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EFFECT OF DIFFERENT POTTING MEDIA ON GROWTH OF AN ORNAMENTAL AND VULNERABLE EPIPHYTIC ORCHID, *RHYNCHOSTYLIS RETUSA* (L.) BLUME FROM NORTHWESTERN HIMALAYAS

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Abstract

An experiment was carried out at the Orchid house of the Department of Botany, Panjab University, Chandigarh during February-May, 2022. The experiment was laid out in Completely Randomized Design (CRD) with 9 treatments, each treatment replicated thrice. The effect of 9 different potting media (comprising charcoal pieces, coconut husk, brick pieces, mango bark, and *Pinus* bark, alone, and in combinations) on the various vegetative growth parameters of *Rhynchostylis retusa* (L.) Blume was studied. It was observed that potting media have profound influence on different growth parameters of the species. The maximum number of leaves per plant was recorded in treatment T7 (12.00±1.15) [charcoal pieces + brick pieces + coconut husk (coir) + mango bark + *Pinus* bark] followed by treatment T6 (11±2.08) [coconut husk (coir) + charcoal pieces + mango bark + *Pinus* bark], and T1 (8.00±0.00) [charcoal pieces]. Similarly, maximum number of new buds formation also occurred in T7 (2.66±0.33) treatment followed by T6 (2.00±0.00) treatment and minimum number of new buds were formed in T3 (1.00±0.00) treatment. Maximum leaf length and width was reported in T7 (8.24±0.001 and 1.55±0.002, respectively) followed by T6 (6.45±0.003 and 1.44±0.008, respectively) media and minimum leaf length and width was reported in T3 (4.34±0.07 and 0.94±0.003, respectively) medium. The experimental findings showed that the maximum growth was obtained in T7 followed by T6 due to better growing environment for the plant, which probably resulted in enhancing the leaf number, leaf width and length, and formation of new vegetative buds. There was a general trend *i.e.,* T7, T6, T1, T9, T8, T4, T2, T5, and T3 which was observed in order of preference for the potting media by presently investigated orchid.

Introduction

THE FAMILY Orchidaceae is a diverse and widespread family of flowering plants with blooms that are often colourful and fragrant. This family comprises of about 29,481 species (WFO, 2023) distributed in about 705 genera (POWO, 2023). Orchids are easily distinguished from other plants, as they share some very evident derived characters or apomorphies. Amongst these are bilateral symmetry of the flower, highly modified petal (labellum), fused stamens and carpels, and extremely small non-endospermic seeds (Prakash and Pathak, 2020a, 2022). In India, orchids are represented by about 1,256 species in 155 genera (Singh *et al*., 2019). Orchid cultivation has emerged as a very rewarding vocation. The orchid plants and flowers are source of income for farmers and orchid growers. The annual income from sale of orchid plants and flowers in Thailand alone estimated at about 2.2 billion baht (Thammasiri, 2020). The orchids, unlike other ornamental plants, have specific requirements for well drained and aerated substratum capable of propping the plants and augmenting their water and nutrient requirements (Prakash and Pathak, 2020b). These plants have been grown commercially on bark, *e.g.,* coarse fir, or redwood bark chips (Freed, 1976). Because of their succulent roots and the large size of the bark chips, potting large bare-rooted orchid plants with bark is labor intensive and increases production costs. Also, bark does not hold much water, resulting in frequent watering and slow plant recovery after being in transit for many days. Additionally, bark decomposes quickly, resulting in nutrient deficiency, poor aeration, pest infestation, and frequent repotting. Although, the use of bark is rapidly increasing in Japan mainly due to the high cost of *Sphagnum* moss, it is seldom used for orchid production, and *Sphagnum* moss is the standard medium in Korea and Taiwan. Potting plants in other recommended media, such as *Sphagnum* moss and shredded tree fern, requires even higher labour costs on a commercial scale. Jin and Ichihashi (2002) reported that *Doritaenopsis* potted with *Sphagnum* moss grew better than when potted with bark, coconut husk or brick pieces. These results were due to the holding ability of moisture and mineral elements in media and mineral release from the media. It is known that water-stressed plants undergo morphological changes (Edgard *et al*., 2001), therefore, structural changes in plants are indicators to evaluate the media used and plant growth. To evaluate the mass production of these orchids, potting media with smaller particle sizes need to be developed so as to provide better root contact. Hence, during the present study, the effect of different potting media combinations with

