

CATALOGUE II

MINIMUM DESCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS



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AICRP ON SPICES
CARDAMOM RESEARCH STATION, PAMPADUMPARA



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Authors:

Mrs. Preethy T.T, Assistant Professor (Plant Breeding and Genetics),
Cardamom Research Station, KAU, Pampadumpara, Idukki district, Kerala

Dr. Nimisha Mathews, Assistant Professor (Horticulture) & Head,
Cardamom Research Station, KAU, Pampadumpara, Idukki district, Kerala

Dr. Remya J.S, Assistant Professor (Plant Pathology),
Cardamom Research Station, KAU, Pampadumpara, Idukki district, Kerala

Dr. Simi Ashraf, Assistant Professor (Agricultural Extension Education),
Cardamom Research Station, KAU, Pampadumpara, Idukki district, Kerala

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Dr. D Prasath -
Project Coordinator (AICRP)

Message





Dr. MADHU SUBRAMANIAN

Director of Research
Kerala Agricultural University K.A.U.
(P.O.) -680656, Thrissur (Dist.),
KeralaPhone: (+91) 0487-2438101,
2438102Mail: dr@kau.in
Web: www.kau.in/dr

PREFACE

DIRECTOR OF RESERCH

CATALOGUE OF MINIMUM DESCRIPTORS OF CARDAMOM
[Elettaria cardamomum (L.) Maton]
AICRP on Spices - CARDAMOM, CARDAMOM RESEARCH STATION
KAU, PAMPADUMPARA
CHARACTERIZATION AND CATALOGUING

INTRODUCTION

Cardamom belongs to family Zingiberaceae and it is indigenous to India, predominantly the southern-southern Western Ghats of the country. It has been used in Indian cuisine and Ayurvedic medicine for thousands of years, with mentions in Sanskrit texts dating back to at least 1000 BCE. Large-scale cultivation began in the 8th century CE in the Cardamom Hills of Kerala. During the British rule, cardamom production expanded, and India became the world's largest producer. In India, more than 80 % of cardamom production is realized in Kerala. However, most of the area under cardamom cultivation is spread over the Idukki district of Kerala. Due to its intrinsic chemical quality, the mature dry cardamom fruit (capsules of the cardamom plant) is known as cardamom of commerce. It is unanimously referred to as "Queen of Spices". Cardamom is a herbaceous, rhizomatous, perennial shade loving plant. Three sorts of panicles are distinguished based on their nature: the prostrate panicle found in *Malabar*, the upright panicle found in *Mysore*, and the semi-erect panicle found in *Vazhukka*. In the case of *Malabar*, plants are robust (3 to 4 m height), with leaves glabrous on both sides and ovoid capsules; in contrast, *Mysore* plants are of medium size (2 to 3 m height) have pubescent leaves (on the dorsal side). Physically, the *Vazhukka* kind is a cross between the two mentioned above.

Germplasm evaluation in cardamom is a comprehensive process that begins with collection of diverse accessions from various sources and regions. Then conduct a thorough assessment of these samples, focusing on morphological, agronomic, biochemical, and molecular characteristics. Morphological evaluation involves examining traits such as plant height, leaf characteristics and capsule features. Agronomic assessment considers factors like yield potential, disease and insect pest resistance, and maturity period. Biochemical traits measure essential oil content and composition, while molecular characterization uses DNA markers to assess genetic diversity. Sensory evaluation of aroma and flavour profiles is also crucial. Throughout the process, information (data) is meticulously collected and analysed statistically to identify superior genotypes. Promising accessions are conserved and documented in a Database for future breeding programs. Cardamom [*Elettaria cardamomum (L.) Maton*] exhibits significant genetic variability, which is crucial for its adaptation to diverse environments and resistance to various biotic and abiotic stresses. This variability is observed in morphological traits, yield components, and biochemical characteristics. Studies have shown considerable diversity in plant height, number of tillers, leaf size, capsule characteristics and essential oil content among different cardamom accessions (Parthasarathy & Prasath, 2012). The genetic diversity in cardamom is attributed to its cross-pollinating nature and the existence of different landraces.



and cultivars across its growing regions. This diversity serves as a valuable resource for breeding programs aimed at developing improved varieties with enhanced yield, quality, and resistance to pests and diseases (Ravindran & Madhusoodanan, 2002).

Preparing a detailed catalogue of cardamom genetic resources is essential for several reasons. In the first, it would serve as a centralized repository of information on existing germplasm, facilitating easy access for researchers and breeders. Next, a well-documented catalogue would aid in identifying unique and promising genotypes for incorporation into breeding programs. In the last, it would help in assessing the genetic erosion of cardamom populations and guide conservation efforts for maintaining genetic diversity (Kumar & Nair, 2004). The catalogue should ideally include comprehensive information on morphological descriptors, agronomic traits, biochemical profiles, and molecular markers for each accession. Such a catalogue would not only streamline the process of germplasm utilization but also identify gaps in existing collections, guiding future germplasm collection missions (Zachariah *et al.*, 2010).

The Cardamom Research Station (CRS), KAU, Pampadumpara is a pioneering institution dedicated to cardamom research and development in India since its inception in 1956. The CRS is famous for development of high-yielding cardamom varieties such as PV-1 (Pampadumpara Variety-1), PV-2 (Pampadumpara Variety-2), KAU PV-3 (Pampadumpara Variety-3), KAU PV-5 (Pampadumpara Variety-5). It is also involved in the standardization of responsible farming practices for cardamom including organic methods besides integrated pest and disease management strategies as well as studies on varietal response to climatic variations. The CRS, Pampadumpara has collaborations with the Spices Board, Indian Cardamom Research Institute (ICRI) and ICAR-Indian Institute of Spices Research (IISR), Kozhikode. The CRS Pampadumpara is well known for its contributions to cardamom varietal wealth and development, agronomic practices, and pest management strategies, etc.

The Indian Cardamom Research Institute (ICRI) in Myladumpara, Kerala, houses one of the largest and most diverse cardamom germplasm collection in the world. This collection includes over 500 accessions, comprising landraces, cultivars, and wild relatives of cardamom. The accessions represent a wide range of morphological and agronomic traits, making them valuable for breeding programs aimed at developing high-yielding, disease-resistant varieties. In addition to the ICRI collection, several other research institutions across India maintain cardamom germplasm. The ICAR-Indian Institute of Spices Research (IISR) in Kozhikode, Kerala, has a significant collection of cardamom accessions, including both cultivated and wild types. These collections have been instrumental in the development of improved cardamom varieties such as IISR Vijetha and IISR Avinash, which offer better yield and disease resistance (Anisha *et al.*, 2020). The CRS's collaboration with such major research institutions like ICRI and IISR enhances its positive impact on the entire cardamom sector.

