CATALOGUE 1

MINIMUM DISCRIPTORS OF CARDAMOM GERMPLASM ACCESSIONS

AICRP-All India Coordinated Research Project on Spices
Cardamom Research Station, Kerala Agricultural University,
Pampadumpara, Idukki, Kerala

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CARDAMOM RESEARCH STATION, PAMPADUMPARA

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Dr. D. Prasath
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03.10.2024

Message

I take immense pride in presenting the first edition of the Catalogue I - Minimum Descriptors of Cardamom Germplasm Accessions, compiled by the dedicated team at the AICRPS Spices, Cardamom Research Station, Kerala Agricultural University, Pampadumpara, Kerala. This catalogue represents a significant achievement in our collective efforts to document and preserve the rich genetic diversity of cardamom, which is of immense historical and economic value.

At the All India Coordinated Research Project (AICRP) on Spices, our mission is to promote germplasm conservation and characterization, critical pillars for any successful crop improvement program. The comprehensive database of cardamom germplasm now available through this catalogue will serve as a vital resource for breeders, researchers, and other stakeholders, ensuring that this valuable genetic material is effectively utilized and preserved for future generations.

This catalogue stands as a testament to the meticulous efforts of the scientists and researchers at the Cardamom Research Station, Pampadumpara, Kerala. It will not only support ongoing research and breeding programs aimed at improving cardamom cultivars but will also inspire further innovations in the cultivation and global dissemination of this esteemed spice.

I would like to extend my sincere gratitude to all the contributors and collaborators who made this important publication possible. I am confident that this catalogue will be an invaluable reference for the spice research community, and I look forward to seeing it serve as a foundation for many more initiatives to strengthen India's role as a global leader in spice cultivation.

(D Prasath)

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PREFACE

Cardamom, known as the Queen of spices is one of the most important spice crop of Kerala. Kerala accounts for 52 per cent of area and 66 per cent of cardamom production in the country.

As with any crop, crip improvement is the most important step in enhancing production and productivity in cardamom too. Crop improvement assumes greater significance in the face of climate change being experienced in the traditional cardamom growing tracts of the state. Varieties that combine high yield with tolerance to abiotic and biotic stresses are crucial to sustain cardamom cultivation.

Given the inherent genetic diversity in the crop, breeding can be a challenging task which can be further complicated by want of information on the available genetic resources. It is in this context that the Cardamom Research Station, Pampadumpara is coming out with a catalogue of "Minimum Descriptors of Cardamom Germplasm Accessions" I am sure that this publication will be of immense use the all concerned with crop improvement in cardamom.

I congratulate the team of scientists whose efforts have made the extensive cataloguing of germplasm available with Kerala Agricultural University, National Bureau of Plant Genetic Resources & ICAR Indian Cardamom Research Institute possible.

07.10.2024
Vellanikara

DIRECTOR OF RESEARCH

CATALOGUE OF MINIMUM DISCRIPTORS 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), 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 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 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 agro-ecological zones, particularly focusing on the Western Ghats region, which is considered the center of origin for 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% (14varieties). The intermodal 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 GERMPLASM 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 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). 102 cardamom accessions were obtained 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 1	PV 1	547920	*Malabar*
CRSP 2	PS44	547921	*Vazhukka*
CRSP 3	S1	547922	*Malabar*
CRSP 4	PS27	547923	*Malabar*
CRSP 5	PV35	547924	*Malabar*
CRSP 6	AEP1	547925	*Mysore*
CRSP 7	Pl. No.14	547926	*Vazhukka*
CRSP 8	PV2	547927	*Vazhukka*
CRSP 9	PV3	547928	*Malabar*
CRSP 10	PV5	547929	*Malabar*
CRSP 11	PRO107	547930	*Malabar*
CRSP 12	PRO17	547931	*Mysore*
CRSP 13	PV6	547932	*Malabar*
CRSP 14	PV7	547933	*Malabar*
CRSP 15	PV8	547934	*Mysore*
CRSP 16	PV9	547935	*Malabar*
CRSP 17	White flower cardamom	547936	*Vazhukka*
CRSP 18	PV10	547937	*Mysore*
CRSP 19	PV11	547938	*Vazhukka*
CRSP 20	PV12	547939	*Vazhukka*
CRSP 21	PV34	547940	*Malabar*
CRSP 22	PPK1	547941	*Vazhukka*
CRSP 23	PPK2	547942	*Vazhukka*
CRSP 24	BEP1	547943	*Vazhukka*
CRSP 25	BEP2	547944	*Vazhukka*

