International Journal of Plant & Soil Science

34(23): 263-269, 2022; Article no.IJPSS.92193
ISSN: 2320-7035

Evaluation of Seed Germination, Establishment and Growth of Different Adenium (*Adenium arabicum*) Hybrids under Prayagraj Agro-Climatic Conditions

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2331587

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/92193

Original Research Article

Received 12 July 2022
Accepted 22 September 2022
Published 27 September 2022

ABSTRACT

An experiment was carried out during October 2021 to April 2022 in naturally ventilated polyhouse, in Completely Randomized Design (CRD) having five different Adenium hybrids with four replications at Department of Horticulture, SHUATS, Prayagraj (Uttar Pradesh). Different Adenium hybrids used in this experiment were Ara Dok Dok, Mammoth, Snp, Kud Jung, Mkmk. From the present investigation it is concluded that hybrid Mammoth reported significantly better performance in all of the parameters like germination percentage (93.33%), seed vigour index (464), seedling height (5.05 cm), seed viability index (93.33), Germination speed index (0.36), survival percentage (93.33%), number of leaves per plant (11.17), estimated leaf area (3.69 cm^2), taproot length (5.98 cm) which is found to be at par with Kud Jung in germination percentage (93.33%), seed viability (93.33%), survival percentage (93.33%). Hence, the hybrid Mammoth could be recommended for Prayagraj agro-climatic conditions.

Keywords: Adenium; germination percentage; growth; hybrids.

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1. INTRODUCTION

Adenium arabicum, also known as desert rose, elephant's foot, and Adan bush, is a succulent shrub that is a member of the Apocynaceae family. *A. arabicum* originally from Yemen and Saudi Arabia, has been introduced and naturalized all over the world. It is frequently used for bonsai and is grown for its glossy leaves, growth shape and flowering features [1,2].

The flowers feature a floral tube made up of five sepals and five petals in various colours [3,4]. Flowers come in a variety of colours, from pink to scarlet, and shine in the sunlight. Even if the habit of the plant varies and the majority of plants grown now are hybrids, only a few cultivar names have meaningful descriptions. Both seeds and cuttings can be used to multiply the slowly growing desert rose. Within 10 years, plants produced from seeds can generate caudexes in the most incredible shapes.

Although the plant has a wide variety of flowers, its caudex shape and development are what are most valued about it. The plant is marketed as seedlings or flowering plants and sold in vases or other similar containers. The use of the proper substrate is therefore important for the large-scale production of these species in order to give physical and chemical support, as well as to enable improved seed germination and seedling development [5,6].

The commercialization of adenium occurred in a variety of ways due to the high genetic variability found in the species, without being certain of the colour and shape of the flowers. Nowadays, the flower market has been organized, and plants, such as traditional potted plants, can be purchased at affordable prices in flower shops and supermarkets. Flowering plants of two to three years are common, but older plants with the most developed and sculptural caudex can also be found in some specialized florists.

Florists report that the thickening of the stem base can be shaped and thus attain higher market value; however, this characteristic is not manifested when the plant is vegetatively propagated [7]. It can be propagated by seeds to ensure maximum development of the caudex. Despite its high economic value, studies on its propagation are still required. To ensure the propagation of a species; and consequently, its sustainable exploitation, knowledge of its seed germination process is essential and their performance in various regions must be assessed.

Thus, this study aims to evaluate seed germination performance, its establishment and seedling development of desert rose seedlings under Prayagraj agro-climatic conditions.

2. MATERIALS AND METHODS

2.1 Experimental Location, Environmental Conditions (Climate and Weather)

The field experiment was carried out in naturally ventilated polyhouse, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, India during the season of 2021-2022. The experiment was laid out in Completely Randomized Design (CRD) with 5 hybrids and each hybrid was replicated four times.

The experimental site is being located at a latitude of 25.41º North and longitude of 81.84º East, with an altitude of 98 meters above the mean sea level (MSL). The area of Prayagraj comes under humid sub-tropical climate, which experiences warm humid monsoon, hot dry summer and cold dry winter. The annual mean temperature is 26.1ºC while monthly mean temperatures are 18-29ºC. The daily average maximum temperature is about 22ºC, and the minimum temperature is 9ºC. The average annual rainfall received is 1042.2 mm. At this location, the temperature reaches upto 46ºC-48ºC and the minimum temperature recorded was 4ºC-5ºC. The relative humidity ranges in this location varies between 20-94%.

