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Evaluation of working collections of cardamom (*Elettaria cardamomum* Maton) for morphological attributes under hill zone of Karnataka

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Abstract
Small cardamom (*Elettaria cardamomum* Maton), belongs to the family Zinziberaceae is one of the important spice crops of India. Cardamom is cross pollinated crop and it is propagated through both vegetative and sexual means hence, lot of variability is noticed. The experiment on study of variability in cardamom was conducted in 2016 at Zonal Agriculture and Horticulture Research Station (ZAHRS), Mudigere. Significant differences were observed amongst different working collections of cardamom for all the morphological traits. The pooled analysis revealed that, SKP-170 produced highest number of tillers per clump (41.1) and was on par with the genotype APG-293 (40.8), M-2 recorded highest tiller height of 333.2 cm, while the lowest was recorded in APG-284 (149.9 cm) in pooled analysis, Pooled analysis over two experimental years revealed that SKP-170 recorded maximum (27.6) number of leaves and while, PV-4 and CL-622 (9.9) genotypes registered lowest number of leaves per tiller. Maximum leaf length of 71.7 cm and leaf breadth of 14.2 cm was recorded in Green Gold under pooled mean analysis, highest number of vegetative buds per clump was noticed in RR-1 (9.1) which was on par with the genotypes PDP-12 (8.8), D-168 (8.7) in the pooled mean analysis for two years data.

Keywords: *Elettaria cardamomum* Maton, number of tillers per clump, leaf length and leaf width

Introduction
Small cardamom (*Elettaria cardamomum* Maton) occupies prime place among the spices. Small cardamom is an herbaceous perennial plant with underground rhizome and aerial pseudo stems which is made of leaf sheaths. The growth habit of the panicles varies with different cultivated varieties/types of cardamom *viz*., Mysore (erect), Malabar (prostrate) and Vazhukka (semi erect) types. Flowering shoot (panicle) arise from the base of the plant and flowering period stretches from May to October. Bees are the major pollinating agent in cardamom and foraging is observed during morning hours as it is very essential in increasing the fruit set (Parthasarathy and Prasath, 2012). Cardamom fruit (capsule) is Pale green to yellow and elongate oval-shape. Each fruit has three chambers filled with small aromatic seeds. The dried capsule seeds are straw-brown to black in colour and are widely used as spice. The ancient Greeks and Romans also used cardamom in food, medicines and perfumes (Korikanthimath *et al*., 2001) [10]. The cardamom of commerce is a dried fruit (capsule) known for its sweet delicate aroma, Hence, it is considered as "Queen of spice". Cardamom is the third costliest spice in the world after saffron and vanilla (Chempakam and Sindhu, 2008; George and Cherian, 2017; Anjali *et al*., 2018 and Mishra *et al*., 2018) [12] and cardamom has figured in world trade for at least 5000 years (Lawrence, 1978 and Nayar, 1987) [13]. In Charaka samhita, cardamom was found to be used for purification therapy done through nose route, as emetic drug, used as ointment for the treatment of skin disease, headache and dental caries (Dattatray *et al*., 2016) [5].

Cardamom is cross-pollinated crop and propagated through seedlings and suckers, occasionally selfing also occurs. Considerable variation is noticed in seedling progenies of cardamom (Padmini *et al*., 2000) [14]. Evaluation of germplasm is the pre-requisite to identify desirable elite genotypes for the breeding programme. Hence, study on evaluation of working

collections of cardamom (*Elettaria cardamomum* Maton) under hill zone of Karnataka was carried out during 2016-17.

