



# Assessment of variability and performance of new landraces of small cardamom (*Elettaria cardamomum* Maton)

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## Abstract

Even though fourteen improved varieties of small cardamom have been released in India so far, many of the farmers in the traditional cardamom tracts still use farmer selected landraces as planting material and hence the importance of landraces is not questionable. Four new landraces of small cardamom identified from Idukki district of Kerala State of India namely *Pulari*, *Pappalu*, *Kalarikkal Bold* and *Arjun* were evaluated along with *Njallani Green Gold* (popular landrace) and ICRI-2 (improved variety released by Indian Cardamom Research Institute) for growth, yield and quality characters. Eight growth characters, eight yield characters and eleven quality characters were analyzed for the purpose and all of them except two yield characters showed statistically significant variation indicating the occurrence of significant genotypic difference between these landraces. A comparative analysis of overall performance of the four landraces was also carried out and the results showed that *Pappalu*, *Kalarikkal Bold* and *Pulari* performed significantly superior to *Njallani Green Gold* and ICRI-2, the controls. *Pappalu* showed 132.22 per cent increase in yield over *Njallani Green Gold* and 158.02-per cent over ICRI-2. The cumulative performance indices of all the new landraces were worked out and the landrace *Pappalu* had the highest performance index of 30.06 followed by *Kalarikkal Bold* (27.45), *Arjun* (25.57) and *Pulari* (24.14). All the four new landraces have been found to be superior to ICRI-2 while *Pappalu*, *Kalarikkal Bold* and *Pulari* showed superiority over *Njallani Green Gold*, under preliminary evaluation.

**Keywords:** *Elettaria cardamomum*, evaluation, landraces, performance index, small cardamom

## Introduction

Small cardamom, often referred to as the 'queen of spices' is the commercial product obtained from the zingiberaceous, perennial, rhizomatous plant *Elettaria cardamomum* Maton. It is grown extensively in the Western Ghat region of South India at an elevation of 800-1300 m as an under crop in forest lands. It is also grown on plantation scale in countries like Guatemala, Sri Lanka, Papua New Guinea, El Salvador, Vietnam, Laos, Cambodia and Tanzania. Cardamom is native to the moist evergreen forests of Western Ghats of South India (Ravindran, 2002). It is cultivated in India in an area of 69,770 ha, out of which Kerala occupies 60 per cent, Karnataka 30 per cent and Tamil Nadu 10 per cent. Cardamom production in

India during 2014-15 was 18,000 MT (Spices Board, 2015).

Even though fourteen improved and location specific varieties of small cardamom have been developed and made available to farmers of India by various research institutes working on the crop, many farmers still depend on promising landraces for cultivation (Radhakrishnan and Mohanan, 2012). Being a crop that is mainly propagated clonally using suckers, screening of such landraces so as to select promising genotypes from them has immense potential in crop improvement of cardamom. Recently, progressive farmers from the Cardamom Hill Reserve (CHR) of Idukki district of Kerala have identified and come out with four new landraces namely *Pulari*, *Pappalu*, *Kalarikkal Bold* and *Arjun*. The present study has been carried

out to characterize and evaluate the variability and performance of the four new landraces of cardamom in comparison with the released variety ICRI-2 and the most popular landrace *Njallani Green Gold* with regard to growth, yield and quality characters.

