Literature Review

2. LITERATURE REVIEW

Besides medicinal importance, orchids are regularly used in the breeding program to develop new varieties and hybrids both at inter generic and inter specific level to improve their horticultural aspects. The major breeding criteria for improving orchids are suitable colors as per consumer's demand flower shape, fragrance, increase flower size, increase number of flower etc. the success of breeding process depends upon the fact that in most of the orchid genera and species there is no genetic barrier and they cross freely with each other. Once a hybrid is made, the only major problem is the large scale propagation because the seed setting capacity of the important hybrid is very poor along with its slow growing vegetative propagation. Other than all above mentioned economic consideration, orchids have some inherent capacities for drought resistance, nutrient conservations and long shelf-life of the flowers etc. These characters are very peculiar and not present in common crops. So, it is believed that orchids can contribute many genes to other crops just as went on creation of 'golden rice'. Therefore, the germplasm of orchids should be conserved because they may act as important gene donor in future for the improvement of other crops through genetic manipulation.

Although orchids belong to one of the largest families, they are also perhaps most seriously threatened plants on the globe. Their vulnerability depends upon following reasons:

1. Orchids have specialized life cycle. The vegetative propagation and multiplication of orchids is very slow process and it takes a long duration. In case of vegetative propagation through separation of stem and pseudobulbs one may not get more than a few plants after 4-5 years.
2. The pollination of orchid flower depends on the pollinators.
3. In the seeds of orchid, there is lack of reserve food material i.e., absence of endosperm, cotyledon etc.
4. The seed germination of orchid is always dependent on the association of mycorrhizal fungi, in some cases they are species specific. Therefore, only less than 1% of seed germinate in their natural environment due to non availability of specific fungi, so slow vegetative propagation through asexual method and the

need of mycorrhizal fungi for seed germination make their life cycle more vulnerable.

5. Owing to ornamental and therapeutic values which they possess has made them so sought after the man.

Each species is adapted to live in a specialized environment because of their specialized requirement and many species are restricted to distribution and so endemism is very high. Any destruction or degradation of their natural habitat beyond a tolerable limit causes threat for the survival. Due to human pressure on land and developmental activities, orchid wealth is depleted sadly and seriously. The epiphytic species of orchids are faced with the maximum danger due to cutting of host tree serving as a substrate. The natural process of extinction of orchids is also accelerated by the global warming as a result due to increasing aridity or decreasing moisture in the climate by deforestation and global warming cause a serious threat to the survivality of epiphytic orchids. In north eastern hill, tribal people are habituated to cultivate following shifting cultivation, this practice results to an ecological imbalance which reduces indirectly the orchid biodiversity and their habitat.

With the advancement of human civilization and exploration of orchid's world over for medicinal, ornamental and scientific purpose, the actual depletion of orchid began from there. During the early phase of exploitation many valuable orchids were exported from India to European destination and there was no attention towards their conservation. Any biological wealth of a country is its valuable heritage which is the product of million year's evolution, so, exploitation without conservation made continuous decrease of wealth. For orchid flora it is estimated that 250 species of native orchid are now under the threats of various categories. Therefore, other than economic consideration it is better to protect and conserve them for generation after generation before they reach the point of extinction. Protection can resist the depletion of orchid wealth in their natural habitats and the biopiracy, while the conservation is also a type of protection but is related with the propagation. Orchids are generally propagated by vegetative methods but vegetative method of propagation is very slow process which is not suitable for their rapid conservation. The slow rate of vegetative reproduction pointed to need for an alternative rapid propagation system. The alternative methods of orchid propagation are from seeds. In their natural condition, the majority of orchid flowers are not pollinated, so their ovules are not fertilized and capsules are rarely formed. In case of successful pollination, fertilization of orchid ovule takes place 50-80 days after pollination and their seeds are formed within the fruit or pod. Orchid seeds are unique in several respects.

