



## Identification of Novel Five Variants of *Caladium* Species Through Multi-Environmental Evaluation

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### Citation:

Lal M., Baruah J., Begum T., Darnei RL., Nyitan J., 2022. Identification of Novel Five Variants of *Caladium* Species Through Multi-Environmental Evaluation. Ekin J. 8(2):146-151.

Received: 10.06.2022

Accepted: 12.07.2022

Published Online: 31.07.2022

Printed: 31.07.2022

### ABSTRACT

Caladiums, commonly termed 'angels wings' are high valued ornamental plants known for their attractive multi-coloured foliage. The plants are toxic to human but the leaves are known to possess antimicrobial, antiangiogenic, antioxidant and antitoxic properties. *Caladium* species show wide range of variations in the length, width and number of leaves per plant and their market value depends on the type and colour of leaf. So, development of unique *Caladium* varieties with attractive foliage thus makes them a highly priced plant in the market. The present study therefore focuses on identification and development of unique *Caladium* varieties for commercialization using twenty-five germplasm collected from different parts of Northeast region. The study was conducted during spring 2019 and 2020, following which five novel variants were identified, viz-*Caladium red flash* (Jor-Lab CL-36), *C. bicolor* var. *florida clown* (Jor-Lab CL-12), *C. humboldtii* var. *mini white* (Jor-Lab CL-54), *C. bicolor* var. *florida sweetheart* (Jor-Lab CL-115), *C. bicolor* var. *red star* (Jor-Lab CL-24). Jor-Lab CL-36 showed olive green foliage, Jor-Lab CL-12 and Jor-Lab CL-24 each showed green foliage. Jor-Lab CL-54 exhibited green and white contrast foliage, while Jor-Lab CL-115 showed pink foliage with green margin. Multilocation trial study conducted during spring 2021 for the identified lines at four locations of North East India further confirmed their stability performance and found stable for different agronomical traits and colour combinations.

**Keywords:** Angel wings, foliage variability, high priced, novel variants, multilocation study

### Introduction

Caladiums (*Caladium* Vent.), also called as angels wings and elephant ears are a highly valued ornamental plants that are grown as an indoor plant for their beautiful multi-coloured and variably-shaped foliage (Deng, 2012; Cao et al. 2017). It belongs to the family Araceae and indigenous to Central and South America (Mayo et al. 1997). Caladiums are heat-loving tropical perennials with large, heart- or arrow-shaped, paper-thin leaves and have striking array of colours and patterns that display amazing colour combinations of white, pink, red and green (Mayo et al. 1997). They rarely flower, but the beautiful foliage guarantees a colourful show wherever they are planted and thrive for few months during spring and summer season till their leaves starts to die and the plant goes to dormant condition.

When Caladiums bloom, they produce a single (rarely 2-3) typical arum-type flower with a green or pinkish spathe surrounding a short white spadix and its fruits are white berries with several to many seeds (Wilfret and Hurner, 1982).

Caladiums are an excellent garden and shady yards plant. While certain *Caladium* varieties are more sun tolerant than others, most prefer moderate shade from the hot evening sun (Wilfret and Hurner, 1982; Wilfret, 1993; Laliberte, 2015). The growth of the plant is affected by the amount of water received during developmental period. They are known to grow best in fertile and well-drained soil with consistent moisture (Vanzile, 2022). Among different species of *Caladium*, *C. bicolor*, a Brazilian species, is the most common in this genus that are used as ornamental plants.