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	Malabar	11	PV1,PV5,PRO107,S1,PS27,PV35,PV3, PV6,PV7,PV9,PV 34
		Mysore	3	AEP1, PV8, PV10, PRO17
		Vazhukka	11	PS44, Pl. No.14, White flower cardamom, PV11, PV12, PPK1, PPK2, BEP1, BEP2, PV2
08	Plant height (m)	Malabar <2m	4	PV5, PV7, PV9, PV6
		2.1-3m	7	PRO107, PV1, S1, PV35, PS27, PV3, PV 34
		>3.1m	-	-
		Mysore/Vazhukka 3m	12	PS44,AEP1,PRO17,PV12,Whiteflower cardamom,PV12,BEP2,PV11,PV8,Pl. No.14,PV10,PPK2,PV2
		3.1-4m	2	PPK1, BEP1
		> 4.1m	-	-
09	No. of tillers per plant	10-50	16	S1, PRO107, PRO17, AEP1, White flower cardamom,PV12,PV34,PPK1,PPK2,BEP1,BEP
				2,PV11,PV9,PV3,PV10,PV7
		50-100	9	PS27,PV35,PV8,PV5,PV2,PS44,PV1,Pl. No.14,PV6
10	Tiller colour	Light green	16	PS44,S1,PS27,PV35,AEP1,PV5,PRO107,PRO17,PV10,PV11,PV9White flower cardamom, PV3,PV2,Pl. No.14,PV7
		Green	9	PV1,PV12,PPK1,PPK2,PV34,BEP2, BEP1,PV6,PV8
11	Rhizome colour	Dull white	6	PV35, PV9,PS44,Pl. No.14,PPK1,PV7
		Pale green	13	PS27,PV5,PRO107,PV12,PV34,BEP2,PV11, PV8,PV3,PV2,PV1,PV6,PPK2
		Light purplish red	6	S1,PRO17,AEP1,White flower cardamom ASK7,SAM16

12	No.of leaves per plant	0-200 200-400	4 10	S1, AEP1,White flower cardamom,BEP2 PRO107,PRO17,PV12, PV34,BEP1,PV11,PV3,PV1,PV9,PV7
		400-600	8	PV35,PV8,PV5,PV2,Pl. No.14,PV6,PV10,PPK1
		Above 600	3	PS27,PS44,PPK2
13	Leaf shape	Lanceolate	13	S1,PS27,PV35,PRO17,AEP1, PPK1,PPK2, BEP1,PV3,PV2,White flower cardamom, Pl. No.14,PV10
		Oblong – lanceolate	12	PRO107,PV34,PV12,PV11,PV6,PV7, PV8,PV9,PV5,PS44,PV1,BEP2
		Ovate	-	-
14	Primary leaf length (cm)	Short <30	-	-
		Intermediate 30-60	14	PS27,PV35,PRO17, AEP1,White flower cardamom, PV34,PPK1,PV9,PV5, PV2,PS44,PV1,PV6,PV7
		Long >60	11	S1,PRO107,BEP2, PV12,PPK2,BEP1, PV11, PV8,PV3,Pl. No.14,PV10
15	Primary leaf width (cm)	Narrow <4cm	1	PV8
		Intermediate 4-6cm	2	PV2,PV7
		Wide >6cm	22	S1,PS27,PV35,PV5,PRO107,PRO17, AEP1,White flower cardamom,PV12, PV34,PPK1,PPK2,BEP2,BEP1,PV11, PV9,PV3,PS44,PV1,Pl. No.14,PV6,PV10
16	Leaf colour	Light green	5	S1,PS27,PV11,PV5,PV7
		Green	16	PV35,AEP1,PRO107,White flower cardamom, PV12,PV34,PPK1,PPK2, BEP2,BEP1,PV9, PV3,PV1,Pl. No.14,PV6,PV10
		Dark green	4	PRO17,PV8,PV2,PS44