They are extremely small and usually undifferentiated. They are produced in large numbers ranging from 1300-40000 per capsule. Each seed contains, an undifferentiated embryo composed of 80-100 cells without any functional endosperms. The entire embryo is covered by a membranous transparent loose air filled seed coat or testa. The embryos are situated in the middle of the testa being attached to it by few fine strands. Testa cells are dead, vary in size and have longitudinal and transverse walls of different thickness which gives them a net like appearance, this is a marked character and is species specific. Since there is no cotyledon and no endospermic nutrient reserve for the embryo, the seed germination and the subsequent germination of the seedlings in orchids are extremely low. This process is activated in the presence of suitable fungus in nature. The fungus digests the seed coat while breaking the starch and cellulose into usable sugar for the embryo to ensure germination. Under natural condition, the orchid seed germinate in association with fungus (orchidomychorrhiza). Most of the orchidomychorrhizal fungi of orchids fall into groups like *Rhizoctonia*, of late; however, 54 different fungi have been isolated from 20 different orchid species. When an orchid seed comes in contact with specific mycorrhizal fungus, then they start to germinate and produce into plantlets. Stoutamire (1974) suggested that the fungus probably provides the growth substance to activate their enzyme system. On the basis of dependency on fungi for seed germination, orchid can be divided into two categories. In one group, the fungi invade the embryonic tissue during germination and such fungi remain associated with the orchid throughout its life in the root system. The orchid root has a partnership in which the fungus penetrates its thread like body or mycelium into the cortical cells of the root tissue. This relationship is of mutual benefit to the orchid to obtain nutrition and to the fungus as assured habitat. Seed of these orchids however germinate without the requirement of fungus when they fall into substratum. On the other hand, most of the orchid cannot germinate in nature without a fungus, because the mature plants do not allow the fungus to remain as orchidomychorrhiza, and they may be less dependent on this relationship. In absence of mycorrhizal association the seeds are not able to geminate in nature and as a result thousands of seeds perish every year. Until the middle of 19^{th}

century, there was no method for germination of orchid seeds, therefore, neither vegetative nor seeds are suitable for rapid mass propagation of orchid by conventional way, but if the vegetative parts or seeds could be propagated by any alternative method, it would provide the basis for a technology to overcome limitation for conventional method of propagation for orchids. Since then plant scientists, made an intelligent attempt to exploit the plant tissue culture technique for the rapid mass propagation of the orchid. Plant tissue culture has opened a number of possibilities and, the literature on this aspect has accumulated rapidly more than thirty years. The application of tissue culture technique for the mass propagation of orchids and the benefits derived are marvelous for the production of orchid plants in large quantities which in time improves the orchid trade and industry.

The pioneer work of Bernard (1909) is important in the development of *in vitro* culture techniques of orchids. He successfully isolated the root infecting fungi helpful in orchid seed germination. Comparative germination studies were made of infected and non infected seeds when sterilized seeds were grown in association with the fungus, the percentage of germination improved considerably. Subsequently, the work of Knudson (1922, 1924, 1925) clarify many important points regarding the formation of seedling and organogenesis. Fungi were chiefly responsible for breaking down starch into simple sugars into germinating seeds. Thus Knudson's work showed for the first time that germination of orchid seeds could be possible *in vitro* without fungal association, Knudson (1951) also suggested a medium that provided balanced organic and inorganic nutrition for the developing seedlings. The medium proposed by Vacin and Went (1949) is widely used for germination of hybrid seeds. The credit for the initiation of meristem culture technique goes to Morel (1960). Therefore, vegetative propagation of orchids is also possible by *in vitro* technique. After Knudson, the seeds of different orchid varieties have been successfully germinated asymbiotically *in vitro* by many workers. The germination potential of embryo varies with their developmental stages. The immature embryos in general germinate readily and much better than the mature ones. Successful germination of immature embryos can depend on selecting the correct time after pollination at which to harvest the pods. The optimal harvest time for immature seed is therefore not easy to guess. In general terms, seeds are removed from the capsule which have progressed approximately ½ to ⅔ in their development from pollination to maturity. There are several advantages in using unripe immature seeds for *in vitro* culture.

