

Systematic and variability studies on ‘hidden purple ginger’, *Curcuma inodora* Blatter J. (Zingiberaceae) – an endemic promising ginger from Peninsular India

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Ornamental horticulture has become an important commercial trade area in India through the steady increase in demand for cut flowers, and potted and landscape plants. India has a rich distribution of many wild gingers and their ornamental potential is yet to be exploited. The present study is a step towards using the potential ornamental value of Indian wild gingers and creating knowledge and awareness about the need for conservation and for detailed study of native wild ornamental plants in societies, local peoples, students and horticulturists. With these objectives, one endemic species with high ornamental potential, *Curcuma inodora* Blatter J., was selected and detailed studies were conducted. All the specimens collected were successfully conserved at the Calicut University Botanical Garden.

Keywords: *Curcuma inodora*; hidden purple ginger; potential ornamental ginger; soil analysis; taxonomy; variability; Zingiberaceae

Introduction

The ginger family, Zingiberaceae consists of about 53 genera and more than 1200 species, distributed mainly in the tropics and subtropics with the centre of distribution in the Indo-Malayan region, but extending through tropical Africa to Central and South America (Kress et al. 2002). Among these, more than 250 gingers are widely used as ornamental plants in other parts of the world, namely the USA, Europe and South-East Asia (Sabu et al. 2013). In India, around 200 species are reported under 21 genera, distributed mainly in northeast India, south India and the Andaman and Nicobar Islands (Sabu 2006) with more than 60 ornamental species.

Though there are many potential ornamental species in the wild, hardly 25 species are used in gardens, of which the majority are exotics (Prabhu et al. 2013). The important genera used as ornamentals are *Boesenbergia*, *Curcuma*, *Globba*, *Hedychium*, *Larsenianthus* and *Zingiber* (Thomas et al. 2010).

Gingers differ in their growth requirements, but generally they like a warm humid climate, part shade, and shelter from cold winds. India has suitable climate and soil to cultivate gingers; Indian horticulture must exploit their ornamental value (Sabu et al. 2011). The main problem in their cultivation is the lack of sufficient planting materials and ignorance among floriculturists about their ornamental aspects (Prabhu et al. 2012). Many plants become endangered through habitat loss by anthropogenic activities and natural disasters, hence it is necessary to conserve the plants in *ex situ* conditions.

The ornamental potential of many Indian gingers is yet to be exploited. With this objective, an endemic

ginger with high ornamental value, *Curcuma inodora*, was selected and conserved; detailed taxonomic and variability studies were carried out to popularize this native ginger.

Curcuma inodora Blatter J. is a potential ornamental ginger endemic to peninsular India (Sabu 2006). It is commonly known as ‘hidden purple ginger’ or ‘surprise ginger’ because the inflorescence comes directly from the underground rhizomes, even before the emergence of a leafy shoot (Prabhu et al. 2010a; Sabu et al. 2011). The specific epithet ‘*inodora*’ refers to the non-aromatic nature of the rhizome (Sabu 2006). The plant can be grown as a cut flower crop and as a ground cover plant and propagated by division of rhizomes. The variation in the flower colour and bract colour gives an additional value to its use as an ornamental cut-flower plant (Thomas et al. 2010).

Material and methods

Twelve accessions of *C. inodora* collected from different parts of Peninsular India including Sanquiline of Goa and Malwan of Maharashtra were successfully domesticated at Calicut University Botanical Garden (CUBG), Kerala, India. Detailed taxonomic and variability studies on the domesticated plants were carried out in the CUBG during 2007–10. They were grown in a completely randomized design with 12 replications under controlled greenhouse conditions in 8-inch (20-cm) diameter porous pots. The planted materials were grown in potting mixture prepared by mixing soil, cow dung and river sand in a 1 : 1 : 1 ratio. The plants were grown

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under 50% shade provided artificially. Fertilizers and pesticides were provided on a standard basis (Prabhu et al. 2010b; Thomas et al. 2010). Irrigation was provided in the non-rainy season. Morphological characters and floral characters of the plants on maturity were studied and recorded. The quantitative data were analysed to study variability of characters. Colour variation and other relevant details were observed and photographed.

As part of the study, soil samples were collected from selected localities and tested at the Soil testing laboratory, Government of Kerala at Pattambi and Malappuram. Various parameters, including pH, total soluble salts, organic carbon, potassium, phosphorus, were analysed.