07:PLANT TYPE

MYSORE

MALABAR

VAZHUKKA

09:NUMBER OF TILLERS PER PLANT

LOW

HIGH

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

17	No. of panicles per plant	0-50	13	PRO17,AEP1,White flower cardamom, BEP2, PV6, PV7,PV8,PV9,PV5,PV2, PV1,Pl. No.14, PPK2
		50-100	9	S1,PS44,PV5,PV12,PV34,BEP1,PV11,PV3,PV10
		100-150	1	PPK1
		150-200	2	PS27,PV35
18	No. of panicles per tiller	2	14	PV1,PS44,PS27,AEP1,PV2,PRO17,PV6,PV7, PV 8,PV 9,white flower cardamom, PV 12,PPK 2,BEP 1
		≥3	11	S1,PV 35,PV 3,PV 5,PRO 107,PV10,PV 11, PV 34,PPK1,BEP 2,Pl.No.14
19	Panicle length (cm)	≤50cm	10	AEP1,White flower cardamom, PV12,PV7,PV8,PV9,PV5,PS44,PV1,Pl. No.14
		51-75cm	10	PS27,PV35,PRO17,PV34,BEP1,PV11, PV3,PV2,PV6,PV10
		>75cm	5	S1,PRO107,BEP2,PPK1,PPK2
20	No. of nodes per panicle	0-15	-	-
		15-24	17	PV35,AEP1,PRO17,White flower cardamom, PV10,BEP2,PV12,BEP1,PV6,PV8,PV9, PV5,PV3,PV2,PS4,PV1,PV7
		25-35	8	S1,PS27,PRO107,PV34,PV11, Pl. No.14,PPK1,PPK2
21	Panicle habit	Prostrate	14	S1,PS27,PV34,PV12,PV34,BEP1,PV11, PV9,PV5,PV3,PV2,PV1,PV10,PV7
		Intermediate	6	PRO107,White flower cardamom,BEP2, Pl. No.14,PV6,PPK2
		Erect	5	PRO17,AEP1,PV8,PS44,PPK1
22	Internodal length (cm)	≤2.1cm	7	White flower cardamom, PV12,BEP1,PV5,PV1,PV6,PV7
		2.1-4cm	17	PS27,PV35,AEP1,PRO107,PRO17,PV34, BEP2,PV11,PV8,PV9, PV3, PV2,PS44, Pl. No.14, PV10, PPK1, PPK2
		>4cm	1	S1

23	Panicle branching	Branched	-	-
		Unbranched	25	White flower cardamom, PV12,BEP1,PV5, PV1, V6,PV7,PS27,PV35,AEP1,PRO107,PRO17, PV34,BEP2,PV11,PV8,PV9, PV3, PV2, PS44, Pl. No.14, PV10, PPK1, PPK2,S1
24	Pseudostem Diameter (mm)	Thin	-	-
		Intermediate	21	PV 1,PS44,S1,PS 27,PV 35,AEP 1,Pl no.14,PV2,PV 3,PV 5,PRO 17,PRO 107, White flower cardamom,PV 6,PV 8,PV 9, PV 10,PV 11,PV 34,PPK 1,BEP 2
		Thick	4	PPK2,PV 7,BEP 1,PV 12
25	No. of racemes per panicle	0-15	1	White flower cardamom
		15-25	20	PS27, PV35, AEP1, PRO17, PV12, PV34, BEP1, PV11, PV6, PV7, PV8, PV9, PV10, PV3, PV2, PS44, PV 1, Pl. No.14,PV5,BEP2
		25-35	4	S1, PV5, PPK1,PPK2
26	No. of flowers per raceme	<2	-	-
		2-5	24	PV 1,PS 44,S1,PS 27,PV 35,AEP 1,Pl.No.14, PV 2,PV 3,PV 5,PRO107,PRO17,PV 6, PV 7,PV 8,PV 9,White flower cardamom, PV10, PV 11,PV 12,PPK 1,PPK2,BEP 1,BEP 2
		>5	1	PV 34
27	Fruit setting capacity (%)	0-50	-	-
		50-80	-	-
		80-100	25	PPK 1,BEP 2,PS 27,PV 35,AEP11, Pl.No.14, PV 3,PRO17,PV 6,PV 7,PV8,PV 9, White flower cardamom,PV 10,PV 11,PV 12,PV 34,PPK 2, BEP 1
28	Flower type	Open	25	White flower cardamom, PV12,BEP1,PV5,PV1, PV6,PV7,PS27,PV35,AEP1,PRO107,PRO17, PV34,BEP2,PV11,PV8,PV9, PV3, PV2,PS44, Pl. No.14, PV10, PPK1, PPK2,S1
		Unopen	-	-
		Cliestogamous	-	-