The National Bureau of Plant Genetic Resources (NBPGR) plays a crucial role in coordinating the collection, conservation, and documentation of cardamom genetic resources across India. They have conducted several exploration missions to identify and collect unique cardamom genotypes from different

of origin of cardamom (Varshney and Dubey, 2009). Characterization and evaluation of these accessions

have revealed significant variations in important traits such as plant height, number of tillers, leaf size, capsule yield, and essential oil concentration. This diversity provides a rich genetic pool for breeders to develop improved varieties tailored to different environmental conditions and market demands across the globe (Backiyarani *et al.*, 2006).

Recent advancements in molecular techniques have further enhanced the understanding and utilization of cardamom genetic resources. DNA fingerprinting and marker-assisted selection techniques are being employed to identify and preserve unique genotypes, as well as to accelerate breeding programs. The conservation efforts extend beyond *ex-situ* collections. *In-situ* conservation of wild cardamom populations in protected areas of the Western Ghats is also being promoted to preserve the natural genetic diversity and evolutionary potential of the species (Mathew *et al.*, 2022). These diverse cardamom accession collections in India not only contribute to the country's position as a leading producer and exporter of cardamom but also play a vital role in global efforts to conserve and utilize the genetic resources of this important spice crop.

From the evaluation of 25 accessions 88% (22 varieties) showed a medium height of plant, 64% (16 varieties) produced 10 to 50 tillers and the rest have given even higher number of tillers between 50 and 100. In case of tiller colour, 64% (16 varieties) accessions had light green colour tillers, 52% (13 varieties) rhizomes showed pale green colour, 40% (10 varieties) produced 200-400 leaves per plant while 32% (8 varieties) formed 400 and 600 leaves. Regarding leaf shape, 52% (13 varieties) exhibited leaf shape of lanceolate and 48% (12 varieties) showed leaf shape of oblong- lanceolate. 56% (14 varieties) accessions reported an intermediate primary leaf length between 30 to 60 cm and 88% (22 varieties) registered a wide leaf width of above 6 cm. Typical green colour leaves were produced by 64% (16 varieties). Number of panicles per plant was below 50 for 52% (13 varieties) and 36% (9 varieties) accessions had 50-100 panicles. Panicle length was up to 75cm recorded in 40% (10 varieties). Prostrate type of panicles was noted in 56% (14 varieties). The internodal length was measured to be between 2.1 to 4 cm in 68% (17 varieties). 80% (20 varieties) have shown 15 to 25 racemes per panicle. Number of capsules per raceme ranged from 1 to 4. In 92% (23 varieties) Ovoid structure of capsules was observed in 60% (15 varieties) whereas 40% (10 varieties) given ovate type of capsules. Capsule cross section showed as angular for 36% (9 varieties). Number of seeds per capsule ranged from 16-24 for 56% (14 varieties).

Identification of promising cardamom varieties can be done by considering the following characters such as number of panicles per tiller, panicle length, number of nodes and racemes per panicle, number of capsules per raceme, capsule shape and cross sections, seed size, 100 capsule weight and 100 seed weight. A total of 25 accessions having IC numbers were selected for the study and various traits were considered to find out the superior genotypes.



WHOLE CARDAMOM CAPSULE



WHOLE CARDAMOM PLANT

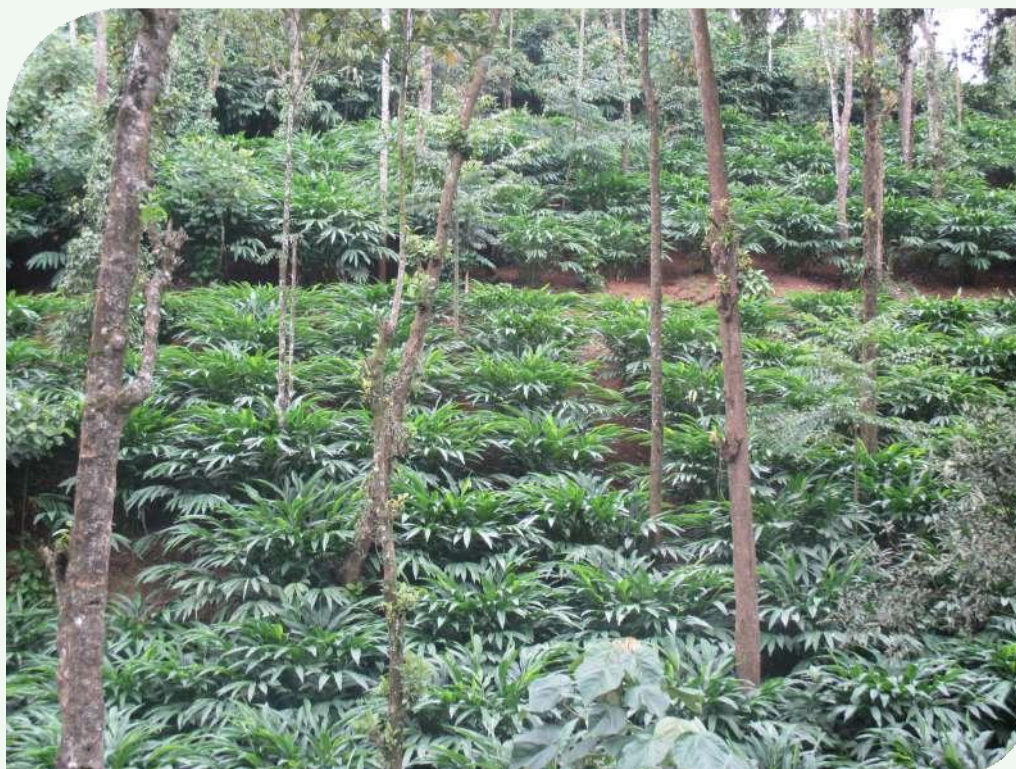


CARDAMOM PANICLES

BACKGROUND INFORMATION OF GERMLASM COLLECTION

The Cardamom Research Station, Pampadumpara was established in the year 1956 under the State Department of Agriculture, Government of Kerala. It was later transferred to the KAU with effect from February, 1972. The station is located on the eastern side of Kumily-Munnar road, 35km away from Kumily and 71 km from Munnar in the Cardamom hill reserves of the Western Ghats. The station's location in the heart of the cardamom growing area of Kerala makes it particularly well-suited for conducting relevant and applicable research. The station has been functioning as one of the co-ordinating centres for spices under the All India Coordinated Research Projects on Spices since 1972.

