



Research Article

PESTS AND DISEASES OF LARGE CARDAMOM IN INDIA AND THEIR MANAGEMENT PRACTICES UNDER ORGANIC CULTIVATION

VIJAYAN A.K.*, SAJU K.A., DHANAPAL K., ESWARAN V.M., VALLATH A., PANDITHURAI G., MANOJ OOMMEN, DIVYA P.V AND MANESH KUNJUMON

Indian Cardamom Research Institute, Spices Board India (Ministry of Commerce and Industry, Govt. of India), Myladumpara, Idukki, 685 553, Kerala, India

*Corresponding Author: Email - drvijayanicri@gmail.com, vijayan.ak@nic.in

Received: July 30, 2019; Revised: August 12, 2019; Accepted: August 13, 2019; Published: August 15, 2019

Abstract: There are as many as 23 insect pests found associated with large cardamom (*Amomum subulatum* Roxb.), but all of them are not causing the economic damage to the plant. Among the insect pests that attack large cardamom, leaf caterpillar (*Artana chorista* Jordon), stem borer (*Glyphipterix* spp.) Shootfly, (*Merochlorops dimorphus* Cherian) and White grub (*Holotrichia* sp.) are considered as important pests. Aphids are responsible for transmitting viral diseases viz., chirke and foorkey. Major threat to the crop is the widespread occurrence of fungal and viral diseases causing considerable damage and consequent loss in devastating proportions. The fungal disease Colletotrichum blight has devastated the large cardamom plantation and is the cause of concern for severe crop loss and decline in plant population in the recent past. The pests and diseases affecting large cardamom and their management practices are presented.

Keywords: Causal organism, Diseases, Epidemiology, Extent of damage, Large Cardamom, Management, Pests

Citation: Vijayan A.K., et al., (2019) Pests and Diseases of Large Cardamom in India and Their Management Practices Under Organic Cultivation. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 11, Issue 15, pp.- 8876-8880.

Copyright: Copyright©2019 Vijayan A.K., et al., This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Academic Editor / Reviewer: P S Bhat

Introduction

Twenty three insect pests, four fungal diseases and two viral diseases are found associated with large cardamom (*Amomum subulatum* Roxb.), but all of them are not causing the economic damage to the plant. Among the insect pests that attack large cardamom, leaf caterpillar (*Artana chorista* Jordon), stem borer (*Glyphipterix* spp.) Shootfly, (*Merochlorops dimorphus* Cherian) and White grub (*Holotrichia* sp.) are considered as important pests. Aphids are responsible for transmitting viral diseases viz., chirke and foorkey. Major threat to the crop is the widespread occurrence of fungal and viral diseases causing considerable damage and consequent loss in devastating proportions [1]. The fungal disease Colletotrichum blight has devastated the large cardamom plantation and is the cause of concern for severe crop loss and decline in plant population in the recent past [2]. The pests and diseases affecting large cardamom and their management practices are presented in this paper.

Leaf eating caterpillar

The leaf eating caterpillar (*Artana chorista* Jordon) is the only major pest presently causing economic loss in all over the region [Fig-1 & Fig-2].

Seasonal occurrence

The pest occurs sporadically in epidemic form every year in all the cardamom growing area of NE region and Darjeeling District of West Bengal. Usually the incidence of the pest is observed from June to July and October to March in the field

Nature and extent of damage

The leaf caterpillar is monophagous and is highly host specific. The larvae are gregarious in nature and feed on lower layer of the leaf, leaving transparent epidermis and veins (skeletonization). Indirectly defoliation of the plant by the pest affects the yield.

There are two generations per year in the field, first generation from May to August and second generation from September to April.



Fig-1 Leaf caterpillar damaged plant

Fig-2 Large cardamom leaf caterpillars

Management

- The larvae are gregarious in nature and feed underneath the cardamom leaf; the infested leaf can easily be identified from a distance and these may be collected along with larvae and destroyed in June-July and October-December.
- There are some natural enemies which kill the larvae and pupae of leaf caterpillars. These natural enemies reduce the pest population considerably in the field. Pentatomid bug and syrphid fly larvae are recorded as predators on leaf caterpillars. Two dipteran, *Nedina* sp. and *Bactromyza* sp. and two hymenopteran (*Venturia* sp. and *Nesochorus* sp.) parasitoids are recorded as natural enemies of leaf caterpillars.