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coir, brick pieces, charcoal piece, *Pinus* bark, and mango bark was assessed on the growth and morphological structure of leaves and roots of orchids, so as to assess the possibility of substituting *Sphagnum* moss with other easy-to-handle potting materials. Literature study revealed that potting media have been proposed earlier for this purpose and their effect on plant growth has been evaluated in some species. The utility of some such and other media was presently tested on a vulnerable epiphytic orchid *i.e. Rhynchostylis retusa* (L.) Blume. *R. retusa* is widely distributed in India (tropical Himalayan valleys from Sikkim Westwards to Garhwal and Eastward to Bhutan), Myanmar, Thailand, Malaysia, Vietnam, China, Bangladesh, and the Philippines. It is commonly known as *fox-tail orchid* because of its brush-like spikes of colorful flowers (Bose *et al.,* 1999); the species is well known for its beautiful white flowers arranged in long, compact, and pendant inflorescences (Thakur and Pathak, 2021). Due to extensive habitat destruction and commercial collection pressures, its natural populations are on decline (Barua *et al*., 2019; Bhandari *et al*., 2018; Sharma *et al*., 2017). Epiphytes are one of the most diverse groups in the plant kingdom and may contribute up to one third of the vascular plant species in tropical and subtropical forests (Benzing, 1990; Migenis and Ackerman, 1993). Eighty per cent of all vascular epiphytes are concentrated in only four families, and indeed over two third of all epiphytic vascular species belong to the single family Orchidaceae (Gentry and Dodson, 1987; Kress, 1986). Species numbers and global distribution patterns of epiphytic orchids are fairly well known (Migenis and Ackerman, 1993). Because of their complex biology, orchids are excellent indicators of overall forest diversity in an area (Christenson, 2003). Kromer *et al.* (2005) found that epiphytic species richness peaks in the subtropical forests at an elevation of about 1500 m amsl. About 161 species of epiphytic orchids have been recorded from Himalayan region (Raskoti, 2009) and most of them occur in tropical and subtropical forests (Acharaya *et al.,* 2011; Chaudhary *et al*., 2002). Epiphytic orchids are abundant up to 1800 m amsl and their frequencies of occurrence decreases with the increase in altitude (Bose *et al.,* 1999). Epiphytes usually grow on trees or shrubs without directly harming the hosts (Nieder and Michaloud, 2001). Epiphytes play a vital role in ecosystem functioning. They provide food and shelter for the animals, especially insects, and micro-organisms (Vance and Nadkarni, 1990). Regardless of their significant role in ecosystem, epiphytes are seldom been studied in relation to forest ecosystems (Benzing, 1990). Moreover, as orchids are the species with storage organs and high activity of polyphenoloxidase, they may function as bio-filters and air cleaners in hermetic capacity (Cherevchenko *et al*., 2001). The life of epiphytes depends on the characteristics of host (Callaway *et al.,* 2002; Partomihardjo *et al.,* 2004) and disturbance factors (Barthlott *et al.,* 2001). Previous studies have reported the influence of different host characteristics (*e.g*., bark rugosity, bark water holding capacity, age, growth, bark pH, sunlight intensity) on the distribution and diversity of epiphytes (Callaway *et al.,* 2002; Frei and Dodson, 1972). Based on the microclimatic conditions of the host species, the epiphytes sometimes prefer a specific host species (Callaway *et al*., 2002). Because of their high conservation value, it is a crucial need to study the ecology of epiphytic orchids in order to generate useful information to design their sustainable conservation and management strategies. The recent distribution of presently investigated *R. retusa,* an ornamental and vulnerable orchid from NorthWestern Himalayas, is influenced not only by natural microhabitat conditions such as bark water-holding capacity, bark pH, bark roughness, light intensity, tree size, and age, but also by human induced environmental factors. Therefore, the present study was aimed to investigate the effect of different potting media on its growth.

Material and Methods

Experimental Site

The experiment was conducted in Orchid house, Orchid Laboratory, Department of Botany, Panjab University, Chandigarh, during the period from February-May, 2022, so as to determine the effect of different potting media on the growth of *R. retusa* plants. The experimental site is situated at latitude of 30°45'43" N and longitude of 76°46'4" E, and at an average elevation of about 306 m amsl. It has a humid subtropical climate characterized by a seasonal rhythm: very hot summers, mild winters, unreliable rainfall, and great variation in temperature (-1°C to 46°C or 30.2°F to 114°F). The average annual rainfall is 1100.7 mm. The city also receives occasional winter rains from the Western Disturbance originating over the Mediterranean Sea.