Results and Discussion

Taxonomy

Curcuma inodora Blatter, J. Proc. Asiat. Soc. Bengal 26: 357. 1930

Type: Bombay Presidency, Moolgaum, Salsette, Hallberg 12,724 (Holo, BLAT).

Santapau, J. Bombay Nat. Hist. Soc. 51: 135. 1952; Phatak and Oza, J. Bombay Nat. Hist. Soc. 56: 368. 1959; Mangaly & M. Sabu, Rheedea 3(2): 154. 1993; M. Sabu and Mangaly, Proc. 2nd Symp. Fam. Zingiberaceae 20. 1996. Thomas et al., Ind. J. Bot. Res. 6(1&2):129. 2010; Prabhu et al., 22nd Kerala Sci. Cong. 816. 2010; Raju et al., J. Econ. Tax. Bot. 30(4): 773. 2006.

Description

Rhizome conical, pale yellow in the centre, whitish towards the periphery; root tubers many, ovoid, white inside. Leafy shoot 20–50 cm tall. Pseudostem 8–10 cm long. Leaves distichous, 3–6, petiolate; petiole 20–25 cm long; lamina 15–30 × 7–12 cm, elliptic, base oblique, tip acuminate, minutely hairy along the prominent side veins on the upper side, lower side glabrous; ligule 2 mm long, hyaline. Inflorescence both lateral and central; peduncle 5–10 cm long; spike 10–16 × 4–5 cm with a distinct, violet coma. Coma bracts large, 4–5.5 × 1.5 cm, tip rounded, ovate or lanceolate. Fertile bracts 3.5–4 × 1.5 cm, tip slightly acute or round, not recurved, pale green with a purple patch at the tip. Bracteoles small, outer 1.5 × 0.6 cm, inner 4 × 2 mm, linear, purple, minutely pubescent. Flowers 4.5–5.5 cm long, equal to the bracts. Calyx tubular, 1–1.2 cm long, shortly and irregularly trilobed at apex, white, tube minutely pubescent. Corolla tube c.2.5 cm long, deep purple, pubescent; lobes unequal, dorsal lobe c.1.6 × 1 cm, apiculate, lateral lobes 1–1.3 × 0.5 cm, ovate-lanceolate, deep purple, glabrous. Labellum obovate, obscurely trilobed, tip emarginate, purple with a median bright yellow band. Lateral stamens oblong, 1.5–1.6 × 0.5–0.7 cm, deep purple. Anther

c.4 mm long, thecae parallel, white with a pink base, spurs bent inwards; filament purple. Epigynous glands two, 5 mm long, linear. Ovary 2.8–3.2 × 2–2.2 mm diameter, trilobular, with many ovules on axile placenta, densely pubescent. Style long, filiform, pink; stigma bilobed. Fruit globose to ovoid, 1–1.2 × 0.9 cm, brown, hairy. Seeds many, 3 × 2 mm, brown, aril white, lacerate (Figures 1, 2 and 3).

Phenology

The species is dormant during November to April and sprouts from the first week of May. Flowering is during May to August.

Distribution

Endemic to Peninsular India, extending from Maharashtra to North Karnataka (Mangaly and Sabu 1993; Sabu 2006) and Gujarat (Phatak and Oza 1959) and it has been more reported from Andhra Pradesh (Raju et al. 2006). (Figure 4)

Habitat

It is common in barren laterite areas, plains and road side cuttings. It is found growing in rocky open places with an altitude of 20–200 m above mean sea level and as semi-evergreen forest undergrowth.

IUCN status

Near Threatened (IUCN 2013).

Specimens examined

INDIA: Karnataka, N. Kanara Dt.: Karwar, Sabu 37,366 (CALI). GOA: Sanquiline, Thomas and Shameer 94,701 (CALI); Sanquiline, Thomas and Shameer 94,702 (CALI). Maharashtra: Vajeshwari, Sckornikova 73,403 (CALI).