After this centre was established, began the program of gathering outstanding plants that are readily available locally for assessment and further selection. A total of 196 cardamom accessions are currently conserved in the field bank of the station. Cardamom varieties with special characters such as high yield, tolerance to biotic and abiotic stress conditions and superior capsule characters are being regularly added to the gene bank (Preethy *et al.*,2023).As of now 102 cardamom accessions have been given IC Numbers from the National Bureau of Plant Genetics Resources, New Delhi.



IMPORTANT CHARACTERS WITH THEIR DESCRIPTOR OF CARDAMOM ACCESSIONS

Data were recorded for 40 characters throughout the evaluation, investigations and characterization of cardamom accessions by applying the IBPGR minimum descriptor for each accession has been given.

TABLE 1: List of accessions selected for cataloguing

ACCESSION NAME	PEDIGREE NAME	IC NUMBER	TYPE
CRSP 26	PS1		<i>Vazhukka</i>
CRSP 27	PS2		<i>Vazhukka</i>
CRSP 28	PS3		<i>Vazhukka</i>
CRSP 29	PS4		<i>Mysore</i>
CRSP 30	PS5		<i>Mysore</i>
CRSP 31	PS6		<i>Vazhukka</i>
CRSP 32	PS7		<i>Vazhukka</i>
CRSP 33	PS8		<i>Vazhukka</i>
CRSP 34	PS9		<i>Vazhukka</i>
CRSP 35	PS10		<i>Vazhukka</i>
CRSP 36	PS11		<i>Vazhukka</i>
CRSP 37	PS12		<i>Vazhukka</i>
CRSP 38	PS13		<i>Malabar</i>
CRSP 39	PS14		<i>Malabar</i>
CRSP 40	PS15		<i>Mysore</i>
CRSP 41	PS17		<i>Vazhukka</i>
CRSP 42	PS20		<i>Vazhukka</i>
CRSP 43	PS21		<i>Vazhukka</i>
CRSP 44	PS23		<i>Vazhukka</i>
CRSP 45	PS24		<i>Vazhukka</i>
CRSP 46	PS25		<i>Vazhukka</i>
CRSP 47	PS26		<i>Vazhukka</i>
CRSP 48	PS28		<i>Vazhukka</i>
CRSP 49			<i>Vazhukka</i>
CRSP 50	PS31		<i>Vazhukka</i>

Characterization of germplasm accessions along with descriptor and IBPGR codes is mentioned below in tabular forms, while detailed descriptor with some photographs is catalogued for 25 accessions in later pages. Information on additional characteristics is also documented.

TABLE 2: Descriptor listed with data field number,descriptor name and descriptor code from IBPGR

DATA FIELD	DESCRIPTOR	IBPGR CODE
01	Accession Number	1.1
02	Donor name	1.2
03	Donor Identification Number	1.3
04	Scientific Name	1.5
05	Type of Maintenance	1.10
07	Plant type	7.1.3
08	Plant height (m)	7.1.4
09	No. of tillers per plant	7.1.5
10	Tiller colour	7.1.6
11	Rhizome colour	7.1.8
12	No. of leaves per plant	7.1.9
13	Leaf shape	7.1.10
14	Primary leaf length (cm)	7.1.13
15	Primary leaf width (cm)	7.1.15
16	Primary leaf colour	7.1.17
17	No. of panicles per plant	7.2.5
18	No. of panicles per tiller	7.2.6
19	Panicle length (cm)	7.2.7
20	No. of nodes per panicle	7.2.8
21	Panicle habit	7.2.9
22	Internodal length(cm)	7.2.10
23	Panicle branching	7.2.11
24	Pseudostem diameter (mm)	7.2.12
25	No. of racemes per panicle	7.2.13
26	No. of flowers per raceme	7.2.14
27	Fruit-setting capacity	7.2.15
28	Flower type	7.2.16
29	Flower colour	7.2.17*
30	Flower labellum variegation	7.2.18*
31	No. of capsules per plant	7.2.19
32	No. of capsules per raceme	7.2.20
33	Capsule shape	7.2.21
34	Cross section of capsule	7.2.22
35	Immature capsule colour	7.2.23
36	Mature capsule colour	7.2.24
37	Cured capsule colour	7.2.25
38	100 capsules weight (kg)	7.2.26
39	Capsule length (mm)	7.2.27
40	Capsule width (mm)	7.2.28
41	No. of seeds per capsule	7.2.30
42	100 seeds weight (g)	7.3.2
43	Seed size	7.3.3
44	Dry recovery rate (%)	8.2.3

*N.B :Additionally added characters, not included under IBPGR descriptor

Table 3: Summary of the characterization and cataloguing of 25 accessions

Data field	Characters	Descriptor state	No. Of Accessions	Pedigree Name
07	Plant type	<i>Malabar</i>	18	PS 1,PS 2,PS 3,PS 4,PS 5,PS 6,PS 7,PS10,PS 13,PS 14,PS 15,PS 20,PS 23,PS 24,PS 25,PS 26,PS 28,PS 29
		<i>Mysore</i>	1	PS 11
		<i>Vazhukka</i>	6	PS 8,PS 9,PS 12,PS 17,PS 21,PS 31
08	Plant height (m)	<i>Malabar</i> <2m	7	PS 1,PS 2,PS 3,PS 4,PS 5,PS 15,PS25
		2.1-3m	11	PS 6,PS 7,PS 10,PS 13,PS 14,PS 20,PS 23,PS 24,PS 26,PS 28,PS 29
		>3.1m		
		<i>Mysore/Vazhukka</i> 3m	7	PS 8,PS 9,PS 11,PS 12,PS 17,PS 21,PS 31
		3.1-4m		
		> 4.1m		
09	No. of tillers per plant	10-50	17	PS 1, PS 2, PS 3, PS 4, PS 5, PS 6, PS 8,PS 9,PS 10, PS 11,PS 12,PS 14,PS 21,PS 26,PS 28 ,PS 31
		50-100	7	PS 7,PS 13,PS 15, PS 17, PS 20,PS 23,PS 25
10	Tiller colour	Light green	7	PS 7,PS 8,PS 9,PS 10,PS 11,PS 12,PS 14
		Green	16	PS 1,PS 2,PS 3,PS 4,PS 5,PS 6,PS 13,PS 17,PS 20,PS 21,PS 23,PS 24,PS 25,PS 26,PS 28,PS 29
11	Rhizome colour	Dull white	1	PS 8
		Pale green	2	PS 2, PS 11
		Light purplish red	22	PS 1, PS 3, PS 4,PS 5, PS 6, PS 7, PS 9, PS 10, PS 12, PS 13, PS 14, PS 15, PS 17, PS 20, PS 21, PS 23, PS 24, PS 25, PS 26, PS 28, PS 31