The advantages are as follows:

1. It increases the rate of orchid seed germination.
2. Seedlings are given an earlier start by green pod culture and this can reduce the time from seed to flowers.
3. Immature seed culture can assist in obtaining seedlings from wide crosses where embryos often abort before reaching maturity.
4. In many species it is easy to miss the point at which capsules become ripe and start to shed seeds. Culturing the immature seeds can lessen the chances of seed loss by natural dehiscence.
5. The advantage of using seeds from capsules or pods for micropropagation is that, virus diseases etc. present in the capsule tissue may be eliminated when they are transferred to culture Mitchell (1989).
6. Large numbers of seedlings are produced to enable reintroduction, reinforcement, habitat restoration or improvement in native and alien forest segments.
7. Sustainable utilization of the commercially important taxa selection is possible; contributing to local nursery trade.
8. These provide an alternative source of species and take the pressure of waning wild population without harming the mother plants thereby, guaranteeing the survival of the species in the wild.
9. These contribute to maintaining a variable gene pool in contrast to clonal propagation. In fact, genetic diversity enhanced since most, if not all the seeds, including those that would not have germinated in the wild, are induced into seedling *in vitro*.
10. Genetic improvement of orchid is possible by culturing inter-specific/inter-generic hybrid seeds.
11. The length of reproductive cycle is shortening thereby achieving considerable saving in time by using immature seeds to produce plants.
12. Flasked orchid species are easier to establish than the wild-collected plants.
13. International transfer of flasked species is easily done avoiding CITES (convention on International trade on endangered species on wild flora and fauna)

Bhojwani and Razdan (1983) also reported that the nutritional requirements of the younger embryos are complex as compared to matured ones. Yam and Witherhead (1988) suggested that better germination response is related to their distending testa cells, metabolically awakened embryos and lack of dormancy and/or inhibitory factors. The embryo germinates just when procured from the capsules which have ceased to grow in diameter and develop deep ridges along the valve (Light 1990, Viz 1995).

The germination potential of immature seed was found to be directly co-related with their physiological age. The mature seeds, on the other hand either fail to germinate or germinate very poorly due probably to loss of growth promoting factors and accumulation of inhibitory and other dormancy factor, besides a change in the quality of food reserves, (Burgeff 1959, Kano 1965, Stoutamire 1974, Withner 1959). Besides the difference in age, and response in culture, the mature and immature seeds are morphologically more or less indistinct.

An analysis of morphogenetic changes in the orchid embryo prior to the development into seedlings *in vitro* indicate that orchid seed germination and subsequent development into seedlings is usually accompanied by an intervening protocorm stage or callus stage. The intervening protocorm stage develops directly from the embryo whereas the intervening callus tissue also develops directly from embryo and such callus tissue further develops into protocorm. In general direct germination related events include swelling of embryos and their emergence by bursting the seed coat as globular or elongated spherules which subsequently form chlorophyllus hairy and pear shaped protocorms. The development of protocorms into seedling is in general monopolar i.e., seedling development takes place from one pole of the protocorm. The protocorms develop directly into seedling in most of the species where their development of seedling is associated with intervening rhizomatous stage.

Transformation of the seedling in case of orchid from heterotrophic to autotrophic mode during early stage of development is an unusual aspect of differentiation, because a reverse trend characterizes most of the other symbiotic systems. The orchid protocorm has been variously considered as an undifferentiated (callus) or a differentiated (shoot primodia) tissue (Ariditti and Ernst 1984, Kanase *et al.*, 1993), whereas, functionally it is believed to behave as a cotyledon for supplying nutrients during development of embryo and its subsequent growth into seedlings (Lee 1987).

