNA genome serves as a messenger RNA and has five to six genes or open reading frames (ORFs) (Figure 9). Some proteins are produced directly from the ORFs of the genomic RNA, while others are expressed from shorter RNAs, called subgenomic RNAs (sgRNAs).The viruses that cause OYD are restricted to the phloem of host plants, where they are seen via electron microscopy in the cytoplasm, nuclei and vacuoles of infected sieve elements, companion and parenchyma cells. Vesicles containing filaments and inclusions containing virus particles are common cytopathological effects of virus infection.

The infection and subsequent death of phloem cells inhibits translocation, slows plant growth, and induces loss of chlorophyll, resulting in typical symptoms.

7.20.3. Hosts

Reported from most countries where onions and shallots are cultivated.Besides the species mentioned above, the virus has been isolated from naturally infected perennial tree, top or topset **onion (*A. cepa* var. *viviparum*) and from garlic (*A. sativum*)** (Brierley & Smith, 1944*b*). It was also said to occur in multiplier onion (*A. cepa* var. *solaninum*) (Brierley & Smith, 1944*a*) and in Welsh onion (*A. fistulosum*) (Costa *et al.,* 1971), although others found this species to be immune (e.g. Brierley & Smith, 1946). It has also been detected in some ornamental *Allium* spp. (D. H. M. van Slogteren, personal communication) and some other *Allium* spp. (Havránek, 1973). *Narcissus pseudonarcissus* was found naturally infected (Brierley & Smith, 1946), and *N. tazetta orientalis* and the true jonquil *N. odorus regulosus* showed symptoms after inoculation (Henderson, 1935), and the virus could be recovered from them (Anon., 1932). Recently, local lesions were obtained with some isolates in *Chenopodium amaranticolor* and *C. quinoa*.

7.20.4. Distribution

- ***Asia****: China, India, Indonesia, Iran, Japan, Thailand, Turkey.*
- ***Africa****: Egypt, South Africa*.
- ***North America:****Canada, Mexico, USA.*
- ***South America:***Argentina, Brazil, Chile.
- ***Oceania:****Australia, New Zealand.*
- ***Europe:****France, Germany, Hungary, Italy, Poland, UK.*

7.20.5. Hazard Identification Conclusion

Considering the facts that *OYDV* -

- It is not known to be present in Bangladesh [CABI, 2016];
- *OYDV* has present in Asian countries like China, India, Indonesia, Iran, Japan, Thailand and Turkey from which onion and garlic are imported in Bangladesh.
- As the symptoms of *OYDV* are now well described and rapid diagnostic protocols (both ELISA and RT-PCR) are available, it is likely that *OYDV* will be reported in many other parts of the world in the years to come.
- *OYDV* is a quarantine pest for Bangladesh and considered to be a potential hazard organism in this risk analysis.

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

Table 28.1 – 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 • *OYDV*has been established worldwide in recent years (21 century). • Among them Asian and Europian countries are present in high risk zone. **b. Posibility of survival during transport, storage and transfer? Yes** • *OYDV* can survive at high temperature 70^0-75^0C and also can servive at low temperature like -10^0C. • *OYDV* overwintered when need to deceminate from one place to	**YES and**

another and also when food scarcity is occurred. • Thetransport of onion and garlic bulb from exporting countries to our countries is about 20 days. So, the transport duration is suitable for its survival and storage environment is also suitable for its survival. **c. Does the pathway appear good for this pest to enter Bangladesh and establish? –Yes** • Several aphid species have transmitted the virus experimentally (Drake, Tate & Harris, 1933; Tate, 1940; Heinze, 1952), and may do so in the field when briefly probing in passing, because none is prevalent on *Allium* crops (Tate, 1940). Acquisition and inoculation is in short feeding times and aphid infectivity is rapidly lost (Drake *et al.,* 1933). *Myzus ascalonicus* may spread the virus among onion bulbs and sprouts during storage (Szirmai, 1958). No experimental transmission by various other insects (Tate, 1940). • Not detected in onion by several authors, although the virus was found in pollen of infected onion plants (Louie & Lorbeer, 1966). Seed transmission seems improbable because the disease was completely controlled in New Zealand by introducing an *Allium*-free period (Chamberlain & Baylis, 1948); however, Härdtl (1962; 1972) reported 6-29 % seed transmission in onion cv. 'Stuttgarter Riesen' on the basis of field observations. **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 *OYDV* in Bangladesh is available. • And the environmental condition also suitable for growth and development of *OYDV*.	**HIGH**
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter Bangladesh and establish, and • Its hosts are not common in Bangladesh and climate is not similar to places it is established.	Low