MINIMUM DESCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

12	No.of leaves per plant	0-200	1	PS 6
		200-400	8	PS 2, PS 7, PS 9,PS 10, PS 11, PS 21, PS 24, PS 31
		400-600	11	PS 1, PS 3, PS 4, PS 5,PS 7, PS 12, PS 13, PS 14, , PS 20, PS 26,PS 28
		Above 600	4	PS 15, PS 17,PS 23, PS 25
13	Leaf shape	Lanceolate		
		Oblong – lanceolate	9	PS 1,PS 2, PS 8,PS 9, PS12,PS 15,PS 17,PS 25, PS 31
		Ovate	15	PS 3,PS 4,PS 5, PS 6, PS 7, PS 10,PS 11,PS 13,PS 14,PS 20,PS 21, PS 23, PS 24,PS 26, PS 28
14	Primary leaf length (cm)	Short <30		
		Intermediate 30-60	21	PS 1, PS 2, PS 3, PS 4, PS 5, PS 6, PS 7,PS 8, PS 9, PS 11, PS 12, PS 13, PS 14, PS 15, PS 20, PS 21, PS 23, PS 24, PS 25, PS 26, PS 28, PS 31
		Long >60	3	PS 2, PS 10, PS 17
15	Primary leaf width (cm)	Narrow <4cm		
		Intermediate 4-6cm		
		Wide >6cm	24	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
16	Leaf colour	Light green	2	PS 1, PS 2
		Green	21	PS 3, PS 4, PS 5, PS 6,PS 7, PS 8, PS 9,PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS28, PS 31
		Dark green	1	PS 10

MINIMUM DESCRIPTORS OF CARDAMOM GERMLASM ACCESSIONS

17	No. of panicles per plant	0-50	23	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, , PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		50-100	1	PS 17
		100-150		
		150-200		
18	No. of panicles per tiller	<2-2	20	PS 1, PS 2, PS 3, PS 4, PS 5, PS 8, PS 10, PS 11, PS 12, PS 13, PS 14, PS 17, PS 20 ,PS 21, PS 23, PS 24, PS 25, PS 26,PS 28, PS 31
		≥3	4	PS 6, PS 7, PS 9, PS 15,
19	Panicle length (cm)	≤50cm	23	PS 1,PS 2,PS 3, PS 4, PS 5, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		51-75cm	1	PS 6
		>75cm		
20	No. of nodes per panicle	0-15	24	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		15-24		
		25-35		
21	Panicle habit	Prostrate	5	PS 13,PS 17, PS 23, PS 24, PS 31
		Intermediate	17	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 14, PS 15,PS 21, PS 25,PS 28
		Erect	2	PS 20, PS 26
22	Internodal length (cm)	≤2.1cm	8	PS 3, PS 4, PS 11, PS 12, PS 13, PS 14, PS 23, PS 25
		2.1-4cm	13	PS 2, PS 5, PS 6, PS 9, PS 15, PS 17, PS 20, PS 21, PS 26, PS 28, PS 31
		>4cm	4	PS 1,PS 7, PS 8, PS 10

MINIMUM DESCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

23	Panicle branching	Branched		
		Unbranched	24	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
24	Pseudostem Diameter (mm)	Thin		
		Intermediate		
		Thick		
25	No. of racemes per panicle	0-15	17	PS 1, PS 4, PS 6, PS 8, PS 9, PS 10, PS 11, PS 12, PS 13, PS 14, PS 15, PS 21, PS 23, PS 25, PS 26, PS 28, PS 31
		15-25	8	PS 2, PS 3, PS 5, PS 7, PS 10, PS 17, PS 20, PS 24
		25-35		
26	No. of flowers per raceme	<2	4	PS 11, PS 12, PS 24, PS 25
		2-5	20	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 26, PS 28, PS 31
		>5		
27	Fruit setting capacity (%)	0-50		
		50-80	1	PS 25
		80-100	23	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 26, PS 28, PS 31
28	Flower type	Open	24	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		Unopen		
		Cleistogamous		

MINIMUM DESCRIPTORS OF CARDAMOM GERmplasm ACCESSIONS

29	Flower colour	White with violet stripes	24	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		White		
30	Labellum variegation	Present	6	PS 6,PS 7,PS 8, PS 10, PS 14, PS 23
		Absent	18	PS 1,PS 2,PS 3, PS 4, PS 5, PS 11, PS 12,PS 13, PS 15, PS 17, PS 20, PS 21, ,PS 24, PS 25,PS 26, PS 28, PS 31
31	No. of capsulesper plant	< 5000		
		5000-10000		
		> 10000		
32	No. of capsules perraceme	1-4		
		5-10		
33	Capsule shape	Globose		
		Ovoid	14	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 12,PS 13,PS 14, PS 23, PS 25,PS 26
		Narrowly ellipsoid to elongate	10	PS 9, PS 10, PS 11, PS 15, PS 17, PS 20, PS 21,,PS 24, PS 28, PS 31
34	Cross sectionof capsule	Round	2	,PS 2,PS 3,
		Angular	8	PS 10,PS 11,PS 12, PS 14, PS 17, PS21, PS 24, PS2 8,
		Ovate	14	PS 1, PS 4, PS 5, PS 6, PS 7, PS 8, PS9 ,PS 14, PS 15, PS 20,PS 23,PS 25, PS 26, PS 31
35	Immature capsule colour	Light green	23	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6,
		green	1	PS 7, PS 8, PS 9, PS 10, PS 12,PS

