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Assessment of seed germination and seedling growth of different adenium (*Adenium arabicum*) hybrids under Prayagraj agro-climatic conditions

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Abstract
The experiment was carried out during May, 2023 to April, 2024 in naturally ventilated polyhouse, Department of Horticulture, SHUATS, Prayagraj, in Completely Randomized Design (CRD), with ten different adenium hybrids, replicated 3 times. Different hybrids used in this experiment were Godji x Jade Bracelet, Godji x Golden Tank, Godji x Big Flower Naresuan Muangkong Marakot, Godji x Iyara Bangkla, Godji Sonkla x Godji Champ, Golden Crown Dork Dok, Petch Pun Lan, Big Foot, Nomsod and Dinosaur. The 10 adenium hybrids under study showed significant variation in all the parameters observed. The hybrid Petch Pun Lan reported significantly better performance in parameters like days to 50% germination (5 days), seed vigour index (1353), germination speed index (0.93), seedling height (13.5 cm), number of leaves per seedling (46), estimated leaf area (12.6 cm^2), caudex diameter (3.03 cm), Primary root length (19.1 cm), diameter of primary root (1.35 cm), number of secondary roots per seedling (12) and survival percentage (93%). Hybrid Godji x Iyara Bangkla was found to be at par with Petch Pun Lan in the parameters like seed vigour index (1238), seedling height (13.4 cm), diameter of primary root (1.35 cm) and number of secondary roots (12). Hybrid Godji x Big Flower Naresuan Muangkong Marakot was at par with Petch Pun Lan in the parameters like days to 50% germination (6 days), germination speed index (0.68) and caudex diameter (2.91 cm).

Keywords: Adenium, germination percentage, growth, hybrids

Introduction
Adenium arabicum belongs to the botanical family Apocynaceae, is a succulent shrub commonly known as desert rose, elephant's foot and Adan bush. *Adenium arabicum* is native to Yemen and Saudi Arabia but has been introduced and naturalized in different parts of the world. It is commonly used for bonsai and cultivated for its shiny leaves, growth form and flowering characteristics. They are monoecious and self-sterile.

Adenium arabicum has been introduced and naturalized in different parts of the world. It is commonly used for bonsai and cultivated for its shiny leaves, growth form and flowering characteristics. They are monoecious and self-sterile. It includes about 215 genera and about 2100 species of mainly tropical trees, shrubs and vines with opposite leaves. Adenium contains whitish mostly poisonous milky sap that exudes from any cut surface that serves against grazing animals. Adeniums are characteristic plants of hotter, drier regions of Africa and their origin extends from East Asia to Socotra. These species are Caudiciform, with swelling stems and roots that serve as the principal organ for water storage [1].

Adeniums can be grouped in herbaceous, shrub and arboreal plants, with succulent stems and roots. The flowers have five sepals and five petals, in different colours, fused to a floral tube. The tube inner surface may have five or 15 red lines called as nectar guides. The five stamens are cone-shaped, and the anthers have their slits facing the inside of that cone. The anther trails protrude from the cone apex appear to be the true anthers. Compact growth habit, thick trunk like structure with showy caudex, good branching and flowering with high level of divergence for flower colour makes adenium a desirable pot plant to display in balconies, in verandas as well as is excellent plant for xeriscaping and roof top gardens. Besides, this plant represents one

of the richest sources of phytochemicals such as glycosides and possess great potential for pharmaceutical application [2].
Propagation by cuttings is easier, but these plants are not well accepted on the ornamental market because they produce underground stems and do not have the same exuberance as plants propagated by seeds [3]. Adenium shows a great deal of natural variation, however, research towards selecting or breeding superior horticultural forms have been meagre. Adeniums are cross pollinated plants and are highly heterozygous in nature [4].

Materials and Methods

Research location: The present investigation was conducted in a poly house during 2023-24 in the Department of Horticulture at the Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology And Science, Prayagraj. From May 2023- April 2024.