Material and Methods

The present investigation on "Performance in working collections of cardamom (*Elettaria cardamomum* Maton) under hill zone of Karnataka was carried out in 2016-17 at Zonal Agricultural and Horticultural Research Station, University of Agricultural and Horticultural Sciences campus Mudigere. The experimental site is situated in the Western Ghats and represents the typical hilly zone (Zone-9 and Region-V) of Karnataka and located at 13º25' North latitude and 75º 25' East longitude at an altitude of 980 m above mean sea level. The experimental material for the present investigation comprised of 67 working collections of cardamom being maintained at Zonal Agriculture and Horticulture Research Station (ZAHRS), Mudigere. The accessions were planted in the year of 2010 in uniform soil condition at spacing of 3x3m. The experiment was laid out in an Augmented Design with eight plants per plot. The statistical analysis of the data was carried out using Windostat programmes at Department of Crop improvement and Biotechnology, College of Horticulture, Mudigere.

Results and Discussion

Number of tillers/clump, tiller height (cm) and number of leaves/tiller

Highly significant differences were observed for number of tillers per clump among the different genotypes during two experimental seasons (Table-1).

Highest number of tillers per clump was recorded in SKP-170 (40.2) which was on par with the genotypes 26-16-D11 (38.1) and CCS 800 (36.0), while lowest was in PDP-12 (12.4) with the mean of genotypes being 25.90 during the year 2016-17. In the year 2017-18, AGP-293 had put forth maximum number of tillers per clump (49.0) followed by SKP-170 (42.0) and 12-7-D11 (40.0), while it was lowest in PDP-12 (15.6). The mean of genotypes was 27.8. The pooled analysis revealed that, SKP-170 produced highest number of tillers per clump (41.1) and was on par with the genotype APG-293 (40.8) and differed significantly from rest of the genotypes studied and was followed by genotypes 26-16-D11, 12-7-D11 and CCS800, recording 37.9, 35.80 and 37.0 tillers per clump respectively, while genotypic mean was 26.9. Minimum number of tillers per clump was observed in PDP-12 (14.0).

Highly significant differences were observed in respect of tiller height among the genotypes during both the years of study.

During 2016-17and 2017-18 maximum tiller height was recorded by M-2 (328.8 and 337.7 cm respectively) followed by MCC-309 (306.0 and 309.1 cm respectively) and D-163 (297.9 and 300.9cm respectively). Lowest was in APG-284 (149.1 and 150.6cm respectively). As per the pooled data of 2016-17 and 2017-18, M-2 recorded highest tiller height of 333.2 cm, while the lowest was recorded in APG-284 (149.9 cm). The genotypes, MCC-309 (307.6 cm), D-163 (299.4 cm) and PS- 44 (296.4 cm) were found to follow M-2 with respect to tiller height. Pooled mean of all the genotypes for the trait was 235.6 cm.

During 2016-17 and 2017-18 highly significant differences were observed among the genotypes for the number of leaves per tiller.

In the first year of experimentation (2016-17), highest number of leaves per tiller was observed in SKP-170 (27.3), which differed significantly from rest of the genotypes and followed by CCS-800 (24.4), SEL-98 (22.4), MHC-18 (22.4) and PS-44 (22.4), whereas, lowest number of leaves per tiller was recorded in PV-4 (9.7). During, second year (2017-18), highest number of leaves per tiller was recorded in SKP-170 (28.0), which was significantly higher than all the genotypes tried during the course of study and followed by CCS-800 (25.0) and SEL-98 (23.0) and lowest (10.0) was in CL-622 and PV-4. Pooled analysis over two experimental years revealed that SKP-170 recorded maximum (27.6) number of leaves and while, PV-4 (9.9) and CL-622 (9.9) genotypes registered lowest number of leaves per tiller. The genotypes CCS-800 (24.7), SEL-98, MHC-18 and PS-44 (22.70) closely followed SKP-170 but differed significantly. More number of tillers per clump will help in bringing higher capsule yield in cardamom. Variation with respect to number of tillers per clump, tiller height (cm) and number of leaves per tiller among the genotypes might be due to the genetic makeup of the genotypes and environmental influence. These results are in line with the findings of Prasath *et al.* (2009), Hrideek *et al.* (2011) [9], Hrideek *et al.* (2015) [7] and Akhila *et al.* (2017) [1] in cardamom.

