

COMMERCIAL POTENTIAL OF ORCHIDS IN INDIA AND SOCIETAL BENEFITS

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Abstract

Orchids have gained importance as one of the highly priced floricultural crops across the world. However, in spite of their rich natural occurrence and ideal agro climatic conditions in India, they have not been systematically developed and the people are yet to reap the benefit out of this natural resource. In this paper, while tracing the history of orchid development in India, distribution of some of the commercially important orchid genera, species and hybrids in various agro climatic conditions have been presented. In the present paper, role of governments, non-government organizations and individuals in promoting the development of orchid industry in India has been discussed. Need for a coordinated effort in focused R and D programme in developing new hybrid strains suiting to various agro climatic conditions of our country involving various institutions of excellence in developing climate specific strains of temperate cymbidiums and paphiopedilums, tropical dendrobiums and vandas and intermediate cattleyas and *Phalaenopsis*, besides other ornamental native species for both cut flowers and pot plants along with their cultivation practices and packages has been suggested. Besides, potentials of medicinally important orchids and their R and D program in boosting commercial production have also been suggested. A strong extension programme of the technology and market driven approach to reach the stake holders, farmers and growers, in villages and urban clusters involving the communities in promoting cultivation and production of the commercial orchids with a market driven approach have been proposed for the development of a vibrant orchid industry. Involvement of corporate sector for the production of quality planting materials in large quantities, distribution to the growers/farmers in village and urban clusters and marketing of their products has been emphasized.

Introduction

OVER THE last half a century, importance of orchids in floriculture has been amply highlighted by various workers and agencies in India (Hegde, 2001, 2014; Singh, 2011; Singh and Dadlani, 2000). Since time immemorial, importance of some orchids in the indigenous systems of medicine has also been mentioned in various treatises (Kaushik, 1988; Paul and Hegde, 2001). Some government agencies/ departments of the state and the center have initiated Research and Development programs to give a boost to floriculture trade based on orchids. Meanwhile however, realizing the endangered status of orchids in their natural habitats in India, attention has been given to ensure conservation of the native germplasm and undertake sustainable development of orchids in the country. Number of Universities and Institutions have also initiated scientific investigations on orchids especially on the aspects of survey, germplasm collection, and selection of plants for breeding, tissue culture, cultivation, propagation and modern poly-house technology adopting biotechnological approaches (Hegde, 1986, 2000, 2001, 2012, 2014; Pathak *et al.*, 2001; Vij, 1986). In this process, we have lost considerable time both in terms of quality and quantity production of plants and flowers required to boost orchid based modern floriculture and pharma industry in India. Besides, we have not been able to compete in

the world market in terms of quality, quantity and regularity. In this paper, an attempt has been made to review and analyze commercial importance of our orchids and find a way out to boost the industry accruing benefits to the stakeholders.

Orchid Development in India

In India, systematic work on orchids began with the monumental works of John Lindley (1857), by describing all the genera and species reported by the earlier workers (Hegde, 1997). Hooker (1890) in his voluminous works of *Flora of British India* described 1200 species unraveling the richness of orchids in this country. Subsequent workers added number of species and today we are a proud nation with about 1350 species in about 185 genera of orchids known in our country (Hegde, 2014; Jain and Mehrotra, 1984; Misra, 2007; Rao, 2014). Out of them, as many as 150 species are highly ornamental, about 55 species are medicinally important and others are biological curiosities with ecological significance (Hegde, 1997; Vij, 2001).

Realising the importance of orchids in floriculture especially that of the hybrid varieties developed from the native ornamental species from India and other parts of the world, government of India initiated developmental programmes through various government and non-government agencies to ensure