## Materials and methods

The study was carried out on participatory mode in planter's field in the CHR of Idukki district, during 2010-2016. The planter's field is located at an altitude of 1,068 m above MSL at 9° 53' N latitude and 77° 09' E longitude. The location enjoys humid tropical climate with a well distributed rainfall of 2700 mm per annum. The soil is forest loam with a pH of 5-6. Populations of the landraces namely *Pulari*, *Pappalu*, *Kalarikkal Bold*, *Arjun* and control varieties such as *Njallani Green Gold* and ICRI-2 were planted in randomized block design (RBD) with four replications and eighteen plants per plot at a spacing of 3 m x 3 m in 2010. The populations were raised from suckers propagated vegetatively to avoid heterogeneity due to segregation. Recommended package of practices of Spices Board, India was followed for cultivation. Data on twenty seven characters including eight growth characters such as tiller number, tiller height, leaves per tiller, leaf length, leaf breadth, leaf area, number of vegetative buds and number of bearing tillers; eight yield characters such as panicles per clump, panicle length, racemes per panicle, capsules per raceme, seeds per capsule, internodal length, fresh seed weight and dry seed weight; and eleven quality characters such as fresh husk weight, dry husk weight, 100 fresh capsule weight, fresh yield per plant, dry yield per plant, volatile oil content, oleoresin content, moisture content, percentage of 7 mm and above sized capsules, recovery percentage and seed:husk ratio were recorded and analyzed statistically. The variation between the landraces in the case of each character and also from the control genotypes was estimated by calculating range, mean, standard deviation, standard error and coefficient of variation. Analysis of variance (ANOVA) was carried out to test the significance of variation between the landraces in comparison with the control genotypes. Test of significance was done with reference to standard F table (Fisher and Yates, 1963). Critical difference was calculated to find out the significance of variation between any two observations. Comparative performance of

the cardamom genotypes was analyzed based on performance index calculated as per Amaravenmathy and Srinivasan (2003).

## Results and discussion

### Study of variability

To analyze the variation between the landraces the data were subjected to statistical analysis and the results are presented in Table 1. Among the 27 growth, yield and quality characters studied, 25 characters showed statistically significant variation between the landraces and controls indicating the presence of variability between them so as to maintaining their genetic identity. Among the growth characters taken for the study significant variations were observed among the landraces and controls in terms of tiller number, tiller height, leaf length, leaf breadth, leaf area, number of vegetative buds and number of bearing tillers. Among the yield characters studied dry yield per plant was found to be the most variable. Significant variation was shown by panicles per clump, panicle length, racemes per panicle, seeds per capsule and fresh yield per plant, but capsules per raceme and internodal length were found to show only non-significant statistical variation. Among the quality characters studied seed: husk ratio was the most variable. Other parameters that were found to be significantly variable among the landraces and controls were 7 mm and above sized capsules, dry husk weight, percentage of oleoresin, 100 capsule weight, dry seed weight, percentage of moisture content, percentage of volatile oil, seed weight fresh, recovery percentage and husk weight fresh.

Study of variability between the genotypes in terms of the variation of the above characters indicated that among the growth characters the highest coefficient of variation was shown by number of vegetative buds (65.84%) followed by number of bearing tillers (20.18%) and the lowest coefficient of variation by tiller number (2.71%). Leaf area showed a coefficient of variation of 17.61 per cent, tiller height showed a coefficient of variation of 16.01 per cent, in leaves per tiller it was 7.54 per cent, 6.56 per cent in the case of leaf length and 6.00 per cent in the case of leaf breadth. Among the yield characters the highest coefficient of variation was shown by dry yield per plant (36.36%) followed by fresh yield per plant (32.22%)

