

***Adenium obesum* as a new potted flower: growth management<sup>(1)</sup>**

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**ABSTRACT**

*Adenium obesum*, also known as desert rose, has recently become popular in Brazil, due to its exuberance and sculptural shape. However, the production of the species in commercial scale has been facing challenges regarding propagation of hybrids by *in vitro* cultivation techniques, potting medium composition, irrigation and fertilization management, disease and pest control. Unlike other species sold as potted plants, there are no commercial production protocols established for *Adenium*, mainly due to the scarcity of technical information about this species. Thus, this technical article aimed to provide information related to the *Adenium* growth, in view of its commercial scale production. In addition, aspects related to floral morphology, pollination and seed production of the species, as well as, vegetative propagation strategies were discussed.

**Keywords:** commercialization, desert rose, nutrition, potting medium, propagation.

**RESUMO*****Adenium obesum* como nova flor de vaso: manejo cultural**

*Adenium obesum*, também conhecida vulgarmente como rosa-do-deserto, tem se popularizado no Brasil nos últimos anos devido à sua exuberância e forma escultural. Porém, a produção da espécie em escala comercial tem enfrentado desafios em relação à propagação de seus híbridos por técnicas de cultivo *in vitro*, escolha de substratos, manejo da irrigação e fertilização, controle de doenças e pragas, dentre outros. Diferente de outras espécies comercializadas como planta de vaso, ainda não existem protocolos de produção comercial totalmente estabelecidos para *Adenium*, devido, principalmente, à escassez de informação técnica sobre a espécie. Assim, esse artigo técnico teve o intuito de trazer à luz da literatura algumas informações relacionadas ao cultivo da espécie, tendo em vista a sua produção em escala comercial. Além disso, abordou-se aspectos da morfologia floral, polinização e produção de sementes da espécie, bem como estratégias de propagação vegetativa.

**Palavras chave:** rosa-do-deserto, propagação, nutrição, substratos, comercialização.

**1. INTRODUCTION**

*Adenium* genus belongs to Apocynaceae, which includes many tropical ornamental species such as *Catharanthus* spp., *Beaumontia* spp., *Carissa* spp., *Allamanda* spp., *Mandevilla* spp., *Nerium* spp. and *Plumeria* spp. (COLOMBO et al., 2015). In this genus only one species is reported, i.e. *Adenium obesum*, firstly classified as *Nerium obesum* (fat oleander).

*A. obesum* (Forssk.) Roem. & Schult. is found in the sub-Saharan region of Africa, from Sudan to Kenya and west of Senegal to south of Natal and Swaziland. Some authors divided *A. obesum* in subspecies or botanical varieties (PLAIZIER, 1980; FORSTER, 1998; HARGREAVES, 2002). However, in horticulture it was adopted to divide the *Adenium* genus into comprising 11 species: *A. oleifolium*,

*A. swazicum*, *A. boehmianum*, *A. multiflorum*, *A. obesum*, *A. somalense* 'Nova' (Tanzania), *A. somalense*, *A. crispum*, *A. socotranum*, *A. arabicum* and *A. Oman* (DIMMITT et al., 2009).

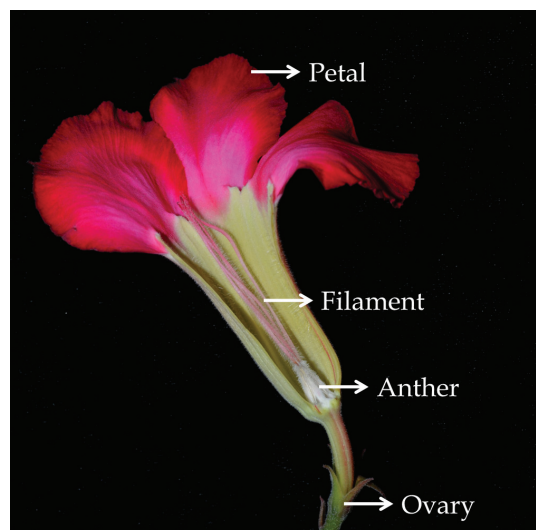
Adeniums can be grouped in herbaceous, shrub and arboreal plants, with succulent stems and roots. Many species are caudiciforms or paucicaules, which develop swollen roots and/or stems that act as primary organs for water reserves. The flowers have five sepals and five petals, in different colors, fused to a floral tube; the tube inner surface may have five or 15 red lines, called as nectar guides (Figure 1). The five stamens are cone-shaped and the anthers have their slits facing the inside of that cone. The anther tails protrude from the cone apex appear to be the true anthers. The stigma is hidden inside the cone formed by the anthers, just below them (DIMMITT et al., 2009).

