

Survey Protocol for Large Cardamom



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Survey & surveillance is one of the most important tools to create the avenues and foundation for many further researches. In addition it is a major activity to generate and update national pest data base, find out the distribution of specific pests on the country; plant protection directorate as designated the National Plant Protection Organization (NPPO) of Nepal is attempting to develop the survey protocol of Large Cardamom as follow.

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Cardamom Crop

Large cardamom (*Amomum subulatum*) is the one of the most important high value cash crops in Nepal which is mostly grown in eastern Mid-hill region of Nepal. Cardamom forms a substantial part of people's livelihoods and food security and, for many families, is the only source of cash income. This crop was introduced into Ilam from Sikkim in 1865. Ilam, Panchthar, Taplejung, Sankhuwasabha, Terhathum, Bhojpur and Dhankuta districts are the major large cardamom producing areas in Nepal. Cultivation of the spice has now spread to more than 38 districts. According to the MoAD, the total area under cardamom cultivation is 14847 ha and total production is 5225 MT. This is one of the major contributors to Nepal's foreign exchange earnings. India is a major market for large cardamom produced in Nepal. From India, the spice is re-exported to Bangladesh, Pakistan, the Gulf countries and other overseas destinations. It is one of the major potential exportable commodities throughout the world. So improvement on quality product, meet up of SPS requirement required by other countries is the major issue in competent market niche.

Large cardamom is a perennial, shade-loving crop found at between 600–2,400 masl. The cultivated species of large cardamom is *Amomum subulatum* Roxb., which belongs to the family Zingiberaceae. It requires a high level of humidity (>90%) and soil moisture (>70%) and, therefore, grows best in areas with annual rainfall of 2,000–4,000 mm and ambient air temperature of 10–22°C (Sharma 2013; Sharma et al. 2000). The major producers of large cardamom are India, Nepal and Bhutan. In recent years Chirke, Furkey, Foot and root rot, stem borers are becoming as a threat on large cardamom cultivation. Similarly Leaf caterpillar, Hairy caterpillar, Aphids, Shoot fly, White grub, Leaf folding caterpillar, Mealy bugs, Thrips are some of the insect pests of this crop. It does not only affect on production but also raise the quality and SPS requirement issues.

Since the research work on this commodity is very less in number, the dependence on reviewed literature may not always give the specific and required information. Survey & surveillance is one of the best tools to create avenues and foundation for many further works. In addition survey & surveillance is major activity to generate and update national pest data base, find out the distribution of specific pests on the country, plant protection directorate as designated the National Plant Protection Organization (NPPO) of Nepal is attempting to develop the survey protocol of major pest of the major crop. It will ease the field workers and concerned officials in carrying out pest survey/ surveillance in a more systematic ways.

Purpose of the specific pest surveillance of large cardamom

1. To establish a surveillance methodology for major cardamom pests
2. To harmonize the pest surveillance work of the nation
3. To facilitate the pest data base generation and its update
4. To find out the distribution of major pests of large cardamom inside the country

Chirke Disease

Information of the target pests

Pest name: Chirke disease

Scientific name : *Maclura mosaic virus, MMV*

Common name: Chirke disease, Streak mosaic,

Scientific Classification

Group : ssRNA positive strand virus, no DNA stage

Order: Unassigned

Family : Potyviridae

Genus : Macluravirus

Species : *Maclura mosaic virus*

Description

Large cardamom is known to be affected by chirke disease. The disease was first noticed in 1956 from Algarah, Darjeeling hills. Chirke was considered to be a viral disease primarily based on transmission by aphids, *Rhopalosiphum maidis* and *Brachycaudus helichrysi* in a non-persistent. Although, chirke is considered as one of the most important biotic constraints for the cultivation of large cardamom in Nepal, distribution of the disease in the large cardamom growing areas is not known. Small cardamom (*Elettaria cardamomum*), which is grown in southern India, is also affected by a similar disease known as ‘katte’ disease.

Target host/alternate host

Chirke virus is known to be transmitted by Peach aphid, maize aphid from these hosts. Similarly wild cardamom (Churumpha) also harbors this virus. Banana is also an alternate host for this virus.

Disease Symptoms

This disease is characterised by light and dark green streaks on leaves. The affected leaves exhibit streak mosaic, which gradually coalesce, turn brown and eventually dry up. The disease

results into progressive degeneration of clumps. By the end of the third year of infection, the loss due to chirke was reported to be >80%.

Disease Transmission

It is an aphid vectored virus in non-persistent transmission manner. The aphid can transmit the virus directly to healthy plants after it has fed on a diseased plant. For the uptake of the virus (acquisition) the aphid has to feed on the infected plant (a short probing by the aphid is sufficient for virus uptake). The acquisition time for the virus is a few seconds. After uptake of the virus an aphid can directly transmit the virus to a healthy plant, but loses the virus a few hours (1-2) after feeding on the diseased plant. This means that non-persistent transmitted viruses are only transmitted over a short distance (e.g. 20-100m).

Survey Methodology

Observation: Visual observations based on symptoms are made. Suspected samples are taken, analyzed in laboratory where it is identified then verified and recorded.

One field at nursery stage and two main fields each at the experimental station in ten villages of the region are to be selected for cardamom disease surveillance. Fixed fields are those fields that once selected in the standing crop and will be continuously monitored till the specified time on fortnightly basis for pests and diseases using the specified data sheet formats (as given in annex). In addition, a random survey covering eight villages other than the ten selected villages has to be conducted fortnightly.

Nursery surveillance

One nursery at the experimental station of the identified centre and one at each of the ten selected villages has to be selected for surveillance. General information on nursery (one time information), and on nursery insect pests and diseases (once a fortnight) has to be collected.

Fields of farmers

Ten cardamom growing villages representing the agro-ecology of the identified region in the same and neighboring district, distributed randomly should be selected. In each village, two farmers' fields (designated as Fixed 1 and Fixed 2) of near to one-half hectare (5000 m²) are to be fixed for fortnightly observations. Assigning fields of farmers as Fixed 1 and Fixed 2 should be made at time of field selection and same should be maintained from the first observation till

the end of season. Care should be taken to select farmers growing common variety (ies) of the region (NICRA, 2011).

Another option in sampling is five random spots of one square feet (four in the corners at least 3 feet inside the borders and one in the centre) have to be used during the fortnightly observations of the selected nurseries and fields.

Aphid Monitoring

Yellow Pan Trap (YPT)

YPT will be used for winged aphid trapping. The dimension of these traps is 50 cm long, 30 cm width and 8 cm high with sides sloping outwards. One bottom corner of the tray will have an outlet tube 2 cm diameter and 4 cm long closed from the inside with a stopper. The bottom and lower 2 cm of the inner sides will be painted yellow, the remaining sides and exterior will be painted dark gray. Traps will be filled with fresh water and a few drops of detergent added to break the surface tension and prevent aphid from escaping as described by Raman, 1985.