Stem borer

Glyphipterix sp. (*Glyphipteridae*: Lepidoptera) is also associated to large cardamom in all the cardamom growing tract.

Seasonal occurrence

Stem borer incidence is noticed throughout the year.

But in four periods, December-January, March-April, May-June and September-October their abundance is more.

Nature and extent of damage

The larvae feed on the central portion of the shoot [Fig-3]. The central leaf of the plant gets dried up and this symptom is known as dead heart. Infestation of this pest is also indicated by the presence of entry holes plugged with excreta.



Fig-3 Stem borer infestation symptoms on large cardamom

Management

This pest can be controlled by removing infested shoots along with caterpillar.

Shootfly

Shootfly, *Merochlorops dimorphus* Cherian (*Chloropidae*:Diptera), was recorded as a major pest of large cardamom damaging young shoots. Low to moderate damage of shootfly is recorded in large cardamom plantation in all the four districts of Sikkim and Darjeeling District of West Bengal.

Seasonal occurrence

It is present throughout the year in large cardamom growing tract. The high incidence is recorded in new plantations within 1-3 year.

Nature and extent of damage

The tip of the shoot becomes brown and later whole shoot dries up. Larva bores the young shoot and feeds on the core of the pseudostem from the top to the bottom resulting in damage of central leaf ultimately leads to death of the tiller [Fig-4].



Fig-4 Shoot fly infestation symptoms

Management

- Infested young shoots should be removed at ground level and destroyed.
- Adult shoot fly can be trapped using fish bait and then kill.

- Application of neem seed kernel extract also reduces the pest problem.

White grubs

Holotrichia sp. (Melolonthidae: Coleoptera) is a polyphagous white grub infesting the roots and rhizomes of large cardamom in some of the places [Fig-5 & Fig-6].

Nature and extent of damage

The grubs are white and 'C' shaped with brown head [Fig-7]. The grub feeds away the feeder root of the plants and the infested plant shows yellowing and withering symptoms.



Fig-5 White grub damaged plant

Fig-6 White grub damage on root



Fig-7 White grub larvae

Fig-8 White grub adult

Management

- Collect the beetles [Fig-8] using hand nets during peak period of emergence i.e., during April- May and kill them.
- Light raking of soil before the insecticide application is essential for effective control of root grubs.

Aphids

The aphids cause more damage as a vector rather than a pest. The aphids are associated with the transmission of viral diseases (Foorkey and Chirke) of large cardamom.

Pentalonia nigronervosa f. *caladii* (Goot) (Aphididae:Hemiptera).

Micromyzus kalimpongensis (Aphididae:Hemiptera)

Rhopalosiphum maidis Fitch (Aphididae: Hemiptera).

Rhopalosiphum padi (Lin.) (Aphididae:Hemiptera)

P. nigronervosa f. *caladii* and *M. Kalimpongensis* are known to be as vectors of 'foorkey' or virus yellow disease. The aphids colonize at the base (rhizome) of the clump and if population is more, they move to aerial portion of the clump. They remain mostly to exposed rhizomes and dried leaf sheaths suck the sap from the pseudostem.

Maize aphids, *Rhopalosiphum maidis* and *R. padi* are used to be on the lower surface of the leaves of large cardamom, congregating near the mid-rib and veins. These aphids are known to be the vector of another viral disease, mosaic streak or 'chirke'.

Management

The removal and destruction of diseased plants is helpful in control of the disease and in reduction of aphid population.

In some occasion minor pest like hairy caterpillar (*Eupterote* sp) cause considerable loss in cardamom plantation. Other minor pests are mealy bugs (*Planococcus* spp) and thrips (*Heliethrips haemorrhoidalis*)

Major threat to large cardamom is the widespread occurrence of fungal and viral diseases causing considerable damage and consequent crop loss in devastating proportions. Diseases affecting large cardamom and their management are dealt herewith in detail.

Blight (*Colletotrichum gloeosporioides*)

Colletotrichum blight has devastated the large cardamom plantation and is the cause of concern for severe crop loss and decline in plant population in the recent past [Fig-9].

Causal organism

Blight is caused by *Colletotrichum gloeosporioides* and its perfect state *Glomerella cingulata*. Lesions on leaf and sheath carry black dots and are rough in its texture. These dots are identified as perithecia of the pathogen.