DOI: <http://dx.doi.org/10.14295/oh.v24i3.1226>

<sup>(1)</sup>Received in 18/05/2018 and accepted in 05/07/2018

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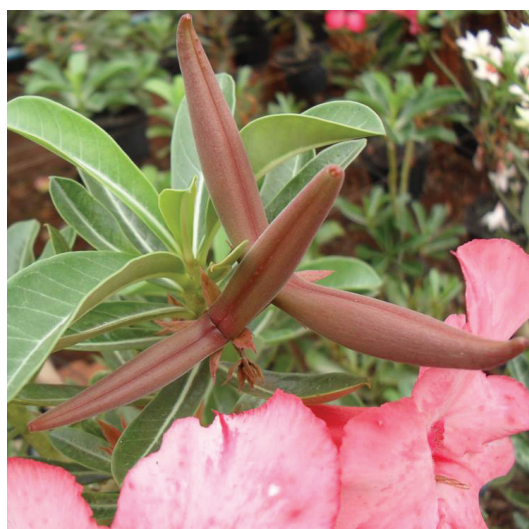
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**Figure 1.** Floral morphology of *A. obesum*.

The fruits are formed in pairs after pollination and classified as follicles (Figure 2); when mature, they open longitudinally for release of the seeds (DIMMITT et al., 2009). However, not all plants produce seeds under cultivation conditions, since pollination is often unsuccessful due to male or female sterility

(McLAUGHLIN and GAROFALO, 2002). The sexual propagation is important, especially for the breeding programs for the species, due to the great morphological variability observed in the progeny resultant from a single crossing; as well as, for the production of rootstocks.



**Figure 2.** Fruits of *A. obesum* in development phase, 40 days after pollination.

Despite the great ornamental and commercial value, this species is known in Brazil for the last two decades and its commercial exploitation is recent. Thus, only limited information about commercial production of *Adenium* is available in the literature, as until recently, adeniums were considered a collector plant.

Thus, the present study aimed to describe the main aspects related to the commercial production of *Adenium* in Brazil, such as seed production and propagation, growing conditions and commercialization.

## 2. ADENIUM PROPAGATION

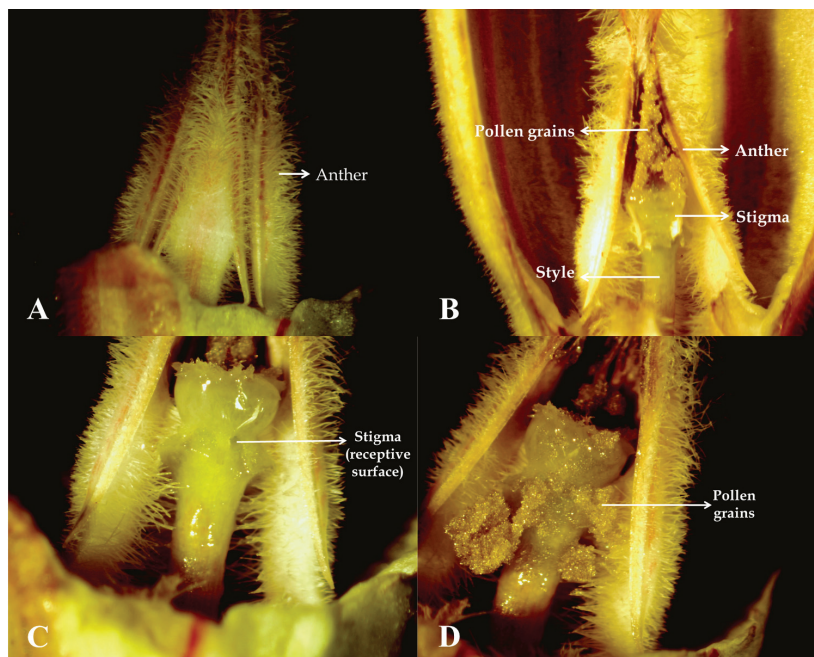
### Seed propagation

*A. obesum* propagation is performed mainly by seeds, since the plants originating from seeds exhibit more swollen caudex and primary roots than those propagated from cuttings (COLOMBO et al., 2015).