Three traps will be established on center row of a 60*60 field sections adjacent to the access road, but halfway between the edges of each field. One trap will be placed 15 m from the edge, and the second and third trap will be placed on 15 m apart from each other and on the platform approximately 1.5 m above the ground. Yellow pan trap will be emptied twice a week (Boiteau and Parry, 1985). Traps will be placed in position at the time of new flushing of cardamom and monitored throughout the year for the first three years and then trap monitoring will be revised.

Aphid/Leaf count method

Virus transmission is more closely related to the progress of aphid infestation from plant to plant than the total number of aphids on a particular plant. Progress of aphid can be determined by the aphid/leaf count method (Raman, 1985). Aphid/leaf count method will be carried out in 250 m² area of each 10 orchards of farmers. Each field will be visited once in 10 days and 50 plants will be randomly selected in each field sections. On these 50 plants, three fully-expanded compound leaves each from upper, middle and lower parts will be inspected. The number of winged aphids will be counted, recorded and transferred to the small bottles filled with 80% ethyl alcohol.

Preparation and identification of aphids

Collected specimens will be prepared for slide mounts and identification of *Rhopalosiphum maidis* and *Brachycaudus helichrysi* will be made by registered entomologist of NPPO.

Virus Identification

Maclura mosaic virus is a flexuous virus particles measuring $625\text{--}650 \times 12.5$ nm when observed in electron microscopy on the sap extracted from diseased samples. Polyclonal antiserum to the purified virus shows serological affinity with cardamom mosaic virus (CdMV) associated with a similar disease known as katte disease of small cardamom (*Elettaria cardamomum*) occurring in southern India. In a molecular test the 3' terminal genome sequence (1776 nucleotides) of the virus can be determined.

Procedure for observation, sampling and record

At first identification will be done based on the symptoms as described above. Observe for the progressing streaks on the leaf surface, presence of alate aphids.

For the sampling of suspected leaves at least 5 fresh suspected leaves should be taken from each two fixes. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, presence of vector, geographical location, aspects etc should be recorded according to the given annex.

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Sampling – Suspected diseased leaves (at least 5) from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC, Entomology Division NARC (For aphid)

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some symptoms of Chirke disease in figure



Fig. General symptom of Streak mosaic

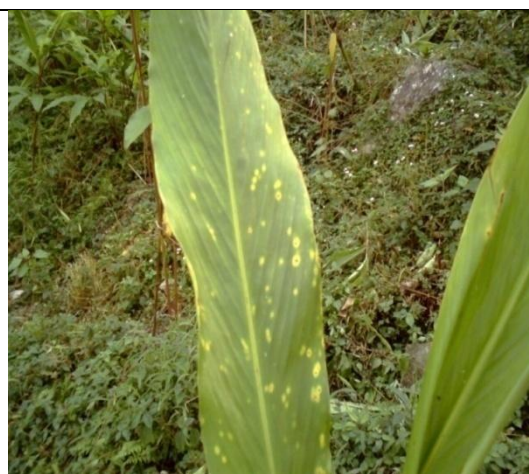


Fig. Symptom of streak mosaic at early stage

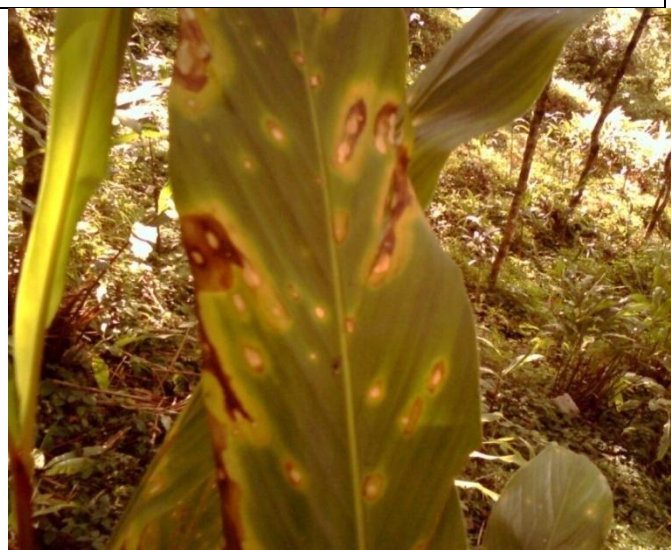


Fig. Symptom of streak mosaic at late stage

Furkey disease

Information of the target pests

Pest name: Furkey disease

Scientific name : *Cardamom bushy dwarf virus, CBDV*

Common name: Furkey disease, Stunty mosaic virus

Scientific Classification

Group : ssDNA

Order: Unassigned

Family : Nanoviridae

Genus : Babuvirus

Species : Nanoviruses

Description

Cardamom Bushy Dwarf Virus (CBDV) is an aphid-borne nanovirus which infects large cardamom, *Amomum subulatum* (Zingiberaceae family), in the Himalayan foothills of Northeast India, Nepal and Bhutan. Two aphid species have been reported to transmit CBDV, including *Pentalonia nigronervosa* and *Micromyzus kalimpongensis* (also described as *Pentalonia kalimpongensis*). However, *P. nigronervosa* was recently split into two species which exhibit different host plant affiliations. Whilst *P. nigronervosa* primarily feeds on banana plants, *Pentalonia caladii* (previously considered a 'form' of *P. nigronervosa*) typically feeds on plants belonging to the Araceae, Heliconiaceae and Zingiberaceae families. It is not reported to be transmitted by seed and mechanical mode.

Target host/alternate host

Furkey virus is known to be harbored by Banana, Peach, wild cardamom (Churumpha) as alternate host.

Disease Symptoms

Clumps of large cardamom exhibits stunted growth, leaves becomes small and grassy. Excessive sprouting and formation of bushy dwarf clumps at the base of mother plants that gradually die, characterize the disease. After 2-3 years whole bush becomes groom like structure. At the later stage, clumps started rotting and the whole plants die. This disease is known to be transmitted by aphids and planting materials.

Disease Transmission

This virus is transmitted by aphid from infected plants to non-infected plants on a persistent manner. It manages to pass through the gut into the haemolymph and then to the salivary glands which is known as persistent manner of transmission.

Survey Methodology

As described in Streak Mosaic Disease.

Aphid Monitoring

As described in Streak Mosaic Disease.

Preparation and identification of aphids

Collected specimens will be prepared for slide mounts and identification of *Pentalonia nigronervosa* and *Micromyzus kalimpongensis* will be made by registered entomologist of NPPO.

