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IISR Avinash – a rhizome rot resistant and high yielding variety of cardamom (*Elettaria cardamomum* Maton)

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Abstract

The cardamom (*Elettaria cardamomum*) variety, IISR Avinash (RR-1) was developed at the Indian Institute of Spices Research, Cardamom Research Centre, Appangala (Karnataka), through clonal selection and recommended for release for its resistance to rhizome rot disease and high yield. The average yield of IISR Avinash was 643 kg ha⁻¹ (dry) with a potential yield of 979 kg ha⁻¹ (dry) with good quality dark green capsules.

Keywords: cardamom, *Elettaria cardamomum*, rhizome rot, yield.

Introduction

Rhizome rot also called clump rot is an important disease of cardamom (*Elettaria cardamomum* Maton) throughout cardamom growing regions of South India (Siddaramaiah *et al.* 1988). The disease is responsible for partial or total decay of plants of all stages and is caused by *Pythium vexans* de Barry and *Rhizoctonia solani* Kuhn. (Thomas *et al.* 1988). Genotypes present in hot-spots of diseases exhibit a wide range of field reaction to natural infection of pathogens. Rich genetic diversity present in the cultivators, fields and wild sources and their recombinations and segregants can yield distinct genotypes possessing high yield and resistance to biotic stress (Venugopal 1999). The present paper reports the identification of a high yielding genotype resistant to rhizome rot disease.

Materials and methods

To identify the disease escapes, surveys were conducted during 1987–88 in the hot-spots of rhizome rot disease (Madenadu, Kandanakolly and Halery in Kodagu District, Karnataka) and plants which were totally free from natural infection and high yielding, were selected. The selected clones along with other germplasm accessions were established in microplots (plastic pots) at Indian Institute of Spices Research, Cardamom Research Centre, Appangala (Karnataka). The clones were tested at tillering stage (8 months old) with artificial inoculation of rhizome rot pathogens namely, *P. vexans* and *R. solani*, separately and in combination. During testing, mycelial mats of 7 day old culture of pathogens were inoculated to the rhizome of emerging and mature tillers with and without injury through pin pricks to ensure

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entry of pathogens into the rhizome. The inoculations were conducted under controlled shade under a humidity range of 82% to 98% and temperature range of 15°C to 23°C, which are congenial for infection and spread of the rhizome rot pathogen. The test accessions were assessed after 15 days by adopting the following disease rating scale:

- 1 - No infection
- 2 - Positive infection with advancing margins less than 1 cm; infection on one tiller
- 3 - Advancing margins and water soaked patches prominent; infection on 2–5 tillers or 25% tillers of the plant
- 4 - Spreading of infection to 50% of the total tillers
- 5 - All the tillers infected; plant decaying or dead

Pooled disease counts of subplots of each treatment was used to calculate the per cent disease index (DI) by using the following formula:

$$DI = \frac{Y_1(1-1) + Y_2(2-1) + Y_3(3-1) + Y_4(4-1) + Y_5(5-1)}{N \times 4} \times 100$$

where,

Y_1 – Y_5 =number of infected plants in each category; N=total number of plants in the plot.

A comparative yield trial (CYT) with 21 entries using local Malabar as check was conducted at Cardamom Research Centre, Appangala during 1992–97 under protective irrigation. In another trial, rhizome rot resistant clones were tested in three hot-spots (Panya, Madenadu and Kandanakolly, Kodagu District) to study their yield performance and reaction to natural infection of rhizome rot disease. All the plots were main-

tained under protective irrigation with recommended package of cultural practices and without fungicide application.

The essential oil in the capsules (after removing the outer skin) was estimated by hydro distillation method using Clevenger trap (ASTA 1968). Analysis of aroma bearing constituents in the essential oil was carried out using a Hewlett Packard-5730A gas chromatograph equipped with flame ionization detector and 3390A HP integrator. The compounds were separated in an OV-101 column using nitrogen as carrier gas. The oven temperature was programmed from 70°C to 120°C at the rate of 8°C min⁻¹. The compounds were identified by comparing the retention times with that of authentic standards.