Table 1: Variability exhibited by cardamom (*Elettaria cardamomum* Maton) genotypes for number of tillers per clump, tiller height and number of leaves per tiller

Genotype	Tillers/clump			Tiller height (cm)			Leaves/tiller		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Wynad	18.0	20.0	19.0	217.5	219.7	218.6	11.2	11.5	11.4
CL-671	19.6	24.4	22.0	204.9	207.0	206.0	11.7	12.1	11.9
CL-622	17.6	26.0	21.8	193.8	195.8	194.8	9.8	10.0	9.9
D-751	16.8	20.2	18.5	199.8	201.8	200.8	11.6	11.9	11.7
PV-4	21.0	21.2	21.1	211.9	214.1	213.0	9.7	10.0	9.9
D-168	26.3	26.8	26.6	215.8	218.0	216.9	11.8	12.1	11.9
PDP-4	24.0	28.0	26.0	214.0	216.1	215.1	11.2	11.5	11.4
PDP-14	27.1	27.6	27.3	253.6	256.2	254.9	16.4	16.9	16.7
Pink Pseudostem	25.5	26.0	25.7	225.0	227.3	226.2	16.6	17.0	16.8
NCL-1	32.0	32.6	32.3	249.5	252.0	250.7	12.5	12.8	12.7
CL-73	24.4	24.9	24.7	294.2	297.2	295.7	19.0	19.6	19.3
Darmada	28.9	29.5	29.2	261.5	264.1	262.8	13.1	13.5	13.3
Ceylon-5	17.6	18.0	17.8	289.0	300.0	294.5	14.3	14.7	14.5
P-10	32.8	33.5	33.1	221.6	223.8	222.7	17.5	18.0	17.8
Ceylon-2	30.0	34.0	32.0	249.0	251.5	250.2	18.5	19.0	18.8
PDP-12	12.4	15.6	14.0	208.1	210.2	209.2	12.3	12.7	12.5
K-5	17.5	19.7	18.6	182.8	184.6	183.7	11.4	11.7	11.6
D-516	31.0	34.0	32.5	215.9	218.1	217.0	19.5	20.0	19.7