Virus Identification

In Nanovirus the genome is consisted of several circular ssDNAs of about 1 kb each. Up to 12 DNA components have been isolated from the diseased plant. The major viral proteins encoded by these components are replication initiator protein (Rep), coat protein, cell-cycle link protein, movement protein and a nuclear shuttle protein. Each ssDNA contains a single gene and a noncoding region with a stable stem and loop structure. Several Rep encoding components have been reported from each virus, only one of them designated as master Rep has ability to control replication of the other genomic components.

Procedure for observation, sampling and record

At first identification will be done based on the symptoms as described above. Observe for the progressing stunted clumps and small as well as grassy leaves on the bush. At the same time observe also the presence of alate aphids.

For the sampling of suspected bushes at least 5 fresh suspected leaves should be taken from each two fixes. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, presence of vector, geographical location, aspects etc should be recorded according to the given annex.

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of new flushing to throughout the year for the first three years

Sampling – Suspected diseased leaves (at least 5) from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC, Entomology Division NARC (For aphid)

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some symptoms of Furkey diseases in figure



Fig. Symptom of Cardamom bushy dwarf virus disease where excessive tillering has been seen

Basal rot, wilt (*Fusarium oxysporum*)

Information of the target pests

Pest name: *Fusarium oxysporum*

Scientific name : *Fusarium oxysporum* Schlechtendahl

Common name: basal rot, corm rot, foot rot, wilt, root rot, seedling wilt

Scientific Classification

Domain: Eukaryota

Kingdom: Fungi

Phylum: Ascomycota

Class: Ascomycetes

Subclass: Sordariomycetidae

Order: Hypocreales

Description

Fusarium wilt has also named as Jurjure, Ghoge and Dadhuwa by farmers. This disease is distributed in Harkate, Nayabazaar, Kanyam, Pashupatinagar, Maipokhari of Ilam district. This disease has been considered as the most important disease from economic point of view (Dhital and K.C., 2012). Chirke and furkey disease gradually loss the production but this disease causes complete collapse of plantation within 5-6 months.

Plant parts liable to carry the pest in trade/transport

- Bulbs/Tubers/Corms/Rhizomes: Spores, Hyphae; borne internally; invisible.
- Roots: Spores, Hyphae; borne internally; invisible.
- Stems (above Ground)/Shoots/Trunks/Branches: Spores, Hyphae; borne internally; invisible.

Target host/alternate host

It has a wide range of host including other crops of Zingiberaceae.

Disease Symptoms

The disease is initiated from root and rhizome. Yellowing of leaves is the first visible symptom. Then the tip of pseudostem starts to curl and emerging leaves deformed on its shape. Gradually leaves, pseudostem and whole plant dried and die completely. There will be no new sprouts and fruits will not be matured, consequently immature seeds will be covered with white mould.

Disease Cycle

This is a lethal fungal disease of large cardamom. The causal pathogen attacks the root and base. As diseased plants die, the fungus grows out. Many chlamydospores are formed which are returned to the soil as the plant decays. Chlamydospores are stimulated to germinate and infect nearby cardamom roots. Following germination, mycelium is produced from which conidia form in 6-8 hours and chlamydospores in 2-3 days. Small secondary or tertiary roots are invaded. In susceptible plants, the fungus is not blocked by the host defence mechanisms and the infection becomes systemic through the vascular system of the root and stem.

Survey Methodology

As described in Chirke disease.

Pest Identification

The formae speciales of *F. oxysporum* each produce three types of asexual spores. The macroconidia (22-36 x 4-5 µm; see Wardlaw, 1961 for measurements) are produced most frequently on branched conidiophores in sporodochia on the surface of infected plant parts or in artificial culture. Macroconidia may also be produced singly in the aerial mycelium, especially in culture. The macroconidia are thin-walled with a definite foot cell and a pointed apical cell. Oval or kidney-shaped microconidia (5-7 x 2.5-3 µm) occur on short microconidiophores in the aerial mycelium and are produced in false heads. Both macroconidia and microconidia may also be formed in the xylem vessel elements of infected host plants, but the microconidia are usually more common. The fungus may be spread by macroconidia, microconidia and mycelium within the plant as well as outside the plant.

Chlamydospores (9 x 7 µm) are thick-walled asexual spores that are usually produced singly in macroconidia or are intercalary or terminal in the hyphae. The contents are highly refractive. Chlamydospores form in dead host-plant tissue in the final stages of wilt development and also in culture. These spores can survive for an extended time in plant debris in soil.

Mutation in culture is a major problem for those working with vascular wilt isolates of *Fusarium oxysporum*. The sporodochial type often mutates to a 'mycelial' type or to a 'pionnotal' type. The former has abundant aerial mycelium, but few macroconidia, whereas the latter produces little or no aerial mycelium, but abundant macroconidia. These cultures may lose virulence and the ability to produce toxins. Mutants occur more frequently if the fungus is grown on a medium that is rich in carbohydrates.

Procedure for observation, sampling and record

At first identification will be done based on the symptoms as described above. Observe for the progressing rotting from the base, curled emerging leaves and gradual death of plants.

For the sampling of suspected plants at least 5 samples from base and roots of different plants should be taken from each two fixes. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, geographical location, aspects etc should be recorded according to the given annex IV.

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Sampling – Roots and base of the suspected diseased plants from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some symptoms of basal rot, wilt in figures



Fig. Wilt of cardamom clumps caused by *Fusarium oxysporum*



Fig. Root tip rot of cardamom roots caused by *Fusarium oxysporum*



Fig. Macro-conidia of *F. oxysporum*

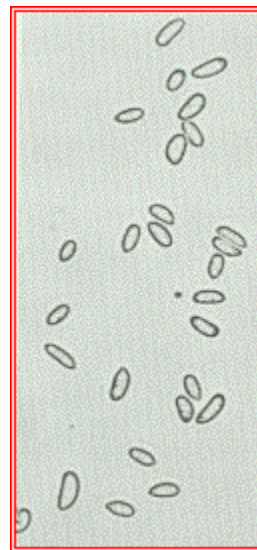


Fig. Micro-conidia of *F. oxysporum*

Rhizome rot, Clump rot, damping off, water rot (*Pythium vexans*)

Information of the target pests

Pest name: *Pythium vexans*

Scientific name : *Pythium vexans* de Bary

Common name: Rhizome rot, Clump rot, damping off, water rot

Scientific Classification

Domain: Eukaryota

Kingdom: Chromista

Phylum: Oomycota

Class: Oomycetes

Order: Saprolegniales

Description

This is one of the important fungal diseases of large cardamom. Since the rotting starts from the root and base of plant, the complete collapse of plant occurs. The disease starts from the joint of rhizome and pseudo-stem. This disease is dispersed by the following mode:

- Bulbs/Tubers/Corms/Rhizomes: Spores, Hyphae; borne internally; borne externally; visible to naked eye.
- Growing Medium Accompanying Plants: Spores; borne externally; invisible.
- Roots: Spores, Hyphae; borne internally; borne externally; visible to naked eye.