Experimental Material

Rhynochostylis retusa orchid plants were selected for experimentation in Orchid house, Department of Botany, Panjab University, Chandigarh, so as to check their growth performance by growing these in different potting media. Different pots were prepared by using coconut husk (coir), charcoal, brick pieces, mango bark, and

Pinus bark in equal proportions as a supporting potting material. Immediately after potting, plants were watered with the help of hand sprayer.

Experimental Treatments

There were two factors used in this experiment *i.e. Rhynochostylis retusa* plants and nine treatments of different potting media.

Factor A: *Rhynochostylis retusa* plants

Factor B: Nine different potting media

Control

T1- Charcoal pieces

T2- Coconut husk (Coir)

T3- Brick pieces

T4- Mango bark + *Pinus* bark

T5- Charcoal pieces + Brick pieces + Mango bark + *Pinus* bark

T6- Coconut husk (Coir) + Charcoal pieces + Mango bark + *Pinus* bark

T7- Charcoal pieces + Brick pieces + Coconut husk (Coir) + Mango bark + *Pinus* bark

T8- Charcoal pieces + Brick pieces + Coconut husk (Coir)

T9- Coconut husk (Coir) + Mango bark + *Pinus* bark + Charcoal pieces

Water Management

Frequent application of water is essential for orchid cultivation. During February 2022, watering was done at alternate day; during March 2022, watering was done once a day, and during April-May 2022, watering was done twice a day, with the help of a hand sprayer.

Nutrient Spray Formulation

The spray solution was prepared in standard concentration by mixing of urea, triple super phosphate, and muriate of potash (100:25:100) which is beneficial for growth of plant so as to provide sufficient nutrition for growth.

Shading

Most epiphytic orchids avoid direct sunlight under natural conditions. Orchids prefer dappled shade. Shade net green cloth was used for covering the Orchid house and creating an artificial shade.

Data Collection

Data was collected periodically for the growth period of orchid plants. The data was recorded on the following growth parameters such as number of leaves per plant, leaf length and width, leaf area, total leaf area, leaf area index, number of roots per plant, number of new vegetative buds formation *etc*. (Table 1).

Number of leaves per plant

Number of leaves per plant was measured by counting manually all leaves in individual plant from each pot at the interval of 15 days.

Leaf length and width

Length and width of leaves was measured with the help of a measuring scale in centimeter of 8 randomly selected leaves from each pot at the interval of 15 days and their average was calculated and expressed in centimeters.

Leaf area

The leaf area was determined by multiplying leaf length with leaf width and expressed in square centimeter.

Total leaf area

Total leaf area was determined by summation of all leaf area and as expressed in square centimeter.

Leaf area index

Leaf area index is the ratio of total leaf area to total ground area. Leaf area index was determined by dividing individual leaf area to individual ground area.

Leaf Area Index = Total leaf area / Total ground area

Number of new vegetative bud formation per plant

Number of new vegetative bud formation per plant was measured by counting these manually, in all plants from each pot at the interval of 15 days.

Experimental Design

The experiment was conducted using a Completely Randomized Design (CRD) with nine treatments and three replications of each treatment. Observations were recorded at 15 days intervals. Various growth parameters were measured and recorded.

Statistical Analysis

The collected data for growth parameters was analyzed for variance (ANOVA) with help of computer package program SPSS (16) and mean difference was compared by Tukey's multiple range test (TMRT) at $p \leq 0.05$.

Results and Discussion

The vegetative growth parameters of the *Rhynchostylis retusa* as influenced by different potting media are presented in Table 1 and Fig. 1. The data clearly showed that growing media have profound influence on different growth parameters of *R. retusa*. Bhattacharjee (1982) explained the influence of different potting substrates on growth and flowering in *R. gigantea.* Grove and Allikas (1998) explained the properties of potting materials for orchids. Srinivasulu *et al.* (2017) studied comparative effect of different potting media on vegetative and reproductive growth of *Dendrobium* orchid var. Sonia 17. Barman *et al.* (2005) studied the effect of media and planting system on growth and flowering of *Cymbidium tracyanum*. The study clearly indicated that increment of plant height, production of new leaves, pseudobulbs, and flowers vary with the growth medium and system of planting. Effect of different potting media on plant growth and spike yield of *Dendrobium* was also studied by Gupta and Saravanan (2017). Sobhana *et al.* (2010) also studied the effect of growing media on the growth and flowering of *Dendrobium* hybrids. The results in all these orchid taxa showed that growing media have profound influence on the growth characters.