KMRD-2	31.6	32.2	31.9	262.6	265.3	263.9	14.6	15.0	14.8
D-11	15.0	17.0	16.0	214.8	217.0	215.9	12.3	12.7	12.5
D-140	30.2	30.8	30.5	191.6	193.5	192.5	13.6	13.9	13.7
D-163	17.7	18.0	17.8	297.9	300.9	299.4	12.7	13.0	12.9
KMRD-10	31.4	32.0	31.7	225.0	227.3	226.2	13.4	13.8	13.6
P-1	28.2	28.8	28.5	270.6	273.3	272.0	19.3	19.8	19.5
Kallar	16.0	18.0	17.0	274.4	277.2	275.8	13.6	14.0	13.8
CL-679	29.2	29.8	29.5	207.8	209.9	208.8	11.6	11.9	11.7
Green Gold	28.0	28.6	28.3	286.8	287.6	287.2	17.1	17.5	17.3
HS-1	17.0	20.0	18.5	233.8	236.1	235.0	9.9	11.2	10.6
MCC-61	30.9	33.1	32.0	256.8	259.4	258.1	22.1	22.8	22.5
SKP-5	19.6	20.0	19.8	268.0	272.5	270.3	10.8	11.1	11.0
MCC-12	19.9	20.3	20.1	200.4	202.4	201.4	10.0	12.0	11.0
MCC-21	28.4	29.0	28.7	233.4	235.8	234.6	12.3	12.7	12.5
CSS-800	18.4	18.8	18.6	228.8	231.2	230.0	10.7	11.0	10.9
ICRI-2	28.5	30.5	29.5	226.6	228.9	227.7	12.5	12.8	12.7
SKP-21	30.0	32.8	31.4	228.1	230.4	229.2	12.0	12.3	12.1
SKP-72	25.5	26.0	25.7	229.6	231.9	230.8	12.0	12.3	12.1
CL-698	30.4	31.0	30.7	247.4	249.9	248.7	14.6	15.0	14.8
MCC-18	30.0	33.0	31.5	198.3	200.3	199.3	16.6	17.0	16.8
CL-668	26.3	26.8	26.5	272.7	275.4	274.1	18.5	19.0	18.8
CCS-800	36.0	38.0	37.0	234.5	236.9	235.7	24.4	25.0	24.7
SEL-98	30.0	34.0	32.0	277.8	280.6	279.2	22.4	23.0	22.7
10-6-D10	23.3	23.8	23.6	198.8	200.8	199.8	12.7	13.0	12.8
2-5-D11	21.6	22.0	21.8	237.6	240.0	238.8	12.1	12.4	12.2
12-7-D11	31.5	40.0	35.8	196.9	198.9	197.9	10.7	11.0	10.9
26-16-D11	38.1	37.7	37.9	266.4	269.1	267.8	18.5	19.0	18.8
8-4-D11	22.4	22.9	22.7	238.1	240.5	239.3	14.7	15.1	14.9
29-9-D11	30.1	30.0	30.1	214.9	217.1	216.0	13.8	14.2	14.0
S-1	23.5	24.0	23.8	216.7	218.9	217.8	11.7	12.0	11.8
MHC-73	27.4	28.0	27.7	223.5	225.8	224.7	17.3	17.8	17.6
MHC-26	29.5	34.0	31.8	248.5	251.0	249.8	15.2	15.6	15.4
MCC-309	31.0	34.0	32.5	306.0	309.1	307.6	21.4	22.0	21.7
APG-284	31.3	31.8	31.5	149.1	150.6	149.9	22.2	23.0	22.6
APG-293	32.5	49.0	40.8	263.6	266.3	264.9	13.2	13.5	13.3
MHC-10	16.0	13.0	14.5	224.4	226.7	225.5	13.4	13.8	13.6
SKP-170	40.2	42.0	41.1	256.5	259.1	257.8	27.3	28.0	27.6
MHC-18	31.5	32.6	32.1	214.0	216.2	215.1	22.4	23.0	22.7
MHC-13	21.0	28.3	24.7	186.3	188.2	187.3	15.6	16.0	15.8
SKP-165	23.7	24.2	23.9	223.0	225.3	224.1	13.6	14.0	13.8
PS-44	31.9	29.8	30.9	294.9	297.9	296.4	22.4	23.0	22.7
MCC-200	29.4	30.0	29.7	237.3	239.7	238.5	15.6	16.0	15.8
CCS-872	30.2	30.8	30.5	256.5	259.1	257.8	15.6	16.0	15.8
RR-1	17.6	30.2	23.9	230.4	232.7	231.5	12.7	13.0	12.8
CCS-1	27.4	28.0	27.7	200.4	202.4	201.4	11.3	11.6	11.5
CL-688	24.0	28.0	26.0	237.6	240.0	238.8	13.6	14.0	13.8
CL-692	30.5	32.3	32.3	226.7	229.8	225.9	17.1	17.8	2.2
M-1	32.2	33.2	32.6	283.9	288.8	285.8	18.1	20.4	4.7
M-2	27.6	28.3	27.8	328.8	337.7	333.2	20.9	23.1	6.7
Mean	25.9	27.8	26.9	234.3	236.8	235.6	23.5	21.4	15.1
SEm±	1.7	1.0	1.3	4.8	3.8	3.7	0.5	0.9	0.5
CD@5%	3.7	2.2	2.9	10.2	8.1	7.9	1.0	1.9	1.1