Epidemiology

The disease appears generally with the advent of the pre-monsoon showers in April-May and progresses rapidly during the rainy season. However, in some areas the incidence starts during winter months (January-March).

Symptoms

Water-soaked lesions appear either at margins or tips or any other point on the leaves which rapidly enlarge, coalesce and cover major portion or the entire leaf lamina giving a blighted appearance. The advancing lesions are blackish brown in color and margins give a yellow halo [Fig-10]. In some cases, the entire lamina becomes yellowish and blighted. The affected area becomes necrotic and dry up.



Fig-9 Blight affected plant in the field



Fig-10 Blight symptoms on leaves



Fig-11 Lesions on pseudostem



Fig-12 Pseudostem lodging

Leaf sheath covering the pseudostem show blackish brown discoloration which extends up to rhizomes and subsequently turn into greyish or blackish patches with brown margins. Gradually the pseudostem becomes brittle and breaks in the middle or at the collar regions. In most cases, the lesions on the pseudostem become necrotic as a result the entire leaves dry out giving a burnt appearance. Later, the pseudostem lodges at the point of necrotic lesion [Fig-11 & Fig-12]. As a whole, the affected clumps and hence, the entire plantation look dried up.

The disease mostly affects the bearing tillers of the clump while the new tillers remain apparently healthy. However, later in the season, in some cases the young emerging leaves of the new tillers in the diseased clump show pale yellow discoloration in the inter-venal areas. Sometimes the emerging leaves are whitish in colour and droop without opening properly. Slight yellowing and narrowing of emerging leaves are also noticed and in some cases the pseudostem break open longitudinally in the middle and the young leaves emerge through the opening. Examination of the rhizomes of such tillers showed brown lesion with air space in the middle.

The spike from the diseased clump exhibit elongated appearance in comparison to the spike from the healthy clump and this is mainly due to lack of fruit setting. However, in other cases, flowering and seed-setting takes place but the seeds do not mature and remains whitish or light brown instead of natural black. Generally the roots are not infected. In the cultivar Varlangey the newly formed tillers in the diseased clump show pale yellowing and rosetting of leaves giving a stunted appearance as compared to the healthy plants.

Collateral hosts

14 species of plants belonging to various families showed symptoms similar to

Colletotrichum blight. Some of them are marigold, *Amomum dealbatum* (Churumpa), canna, wild colocasia, ornamental basil, *Alnus nepalensis* etc.

Blight Management

It must be kept in mind that high disease pressure exists in the large cardamom ecosystems which has developed over the last few years in the absolute absence of management practices either developed or followed. Moreover, Sikkim being an organic state, only eco-friendly and non-chemical measures can be adopted. It is observed that, generally, the bearing and old tillers are cut and spread around the plant base during the harvesting time. Since bearing tillers (old tillers) are the infected ones with plenty of lesions and sporulation all over, they serve as the inoculum in the next season. Hence, the disease perpetuates in the subsequent season resulting in greater devastation and crop loss. In this context, reducing the initial disease pressure is an unconditional pre-requisite before undertaking any management practice.

Considering this aspect, the following approach is suggested that would help tackle the problem systematically. The mature and bearing tillers cut during harvesting must be composted. Even the leaves and residue of spikes must also be composted. During the composting process, temperature increase and most pathogens are killed. Compost pits for the purpose may be made at convenient places in each plantation prior to harvest. Use of EM (Effective Microorganisms) solution or cow dung slurry may be encouraged for easy composting. If this is followed at least for 2-3 years, the adoption of other management practices such as application of bio-control agents or permissible chemicals etc. would give better results. The tillers cut during harvest and other plant debris can also be burnt, wherever possible for safe disposal. However, burning is not permitted under organic norms. As a third alternative, the plant debris generated during harvest can be chopped into small pieces and buried in pits for quick decomposition.