Results and discussion

Surveys conducted in the hot-spots of rhizome rot disease namely, Madenadu, Kandanakolly and Halery (Kodagu District) indicated that the disease incidence ranged from 72% to 99% and disease index ranged from 43% to 57%. After recording the observation from a population of over 51,000 plants, 4 plants were selected because of their non-susceptibility to natural infection for 4 to 5 years and also due to their high yield. Initially fresh yield in the original location and reaction to natural infection to rhizome rot were recorded for 3 years (Table 1). The rhizome rot selection (RR-1) surpassed all other populations in terms of yield and disease incidence (0).

Artificial screening of rhizome rot disease escapes and other germplasm accessions indicated that the disease index varied from 8% to 56% with injury and 4% to 38% without injury, respectively (Table 2a). RR-1 showed a disease index of 10% even after artificial inoculation through pin pricking and only 4% without injury and further advancement of

Table 1. Yield of cardamom accession RR-1 at original location of collection

Entry	Fresh yield (g plant ⁻¹)			Disease index (%)		
	1988–89	1989–90	1990–91	1988–89	1989–90	1990–91
RR-1	4,600	2,800	3400	0.0	0.0	0.0
Population mean	1,800	850	980	11.4	27.3	57.0

water soaked patches in the rhizomes was not noticed. Further grouping of accessions based on artificial inoculation disease index led to the identification of two resistant accessions (Table 2b).

The results of the CYT indicated that the cumulative mean dry yield of three crop seasons varied from 238 to 848 kg ha⁻¹. The cumulative yield of RR-1 was significantly higher than the released varieties CCS-1 and M-1 (Table 3). RR-1 was the highest yielder with 848 kg ha⁻¹ (dry). The on-farm yield evaluation of the RR-1 along with local check at four hot spots with known history of the disease revealed significant differences between these two for yield and disease index (Table 4). The yield of RR-1 in different locations varied from 168 to 875 kg ha⁻¹ compared to 110 to 391 kg ha⁻¹ in the local check. The disease index during different years varied from 0.2% to 5.4% in RR-1 compared to 5.3% to 33.6% in the local checks, confirming the resistance of RR-1 to rhizome rot.

RR-1 had medium sized elongated green capsules at maturity and yellow green capsules at full-ripened stage. It had 51% of bold capsules (7.2 mm and above). The average number of seeds capsule⁻¹, number of capsules kg⁻¹ and dry recovery were 13.3, 4670 and 20.8% respectively. Significant variability was observed among the clones for essential oil content of dry capsules. Highest oil yield was observed in NKE-5 (8.9%), followed by NKE-19 (8.7%) and CCS-1 (8.5%). RR-1 had a moderate level of essential oil (6.7%). The composition of the sweet flavoured α -terpinyl acetate was higher compared to that of less flavoured 1,8-cineole in RR-1 (Table 5). The effectiveness of strait selection in improving resistance, yield and quality of cardamom was reported by Venugopal (1999).

Based on the superior yield performance and resistance to rhizome rot, the line RR-1 was proposed for release as IISR Avinash. The Group Meeting of All India Coordinated Re-

Table 2a. Disease index of cardamom accessions in micro plots with artificial inoculation

Accession	Disease index (%)		
	<i>Pythium vexans</i>	<i>Rhizoctonia solanii</i>	<i>P. vexans</i> + <i>R. solanii</i>
RR-1	6	8	10
RR-2	8	10	12
LR-1	6	4	8
CCS-1	28	22	30
CL-800	56	36	60
CL-893	28	22	36
APG-75	12	10	20
APG-134	28	28	34
APG-132	28	22	38
MB-3	42	34	50
APG-223	28	18	32
APG-221	14	14	22
SKP-14	22	12	24
M-1	14	22	42
MA	22	38	56