conservation of native germplasm both *in situ* and *ex situ*, and promoting sustainable development of orchid industry through Research and Development programs through ICAR, Universities and state and central government agencies. Many private players *i.e.*, U.C. Pradhan Laboratories, Kalimpong, Indo-American Hybrid Seeds, Bangalore, A.V. Thomas and Co., Kerala, are also involved in production of planting materials adopting tissue culture and modern biotechnological approaches and trade of planting materials. National Horticulture Board, National Bank for Agriculture and Rural Development (NABARD) and Agricultural and Processed Food Products Export Development Authority (APEDA) have been supporting entrepreneurs to undertake export oriented orchid trade. Some NGO activities to promote research and development and creating awareness have also been undertaken by The Orchid Society of India (TOSI) and some other state floriculture societies including Orchid Society of Arunachal Pradesh (OSA), The Orchid Society of Karnataka (TOSKAR). Meanwhile, orchid growing as a hobby elsewhere in the world has transformed itself as a vibrant floriculture industry of commerce with multi-million-dollar business of plants and cut-flower trade. Discovery of aseptic culture of seeds by Knudson (1946) and Vacin and Went (1949) and meristem culture by Morel (1960, 1964) have revolutionized orchid industry elsewhere in the world with an array of orchid hybrids and cut-flower varieties grown in modern climate controlled poly-houses. Over the last 50 years, tissue culture technology has added dimension to the industry both in terms of quality and quantity. There are over 1,25,000 manmade hybrids besides about 25,000 species world over making it highly specialized, and competitive, vibrant industry of commerce. With the modern biotechnological approaches, it has become possible to produce an array of hybrids and newer clones released to the market – specializing in flower decorations, corsages, bouquet making, pot plants with amazing colour of flowers of orchids, besides various social functions (Hegde, 2006, 2009; Pathak *et al.*, 2001; Vij, 1986).

World Scenario

It has been observed that the production and trade of floricultural crops has ever increasing trend. Out of about US \$21 billion floriculture trade, 8% is that of orchids and has an increasing trend of 15% annually (Singh, 2011). It is significant to note that Netherlands is the world's leading flower producer and exporter supplies with more than 170,000 tons of flowers to Germany. The Dutch control the world export and auctioning of floricultural products. Major consumers of floriculture products are Japan, European countries,

South Korea, Thailand, Indonesia and Pacific countries with ever increasing demand. Major exporters of floriculture products are Holland, Columbia, Israel, Italy, Spain, Thailand, France, USA, South America, New Zealand, Ecuador, *etc.* Important flower crops in the world trade are *Alstroemeria*, *Anthurium*, *Carnation*, *Chrysanthemum*, *Gerbera*, *Gladiolus*, *Gypsophila*, *Statice*, *Roses*, *Orchids* (arandas, cymbidiums, dendrobiums, paphiopedilums) *etc.* Orchids command high value and are great in demand in the World Flower Trade.

Indian Scenario

Important floriculture crops in India are roses, *Gladiolus*, petunias, carnation, *Chrysanthemum*, *Amaryllis*, jasmine, marigold, and of course, orchids. Total acreage of these crops is about 73,619 ha with 34,349 tons of loose flowers and 49,366 cut flowers. Orchids have the least production area and minimum contribution in the overall turnover of floriculture products. In fact, India has lagged behind other countries in the orchid trade inspite of its rich natural resources, ideal agro climate and technical knowhow. Out of about Rs. 500 crore business in floriculture industry in India, orchids have the least contribution in our country.

Analysis

Commercial potentials of orchids in India or its strength in orchid development and trade lies in: i) rich orchid diversity/germplasm; ii) varying an ideal agro climate from tropical to temperate regions to grow varieties of orchids; iii) technical knowhow of orchid growing, propagation technique, biotechnological backing, green house technology; iv) cheap labour; and v) ever growing high end consumer market. Our weaknesses include: i) lack of quality planting materials in adequate quantity; ii) lack of market driven approach in the production of plants and flowers adopting modern technologies; iii) lack of production of our own hybrids that can compete in world market; iv) lack of consistent R and D back up with new hybrid varieties and technical innovations; v) lack of production of planting material; vi) lack of quality and quantity of cut flowers to feed the market; vii) lack of training and extension programs; and viii) lack of the involvement of communities both at rural and urban levels in suitable agro climatic zones and develop hub of activities leading to market places.

Agroclimate and Orchid Germplasm

There are mainly three broad climatic zones: i, tropical; ii, sub-tropical, and iii, temperate for growing orchids.