29	Flower colour	White with violet stripes		PS27, PV35, AEP1, PRO17, PV12, PV34, BEP1, PV11, PV6, PV7, PV8, PV9, PV10, PV3, PV2, PS44, PV 1, Pl. No.14,PV5,BEP2,S1, PV5, PPK1,PPK2
		White		White flower cardamom
30	Labellum variegation	Present Absent	3 22	S1,PV 8,PV 9 PS27, PV35, AEP1, PRO17, PV12, PV34, BEP1, PV11, PV6, PV7, PV10, PV3, PV2, PS44, PV 1, Pl. No.14,PV5,BEP2, PV5, PPK1,PPK2, White flower cardamom
31	No. of capsules per plant	< 5000	16	PV1,PRO17,AEP1,White flower cardamom, BEP2,BEP1,PV11,PV6,PV7,PV8,PV9, PV5,PV2,PS44,Pl. No.14,PV10
		5000-10000	6	S1,PRO107,PV12,PV34,PV3,PPK2
		> 10000	3	PS27,PV35,PPK1
32	No. of capsules per raceme	1-4	22	PS44,S1,PS27,PV35,AEP1,PV5,PRO107,PV11, PV6,PV7,PV10,PV8,PV2,PV9,PV3,PV1,Pl. No.14, PRO17,White flower cardamom, BEP1,BEP2,PPK1,PPK2
		5-10	3	PV12,PV34,PV 35
33	Capsule shape	Globose	7	PS27, PV35, PRO17, White flower cardamom, PV9, Pl. No.14, PV7
		Ovoid	15	PV5, PRO107, AEP1, PV12,PV34, PPK1,PPK2, BEP2, PV11, PV6,PV8,PV3, PS44, PV 1, PV10
		Narrowly ellipsoid to elongate	3	S1, BEP1, PV2
34	Cross section of capsule	Round	6	PS27, White flower cardamom, PV9, PS44, Pl. No.14, PV10
		Angular	9	S1, AEP1, PV34, BEP1, PV8, PV 1, PV6,PV7,PPK2
		Ovate	10	PV35, PV5, PRO107, PRO17,BEP2, PV11, PV12,PPK1,PV3, PV2
35	Immature capsule colour	Pale green Light green	- 23	- PS44,,PS27,PV35,AEP1,PV5,PRO107,PV11,

				PV6,PV7,PV10,PV9,,PV1,Pl. No.14,PRO17, White flower cardamom, PV12,PV34,BEP1, BEP2,PPK1,PPK2,PV 3,S1
		Green	-	-
		Dark green	2	PV 8,PV2
36	Mature capsule colour	Pale green	11	PV 1,PV 5,PRO107,S1,PS 27,PV 35,PV 3, PV 6,PV 7,PV 9,PV 34
		Parrot green	6	PRO 107,White flower cardamom,PV 8, PV 10,AEP1,AEP 2
		Dark green	8	PS 44,Pl. no 14,PV 11,PV12,PPK 1, PPK 2,BEP1,BEP 2
37	Cured capsule colour	Green	12	PV 2, PV 3,PV 5,PRO 17,PS 44,PV 35,PV 8, PV 10,PV 11,PPK 1,PPK 2,BEP 1,
		Pale green	10	White flower cardamom,PV 34,AEP 1, Pl no.14,PV 9,PV 7,PV 6,PS 27,PV 1,PRO 107,
		Dark green	3	BEP 2,PV 12, S1
38	100 capsules weight (kg)	50-100	17	PV1,PS44,PS27,PV35,AEP1,Pl.No.14,PV 2, PV 5,PRO107,PRO17,PV6,PV 7,PV 8,PV 9 , PV11,BEP1,PV10,white flower cardamom
		100-150	7	S1,PV 3,PV12,PV34,PPK1,PPK2,BEP2
		150-200		
39	Capsule length (mm)	<15.0	3	PS27,PV9,PRO17
		Short 15-20.0 Medium	19	PV 1,PV 35,AEP1,Pl.No.14,PV 2,PV 3,PV 5, PRO107,PV6,PV 7,PV 8,White flower cardamom, PV 10,PV11,PV 12,PPK1,PPK2,BEP1,BEP2
		>20.0	3	PS44,S1,PV 34,
40	Capsule width (mm)	<10	3	PS44,AEP1,PV 2.
		Small 10-15.0 Medium	22	PV1,S1,PS27,PV 35,Pl.No.14,PV3,PV 5, PRO107,PRO17,PV 6,PV 7,PV 8,PV 9, White flower cardamom,PV10,PV 11, PV 12,PV 34,PPK 1,PPK 2,BEP 1,BEP 2
		>15	-	-
41	No. of seeds per capsule	> 15	10	PRO17, White flower cardamom, PV12, BEP1, PV6,PV7,PV8, PV9, PV5, PV 1,