Target host/alternate host

It has a widespread range of host including wild cardamom (Churumpha).

Disease Symptoms

The infection is initiated from the joint of rhizome and pseudo-stem with a visible water soaked lesions. The first visible symptom is yellowing of leaves starting from top and gradually to bottom. Leaves are wilted and gradually dried. Base of pseudo-stem, rhizome and root starts rotting. Pseudo-stem is easily

pulled out from the joint with rhizome. There are copious black and brown patches seen on rhizome and root. The intensity of this disease is higher in lower altitude.

Disease Cycle

P. vexans survives in soil by means of zoospores and sporangia for short and intermediate periods and by means of oospores for longer periods (Hendrix and Campbell, 1973). The oospores germinate indirectly by releasing zoospores. The zoospores swim around in water and infect the roots of host plants. Mycelial growth occurs between 5 and 35°C (optimum 30°C) (Plaats-Niterink, 1981). Peach stunting induced by *P. vexans* is more severe under high moisture conditions (Biesbrock and Hendrix, 1970).

Survey Methodology

As described in Fusarium disease.

Pest Identification

According to Plaats-Niterink (1981), *P. vexans* produces terminal or intercalary spherical sporangia, 15-27 (av. 20.2) x 11-23 (av. 17.9) µm. Oogonia are mostly terminal, usually with a single monoclinal antheridia and an aplerotic oospore of diameter 14-20 (av. 17.3) µm.

Procedure for observation, sampling and record

At first identification will be done based on the symptoms as described above. Observe the joint of rhizome and pseudo-stem with a visible water soaked lesions, yellowing of leaves starting from top to bottom, wilted leaves, rotting of rhizomes and roots.

For the sampling of suspected plants at least 5 samples from base especially from the joint of pseudo-stem and rhizome, and roots of different plants should be taken from each two fixes. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, geographical location, aspects etc should be recorded according to the given annex IV.

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Sampling – Roots and base of the suspected diseased plants from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Symptom and causal organism in figure



Fig. Symptom of Rhizome rot of large cardamom

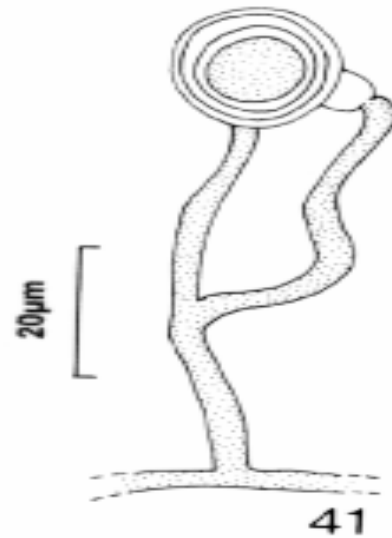


Fig. Sporangia of *Pythium vexans* (Antheridium on right and Oogonium on left)

Bacterial wilt (*Erwinia chrysanthemi*)

Information of the target pests

Pest name: *Erwinia chrysanthemi*

Scientific name : *Erwinia chrysanthemi* (Burkh.) Young et al. 1978

Common name: Bacterial wilt of dahlia, bacterial wilt of chrysanthemum, bacterial soft rot of tobacco, bacterial wilt of ornamentals, blackleg of potato, wet rot of the pseudostem of plantain, bacterial head rot of banana, fruit collapse of pineapple

Scientific Classification

Domain: Bacteria

Phylum: Proteobacteria

Class: Gammaproteobacteria

Order: Enterobacteriales

Family: Enterobacteriaceae

Description

It is the threatening bacteria in cardamom. *E. chrysanthemi* is probably distributed worldwide. Strains of biovars 1, 7 and 9 (not growing at 39°C) seem restricted to cooler countries such as European countries, the USA and New Zealand (Janse and Ruissen, 1988; Samson et al., 1990), whereas biovars 3 and 8 are found at all latitudes (Samson et al., 1990). Plant parts liable to carry the pest in trade/transport are :

- Bulbs/Tubers/Corms/Rhizomes: borne internally; borne externally; visible to naked eye.
- Leaves: borne externally; visible to naked eye.
- Seedlings/Micropropagated Plants: borne internally; borne externally; invisible.
- Roots: borne internally; borne externally; visible to naked eye.
- Stems (above Ground)/Shoots/Trunks/Branches: borne internally; borne externally; visible to naked eye.

Target host/alternate host

Aglaonema , Allium (onions, garlic, leek, etc.), Ananas comosus (pineapple), Araceae , Begonia , Brachiaria (signalgrass), Brassica oleracea (cabbages, cauliflowers), Chrysanthemum maximum hybrids , Chrysanthemum vestitum , Dianthus (carnation), Dieffenbachia (dumbcanes), Dracaena marginata

(Madagascar dragon tree), *Elettaria cardamomum* (cardamom), *Pelargonium zonale* hybrids ,
Philodendron

Disease Symptoms

E. chrysanthemi can affect any plant parts such as roots, stems, leaves and storage organs, depending on plant species and environmental conditions. The resulting symptoms vary from soft rot to wilting.

Disease caused by *E. chrysanthemi* usually occurs in a severe form on succulent plant organs at high temperatures, a humid atmosphere and high nitrogen levels. The symptoms are usually destructive at temperatures at or above, 28°C. However, the disease may be very mild, or the plants remain symptomless, at temperatures below 20°C.

Systematically infected stock-plants, or externally infested seed materials, become important sources of primary infection in vegetative propagation (*Dahlia*, *Dianthus*, *Dieffenbachia*, *Musa* spp. and *Solanum tuberosum*). The disease may be spread by knives or fingers during farming practices such as pruning, cutting and harvesting (Burkholder et al., 1953; McGovern et al., 1985; Serfontein et al., 1991).

Symptoms by affected plant part

Fruits/capsules: lesions.

Growing points: lesions.

Inflorescence: abnormal forms.

Leaves: wilting; rot.

Roots: rot.

Stems: internal discoloration; abnormal growth; wilt.

Whole plant: plant dead; dieback; damping off; dwarfing; uprooted or toppled.

