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Effect of growing conditions on flowering and yield of calla lily (*Zantedeschia* Spp.) cultivars

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Abstract
An experiment was conducted in open field (G_1), Polyhouse (G_2) and shade net (G_3) conditions at Floricultural Research Station, ARI, Rajendranagar, Hyderabad during *Rabi* season of 2021-22 and 2022-23 to assess the performance of calla lily cultivars, Captain Murano (V_1), Picasso (V_2) and Captain Brunello (V_3) under different growing conditions. The experiment was laid out in Factorial Randomized Block Design with three replications and nine treatments. The study indicated the effect of temperature, humidity and light under protected as well as open field conditions on the performance of plant flowering and yield characters. The various flowering and yield parameters like highest long and medium blooms (48.22%), lowest short blooms (49.27%), maximum fresh weight of the flower (15.41 g), flower longevity (13.37 days), flower yield per plant (7.29), flower yield per plot (14.56), rhizome yield per plant (149.67 g) and rhizome yield per plot (898.00) were recorded to be highest in cv. Captain Murano under shade net conditions.

Keywords: Calla lily, growing conditions, cultivars, flowering and yield

Introduction
Zantedeschia attained popularity due to its waxy and trumpet shaped cut flowers in wide range of colours and its suitability as a pot plant. It is grown mainly in the Netherlands, New Zealand and USA, cultivated area in 2000 was 177 ha with the leading production in Netherlands, with 100 ha in 2002 (Brown *et al*., 2005) [2]. Cultivated areas of *Zantedeschia* as cut flowers has increased steadily in recent years to 288 ha in 2012 and it production spreaded to other countries *viz*. Brazil, Zimbabwe, Costa Rica and Israel (Janowska, 2013) [8]. Florist's calla (*Z. aethiopica* L. Spreng.) was the popular and dominant species in cultivation initially, however, its significance has declined gradually due to the development of cultivars with colourful spathes. Intensive breeding efforts made possible to obtain new cultivars, first in the United States of America and New Zealand, and later in South Africa and the Netherlands. A growing interest in the calla lily with colourful spathes is shown by the fact that at the start of 2000 it occupied 6th position, right after orchids, among cut flowers exported from New Zealand (Palmer, 2001) [13].

Among the most popular flowers, especially for bridal bouquets, calla lilies are stunning with a simple yet sophisticated and elegant look. Today, calla lilies are mostly used for decoration and aesthetic purposes. It is a good option for beautifying any landscape and for creating a focal point in gardens and outdoor spaces. Calla lilies are also used for various occasions, many people use it as a gift to celebrate the arrival of a newborn child, a promotion, or a business venture.

Among the several factors influencing the growth, yield and quality of flowers, the selection of suitable variety/hybrid and growing environment plays significant role in the performance in terms of growth and flowering parameters of this crop under local agro-climatic conditions, for ensuring higher production of quality flowers that fetches higher income to the flower growers. It has been reported that crop yield depends on the response of plants to the environmental influences (Ellis *et al*., 1990) [5], for example, temperature has considerable influence on crop timing and yield (Pearson, 1992) [14] and light is primary determinant of crop growth

Materials and Methods
The present experiment entitled "Effect of growing conditions on flowering and yield of calla lily cultivars" was conducted at Floricultural Research Station, ARI, Rajendranagar,

Hyderabad during 2021-22 and 2022-23. The study was laid out as Factorial Randomized Block Design with 3 different protected structures (Open condition G_1, Polyhouse G_2 and Shade net G_3) which were replicated three times. Weeds and stubble were removed and the land was brought to a fine tilth and raised beds were prepared in open condition, shade net and polyhouse. The rhizomes were planted at a depth of 6-8cm. The experimental site was kept weed free by periodic hand weeding. Irrigations were given as and when required, during crop growth period. observations related to flowering and yield parameters was recorded. Data was recorded on percentage of long and medium blooms, percentage of short blooms, fresh weight of flower, flower longevity, flower yield per plant, flower yield per plot, rhizome yield per plant and rhizome yield per plot.

Results and Discussion

a) Flowering parameters

1. Percentage of short blooms (%)

Pooled data of both the years (2021-22 & 2022-2) showed that in the interaction cv. Captain Murano under Shade net condition (G_2V_1) recorded lowest percentage of short blooms (51.79%) followed by the interaction G_2V_3 - cv. Captain Brunello under Shade net condition (58.86%). Whereas, the highest percentage of short blooms (80.81%) was recorded in the cultivar Picasso grown under Open condition (G_1V_2).