- Most of the cultivars were found susceptible to the disease under natural conditions. The disease can be managed by the following methods.
- Proper phyto-sanitation by removal and destruction of disease affected plants/plant parts in the plantation and nursery.
- Pre treatment of suckers with bio- agent *Pseudomonas fluorescens* @ 5 lit in 100 lit water or Copper oxychloride @ 0.3% (i.e. 300gm in 100 lit water) at the time of planting in nursery/ field.
- Destroy the collateral host plants such as Marigold, *Amomum dealbatum* (Churumpa), Canna, wild Colocasia, ornamental Basil etc
- Regulate shade in thickly shaded areas and also ensure proper shade in open conditions.
- Apply bio- control agent *Trichoderma* mixed with FYM (1:100) @ 2kg /clump at plant soil basin.
- Prophylactic spraying and drenching of *Pseudomonas fluorescens* @3-4 lt. per clump during April last week or May 1st week. Repeat the application again in August & September (mix 3- 5 liters of the bioagent in 100 liters of water). OR

Application of 1% Bordeaux mixture as prophylactic spray before onset of monsoon and after monsoon. Spray and drench 0.3% (i.e 300gm in 100 lit water) Copper oxychloride (50% WP). Three sprays at 20 - 25 days interval may be given based on disease intensity. If the soil is drenched with Copper oxychloride or spray Bordeaux mixture, bioagents should be applied only after 15 days interval. Avoid mixing Copper fungicides with biocontrol agents.

Phoma leaf spot disease

Leaf spot caused by Phoma was found to be of serious concern in the seedling nurseries in Arunachal Pradesh and field plants in Sikkim.

Symptoms

Numerous water-soaked lesions, round in shape appear on the lamina [Fig-13] which coalesce and become yellowish and dry out [Fig-14].

Epidemiology

Rapid spread during continuous rain and consequent damage indicate its potential to devastate. In Sikkim, the disease was found to occur during late winter and peak rainy periods.



Fig-13 Initial symptoms on leaves

Fig-14 Phoma leaf spots affected plant



Fig-16 Symptoms of chirke on new leaves

Management

Field phyto-sanitation by removal and destruction of disease affected plants or plant parts

Provide adequate drainage.

Spray 1% Bordeaux mixture at 20-25 days interval during rainy days based on disease severity.

Leaf streak disease (*Pestalotiopsis royenae*)

It is prevalent round the year and results in considerable damage to foliage in variety Golsey.

Symptoms

The disease symptom is the formation of numerous translucent streaks on young leaves along the veins. The infection starts from emerging folded leaves [Fig-15].



Fig-15 Leaf streak disease

Management

Three rounds of 0.2 per cent Copper oxychloride (i.e., 200 g in 100 lit water) or 1% Bordeaux mixture at 15 days interval can control the disease.

Chirke disease

The corn aphid *Rhopalosiphum maidis* is one of the prevalent insect-vectors of the disease. Primary spread of the disease from one area to another is through infected rhizome and further spread within the field takes place by contaminated farm implements and aphids.

Symptoms

The disease is characterized by mosaic appearance on leaves.

The symptom is more prominent on young emerged leaves where discrete pale green to yellow longitudinal stripes running parallel to each other can be seen [Fig-16].

The above symptoms are masked on mature leaves.

The flowering is greatly reduced, gradually reducing the yield over the years. The disease is caused by virus and transmitted through insect vector and mechanically through sap.

Foorkey disease

The causal agent of the disease is virus which is not transmitted mechanically through sap but through vector, viz., banana black aphid, *Pentalonia nigronervosa* and *Micromyzus kalimpongensis*. It is transmitted in a persistent manner, means the virus can survive inside the aphid for a long time after acquisition feeding on infected plants. The virus also spread primarily through infected rhizomes.

Symptoms

The affected plants produce many stunted shoots which fail to produce flowers.

The leaves become small, lightly curled and pale green in colour. Sometimes, slightly broadened leaves resembling pan is also seen.

The inflorescence becomes stunted, thereby producing no flowers and fruits [Fig-17].



Fig-17 Symptoms of Foorkey affected large cardamom

Management of viral diseases

Viral diseases affected plants are difficult to cure. Early identification of the diseased plants and reducing the spread are the easy ways to tackle the problem. Hence, from an environmentally safe and economically viable perspective the following measures would be adopted for effective management of the diseases [Table-1].

Monitor the plantation every month particularly during rainy season and carefully identify the diseased plants.

The diseased plants may be uprooted and destroyed as and when they are seen. They should be taken to an isolated place, chopped into small pieces and buried in pits for quick decomposition. As an alternative, mass uprooting and burning of infected plants at the village / area level could be taken up for eradication of the disease.

