

Viral diseases of cardamom (*Elettaria cardamomum* Maton) and their management

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ABSTRACT

Small cardamom (*Elettaria cardamomum* Maton) is affected by many diseases which have been identified as a major production constraint. Among the viral diseases 'katte' or mosaic is the major viral disease causing severe yield losses to an extent of 68 per cent. In addition, Nilgiri necrosis, infectious variegation virus and 'kokke kandu' diseases are gaining importance in recent years. The present paper reviews the information available on distribution of viral diseases, symptomatology, crop loss, transmission, etiology, host range and disease management. The future plan of work on aspects such as breeding for disease resistance through genetic engineering, virus characterization and early detection methods are indicated.

Key words : cardamom, control measures, *Elettaria cardamomum*, viral diseases.

Introduction

Cardamom (*Elettaria cardamomum* Maton) is one of the important spices used for flavouring food and beverages. In India cardamom is cultivated in an area of about 81,113 ha in Kerala, Karnataka and Tamil Nadu (Spices Board(1991). Kerala accounts for 60 per cent of the cultivation and production followed by Karnataka and Tamil Nadu.

Cardamom is grown at higher altitudes with perennial shade canopy, heavy rainfall and humid conditions which are also congenial for the occurrence of

many fungal, bacterial and viral diseases (Agnihotrudu 1987). The virus diseases affecting cardamom are mosaic or 'katte' Nilgiri necrosis, infectious variegation and cardamom vein clearing virus or 'kokke kandu'. Among these 'katte' caused by cardamom mosaic virus (poty virus) is the most important disease and causes severe yield losses to cardamom in India (Buchanan 1807). Of late a new virus disease, cardamom vein clearing 'kokke kandu', which means hooked tiller in Kannada was reported from many plantations in Karnataka posing a serious threat to cardamom

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cultivation. A review of the work done on viral diseases of cardamom and future prospects for diagnosis and management are dealt with here.

Mosaic or 'katte' disease

Mosaic disease is locally known as 'katte' meaning a disorder and is known as marble disease in Anamalais (Varma & Capoor 1953).

Distribution

Earliest reference of 'katte' dates back to 1900 (Mollison 1900). In South India, 'katte' is widely distributed in all the cardamom growing tracts with incidence ranging from 0.01 to 99.0 per cent (Mayne 1951).

Crop loss

The loss in yield due to the disease depends upon the stage of the crop at the time of infection and duration that the plants have been infected. If the plants are infected in the seedling stage or early pre-bearing stage, the loss will be almost total (Samraj 1970). In monocrop situations, the infection on bearing plants reduced the yield to 38 per cent, during the same year of infection. 62 per cent in the second year of infection, and 68.7 per cent in the third year of infection (Venugopal & Naidu 1984). Total decline of plants occurs after 3-5 years of infection.

Symptomatology

The first visible symptom appears on the youngest leaf of the affected tiller as slender chlorotic flecks measuring 2-5 mm in length. Later these flecks develop into pale green discontinuous stripes. These stripes run parallel to the vein from the mid rib to leaf margin. All subsequently emerging new leaves show characteristic mosaic symptoms with

stripes of green tissue almost evenly distributed over the entire lamina (Uppal, Varma & Capoor 1945). Often mosaic type of mottling is seen on the leaf sheaths and young pseudostems. The infection is systemic in nature and it gradually spreads to all the tillers in a plant. In the advanced stage the affected plants produce shorter and slender tillers with few shorter panicles and degenerate gradually.

Transmission

The virus is not transmitted through seed, soil, root to root contact and through manual operations (Thomas 1938; Rao 1977 a & b). The only method of dissemination of virus is by means of banana aphid (*Pentalonia nigronervosa* Coq.) and also through infected rhizomes. The first experimental transmission of 'katte' virus in India was obtained with the banana aphid (Uppal, Varma & Capoor 1945). So far 13 aphid species namely, *Aphis craccivora* Koch., *A. gossypii* Glover, *A. nerii* B. de. F., *A. rumicis* L., *Brachycaudus helichrysi* L., *Greenidia artocarp* W., *Macrosiphum pisi* Kalt., *M. rosaeformis* Das, *M. sonchi* L., *Schizaphis cyperi* van der Goot, *S. gramimum* Rondm., *Pentalonia nigronervosa* f. *typica* and *P. nigronervosa* f. *caladii* van der Goot were reported to transmit 'katte' virus (Varma & Capoor 1958; Rao & Naidu 1974).