Disease Cycle

E. chrysanthemi appears to be mainly soil-borne, probably as a result of infection of alternative weed host plants. It is commonly found in association with plant residues. When the pathogen was discovered on maize in Florida, USA, irrigation water was believed to be the primary inoculum source (Lopes et al., 1986). The pathogen could be isolated from water in India (Saxena and Lal, 1987) and it was demonstrated in Australia (New South Wales) as a natural component of the alpine aquatic microflora which could infect potatoes via irrigation water (Cother and Gilbert, 1990; Cother et al., 1992).

Otherwise, planting material generally transmits the pathogen. Cuttings of *Musa* sp., carnation, dahlia, *dieffenbachia*, *chrysanthemum*, and tubers of dahlia and potato, are able to transmit the disease because of internal infection in the vascular bundles. However, *E. chrysanthemi* is not seedborne on maize, either

externally or internally (Prasad and Sinha, 1978). Dispersal of the pathogen within and between crops can also occur by insect pests and contaminated wind-splashed water and aerosols.

Survey Methodology

As described in Fusarium disease.

Pathogen Identification

E. chrysanthemi is a Gram-negative, facultative anaerobic, rod-shaped bacterium measuring 1.1-3.8 x 0.5-1 µm, usually single, motile with several peritrichous flagella. It is oxidase-negative, catalase-positive, ferments glucose and reduces nitrate (for details, see Bergey, 1994; Bradbury, 1986). The main character that distinguishes the soft rot *Erwinia*s from other species of *Erwinia* is the ability to produce large quantities of pectolytic enzymes that enable them to macerate parenchymatous tissue of a wide range of plant species.

Compared to the other soft rot *Erwinia*s, there is considerable diversity within *E. chrysanthemi* at both immunological level with some 12 serovars based on lipopolysaccharides (Samson et al., 1990) and molecular level, with 24% mean similarity (Avrova et al., 2002) and 15 RFLP groups (Waleron et al., 2002). There was no correlation between these groups and original host and geographic origin. However, ribotyping of the bacterium yielded seven clusters which could be related to pathovars, biovars and to a lesser extent to geographical distribution (Nassar et al., 1994).

Procedure for observation, sampling and record

The identification on field will be done based on the symptoms as described above. Soft rot with black to brown lesion on base or lower part of the plants followed by wilting is the symptom of this disease.

For the sampling of suspected plants at least 5 samples from base or the part where rotting is progressing from, of different plants should be taken from each two fixes. Always notice for the disease progressing parts while sampling because the disease progressing margin contains the highest number of bacteria and can be isolated easily in laboratory. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, geographical location, aspects etc should be recorded according to the given annex IV.

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Sampling – Roots and base of the suspected diseased plants from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some symptom and colony character of bacteria on figure



Fig. Colony characteristics of *E. carotovora* in MacConkey Agar media



Fig. Symptoms of aerial stem rot caused by *E. chrysanthemi* on potato plant (for a reference)

Aphid (*Aphis craccivora*)

Information of the target pests

Pest name: Aphid

Scientific name: *Aphis craccivora* Koch, 1854

Common name: groundnut aphid, black legume aphid, cowpea aphid, oriental pea aphid, bean aphid, lucerne aphid, black Lucerne aphid, African bean aphid

Scientific Classification

Phylum: Arthropoda

Class: Insecta

Order: Hemiptera

Family: Aphididae

Genus: *Aphis*

Species: *craccivora*

Description

A. craccivora is a cosmopolitan species with a worldwide distribution; abundant in subtropical and tropical regions, and in the Mediterranean. It is one of the commonest aphid species in the tropics. It is anholocyclic almost everywhere. In the tropics it is exclusively anholocyclic, with only females (winged and wingless) normally encountered, and parthenogenetic reproduction occurring throughout the year. The aphid is ovoviviparous, with females retaining eggs inside their bodies and giving birth to small larvae. In areas with colder winters, overwintering may be as egg or hibernation. Males are alate and sexual forms have been recorded from Germany (Falk, 1960), Argentina (la Rossa et al., 1993) and India (Basu et al., 1969). Müller (1977) compares tropical and central European populations.

Young colonies of this small aphid concentrate on growing points of plants and are regularly tended by ants. Optimal development of *A. craccivora* is dependent on fairly specific climatic

conditions, such as temperatures 24-28.5°C and around 65% RH (Réal, 1955; Mayeux, 1984). In the field, aphids do not generally survive periods of heavy rain.

Target host/alternate host

A. craccivora is polyphagous, but with marked preference for Leguminosae, for example, Caragana, Lupinus, Medicago, Melilotus, Robinia, Trifolium and Vicia. It is found in small colonies on many other families, including Zingiberaceae.

Geographic Distribution

Probably palearctic warm temperate in origin, *A. craccivora* now is virtually worldwide. It is particularly well distributed in the tropics, where it is one of the most common aphid species (CIE, 1983; Blackman and Eastop, 2000). *A. craccivora* has expanded its distribution in recent decades, now north to Siberia (Russia) and Alberta (Canada), south to Chile and Argentina.

Nature of Damage

Direct Feeding Damage

Direct damage caused by *A. craccivora* occurs on the seedling, vegetative and flowering stages of plants. Aphids prefer to feed on young leaves, shoots, flowers and immature seed pods. It is when aphid colonies concentrate on the growing tips of plants in the spring that the highest yield losses due to direct damage occur.

Indirect Damage

Honeydew

Indirect damage caused by *A. craccivora* is due to the production of honeydew and the transmission of plant viruses. Aphid honeydew is a digestive product with a very high sugar content. It builds up on plants when high aphid numbers occur, and acts as a substrate for fungal growth, particularly of sooty moulds. Plant respiration and photosynthetic efficiency are adversely affected (Mayeux, 1984).

Symptoms by affected plant part

Growing points: external feeding.

Leaves: lesions; abnormal colours; abnormal patterns; honeydew or sooty mould.

Whole plant: Dwarfing; external feeding.

Life Cycle

A. craccivora is capable of rapid population development. It is observed that offspring from a single gravid adult aphid averaged 17-43 in 15 days. It has four nymphal instars. The total nymphal period is 5. The duration of the total life cycle during the corresponding periods is 11 days (Patel and Srivastava, 1989).

Survey Methodology

Aphid Monitoring

Yellow Pan Trap (YPT)

YPT will be used for winged aphid trapping. The dimension of these traps is 50 cm long, 30 cm width and 8 cm high with sides sloping outwards. One bottom corner of the tray will have an outlet tube 2 cm diameter and 4 cm long closed from the inside with a stopper. The bottom and lower 2 cm of the inner sides will be painted yellow, the remaining sides and exterior will be painted dark gray. Traps will be filled with fresh water and a few drops of detergent added to break the surface tension and prevent aphid from escaping as described by Raman, 1985.