Soil analysis

Soil samples collected from Sanquiline of Goa and Malwan of Maharashtra were analysed to understand the quality of soil and natural availability of phosphorus, potassium, carbon, etc. In the present investigation, soil samples collected from different habitats of *C. inodora* showed a pH range of 4.7–5.4 and total soluble salts of 0.1–0.2 moh/cm. The organic carbon showed a range of 0.80–0.94 kg/ha, phosphorus content varied from 8.6 to 9.2 kg/ha and potassium content ranged from 85 to 122 kg/ha. From the study it was clear that there was no relation between the soil parameters and the variations observed within the species in natural and *ex situ* conditions. The variations are genotypic.

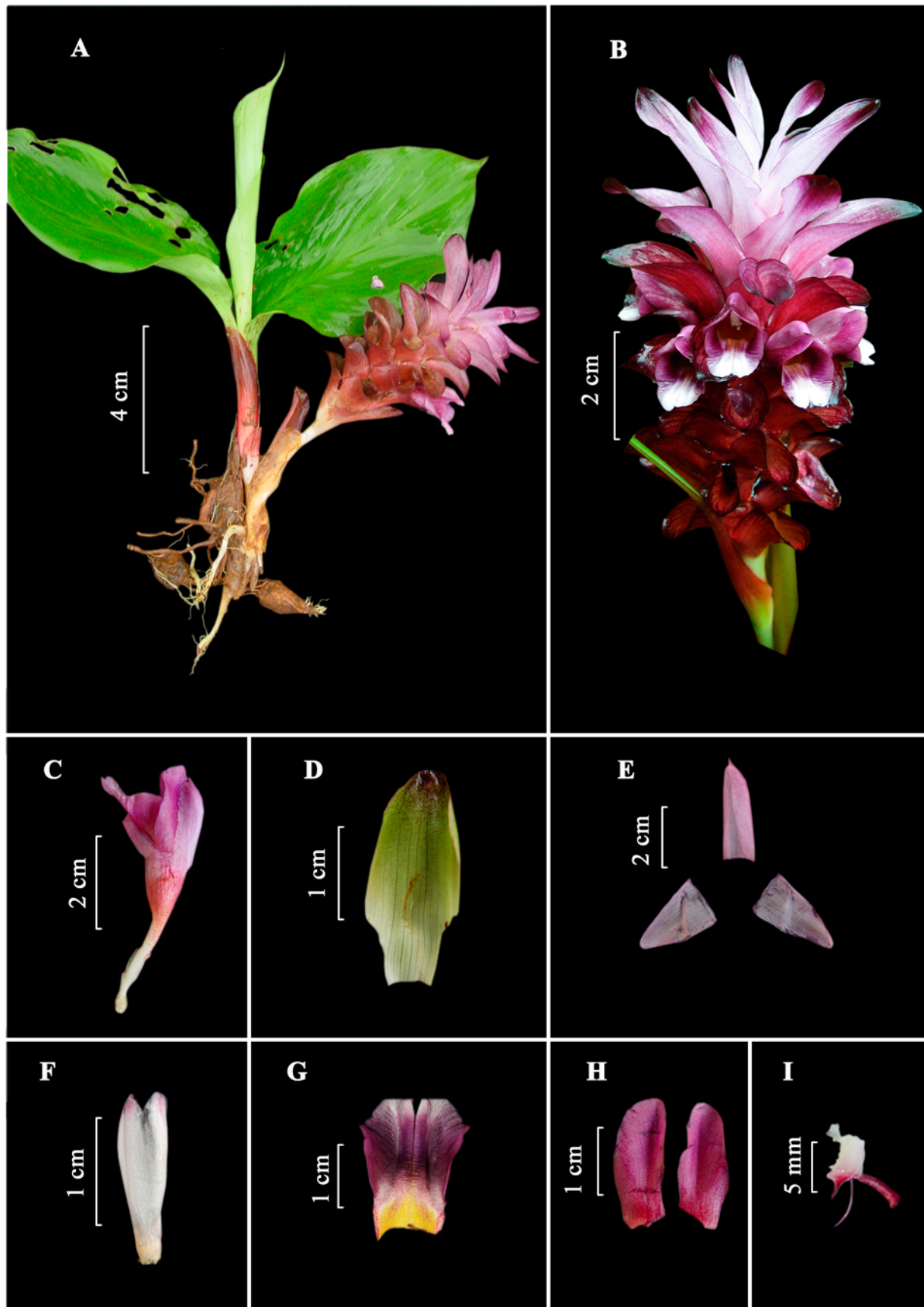


Figure 1. *Curcuma inodora* Blatter. J. (A) Habit. (B) Inflorescence. (C) Flower. (D) Bract. (E) Calyx. (F) Corolla lobes. (G) Labellum. (H) Lateral staminodes. (I) Stamen.