Although they are toxic, the leaves were found to possess antimicrobial (Essien et al. 2015; Uche et al. 2019), antiangiogenic, antioxidant and antitoxic properties (Tosoc et al. 2016). It has been seen among various species of Angiosperms that variegation of leaves is the main characteristics among understory herbs of temperate and tropical forests (Givnish, 1990). It has been contemplated that the variegated leaves that have partial loss of photosynthetically active surface affects the utilisation and absorption of light therefore effecting their growth and reproduction as well as the net photosynthesis (Deng, 2012). Caladium cultivars show a wide range of variations in the length, width of mature leaves and the number of leaves per plant (Wilfret and Hurner, 1982). Notably, leaves of Caladium can be classified into three types: lance, strap, and fancy. Firstly, the lance leaves are intermediate between the strap and fancy types, basal lobes if present are broadly separated by sinus and have a broad sagittate to cordate-lanceolate and usually grow less than 12 inches tall. Secondly, strap leaves have ribbon-like and narrow leaves with one main vein and no obvious basal lobes. Thirdly, fancy type have triangular heart-shaped leaves with three main veins, two obvious basal lobes and separated by a short narrow sinus as well as a peltate petiole attachment and it grows between 12 and 30 inches tall (Russ and Polomski, 1999; Deng, 2012). The marketing price and value of the plant in the market depends mainly on the type and colour of leaf the plant attains (Deng, 2012; 2018). The method for introducing new cultivars of Caladium is through hybridization between elite lines and cultivars to produce variants with different plant growth, leaves pattern, leave size, number of leaves and venation pattern (Wilfret, 1993). These entire characters make Caladium a highly priced plant in the ornamental market. It is also necessary to develop suitable stable cultivars which are favourable and is well adapted in all environments. So far to the best of our knowledge this is the first report on systemic evaluation of collected germplasm and identified some unique traits lines which were again tested in multi-locational trial.

## Materials and Methods

### Plant sample

During the year 2019, a total of 25 Caladium germplasm was collected from different North East region and planted at experimental farm (CSIR-NEIST, Jorhat, Assam) following RBD (Randomized Block Design) with three replications. Necessary agro-practices were followed, viz- a 4×4 meters plot size with 60×60 cm spacing, application of NPK in

dose of 40:30:30 and consistent moisture to raise a good plant. Nitrogen was given in two split doses, while phosphorus and potassium applied at the time of planting. Caladiums prefer acidic soil and so the experimental field was ideal in this regard with a pH of 4.9. Identification of germplasm was performed by breeder of the institute and voucher specimen submitted in the departmental herbarium.

### Observation recorded

Agronomical and other morphological observations were recorded for two consecutive seasons, i.e. *spring* 2019 and 2020. Characters taken for study includes plant height (cm), leaf length (cm), leaf width (cm), tillers/plant, leaf colour, midrib colour and leaf spot.

### Assessment

After two years of initial plant trial five unique germplasm were selected and taken for multilocation trial at four locations of North East region- Lakhimpur (Assam), Pasighat (Arunachal Pradesh), Nongpoh (Meghalaya) and Madang (Assam) during spring 2021. These germplasm (*Caladium red flash*, *C. bicolor* var. *florida clown*, *C. humboldtii* var. *mini white*, *C. bicolor* var. *florida sweetheart*, *C. bicolor* var. *red star*) were selected from the initial trial on the basis of leaf size, colour variations, plant height and comparison were done taking the locally grown cultivars as check varieties.

## Results and Discussion

Twenty-five Caladium germplasm were subjected to morphological studies during *spring* 2019 and 2020, which showed variation in leaf colour and size, leaf spot, colour of mid vein and tillers per plant (Table 1). In *Caladium red flash*, plant height ranged from 39-54 cm, leaf length from 17.2-30.7 cm, leaf width from 15.5-25.2 cm and tillers/plant from 2-6 (Table 1). The colour of leaf showed olive green with pink spots and red colour midrib. *C. bicolor* var. *florida clown* showed 30-42 cm plant height, 14-20 cm leaf length, 10-18 cm leaf width and 5-20 tillers/plant and showing green coloured leaves with distinct pink, red and white spot. *C. humboldtii* var. *mini white*, *C. bicolor* var. *florida sweetheart* and *C. bicolor* var. *red star* each showed 10-25, 23-43, 18-27 cm plant height, 4-10, 13-30, 10-19 cm leaf length, 3-8, 7-13, 8-16 cm leaf width and 4-18, 2-5, 2-4 tillers/plant respectively. *Mini white* variety showed green and whitish coloured leaf with white midrib and leaf spots. *Florida sweetheart* variety have bright pink leaves and green margin with dark pink midrib colour and no noticeable leaf spot, whereas *red star* variety have green leaves, red colour midrib with distinct white and indistinct pink spots. The development of elite lines with unique leaf traits