Never collect planting materials from an infected garden or apparently healthy plants from severely infected gardens.

Establish nursery about 500 m away from main plantation in order to avoid aphid colonization

Maintain clean clumps by removing old tillers with loosened leaf sheath so that aphids will not colonize.

During plantation monitoring, especially prior to harvesting, the plantation must be inspected carefully for identification of diseased plants. These plants may be uprooted and destroyed on priority. The knife and other implements used for the purpose should not be used on healthy plants since disease could be transmitted through sap. Dip the implements in hot water for half an hour for killing the inoculum before going to the healthy plants for harvesting or cleaning.

Conclusion

Large cardamom (*Amomum subulatum* Roxb.) is an economically important cash crop and there is a need to increase the area under its cultivation for increasing the productivity of the crop in the North Eastern region. Major threat to large cardamom is the widespread occurrence of fungal and viral diseases causing considerable damage and consequent crop loss in devastating proportions. The pests and diseases affecting large cardamom and their management practices are described in this paper.

Table-1 Integrated pest and disease management (IPM) schedule for organic large cardamom production

Month	Operation	Target pests / pollinators
January-December	Monitoring of plantations at 30 days interval to identify <i>chirke</i> and <i>foorkey</i> infected plants for removal and destruction by burning/deep burring outside the plantation. Thrashing and phyto-sanitation. (Depending on pest incidence)	Aphids and viral diseases (<i>chirke</i> and <i>foorkey</i>) (To make large cardamom plantation virus and pest free)
March-May	Weeding in large cardamom plantations during flowering period will facilitate foraging of pollinators. Phyto-sanitation by collecting blight infected leaves, caterpillar infested leaves and destroy them by burning/deep burring outside the plantation. Application of Copper oxychloride (0.2%) as spraying and drenching in plantations after phyto- sanitation. Application of bio-control agents and botanicals as basal drenching and foliar spray (Two to three applications at monthly intervals)	Pollination by bumble bees/ honey bees and conservation of bumble bee nests in the soil. <i>Colletotrichum</i> blight Leaf caterpillar(<i>A. chorista</i>),
June-July	Phyto-sanitation by collecting blight infected leaves, caterpillar infested leaves, uprooting of viral infected plants and destroy them by burning/ deep burring outside the plantation.	<i>Colletotrichum</i> blight Leaf caterpillar (<i>A. chorista</i>), Viral diseases (<i>chirke</i> and <i>foorkey</i>)
August-December	Weeding, covering of spike with dried leaves and small branches of trees Thrashing and phyto-sanitation. Application of bio-control agents and botanicals as basal drenching and foliar spray.	Mammalian pests <i>Colletotrichum</i> blight, Leaf caterpillar (<i>A. chorista</i>), Viral diseases (<i>chirke</i> and <i>foorkey</i>)

Application of research: Major threat to large cardamom is the widespread occurrence of fungal and viral diseases. These pests and diseases cause considerable damage and consequent crop loss in devastating proportions.

Research Category: Large cardamom, Spices and Plantation crops.

Abbreviations: NE-North East, EM-Effective Microorganism,
WP-Wettable Powder, FYM- Farm Yard Manure,
IPM- Integrated Pest and Disease Management

Acknowledgement / Funding: Authors are thankful to the Director Spices Board of India (Ministry of Commerce and Industry, Govt. of India), Cochin, 682025, Kerala, India.

***Principal Investigator or Chairperson of research: Dr A K Vijayan**
Institute: Indian Cardamom Research Institute, Myladumpara, Idukki, 685 553
Research project name or number: Large cardamom

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Indian Cardamom Research Institute, Myladumpara, Idukki

Cultivar / Variety / Breed name: Cardamom

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

- [1] Vijayan A.K., Bhat S.K., Gudade B. A., Bora S.S., Mary Mathew K. and Remashree A.B. (2018) *International Journal of Agriculture Sciences*, 10(20), 7364-7368.
- [2] Remashree A.B and Vijayan A.K. (2018) *Plant Protection Code-Policy on usage of Plant Protection Formulations in Large Cardamom Plantations in India*, Spices Board(Ministry of Commerce & Industry, Govt. of India),Kochi – 682025 Kerala, India