MINIMUM DESCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

				13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
				PS 11
36	Mature capsule colour	Pale green	22	PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 12,PS 13, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		Parrot green	2	PS 1, PS 14
		Dark green		
37	Cured capsule colour	Green	18	PS 1,PS 2, PS 5, PS 6, PS 7, PS 8, PS 9, PS 10, PS 11, PS 12,PS 13, PS 17, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28,
		Pale green	6	PS 3, PS 4, PS 14, PS 15, PS 20, PS 31
		Dark green		
38	100 capsules weight (kg)	50-100	20	PS 1, PS 2, PS 3, PS 4, PS 6, PS 7, PS 8 ,PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17,PS 21, PS 23, PS 24, PS2 5,PS 31
		100-150	4	PS 5, PS 20, PS 9, PS 28
		150-200		
39	Capsule length (mm)	<15.0		
		Short 15-20.0 Medium	19	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, , PS 10, PS 11, PS 12,PS 13,PS 14, PS 20, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		>20.0	5	PS 8, PS 9, PS 15, PS 17,PS 21
40	Capsule width (mm)	<10	1	PS 1,PS 2,PS 3, PS 4, PS 5, PS 6, PS 7, PS 8, PS 10, PS 11, PS 12,PS 13,PS 14, PS 15, PS 17, PS 20, PS 21, PS 23,PS 24, PS 25,PS 26, PS 28, PS 31
		>10	23	
41	No. of seeds per capsule	> 15		
		16-24		
		> 25		

MINIMUM DESCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

42	100 seedsweight(g)	0.1-0.5	1	PS 11
		0.5-0.9	17	PS 1, PS 2, PS 4, PS 6, PS 7,PS 9, PS 10, PS 12, PS 13, PS 14, PS 15, PS 20, PS 21, PS 23, PS 24, PS 25, PS 26
		0.9-1.5	6	PS 3, PS 5, PS 8,PS 17, PS 28, PS 31
43	Seed size	Small		
		Medium	14	PS 1, PS 2, PS 3,PS 6, PS 9, PS 14, PS 17, PS 20, PS 23,PS 25, PS 26, PS 28, PS31
		Large	10	PS 4, PS 5, PS 7, PS 10, PS 11, PS 12, PS 13, PS 14, PS 15
44	Dry recovery rate (%)	Low (>16)		
		Medium (16-19)	5	PS 6, PS 9, PS 10 ,PS12, PS 26
		High(19-22)	11	PS 1, PS 7, PS 13, PS 14 , PS 17, PS 21, PS 23, PS 24, PS 25, PS 28, PS 31
		Very high(>22)	8	PS 2, PS 3, PS 4, PS 5, PS 8, PS 11, PS 15, PS 20,

REFERENCES

Anisha, C.S., Mathew, M.K., Sasidharan, S., Jose, S., Varghese, R.C., Ranjanan, R., Geethu, M., Rao, Y.S., and Remashree, A.B. 2020. Diversity analysis of released varieties of Indian cardamom using ISSR markers reveal narrowing genetic base. *Indian J. Biotechnol.* 19: 311-322.

Backiyarani, S., Josephraj Kumar, A., Sainamolekurian, P., Murugan, M., and Sivakumar, G. 2006. A bold capsuled cardamom [*Elettaria cardamomum* (L.) Maton] variety PV 2-suitable for cardamom hill reserves of Kerala. *Indian J. Genet. Plant Breed.* 66(3): 267-268.

Kumar, B.M. and Nair, P.R. 2004. The enigma of tropical homegardens. In: Nair, P.K.R., Rao, M.R., and Buck, L.E. (eds.), *New Vistas in Agroforestry: A Compendium for 1st World Congress of Agroforestry (1st Ed.)*. Springer, Netherlands, pp. 135-132.

Lakshmi, P. and Sutton, J. 2016. *The Encyclopedia of Spices & Herbs: An Essential Guide to the Flavors of the World*. HarperCollins, New York, 351p.

Mathew, K.M., Ranjanan, R., Rithin, V.C., Bhat, S.K., and Remashree, A.B. 2022. Genetic resources of small cardamom. In: Priyadarshan, P. and Jain, S.M. (eds.), *Cash Crops: Genetic Diversity, Erosion, Conservation and Utilization (1st Ed.)*. Springer Nature, Switzerland, pp. 559-608.

Parthasarathy, V.A. and Prasath, D. 2012. Cardamom. In: Peter, K.V. (ed.) *Handbook of Herbs and Spices (2nd Ed.)*. Woodhead Publishing Series, New Delhi, India, pp. 131-170.

Preethy, T.T., Murugan, M., Mathews, N., and Kuriakose, A. 2023. Insights into the genetic diversity of Indian cardamom [*Elettaria cardamomum* (L.) Maton]: for a future research perspective. *Plant Genet. Resources: Characterization Utilization* 21(1): 12-18.

Ravindran, P.N. and Madhusoodanan, K.J. (eds.). 2002. *Cardamom: The Genus Elettaria*. (1st Ed.). CRC Press, London, 400p.

Varshney, R.K. and Dubey, A. 2009. Novel genomic tools and modern genetic and breeding approaches for crop improvement. *J. Plant Biochem. Biotechnol.* 18(2): 127-138.

Zechariah, N., Finch, C., Girard, T., Hambly, N., Wycoff, G., Zacharias, M.I., Castillo, D., Corbin, T., DiVittorio, M., Dutta, S., and Gaume, R. 2010. The third US Naval Observatory CCD Astrograph Catalog (UCAC3). *Astron. J.* 139(6): 2184-2199.