Table 1. Characters of the new landraces and controls of cardamom studied

Sl. No.	Characters	Pulari	Pappalu	Kalarikkal	Arjun	Njallani Green Gold	ICRI-2	Mean±SE	SD	CV %	CD
1	Tiller number **	41.00	45.70	63.10	77.25	66.35	95.30	64.78±0.71	1.76	2.71	11.76
2	Tiller height (cm) **	300.56	400.41	400.10	300.53	300.09	200.70	300.56±0.23	0.57	16.01	0.44
3	Leaves/tiller *	20.60	20.60	20.30	22.05	20.31	17.00	20.14±0.62	1.52	7.54	2.53
4	Leaf length (cm) **	72.72	67.06	60.32	63.20	65.50	60.50	64.88±1.73	4.26	6.56	4.01
5	Leaf breadth (cm) **	13.18	12.66	12.14	11.02	12.15	11.42	12.15±0.30	0.73	6.00	0.78
6	Leaf area (cm <sup>2</sup> ) **	627.53	529.82	545.16	517.70	599.46	337.86	526.26±37.82	92.68	17.61	134.48
7	No. of veg. buds **	4.35	10.05	4.00	2.95	14.35	3.15	6.74±1.73	4.26	65.84	2.44
8	No. of bearing tillers **	22.40	43.00	45.95	41.10	39.00	45.15	39.43±3.24	7.96	20.18	7.25
9	Panicles clump <sup>-1</sup> **	41.95	87.95	97.85	94.40	81.25	80.75	80.69±7.51	18.42	22.82	12.49
10	Panicle length (cm) **	100.50	119.25	134.00	86.00	79.00	72.25	98.50±9.00	22.06	22.39	16.58
11	Racemes panicle <sup>-1</sup> **	27.65	33.10	26.75	28.30	29.50	19.50	27.46±1.66	4.09	14.89	4.16
12	Capsules raceme <sup>-1</sup>	11.30	10.05	9.75	9.30	10.35	8.75	9.91±0.32	0.80	8.07	NS
13	Seeds capsule <sup>-1</sup> **	22.65	21.75	17.15	18.15	21.55	17.90	19.85±0.95	2.33	11.73	3.60
14	Internodal length (cm)	4.62	4.42	4.26	4.82	4.83	5.45	4.73±0.15	0.37	7.82	NS
15	Seed fresh weight (g) **	33.29	29.33	25.53	34.83	32.66	33.42	31.51±1.28	3.15	9.99	1.68
16	Seed dry weight (g) **	17.63	14.37	12.15	14.38	15.32	20.36	15.70±1.08	2.66	16.94	0.84
17	Husk fresh weight (g) **	63.51	68.26	73.27	63.28	66.13	62.03	66.58±1.39	3.42	5.13	0.61
18	Husk dry weight (g) **	6.70	9.87	5.89	5.83	5.84	8.37	7.08±0.62	1.53	21.61	0.86
19	100 Capsule fresh weight (g) **	172.22	164.92	169.09	137.75	127.37	100.41	145.29±10.62	26.03	17.91	0.66
20	Yield plant <sup>-1</sup> fresh(kg) **	10.33	18.10	14.71	8.58	8.87	8.09	11.45±1.50	3.69	32.22	0.96
21	Yield plant <sup>-1</sup> dry(kg) **	2.33	4.18	3.36	1.89	1.80	1.62	2.53±0.37	0.92	36.36	0.21
22	Volatile oil (%) *	7.00	8.00	9.00	6.56	8.56	9.00	8.02±0.38	0.94	11.72	1.84
23	Oleoresin (%) **	8.80	10.40	6.60	7.00	6.20	6.80	7.63±0.60	1.48	19.39	0.21
24	Moisture content (%) **	8.80	8.00	9.00	8.20	6.20	7.11	7.88±0.39	0.96	12.18	2.21
25	% of 7 mm and above sized capsules **	69.54	73.06	72.03	68.22	71.31	62.91	69.51±1.35	3.33	4.79	0.86
26	Recovery percentage **	22.53	23.12	22.85	22.09	20.33	20.04	21.82±0.48	1.20	5.49	0.87
27	Seed:husk **	0.52	0.42	0.34	0.53	0.52	0.50	0.47±0.12	0.30	63.82	0.01

\*\*: Significant at 1% level; \*: significant at 5% level.

and the lowest coefficient of variation by internodal length (7.82%). Panicles per clump showed a coefficient of variation of 22.82 per cent, in the case of panicle length it was 22.39 per cent, 14.89 per cent in the case of racemes per panicle, 11.73 per cent in the case of seeds per capsule and 8.07 per cent in the case of capsule per raceme. Among the eleven quality characters analyzed the highest coefficient of variation was shown by seed: husk ratio (63.82%) and the lowest coefficient of variation by percentage of 7 mm and above sized capsules (4.79%). Dry husk weight showed a coefficient of variation of 21.61 per cent, in the case of percentage of oleoresin it was 19.39 per cent, in the case of 100 capsule weight it was 17.91 per cent, in the case of dry seed weight it was 16.94 per cent, in the case of moisture content it was 12.18 per cent, in the case of volatile oil it was 11.72 per cent, in the case of seed weight fresh it was 9.99 per cent, for recovery percentage it was 5.49 per cent and for husk weight it was 5.13 per cent.