The seed formation occurs by self-pollination or cross-pollination. The manual pollination is carried out taking off one or two petals from the receiving flower, to

expose the anthers. Next, the anthers must be removed using a tweezer to collect the pollen grains, which are transferred to stigma from the receiving flower (Figure

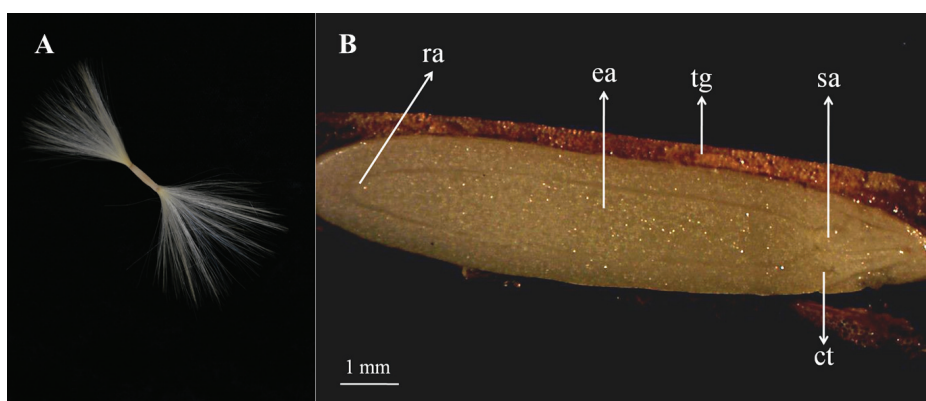
3 A-D). After 90 days of flower pollination, the follicle starts dehiscence and the seeds can be collected for sowing.



**Figure 3.** Details of *A. obesum* pollination: cone shaped by anthers protecting the stigma (A), exposure of stigma and pollen grains after anthers removal (B), detail of receptive surface in the stigma (C), and pollen grains released to stigma, effective pollination (D).

According to Colombo et al. (2015) the *A. obesum* follicles may present measures varying between 15.1 to 25.1 cm for length and 11.1 to 15.5 for central diameter, with the number of seeds varying from 28 to 118 seeds per follicle.

The seeds exhibit a cylindrical shape, brown staining integument and brown gold pappus (bristles) on both extremities, which helps dispersion by wind (Figure 4). *A. obesum* seeds are similar to the ones in oleander (*Nerium oleander*), but in this species bristles are on only one extremity (COLOMBO et al., 2015).



**Figure 4.** Morphological characterization of *A. obesum* seed, external (A) and internal (B) aspects: tg – tegument; ea – embryonic axis; ra – root apex; sa – stem apex; ct – cotyledons. Adapted from Colombo et al. (2015).

Seed germination is commonly performed in different substrates, which are chosen according to the local availability of material. Substrates based on semi-composted pine bark employed for germination of *A. obesum* seeds, providing emergence rates > 93% (COLOMBO et al., 2017). These results corroborate to those observed in germination tests that were conducted in laboratories, confirming the elevated germination potential of this species (COLOMBO et al., 2015; COLOMBO et al., 2017).

In contrast, substrates presenting high water retention capacity, if handled incorrectly, can decrease the seedlings

emergence due to seed rot. Colombo et al. (2017) observed that the *A. obesum* emergence in coconut fiber + sand was 83%, while the mixture of coconut fiber + semi-composted pine bark provided 98% of emergence. Thereby, the importance to select the adequate mixture to be used as substrate was confirmed.

Another choice to germinate *Adenium* seeds is to employ commercial mixtures as Carolina Soil II substrate (Grow Plant, Brazil), in which the seedlings emergence can reach values close to 100% (Figure 5).