07:PLANT TYPE



MYSORE



MALABAR



VAZHUKA

09:NUMBER OF TILLERS PER PLANT



10: TILLER COLOUR



GREEN

LIGHT GREEN

11: RHIZOME COLOUR



WHITE



PALE GREEN



PALE PURPLE

13.LEAF SHAPE



Lanceolate



Oblong-lanceolate

14.PRIMARY LEAF LENGTH



Long



Intermediate

15.PRIMARY LEAF WIDTH



NARROW



INTERMEDIATE



WIDE

16..PRIMARY LEAF COLOUR



DARK GREEN



GREEN



LIGHT GREEN

18:NUMBER OF PANICLES PER TILLER

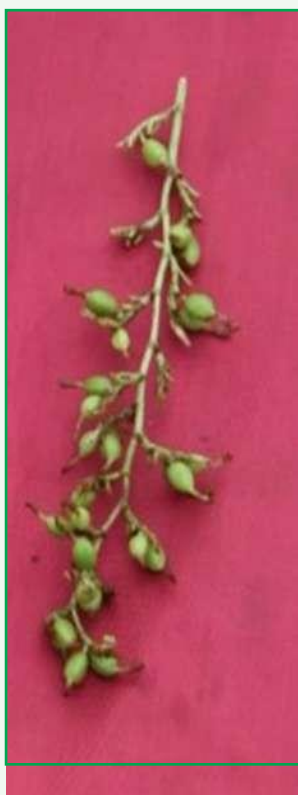


2 PANICLES



5 PANICLES

19: PANICLE LENGTH



SHORT



MEDIUM



LONG

22. INTERNODAL LENGTH



<2.1 cm



2.1-4 cm



> 4 cm

24 : PSEUDOSTEM DIAMETER

THIN



MEDIUM

THICK



28: FLOWER TYPE

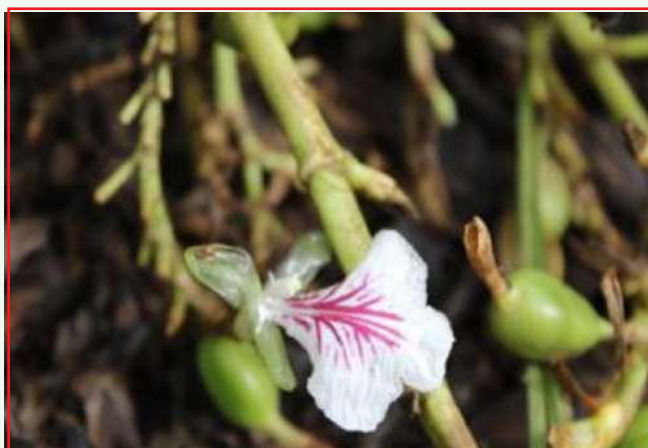


WHITE FLOWER WITH PURPLE STRIPES



WHITE FLOWER

30: LABELLUM VARIEGATION



PRESENT



ABSENT

32: NUMBER OF CAPSULES PER RACEMES

LOW



MEDIUM



HIGH



33: CAPSULE SHAPE



NARROWLY ELLIPSOID TO ELONATE



OVOID



GLOBOSE

34.CROSS SECTION OF CAPSULE



ROUND



ANGULAR



OVATE

36.MATURE CAPSULE COLOUR



DARKGREEN



GREEN



PALE GREEN

37: CURED CAPSULE COLOUR



DARKGREEN



GREEN



PALE GREEN

39: CAPSULE LENGTH



LONG



SHORT



MEDIUM

40:CAPSULE WIDTH



BOLD



MEDIUM



SMALL



CARDAMOM GERMPLASM ACCESSIONS

Table 4: Statement showing detailed characteristics of the germplasm planted in 2019 at Cardamom Research Station Field Gene Bank, Pampadumpara

ACCESSIONS	Donor Name	Donor Identification Number	Scientific name	Plant type	Plant height (m)	No. of tillers per plant
CRSP26	CRS Pampadumpara	PS 1	<i>Elettaria cardamomum</i>	Malabar	180	44
CRSP27	CRS,Pampadumpara	PS 2	<i>Elettaria cardamomum</i>	Malabar	160	36
CRSP28	CRS,Pampadumpara	PS 3	<i>Elettaria cardamomum</i>	Malabar	190	40
CRSP29	CRS,Pampadumpara	PS 4	<i>Elettaria cardamomum</i>	Malabar	200	49
CRSP30	CRS,Pampadumpara	PS 5	<i>Elettaria cardamomum</i>	Malabar	192	49
CRSP31	CRS,Pampadumpara	PS 6	<i>Elettaria cardamomum</i>	Malabar	205	20
CRSP32	CRS,Pampadumpara	PS 7	<i>Elettaria cardamomum</i>	Malabar	230	52
CRSP33	CRS,Pampadumpara	PS 8	<i>Elettaria cardamomum</i>	Vazhukka	200	48
CRSP34	CRS,Pampadumpara	PS 9	<i>Elettaria cardamomum</i>	Vazhukka	160	21
CRSP35	CRS,Pampadumpara	PS 10	<i>Elettaria cardamomum</i>	Malabar	300	19
CRSP36	CRS,Pampadumpara	PS 11	<i>Elettaria cardamomum</i>	Mysore	210	38
CRSP37	CRS,Pampadumpara	PS 12	<i>Elettaria cardamomum</i>	Vazhukka	140	27

Accessions	Tiller colour	Rhizome colour	No. of leaves per plant	Leaf shape	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf colour
CRSP26	Green	Pale green	400	Oblong-lanceolate	51	9	Light green
CRSP27	Green	Light purplish red	250	Oblong-lanceolate	60	10	Light green
CRSP28	Green	Pale green	440	Ovate	40	9	Green
CRSP29	Green	Pale green	416	Ovate	40	10	Green
CRSP30	Green	Pale green	410	Ovate	47	10	Green
CRSP31	Green	Pale green	200	Ovate	53	11	Green
CRSP32	Light green	Pale green	506	Ovate	53	10	Green
CRSP33	Light green	Dull white	320	Oblong-lanceolate	50	9	Green
CRSP34	Light green	Pale green	210	Oblong-lanceolate	50	8.5	Green
CRSP35	Light green	Pale green	308	Ovate	62	12	Dark green
CRSP36	Light green	Light purplish red	240	Ovate	40	10	Green
CRSP37	Light green	Pale green	440	Oblong-lanceolate	44	7.5	Green



MINIMUM DISCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

Accessions	No. of panicles per plant	No. of panicles per tiller	Panicle length (cm)	No. of nodes per panicle	Panicle habit	Inter-nodal length (cm)	Panicle branching	Pseudo-stem diameter (mm)
CRSP26	36	2	32.0	9	Semi erect	5	Unbranched	12.73
CRSP27	17	2	22.0	12	Semi erect	3	Unbranched	15.92
CRSP28	13	2	22.0	9	Semi erect	2	Unbranched	15.78
CRSP29	45	2	28.0	13	Prostrate	2	Unbranched	20.70
CRSP30	48	2	42.0	10	Prostrate	3.5	Unbranched	12.73
CRSP31	30	3	56.0	13	Semi erect	4	Unbranched	12.56
CRSP32	25	3	26.0	10	Semi erect	4.5	Unbranched	12.76
CRSP33	24	2	43.0	9	Semi erect	6	Unbranched	9.55
CRSP34	27	3	26.0	10	Semi erect	3.5	Unbranched	12.64
CRSP35	28	2	40.0	14	Semi erect	6	Unbranched	17.52
CRSP36	45	2	46.0	12	Semi erect	1.5	Unbranched	14.78
CRSP37	14	1	29.0	7	Semi erect	2	Unbranched	11.98

