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Natural disease escapes as sources of resistance against cardamom mosaic virus causing *katte* disease of cardamom (*Elettaria cardamomum* Maton)

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Abstract

Resistant sources to cardamom mosaic virus causing *katte* disease of cardamom (*Elettaria cardamomum)* were identified by collecting 134 disease escapes from hot spots of virus infection in South India and screening them in greenhouse, sick plot and hot spots. Testing of promising collections in four hot spots and also against natural infection confirmed the resistant nature of the collections.

Key words : cardamom, cardamom mosaic virus, *Elettaria cardamomum, katte,* natural disease escapes, resistance.

Abbreviations

NKE : Natural *katte* escape

Car MV : Cardamom mosaic virus

Introduction

Cultivation of cardamom (*Elettaria Cardamomum* Maton) in India and Guatemala is threatened due to the severe incidence of *katte* disease caused by Car MV which is an aphid transmitted poty virus. In monocropping situations, the infection on bearing plants reduces the yield up to 69% in the third year of infection and total decline of plants occurs after 3-5 years of infection (Venugopal 1995). The symptoms of the disease include characteristic mosaic symptoms with stripes of green tissue evenly distributed over the leaf lamina and mosaic type mottling on leaf sheaths and young pseudostems. In the advanced stage of infection, the affected plants produce shorter and slender tillers with few shorter panicles and degenerate gradually.

So far no reliable source of resistance is known against Car MV. Cardamom occurs in its native state only in the tropical evergreen forests of western ghats in India. In nature it forms a freely interbreeding population with rich genetic diversity (Abraham & Tulasidas 1958; Sudharshan *et al.* 1989). Open pollinated seedling progenies in

the hot spots offer tremendous scope to isolate mosaic tolerant/resistant sources which can be of immense help to sustain productivity in virus prone plantations. This paper reports the successful attempts to identify resistant sources from the disease escapes collected from different hot spots of Car MV in western ghats of South India.

Materials and methods

Collections of disease escapes were made from hot spots of Car MV in cultivators' fields and also from wild sources during 1986-88. The criteria fixed for identifying the potential disease escapes were (i) more than 98% incidence in infected plantation (ii) minimun 8 years of exposure to virus access (iii) vigour of plants (iv) disease history (v) planter's opinion on the identified plants (vi) presence of vectors in the infected plantation. Clonal collections were made from the disease escapes in quadruplicate from severely infected plantations of Uttara Kannada, Chickmagalur and Hassan districts of Karnataka; Wynad, Malappuram and Idukki districts of Kerala, and Nilgiris, Coimbatore and Madurai districts of Tamil Nadu. Many forest areas like Agumbe forests in Karnataka, Edamalakudi and Plamalakudi in Kerala and Manjolai and Tambraparni valley in Tamil Nadu were surveyed to identify disease escapes existing in the wild state.

The clones collected from each disease escape were initially established in microplots in greenhouse for internal quarantine. A combination of neamaticides and fungicides were given to the clones as pre planting treatment to avoid nematodes, rhizome borne insects and rhizome rot fungal pathogens. After satisfactory growth, each clone was assessed for possible mild symptoms of virus infection. Three clones of each accession were inoculated with viruliferous aphids (*Pentalonia nigronervosa* f. *caladii* Van der Goot) carring local severe isolate of mosaic virus. In each microplot two leaves of actively growing tillers were rolled to make leaf funnels and viruliferous aphids were released @ 5 per tiller (Varma & Capoor 1958). The inoculants were assessed for symptoms up to 45-50 days and the screening was repeated twice at an interval of 50 days. The collections which did not take up infection after three rounds of greenhouse screening were shifted to clonal repository of disease escapes which also served as clonal multiplication block. All the promising test entries were clonally multiplied and exposed for field screening in the sick plot located in the Experimental Farm of Cardamom Research Centre, Appangala. In the sick plot, infector rows were maintained in every 3rd row so that one side of the tester rows get an access to virus source. All the guard rows were also inoculated artificially to create virus inoculum pressure from all the sides. The experiment was maintained under normal package of practices under protective irrigation. Cultural practices like trashing and plant protection methods like application of insecticides and fungicides were avoided for 6 years to provide ideal conditions for vector multiplication and migration.