Virus-vector relationship

It was earlier believed that the aphids on banana and cardamom were the same. Later, it was found that the *P. nigronervosa* f. *typica* breeds on Musaceae and *P. nigronervosa* f. *caladii* breeds on cardamom, colacasia and caladium (Siddappaji & Reddy 1972).

The aphid population is seen throughout the year with one or two peaks in November - May and the population is drastically reduced during monsoon season. Nymphs of all the instars are capable of transmitting the virus (Rajan 1981). The bimodal transmission was examined by using two distinct virus strains with respect to acquisition, latent period and persistence and the non-persistence nature of cardamom 'katte' virus was determined (Naidu, Venugopal & Rajan 1985).

Host range and varietal resistance

Several zingiberaceous plants, namely, *Amomum connecarpum*, *A. involucreatum*, *A. microstephanum*, *A. subulatum*, *Alpinia neutans*, *A. mutica*, *Curcuma neilgherrensis*, *Zingiber cernuum* and a member of Marantaceae viz., *Maranta arundinacea* were found infected in lab inoculation tests (Rao & Naidu 1973; Viswanath & Siddaramaiah 1974; Yaraguntaiah 1979 & Siddarmaiah *et al.* 1986).

All the 18 germplasm accessions with distinct morphotypes collected from cardamom growing tracts of South India and 27 elite selections of cardamom mutants in M1 and M2 stage were susceptible to virus infection (Rao & Naidu 1973; Rao 1977a; Subba Rao & Naidu 1981).

Etiology

The first evidence of the viral nature of the disease was established in 1945 with successful transmission of virus through banana aphid *P. nigronervosa* Coq. (Uppal, Varma & Capoor 1945). In India the association of virus particles measuring 650 nm in length and 10-12 nm in diameter were reported in dip and purified preparations (Naidu, Venugopal & Rajan 1985). The purified

preparations of six strains also revealed homogenous flexuous particles. Presence of inclusion bodies was also reported from leaf tissues of 'katte' infected plants. Based on the morphology of virus particles and presence of inclusion bodies it was suggested to include 'katte' virus in 'poty virus' group (Naidu, Venugopal & Rajan 1985). The presence of three natural strains was first reported by Rao (1977a).

Epidemiology

Clones from infected gardens, seedlings raised in the vicinity of infected plantation, voluntary seedlings collected from infected gardens and few infected zingiberaceous hosts form the primary foci of disease introduction to cardamom plantations. Entry of disease also occurs in contiguous and nearby plantations up to 1000 m from the external inoculum source (Naidu & Venugopal 1984; Naidu, Venugopal & Rajan 1985).

After initial introduction, the spread of the disease is mainly internal and the rate of spread is very low (Deshpande, Siddappaji & Viswanath 1972). Centrifugal influx was found around primary foci due to spread by the activity of the vector. In plantations the disease is concentrated within 40 m radius and occasionally extending up to 90 m. The gradient of infection is steep within 40 m from initial foci and flattens there after.

In the field the disease incubation period varies from 20 to 114 days during different months and its expression is directly influenced by the growth of the plants. Usually young seedlings at 3-4 leaves stage express the symptoms within 15-20 days of inoculation, whereas grown up plants show symptoms within 30-40 days during active growing period

and 90-120 days during winter months (Naidu & Venugopal 1986).

Senile leaf sheaths which are natural breeding sites of the vector are poor inoculum sources but the young actively growing parts serve as better sources of inoculum (Naidu & Venugopal 1986).

Disease management

Control of 'katte' is highly dependent on the use of healthy rhizomes or seedlings for planting (Varma & Capoor 1953; Varma 1959). Healthy planting materials should be used for planting and gap filling. Periodic surveillance of the plantation should be done to detect virus infection at least twice a year and infected plants are to be removed immediately (Capoor 1969).

Controlling inoculum sources within the infected plantation is the only means of disease management. Roguing is reported to be very effective in minimizing the spread of the disease and enhancing the economic life of the plantation (Capoor 1967; George 1967 & 1971; Deshpande *et al.* 1972). Isolated attempts are not adequate to contain the disease economically. Community approach through total destruction of all infected plants followed by replanting and surveillance are more feasible (Varma 1962 b).