Three traps will be established on center row of a 60*60 field sections adjacent to the access road, but halfway between the edges of each field. One trap will be placed 15 m from the edge, and the second and third trap will be placed on 15 m apart from each other and on the platform approximately 1.5 m above the ground. Yellow pan trap will be emptied twice a week (Boiteau and Parry, 1985). Traps will be placed in position at the time of new flushing of cardamom and monitored throughout the year for the first three years and then trap monitoring will be revised.

Aphid/Leaf count method

Virus transmission is more closely related to the progress of aphid infestation from plant to plant than the total number of aphids on a particular plant. Progress of aphid can be determined by the

aphid/leaf count method (Raman, 1985). Aphid/leaf count method will be carried out in 250 m² area of each 10 orchards of farmers. Each field will be visited once in 10 days and 50 plants will be randomly selected in each field sections. On these 50 plants, three fully-expanded compound leaves each from upper, middle and lower parts will be inspected. The number of winged aphids will be counted, recorded and transferred to the small bottles filled with 80% ethyl alcohol.

Nursery surveillance

One nursery at the experimental station of the identified centre and one at each of the ten selected villages has to be selected for surveillance. General information on nursery (one time information), and on nursery insect pests and diseases (once a fortnight) has to be collected.

Aphid/leaf count method will be done on nursery also.

Another option in sampling is five random spots of one square feet (four in the corners at least 3 feet inside the borders and one in the centre) have to be used during the fortnightly observations of the selected nurseries and fields.

Preparation and identification of aphids

Collected specimens will be prepared for slide mounts and identification of *A. craccivora* will be made by registered entomologist of NPPO.

Pest Identification

A. craccivora is a relatively small aphid. Apterous viviparous females have a shiny black or dark brown body with a prominent cauda and brown to yellow legs. Immature aphids are slightly dusted with wax, adults without wax. Six-segmented antennae, distal part of femur, siphunculi and cauda black.

Alate viviparous *A. craccivora* females have abdomens with dorsal cross bars, alatae 1.4-2.1 mm.

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Methodology – Yellow Pan Trap (YPT) & Aphid/leaf count

Sampling – Individual aphid or mass of the aphids with similar morphology as possible as distinguished

Field Observation – Twice a week for YPT observation and once on 10 days for aphid/leaf count

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Entomology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Figures of *A. craccivora* mass



Fig. Mass of Black Aphid (*Aphis craccivora*)

Pseudo-stem Borer (*Glyphipterix* spp.)

Information of the target pests

Pest name: Borer

Scientific name: *Glyphipterix* spp.

Common name: Borer

Scientific Classification

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera

Family: Glyphipterigidae

Description

Stem borer infestation of large cardamom is increasing in Nepal. Though the incidence in main cardamom plantation is low, it causes considerable damage on the nursery. Stem borer is recorded from March to November. This pest causes dead heart on plantation and makes the fruit empty without seed eating seed of small capsule. The intensity of infestation is higher in lower altitude.

Target host/alternate host

This insect lives in Castor plant (*Ricinus communis*) as an alternative host.

Nature of damage

Female of this moth lays eggs on tender leaves of new clumps of cardamom bushes. Small rosy larvae with black head hatched out after 6-9 days of egg laying. These larvae of stem borer feed on the tip of the shoot and move downward. They reach up to the rhizome on feeding. This results the terminal leaf of plant get dried up and this symptom is known as dead heart. The infestation of this pest is also indicated by the presence of entry holes plugged with excreta.

Life Cycle

The damaging stage of this pest is larvae. Female lays eggs on tender leaves, generally on new clumps. The small rosy larvae with black head hatched out after 6-9 days. It is active from March to November. Larvae come out to pupate which is attached on the joint of pseudo-stem and leaves. The color of pupae is faint red. This period lasts about 12-15 days however it depends on the external environment. Adults with silvery with black marking and bronzy forewings come out from the pupae.

Survey Methodology

Monitoring & Observation

Wilted plants will be observed from March to November. Pseudostem will be tore to find the larvae of borer and these borers will be kept for cup study. Pupae and adults got from cup study will be recorded. Life cycle study will also be done correlating with the temperature and locations of different places. All the morphological characteristics of larvae, pupae and adults will be recorded.

One field at nursery stage and two main fields each at the experimental station in ten villages of the region are to be selected for cardamom borer surveillance. Fixed fields are those fields that once selected in the standing crop and will be continuously monitored till the specified time on weekly basis using the specified data sheet formats (as given in annex IV). In addition, a random survey covering eight villages other than the ten selected villages has to be conducted fortnightly.

Nursery surveillance

One nursery at the experimental station of the identified centre and one at each of the ten selected villages has to be selected for surveillance. General information on nursery (one time information), and on nursery insect pests and diseases (once a fortnight) has to be collected. The borer might have a significant damage at nursery stage of large cardamom. So intensive monitoring of nursery will be made once a week from March to November. Since having the low and dense population on nursery no samples will be taken rather the size of sample will be the size of population.

Fields of farmers

Ten cardamom growing villages representing the agro-ecology of the identified region in the same and neighboring district, distributed randomly should be selected. In each village, two farmers' fields (designated as Fixed 1 and Fixed 2) of near to one-half hectare (5000 m²) are to be fixed for weekly observations. Assigning fields of farmers as Fixed 1 and Fixed 2 should be made at time of field selection and same should be maintained from the first observation till the end of season. Care should be taken to select farmers growing common variety (ies) of the region (NICRA, 2011).

Pest Identification

Wingspan is about 11-15 mm. Body has silver and black markings against a bronzy forewing and peculiarly indented termen. The moths can be found flying among the bushes, rushes in sunshine. The flight period is March to November.

Procedure for observation and record keeping

Wilted plants will be observed from March to November. Pseudostem will be tore to find the larvae of borer and these borers will be kept for cup study. Pupae and adults got from cup study will be recorded. Life cycle study will also be done correlating with the temperature and locations of different places. All the morphological characteristics of larvae, pupae and adults will be recorded.

There will also be adult monitoring just by observation. Adult will be collected using sweep net and collected using glass vile/bottle with cap. The number of borer infected plants, number of larvae found in the specified sample plants, number of adults seen on general observation and adults swept on net will be count and recorded.

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey – March to November.