7.20.7. Determine the Consequence establishment of this pest in Bangladesh

Table 28.2: Which of these descriptions best fit of this pest?

Description	**Consequence potential**
a. Is this a serious pest of Bangladesh? - Yes. • The pathogen is transmitted by various aphids which are already present in our country. • The major hosts are also available in our country. So, estabilishment of virus became a serious problem for our crops.	**Low**
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in Bangladesh.	**Low**

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

Establishment Potential X Consequence Potential = Risk

Table 28.3 – Calculation of risk rating

Establishment Potential	Consequence Potential	Risk Rating

High	High	High
High	Moderate	High
Moderate	High	High
High	**Low**	**Moderate**
Low	High	Moderate
Moderate	Moderate	Moderate
Moderate	Low	Low
Low	Moderate	Low
Low	Low	Low

Calculated Risk Rating – Moderate

7.20.9. Risk Management Measures

- *OYDV* represents an immediate and serious threat to sustainable and productive onion cropping systems around the world, and the recent detection of this disease in numerous onion-producing countries demonstrates that the disease is spreading rapidly in a range of environments.
- Avoid importation of bulbs and seeds from countries, where this pest is available.
- In countries where *OYDV* is not already present, the enforcement of strict phytosanitary regulations as required for *OYDV*, may help to reduce the risk of this leek moth 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 *OYDV* are present.

7.20.10. References

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WEED

7.21.	**Parthenium weed: *Parthenium hysterophorus***

7.21.1 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.

7.21.2 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).

7.21.3 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, onion and garlic, 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).

7.21.4 Geographical distribution

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

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

Exotic distribution

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

7.21.5 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.

7.21.6 Determine likelihood of pest establishing in Bangladesh via this pathway

Table 29.1. – Which of these descriptions best fit of this pest?

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

• Entries as a contaminant of agricultural produce and machinery have historically been important pathways for the introduction of *P. hysterophorus* in new regions. • **Contaminant of used machinery:** *P. hysterophorus* can enter new territories as a contaminant of used machinery, either as seeds, e.g. lodged on the radiators and grills of automobiles, or as seeds in soil attached to machinery, such as harvesters, road construction and maintenance machinery, military equipment and other vehicles. Vehicles and harvesters may circulate quite frequently across EPPO countries. The release of seeds of *P. hysterophorus* from the vehicles on the roads networks may facilitate its transfer to other unintended habitats connected by roads. • **Contaminant of grain:** *P. hysterophorus* was accidentally introduced into Israel in 1980 most likely through import of contaminated grains from the USA for fishponds (Dafni& Heller 1982). Wheat and other cereals were reported for the introduction of *P. hysterophorus* in India (Sushilkumar&Varshney, 2010), and sorghum is also reported to be infested in Ethiopia (Tamado*et al.,* 2002). • **Contaminant of seed:** - Pasture seeds (grass) from Texas into central Queensland (Everist, 1976), as well as in Egypt from Texas in the 1960s (Boulos& El-Hadidi, 1984); - Cereal seed from the United States in Africa, Asia and Oceania (Bhomik&Sarkar, 2005); - Soybean seed from the USA in the Shandong Province in China in 2004 (Li & Gao, 2012). **d.Are the host(s) and habitats of this fairly common in Bangladesh and the climate is similar to places it is established?– Yes** • *P. hysterophorus* grows in a wide range of habitats, including degraded and disturbed lands and streams and rivers. It is a pioneer species that can invade grazing land and degraded pastures, crops, orchards, summer crops, disturbed and cultivated areas, forests, railway tracks and roadsides, recreation areas, as well as river banks and floodplains (Navie*et al*. 1996a). • *P. hysterophorus* is now being reported from India as a serious problem in cotton, groundnuts, potatoes and sorghum, as well as in more traditional crops such as okra (*Abelmoschus esculentus*), brinjal (*Solanum melongena*), chickpea and sesame (Kohli and Rani, 1994), and is also proving to be problematic in a range of orchard crops, including cashew, coconut, guava, mango and papaya (Tripathi *et al.,* 1991; Mahadevappa, 1997). • Where climatic conditions are appropriate (e.g. Mediterranean area, Black Sea, Eastern Asia, the warmest temperate area) there are numerous suitable habitats. Consequently, for these areas, the probability of establishment is high with low uncertainty. • Therefore, the hosts and habitats as well as climatic requirements for this weeds are mostly common in Bangladesh.	
• NOT AS ABOVE OR BELOW	Moderate
• This pest has not established in new countries in recent years, and • The pathway does not appears good for this pest to enter your country and	Low