Figure 2. *Curcuma inodora* Blatter. J. Variation in the colour of the labellum.

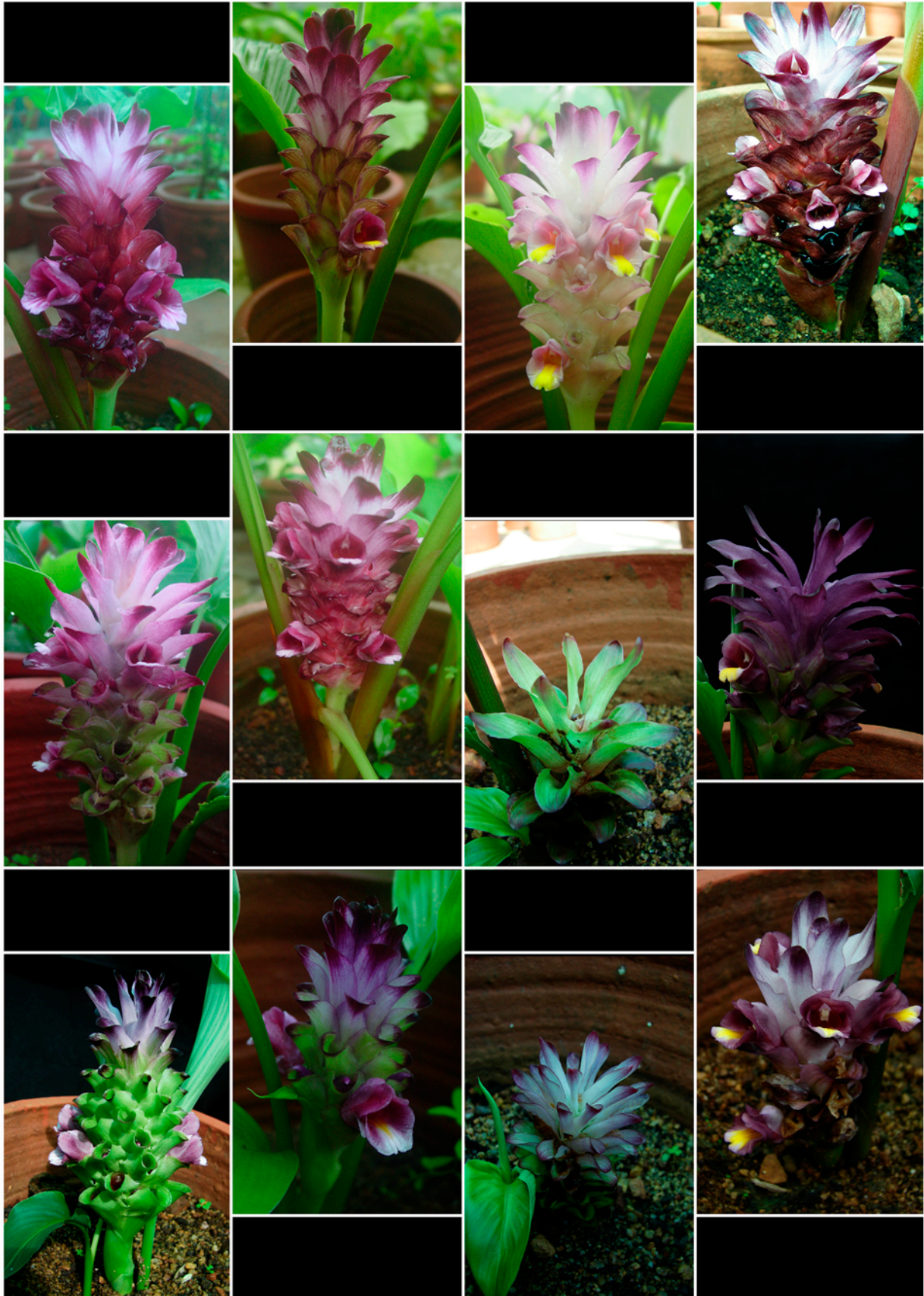


Figure 3. *Curcuma inodora* Blatter. J. Variation in the shape and colour of bract and inflorescence.