		16-24	14	PS27, PS44, S1, PV35, AEP1, PRO107, PV34, BEP2,PV11, PV3, PV2, Pl. No.14, PV10, PPK2
		> 25	1	PPK1
42	100 seeds weight(g)	0.1-0.5	-	-
		0.5-0.9	5	PV 11,PV 1,PV 8,PV 3,S1
		0.9-1.5	20	PV 10,PS 44,PV 6,PV 3,PS 27,BEP 2,PV 12, Pl .no.14,PV 7,PPK 2,PV 35,PV 34,PPK 1,PV 5, PRO107,PV 9,AEP 1,PRO17,BEP 1, White flower cardamom
43	Seed size	Small	-	-
		Medium	5	PV 1,S1,PV 3,PV 8,PV 11
		Large	20	PS 44,PS 27,PV 35,AEP 1,Pl no.14,PV 3, PV 5,PRO 107,PRO 17,PV 6,PV 7,PV 9, White flower cardamom, PV 10, ,PV 12, PV 34,PPK 1,PPK 2,BEP 1,BEP 2
44	Dry recovery rate (%)	Low (>16)	6	PV 8,BEP 2,PV 12,PRO 107,AEP 1,BEP 1
		Medium (16-19)	6	PV 35,S1,PV 6,Pl no.14,PV 1,PV 34,
		High(19-22)	9	PV 2,PS 27,PV 3,PV 10,PS 44,PRO17, PV 5,PV 9,PPK1
		Very high(>22)	4	PV 7,PV 11,PPK 2,White flower cardamom

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 ELONGATE

OVOID

GLOBOSE

34: CROSS SECTION OF CAPSULE

ROUND

ANGULAR

OVATE

36: MATURE CAPSULE COLOUR

DARK GREEN

GREEN

PALE GREEN

37: Cured capsule colour

DARK GREEN

GREEN

PALE GREEN

39: CAPSULE LENGTH

SHORT

MEDIUM

LONG

40:CAPSULE WIDTH

BOLD

MEDIUM

SMALL

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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
CRSP1	CRS Pampadumpara	PV1	*Elettaria cardamomum*	*Malabar*	206	56
CRSP2	CRS,Pampadumpara	PS44	*Elettaria cardamomum*	*Vazhukka*	190	76
CRSP3	CRS,Pampadumpara	S1	*Elettaria cardamomum*	*Malabar*	219	37
CRSP4	CRS,Pampadumpara	PS27	*Elettaria cardamomum*	*Malabar*	251	89
CRSP5	CRS,Pampadumpara	PV35	*Elettaria cardamomum*	*Malabar*	220.5	71
CRSP6	CRS,Pampadumpara	AEP1	*Elettaria cardamomum*	*Mysore*	141	23
CRSP7	CRS,Pampadumpara	Pl. No.14	*Elettaria cardamomum*	*Vazhukka*	188	69
CRSP8	CRS,Pampadumpara	PV2	*Elettaria cardamomum*	*Vazhukka*	211	66
CRSP9	CRS,Pampadumpara	PV3	*Elettaria cardamomum*	*Malabar*	210	28
CRSP10	CRS,Pampadumpara	PV5	*Elettaria cardamomum*	*Malabar*	182	68
CRSP11	CRS,Pampadumpara	PRO107	*Elettaria cardamomum*	*Malabar*	269	41
CRSP12	CRS,Pampadumpara	PRO17	*Elettaria cardamomum*	*Mysore*	194	34

Accessions	Tiller colour	Rhizome colour	No. of leaves per plant	Leaf shape	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf colour
CRSP1	Green	Green	350	Oblong-lanceolate	55.0	7.0	Green
CRSP2	Light green	White	663	Oblong-lanceolate	56.5	10.0	Dark green
CRSP3	Light green	Light purplish red	184	Lanceolate	71.5	7.5	Light green
CRSP4	Light green	Pale green	665	Lanceolate	54.5	7.0	Light green
CRSP5	Light green	White	460	Lanceolate	55.5	8.0	Green
CRSP6	Light green	Pale purple	106	Lanceolate	51.0	10.5	Green
CRSP7	Light green	White	533	Lanceolate	65.0	8.5	Green
CRSP8	Light green	Light green	540	Lanceolate	51.0	5.8	Dark green
CRSP9	Light green	Green	240	Lanceolate	64.0	8.0	Green
CRSP10	Light green	Pale green	430	Oblong-lanceolate	46.0	8.0	Light green
CRSP11	Light green	Green	330	Oblong-lanceolate	62.5	10.5	Green
CRSP12	Light green	Pale purple	286	Lanceolate	57.0	9.5	Dark green