Accessions	No. of racemes per panicle	No. of flowers per raceme	Fruit-setting Capacity(%)	Flower type	Labellum variegation	No. of capsules per plant	No.of capsules per raceme
CRSP26	11	2	87.50	Open	Absent	136	2
CRSP27	15	2	87.21	Open	Absent	217	1
CRSP28	16	3	82.31	Open	Absent	193	2
CRSP29	14	2	87.51	Open	Absent	362	1
CRSP30	15	2	91.32	Open	Absent	312	2
CRSP31	10	3	91.24	Open	Present	144	2
CRSP32	15	3	86.23	Open	Present	242	2
CRSP33	9	2	90.81	Open	Present	198	1
CRSP34	10	2	91.32	Open	Absent	293	1
CRSP35	16	2	86.11	Open	Present	428	2
CRSP36	10	1	86.58	Open	Absent	517	1
CRSP37	11	1	87.31	Open	Absent	163	1

MINIMUM DISRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

Accessions	Capsule shape	Cross section of capsule	Immature capsule colour	Mature capsule colour	Cured capsule colour	100 capsules weight (kg)
CRSP26	Ovoid	Ovate	Light green	Parrot green	Green	0.084
CRSP27	Ovoid	Round	Light green	Pale green	Green	0.098
CRSP28	Ovoid	Round	Light green	Pale green	Pale green	0.088
CRSP29	Ovoid	Ovate	Light green	Pale green	Pale green	0.100
CRSP30	Ovoid	Ovate	Light green	Pale green	Green	0.110
CRSP31	Ovoid	Ovate	Light green	Pale green	Green	0.093
CRSP32	Ovoid	Ovate	Light green	Pale green	Green	0.089
CRSP33	Ovoid	Ovate	Light green	Pale green	Green	0.98
CRSP34	Narrowly ellipsoid to elongated	Ovate	Light green	Pale green	Green	0.104
CRSP35	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Green	0.092
CRSP36	Narrowly ellipsoid to elongated	Angular	Green	Pale green	Green	0.078
CRSP37	Ovoid	Angular	Light green	Pale green	Green	0.084

Accessions	Capsule length (mm)	Capsule width (mm)	No. of seeds per capsule	100 seedsweight (g)	Seed size	Dry recovery rate (%)
CRSP26	15.79	11.28	16	0.80	Medium	21.19
CRSP27	16.34	12.52	16	0.71	Medium	27.24
CRSP28	17.51	11	14	1.12	Medium	24.25
CRSP29	15.43	11.04	20	0.88	Large	25.81
CRSP30	17.55	13.02	16	1.10	Large	22.75
CRSP31	14.53	12.42	17	0.78	Medium	18.29
CRSP32	16.06	13.17	16	0.85	Large	21.79
CRSP33	18.05	13.65	22	1.29	Medium	25.89
CRSP34	20.13	9.85	17	0.77	Medium	17.27
CRSP35	20.49	11.52	14	0.82	Large	18.80
CRSP36	19.82	10.96	13	0.56	Large	23.81
CRSP37	16.55	11.56	12	0.78	Large	17.74

MINIMUM DISCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

ACCESSIONS	Donor Name	Donor Identification Number	Scientific name	Plant type	Plant height (m)	No. of tillers per plant
CRSP38	CRS Pampadumpara	PS 13	<i>Elettaria cardamomum</i>	Malabar	215	51
CRSP39	CRS,Pampadumpara	PS 14	<i>Elettaria cardamomum</i>	Malabar	210	34
CRSP40	CRS,Pampadumpara	PS 15	<i>Elettaria cardamomum</i>	Malabar	200	52
CRSP41	CRS,Pampadumpara	PS 17	<i>Elettaria cardamomum</i>	Vazhukka	215	68
CRSP42	CRS,Pampadumpara	PS 20	<i>Elettaria cardamomum</i>	Malabar	203	55
CRSP43	CRS,Pampadumpara	PS 21	<i>Elettaria cardamomum</i>	Vazhukka	210	23
CRSP44	CRS,Pampadumpara	PS 23	<i>Elettaria cardamomum</i>	Malabar	215	54
CRSP45	CRS,Pampadumpara	PS 24	<i>Elettaria cardamomum</i>	Malabar	206	32
CRSP46	CRS,Pampadumpara	PS25	<i>Elettaria cardamomum</i>	Malabar	190	52
CRSP47	CRS,Pampadumpara	PS26	<i>Elettaria cardamomum</i>	Malabar	215	40
CRSP48	CRS,Pampadumpara	PS28	<i>Elettaria cardamomum</i>	Malabar	221	42
CRSP49	CRS,Pampadumpara	PS29	<i>Elettaria cardamomum</i>	Malabar	217	22
CRSP50	CRS,Pampadumpara	PS31	<i>Elettaria cardamomum</i>	Vazhukka	204	34

Accessions	Tiller colour	Rhizome colour	No. of leaves per plant	Leaf shape	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf colour
CRSP38	Green	Pale green	540	Ovate	52	10	Green
CRSP39	Light green	Pale green	507	Ovate	55	8	Green
CRSP40	Green	Pale green	610	Oblong-lanceolate	56	9	Green
CRSP41	Green	Pale green	720	Oblong-lanceolate	65	10	Green
CRSP42	Green	Pale green	565	Ovate	52	8.5	Green
CRSP43	Green	Pale green	308	Ovate	50	8.5	Green
CRSP44	Green	Pale green	620	Ovate	53	9.5	Green
CRSP45	Green	Pale green	304	Ovate	50	8.5	Green
CRSP46	Green	Pale green	620	Oblong-lanceolate	52	7.5	Green
CRSP47	Green	Pale green	435	Ovate	48	10	Green
CRSP48	Green	Pale green	425	Ovate	46	9	Green
CRSP49	Green	Pale green	300	Ovate	45	9.5	Green
CRSP50	Green	Pale green	260	Oblong-lanceolate	52	7	Green