Sensitive virus detection through enzyme linked immunosorbent assay (ELISA) to detect virus in apparently healthy, latent carriers and alternate hosts help in a long way in eliminating chances of virus spread. In India such studies need to be undertaken immediately to upgrade the efficiency of disease management techniques (Saigopal, Naidu & Joseph 1992).

Nilgiri necrosis disease

This disease was first noticed in a severe form in Nilgris, Tamil Nadu and hence the name Nilgiri necrosis disease (NNV). Recent surveys revealed the occurrence of the disease in new pockets in Kerala and Tamil Nadu and few areas in Karnataka.

Importance

The disease is prevalent in some of the cardamom growing regions of Tamil Nadu with an incidence ranging from 7.7 to 80.0 per cent (Sridhar, Muthuswamy & Naidu 1990). In Kerala, in some estates in Munnar and Thondimalai areas of Idukki an incidence of 4.6 and 1.46 per cent was recorded, respectively. Unlike 'katte' the infected plants decline very rapidly and become stunted and unproductive.

Symptomatology

The symptoms are seen on young leaves as whitish to yellowish continuous or broken streaks proceeding from the midrib to the leaf margins. In advanced stages of infection these streaks turn reddish brown. Often leaf shredding is noticed along these streaks. Leaf size is reduced with distorted margins. In initial stages of infection the plants produce few panicles and capsules but in advanced stage, tillers are highly stunted and fail to bear panicles and capsules (Sridhar, Muthuswamy & Naidu 1991). All types of cardamom cultivars are susceptible to the disease (Sridhar 1988).

Transmission

The disease is not transmitted by seed, soil, sap and mechanical means and no insect transmission of the disease from infected to healthy plant was recorded

so far (Sridhar 1988). The disease is transmitted through infected rhizomes.

Etiology

Association of flexuous particles of 570 - 700 nm length and 10-12 nm breadth were seen in dip preparations of NNV infected leaf tissue belonging to 'Carla' virus group (RRS, Mudigere 1990).

Epidemiology

The spread of the disease is mainly internal and new infections occur in a centrifugal fashion from the source of inoculum. Most of the infections occurred within 10-15 m radius from the source of inoculum and the number of new infections decreased as the distance increased (Sridhar 1988). The pattern of spread is similar to that of 'katte' disease (Deshpande, Siddappaji & Viswanath 1972; Naidu & Venugopal 1984). The rate of spread of the disease is rather low being 3.3 per cent for one year.

Disease management

The viral etiology, low incidence and internal spread indicate the feasibility of roguing to contain the disease. Periodical inspection and roguing of infected plants resulted in reducing new outbreaks in selected disease prone gardens in Nilgiris and Valparai (Tamil Nadu) (Sridhar 1988).

Infectious variegation virus

This disease was first noticed in Vandiperiyar area in Kerala in a severe form. Further it was also noticed in Coorg, Hassan and North Kanara in Karnataka. A disease incidence of 15 per cent was recorded in Vandiperiyar zones. Infected plants show typical

variegated symptoms on leaf with characteristic slender to broad radiating stripes of light green and dark green on the lamina. Distortion of leaves, tillers and stunting are other common symptoms. The infected plants become stunted with profuse tillers and become unproductive within the same year of infection. Only 2 per cent transmission of the disease was obtained through the aphid *P. nigronervosa* f. *caladii*. Roguing resulted in near elimination of disease in all the three test plantations.

Cardamom vein clearing virus ('kokke kandu')

This is of recent occurrence in certain cardamom plantations located in a radius of 23 km in Hongadahalla zone, Saklespur taluk, Hassan District and adjacent cardamom growing pockets located in Coorg and Chickmagalur districts and among areca based cardamom gardens in most of the area in North Kanara in Karnataka. A survey of six plantations in Hongadahalla revealed an incidence ranging from 10.4 to 42.8 per cent in different plantations. The affected plants decline very rapidly and become stunted and perish within the same year of infection.