Since the germinating entities (spherule, protocorms) profusely develop epidermal hairs and penetrate into the medium, it indicates their absorptive function. Therefore, the orchid seed germination with the development of rhizoids during early stage of *in vitro* germination is another unusual aspect because symbiotic seed germination has been changed into independent asymbiotic condition by the development of epidermal hairs. The protocorm budding characterizes orchid and it leads to the development of multiple plantlets. Depending upon the genotype and nutritional environment majority of the orchid species either follow the direct protocorm formation or callus mediated multiplication. The immature condition of the seed and the undifferentiated embryos are probably factors for callusing of the embryos and the callus develop from the undifferentiated embryo has been considered to be analogous to highly proliferated protocorm. Since the callus can be maintained or differentiated into multiple seedling at any time by varying chemical stimulus, so the callus mediated development is highly beneficial where the seeds are limited in number or their germination frequency is very low. It is also useful where the capsule otherwise take several months to develop. But only limitation is that numerical chromosomal abnormalities may occur in callus tissue after prolong culture and such cultures are not suitable for differentiation into multiple seedling. The germination responses of seed and their subsequent development into seedlings have been tested in a variety of standardizes nutritional media.

Since, the seedlings or plants obtained from seeds are genetically different, so, clonal propagation is not possible from seeds. This type of propagation only becomes possible on large scale by using the meristem or shoot tip explant of an orchid. This is also termed as vegetative micropropagation; the culture of an orchid meristem or shoot tip explant usually results in either the direct formation of protocorms or to the formation of callus from which protocorms can be regenerated. Thus the callus formed from orchid explant could be considered to be embryogenic callus in that protocorms are regenerated from it. The work mericloning is also adopted for the production of clones from meristem. Therefore, plant produce through the tissue culture of vegetative orchid tissue containing meristems are often called as mericlones. Besides terminal or axillary bud, the other parts of the plant were also used as explant. Among the other parts of the plant, young leaves, leaf tips, nodal sections, inflorescence stalk, young inflorescence and roots have been used for *in vitro* culture of orchids. But in general, immature seeds and shoot tips containing meristems are commonly used for rapid mass propagation in terms of either conservation or commercial exploitation for orchid industry.

Conservation of orchid is not only linked with the large scale propagation but it is also related to commercialization. In order to truly conserve orchids, a large market must be created to promote and propagate orchids extensively by growers specifically for the economic development in the hill and foot hill regions of North Eastern India and elsewhere. When a large market condition is guaranteed, automatically the growers will be interested. To meet the large demand and commercialization of orchids, the large scale propagation can only be handled by tissue culture methods.

The seedlings when they are sufficiently large within the culture vessels then they are easier to handle and have better chances of survival. Generally, the flask seedlings are useless until and unless they are transferred to the community pots where the plantlets resume its growth like natural wild plant. The number of plants within the culture further maintained exploitation. The process, by which the seedlings are made to form independently from *in vitro* condition to *in situ* condition, is called hardening. In this process, seedlings are generally placed into the substratum in a group or singly. During removal from the flask seedlings are thoroughly washed in warm water in order to remove the agar and finally they are placed into a pot containing hardening medium. Mixtures of charcoal, brick pieces, pit moss etc. are generally used as hardening media. The seedlings are kept into shady place for few initial days and then gradually they are shifted to normal natural condition. On the basis of their habitat, the plantlets are reintroduced either as epiphyte or as terrestrial plant in the nature for enriching the declining population particularly in case of endangered and rare orchids.

Orchids are well known for their economic importance and widely cultivated for ornamental purposes as because of their beautiful long lasting flowers; but less for their medicinal value. History of alternative system of medicine, ayurveda and traditional chinese medicine has been found to utilize orchids in the preparation of medicines. Ayurvedic formulations like Chavyanprasa consists of eight ashtavarga (group of eight medicinal plants) and out of which four have been reported to be orchids.