Methodology: The experimental material consisted of 10 different adenium hybrids *viz.* Godji x Jade Bracelet, Godji x Golden Tank, Godji x Big Flower Naresuan Muangkong Marakot, Godji x Iyara Bangkla, Godji Sonkla x Godji Champ, Golden Crown Dork Dok, Petch Pun Lan, Big Foot, Nomsod and Dinosaur of *Adenium arabicum* species, whereas 15 number of plants per hybrid were used respectively.
The experiment was conducted using Completely Randomized Design (CRD) consisting of 10 different adenium hybrids, each replicated three times. Analysis of data collected during the experiment was done by analysis of variance (ANOVA)

Results and Discussion

Seed Germination Parameters

Significant differences were observed in all varieties of the 10 *A denium arabicum* hybrids examined and the data are presented in Table 1.
The data on germination percentage of all the hybrids were recorded and non-significant differences were observed.
Significantly, lesser number of days to 50% germination (5 days) were observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with H3 (Godji x Big Flower Naresuan Muangkong Marakot) (6 days) and H4 (Godji x Iyara Bangkla) (6 days) while, higher Days to 50% germination (10 days) were observed in the hybrid H10 (Dinosaur). Adenium germination times are also influenced by environmental factors such as soil nutrient levels, composition, moisture content, light exposure, soil temperature and ambient temperature. The right genetic makeup and environmental conditions promote rapid germination of adenium seeds. Similar results are recorded in adenium [5, 6, 7].
Significantly, higher seed vigour index (1353) was observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with H4 (Godji x Iyara Bangkla) (1238) while, lessere seed vigour index (724) was observed in the hybrid H10 (Dinosaur). The vigor of the seedlings in the different hybrids was influenced by the genetic composition of the hybrid, the genotypes of the parents, the quality of the seeds, and the growing media. Innate variations in the hybrid's seedling vigor and growth rates also affect these variances. The nutrients, air temperature, light intensity, soil composition and water availability are some of the environmental elements that impact seedling growth. Similar results were shown in tuberose [8]
Significantly, higher germination speed index (0.90) was observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with with H3 (Godji x Big Flower Naresuan Muangkong Marakot) (0.68) while, lesser germination speed index (0.39) was observed in the hybrid H10 (Dinosaur). Noticeable variations in germination speed index between the adenium hybrids might be due to genetic diversity, environmental factors and substrate type had an impact on the germination speed index. It is known that adenium hybrids have increased enzyme activity, which increases the likelihood of early vigor and quick germination in the seedlings. Furthermore, germination speed index also impacted by environmental factors such as soil composition, moisture content, light exposure, air temperature and nutrient availability. Similar results were recorded in adenium by [3, 6, 7, 9] in tuberose.

Vegetative Parameters

From the present study, it was determined that significant chang es were observed in all nutrient deficiencies of 10 Adenium hybr ids studied and data are presented in Table 2.
Among all the hybrids significantly, taller seedlings height (13.5 cm) were observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with hybrid H4 (Godji x Iyara Bangkla) (13.4 cm), H9 (Nomsod) (12.7 cm) and H8 (Big Foot) (11.8 cm) while, shorter seedlings height (10.1 cm) were observed in the hybrid H10 (Dinosaur). Genetic differences and growing environment factors are the main causes of plant height variation in hybrids. Environmental variables also have an impact on seedling height in addition to these the extreme cold that characterized at December and January had an impact on seedling height. The plant was in a dormant state at this time. Seedling height is also influenced by the soil media. Similar results were recorded in desert rose by [10, 11, 12].
Among all the hybrids significantly, more number of leaves (46.6) were observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with hybrid H9 (Nomsod) (45.1), H6 (Golden Crown Dork Dok) (41.1), H1 (Godji x Jade Bracelet) (40.7), H4 (Godji x Iyara Bangkla) (40.5) and H8 (Big Foot) (32.2) while, lesser number of leaves (18.3) were observed in the hybrid H10 (Dinosaur). The variation in number of leaves among the adenium hybrids can be attributed to several factors. Primarily, genetic variability and parental genotypes play a crucial role, as each hybrid possesses distinct genetic makeup to influence growth and development. Moreover, some hybrids may exhibit better adaptability to specific environmental conditions, allowing their seedlings to produce more leaves and to grow longer compared to others. Significant variation in number of leaves can be attributed to genetic variability of the hybrids along with environmental conditions which govern the plant growth were recorded in adenium by [1, 6, 7].
Among all the hybrids significantly, bigger caudex diameter (3.03 cm) was observed in the hybrid H7 (Petch Pun Lan) which was found to be at par with H3 (Godji x Big Flower Naresuan Muangkong Marakot) (2.91 cm), H8 (Big Foot) (2.89 cm), H2 (Godji x Golden Tank) (2.77 cm), H9 (Nomsod) (2.70 cm), H4 (Godji x Iyara Bangkla) (2.69 cm) and H1 (Godji x Jade Bracelet) (2.59 cm) while, smaller caudex diameter (2.09 cm) was observed in the hybrid). H10 (Dinosaur). Several factors affect the caudex diameter of adenium hybrids. Genetic variation is especially important because each hybrid has unique genetic features that influence caudex growth and development. Adenium produced from seed exhibited a thicker caudex than grafted plants. Additionally, environmental variables have a substantial impact on caudex development. Significant variation in caudex diameter can be attributed to genetic variability of the hybrids along with environmental conditions which govern the plant growth were recorded in adenium [11, 6, 7].