**Figure 5.** Germination of *A. obesum* seeds in semi-composted pine bark + turf.

### Cuttings propagation

All commercially available *Adenium* material is the result of hybridization and has a high segregation rate when propagated by seeds, especially, cultivars with folded

flowers. Thus, the *Adenium* vegetative propagation has been outstanding due to the maintenance of the cultivar characteristics. Propagation by cutting (Figure 6) and grafting are the most common.



**Figure 6.** Hybrid *Adenium* cuttings submitted to rooting in carbonized rice husk bark and vermiculite, under the concentrations of 0 and 3000 mg L<sup>-1</sup> of AIB diluted in talc.

Studies related to *Adenium* propagation by cuttings are scarce. The available information is based on producer's observations and technical reports. The species propagation by cuttings has the advantage of obtaining plants genetically identical to the mother plant. However, seedlings propagated by cuttings may not be interesting, because they have less developed caudex compared to seedlings propagated by seeds; and the presence of well-developed caudex is an appreciated characteristic by consumers.

Although cuttings present high rooting potential, the use of auxins can be applied to optimize the rooting process. Tests performed at several periods with the propagation of two *Adenium* cultivars by cuttings, showed that the use of 8000 mg L<sup>-1</sup> of indolebutyric acid (IBA) is suitable for apical cuttings rooting of the Ice Pink and Red cultivars. At some periods of the study, 100% rooting of the cuttings was observed in the absence of IBA (McBRIDE, 2012).

Regarding the substrates that can be used for the *Adenium* cuttings rooting, vermiculite, carbonized rice husk and semi-composted pine bark, among others, can be recommended. However, attention should be paid to irrigation management, since *Adenium* cuttings are susceptible to rot, due to their high water content.

### Grafting

*Adenium* seedlings production by grafting has been

outstanding in recent years, mainly, due to the consumer market demands for new varieties, such as folded flowers and new colors. Thus, grafting allows to produce seedlings of these highly segregated materials on rootstocks produced by seeds, which presents a swollen caudex, characteristic of the *Adenium* genus.

Seedlings aged from one year can already be used as rootstocks, since they have the caudex developed enough for grafting. Grafting on *Adenium* may be performed by the graft method or a method similar to the graft approach ('cork'). The grafting method may present a disadvantage, as uneven healing of the tissues in the graft region, while the 'cork' method presents uniform healing of this region, which becomes imperceptible after a few months of cultivation.

The 'cork' grafting method is described in the figure 7. The method consists of making a straight cut on the rootstock above the region where the caudex is most pronounced. The branch from the canopy variety to be grafted is cut into segments, similar to a small cork, with at least one vegetative bud. The union between the rootstock and the graft is by approaching grafts of the cut sides. To protect and better fix the graft, it is required to cover the area with plastic tape or other impermeable material (Figure 7A). After the graft initiates the emission of shoots, the plastic shall be removed, in order not to harm the shoot growth (Figures 7B).



**Figure 7.** Graft protected with plastic, after the rootstock / canopy union (A) and graft emitting new shoots (B).

### *In vitro* propagation

*In vitro* propagation is a viable alternative for the ornamental plants and their hybrids propagation in commercial scale. However, for *Adenium*, little is known about this subject, which may encourage new research aiming to establish protocols for *Adenium* *in vitro* propagation.

There are some satisfactory results presented in studies with the *Adenium in vitro* propagation. It has been verified that the establishment of the *Adenium in vitro*

propagation came from the seed propagation, as shown by Kanchanapoom et al. (2010) and Rasad et al. (2015). However, seed propagation is not interesting to hybrids propagation and maintenance of their morphological characteristics.

When *in vitro* culture is established by seeds in culture media with auxin and cytokinin, callus formation in the explants is observed. Some of these calli differentiate into seedlings, but at low frequency (Figure 8).



**Figure 8.** *In vitro* regeneration of *Adenium obesum* calli from seedlings culture.

Results obtained by *in vitro* culture using vegetative material, e.g. stems, leaves, are unknown to our knowledge. Initial trials with *Adenium in vitro* propagation using stem and leaf segments, the formation of callus was observed (data not shown), but there was not regeneration of shoots. In this sense, the need for more studies related to the *Adenium in vitro* propagation is crucial.