In India work has been carried out on chemical analysis of some medicinally useful orchids; many of them are reported to contain alkaloids, triterpenoids, flavonoids and stilbenoids. Recently there has been tremendous progress in medicinal plants research; however, orchids have not been exploited fully for their medicinal application. Habitat loss, forest destruction and degradation and over exploitation has posed threats to the conservation of orchids in local area.

Different orchids have been categorized in different headings below in seven different tables. Twenty five species of medicinally important orchids along with their habitat, flowering time, medicinal usage have been listed in (table-2). Seven ornamental orchids have been presented below for their commercial importance in cut flower nurseries (table-3). Forty one species have been found suitable as potted ornamental varieties (table-4) and twelve as hanging varieties (table-5). Fifty three species have been listed in (table-6) suitable for inter-specific breeding. Considering the cost effectiveness several species (table-7) have been suggested for trade by the orchid growers in Darjeeling and Sikkim Himalayas (Pal and Nagrare, 2006).

Table-2: List of medicinally important orchids of Darjeeling and Sikkim Himalaya.

Name of orchids (Habitat)	Flowering time	Medicinal uses (References)
Acampe papillosa (Epiphyte)	Sept-Dec	Roots used for rheumatism, sciatica, neuralgia, syphilis and uterine diseases. (Rao , 2004)
Aerides odorata Lour. (Epiphyte)	May-July	Fruits used for healing wounds, juice of leaves to heal boils in ears and nose. (Rao , 2004)
Anoectochilus regalis Bl. (Epiphyte)	June- August	Stems and leaves are used to prepare medicinal oils. (Rao , 2004)
Arundina graminifolia (Terrestrial)	July- August	Scrapped bulbous stem applied on heels to treat cracks, anti bacterial. (Singh, 2001)
**Coelogyne corymbosa* Lindl. (Epiphyte)	April-May	Pseudo-bulb A paste of the pseudo bulb is applied to the forehead to relieve headache. (Rao , 2004)
**Coelogyne cristata* Lindl. (Epiphyte)	March-April	Juice of the pseudobulb is applied to boils Pseudo-bulb and wounds for cooling and soothing effect, also used as diuretic. (Rao , 2004)
Coelogyne punctulata Lindl.(Epiphyte)	April-June	Pseudo-bulb dried, crushed and used in burn injuries and healing of wounds. (Rao , 2004)
**Coelogyne ovalis* Lindley (Epiphyte)	April- June	Aptly called as Jeevanti, the whole plant is used for cough, urinary infections and eye disorders. (Rao , 2004)
Cremestra appendiculata (Terrestrial)	March-April	Roots paste used for toothache and as emollient. Tuber used for abscesses, scrofula, and freckles and as an antidote to snakebite. (Rao , 2004)
Cymbidium aloifolium (L) Sw. (Epiphyte)	April- May	Whole plant used as an emetic, to induce vomiting and diarrhoea, to cure chronic illness, weakness of the eyes, vertigo and paralysis, to cure benign and malignant tumors. (Rao , 2004)
Cymbidium hookerianum (Epiphyte)	Jan-April	Seeds applied on cuts and injuries as hemostatic. (Rao , 2004)
**Dendrobium chrysanthum Lindl. Ex Wall.* (Litho-Epiphyte)	July – October	Stem is powdered used to replenish body fluids, tonic to moisten the stomach, lungs, enhance skin quality. As an aphrodisiac. (Singh, 2001)
Dendrobium jenkinsii Wall. Ex Lindl(Epiphyte)	March-April	Fresh and dried stems used in preparation of Chinese drug Shih-hu as a tonic. (Rao, 2004)
**Dendrobium densiflorum Lindl. Ex Wall. (Epiphyte)*	April- May	Leaves crushed to make paste with salt and applied on fractured area to set the bones. Pulp of pseudo bulb is applied to boils and pimples. (Rao, 2004)

Contd…

Table-2: (Contd.) List of medicinally important orchids of Darjeeling and Sikkim Himalaya.