Methodology – Infected plants count, larvae count and adult swept using sweep net

Sampling – Individual or mass of larvae, adult trapped on sweep net, digital photographs of damaged plants

Field Observation – Once a week

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV





Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Entomology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some figures of pest and its damage

	
Fig. Wilt starting due to borer attack on a single cardamom plant	Fig. Wilt starting due to borer attack on a bush of cardamom
	
Fig. Larva of Cardamom borer	Fig. Adult moth of Cardamom borer

Sclerotium Rot (*Corticium rolfsii*)

Information of the target pests

Pest name: *Corticium rolfsii*

Scientific name : *Corticium rolfsii* Curzi [teleomorph]

Common name: Sclerotium rot

Scientific Classification

Domain: Eukaryota

Kingdom: Fungi

Phylum: Basidiomycota

Class: Basidiomycetes

Subclass: Agaricomycetidae

Order: Polyporales

Family: Corticiaceae

Description

Disease caused by *C. rolfsii* occurs on a broad range of crops and can be of economic importance in tropical and subtropical regions of the world. It is distributed worldwide and not reported to be seed borne. So the phytosanitary significance is moderate however seed should have to be treated with fungicide. It causes considerable damage on large cardamom.

Plant parts liable to carry the pest in trade/transport

- Rhizome/Bulbs/Tubers/Corms: Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- Fruits (inc. Pods, capsule): Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- Growing Medium/soil/lichen Accompanying Plants: Sclerotia, Hyphae; borne externally; invisible.
- Flowers/Inflorescences/Cones/Calyx: Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- Leaves: Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- Roots: Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- Stems (above Ground)/Shoots: Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.
- True Seeds (inc. Grain): Sclerotia, Hyphae; borne internally; borne externally; visible to naked eye.

Target host/alternate host

C. rolfii infects more than 500 species of monocotyledonous and dicotyledonous plants, but is especially severe on legumes, solanaceous crops, cucurbits and other vegetables grown in rotation with beans (Hall, 1991).

Disease Symptoms

This fungus primarily attacks pseudo-stems of large cardamom, although it may infect any part of a plant under favorable environmental conditions including roots, fruits, petioles, leaves, and flowers. The first signs of infection, though usually undetectable, are dark-brown lesions on the pseudo-stem at or just beneath the soil level; the first visible symptoms are progressive yellowing and wilting of the leaves. Following this, the fungus produces abundant white, fluffy mycelium on infected tissues and the soil. Sclerotia of relative uniform size are produced on the mycelium: roundish and white when immature then becoming dark brown to black. Mature sclerotia resemble mustard seed.

Seedlings are very susceptible and die quickly once they become infected. Older plants that have formed woody tissue are gradually girdled by lesions and eventually die. Invaded tissues are pale brown and soft, but not watery.

Disease Cycle

C. rolfii grows, survives, and attacks plants at or near the soil line. Before the pathogen penetrates host tissue it produces a considerable mass of mycelium on the plant surface, a process which can take 2 to 10 days. Penetration of host tissue occurs when the pathogen produces an enzyme which deteriorates the hosts' outer cell layer. This results in tissue decay, further production of mycelium and the formation of sclerotia. The latter two rely upon favorable environmental conditions.

Sclerotia undergo either hyphal or eruptive germination. Hyphal germination is characterized by the growth of individual strands of hyphae from the sclerotial surface while eruptive germination is characterized by plugs or aggregates of mycelium bursting through the sclerotial surface.

C. rolfii is able to survive (and thrive) within a wide range of environmental conditions. The optimum pH range for mycelial growth is 3.0 to 5.0, and sclerotial germination occurs between 2.0 and 5.0. Germination is inhibited at a pH above 7.0. Maximum mycelial growth occurs between 25 and 35 C with little or none at 10 or 40 C. Sclerotial formation is also greatest at or near the optimum temperature for mycelial growth. Mycelium is killed at 0 C, but sclerotia can survive at temperatures as low as -10 C. Sclerotia fail to germinate when the relative humidity is much below saturation.

Occasionally *S. rolfii* has a sexual fruiting stage which develops on the margins of lesions and in locations that are shaded from the sun. Two or four thin-walled colorless spores are borne on short spines at the ends of slightly enlarged short threads.

Survey Methodology

As described for Chirke disease.

Pest Identification

In Culture

Colonies

Colonies on potato dextrose agar are white, usually with many narrow mycelial strands in the aerial mycelium. Sclerotia develop on the colony surface; these are nearly spherical (slightly flattened below), mostly 1-2 mm across when fresh, shrinking slightly when dry, with a smooth or shallow pitted shiny surface. Cells of primary hyphae at the advancing edge of the colony are usually 4.5-9.0 μm wide and up to 350 μm long with one or more clamp connections at septa. Secondary hyphae arise immediately below the distal septum of the cell and often grow adpressed to the primary hyphae; tertiary and subsequent branches are narrow (1.5-2.0 μm wide), have comparatively short cells and a wide angle of branching not closely associated with septation, and are usually without clamps.

Sclerotia

Sclerotia show sharply differentiated rind with evenly thickened, strongly pigmented walls, cortex with faintly pigmented walls, and medulla with colourless, unevenly thickened walls. The cortex and medulla contain vesicles of reserve materials; rind cells do not.

Hymenium

The hymenium on agar media contains white to ochraceous stromata, which may be sparse or aggregated in irregular masses; fructifications are dense, forming a crustose hymenial layer.

Basidia

Basidia are clavate.

Basidiospores

Basidiospores smooth, hyaline, globose-pyriform and 4.5-6.5 x 3.5-4.5 μm . Dimensions given by other investigators range from 2-5.5 x 1.5-3.5 μm to 19-57 x 4.5-7.5 μm for basidia; 1.5-2.5 x 1-1.5 μm to 6-12 x 3.5-8 μm for basidiospores. Dimensions are partly dependent on the media used (Mordue, 1974).

On Host

Fans of white mycelium spread over organs near the soil surface. Appressoria develop as swollen tips of short branches behind the advancing edge. Sclerotia often do not develop until after the death of the host. Hymenium development has been recorded on leaves (Mordue, 1974).

Procedure for observation, sampling and record

Identification will be done based on the symptoms as described above. Observe for the dark-brown lesions on the pseudo-stem at or just beneath the soil level; progressive yellowing and wilting of the leaves, white, fluffy mycelium on infected tissues and the soil. Also try to observe sclerotia of relative uniform size on the mycelium. Notice that they are round and white when immature then becoming dark brown to black. Mature sclerotia resemble mustard seed.

Seedlings are very susceptible and die quickly once they become infected. So observe these symptoms on nursery and just transplanted seedlings closely. Older plants that have formed woody tissue are gradually girdled by lesions and eventually die. Invaded tissues are pale brown and soft, but not watery.

For the sampling of suspected plants at least 5 samples from base and roots of different plants should be taken from each two fixes. Samples should be gently pressed on blotting paper so that excess moisture will be easily drawn out and there will not be any chance for other saprobes to grow. Samples should be brought to laboratory as soon as possible.

The presence of disease, disease incidence, geographical location, aspects etc should be recorded according to the given annex IV.