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

7.21.7 Determine the Consequence establishment of this pest in Bangladesh

Table 29.2 – Which of these descriptions best fit of this pest?

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

in both India and Australia (Jayachandra 1971; McFadyen, 1992; Evans, 1997a; Kumar and Rohatgi, 1999). • Parthenium weed, due to its allelopathic potential, replaces dominant flora and suppresses natural vegetation in a wide range of habitats and thus becomes a big threat to biodiversity. Batish et al. (2005) recorded 39 plant types in a *Parthenium*-free area, but only 14 were present in an infested area, and very little or sometimes no vegetation can be seen in some *Parthenium*-dominated areas (Kohli, 1992). Wherever it invades, it forms a territory of its own, replacing indigenous grasses and weeds which are supposedly useful for the grazing animals (De and Mukhopadhyay, 1983). Parthenium weed has an adverse effect on a variety of natural herbs which are the basis of traditional systems of medicines for the treatment of several diseases in various parts of the world (Mahadevappa *et al.,* 2001; Shabbir and Bajwa, 2006).	
• Not as above or below	Moderate
• This is a **not** likely to be an important pest of common crops grown in your country.	Low

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

Establishment Potential X Consequence Potential = Risk

Table 29.3 – Calculating risk rating

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

Calculated Risk Rating – High

7.21.9 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.

7.21.10 References

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7.B. 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 onion and garlic pathway to Bangladesh from India, China, Pakistan, Japan, Thailand, Taiwan, UAE, Vietnam, Philippines, Indonesia, U.S.A, Australia, France, Germany, Italy, Netherlands, Belgium, and Brazil, Chille and other exporting countries, out of 21 potential hazard organisms, 17 hazard organisms were identified with high risk potential, 1 was moderate and 2 organisms were with low potential risk.

The overall pest risk potential ratings of 21 quarantine pests of onion and garlic for Bangladesh have been included in the following Table 11:

Table 11: The Overall Pest Risk Potential Rating

Sl. No.	Potential Hazard Organism	Scientific name	Family	Order	Pest Risk Potential
Insect pests					
1	Western flower thrips	*Frankliniella occidentalis*	Thripidae	Thysanoptera	**High**
2	Serpentine leaf miner	*Liriomyza trifolii*	Agromyzidae	Diptera	**High**