MINIMUM DISRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

Accessions	No. of panicles per plant	No. of panicles per tiller	Panicle length (cm)	No. of nodes per panicle	Panicle habit	Inter-nodal length (cm)	Panicle branching	Pseudo-stem diameter (mm)
CRSP38	14	2	26	9	Postrate	1.5	Unbranched	12.72
CRSP39	27	2	32	12	Semierect	2	Unbranched	14.33
CRSP40	36	3	30	12	Semierect	2.5	Unbranched	12.70
CRSP41	65	2	34	14	Postrate	3.5	Unbranched	17.52
CRSP42	40	2	37	18	Erect	3	Unbranched	15.92
CRSP43	20	1	32	13	Semierect	3.5	Unbranched	17.50
CRSP44	24	1	35	15	Postrate	2.5	Unbranched	13.40
CRSP45	30	2	36	11	Postrate	2	Unbranched	12.72
CRSP46	40	1	31	12	Semierect	1.5	Unbranched	11.12
CRSP47	30	2	30	7	Erect	3.5	Unbranched	15.91
CRSP48	29	2	32	8	Semierect	3	Unbranched	15.76
CRSP49	15	1	30	10	Postrate	2.5	Unbranched	14.30
CRSP50	25	1	32	7	Postrate	3.5	Unbranched	13.72

Accessions	No. of racemes per panicle	No. of flowers per raceme	Fruit-setting Capacity (%)	Flower type	Labellum variegation	No. of capsules per plant	No. of capsules per raceme
CRSP38	10	2	78.94	Open	Absent	242	2
CRSP39	14	3	86.00	Open	Present	147	2
CRSP40	11	3	87.31	Open	Absent	412	2
CRSP41	15	2	93.33	Open	Absent	957	1
CRSP42	16	3	90.21	Open	Absent	381	2
CRSP43	12	3	84.00	Open	Absent	159	3
CRSP44	13	2	82.74	Open	Present	522	1
CRSP45	15	1	92.28	Open	Absent	284	1
CRSP46	10	1	78.93	Open	Absent	277	1
CRSP47	14	2	68.91	Open	Absent	275	1
CRSP48	9	3	82.31	Open	Absent	78	2
CRSP49	10	3	90.56	Open	Absent	62	3
CRSP50	8	2	92.31	Open	Absent	76	2

MINIMUM DISCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

Assession	Capsule shape	Cross section of capsule	Immature capsule colour	Mature capsule colour	Cured capsule colour	100 capsules weight (kg)
CRSP38	Ovioid	Angular	Light green	Pale green	Green	0.078
CRSP39	Ovioid	Ovate	Light green	Parrot green	Pale green	0.096
CRSP40	Narrowly ellipsoid to elongated	Ovate	Light green	Pale green	Pale green	0.094
CRSP41	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Green	0.098
CRSP42	Narrowly ellipsoid to elongated	Ovate	Light green	Pale green	Pale green	0.120
CRSP43	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Pale green	0.098
CRSP44	Ovioid	Ovate	Light green	Pale green	Pale green	0.090
CRSP45	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Pale green	0.098
CRSP46	Narrowly ellipsoid to elongated	Ovate	Light green	Pale green	Pale green	0.100
CRSP47	Ovioid	Ovate	Light green	Pale green	Pale green	0.098
CRSP48	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Green	18.59
CRSP49	Narrowly ellipsoid to elongated	Angular	Light green	Pale green	Pale green	17.68
CRSP50	Narrowly ellipsoid to elongated	Ovate	Light green	Pale green	Pale green	17.92

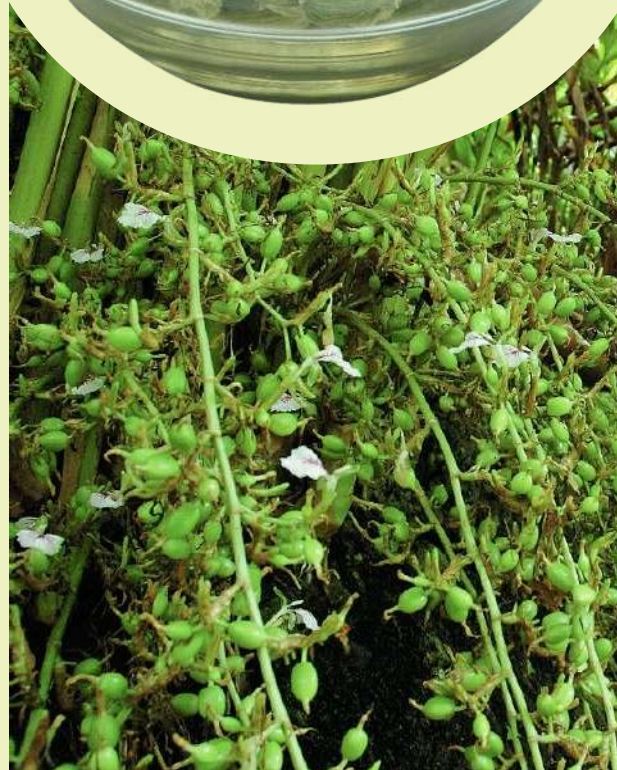
Accessions	Capsule length (mm)	Capsule width (mm)	No. of seeds per capsule	100 seeds weight (g)	Seed size	Dry recovery rate (%)
CRSP38	19.07	10.20	11	0.69	Large	19.38
CRSP39	18.56	10.73	12	0.91	Large	19.99
CRSP40	22.56	14.81	18	0.78	Medium	26.99
CRSP41	22.45	10.63	17	1.12	Medium	19.92
CRSP42	19.58	15.09	16	0.92	Medium	22.49
CRSP43	19.43	15.09	13	0.96	Large	19.30
CRSP44	22.45	12.34	14	0.75	Medium	20.60
CRSP45	19.92	16.57	12	0.74	Large	20.95
CRSP46	16.53	14.54	18	0.83	Medium	20.30
CRSP47	16.62	17.89	19	0.86	Medium	18.86
CRSP48	20.21	16.44	16	0.98	Medium	20.95
CRSP49	20.42	16.43	18	0.92	Medium	19.93
CRSP50	19.57	15.34	17	0.98	Medium	19.67



S1



PI.NO.14



ICAR-All India Coordinated Research Project on Spices
Cardamom Research Station, KAU, Pampadumpara