Depending upon rain pattern, humidity, temperature, and elevation, there are varying types of microclimatic conditions. This has in fact given rise to orchid diversity with about 1,350 species in 185 genera occurring in their natural habitats of our country. About 150 species of them are considered to be ornamental which could serve as germplasm for breeding, cultivation/farming and production of quality planting materials in the respective agro climatic zones (Hegde, 2001; Pathak *et al.*, 2001; Upadhyaya and Pal, 2001). Besides, a large number of exotic species and

hybrids have been imported and grown in various Institutions and by individual hobbyists, over the last 50 years. This is indeed our strength and potential that should be sustainably utilized for developing orchid industry (Hegde, 2014). In the following table, selected ornamental orchid genera/species in various agro climatic conditions in India have been given for R & D programmes for the development of orchid industry.

Table 1. Selected orchid genera for various agro climatic zones.

Agroclimatic zone	Temperature range	Suggested ornamental orchid genera - both species and their hybrids	Suggested centers/states for orchid development
Tropical	Warm temperature ranging from 21°C – 29°C day to 18°C -21°C nights	Species: <i>Aerides</i> , <i>Arachnis</i> , <i>Armadorum</i> , <i>Ascocentrum</i> , <i>Calanthe</i> , <i>Dendrobium</i> , <i>Hygrochilus</i> , paphs, <i>Papilionanthe</i> , <i>Phaius</i> , <i>Renanthera</i> , <i>Spathoglottis</i> , <i>Vanda</i> . Hybrids: <i>Aranda</i> , <i>Ascocenda</i> , cattleyas, <i>Dendrobium</i> clones, <i>Mokara</i> , oncidiums, <i>Phalaenopsis</i> , paphs.	Assam, Goa, Karnataka, Kerala, Maharashtra, Tamil Nadu, Tripura, West Bengal
Sub-tropical	Intermediate with 18°C -24°C day to 16°C -18°C nights	As above and other ornamental native species like <i>Aerides</i> , <i>Anoectochilus</i> , <i>Bulbophyllum</i> , <i>Calanthe</i> , <i>Coelogyne</i> , <i>Dendrobium</i> , <i>Eria</i> , <i>Goodyera</i> , etc.	Foothills of Himalayas in NorthEastern region, Western Ghats and Eastern India
Temperate	Cool with 16°C -21°C day to 13°C nights	<i>Coelogyne</i> , <i>Cymbidium</i> , <i>Cypripedium</i> , <i>Paphiopedilum</i> , <i>Pleione</i> , etc.	Hills of NorthEastern States, Himachal Pradesh, Uttarakhand, West Bengal

However, humidity ranging between 50 to 80% is a common requirement for all types. Light regime of 3000 – 6000-foot candle (30000 to 60000 lux) is considered ideal. It is worthy to note that large number of the species mentioned in the above table have been used in developing modern day hybrids, elsewhere in the world. Hence, there is a need of intensive breeding programmes on selected orchid genera making use of wild varieties and their modern hybrids and to achieve this, we need to have international cooperation, especially with Australia, Europe, New Zealand, South East Asian Countries and USA to get the desired germplasm for breeding.

Thus, India with its varied agro-climatic zones from tropical conditions of peninsular India to subtropical and temperate areas of the Himalayas offers wonderful opportunity to grow varieties of orchids round the year. Gangtok in Sikkim, Kalimpong in West Bengal, NorthEastern States, Kerala, Goa, Western parts of Karnataka and Maharashtra (Pune), Eastern parts of Tamil Nadu (Nilgiri), Andhra and Orissa and some parts of North India are the ideal places for growing various types of orchids. Native ornamental species and exotic hybrids should be improved through intensive breeding adopting modern biotechnological approaches. Besides,

cheap labour and ever growing high end consumer market make it highly profitable proposition to grow various orchids in India in a profitable manner (Hegde, 2014). At present in India, these plants are grown either as hobby or as a commercial enterprise. Hobbyists tend to grow varieties of orchid hybrids and species in the available space around the house or balcony. Commercial cultivation of orchids require more space and perfection, adopting the modern biotechnological approaches for producing quality plants and cut flowers in good quantity aiming at the market. However, the approach here should be market driven.