### 3. ADENIUM GROWTH MANAGEMENT

#### Potting media and irrigation

To produce potted ornamentals plants, it is available different types of potting media that can be used alone or mixed (GRUDA, 2012). However, to *Adenium* commercial production as potted plant, just a few studies are found regarding potting media and irrigation management (COLOMBO et al., 2018).

Plants grown in pots under greenhouse conditions are characterized by a high and unbalanced ratio between the plants canopy and the roots. These plants require greater water, air and nutrients than those grown directly in field conditions, where growth rates are slower and the volume of soil available for the roots is theoretically unlimited (GRUDA, 2012).

In view of these aspects, it is fundamental to choose a substrate that allows an adequate relation between water retention capacity and aeration. For *Adenium* cultivation, several materials can be used as substrate. In seedling production, substrates with low density and high aeration are recommended in order to avoid seed rotting. Among the recommended materials, substrates based on semi-composted pine bark, pure or in combination with coconut fiber, provide a high emergence percentage of seedlings, i.e. 97% and 98%, respectively (COLOMBO et al., 2017).

According to the same authors, these substrates are also suitable for the initial development of *Adenium* seedlings, since these substrates provide greater initial nutrient input for plant growth. Similar results were presented by Alves et al. (2018), where the initial growth of *Adenium* was

higher in substrate composed of sand:pine powder (1:1, v/v) associated with fertilization with Hoagland and Arnon solutions supplemented with  $\text{NH}_3\text{NO}_4$ .

Substrates based on semi-composted pine bark are widely employed by the producers and present satisfactory results in the growth and development of the species. The main characteristics of the substrates based on pine bark are the water retention capacity, great aeration space in relation to coconut fiber and it presents low density.

On the other hand, the coconut fiber substrate mixed with sand (1:1, v/v) or vermiculite (1:1, v/v), showed satisfactory initial growth in *Adenium* at 45 days after the seedlings transplanting and the absence of additional fertilization (COLOMBO et al., 2018). In the same study, it was verified that the effect of the mentioned substrates persisted during a period of seven months, similar to the substrate recommendation for *Adenium* commercial cultivation.

Physical analysis of the mix between vermiculite and coconut fiber (1:1, v v<sup>-1</sup>), showed that the mix presented low density (136 g L<sup>-1</sup>) and high water retention capacity (528 mL L<sup>-1</sup>); these characteristics seem to be ideal to *Adenium* growth in pots (COLOMBO et al., 2016). Moreover, the low density of this substrate is an interesting characteristic to provide lighter pots, which facilitates their handling and transport.

Regarding the irrigation management, attention must be paid to the water supply required by the crop, despite its arid region origin, *Adenium* plants respond well to most constant irrigations. In a study carried out with *Adenium* cultivation on vermiculite and coconut fiber substrate (1:1, v v<sup>-1</sup>), the plants consumed about 10.7 L of water over a period of 210 days (COLOMBO et al. al. 2018). However, the water consumption is directly related to the substrate water retention capacity and the plant growth. For example, for vermiculite and pine bark (1:1, v/v) substrate, in the same growing period, the plants consumed about 7.5 L of water, but presented a lower fresh mass compared to the plants grown in the vermiculite and coconut fiber substrate (COLOMBO, et al., 2018).

Irrigation can be performed by sprinkler system or microtube drippers, being the last one more suitable as shoot wetting can harm flowering.

### Nutrition

Despite being considered as a rustic plant, *Adenium obesum* presents a significant response to the fertilizers, which stimulate vegetative growth and anticipate flowering, accelerating the cultivation cycle of this species.

The crop cycle can be divided into three periods. The first, up to 100 days after seedling transplanting (DAT), is characterized by a slow growth, low dry matter accumulation and increase on plant height. The second period, from 100 to 200 DAT, begins with the development of secondary branches and extends until flowering, during this period there are increases in dry matter accumulation, initially in roots, leaves, branches and later in the caudex. The last period occurs after flowering, when the growth of roots, leaves and branches present a decrease.