Among all the hybrids significantly, higher survival percentage (93%) was observed in the hybrid H7 (petch Pun Lan) which was found to be par with H1 (Godji x Jade Bracelet) (80%), H2 (Godji x Golden Tank) (73%), H3 (Big Flower Naresuan Muangkong Marakot) (73%) and H4 (Godji x Iyara Bangkla) (86%) while, lesser survival percentage (53.33) was observed in the hybrid H10 (Dinosaur). Variation in survival and establishment percentages among the varieties can be attributed to several factors, including genetic characteristics and environmental conditions. Higher survival rates are likely to be attained by hybrids that are well-suited to the current conditions and receive the greatest amount of attention during establishment. The variation in the survival rate of various hybrids may be due to their genetic makeup, which allows them to respond differently to the environmental conditions in a particular place. Similar results were recorded by [11, 6, 7].

Table 1: Seed Germination parameters of different adenium hybrids.

Hybrids	Germination percentage	Days to 50% germination (days)	Seedling vigour Index (%)	Germination speed index
Godji x Jade Bracelet	86	7	935	0.53
Godji x Golden Tank	86	8	935	0.50
Godji x Big Flower Naresuan Muangkong Marakot	86	6	1032	0.68
Godji x Iyara Bangkla	93	6	1238	0.81
Godji Sonkla x Godji Champ	86	9	928	0.47
Golden Crown Dork Dok	86	7	941	0.57
Petch Pun Lan	100	5	1353	0.90
Big Foot	86	8	1020	0.61
Nomsod	86	7	1100	0.58
Dinosaur	73	10	724	0.39
F-TEST	NS	S	S	S
C.D. $_{0.05}$	N/A	1.62	170.12	0.11
SE.d (±)	15.07	0.77	81.55	0.05
C.V. (%)	21.74	13.00	9.78	10.76

%: Percentage

Table 2: Vegetative parameters of different adenium hybrids.

Hybrids	Seedling height (cm)	Number of leaves per seedling	Caudex diameter (cm)	Survival percentage (%)
Godji x Jade Bracelet	10.7	40.7	2.59	80
Godji x Golden Tank	10.8	18.4	2.77	73
Godji x Big Flower Naresuan Muangkong Marakot	11.5	23.5	2.91	73
Godji x Iyara Bangkla	13.4	40.5	2.69	86
Godji Sonkla x Godji Champ	10.7	24.1	2.48	66
Golden Crown Dork Dok	10.9	41.1	2.25	66
Petch Pun Lan	13.5	46.6	3.03	93
Big Foot	11.8	32.2	2.89	66
Nomsod	12.7	45.1	2.70	60
Dinosaur	10.1	18.3	2.09	53
F-TEST	**S**	**S**	**S**	**S**
C.D. $_{0.05}$	1.794	20.960	0.526	20.63
SE.d (±)	0.854	9.978	0.250	9.89
C.V. (%)	8.972	36.931	11.605	16.82

%: Percentage
cm: Centimeter

Conclusion

From the present study it was concluded that the 10 Adenophora hybrids examined showed no apparent differences**.** The hybrid Petch Pun Lan reported significantly better performance in parameters like days to 50% germination, seed vigour index, germination speed index, seedling height, number of leaves per seedling, estimated leaf area, caudex diameter, Primary root length, diameter of primary root, number of secondary roots per seedling and survival percentage. Hybrid Godji x Iyara Bangkla was found to be at par with Petch Pun Lan in the parameters like seed vigour index, seedling height, diameter of primary root and number of secondary roots and y Hybrid Godji x Big Flower Naresuan Muangkong Marakot was at par with Petch Pun Lan in the parameters like days to 50% germination, germination speed index and caudex diameter.

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