Leaf length (cm), Leaf breadth (cm) and number of vegetative buds /clump

The leaf length showed significant among the genotypes for both the years of experimentation (Table-2)

It was observed that, the genotype Green Gold proved maximum leaf length of 71.4 cm which on par with the genotypes KMRD-2 (69.3 cm) and CSS-800 (68.6 cm). Minimum leaf length was observed in the genotype APG- 284 (37.1cm) during the year 2016-17. Similar trend was registered during the year 2017-18 with Green gold recording the highest leaf length of 72.0 cm, which was on par with the genotypes KMRD-2 (69.7 cm) and CSS-800 (69.0 cm) and minimum leaf length was observed in APG -284 (37.4). Pooled analysis of two years data showed that, maximum leaf length of 71.7 cm was in Green Gold which was on par with the genotypes KMRD-2 (69.5 cm) and CSS-800 (68.8 cm), MHC-26 (68.6), PS-44 (68.0), M-2 (67.8), CCS-800 and 2-5-D-11 (67.3). Minimum leaf length was noted in APG-284 with 37.2 cm.

Leaf breadth recorded in cardamom varieties, entries and genotypes exhibited significant differences in first year, second year and as well as in pooled mean analysis.

Highest leaf breadth was recorded in Green Gold (14.0 cm) and SEL-98 (14.0 cm), whereas lowest was in D-751 (7.0 cm) in the year 2016-17. The genotypes CCS-800 (13.9 cm), SKP1-70 (13.7 cm) and APG-284 (13.5 cm) were on par with the genotypes Green Gold and SEL-98 with respect to the leaf breadth and similar trend was observed for the second year as well as for the pooled mean analysis, wherein Green Gold (14.5 cm) recorded maximum leaf breadth followed by CCS-

800 (14.0 cm) and SKP-170 (13.8 cm) in the second year and Green Gold (14.2 cm) showed maximum leaf breadth followed by CCS-800 (13.9 cm) and SKP-170 (13.8cm) as per the analysis of pooled data of two years. The variety D-751 recorded the lowest in second year and pooled analysis with 7.0 cm.

Highly significant differences in number of vegetative buds per clump were observed among the genotypes in both the years of study as well as in the pooled mean analysis.

In the year 2016-17, significantly highest numbers of vegetative buds per clump was observed in the genotype RR-1 (9.9) followed by 2-5-D11 (9.6), D-168 (9.5) and PDP-12 (9.3) and the lowest numbers of vegetative buds was recorded in the genotype ICRI-2 (3.0). However, in the year 2017-18, highest number of vegetative buds was recorded in the genotype 10-6-D10 (8.8) which was on par with the genotypes MHC-13 (8.5), RR-1 (8.3) and PDP-12, K-5, MCC-12, CCS-800, SEL-98 and MCC-309 which registered 8.3 vegetative buds per clump. Lowest number of vegetative buds per clump was in MCC-61 (4.5). Pooled analysis of two years data clearly revealed that, highest number of vegetative buds per clump was in RR-1 (9.1) which was on par with the genotypes PDP-12 (8.8), D-168 (8.7) and differed significantly from rest of the genotypes studied and closely followed by K-5, CCS-800, SEL-98 and MCC-309 which recorded 8.6 vegetative buds per clump. Lowest number of vegetative buds was present in MCC-61 (4.1). More the leaf length and width will help in improve the photosynthetic efficiency and more the vegetative buds per plant will help in improve the capsule yield in succeeding year. Variation with respect to leaf length, leaf width and number of vegetative buds per clump among the genotypes might be due to the genetic constitution of individual genotype. These results are in accordance with the findings of Backiyarani *et al.* (2002) [3], Radhakrishnan (2003) [17] Hrideek *et al.* (2008) [7] and Akhila *et al*. (2017) [1] in small cardamom.