Symptoms

The first symptom of the disease is continuous or discontinuous vein clearing. Later these turn necrotic followed by shredding of lamina. All the new shoots are greatly stunted with yellow mottling on pseudostems. Often light yellow mottling is clearly visible on panicles and capsules. Plants in advanced stages of infection produce distorted leaves and capsules. During slow growing months the new leaf gets entangled in the old leaf and forms

characteristic hook like tillers and hence the name 'kokke kandu'. Rosetting of leaves and cracking of capsules are also seen in advanced stages of infection. In summer, the newly infected plants show only faint discontinuous vein clearing symptoms. However mottling on pseudostem is clear during summer months also.

Transmission and spread

Successful transmission of the disease was obtained through cardamom aphid *P. nigronervosa* f. *caladii*. In plantations the disease is noticed in pockets with many new infections around the initial virus source suggesting a centrifugal nature of disease spread.

Prospects for diagnosis and management of viral diseases

Virus characterization and reliable detection methods are essential for formulating integrated disease management systems. Few important viruses are yet to be characterized and the identities of some of the causal viruses are yet to be clearly established. During the last decade there has been a phenomenal development in the use of serodiagnosis for early detection of viruses. By utilizing specific antisera and set of diagnostic hosts it is possible to identify several viruses. Enzyme Linked Immunosorbent Assay (ELISA) which is a sensitive and quick method for detecting early infection in mother plants is essential for developing virus free progenies in conventional multiplication as well as in micro propagation systems (Saigopal, Naidu & Joseph 1992). Further studies need to be taken in this direction for production of serum of high titre value for early diagnosis of viruses. It is also essential in future to set up a sera bank for viruses to facilitate an adequate and continuous supply of antisera. Screen-

ing of germplasm for disease resistance has raised the hopes of isolating resistant /less susceptible lines in cardamom. But the lines isolated are found to be average yielders with small or medium sized capsules. Plant improvement programmes to transfer these genes through genetic engineering to high yielding lines need to be intensified.

References

- Agnihotrudu 1987 Diseases of small and large cardamom. Rev. Trop. Plant Path. 4 : 127-147.
- Buchanan F 1807 A journey from Madras through the countries of Mysore, Kanara and Malabar 3 : 225.
- Capoor S P 1967 Katte disease of cardamom. Seminar on Cardamom (p.25). Cardamom Board, Cochin.
- Capoor S P 1969 Katte disease of cardamom. Cardamom News 3 : 2-5.
- Deshpande R S, Siddappaji C & Viswanath S 1972 Epidemiological studies on 'katte' disease of cardamom (*Elettaria cardamomum* Maton). Mysore J. agric. Sci. 6 : 4-9.
- Deshpande R S, Siddappaji C, Viswanath S & Reddy D M R N 1972 'Katte' disease of cardamom can be controlled. Curr. Res. 1 : 8.
- George K V 1967 Katte disease threatens the future of cardamom plantation industry. Cardamom News 1 : 1-3.
- George K V 1971 Research on cardamom - some suggestions. Cardamom News 5 : 2-3.