The above analysis of the four landraces of cardamom in comparison with two standard checks showed that *Arjun* produced higher number of tiller per clump when compared to ICRI-2, but not with *Njallani Green Gold*, the standard check. Tiller height in *Pulari*, *Pappalu*, *Kalarikkal Bold* and *Arjun* was found to be higher when compared to the controls. Leaves per tiller, leaf length and leaf breadth were higher in *Pulari* and *Pappalu*. Leaf area was higher in all the four landraces when compared to ICRI-2. Number of vegetative buds was higher in *Pappalu* and *Kalarikkal Bold* when compared to ICRI-2. Number of bearing tillers was higher in *Pappalu*, *Kalarikkal Bold* and *Arjun* when compared with *Njallani Green Gold*. Panicles per clump were higher in *Pappalu*, *Kalarikkal Bold* and *Arjun* when compared to both the controls. Panicle length was higher in all the four selected landraces when compared to both the checks. Only *Pappalu* produced higher number of racemes per panicle when compared to *Njallani Green Gold* and ICRI-2. Capsules per racemes were higher in all the four landraces when compared to ICRI-2. Seeds per capsule were higher in all the four landraces compared to both the checks. Only *Arjun* showed higher fresh seed weight when compared with ICRI-2. Only *Pulari* showed higher dry seed weight when compared with *Njallani Green Gold*. Fresh

husk weight, 100 capsule weight and dry husk weight were higher in all the four landraces when compared with standard checks. Fresh yield per plant was higher in *Pulari*, *Pappalu* and *Kalarikkal Bold* when compared with both the checks while *Arjun* showed higher fresh yield per plant than ICRI-2. Dry yield per plant was higher in all the four selected landraces when compared to the standard checks. Percentage of volatile oil was higher in *Kalarikkal Bold* when compared to *Njallani Green Gold* but was on par with ICRI-2. Percentage of oleoresin was higher in *Pulari*, *Pappalu* and *Arjun* when compared with both the controls. Percentage of moisture content, percentage of 7 mm and above sized capsules and recovery percentage were higher in all the selected landraces when compared to the *Njallani Green Gold* and ICRI-2. Seed: husk ratio was higher in *Arjun* when compared to *Njallani Green Gold* and ICRI-2 and in *Pulari* it was higher when compared with ICRI-2 only.

### Study of yield performance

Comparative yield performance of *Pulari*, *Pappalu*, *Kalarikkal Bold*, *Arjun*, *Njallani Green Gold* and ICRI-2 is provided in Table 2 and it shows that *Pappalu* and *Kalarikkal Bold* offer better performance over the controls. *Pappalu* showed 132.22 per cent increase of yield over *Njallani Green Gold* and 158.02 per cent over ICRI-2. *Kalarikkal Bold* showed 86.66 per cent increase of yield over *Njallani Green Gold* and 107.40 per cent over ICRI-2.

### Evaluation of performance index

Study of comparative performance of the landraces in comparison with the controls revealed that *Pappalu* (30.06) showed the highest cumulative

**Table 2. Yield of new landraces – comparative performance**

Sl. No.	Name of landraces	Yield plant <sup>-1</sup> (kg)	Percentage increase over <i>Njallani Green Gold</i>	Percentage increase over ICRI - 2
1	<i>Pulari</i>	2.33	29.4	43.82
2	<i>Pappalu</i>	4.18	132.2	158.02
3	<i>Kalarikkal Bold</i>	3.36	86.7	107.40
4	<i>Arjun</i>	1.89	5.0	16.66

performance index followed by *Kalarikkal Bold* (27.45), *Arjun* (25.57) and *Pulari* (24.14) (Table 3). In the case of the controls, cumulative performance index was 27.11 in the case of *Njallani Green Gold* and 24.11 in the case of ICRI-2. From the above data, it can be seen that in terms of the agronomic characters studied, *Pappalu* showed the best performance followed by *Kalarikkal Bold*, *Njallani Green Gold*, *Arjun*, *Pulari* and ICRI-2.