is the most preferred criterion in *Caladium* breeding programme (Wilfret, 1993; Deng, 2012). But due to increasing population size in this genus the efforts to find unique leaf characteristics has possibly been increased, thus making difficult for successful breeding. This may be due to lack of variability in *Caladium* gene pool as also reported by Deng (2018). The process for obtaining new cultivars with unique leaf traits in *Caladium* is through hybridization between elite lines, which makes them highly valued in the market (Cao et al. 2016a). This can be achieved when there is high variability in the experimental material. The germplasm used for the study showed great variations in leaf characteristics and other studied traits and this variability can be utilized for *Caladium* improvement and varietal development programme. It is also necessary to develop suitable stable cultivars which are favourable and can be adopted to all growing environments. Therefore, identifying lines with unique leaf traits from its wild collection will be a boost in *Caladium* breeding programme and the present study is attempt to the same. Deng (2018) in *Caladium* breeding study also observed highest variation in leaf colour, followed by leaf patterns and leaf types. Hartman et al. (1972) reported that *Caladium* showed high variability when propagated by seeds, but for commercial cultivation tuberous corm is mainly preferred. It is because although they show high variability, they tend to lose their germination capacity easily and rapidly (Carpenter, 1990). Zhu et al. (1984) and Ali et al. (2007) obtained excellent shoot multiplication during rapid micropropagation of *Caladium* species on *in vitro* study, thereby describing the method to be successful for large scale quality planting material propagation. Cao et al. (2016b) observed much variability (25%) in terms of leaf shape and size, midrib colour and leaf spots among the somaclones of red flash variant. Chu and Yazawa (2001) also observed high variation frequency (65- 79%) in somaclones produce through tissue culture. Hussain et al. (2016) reported that application of potting mixers is the best method for improving crop productivity and providing best environment for *Caladium* growth.

Based on two years assessment, lines with best leaf traits for each of the five varieties were identified and named as- Jor-Lab CL-36 (RRL-C-36) for *Caladium red flash*, Jor-Lab CL-12 (RRL-C-12) for *C. bicolor* var. *florida clown*, Jor-Lab CL-54 (RRL-C-54) for *C. humboldtii* var. *mini white*, Jor-Lab C-115 (RRL-C-115) for *C. bicolor* var. *florida sweetheart* and Jor-Lab CL-24 (RRL-C-24) for *C. bicolor* var. *red star* (Fig. 1). Jor-Lab CL-36 was found to obtain a height of 53.80 cm, 25.30 cm leaf length,

21.20 cm leaf breadth and 4 tillers/plant (Table 2). Similarly, Jor-Lab CL-12 obtained a height of 41.30 cm, 19.20 cm leaf length, 15.80 cm leaf breadth and 15 tillers/plant; Jor-Lab C-54 obtained a height of 23.00 cm, 8.80 cm leaf length, 6.70 cm leaf breadth and 13 tillers/plant. Jor-Lab C-115 and Jor-Lab CL-24 each showed 42.11, 25.40 cm plant height, 25.70, 16.01 cm leaf length, 9.90, 15.70 cm leaf width and 4, 3 tillers/plant respectively. These lines were further evaluated through multilocation trial performed at Lakhimpur, Pasighat, Nongpoh and Madang of Northeast India. Multilocation trial is an important aspect of plant breeding programme for developing superior lines with stable performances (Lal et al. 2021). The present study was performed taking these criteria into mind with one check variety for each identified line. The average multilocation trial data of identified lines along with check varieties were presented in Table 3. These lines showed superior performances than their respective check counterpart for the studied traits. Moreover, it was also observed that these lines did not show any variation in colour when multilocation trial study was conducted, a common phenomenon when there is a change in environmental condition (Sevik et al. 2014). Further the lines showed consistent performance at multilocation studies as reflected by three years average data. Selection of stable lines with consistent performance is very important in formulating targeted breeding programme as this would ultimately help in varietal development of the species (Lal et al. 2020).