Sl. No.	Potential Hazard Organism	Scientific name	Family	Order	Pest Risk Potential
3	Pea leaf miner	*Liriomyza huidobrensis*	Agromyzidae	Diptera	**High**
4	Onion fly	*Delia antiqua*	Anthomyiidae	Diptera	**High**
5	Leek moth	*Acrolepiopsis assectella*	Acrolepiidae	Lepidoptera	**High**
6	Vegetable weevil	*Listroderes costirostris*	Curculionidae	Coleoptera	**High**
Mite					
7	Dry bulb mite	Aceria tulipae	Eriophyidae	Trombidiformes	**High**
8	Bulb mite (Post harvest)	*Rhizoglyphus echinopus*	Acaridae	Sarcoptiformes	**Moderate**
Snail					
9	Common garden snail	*Cornu aspersum*	Helicidae		**High**
Fungus					
10	Neck rot of onion	*Botryotinia porri*	Sclerotiniaceae	Helotiales	**High**
11	Leaf blight of onion	*Botryotinia squamosa*	Sclerotiniaceae	Helotiales	**High**
12	White rot	*Stromatinia cepivora*	Sclerotiniaceae	Helotiales	**High**
13	Onion smut	*Urocystis cepulae*	Urocystidaceae	Urocystidales	**High**
14	Downy mildew of onion	*Peronospora destructor* (Berk.)	Peronosporaceae	Peronosporales	**Low**
Bacteria					
15	Yellow disease phytoplasmas	*Candidatus Phytoplasma*	Acholeplasmataceae	Acholeplasmatales	**High**
16	Crown gall	*Rhizobium radiobacter*	Rhizobiaceae	Rhizobiales	**High**
Nematode					
17	Stubby root nematodes	*Trichodorus*	Trichodoridae	Triplonchida	**Low**
Virus					
18	Ring spot of beet	*Tomato black ring virus*	Secoviridae	Picornavirales	**High**
19	Iris yellow spot	Iris yellow spot virus	Bunyaviridae	Mononegavirales	**High**
20	Onion yellow dwarf	Onion yellow dwarf virus	Potyviridae		**Moderate**
Weed					
21	Parthenium weed	*Parthenium hysterophorus*	Asteraceae	Asterales	**High**

Uncertainity

The quarentine pest species those remain uncertainitry as potential hazards due to lack of their detail information. Such uncertain species was pink root rot (*Pyrenochaeta terrestris*). The taxonomic identity of this uncertain species is given in the table 12.

Table 12: Quarantine pest species for Bangladesh likely to be associated with host plants during importation from exporting countries, but remained as uncertain hazards due to lack of detail information

Sl. No.	Common name	Scientific name	Family	Order
01.	Pink root rot	*Pyrenochaeta terrestris*	-	Pleosporales

CHAPTER 8

RISK MANAGEMENT

8.1. Risk Management Optionsand 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 onion and garlicfrom India, China, Japan, Thailand, Mayanmar, Indonesia, or any other countries of onion and garlicexport (i.e. produced under standard cultivation, harvesting and packing activities). Plant Quarantine Wing of Bangladesh will consider the risk management measures proposed below is commensurate with the identified risks.

8.1.1. Pre-harvest Management Options

i. **Use of pest resistant varieties**: The use of resistant varieties is a common and effective component in reducing pest risk.

ii. **Chemical spray program**: Pre-harvest chemical sprays may be used to control pests within production fields, for example, the use of nematicides to control the nematode.

iii. **Crop rotation**: Certain onion and garlic diseases can survive from season to season in the field. Depending on the type of pathogen, it may survive in the resting form either in the soil or in plant debris, or in a living form in surviving fallen fruit. On occasion, diseased bulbsare the sources of contamination for the current season crops. Therefore, acrop rotation to minimize soil disease problems is recommended.

iv. **Control of Insects**: Sucking and chewing insects may transmit many diseases. For example the *Tomato black ring virus* disease was found to be transmitted by the aphids (EPPO, 1997). The control of these insects and the rouging of infected parts of plants as early as possible may prevent spread of diseases in the field.

v. **Irrigation practices and soil type**: A well drained soil is recommended for planting of onion and garlic as this make conditions less favourable to disease infection (Johnson, 1969). Over irrigation and a poorly drained soil increases the susceptibility to diseases. The type of irrigation system may also aid in the transmission of some diseases.

vi. **Pre-harvest Inspection**: The relevant officers and inspectors from the importing country should inspect and verify the cleaning and disinfecting of equipment and storage used in onion and garlic production. Laboratory testing should be done periodically. Quarantine restrictions may be used to limit spread of diseases detected.