The number of leaves per plant was also influenced by growing media. In *R. retusa*, the maximum number of leaves (12±1.15) per plant was recorded when the plants were subjected to T7 [charcoal pieces + brick pieces + coconut husk (coir) + mango bark + *Pinus* bark] treatment followed by treatment T6 (11±2.08) [coconut husk (coir) + charcoal pieces + mango bark + *Pinus* bark], and T1 (8.00±0.00) (Charcoal pieces) media. A potting mix of charcoal + brick pieces + coconut husk (coir) + mango bark + *Pinus* bark was found to be the most effective for growth of these plants indicating there by that this potting medium provides proper aeration and nutrition; it also has certain chemical compounds which prevent bacterial and fungal infection. *Pinus* bark provides biopolymers (lignin, resin *etc.*) which is resistant to the bacteria, fungi, and other microorganisms which effect the growth of epiphytic orchids. Mango bark is rich in different nutrients which help in growth of potted plants. Charcoal allows free air movement in the medium and also has property of adsorbing gases, retaining moisture, and it slows down unwanted acid build up. Further, it is also light in weight so it can be used either alone or in combination with other potting media like *Pinus* + mango bark, coconut husk (coir), brick pieces. Charcoal has been reported to be as an excellent medium for epiphytic orchids (Bose and Bhattacharjee, 1972; Grove, 1988). Coconut husk holds moisture and supplies a little quantity of nutrients to plants. The experimental findings showed that the maximum growth was obtained in T7 followed by T6 due to better growing environment for the plant, which probably resulted in enhancing the leaf number, leaf width and length, and formation of new vegetative buds. Hence, all these reasons may be attributed to the favourable effect of these potting media components on the vegetative characters like number of leaves, leaf length and width, and number of new vegetative buds. According to Bose and Bhattacharjee (1980), an ideal medium for growing orchids should preferably be inert and resistant to organic decomposition. Maximum number of new vegetative buds formed in T7 (2.66±0.33) followed by T6 (2.00±0.00) and minimum number of new buds formed in T3 (1.00±0.00). Maximum leaf length and width was reported in T7 (8.24±0.001 and 1.55±0.002, respectively) followed by T6 (6.45±0.003 and 1.44±0.008, respectively) and minimum leaf length and leaf width was reported in T3 (4.34±0.07 and 0.94±0.003, respectively). A perusal of literature revealed that the requirements for potting medium vary with the type of orchid plant and environmental conditions. Pine bark, cork, *Osmunda* roots, *Sphagnum* moss, gravel, charcoal pieces, and coconut fibers are more commonly used potting materials for these plants (Suresh Kumar, 1992). The

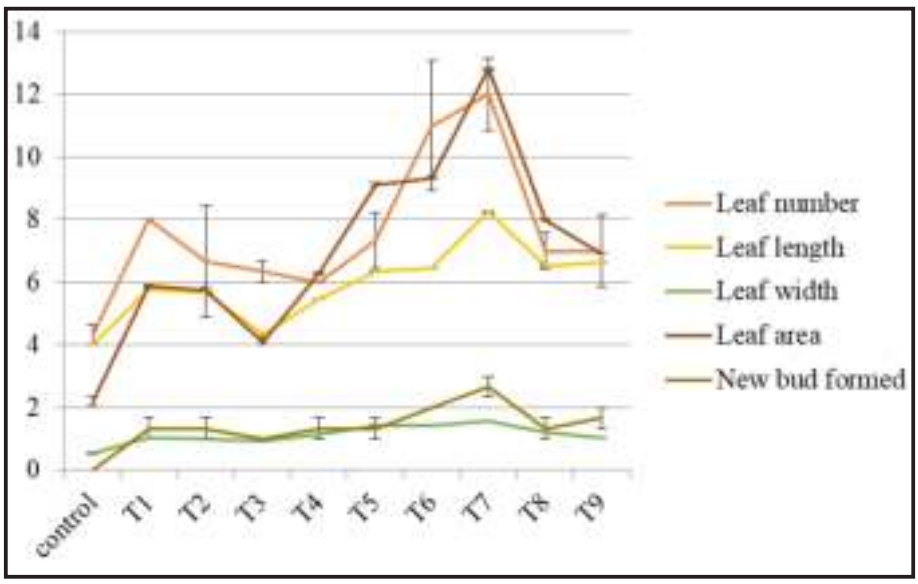

Fig. 1. Effect of different potting media on growth parameters of an epiphytic orchid, *Rhynchostylis retusa*

Table 1. Effect of different potting media on growth of an epiphytic orchid, *Rhynchostylis retusa*.