Table 2b. Reaction of cardamom accessions against rhizome rot

Disease index (%)	Classification	Accession
0.0–5.0	Highly resistant	-
5.1–10.0	Resistant	RR-1, LR-1
10.1–25.0	Moderately susceptible	RR-2, APG-75, SKP-14, APG-221, CCS-1, CL-893, APG-134
25.1–50.0	Susceptible	APG-132, M-1, APG-223, MB-3
> 50	Highly susceptible	CL-800, MA

Table 3. Yield performance of cardamom accessions in comparative yield trial

Accession	Mean fresh yield (g plant ⁻¹)			Cumulative mean fresh yield (g plant ⁻¹)	Mean dry yield (kg ha ⁻¹)
	1994-95	1995-96	1996-97		
RR-1	2853	744	1296	1631.0	848
CCS-1	2448	751	938	1379.0	745
M-1	1979	783	871	1211.0	648
NKE-12	1780	952	775	1169.0	643
NKE-3	1936	757	780	1158.0	603
NKE-19	1852	631	910	1131.0	610
MB-3	1520	611	1159	1097.0	583
NKE-27	1927	523	824	1091.0	535
NKE -9	2027	408	783	1073.0	558
NKE -32	1312	887	616	938.1	502
NKE-31	1516	571	675	920.8	478
NKE-34	1500	843	392	911.7	502
NKE-8	1350	301	1049	900.2	486
NKE-26	1593	443	625	887.1	439
NKE-72	1187	735	696	872.4	453
NKE-4	1607	332	618	852.3	460
NKE-78	1136	617	798	850.3	455
NKE-71	1429	405	679	837.7	448
NKE-28	1768	301	316	795.5	394
MA (Control)	1158	478	659	764.9	409
NKE-11	1543	233	500	758.7	406
NKE-5	594	250	475	439.8	238
CD (P=0.05)	279	80	163	199.8	-

Table 4. Performance of RR-1 at farmers plots

Location	Average annual rainfall (mm)	Altitude (m above MSL)	Characteristics of plot	Selection	Dry yield (kg ha ⁻¹)		Disease index (%)	
					1996-97	1997-98	1996-97	1997-98
Attihadlu Estate, Panya* (Madikeri)	2800-3200	1050	Low lying flat valley bottom; spinkler irrigated	RR-1	384	750	0.8	3.7
				LM	195	180	11.4	18.2
Balkomal Estate, Madenadu* (Madikeri)	3750-4250	1100	Flat and gentle slope; drip irrigated	RR-1	168	509	1.3	2.8
				LM	110	242	7.6	13.4
Dwaraka Estate, Hakathur (Madikeri)	2400-2600	850	Moderate slope; spinkler irrigated	RR-1	368	347	0.2	1.4
				CI-37 OPS	210	295	5.3	9.5
Sri Laxmi Estate, Kandanakolly* (Somwarpet)	2000-2250	900	Flat land; spinkler irrigated	RR-1	-	875	-	5.4
				CI-37 OPS	-	391	-	33.6

*Hot-spots of rhizome rot disease

LM=Local Malabar, OPS=OP seedlings

Table 5. Salient features of IISR Avinash

<i>Plant characters</i>	
Plant type	Malabar
Colour of aerial shoot	Dark green
Plant height (m)	2.286
Leaf length / breadth (cm)	69/13
No. of tillers plant ⁻¹	46
No. of panicles plant ⁻¹	43
No. of flowers panicle ⁻¹	163
<i>Quality characters</i>	
Essential oil (%)	6.7
Dry recovery (%)	20.8
α -terpinyl acetate (%)	34.6
1,8-cineole (%)	30.4

search Project on Spices, held at Calicut during 1999 also recommended the variety for Karnataka State Varietal Release Committee.

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