8.1.2. Post-harvest Management Options

i. **Sanitization of equipment and material**: All machinery, transport and storage surfaces that the onion and garlic bulbs and seeds will contact should be cleaned and disinfected prior to receiving new bulbs and seeds. Since most disinfectants are inactivated by soil and plant debris, it is essential that this material be removed by thoroughly cleaning the equipment and storage with a pressure washer or steam cleaner before the disinfectant is applied.

ii. **Disposal of infected bulbs**: All infected bulbs should be discarded away from production site (Rowe *et. al*).

iii. **Bulbsgrading**: The class and variety of onion and garlicbulbsmust be kept separate through harvesting, grading and storage. Grading must be done according to class, variety and disease tolerance. The class of onion and garlic must clearly identifiable and labeled.

8.1.3. Phytosanitary Measures

i. **Pest free areas**: As a sole mitigation measure, the establishment of pest-free areas or pest-free places of production may be completely effective in satisfying an importing country's appropriate level of phytosanitary protection (IPPC, 1996b, 1999).Establishment and maintenance of pest-free areas or production sites should be in compliance with international standards (*e.g.*, IPPC, 1996b, 1999, 2006).

ii. **Stipulated commercial grade for bulbs**: This ensures a certain level of quality and cleanliness which results from commercial handling. This is a significant measure for pests that affect quality or associated with contaminants (eg. soil). Bangladesh should therefore make request for a certain grade of bulbs that reflects the acceptable tolerance level of the country.

iii. **Accept only certified onion and garlic bulbs and seeds for production**: This measure is highly effective in mitigating pest risk, because it ensures the absence of specific pests, particularly pathogens, or a defined low prevalence of pests at planting. The main components of seed certification include: sampling and testing of production areas to ensure free from viruses; approval of land and seed to be multiplied; inspection of crops for variety purity and crop health; inspection of bulb samples; and sealing and labeling of certified seed. Onion and garlic seeds to be imported from the exporting countries should be sourced from an officially recognized seed certification system.

iv. **Shipments traceable to place of origin in exporting countries**: A requirement that onion and garlic seeds and bulbs be packed in containers with identification labels indicating the place of origin, variety and grade is necessary to ensure traceability to each production site.

v. **Pre export inspection and treatment:** The NPPOs of exporting countries will inspect all consignments in accordance with official procedures in order to confirm those consignments are satisfied with import requirements on phytosanitary of Bangladesh.If quarantine pestswith high risk potential are found during inspection, the phytosanitary procedures should maintained:

- Consignments of bublsand seeds from countries where these pests occur should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. EPPO recommends (OEPP/EPPO, 1990) that such bulbs should come from an area wherehigh risk potential pestsdo not occur and where routine intensive control measures are applied.
- Bulbs and seeds may also be treated in transit by cold treatment (e.g. 13 or 14 days at 0.0 or 0.6°C,, respectively)(FAO, 1983).

vi. **Requirement of phytosanitary certification from country of origin:** The phytopathological service of the country of origin should ensure the seeds and bulbs from which the consignment is derived was not grown in the vicinity of unhealthy onion and garlic and was inspected by a duly authorized official/phytopathological service and the seeds and bulbs have been produced in areas within the country free from all pests and diseases.

vii. **Port-of-entry inspection and treatment**: Upon arrival in Bangladesh, each consignment of onion and garlic should be inspected to detect pests, with export phytosanitary certificate and seed certificate. Sampling of seeds and bulbs consignments at port-of-entry in Bangladesh should combine visual inspection and laboratory testing. Visual inspection is useful to verify that certain phytosanitary certification requirements have been met and consignment is generally free of contaminants. The efficacy of this measure depends on the statistical level of sampling and the ability to detect the pests or article of concern (eg. soil). Laboratory testing requires that a portion of each sample taken for inspection be subjected to laboratory analysis for the detection of pathogens.

The consignment could re-export or destroy if quarantine pests or regulated articles with high risk potential are found during an inspection.

8.2. 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.

Development Technical Consultants Pvt. Ltd. (DTCL)

JB House, Plot-62, Road-14/1, Block-G, Niketon

Gulshan -1, Dhaka-1212, Bangladesh

Tel: 88-02-9856438, 9856439
Fax: 88-02-9840973
E-mail: info@dtcltd.org
Website: www.dtcltd.org