IN-VITRO SEED GERMINATION AND EFFECT OF GROWTH REGULATORS ON SUBSEQUENT DEVELOPMENT OF PROTOCORMS OF EULOPHIA NUDA LINDL

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Abstract
Asymbiotic seed germination of Eulophia nuda Lindl. was observed on Knudson C medium. About 90% seeds germinated within 8-10 weeks and formed green protocorms in 11-12 weeks. Effect of BA and IBA was studied on plantlet development from protocorms. BA shows the best results with respect to number and length of shoots. Maximum number (6.45±1.36) and length (3.90±0.99) was observed on MS medium supplemented with 4.44μM BA. Maximum root growth was also observed on same medium (4.8±0.99 number of roots and 1.43±0.13 cm length). The regenerated plantlets were successfully acclimatized and transferred to earthen pots. The results presented here show that in vitro seed germination and plantlet development in Eulophia nuda Lindl., an endangered orchid, can be achieved at a higher rate by this method.

Key words: Eulophia nuda Lindl.; orchid; BA; IBA.

Introduction
Orchids, one of the major families of angiosperms, are having immense importance as ornamental and medicinal potential. Nowadays, many orchid species are threatened and enlisted in the Red Data book of IUCN (Chugh et al., 2009 and IUCN, 2011). The entire family is now included in Appendix-II of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), where the international trade is strictly controlled and monitored (Chugh et al., 2009 and Reed et al., 2011). Orchid species are under serious threat with an uncertain future due to unscrupulous collection for commercial uses (Swarts and Dixon, 2009).

Common orchid taxa may serve as models for developing reintroduction programs, which can then be applied to threatened and endangered taxa. The first step in this process is establishing efficient propagation protocols to produce plants for subsequent experimentation the most efficient method of propagating native terrestrial orchids. Seed propagation represents the straight forward method to produce large number of propagules. (Stewart and Kane 2006).

Symbiotic seed germination can be a cumbersome process; root samples must be collected from which many fungi are often isolated. Fungi must then be identified and screened for growth promoting strains. Asymbiotic seed germination can be a more straight forward process since mycobionts need not be isolated to germinate seeds of orchid taxa. Populations of orchids that are established with asymbiotic seedlings remain dependent on naturally occurring fungal symbionts for seedling recruitment (Zettler 1997b).

Eulophia nuda Lindl. [Synonym: Eulophia spectabilis (Dennst.) Suresh] known as ‘Manya’ (in Sanskrit) and as ‘Amarkand’ (in Marathi) primarily is used as an ornamental but is also used in herbal medicines and food (rhizome) by many different tribes. An amorphous phenantherene, named nudol, later identified as 2,7-hydroxy-3,4-dimethoxyphenantherene has been isolated from Eulophia nuda, E. ohrenta, Erica carinata and Erica stricta (Merchant et al., 1962., Bhandari et al., 1985, Datla et al., 2010 and Kshirsagar et al., 2010). Eulophia nuda is exploited for several of its ethno-medicinal properties like antiodote for snake bite, as antihelminthic, against tumors, cases of bronchitis, Scurfulous affection of the glands of the neck and in disease of the blood (Singh and Duggal, 2009). The plant is also claimed to be useful in tuberculosis (Chopra, 1956). Eulophia nuda mainly propagate through the rhizomes in nature and they produce only limited number of propagules. This plant species has been over harvested because of increasing demand in the market. Threat is further exaggerated due to destruction of its natural habitat. Therefore, it is important to establish an efficient regeneration and multiplication system for the production of large number of rhizomatous plantlets. The present study describes the protocol for propagation through in vitro seed germination and multiplication system for its conservation and sustainable utilization.
Materials and Methods

Plant material, surface sterilization and explant preparation
Capsules of *Eulophia nuda*, maintained in Botanical garden, Shivaji University, Kolhapur, India were harvested in the month of October before dehiscence. The capsules were washed with liquid soap under tap water and further surface sterilized by dipping in 70% ethanol for 30 seconds in laminar air flow unit.

Culture medium and culture conditions
The capsules were cut open and seeds sowed aseptically in petri dishes (Laxbro India 88X55mm), containing Knudson media (1946) fortified with 3% (w/v) sucrose and 0.9% agar (Himedia) as gelling agent without addition of plant growth regulators. The small protocorms obtained were transplanted on to Murashige and Skoog (1962) medium containing various concentrations of BA (6-benzyl aminopurine) and IBA (Indol-3-butyric acid), supplemented with 2%(w/v) sucrose and 0.8 % agar (Himedia) as gelling agent. The pH of the medium was adjusted to 5.8±0.02 using 1 N NaOH or 0.1N HCL prior to autoclaving for 15 min at 15psi, 121 °C. The cultures were maintained at 28 ± 2 °C under a 12 h d-1 photoperiod with a white cool fluorescent light (40µMolm-2s-1). Subsequent transfer to fresh medium was carried out according to growth rate and stage of development, usually after each 4 to 6 weeks. The cultures were observed constantly for any response and results recorded after every 15 days.

Acclimatization of regenerated plantlets
Rooted plantlets with fully expanded leaves and well developed roots were successfully transferred to pots containing sand and soil (1:1) and maintained in controlled growth chamber conditions 25 ± 1°C, 16 hrs photoperiod and 80% relative humidity followed by gradual shift to greenhouse conditions.

Experimental design and statistical analysis
All the experiments were conducted with the minimum of 30 replicates per treatment and the experiments were repeated three times. MS medium without growth regulator was used as control in all experiments. The results are expressed as mean± SD of three experiments. Data were subjected to analysis of variance (ANOVA) and means were compared by Duncan’s multiple range test at P<0.05 using the SPSS ver.21 (IBM SPSS ver 21).