Table 2: Variability in cardamom (*Elettaria cardamomum* Maton) genotypes for leaf length, leaf breadth and number of vegetative buds per clump

Genotype	Leaf length (cm)			Leaf breadth (cm)			Number of vegetative buds/clump		
	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
Wynad	47.6	47.9	47.8	11.0	11.0	11.0	6.7	6.8	6.7
CL-671	50.1	50.4	50.3	8.6	8.6	8.6	7.3	6.5	6.9
CL-622	50.3	50.6	50.5	9.4	9.5	9.4	4.0	5.0	4.5
D-751	51.8	52.1	52.0	7.0	7.0	7.0	8.0	7.3	7.6
PV-4	46.2	46.5	46.3	8.5	8.5	8.5	6.4	5.3	5.9
D-168	49.4	49.7	49.6	9.2	9.2	9.2	9.5	7.9	8.7
PDP-4	46.9	47.2	47.1	7.3	7.3	7.3	3.3	5.0	4.2
PDP-14	58.9	59.3	59.1	9.1	9.1	9.1	8.3	7.3	7.8
Pink pseudostem	46.4	46.7	46.5	8.2	8.2	8.2	7.2	6.4	6.8
NCL-1	54.3	54.7	54.5	11.6	11.6	11.6	6.3	5.5	5.9
CL-73	53.9	54.2	54.0	10.6	10.6	10.6	7.3	6.5	6.9
Darmada	54.0	54.3	54.1	9.5	9.6	9.6	8.7	7.5	8.1
Ceylon-5	45.0	45.2	45.1	11.6	11.7	11.6	6.0	7.0	6.5
P-10	59.4	59.8	59.6	12.6	12.6	12.6	7.3	6.5	6.9
Ceylon-2	54.9	55.2	55.0	12.8	12.8	12.8	7.3	7.5	7.4
PDP-12	38.7	38.9	38.8	7.9	8.0	8.0	9.3	8.3	8.8
K-5	64.4	64.8	64.6	9.6	9.6	9.6	9.0	8.3	8.6
D-516	48.2	48.5	48.3	13.2	13.2	13.2	6.3	6.8	6.5
KMRD-2	69.3	69.7	69.5	12.8	12.8	12.8	6.0	7.3	6.6
D-11	49.5	49.8	49.7	10.9	11.0	10.9	5.0	6.4	5.7
D-140	58.3	58.7	58.5	11.6	11.6	11.6	4.3	5.3	4.8
D-163	62.5	62.9	62.7	11.0	11.0	11.0	3.7	5.0	4.3
KMRD-10	57.9	58.3	58.1	13.0	13.0	13.0	4.3	5.3	4.8
P-1	63.3	63.6	63.4	13.0	13.0	13.0	7.3	6.4	6.8
Kallar	63.0	63.4	63.2	9.0	9.0	9.0	4.7	5.5	5.1
CL-679	55.1	55.4	55.2	11.8	11.8	11.8	5.3	6.3	5.8
Green Gold	71.4	72.0	71.7	14.0	14.5	14.2	4.0	5.5	4.8
HS-1	54.0	58.0	56.0	7.0	7.1	7.0	8.3	7.0	7.7
MCC-61	57.2	57.6	57.4	12.8	12.8	12.8	3.7	4.5	4.1
SKP-5	50.9	51.3	51.1	7.9	8.0	8.0	4.3	5.5	4.9
MCC-12	49.4	49.6	49.5	10.5	10.5	10.5	7.8	8.3	8.0
MCC-21	63.3	63.6	63.4	12.8	11.2	12.0	4.7	5.5	5.1
CSS-800	68.6	69.0	68.8	8.1	8.2	8.2	8.7	7.9	8.3
ICRI-2	60.1	60.5	60.3	11.5	11.5	11.5	3.0	4.5	3.8
SKP-21	49.1	49.4	49.3	12.8	12.8	12.8	4.0	5.5	4.8
SKP-72	61.0	61.3	61.2	11.1	11.1	11.1	6.0	7.2	6.6
CL-698	64.4	64.8	64.6	12.6	12.7	12.6	6.3	7.3	6.8
MCC-18	53.0	53.3	53.1	13.0	13.0	13.0	6.3	7.5	6.9
CL-668	46.1	46.4	46.2	12.0	12.0	12.0	5.3	6.4	5.8
CCS-800	67.1	67.5	67.3	13.9	14.0	14.0	9.0	8.3	8.6
SEL-98	58.7	59.0	58.9	14.0	13.2	13.6	9.0	8.3	8.6
10-6-D10	47.6	47.9	47.8	10.0	10.0	10.0	8.0	8.8	8.4
2-5-D11	67.1	67.5	67.3	10.0	10.0	10.0	9.6	7.4	8.5
12-7-D11	51.9	52.3	52.1	8.8	8.8	8.8	6.0	7.0	6.5