Modern floriculture is an integrated technology based on biological sciences making use of hardware engineering mechanisms. Understanding of genetics and physiological requirements of a particular crop is essential to meet the stringent requirements in the quality of cut-flowers to match the market demands. Hence, right from seed production, quality seedling production (through seeds or tissue culture), transplanting to farm houses, growing them to flower as per the requirement, harvesting and up to transportation to the market, everything at every stage biological principles are employed in achieving

perfection. Accordingly, the tissue culture lab, hardening unit, farm-houses, post-harvest packing and packaging requires hardware engineering to achieve this perfection in floriculture industry. Breeding must be a

continuous endeavor applying modern biotechnological tools coupled with micro propagation of selected clones to finally meet market demand, which is ever changing with occasions and trend (Table 2).

Table 2. Market specification and technological requirement in orchid trade.

Quality specification	Requirements of the plant	Technological makeup
Preference of color shape and size is very specific and is subject to change with time.	These are genetic characters of the plant. Breeding new varieties should be continuous	Select the current varieties. Replace plants at every 4-5 year's interval with upcoming varieties.
Strong straight spike.	Plants should be healthy and must produce limited number of flowers.	Proper nutritional management. Regulation of flowering beyond the optimum limit.
Flowers fully open, free from blemish, clear colour, broad strong petals each flower facing the same side.	Plants should be healthy and must produce only limited number of flowers. Distribution of sunlight should be uniform. Direct rainfall on plants and flowers to be avoided.	Proper nutritional management. Regulation of flowering, perfect layout in the North to south direction, appropriate shade, rain protection either with UVR film or Netlons.
No sign of insect damage or any diseases. At the same time, insecticides and other chemicals should not adhere to the flowers.	Prevent entry of insects. Maintain proper pH of the medium. Prevent growth of algae. Assure drainage. Ensure mild breeze 200 mph all the time.	Green house cultivation can prevent entry of insects. Follow integrated pest managements. Use proper size of the pot, repot timely. Use proper ratio in planting medium. Install proper ventilation device or adjust the layout with wind direction.

Green house technology is the latest trend and is most desired for export production with the required quality, quantity, and regularity. In this regard, government of India's initiative to adopt plastics in agriculture has yielded considerable progress in augmenting floriculture. This is required to be modified and adopted to various agro climatic zones, depending upon the crop (Singh and Dadlani, 2000). There are specialized companies which manufacture modern environment controlled green houses so as to suit the need of the crop. In India, at present, most of the commercial labs have started tie up/joint venture programs with leading companies like BV, Florist (Holland) and others from South East Asia and procure latest varieties to grow in India. In fact, these companies are specialized in particular crop like cymbidiums from Australia, New Zealand, dendrobiums and vandas/mokaras, etc. from Singapore and Thailand, *Phalaenopsis* from Holland and Taiwan, so on. In other words, we are totally dependent on other countries for planting materials. India will have to depend upon advanced countries for quality planting stock and distribute to the growers or farmers for production of plants and flowers, till the time, we become self-reliant. In order to achieve quality production, it is essential to identify the suitable agroclimatic areas to establish *Flori-tech village* clusters in each State of the region (Hegde, 1999) to adopt low cost green house and rain shelters (Dutta, 2001) for small farmers and climate controlled green

houses for large export houses. In the *Flori-tech Village* Concept, cluster of villages will have a cooperative with central model farm to cater the needs of planting materials, impart training to the farmers, set up low cost small farm/poly houses and to organize marketing of the produces.

In an export oriented venture where quality, quantity and regularity of production and supply are to be ensured, green-house technology has to be adopted. It requires investment and intensive management by trained managers devoted to the profession. Clockwise, timely action right from planting, watering, fertilizing, controlling humidity, temperature, ventilation, light, pest and disease management, training of flower spikes, harvesting and post-harvest handling, transporting quickly and freshly up to the markets are of paramount importance for the success of orchid industry.

Medicinal and Aromatic Orchids

About 55 species have been reported to be used in various systems of medicines in India for treating various disorders and diseases (Kaushik, 1983; Paul and Hegde, 2001). Traditional practitioners mostly collect the plants in the wild and as a result, most of them have become rare and endangered. Hence, there is a need to develop a package and practice for their cultivation and propagation commercially so as to help

the pharma industry with authentic, quality of planting materials with sufficient quantity and also help conserve the natural population to survive and proliferate.