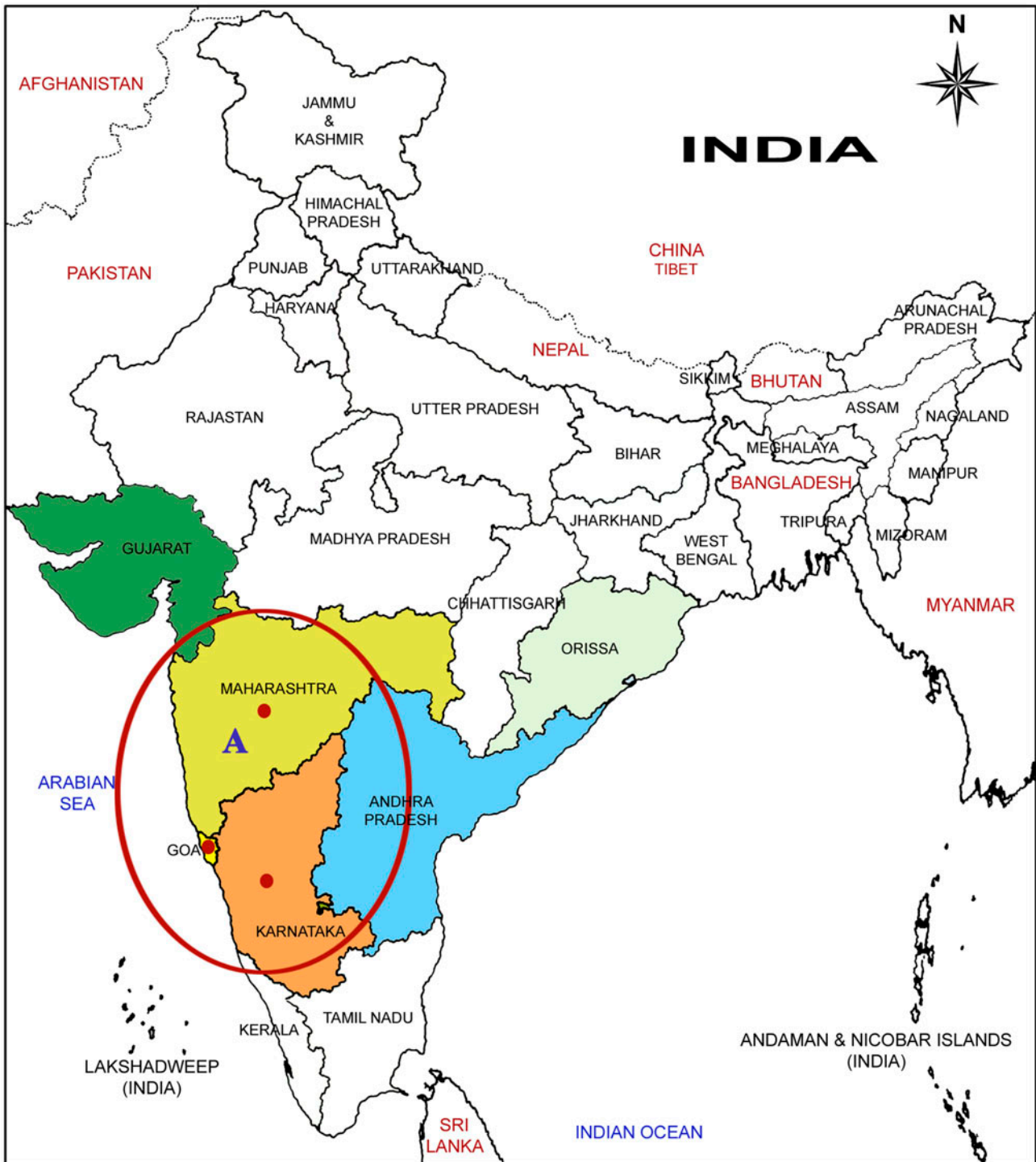


Figure 4. Distribution map of *Curcuma inodora* in India. A indicates Peninsular India: Goa, Maharashtra, Gujarat, Karnataka and Andhra Pradesh.