26-16-D11	55.6	55.9	55.8	13.0	13.0	13.0	6.3	7.0	6.7
8-4-D11	60.0	60.3	60.2	10.0	10.1	10.0	8.0	7.3	7.6
29-9-D11	46.9	47.2	47.0	11.8	11.8	11.8	8.3	7.2	7.7
S-1	54.1	54.5	54.3	10.1	10.2	10.1	5.3	6.0	5.6
MHC-73	45.4	45.7	45.5	12.4	12.4	12.4	6.7	7.5	7.1
MHC-26	68.6	69.0	68.8	12.4	12.4	12.4	5.3	6.9	6.1
MCC-309	61.6	62.0	61.8	12.6	12.6	12.0	9.0	8.3	8.6
APG-284	37.1	37.4	37.2	13.5	13.5	13.5	4.0	5.9	4.9
APG-293	64.4	64.8	64.6	10.0	10.0	10.0	8.3	7.3	7.8
MHC-10	55.6	56.0	55.8	10.2	10.2	10.2	6.0	7.2	6.6
SKP-170	59.5	59.9	59.7	13.7	13.8	13.8	7.3	6.3	6.8
MHC-18	51.3	51.6	51.4	13.4	13.4	13.4	8.0	7.2	7.6
MHC-13	57.9	58.3	58.1	12.4	12.4	12.4	7.3	8.5	7.9
SKP-165	48.1	48.4	48.3	10.4	10.4	10.4	8.5	7.4	8.0
PS-44	67.8	68.2	68.0	13.0	13.0	13.0	8.0	7.0	7.5
MCC-200	46.3	46.6	46.4	12.0	12.0	12.0	7.0	6.5	6.7
CCS-872	63.3	63.6	63.4	12.0	12.0	12.0	6.7	5.3	6.0
RR-1	48.4	48.7	48.5	11.0	11.0	11.0	9.9	8.3	9.1
CCS-1	57.2	57.5	57.3	11.6	11.6	11.6	7.0	7.8	7.4
CL-688	40.8	41.0	40.9	11.0	11.0	11.0	7.0	6.5	6.8
CL-692	56.2	58.3	57.2	11.2	11.4	11.3	5.1	6.1	5.6
M-1	59.5	60.9	60.2	11.7	12.1	11.9	6.7	7.0	6.8
M-2	67.4	68.2	67.8	12.7	13.2	12.3	7.1	7.5	7.3
Mean	55.2	55.6	55.4	11.1	11.1	11.1	6.7	6.7	6.7
SEm±	2.2	2.1	2.1	0.3	0.3	0.2	0.1	0.3	0.2
CD@5%	4.8	4.5	4.6	0.7	0.6	0.5	0.2	0.6	0.4

Conclusion

It was concluded from the study that, out of 67 cardamom working collections, KMRD-2, CSS-800, SKP-170, 26-16-D11, SEL-98, RR-1 and PDP-12 were found better with respect to morphological traits.

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