Societal Benefits

Once the package and practice of growing a particular crop, e.g., *Cymbidium*, *Dendrobium*, *Paphiopedilum*, *Phalaenopsis*, *Vanda*, etc. for the respective agro climate is standardized; extension programs through recognised agencies trained in growing a particular crop should be taken up. It must start with establishing a pilot project in the respective region with a model farm and biotech lab for production. In this venture, research centers should impart training to the extension officers of the state governments, entrepreneurs and NGOs of the respective region. In turn, these agencies should take up awareness and training programs by organizing workshops in selected village clusters or urban areas and help establish floritech villages, societies and associations. They need to ensure supply of quality planting materials, impart technical help in establishing farm/poly houses for growing pot plants and cut flowers and extend financial assistance through banks and other agencies. Finance is the lubricant for fast development. In this venture, National Horticulture Board (NHB), APEDA, NABARD, Universities and research organization need to work in a coordinated manner creating infrastructure through the States concerned. Corporate participation will help investment and development in export oriented production. In order to create awareness and to highlight the importance of orchids in the States, declaring prominent orchid of the region/State as state flower and releasing of postal stamps should be taken up with government.

Urban Involvement

Urban areas are the market centers for flowers, both loose and cut flower spikes for various purposes and occasions like decorations in marriages, various functions, as bouquet, flower arrangements in hotels, etc. Even potted plants with flowers are also consumed for decoration and landscaping. Hobbyists are other consumers of growing orchids for pleasure, relaxation and for garden and home decoration. Besides, there are urban women, unemployed youths and entrepreneurs who would like to grow orchids for supplementing their income. Such folk need to be trained in growing, marketing and production of plants and flowers to meet the demand for orchids. Another sector is the corporate participation in establishing export oriented orchid farms with modern greenhouse

technology attached with tissue culture labs to boost quality production of planting materials as well as cut flowers for export. In this regard, both NGOs and respective governments have great role to play in promoting orchid based floriculture industry. In this regard, effort of A. V. Thomas and Co. in Kerala is exemplary. The Orchid Society of India (TOSI), state orchid societies, orchid growers association, Trivandrum, Kanflora of Sirsi and similar other organizations have to play a key role in imparting training, supply of quality planting materials, and promoting quality production in required quantity and regularity linking with the market (Singh, 2011).

Rural Involvement

Rural livelihood is dependent upon growing varieties of agricultural, horticultural, plantation and floricultural products and commodities, and marketing them. They have the knack of growing and they grow it perfectly, once they are trained as to how to grow and once they realize that the products they grow have market demand. Hence, any enterprise would succeed when there is demand for the product – quality product in quantity and regularity. To achieve the same, Flori-tech-village concept will have to be adopted with the entire infrastructure. In this regard, government agencies like NHB, APEDA, state horticulture departments, research institutes, financial institutions and banks will have to make a coordinated effort involving the local rural folk or organizations. Even the Department of Forests under Joint Forest management could promote orchid growing in the villages through Village Forest Committees (VFMC). An effort made in this direction by an NGO, Kanflora, Sirsi in Uttara Kannada district of Karnataka is a good example where farmers in a cluster of villages have successfully grown *Dendrobium* cut flower varieties and marketed them (Hegde and Hegde, 2006). Sikkim also has done wonderful works in involving the local communities in growing *Cymbidium* cut flower varieties and this has given a boost to the orchid industry in India. More such examples are needed in various parts of our country to really make an impact in world market. Model of development in orchid industry in Thailand should serve as an example.