2. Percentage of Long and medium blooms (%)

Pooled data of both the years registered significant difference between cultivars and growing conditions. In the interaction G_2V_1 - cv. Captain Murano under Shade net condition recorded highest percentage of long and medium blooms (48.22%) followed by G_2V_3 - cv. Capatin Brunello under Shade net condition (41.14%). Whereas, the lowest percentage of long and medium blooms (19.19%) was recorded in the interaction G_1V_2 - cultivar Picasso under Open condition.

The highest percentage of long and medium blooms and lowest percentage of short blooms was recorded under shade net condition in cv. Captain Murano. These results can be positively correlated to increased leaves due to favorable micro climatic conditions (light, temperature and relative humidity etc). As a result, there is increased availability of photosynthates from the source to the sink.

3. Fresh weight of flower (g/f)

In the pooled data during the both years 2021-22 and 2022-23 highest fresh weight of flower (15.37 g) was noticed in G_2V_1- cv. Captain Murano under Shade net followed by G_2V_3 - cv. Picasso under Shade net condition (13.76 g), while the lowest fresh weight of flower (4.65 g) was recorded in G_1V_2 - cv. Picasso under Open condition.

During both the seasons, significantly higher fresh weight was observed in the plants grown under shade net condition might be due to the maximum accumulation of photosynthates and bigger size flowers resulted in increased weight. Similar results were reported by Naik *et al*., (2006) [11] in gerbera.

4. Flower longevity on plant

In the interaction between cultivars grown under different growing conditions, maximum flower longevity on plant (13.11 days) was noticed in V_1 - cv. Captain Murano grown under Shade net (G_2) followed by the same cultivar (V_1) grown under (G_3) Polyhouse condition (12.20 days), whereas minimum flower longevity on plant (3.49 days) was noticed in cv. Picasso (V_2) grown under Open condition (G_1) as per the pooled data of both the years 2021-22 & 2022-23

Therefore, flower longevity was observed maximum under shade net in may be due to vigorous vegetative growth which might have helped the plants to synthesis more photosynthates which enabled the plant to supply and accumulate in the flower stalk and to carry out the metabolic activity which might have retained freshness of flower for a longer time. Variation in vase life of flowers with respect to growing conditions was also reported by Gaikwad *et al*., (2002) [6] in chrysanthemum, Singh and Srivastava, (2008) [17] in gerbera.

b) Yield parameters

1) Flower yield per plant (Number)

As per the pooled data in the interaction between cultivars grown under different growing conditions, the highest yield per plant (6.82) was recorded in V_1 - cv. Captain Murano grown under G_2 - Shade net followed by the same cultivar V_1 grown under G_3 - Polyhouse condition (5.88). However, the lowest yield per plant (0.93) was registered in cv. Picasso (V_2) grown under Open condition (G_1).

2) Flower yield per plot (Number)

In the interaction between cultivars and growing conditions, the highest yield per plot (14.44) was recorded in V_1 - cv. Captain Murano grown under Shade net (G_2) followed by the same cultivar (V_1) grown under (G_3) Polyhouse condition (13.87). Whereas, the lowest yield per plot (5.58) was registered in cv. Picasso (V_2) grown under Open condition (G_1) with respect to pooled data.

The findings of Gantait and Patil (2011) [7] in chrysanthemum and Dixit *et al*., (2005) [4] in leafy vegetables. Loeser, (1986) [10] and Nair *et al*., (2002) [12] in gerbera with respect to higher yields under shade net might be due to more number of branches and the number of leaves resulted in more photosynthate accumulation which have attributed for increased flower yield.

3) Rhizome yield per plant (g)

As per the pooled data the highest rhizome yield per plant the highest rhizome yield per plant (210.61 g) was obtained in the interaction G_2V_1 - cv. Captain Murano under Shade net condition followed by G_3V_1 - cv. Captain Murano under Polyhouse condition (200.99 g), whereas the lowest rhizome yield per plant (61.59 g) was obtained in G_1V_3 - cv. Captain Brunello under Open condition.