**Dendrobium longicornu* Lindl. (Epiphyte)	Oct- Nov	Juice of the plant is used to relieve fever. Root is fed to livestock suffering from cough.(Rao, 2004)
**Dendrobium nobile* Lindl. (Epiphyte)	April - May	Stems used in preparation of Chinese drug Shih-hu for longevity and as an aphrodisiac, stomachic, analgesi (Rao, 2004). Plant is used in the treatment of pulmonary tuberculosis, general debility, flatulence, dyspepsia, reduced salivation, night sweats, fever and anorexia. (Singh, 2001)
Goodyera schlechtendaliana (Terrestrial)	March –June	Tincture of the plant in rice wine is used as a tonic for internal injuries and to improve circulation. (Rao, 2004)
Papilionanthe teres (Epiphyte)	March –June	Whole plant Used for remission of bodily heat in fever. (Rao, 2004)
Phaius tankervilliae Bl. (Terrestrial)	Sept-Oct	Paste of Pseudo bulbs is used to heal swelling of hands & legs, poultice to soothe pain of abscess. (Rao , 2004)
**Pleione humilis* (Smith) D.Don (Litho/Epiphyte)	Feb- March	Paste of the pseudo bulb is applied to the cuts and wounds. (Singh,2001)
**Pleione maculate* Lindl (Epiphyte)	October-Nov	Pseudo bulb is used in liver complaints and headache. (Rao , 2004)
**Rynchostylis retusa* Bl. (Epiphyte)	July - Sept	Roots are used for rheumatism, asthma, tuberculosis, nervous twitching, cramps, infantile epilepsy, vertigo, palpitation, kidney stone, and menstrual disorders. (Rao , 2004)
Satyrium nepalense (Epiphyte)	October- Dec	Tubers eaten for Malaria, dysentery, also used as aphrodisiac. (Rao , 2004)
Vanda corulea Griffex Lindl. (Epiphyte)	Sept-October	Leaf juice used for diarrhoea, dysentery and also used as aphrodisiac. (Rao, 2004)
Vanda tessellata (Roxb.) Hook. Ex Don (Epiphyte)	April - July	A paste of the plant is applied to cuts and wounds. The root is used as antidote against scorpion sting and remedy for bronchitis. (Singh, 2001).

* Indicates materials used in the present investigation

Table 3: Ornamental orchids suitable for cut flowers from the present study area.

1. Cymbidium eubrneum	*5. Paphiopedilum venustum*
2. Paphiopedilum insigne	*6. Vanda coerulea*
3. Paphiopedilum farrieanum	*7. Renanthera imschootiana*
4. Paphiopedilum villosum	

Table 4: List showing orchid species suitable as potted ornamentals

1. Anoectochilus brevilabris	*22.Goodyera hemsleyana*
2. Ascocentrum ampullaceum	*23.Goodyera hispida*
3. Bulbophyllum putidum	*24. Malaxis calophylla*
4. Calanthe chloroleuca	*25. Paphiopedilum farrieanum*
5. Calanthe masuca	*26. Paphiopedilum villosum*
6. Calanthe plantaginea	*27. Paphiopedilum venustum*
7. Coelogyne corymbosa	*28. Paphiopedilum insigne*
8. Coelogyne cristata	*29. Phaius flavus*
9. Coelogyne nitida	*30. Phaius tankarvillae*
10. Coelogyne ochracea	*31. Phalaenopsis lobbii*
11. Cymbidium aloifolium	*32. Phalaenopsis mannii*
12. Cymbidium eubrneum	*33. Pleione hookeriana*
13. Cymbidium lancifolium	*34. Pleione humilis*
14. Cymbidium mastersii	*35. Pleione maculata*
15. Dendrobium chrysotoxum	*36. Pleione praecox*
16. Dendrobium densiflorum	*37. Rynanthera imschootiana*
17. Dendrobium fimbriatum	*38. Vanda coerulea*
18. Dendrobium moschatum	*39. Vanda cristata*
19.Dendrobium nobile	*40. Vanda stangeana*
20. Eria bambusifolia	*41. Vandopsis undulata*
21. Eria coronaria	