During flowering, the nitrogen (N), phosphorus (P), and mainly potassium (K) contents, decrease in the leaves, branches and caudex. The flowers are the main drains in this period, presenting average levels of 36 g kg<sup>-1</sup> of K, 10 g kg<sup>-1</sup> of N, 6 g kg<sup>-1</sup> of calcium (Ca), 5 g kg<sup>-1</sup> of P and 3 g kg<sup>-1</sup> of magnesium (Mg).

Among the nutrients, potassium is the most accumulated in the tissues, presenting content between 30 to 45 g kg<sup>-1</sup>; in which, caudex presents smaller values compared to leaves, branches and roots. The nutrient accumulation is followed by nitrogen and calcium. The calcium content range from 15 to 22 g kg<sup>-1</sup> in leaves and branches, while caudex and roots present lower contents, ranging from 4 to 7 g kg<sup>-1</sup> (COLOMBO et al., 2016; ALVES et al. al., 2018).

Nitrogen is observed in high concentration in leaves and branches, ranging from 10 g kg<sup>-1</sup> on initial stages, reaching 15 g kg<sup>-1</sup> in leaves to 25 g kg<sup>-1</sup> in branches during the flowering period. In the roots, the nitrogen content is close to 12 g kg<sup>-1</sup> until the beginning of secondary branches development. After this period, the root dry matter increases substantially, which reduces the nitrogen content between 6 to 9 g kg<sup>-1</sup>. In the caudex, the nitrogen content does not vary throughout the plant cycle, and it is similar to the roots level at the latter development stage.

The magnesium content for leaves, branches and roots vary from 4 to 5 g kg<sup>-1</sup>, and for the caudex presents between 2 and 3.5 g kg<sup>-1</sup> for the whole cycle. The phosphorus level in tissues rise until the flowering period, starting from 1 to 2 g kg<sup>-1</sup>, reaching 3.5 g kg<sup>-1</sup> in caudex and roots, 4 g kg<sup>-1</sup> in branches, and 5 g kg<sup>-1</sup> in leaves.

As in other crops, nitrogen gives the greatest response to *A. obesum* vegetative growth, in which nitric (NO<sub>3</sub>) or ammonium (NH<sub>4</sub>) supply can influence the fertilization efficiency. In this way, the NO<sub>3</sub>:NH<sub>4</sub> ratio is an important parameter to nitrogen fertilization management, presenting an adequate ratio close to 1:3 (NO<sub>3</sub>:NH<sub>4</sub>) that provides superior growth and development to roots and caudex. In this way, urea becomes an important source of additional nitrogen due to its amine radical, easy accessibility and low cost.

Another issue that directly influences the efficiency of fertilization is the substrate choice, since it presents interaction to the fertilization. Plants fertilized with Hoagland and Arnon solution, supplemented with 590 mg L<sup>-1</sup> of nitrogen (NO<sub>3</sub>NH<sub>4</sub>), when cultivated in sand and composed pine powder presented 4.0 and 1.6 g dry matter of caudex and leaves, respectively. On the other hand, the plants presented lower accumulation of dry matter in caudex and leaves (2.8 and 0.5 g, respectively), using the same fertilization using sand and coconut fiber mixture (ALVES et al., 2018).

## 4. DISEASE AND PEST

Some diseases have been reported for this species, mainly caused by fungi and vira, as brown leaf spot, *cucumber mosaic virus* (CMV) and *tomato spotted wilt virus* (TSWV).

The first report of brown leaf spot on *A. obesum* or any other member of the Apocynaceae family was described in 1995 by McMillan et al. (1997), caused by *Aristastoma* spp.. These authors isolated some known and unknown species of *Aristastoma* spp. from foliar lesions of *A. obesum* in a commercial nursery, where 100% of the crop was affected by these pests. According to the authors, the plant foliage presented irregular, oval to circular, rusty brown, and necrotic lesions from 5 to 15 mm in diameter.

In relation to viral diseases, Baker et al. (2003) firstly reported the CMV infection of *A. obesum* in Florida nurseries in 2002. Later, Chen et al. (2010) observed CMV infection in *A. obesum* plants occurring in Taiwan. The foliar symptoms are described as a mosaic with dark green islands surrounding the veins and chlorosis on the leaf margins.