2.2 Biologic Material

The experiment was conducted with 5 adenium hydrids viz. Ara Dok Dok, Mammoth, Snp, Kud Jung and Mkmk.

2.3 The Experimental Design and Parameters Determined

2.3.1 Experimental design

The trial was laid out in Completely Randomized Design (CRD) with 5 hybrids which have been replicated 4 times. They were Ara Dok Dok (H_1); Mammoth (H_2); Snp (H_3); Kud Jung (H_4); Mkmk(H_5).

2.3.2 Seed germination parameters

Germination percentage (%), seed vigour index, seed viability index, GSI (Germination Speed Index), survival percentage (%). For sowing the seeds, trays filled with cocopeat were used and seeds are sown at a depth of 0.5 cm.Trays were maintained in the naturally ventilated polyhouse.

1. Germination percentage

Germination percentage indicates the proportion by number of seeds which have produced normal seedlings within specified period under favourable conditions. It was calculated by using the following formula:

Germination (%) = (Number of seeds germinated / Number of seeds used for germination) X 100

2. Seed vigour index

Seedling vigor index was calculated by adopting the method suggested by Baki and Anderson (1973).

Seedling vigor index = germination (%) x total seedling length (cm).

3. Seed viability index

Viability is "the percentage or proportion of viable seeds in a seed lot". Seed viability index was calculated by the formula:

Seed viability index = (Number of seeds germinated / 100 seeds)

4. GSI (germination speed index)

The Germination Speed Index (GSI) which is a measure of the percentage and speed of germination indicates a slight difference between each variety and light regime. Higher values for this measure indicate a greater rate of germination.

$$GI = \sum (Gt / Dt)$$

Where,

Gt is the number of the germinated seed on day t and
Dt is the corresponding to Gt in days.

5. Survival percentage (%)

Survival percentage was calculated based on number of surviving plants at the end of the study as a percentage of the number of seeds planted.

Survival percentage = (Number of plants survived / Total number of planted seeds) X 100

2.3.3 Vegetative parameters

Seedling height (cm), number of leaves per plant, estimated leaf area (cm^2), taproot length (cm).

1. Seedling height (cm)

Three normal seedlings in each replication were randomly selected for measuring the seedling height. The root length was measured from the collar region to the tip of primary root. The shoot length was measured from the collar region to the point of attachment of cotyledons. The sum of root and shoot length was considered as seedling length. The mean was computed and expressed in centimeters. Seedling height was taken 60,90,120,150,180 DAS.

2. Number of leaves per plant

The number of leaves per plant were recorded at 60 days after transplanting till March, 2022 at monthly intervals. The mean was recorded by calculating the data.

3. Estimated leaf area (cm^2)

Estimates of leaf area was calculated with the help of graph method which was recorded at 180 days after transplanting. The mean was computed and expressed in cm^2.

4. Taproot length (cm)

Three seedlings were selected randomly from each replication and taproot length was measured from the tip of the primary root to base of the stem at 180 days after transplanting with the help of a scale and mean root length was expressed in centimeters.

2.4 Statistical Analysis

The results and data were subjected to statistical analysis separately by using analysis of variance technique (ANOVA) using one factor analysis. The difference among treatments means was compared by using least significant difference test at 5% probability levels.