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)
CRSP1	40	2	29.0	17	Prostrate	1.5	Unbranched	15.20
CRSP2	51	2	47.0	22	Erect	2.5	Unbranched	16.26
CRSP3	73	4	75.5	34	Prostrate	5.5	Unbranched	19.28
CRSP4	153	2	54.0	25	Prostrate	3.0	Unbranched	15.08
CRSP5	160	4	220.5	22	Prostrate	2.5	Unbranched	16.87
CRSP6	28	2	33.0	19	Erect	2.5	Unbranched	17.18
CRSP7	36	3	43.5	26	Semi erect	2.5	Unbranched	14.31
CRSP8	27	2	52.0	22	Prostrate	3.0	Unbranched	16.63
CRSP9	62	5	63.5	24	Prostrate	3.5	Unbranched	16.81
CRSP10	35	3	33.0	18	Prostrate	1.5	Unbranched	11.96
CRSP11	74	3	78.0	28	Semi erect	3.5	Unbranched	19.97
CRSP12	44	2	58.5	22	Erect	3.0	Unbranched	18.77

Accessions	No. of racemes per panicle	No. of flowers per raceme	Fruit-setting Capacity(%)	Flower type	Labellum varigetion	No. of capsules per plant	No.of capsules per raceme
CRSP1	18	3	88.63	Open	Absent	1360	2
CRSP2	18	3	82.14	Open	Absent	2244	2
CRSP3	31	5	93.22	Open	Present	9060	4
CRSP4	23	4	94.50	Open	Absent	10350	3
CRSP5	20	5	94.60	Open	Absent	10560	5
CRSP6	16	4	91.83	Open	Absent	1596	3
CRSP7	23	3	83.33	Open	Absent	1872	2
CRSP8	19	5	89.55	Open	Absent	2376	4
CRSP9	22	5	94.44	Open	Absent	5952	4
CRSP10	17	3	85.10	Open	Present	1260	2
CRSP11	27	5	88.23	Open	Absent	8288	4
CRSP12	19	3	88.90	Open	Absent	2904	2

Accessions	Capsule shape	Cross section of capsule	Immature capsule colour	Mature capsule colour	Cured capsule colour	100 capsules weight (kg)
CRSP1	Ovoid	Angular	Light green	Pale green	Pale green	0.097
CRSP2	Ovoid	Round	Light green	Dark green	Green	0.084
CRSP3	Narrowly ellipsoid to elongate	Angular	Light green	Pale green	Dark green	0.118
CRSP4	Globose	Round	Light green	Pale green	Pale green	0.067
CRSP5	Globose	Ovate	Light green	Pale	Green Green	0.090
CRSP6	Ovoid	Angular	Light green	Parrot green	Pale Green	0.071
CRSP7	Globose	Round	Light green	Dark green	Pale green	0.083
CRSP8	Narrowly ellipsoid to elongate	Ovate	Dark green	Parrot green	Green	0.082
CRSP9	Ovoid	Ovate	Light green	Pale green	Green	0.116
CRSP10	Ovoid	Ovate	Light green	Pale green	Green	0.089
CRSP11	Ovoid	Ovate	Light green	Pale green	Pale green	0.100
CRSP12	Globose	Ovate	Light green	Parrot green	Green	0.075

Accessions	Capsule length (cm)	Capsule width (cm)	No. of seeds per capsule	100 seeds weight (g)	Seed size	Dry recovery rate (%)
CRSP1	1.87	1.02	11	0.684	Medium	17.28
CRSP2	2.17	0.97	16	0.910	Large	20.00
CRSP3	2.20	1.25	18	0.676	Medim	16.73
CRSP4	1.33	1.08	18	1.012	Large	19.27
CRSP5	1.80	1.18	18	1.007	Large	16.76
CRSP6	1.56	0.95	17	1.235	Large	15.81
CRSP7	1.67	1.08	18	1.025	Large	16.40
CRSP8	1.94	0.98	16	0.640	Medium	21.03
CRSP9	1.71	1.25	18	1.200	Large	19.36
CRSP10	1.50	1.11	12	1.264	Large	25.38
CRSP11	1.85	1.14	16	0.946	Large	14.28
CRSP12	1.17	1.06	13	0.998	Large	25.42