Performance assessment of several cardamom genotypes was carried out by earlier workers and they have succeeded in selecting certain promising

selections and hybrids (Korikanthimath *et al.*, 1997; Kuruvilla *et al.*, 2006). Performance assessment of fourteen cardamom genotypes was carried out by Radhakrishnan *et al.* (2005) and it resulted in the selection of certain promising genotypes and hybrids. Hrideek *et al.* (2015) have studied the variability of some other landraces of cardamom so as to select the best performers. By analyzing all the facts the present findings indicate the potential of using the genotypes like *Pappalu*, *Kalarikkal Bold* and *Pulari* for further breeding programmes as parental material so that varieties with

**Table 3. Performance indices of landraces and controls**

Sl. No.	Characters	<i>Pulari</i>	<i>Pappalu</i>	<i>Kalarikkal Bold</i>	<i>Arjun</i>	<i>Njallani Green Gold</i>	ICRI-2
1	Tiller number	0.43	0.47	0.97	1.19	1.02	1.47
2	Tiller height (m)	1.00	1.33	1.33	0.99	0.99	0.66
3	Leaves tiller <sup>-1</sup>	1.02	1.02	1.00	1.09	1.00	0.84
4	Leaf length (cm)	1.12	1.03	0.92	0.97	1.00	0.93
5	Leaf breadth (cm)	1.08	1.04	0.99	0.90	1.00	0.93
6	Leaf area (cm <sup>2</sup> )	1.19	1.00	1.03	0.98	1.13	0.64
7	Number of vegetative buds	0.64	1.49	0.59	0.43	2.12	0.46
8	Number of bearing tillers	0.56	1.09	1.16	1.04	0.98	1.14
9	Panicle clump <sup>-1</sup>	0.51	1.08	1.21	1.16	1.00	1.00
10	Panicle length (cm)	1.02	1.21	1.36	0.87	0.80	0.73
11	Racemes panicle <sup>-1</sup>	1.00	1.20	0.97	1.03	1.07	0.71
12	Capsules raceme <sup>-1</sup>	1.00	1.01	0.98	0.93	1.04	0.88
13	Seeds capsule <sup>-1</sup>	1.14	1.09	0.86	0.91	1.08	0.90
14	Internodal length (cm)	0.97	0.93	0.90	1.01	1.02	1.15
15	Seed fresh weight (g)	1.05	0.93	0.81	1.10	1.03	1.06
16	Seed dry weight (g)	1.12	0.91	0.77	0.91	0.97	1.29
17	Husk fresh weight (g)	0.95	1.02	1.10	0.95	0.99	0.93
18	Husk dry weight (g)	0.94	1.39	0.83	0.82	0.82	1.18
19	100 capsule fresh weight (g)	1.18	1.13	1.16	0.94	0.87	0.69
20	Yield plant <sup>-1</sup> fresh (kg)	0.90	1.58	1.28	0.74	0.77	0.70
21	Yield plant <sup>-1</sup> dry (kg)	0.92	1.65	1.32	0.74	0.71	0.64
22	Volatile oil (%)	0.87	0.99	1.12	0.81	1.06	1.12
23	Oleoresin (%)	1.15	1.36	0.86	0.91	0.81	0.98
24	Moisture content (%)	1.11	1.01	1.14	1.04	0.78	0.90
25	Percentage of 7 mm and above sized capsules	1.00	1.16	1.03	0.98	1.02	0.90
26	Recovery percentage	1.03	1.05	1.04	1.01	0.93	0.91
27	Seed: husk	1.10	0.89	0.72	1.12	1.10	1.06
	Total	24.14	30.06	27.45	25.57	27.11	24.71



significantly superior characters could be developed.

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