Variability studies

Variability is the quantity of variation seen in a particular population. Twenty-one morphometric plant/flower characters were studied biometrically and the mean, range, standard deviation, coefficient of variation and coefficient of determination were calculated. From that data analysis, plant height, leaf number, leaf length, leaf breadth, number of fertile bracts, number of flowers per

inflorescence, standing duration of inflorescence, flower length, length of sepals, breadth of sepals, breadth of petal and breadth of labellum showed statistically significant variation between accessions (Table 1).

The plant produces two inflorescences; one lateral and one central. The differently coloured labellum and differently shaped floral bracts add more beauty to the plant. Comma and fertile bracts are usually oblong or

Table 1. Showing the comparison of different morphometric characters studied in *Curcuma inodora*

Sl. No	Character	Mean	Range	SD	CV	CD@5%
1	Plant height	26.20	10–53	7.47	28.51	5.1
2	Leaf number	4.95	1–7	3.52	71.11	0.88
3	Leaf length	18.97	8.9–33.5	4.08	21.51	3.24
4	Leaf breadth	6.86	1.7–13.6	2.04	29.74	1.42
5	Number of comma bracts	4.79	3–8	1.30	27.14	NS
6	Number of fertile bracts	23.3	9–48	8.84	37.93	9.1
7	Number of flowers/ inflorescence	17.55	2–90	11.68	66.55	13.06
8	Standing duration of Inflorescence	17.59	7–36	5.05	28.71	4.88
9	Length of flower	5.28	4–18	2.64	50.00	2.1
10	Length of sepal	1.11	0.8–1.9	0.17	15.32	0.2
11	Breadth of sepal	0.98	0.7–1.4	0.27	27.55	0.2
12	Length of petals	1.54	0.18–1.9	0.23	14.94	NS
13	Breadth of petals	1.31	0.9–1.8	0.21	16.03	0.6
14	Labellum length	1.95	1.4–2.4	0.23	11.79	NS
15	Labellum breadth	1.59	1–2.2	0.17	10.69	0.2
16	Staminode length	1.52	1–2	0.26	17.11	NS
17	Staminode breadth	0.78	0.6–1	0.10	12.82	NS
18	Length of Anther	0.40	0.25–3.5	0.06	15.00	NS
19	Length of epigynous gland	0.41	0.3–0.5	0.04	9.76	NS
20	Length of ovary	0.28	0.2–0.4	0.03	10.71	NS
21	Diameter of ovary	0.21	0.18–2.2	0.02	9.52	NS

SD, standard deviation; CV, coefficient of variation; CD, coefficient of determination.

Table 2. Showing overall performance index of various accessions of *Curcuma inodora*

Accession No.	Overall performance index	Rank
CUCIN 1	12.61	VI
CUCIN 2	12.54	VII
CUCIN 3	12.92	IV
CUCIN 4	13.33	II
CUCIN 5	11.80	IX
CUCIN 6	12.15	VIII
CUCIN 7	12.72	V
CUCIN 8	10.74	XI
CUCIN 9	10.55	XII
CUCIN 10	11.26	X
CUCIN 11	13.83	I
CUCIN 12	13.06	III

rarely lanceolate with rounded apex. The colour of the bracts shows extreme variation, ranging through green, pink, white and various shades of pink. The most attractive traits observed in this species are the colour variation of labellum (Figure 2) and shape and colour variation in inflorescence (Figure 3). The colour of the labellum may be violet or various shades of violet with yellow, white or magenta.

Selection of best performing accession

Performance analysis showed that Accession No. 11 (CUCIN 11, Coll. No. 94,716, Collem, Goa) performed best by means of its growth and all other morphometric characters studied followed by Accessions 4, 12, 3, 7, 1, 2, 6, 5, 10, 8 and 9 in descending order. The superior accession can be selected and used for further studies and variety release protocols.

Conclusion

The present study revealed that *C. inodora*, a rare and Near Threatened wild ginger possesses good potential ornamental value as a potted plant. The main attraction is the beautifully coloured bracts, flowers and inflorescence. Gingers differ in their growth requirements, but generally they like a warm, humid climate, part shade and shelter from cold winds. The climate and soil in India are suitable for the cultivation of this ginger and it will be a promising crop for our gardens both as a potted and landscape plant. Moreover, soil parameters did not directly affect the morphological or reproductive variations within the species in natural and *ex situ* conditions. All the variations observed in the species are genotypic. Popularization of this plant will not only enrich growers, but will also help to increase the population of this limitedly distributed plant.

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