ACCESSIONS	Donor Name	Donor Identification Number	Scientific name	Plant type	Plant height (m)	No. of tillers per plant
CRSP13	CRS Pampadumpara	PV6	*Elettaria cardamomum*	*Malabar*	169	64
CRSP14	CRS,Pampadumpara	PV7	*Elettaria cardamomum*	*Malabar*	160	41
CRSP15	CRS,Pampadumpara	PV8	*Elettaria cardamomum*	*Mysore*	252	72
CRSP16	CRS,Pampadumpara	PV9	*Elettaria cardamomum*	*Malabar*	168	45
CRSP17	CRS,Pampadumpara	White flower cardamom	*Elettaria cardamomum*	*Vazhuka*	188	13
CRSP18	CRS,Pampadumpara	PV10	*Elettaria cardamomum*	*Mysore*	218	46
CRSP19	CRS,Pampadumpara	PV11	*Elettaria cardamomum*	*Vazhukka*	208	46
CRSP20	CRS,Pampadumpara	PV12	*Elettaria cardamomum*	*Vazhukka*	176	44
CRSP21	CRS,Pampadumpara	PV34	*Elettaria cardamomum*	*Malabar*	241	41
CRSP22	CRS,Pampadumpara	PPK1	*Elettaria cardamomum*	*Vazhukka*	310	45
CRSP23	CRS,Pampadumpara	PPK2	*Elettaria cardamomum*	*Vazhukka*	250	44
CRSP24	CRS,Pampadumpara	BEP1	*Elettaria cardamomum*	*Vazhukka*	309	48
CRSP25	CRS,Pampadumpara	BEP2	*Elettaria cardamomum*	*Vazhukka*	179	24

Accessions	Tiller colour	Rhizome colour	No. of leaves per plant	Leaf shape	Primary leaf length (cm)	Primary leaf width (cm)	Primary leaf colour
CRSP13	Green	Pale green	495	Oblong-lanceolate	52.0	7.5	Green
CRSP14	Pale green	White	200	Oblong-lanceolate	51.0	5.0	Pale green
CRSP15	Green	Green	560	Oblong-lanceolate	67.0	3.5	Dark green
CRSP16	Pale green	White	276	Oblong-lanceolate	47.5	7.5	Green
CRSP17	Pale green	Pale purple	63	Lanceolate	52.0	8.5	Green
CRSP18	Light green	Pale purple	418	Lanceolate	63.0	8.5	Green
CRSP19	Pale green	Pale green	372	Oblong-lanceolate	67.0	7.5	Light green
CRSP20	Green	Green	250	Oblong-lanceolate	62.5	7.5	Green
CRSP21	Green	Green	320	Oblong-lanceolate	56.0	7.0	Green
CRSP22	Green	White	450	Lanceolate	57.5	10	Green
CRSP23	Green	Green	616	Lanceolate	64.0	10	Green
CRSP24	Green	Pale purple	360	Lanceolate	61.0	10	Green
CRSP25	Green	Green	81	Oblong-lanceolate	67.0	9.5	Green

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)
CRSP13	42	2	56	20	Semi erect	1.5	Unbranched	18.06
CRSP14	20	2	26	18	Prostrate	2.0	Unbranched	20.26
CRSP15	42	2	36	23	Erect	2.5	Unbranched	16.12
CRSP16	36	2	44	23	Prostrate	2.5	Unbranched	15.03
CRSP17	22	2	29	16	Semi erect	2.0	Unbranched	15.47
CRSP18	65	5	51	24	Prostrate	2.5	Unbranched	19.31
CRSP19	73	3	59	25	Prostrate	2.5	Unbranched	18.57
CRSP20	51	2	41	21	Prostrate	2.0	Unbranched	20.04
CRSP21	54	2	55	25	Prostrate	3.5	Unbranched	19.45
CRSP22	120	4	79	31	Erect	2.5	Unbranched	25.41
CRSP23	42	2	75	29	Semi erect	2.5	Unbranched	20.77
CRSP24	54	2	54	23	Prostrate	2.0	Unbranched	22.27
CRSP25	33	4	76	18	Semi erect	3.0	Unbranched	19.67