Another virus that can damage this specie is the TSWV that was first reported in Europe in 1994 and Florida in 2004 (Adkins and Baker, 2005). The foliar symptoms include chlorotic ring and line patterns. According to Adkins and Baker (2005), attention to sanitation and insect vector management is required during the propagation and production as of the wide distribution of TSWV, the increasing popularity of *A. obesum* and the identification of CMV in this species.

For this specie, some insects as cochineals, aphids, caterpillar and thrips are the main pests. Neto et al. (2017) reported and described some of these organisms found in 2012 when investigating *A. obesum* used in landscaping in Goias-Brazil. These authors identified two species of cochineals, *Hemiberlesia rapax* Comstock (Hemiptera: Diaspididae) and *Parasaissetia nigra* Nietner (Hemiptera: Coccoidea); and one oleander aphid *Aphis nerii* Boyer (Hemiptera: Aphididae), damaging the leaves, flowers and stem of *A. obesum*. According to the authors, it was the first report of *H. rapax* occurring in *A. obesum*.

Besides cochineals and aphids, it was also reported the caterpillar *Daphnis nerii* Linnaeus (Lepidoptera: Sphingidae) occurring in *A. obesum* plants in Taiwan (LIN, 1997). However, to our knowledge, there was no available information to date about mite and thrips occurring on *A.*

*obesum*, but these organisms are commonly found in some production area, where this specie is cultivated. When infested with mites, the *A. obesum* plants can present webs on the foliage and their leaves may appear scorched or bronzed, being able to shed the leaves. The *A. obesum* can also be infested by thrips, which drains the sap from the leaves and may experience dieback, wilt or leaf curling (personal communication - TAKEMURA, 2018).

## 5. FLOWERING

*Adenium* presents terminal inflorescences that arise from the apex of the branches. The inflorescences are the corymb type, presenting a varied number of flowers. The flowers open successively and remain opened for about seven days, if not irrigated directly on the petals, which can reduce the durability and quality of flowers (Figure 9).



**Figure 9.** Commercial plants of *Adenium obesum*.

*Adenium* flowering can occur between seven to eight months after sowing, depending on the cultivation conditions (DIMMITT et al., 2009).

Irrigation management seems to influence the flowering period of this species, as plants grown on substrates of sand and coconut fiber (1:1, v/v) and vermiculite and coconut fiber (1:1, v/v) using water retention capacity between 60% and 70%, indicated earlier flowering compared to plants kept on the same substrate, but using higher water availability (COLOMBO et al., 2018).

In Brazil, the species can flourish year-round, except in regions with lower temperatures, such as the Southern region. In these regions, it is also common to observe the leaves falling during the coldest period, and in early spring, the inflorescences and new leaves start to appear.

## 6. COMMERCIALIZATION

The commercialization of *Adenium* in Brazil, until few years ago, was carried out in an informal way, in which one could acquire flowering plants from small producers, or even acquire young seedlings, without being certain of the color and shape of the flowers, due to the high genetic variability found in the species.

Nowadays, this market has been organized and it is being possible to acquire plants in flower shops and supermarkets, such as traditional potted plants, with an affordable price. It is common to find flowering plants of two and three years, but it is also common to find older

plants in some specialized florists, presenting the most developed and sculptural caudex.

## 7. FINAL CONSIDERATIONS

*Adenium* plants have substantial ornamental potential as a potted plant due to its peculiar and sculptural forms, associated to exuberant flowering with flowers of different shapes and colors.

Regarding the seedlings production, there is a market gap for seed production and multiplication of hybrid materials. The establishment of *in vitro* propagation protocols of this species presents as an opportunity to new research.

The commercial cultivation of this specie is not yet well established in Brazil. There is a lack on scientific information about crop management and production uniformity. Another challenge is the development of plant classification standards, aiming to establish a pricing system, since the plant price suffers a lot of regional variation.

## AUTHORS CONTRIBUTIONS

**R.C.C.:** Creation of the idea and manuscript preparation. **M.A.C.:** Manuscript preparation. **D.U.C.:** Manuscript preparation. **R.T.H.:** Manuscript preparation. **G.A.C.A.:** Manuscript preparation. **R.T.F.:** Orientation of the work and important suggestions incorporated to the work.



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