3. RESULTS AND DISCUSSION

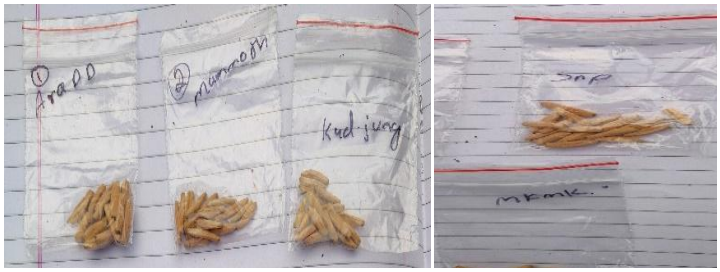
3.1 Seed Germination Parameters

Seed germination parameters are shown in Table 1. The higher germination percentage was observed in the hybrid Mammoth (93.33%) which is found to be at par with Kud Jung (93.33%)

followed by Ara Dok Dok (86.67%), Mkmk (80%). While the lower germination percentage was observed in the hybrid Snp (60%) [8] reported that increase in germination percentage might be due to the substrate used. Since the substrate used had many physical properties such as high porosity, goodwater drainage and aeration which was fundamental for germination. There by increasing the probability for sufficient supply of sunlight and water enhancing the eruption of radicle and plumule.

The higher seed vigour index was observed in the hybrid Mammoth (464) which is found to be at par with Ara Dok Dok (445), Kud Jung (397). While the lower seed vigour index was observed in the hybrid Snp (261). Seedling vigour is mainly influenced by the genetic inheritance of the hybrid, the substrate in which the seedling is grown and the early seedlings growth. Since there is a great amount of aeration through porosity and nutrient availability, they are likely to influence the seedling vigour. Similar results were recorded in pea seeds by Barbosa et al. [9].

The highest seed viability index was observed in the hybrids Mammoth (93.33) and which is found to be at par with Kud Jung (93.33) followed by Ara Dok Dok (86.67), Mkmk (80). While the lowest seed viability index was observed in the hybrid Snp (60). The seed viability index depends upon the genetic inheritance and was not influenced by the substrate stored. As the temperature and kinetic energy are increased water viscosity is reduced, thus favouring imbibition and the seeds metabolism compared reactions rate such as changing the structure of proteins and nucleic acids besides modifying the cell membranes fluidity. Similar results were shown in Mattana et al. [10].



Seeds

Different stages of seed germination

Table 1. Seed germination parameters of different adenium hybrids

Notation	Name of the hybrid	Germination percentage	Seed vigour index	Seed viability index	Germination speed index	Survival percentage
H1	Ara Dok Dok	86.67	302.33	86.67	0.3	86.67
H2	Mammoth	93.33	326.00	93.33	0.36	93.33
H3	Snp	60	109.67	60	0.18	60
H4	Kud Jung	93.33	193.00	93.33	0.32	93.33
H5	Mkmk	80	174.67	80	0.28	80
	F-TEST	S	S	S	S	S
	SE.d (±)	10.33	35.89	10.33	0.05	10.33
	$CD_{0.05}$	23.31	81.00	23.31	0.11	23.31
	CV	15.3	19.88	15.3	21.09	15.3

Table 2. Vegetative parameters of different adenium hybrids

Notation	Name of the hybrid	Seedling height					No. of leaves per plant					Estimated leaf area	Taproot length
		60 DAT	90 DAT	120 DAT	150 DAT	180 DAT	60 DAT	90 DAT	120 DAT	150 DAT	180 DAT		
H1	Ara Dok Dok	3.47	4.55	5.13	6.17	7.18	3.17	5.5	7	9.33	10.83	3.24	5.72
H2	Mammoth	3.55	4.64	5.17	6.53	7.83	3.17	5.67	8	10.5	11.17	3.69	5.98
H3	Snp	1.78	2.85	3.88	4.42	5.22	2.17	3.5	6.17	7.83	9	1.56	3.1
H4	Kud Jung	2.08	3.08	4.22	4.67	5.63	2.83	5.33	7	8.93	10.17	2.69	4.55
H5	Mkmk	2.18	3.35	4.25	4.73	5.48	2.33	5	6.77	8.5	10.17	1.58	4.33
	F-TEST	S	S	S	S	S	S	S	S	S	S	S	S
	SE.d (±)	0.31	0.31	0.43	0.56	0.7	0.3	0.62	0.47	0.75	0.62	0.67	0.8
	$CD_{0.05}$	0.7	0.71	0.96	1.27	1.58	0.67	1.41	1.06	1.69	1.39	1.51	1.81
	CV	14.18	10.38	11.53	13.01	13.68	13.36	15.28	8.21	10.14	7.33	32.16	20.71

The highest germination speed index was observed in the hybrid Mammoth (0.36) which is found to be at par with Kud Jung (0.32), Ara Dok Dok (0.3), Mkmk (0.28). While the lowest germination speed index was observed in the hybrid Snp (0.18). The Germination speed index was affected by the germination energy and substrate used. The higher enzyme activity in adenium hybrid is known more likely to trigger the rapid germination and early vigour of the seedling. Similar results were recorded by Wielewicki et al. [11].