Table 5: List of hanging species of orchids

1. Aerides odorata	*7. Dendrobium farmeri*
2. Cymbidium devonianum	*8. Dendrobium pendulum*
3. Dendrobium chrysanthum	*9. Dendrobium primulinum*
4. Dendrobium crepidatum	*10. Gastrochilus acutifolius*
5. Dendrobium desiflorum	*11. Gastrochilus dasypogon*
6. Dendrobium falconeri	*12. Rhynchostylis retusa*

Table 6: List showing species of orchids used for inter-specific breeding

1. Ascocentrum ampullaceum	*28. Dendrobium primulinum*
2. Bulbophyllum leopardinum	*29. Paphiopedilum farrieanum*
3. Bulbophyllum putidum	*30. Paphiopedilum insigne*
4. Calanthe chloroleuca	*31. Paphiopedilum spicerianum*
5. Calanthe masuca	*32. Paphiopedilum villosum*
6. Calanthe plantaginea	*33. Paphiopedilum venustum*
7. Coelogyne barbata	*34. Papilionanthe teres*
8. Coelogyne corymbosa	*35. Phaius flavus*
9. Coelogyne cristata	*36. Phaius tankervillae*
10.Coelogyne fuscescens	*37. Phalaenopsis decumbens*
11. Coelogyne nitida	*38. Phalaenopsis lobbii*
12. Coelogyne ochracea	*39.Halaenopsis mannii*
13. Cymbidium devonianum	*40. Pleione hookeriana*
14. Cymbidium eubrneum	*41. Pleione humilis*
15. Cymbidium hookerianum	*42. Pleione maculata*
16. Cymbidium lancifolium	*43. Pleione praecox*
17. Cymbidium longifolium	*44. Rynanthera imschootiana*
18. Cymbidium tigrinum	*45. Thunia alba*
19. Cymbidium tracyanum	*46. Thunia marshalliana*
20. Cymbidium whiteae	*47. Thunia venosa*
21. Dendrobium densiflorum	*48. Vanda corulea*
22. Dendrobium farmeri	*49. Vanda cristata*
23. Dendrobium formosum	*50. Vanda pumila*
24. Dendrobium gibsoni	*51. Vanda stangeana*
25. Dendrobium nobile	*52. Vanda tessellate*
26. Dendrobium parishi	*53. Vandopsis undulata*
27. Dendrobium pendulum	

Table 7: List of Orchid species suitable for market trade

1. Anoectochilus brevilabris	*20. Paphiopedilum fairrieanum*
2. Ascocentrum ampullaceum	*21. Paphiopedilum insigne*
3. Calanthe masuca	*22. Paphiopedilum spicerianum*
4. Coelogyne cristata	*23. Paphiopedilum villosum*
5. Coelotyne nitida	*24. Paphiopedilum venustum*
6. Coelogyne ochracea	*25. Phaius flavus*
7. Cymbidium devonianum	*26. Phaius tankervillae*
8. Cymbidium eubrneum	*27. Halaenopsis decumbens*
9. Cymbidium lancifolium	*28. Phalaenopsis lobbii*
10. Cymbidium mastersii	*29. Phalaenopsis mannii*
11. Cymbidium tigrinum	*30. Pleione hookeriana*
12. Cymbidium whiteae	*31. Pleione humilis*
13. Dendrobium chrysotoxum	*32. Pleione maculata*
14. Dendrobium densiflorum	*33. Pleione praecox*
15. Dendrobium falconeri	*34. Rynanthera imschootiana*
16. Dendrobium farmeri	*35. Vanda corulea*
17. Dendrobium nobile	*36. Vanda coerulescends*
18. Dendrobium pendulum	*37. Vanda cristata*
19. Dendrobium primulinum	*38. Vanda stangeana*