Results and Discussions
Germination of orchid seeds is different from other seeds. The seeds are produced in large number within a capsule. They are very minute, with undifferentiated embryo and lack of endosperm. Due to non-endospermic nature of seed, the germination in nature is unique phenomenon and requires fungal infection. Germination is much more successful *in vitro* on medium containing simple sugars. The production of orchid seedling from seed involves sequential phases as germination, protocorm formation and development of seedling. In present study similar sequence was observed when seeds of *Eulophia nuda* were grown on KC medium devoid of plant growth regulators (Fig 1).

Seed germination started relatively slowly within 8-9 weeks of culture where embryos swelled and broke out of the testa, and then formed green protocorms after 11-12 weeks of sowing. The germination of nongerminated seeds continued for a prolonged period of time lasting more than 10-12 months. Similar observations are reported in *Dactylorhiza futchsii*, (Jakobson 2008), where seed germination continued for almost 2.5 years under *in-vitro* conditions. The protocorms take 4 weeks to develop chlorophyll, as evident in most of the terrestrial orchids (Dressler, 1990) in contrast with *Bletilla*, *Thunia* and *Cymbidium*, where early in germination; chlorophyll appears in the protocorm cells as described by Yakovlev and Zhukova (1973).

Fig. 1: 1.Germinating seeds, 2. In-vitro produced rhizomes, 3. Effect of IBA and BA on development of shoots and roots, 4. Plantlet ready for hardening, 5. Acclimatized plant of *Eulophia nuda*
Asymbiotic germination of seeds is the most common method practiced for the propagation of both epiphytic and terrestrial orchids even though symbiotic germination succeeded in some species has been recommended for utilization in restoration programs (Stewart and Kane 2006; Aggarwal and Zettler 2010). Asymbiotic seed germination is reported to be successful in some Eulophia species, including E. alta, E. graminea, E. cactilata, E. streptopetala, E. petersii and E. nuda (McAlister and Van Staden 1998; Johnson et al. 2007; Chang et al. 2010, Nanekar et al 2014) using MS, ½ MS, ¼ MS + coconut water, BM1+coconut water, or P723 (Orchid Seed Sowing Medium, PhytoTechnology Laboratories, Shawnee Mission, KS) as culture media. The present study revealed Knudson-C medium equally good for supporting seed germination without any additives. For subsequent development, the green protocorms of ~2 mm diameter were transplanted on Murashige and Skoog (1962) medium, supplemented with BA and IBA alone and in combination, where they grew in size and differentiated to form shoots and roots (Table 1). Rhizome formation was observed after two subcultures on same medium. Their size and number increased during further subcultures. The maximum number of shoots (6.45±1.36) and length of shoots (3.90±0.99) were observed on medium fortified with BA 4.44µM. Maximum root growth was also observed on same medium (4.8±0.99 number of roots and 1.43±0.13 cm length of roots). Similar results were observed in Orchis coryophora where shoot length and number and length of roots in medium supplemented with 0.25 mg/L 6-BA were longer than those grown in other medium (Bektas 2013). Cytokinins promote rhizome formation which was best observed on media supplemented with BA alone. Development of storage organs such as root rhizome and rhizomes in vitro, of terrestrial orchids is important as the means to improve plant reproduction by allowing ex vitro translocation for the use of plant tissues that possess a greater desiccation tolerance than seedlings with photosynthetic leaves.

The type, concentrations and different combinations of PGRs plays an important role during in vitro propagation of many orchid species (Arditti and Ernst, 1993). The promotory effects of growth regulators in in-vitro culture have been worked out by a number of workers (Kano1965, Methews and Rao 1980, Sharma and Tandon 1986, Kumaria and Tandon1990). The enhancing effects of cytokinins on morphogenesis were previously reported (Goh & Wong, 1990). The differentiation of multiple shoots from corm and/or protocorm like bodies (PLBs) have been reported in Renanthera inschootiana (Seeni and Latha, 1992); Cymbidium aloifolium (Kaur and Sharma, 1997; Bujabarua and Sharma, 1997); Dendrobium aphyllum (Talukdar, 2001) Habeneria marginata (Seenavalmath and Murthy, 2001) and Eulopina nuda (Panwar et al 2012).

IBA in combination with BA has showed best results for plant development in Cattleya walkeriana (Marinag, et al 2003). The highest rate of elongation was reported in Dendrobium fimbriatum in MS medium containing 2.0 mg/l BAP and 0.01 mg/l IBA. In majority of cases auxins (NAA, IAA and IBA) enhanced the seed germination and seedling growth. In present investigations IBA does not show any promotory effect in shoot, root or rhizome formation alone as well as in combination with BAP suggesting that auxins did not support differentiation in germinated seeds of E. nuda.

**Conclusion**

The in vitro propagation of orchids has always been envisaged as problematic. On the other hand, such plants are economically important since they have long been used as a herbal remedy for various ailments by tribal people. As they are collected from nature, not cultivated, their

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<th>BA (µM)</th>
<th>IBA (µM)</th>
<th>No. of Shoots</th>
<th>Length of shoots (cm)</th>
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<td>3.19±0.79d</td>
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<td>2.46±0.89cd</td>
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<td>4.44</td>
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<td>0.98</td>
<td>1.45±0.56c</td>
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Basal medium: MS supplemented with 2% (w/v) sucrose and 0.8% (w/v) Agar. Means followed by the different letter within column are significantly different (P<0.05) using Duncan’s multiple range test.

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extinction is inevitable; careless collection will cause genetic and ecological erosion. The results presented here show that in vitro seed germination and plantlet formation of *Eulophia nuda*, an endangered orchid, can be achieved at a higher rate by this method. This data may hold the key to the mass propagation of other orchid species.

**References**