Accessions	No. of racemes per panicle	No. of flowers per raceme	Fruit-setting Capacity (%)	Flower type	Labellum varigetion	No. of capsules per plant	No.of capsules per raceme
CRSP13	18	3	78.94	Open	Absent	1680	2
CRSP14	17	3	86.00	Open	Absent	720	2
CRSP15	20	3	83.33	Open	Present	1932	3
CRSP16	21	4	85.10	Open	Present	1656	2
CRSP17	12	2	84.00	Open	Absent	704	1
CRSP18	21	3	83.33	Open	Absent	3120	2
CRSP19	23	2	87.50	Open	Absent	3650	1
CRSP20	18	4	93.33	Open	Absent	5355	5
CRSP21	23	6	93.91	Open	Absent	6250	5
CRSP22	29	5	93.30	Open	Absent	14880	4
CRSP23	26	4	92.30	Open	Absent	3654	3
CRSP24	21	5	96.00	Open	Absent	3795	4
CRSP25	14	4	92.70	Open	Absent	1782	3

Accessions	Capsule shape	Cross section of capsule	Immature capsule colour	Mature capsule colour	Cured capsule colour	100 capsules weight (kg)
CRSP13	Ovoid	Angular	Light green	Pale green	Pale green	0.091
CRSP14	Globose	Angular	Light green	Pale green	Pale green	0.072
CRSP15	Ovoid	Angular	Dark green	Parrot green	Green	0.095
CRSP16	Globose	Round	Light green	Pale green	Pale green	0.097
CRSP17	Globose	Round	Light green	Parrot green	Pale green	0.068
CRSP18	Ovoid	Round	Light green	Parrot green	Green	0.087
CRSP19	Ovoid	Ovate	Light green	Dark green	Green	0.090
CRSP20	Ovoid	Ovate	Light green	Dark green	Dark green	0.118
CRSP21	Ovoid	Angular	Light green	Pale green	Pale green	0.119
CRSP22	Ovoid	Ovate	Light green	Dark green	Green	0.134
CRSP23	Ovoid	Angular	Light green	Dark green	Green	0.139
CRSP24	Narrowly ellipsoid to elongate	Angular	Light green	Dark green	Green	0.098
CRSP25	Ovoid	Ovate	Light green	Dark green	Dark green	0.109

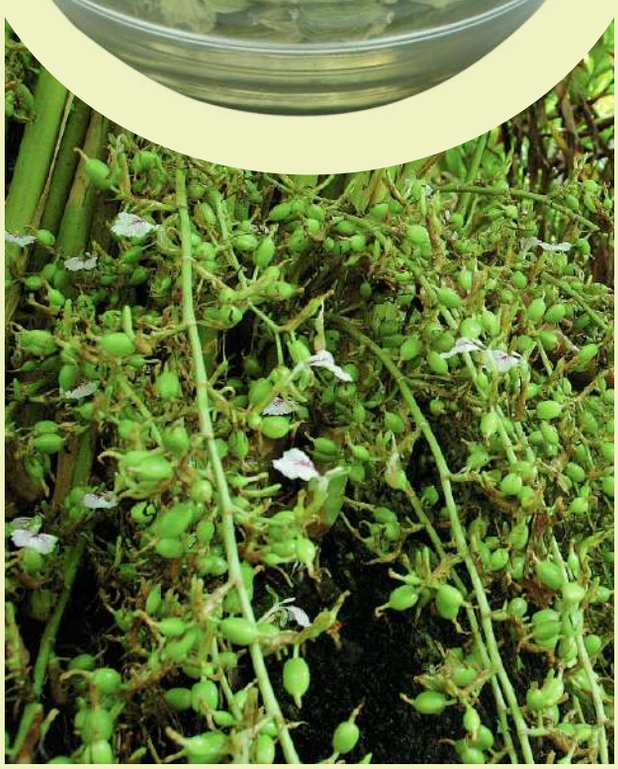
Accessions	Capsule length (cm)	Capsule width (cm)	No. of seeds per capsule	100 seeds weight (g)	Seed size	Dry recovery rate (%)
CRSP13	1.90	1.07	13	1.001	Large	18.13
CRSP14	1.85	1.04	11	1.011	Large	24.88
CRSP15	1.50	1.03	6	0.718	Medium	12
CRSP16	1.30	1.10	13	1.110	Large	23.38
CRSP17	1.83	1.18	11	1.008	Large	29.41
CRSP18	1.57	1.13	18	1.040	Large	20.91
CRSP19	1.92	1.12	21	0.815	Medium	23.40
CRSP20	1.73	1.20	10	1.118	Large	12.72
CRSP21	2.03	1.17	19	1.873	Large	18.33
CRSP22	2.00	1.32	25	1.277	Large	19.83
CRSP23	1.83	1.32	18	1.037	Large	24
CRSP24	2.00	1.07	10	1.1700	Large	15.16
CRSP 25	1.86	1.27	16	1.065	Large	11.44

PV 1

PS 44

S 1

Pl.No. 14



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