4) Rhizome yield per plot (g)

From the pooled data of both the years 2021-22 & 2022-23 in the interaction between growing conditions and cultivars highest rhizome yield per plot (1245.60 g) was obtained in the interaction G_2V_1 - cv. Captain Murano under Shade net condition followed by G_3V_1 - cv. Captain Murano under Polyhouse condition (1205.96 g), whereas lowest rhizome yield per plot (361.66 g) was obtained in G_1V_3 cv. Captain Brunello under Open condition.

Highest rhizome yield per plant and rhizome yield per plot is due to late senescence of crop plants under shade net condition, where aerial parts remained green for longer time which resulted in better performance of the crop plants in rhizome production under shade net as compared to

polyhouse as well as open field conditions reported by Jhon *et al*., (2005) [9] in tulip.

It is attributed that yield of cultivar is dependent on vigour of plant and other rhizome characters. Therefore, it is concluded that increased plant height, number of leaves per plant and leaf area per plant which increased rhizome characters ultimately resulted in highest yield in cv. Captain Murano compared to other cultivars under shade net condition. Surendra *et al*., (2019) [19] in ginger. Similar results were also reported by Sanwal *et al*., (2012) [16], Chongtham *et al*., (2013) [3], Raviraja Shetty *et al*., (2015) [15], Azeze *et al*., (2013) [1] in ginger and Virendra *et al*., (2015) [18] in turmeric.

Table 1: Effect of growing conditions on flowering parameters of calla lily cultivars

Pooled data (2021-22 & 2022-23)				
Treatments	**Long and medium blooms (%)**	**Short blooms (%)**	**Fresh weight of the flower (g)**	**Flower Longevity (days)**
G1V1 – Open condition + Captain Murano	28.09	71.91	10.17	7.67
G1V2 – Open condition + Picasso	19.19	80.14	4.50	3.97
G1V3 – Open condition + Captain Brunello	22.39	75.70	8.47	6.00
G2V1 – Shade net condition + Captain Murano	48.22	49.27	15.41	13.37
G2V2 – Shade net condition + Picasso	35.38	63.81	10.67	10.67
G2V3 – Shade net condition + Captain Brunello	41.14	57.19	13.33	11.85
G3V1 – Polyhouse condition + Captain Murano	38.63	60.39	11.60	12.23
G3V2 – Polyhouse condition + Picasso	30.29	68.74	9.00	9.00
G3V3 – Polyhouse condition + Captain Brunello	33.45	66.63	10.67	10.67
G X V				
S.Em ±	0.438	0.566	0.179	0.134
CD (5%)	1.325	1.711	0.541	0.404

Table 2: Effect of growing conditions on yield parameters of calla lily cultivars

Pooled data (2021-22 & 2022-23)				
Treatments	**Flower yield per plant (Number)**	**Flower yield per plot (Number)**	**Rhizome yield per plant (g)**	**Rhizome yield per plot (g)**
G_1V_1 – Open condition + Captain Murano	3.31	12.17	127.40	838.00
G_1V_2 – Open condition + Picasso	1.26	6.08	54.82	329.00
G_1V_3 – Open condition + Captain Brunello	2.37	10.14	44.00	268.12
G_2V_1 – Shade net condition + Captain Murano	7.29	14.56	149.67	898.00
G_2V_2 – Shade net condition + Picasso	3.07	9.15	77.15	475.12
G_2V_3 – Shade net condition + Captain Brunello	4.38	12.98	109.26	600.53
G_3V_1 – Polyhouse condition + Captain Murano	6.31	13.97	143.33	860.00
G_3V_2 – Polyhouse condition + Picasso	2.24	7.09	72.40	391.92
G_3V_3 – Polyhouse condition + Captain Brunello	3.67	12.00	60.40	453.00
G X V				
S.Em ±	0.199	0.228	0.992	8.752
CD (5%)	0.603	0.691	3.001	26.465

Conclusion

From the present investigation, it is concluded that the cv. Captain Murano performed better in floral parameters as compared to other cultivars *viz*. Picasso, Captain Brunello resulting in highest long and medium blooms (48.22%), lowest short blooms (49.27%), maximum fresh weight of the flower (15.41 g), flower longevity (13.37 days), flower yield per plant (7.29), per plot (14.56), rhizome yield per plant (149.67 g) and per plot (898.00). Out of the three growing conditions, cultivars of Asiatic lily cultivated under shade net performed better in most of the floral and yield parameters than the polyhouse as well as open field conditions.

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