The higher survival percentage was observed in the hybrids Mammoth (93.33%) and which is found to be at par with Kud Jung (93.33%) followed by Ara Dok Dok (86.67%), Mkmk (80%). While the lower survival percentage was observed in the hybrid Snp (60%). The substrate and environment in which the seedling is grown had a deliquent effect on the survival percentage of the seedling. As of the timely availability of the sufficient aeration and moisture through the substrate. The temperature inside the substrate is known to have less temperature than the outer environment ensuring the proper availability of moisture and as the temperature increases the seeds imbibition rate increases. Thus, causing the integument disruption and emergence of the root hypocotyl axis and other internal stuctures of the seed. Similar results were recorded by Van der Walt, K. [12].

3.2 Vegetative Parameters

The taller seedling height was observed in the hybrid Mammoth (7.83 cm) which is found to be at par with Ara Dok Dok (7.18 cm). While the shorter seedling height was observed in the hybrid Snp (5.22 cm). The genetic inheritance of the hybrids had a drastic influence over the seedling height. High heritability coupled with high genetic advance had a correlation effect on the seedling height. High water and nutrient uptake had increased the internodal length there by increasing the seedling height. Similar results were recorded by R. C. Colombo et al. [13].

More number of leaves per plant was observed in the hybrid Mammoth (11.17) which is found to be at par with Ara Dok Dok (10.83), Kud Jung (10.17), Mkmk(10.17). While the lesser number of leaves per plant was observed in the hybrid Snp (9). A higher no.of leaves is related to more vigorous seedlings because of greater germination potential and consequently higher speed of leaf formation. As there is sufficient gap for the tap root to grow there will be continuous supply of nutrients resulting in increase in increase of leaf size and consequently increasing the leaf number. Similar results were recorded by Mondo et al. [14].

The maximum leaf area was observed in the hybrid Mammoth (3.69 cm^2) which is found to be at par with Ara Dok Dok (3.24 cm^2), Kud Jung (2.69cm^2). While the minimum leaf area was observed in the hybrid Snp (1.56 cm^2). Leaf production of any crop decides the spread of the plant, leaves are the important functional units for photosynthesis, transpiration which greatly influence the growth and flower yield. The difference found in the leaf area demonstrates the plant genotypes variability for this trait. The results clearly indicated genetic inheritance and influence of the variety with respect to growth parameters. Thus, variation among cultivars can be attributed to difference in genetic makeup and its constituents. Similar results were shown by Paul, D et al. [15].

The highest taproot length was observed in the hybrid Mammoth (5.98 cm) which is found to be at par with Ara Dok Dok (5.72 cm), Kud Jung (4.55 cm), Mkmk (4.33 cm). While the lowest taproot length was observed in the hybrid Snp (3.1 cm). The tap root of adenium is of significant variance. The taproot length corely depends upon the substrate grown. As the root of adenium is robust it requires more nutrients and water for their growth. The substrate porosity and sufficient aeration, proper drainage of water helps in the better robust growth of root length. Similar results were recorded by Silva et al. [16].

4. CONCLUSION

It is concluded from the present investigation that the 5 adenium hybrids under study showed significant variation in all the parameters observed. The hybrid Mammot reported significantly better performance in all of the parameters like germination percentage (93.33%), seed vigour index (464), seedling height (5.05 cm), seed viability index (93.33), germination speed index (0.36), survival percentage (93.33%), number of leaves per plant (11.17), estimated leaf area (3.69 cm^2), taproot length (5.98 cm) which is found to be at par with Kud Jung in germination percentage (93.33%), seed viability (93.33%), survival percentage (93.33%). Hence, the hybrid

Mammoth could be recommended for Prayagraj agro-climatic conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/92193