- Mayne W W 1951 Report on cardamom cultivation in South India. ICAR Bull. 50, 62 pp.
- Mollison J W 1900 Cultivation of the betel palm, cardamom and pepper in the Kanara district of Bombay presidency with notes on the manures used in spice gardens of that tract. Bull. No. 20, Dept. Land Rec. and Agric., Bombay.
- Naidu R & Venugopal M N 1987 Epidemiology of 'katte' virus of small cardamom. I. Disease incubation period and role of different host parts as a source of inoculum in relation to disease spread. In: Proc. PLACROSYM VI 1984 (pp. 121-127). Indian Society for Plantation Crops, Kasaragod, India.
- Naidu R & Venugopal M N 1986 Epidemiology of 'katte' virus disease of small cardamom II. Foci of primary disease entry, patterns and gradients of disease entry and spread. J. Plantn. Crops 16 : (Suppl.) 267-271.
- Naidu R, Venugopal M N & Rajan P 1985 Investigations on strainal variation, epidemiology and characterization of 'katte' virus agent of small cardamom. Final Report of Research Project. Central Plantation Crops Research Institute, Kasaragod, Kerala, India.
- Rajan P 1981 Biology of *Pentalonia nigronervosa* f. *caladii* Van der Goot vector of 'katte' disease of cardamom. J. Plantn. Crops 9 : 34-41.
- Rao D G 1977 a 'Katte' disease of small cardamom and its control. Indian J. Hort. 34 : 184-187.
- Rao D G 1977 b 'Katte' disease of small cardamom. J. Plantn. Crops 5 : 23-27.
- Rao D G & Naidu R 1973 Studies on 'Katte' or mosaic disease of small cardamom. J. Plantn. Crops 1 : (Suppl.) 129-136.
- Rao D G & Naidu R 1974 Additional vectors of 'Katte' disease of small cardamom. Indian J. Hort. 31 : 380-381.
- Regional Research Station, Mudigere 1990 Technical Bulletin - 2. Three Decades of Cardamom Research (1958-88), Regional Research Station, Mudigere, Karnataka, India.
- Saigopal D V R, Naidu R & Joseph T 1992 Early detection of 'Katte' disease of small cardamom through Enzyme Linked Immunosorbent Assay (ELISA). J. Plantn. Crops 20 (Suppl.) : 73-75.
- Samraj J 1970 Mosaic disease of cardamom. Cardamom News 4 : 12.
- Siddappai C & Reddy D N R N 1972 A note on the occurrence of the aphid, *Pentalonia nigronervosa* f. *caladii* Van der Goot (Aphididae : Hemiptera) on cardamom (*Elettaria cardamomum* Maton). Mysore J. agric. Sci. 6 : 192-195.
- Siddaramaiah A L, Chandrashekar S C, Balachandra C K & Pattanshetti V 1986 Arrowroot (*Marantha arundinacea* L.) is a new collateral host for 'Katte' disease of cardamom (*Elettaria cardamomum* Maton.). Curr. Sci. 55:
- Spices Board 1991 Spices Statistics 1991, Trade Information Services. Spices Board, Cochin.

- Sridhar V V 1988 Studies on Nilgiri necrosis. A new virus disease of cardamom. Thesis, Tamil Nadu Agricultural University, Coimbatore.
- Sridhar V V, Muthuswamy M & Naidu R 1990 Survey on the occurrence of Nilgiri necrosis - a new virus disease on cardamom. South Indian Hort. 38 : 163-165.
- Sridhar V V, Muthuswamy M & Naidu R 1991 Yield loss assessment in Nilgiri necrosis infected cardamom. South Indian Hort. 39 : 169-170.
- Subba Rao G & Naidu R 1981 Breeding cardamom for 'Katte' disease resistance. In: Proc. PLACROSYM IV 1980 (pp. 320-324), Indian Society for Plantation Crops, Kasaragod, Kerala, India.
- Thomas K M 1938 Detailed Administrative Report of the Government Mycologist, Madras 1937-38.
- Uppal B N, Varma P M & Capoor S P 1945 A mosaic disease of cardamom. Curr. Sci 14 : 208-209.
- Varma P M 1959 Information on 'Katte' disease of small cardamom for cultivators. Arecanut J. 10 : 7-16.
- Varma P M 1962 a The banana aphid (*Pentalonia nigronervosa* Cog.) and the transmission of 'Katte' disease of cardamom. Indian Phytopath. 15 : 1-10.
- Varma P M 1962 b Control of Katte or mosaic disease of cardamom in North Kanara. Arecanut J. 13 : 79-88.
- Varma P M & Capoor S P 1953 Marble disease of cardamom. Indian Fmg. 3 : 22-23.
- Varma P M & Capoor S P 1958 Mosaic disease of cardamom and its transmission by the banana aphid *Pentalonia nigronervosa* Coq. Indian J. agric. Sci. 28 : 97-107.
- Venugopal M N & Naidu R 1987 Effect of natural infection of 'Katte' mosaic disease on yield of cardamom a case study. In: Proc. PLACROSYM - VI (pp. 115-119). Oxford & I B H, New Delhi.
- Viswanath S & Siddaramaiah A L 1974 *Alpinia neutans*, a new host of 'Katte' disease of cardamom. Curr. Res. 3 : 96.
- Yaraguntaiah R C 1979 *Curcuma neilgherrensis* WT - a new host of 'Katte' mosaic disease of cardamom. In: Proc. PLACROSYM II 1979 (pp. 313-315). Central Plantation Crops Research Institute, Kasaragod, Kerala, India.