## Conclusions

The present study makes an attempt to identify unique five novel variants of *Caladium*- Jor-Lab CL-36 for *Caladium red flash*, Jor-Lab CL-12 for *C. bicolor* var. *florida clown*, Jor-Lab CL-54 for *C. humboldtii* var. *mini white*, Jor-Lab C-115 for *C. bicolor* var. *florida sweetheart*, Jor-Lab CL-24 for *C. bicolor* var. *red star*. Since these plants are highly valued for their attractive colour and beauty, it is therefore necessary to develop suitable stable cultivars which are favourable and can be adopted to all growing environments.

This varietal development study is by far the first report on *Caladium* as far our knowledge. These newly identified lines can be adopted for commercial cultivation as evaluated from multilocation studies and found stable performance.

## Acknowledgements

The authors wish to thank Director, CSIR-NEIST and to MLT trial teams for providing necessary provision to carry out the experiment.

Table 1. Range of traits taken for study among *Caladium* germplasm used in initial varietal trial during spring 2019 and 2020.

Traits	Range				
	<i>Caladium red flash</i>	<i>C. bicolor</i> var. <i>florida clown</i>	<i>C. humboldtii</i> var. <i>mini white</i>	<i>C. bicolor</i> var. <i>florida sweetheart</i>	<i>C. bicolor</i> var. <i>red star</i>
Plant height (cm)	39-54	30-42	10-25	23-43	18-27
Leaf length (cm)	17.2-30.7	14-20	4-10	13-30	10-19
Leaf width (cm)	15.5-25.2	10-18	3-8	7-13	8-16
Tillers/plant	2-6	5-20	4-18	2-5	2-4
Leaf colour	olive green	green	green/white contrast	pink with green margin	green
Midrib colour	red	green	white	dark pink	red
Leaf spot	pink	pink/red/white	white	absent	pink/white

Table 2. Morphological traits of identified five unique lines of *Caladium*.

Traits	Jor-Lab CL-36	Jor-Lab CL-12	Jor-Lab CL-54	Jor-Lab C-115	Jor-Lab CL-24
Plant height (cm)	53.80	41.30	23.00	42.11	25.40
Leaf length (cm)	25.30	19.20	8.80	25.70	16.01
Leaf width (cm)	21.20	15.80	6.70	9.90	15.70
Tillers/plant	4	15	13	4	3
Leaf colour	olive green	green	green/white contrast	pink with green margin	green
Midrib colour	red	green	white	dark pink	red
Leaf spot	pink	pink/red/white	white	absent	pink/white

Table 3. Average multilocation trial data of identified lines along with check varieties at Lakhimpur, Pasighat, Nongpoh and Madang during spring 2021.

Variety	Plant Height	Leaf Length	Leaf Width	Tillers/Plant	Leaf Colour	Midrib Colour	Leaf Spot
Jor-Lab CL-36	51.80	24.16	19.61	4	olive green	red	pink
Check-1	47.30	20.20	15.50	3	olive green	red	pink
Jor-Lab CL-12	39.60	17.28	13.50	13	green	green	pink/red/white
Check-2	35.70	13.30	9.70	8	light green	green	pink/red/white
Jor-Lab CL-54	20.70	7.29	6.00	11	green/white contrast	white	white
Check-3	15.70	6.40	5.30	9	green/white contrast	white	white
Jor-Lab C-115	39.30	22.70	9.30	3	pink with green margin	dark pink	absent
Check-4	34.90	18.90	8.70	3	pink with green margin	dark pink	absent
Jor-Lab CL-24	23.40	14.90	13.71	3	green	red	white/pink
Check-5	23.30	12.30	10.20	2	green	red	white/pink



Figure 1. Identified Caladium varieties (a) Jor-Lab CL-36, (b) Jor-Lab CL-12, (c) Jor-Lab CL-54, (d) Jor-Lab CL-115, (e) Jor-Lab CL-24. (Original)

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