After 3 years of continuous exposure, the promising entries were simultaneously sub cloned, multiplied and tested in four locations namely, Appangala (Madikeri Taluk, Kodagu), Pallakere (Virajpet Taluk, Kodagu), Madenadu (Madikeri Taluk, Kodagu) and Salkeri (Sirsi Taluk, Uttara Kannada) repre-

senting high, moderate and low rainfall conditions in hot spots with known history of higher disease spread. In all the locations, the local susceptible cultivar was used as check. The test entries were monitored periodically for virus infection.

In another trial with disease escapes, the natural infection of mosaic virus in different years was monitored for 7 years from the initiation of the experiment.

The promising clones were back - indexed on the susceptible seedlings through aphid vector *P. nigronervosa* to assess their virus-free status.

Results and discussion

Collection and establishment of disease escapes

One hundred and thirty four collections were made from different cardamom growing tracts (Table 1). Because of better awareness and disease management practices among planters, only 18 collections could be made from Idukki District. In Wynad and Valparai also, only seven collections could be made due to low incidence of mosaic disease. Mosaic infection was not recorded in Manjolai hills and Tambraparni valley. The incidence of mosaic disease was also less in plantations owned by tribals in Edamalakudi and Plamalakudi. Two collections were made from forests contiguous with Plamalakudi. The collections comprised of 4 Mysore types, 29 Vazhukka types and 105 Malabar types and the approximate age of disease escapes ranged from 8-34 years (Table 1). The highly infected continuous belt of small holdings in arecanut-based spice gardens of Uttara Kannada was a potential area for disease escapes. Many vigilant and devoted growers in Uttara Kannada, Kodagu and Chickmagalur districts maintained the identity of disease escapes for 2-3 decades. All the 134 clonal collections were established successfully and were found free from virus symptoms.

Screening in greenhouse

In the three individual screenings in greenhouse conditions, 67 collections took infection and all showed clear severe mosaic symptoms (Table 2). Test

Table 1. Collection of mosaic disease escapes of cardamom

State	District	No. of disease escapes in different age groups (years) in original location					
		8-10	10-15	15-20	20-30	>30	Total
Karnataka	Uttara Kannada	11	6	23	12	4	56
	Chikmagalur	5	2	14	-	-	21
	Hassan	13	3	3	8	3	30
Kerala	Idukki	7	8	3	-	-	18
	Wynad	3	2	-	-	-	5
Tamil Nadu	Coimbatore	-	-	2	-	-	2
	Madurai	-	2	-	-	-	2
Total		39	23	45	20	07	134

Table 2. Reaction of mosaic disease escapes of cardamom in greenhouse and field screening

Stage of screening	No. of uninfected collections in different age groups (years)					
	8-10	10-15	15-20	20-30	>30	Total
Initial stage of screening	39	23	45	20	7	134
I round of greenhouse screening	14	19	31	18	5	87
II round of greenhouse screening	12	15	29	15	4	75
III round of greenhouse screening	11	12	26	13	5	67
2 years of field screening	5	6	14	5	4	34
4 years of field screening	3	3	9	5	4	24
6 years of field screening	3	3	8	5	4	23

entries of Mysore and Vazhukka types showed distinct marble mosaic symptoms and Malabar types expressed typical mosaic symptoms.

Screening in sick plot

In the sick plot, the screening was carried out for 6 years. Most of the tester lines took infection within 2 years of exposure to natural infection. Only 23 tester lines remained totally free from virus symptoms. Four tester lines namely, NKE-11, NKE-16, NKE-22 and NKE-71 expressed faint granular symptoms in actively growing months (September-October) which disappeared in emerging leaves. Biological indexing through aphid vector with such suspected symptomatic leaves did not reveal the association of the virus.

Screening in hot spots

In four simultaneous screening trials located in diverse conditions, 19 tester lines were promising in spite of exposure to virus access for 2-6 years (Table 3). Out of 19 entries, 17 appeared promising having better agronomical characters.