Treatments	Growth parameters				
	Leaf number	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Number of new vegetative buds formed
Control	4.33±0.33^{a}	4.00±0.00^{a}	0.55±0.03^{a}	2.22±0.14^{a}	-
T1	8.00±0.00^{bc}	5.79±0.02^{e}	1.02±0.001^{c}	5.90±0.02^{c}	1.33±0.33^{ab}
T2	6.66±1.76^{ab}	5.69±0.01^{d}	1.01±0.02^{c}	5.76±0.10^{c}	1.33±0.33^{ab}
T3	6.33±0.33^{ab}	4.34±0.07^{b}	0.94±0.003^{b}	4.09±0.08^{b}	1.00±0.00^{b}
T4	6.00±0.00^{ab}	5.45±0.004^{c}	1.15±0.005^{d}	6.27±0.03^{d}	1.33±0.33^{ab}
T5	7.33±0.88^{ab}	6.33±0.005^{f}	1.44±0.005^{e}	9.12±0.04^{g}	1.33±0.33^{ab}
T6	11.00±2.08^{cd}	6.45±0.003^{g}	1.44±0.008^{e}	9.33±0.06^{h}	2.00±0.00^{cd}
T7	12.00±1.15^{d}	8.24±0.001^{j}	1.55±0.002^{f}	12.81±0.02^{i}	2.66±0.33^{d}
T8	7.00±0.57^{ab}	6.54±0.01^{h}	1.22±0.001^{e}	7.98±0.02^{f}	1.33±0.33^{ab}
T9	7.00±1.15^{ab}	6.64±0.004^{i}	1.03±0.00^{c}	6.91±0.01^{e}	1.66±0.33^{ab}

T1, Charcoal pieces; T2, Coconut husk (Coir); T3, Brick pieces; T4, Mango bark + *Pinus* bark; T5, Charcoal pieces + Brick pieces + Mango bark + *Pinus* bark; T6, Coconut husk (Coir) + Charcoal pieces + Mango bark + *Pinus* bark; T7, Charcoal pieces + Brick pieces + Coconut husk (Coir) + Mango bark + *Pinus* bark; T8, Charcoal pieces + Brick pieces + Coconut husk (Coir); T9, Coconut husk (Coir) + Mango bark + *Pinus* bark + Charcoal pieces.

present study indicated that the growing medium plays an important role on the growth of orchid plants. Selection of suitable medium for epiphytic orchids depends not only on its efficiency but also on the availability and cost (De *et al*., 2014). It is essential to find inexpensive and locally available potting media to promote orchid cultivation. A general trend *i.e.,* T7, T6, T1, T9, T8, T4, T2, T5, and T3 was observed in order of preference for the potting media in the presently investigated species. The best medium for growth of potted *Rhynchostylis retusa* was found as T7 [charcoal pieces + brick pieces + coconut husk (coir) + mango bark + *Pinus* bark].

The abundance and diversity of orchids is decreasing throughout the world, beginning with genetic erosion and ending up with local or global species loss. The main driving forces are habitat loss due to deforestation, agricultural and industrial expansion, urbanization, illegal collection, and trade (Bajracharya, 2005; Medhi and Chakrabarti, 2009, Prakash and Pathak, 2019). There is an urgent need to protect the orchid species in their natural habitats. Conventionally, habitat protection and species protection are two important strategies, which can prevent the species from extinction. Both the ecology and distribution of epiphytic orchids, especially their microhabitat requirements and the human induced environmental changes, are scarcely known in the Himalayan region (Sharma *et al.,* 2017). Most of the researches on orchids are related to floristic exploration and taxonomic description, while some addressed ecological and conservational issues (Bailes, 1985; Bajracharya *et al*., 1994; Chaudhary *et al*., 2002; Shakya *et al.,* 1994; Sparrow, 1996; Subedi, 2002), none of them, however, addressed human influence on orchid distribution. Given the high rate of population depletion and their relatively high vulnerability, the study on epiphytic orchids in relation to host preference, microhabitat quality, including human disturbance is a prerequisite to know the ecological response with their host and changing environment (Callaway *et al*., 2002).

Conclusion

From the above results, it may be concluded that different potting media variously influenced the vegetative growth of presently investigated species, *R. retusa*. The growth was positively influenced by potting medium used as T7 [charcoal pieces + brick pieces + coconut husk (coir) + mango and *Pinus* bark] during the present experiment under green house conditions in clay pots. Further detailed studies in this direction are required so as to find out the efficiency of different potting media during the reproductive stage of this species in particular and other epiphytic orchids, in general.

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