No. of infected plants

$$\text{Disease incidence} = \frac{\text{No. of infected plants}}{\text{Total no. of plants}} \times 100\%$$

Observation and Documentation

Target area for survey – As decided by survey plan of NPPO

Timing of survey -- From the time of flushing to throughout the year for the first three years

Sampling – Roots and base of the suspected diseased plants from different plants

Field Observation – Once in a fortnight

Collector—Trained technicians as identified by Plant Protection Officer of respective district

Sample Collection – Follow the format given in annex IV

Identifier – PPO/SPPO as identified by NPPO, Complete the format IV

Verifier – Scientist/SPPO/PPO as identified by NPPO

Reference lab – Plant Pathology Division, NARC

Repository – RPPL, NARC lab or other identified lab

Documentation – As per the annex V

Some figures of Sclerotium rot for the references



Fig. White and fluffy mycelium of *Corticium rolfsii*

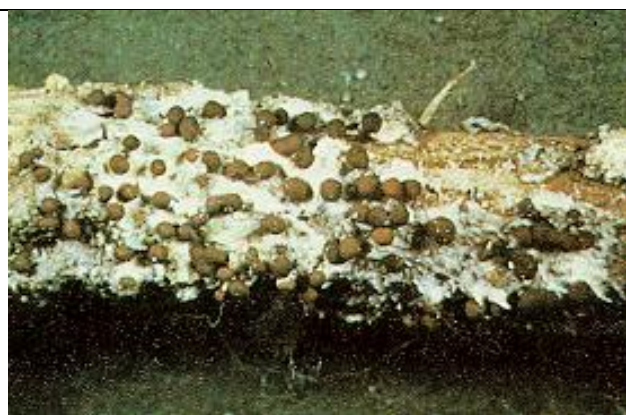


Fig. Mustard seed like Sclerotia produced by *C. rolfsii*

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Annex I

Data Collection Form

1. Orchard General Information	
A. Name of field/Site visited	
B. Cardamom Estate	
C. Age of the particular bush	
D. Kind of the bush	Suckers/Seedling
E. Altitude of the Estate	
F. Aspect/Facing of orchard	East/West/North/South
G. Total number of seedlings in the estate	
H. Total number of bushes in the estate present	
I. Bushes/tillers died in last five years	
J. Saplings supplied by:	DADO/NGO/Produced by own/Brought by neighbors
K. Management practices applied by the farmers:	
L. Removing of diseased, unproductive tillers/bushes and dense tillers	Yes/No <i>if yes:</i> <i>When:</i> <i>How:</i>
M. Application of plant protection chemicals:	Yes/No, <i>If yes:</i> What (name of chemicals): Dose : Date : Frequency:.....
N. Use of Manures and Chemical Fertilizers	Yes/No, <i>If yes:</i> Compost/FYM:Kg/bush Urea :g/bush DAP:g/bush Potash:g/bush Other minirals:.....g/ml/bush

	Date : Frequency:.....
O. Shade trees	Yes/No, if yes, Name of trees:..... Density (how many bushes get one tree):.....
P. Mulching	Practiced/Not Practiced
Q. Irrigation Facility	Yes/Rain Fed, if there is irrigation facility, What type: canal/pipe/sprinkler Frequency:.....
R. General appearance of the estate and bush/tiller health	
S. Number of tillers/bush and number of bushes in the estate showing basal rot symptom	<i>(Just starting of symptom: <25%, Medium damage 25-50%, Severely damage: >50%)</i>
T. Number of bushes in bearing stage	
U. Capsule yield/bush	
2. Date/Time of Visit:	
3. GPS Reference Point	Latitude: Longitude: Altitude:
4. Locality:	Village: VDC: District:
5. Climate Data of Locality:	Average Min. temp (in °C): Average Max. temp (in °C): Annual Rainfall (in mm) {Average of last three years}
6. Survey/Field plot No.	
Field Datasheet	
7. Variety of cardamom inspected	i. ii.
8. Description of habitat (eg. Vegetation, soil type and	Sandy....., Loam....., Clay, Depth of soil :

depth)	
9. Phenological stage of plant	Just harvested, intermediate growing, flowering, capsule forming, capsule growing
10. Alternate host (Ginger, Churumpha, Castor)	
11. Sampling Method	Full sampling
12. Contact detail Surveyor and local farmer involved in assisting	Surveyor : Local Farmer
13. If there is any additional information including collection of specimens for investigation:	

Name of Surveyor:

Signature and Date

Annex II

Format for Specimen Forward

Specimen Forwarded for identification by Diagnostic/Referral Laboratory	
1. Collection Number:	2. Date of Collection:
3. Submitting Organization	
4. Name/Address of the Sender	
5. Locality of Collection (District/VDC/Village)	
6. Reasons for identification	
7. Name of the host plant species (Common/Scientific)/Variety and or/Commodity	
8. Plant Part Affected	Base of plant (), Root ()
9. Type of pest specimen submitted	() preserved specimen; () dry specimen with host; () Culture, () Culture ; () Disease specimen (Fresh); Disease Specimen (Partially dry); Slide Mount; () Others (.....)
10. Number of specimens submitted per collection	
11. Name/Signature/Office Stamp and Date	

For Identifier Use

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Annex IV

General Format for Pest Recording

(Suitable for both field surveyor and laboratory use)

Pest Record	
Reference Number	Name of Laboratory: Address : Catalogue Reference number of the specimen in the pest library :
Scientific Name of Pest :	
Common Name of Pest:	
Growth Habit :	
Habit Characters :	
Species Name :	
Family :	
Order:	
Life stage of Pest	Active.....or resting spore.....or others.....
Scientific Name of Host	
Variety	
Common Name	
Family	
Parts Affected	() Base, () Crown, () Root, () Capsule, Whole plants (), Leaves ()
Stage of Plant	() Seedling Stage; () Vegetative Growth Stage () Flowering Stage, () Fruiting/Capsule Formation Stage ()
Locality	
Village	
VDC	
Ward	
District	
Date, time and GPS location of pest collection	
Method of Collection	

Name of the Collector	
Species Accumulation Curve	
Method of Identification	
Name of the Identifier	
Date of Verification	
Method of Verification	
Name of the Verifier	
Method of Pest Preservation (Detail)	
Suitable for :	Taxonomic analysis or DNA Analysis
Life stage of Pest Affecting Alternate Host	Active stage or Dormant Spore
Scientific Name of Alternate Host	
Common Name of Alternate Host	
Species Name	
Family	
Alternate Host Plant Parts Affected	
Stage of Alternate Host Plant	
Locality	
Village	
VDC	
Ward	
District	
State	

Name of Recorder:

Signature of Recorder