In a separate trial wherein tester lines were randomized in groups of 4 x 3 rows in 1.8 m x 1.8 m spacing with known susceptible check, all the promising 17 entries continued to show resistance against natural infection (Table 4) which occurs at random through incoming migratory aphids from adjacent infected plantations. All the known susceptible test entries took infection during 7 years period.

Back-indexing

In the biological indexing involving the 17 field grown mosaic resistant clones through aphid vector to known susceptible line (Cl 37), none of the inoculants expressed mosaic symptoms in spite of repeated inoculations, thus revealing the virus free status of the clones.

Table 3. Field reaction of mosaic disease escapes of cardamom in sick plots

Acc. No.	Reaction of disease escapes to natural infection			
	Appangala (6 years)	Pallakere (4 years)	Madenadu (3 years)	Salkani (2 years)
NKE-3	R	R	R	R
NKE-4	R	R	R	-
NKE-5	R	R	R	R
NKE-8	R	-	R	R
NKE-9	R	R	R	R
NKE-11	R	R	R	R
NKE-12	R	R	R	R
NKE-16	R	-	R	-
NKE-19	R	R	R	R
NKE-22	R	-	-	R
NKE-26	R	R	R	R
NKE-27	R	R	R	-
NKE-28	R	R	R	R
NKE-29	R	-	-	-
NKE-30	R	R	-	-
NKE-31	R	-	-	R
NKE-32	R	R	-	R
NKE-34	R	-	R	R
NKE-38	R	S (25%)	-	-
NKE-43	R	R	-	-
NKE-48	S (12%)	S (25%)	-	S (17%)
NKE-56	R	R	-	R
NKE-71	R	R	-	-
NKE-72	R	-	R	-
NKE-78	R	-	-	R
Control	S (93%)	S (100%)	S (53%)	S (58%)

R = Resistant; S = Susceptible; - = Not tested

However, this has to be confirmed through more sensitive biochemical and immunological techniques.

In a majority of plantations, cardamom is mainly cultivated through seedlings and since the crop is cross pollinated, each seedling is a recombinant and

Table 4. Field reaction of *katte* resistant cardamom selections against natural infection of mosaic disease

Acc. No.	No. of plants	
	Planted	Infected
NKE-3	36	0
NKE-4	36	0
NKE-5	36	0
NKE-8	36	0
NKE-9	36	0
NKE-11	36	0
NKE-12	36	0
NKE-19	36	0
NKE-26	36	0
NKE-27	36	0
NKE-28	36	0
NKE-31	36	0
NKE-32	36	0
NKE-34	36	0
NKE-71	36	0
NKE-72	36	0
NKE-78	36	0
CCS-1	36	2
MB-3	36	2
RR-1	36	1
M-1	36	1
MA	36	4
Bulk (Malabar)	141	28

forms a source to identify desirable plants possessing resistance against the virus. The gene pool existing in the form of millions of seedlings in the planters fields particularly in severely infected plantations offers tremendous opportunity to identify resistant sources. The present study clearly confirms the resistance of 17 promising accessions are of typical Malabar type which produce prostrate panicles with golden yellow capsules at full maturity. Since the preference in export market is for green cardamom, futher studies are required to study their characters for direct use as resistant varieties or hybrids to combine resistance and desired yield and quality.

Resistance to virus is controlled by several factors like vector deterrence, interference to vector feeding, delay in symptom expression and inhibition of virus multiplication (Fraser 1990). At present nothing is known about the mechanism of resistance in the identified virus resistant lines. Further, occurrence of distinct natural strains of cardamom mosaic virus has been reported from different virus infected zones (Rao & Naidu 1973; Naidu *et al.* 1985; Venugopal & Naidu 1985). Some zingiberaceous plants like *Alpinia mutica* which was found resistant against Kodagu, Wynad, Hassan and Chickmagalur isolates showed higher susceptibility to Nelliampathy isolate. Similar studies are also required to study the performance of virus resistant clones against other distinct virulent strains of virus from potential cardamom growing areas.

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