Support and Development of Subsidiary Industries

As in any other industry, success of orchid development with societal benefit requires support of other industries in the manner hardware engineering supporting software. Plant biotechnology is the backbone for production of quality planting materials of the latest hybrid clone in sufficient quantity to meet

the demand of growers or farmers in an affordable rate. So also farmers or entrepreneurs require poly house structures, foggers, humidifiers, temperature controllers, timers, agro chemicals, poly pots, compost, benches, tools and equipment, so on, to produce quality flowers that has demand in the market. Post-harvest mechanism involves packing materials, transport system *etc.* to reach fresh flowers to the market with value addition. Trained and skilled labour is of course a requirement for the cost effective quality production with value addition. Our cosmopolitan cities are the market places where infrastructure for appropriate temperature controlled storage facility is required. National and international flower auction centers must also be equipped and energized to give support value to the products. Coordination and support to all these subsidiary industries is also of paramount importance that would generate employment and accrue societal benefits. Number of hobbyists in our cosmopolitan cities and across the world possess rare, curious, attractive orchid species and hybrids as pot plants. Besides cut flowers such pot plants are to be propagated and promoted which would bring additional income. Of course, it should be ensured that all such plants are propagated artificially in laboratory and not collected from wild. Production of seedlings in an aseptic condition in flasks should be popularized as a cottage industry, as in Thailand. Production of both cut-flower and pot plants should be encouraged in sub-tropical and temperate zones to give a boost to orchid trade both in rural and urban areas.

Conclusion

In fact, orchid industry is highly competitive and sophisticated. There are ever changing taste and trend in the market with respect to colour of flowers, shape, size, etc. Similarly, there is always a demand for newer planting materials. Hence, there is a need for a strong and focused R and D programme in developing new hybrid strains involving native species and exotics suiting to various agro climatic conditions of our country. A coordinated effort in these programs involving various institutions of excellence in developing climate specific strains (*e.g.* temperate cymbidiums and paphiopedilums, tropical dendrobiums and vandas and intermediate cattleyas and *Phalaenopsis* for both cut flowers and pot plants) and their cultivation practices and packages has been suggested. Production of native hybrids and rare species through tissue culture would be an attraction to hobbyists, world over. Selected Universities, agricultural colleges and research institutes should be encouraged to take up research activities in breeding and evolving newer hybrids and strains adopting

modern biotechnological approaches to compete in the world market. Technical man-power in floriculture at various levels is another important aspects requiring attention. Accordingly, training in various aspects of orchid farming and in various crops, in addition to macro and micropropagation are to be organized at selected centers.

There is a need to create awareness amongst farmers, educated unemployed youths and women to take up orchid farming. Horticultural societies and Self-Help Groups should be encouraged to take up awareness campaign providing adequate financial assistance. Adopting an orchid species/hybrid of the region by the respective state governments and bringing out postal stamps of rare and ornamental orchids of our country would help create awareness on the importance of orchids in India and to boost orchid trade. Allied support industries like orchid fertilizers, specific organic or inorganic pesticides and fungicides, planting materials in flasks and tubes, pots and potting media (coco pith, perlite mix *etc.*), encased seeds, value added cut flowers/bouquets, orchid dry flowers and embedded articles, jewelries, *etc.* should also be promoted simultaneously. Concept of village and urban clusters involving the communities in promoting cultivation and production of the commercial orchids with a market driven approach - one for domestic market and the other for export purpose would help boost the development of a vibrant orchid industry in India. Involvement of corporate sector for the production of quality planting materials in large quantities, distribution to the growers/farmers in village and urban clusters and marketing of their products has been emphasized to boost orchid industry benefiting the communities and the country.

References

- Dutta, T. 2001. Utility of low-cost greenhouse cum rain-shelter in orchid cultivation. *In : Orchids: Conservation, Culture Farming and Trade* (ed. S. N. Hegde) pp. 61-69, Himalayan Publishers, New Delhi, India.
- Hegde, S. N. 1986. Role of orchid sanctuaries in conservation in India with particular reference to orchid sanctuary, Arunachal Pradesh. *In: Biology, Conservation and Culture of Orchids* (ed. S.P. Vij) pp. 387-96. East West Press Pvt. Ltd., New Delhi, India.
- Hegde, S. N. 1997. Orchid Wealth of India. *Proc. Indian Natn. Sci. Acad. B63 No. 3:* 229-44.
- Hegde, S. N. 1999. *Cymbidiums: Cultivation Technique and Trade*. SFRI Information Bulletin No.8. Itanagar, India.
- Hegde, S. N. 2000. Orchids of North-East India: Conservation and export potential. *In: Natural Resources Conservation and Management for Mountain Development* (eds. S.C. Tiwari and P. P. Dabral) pp. 91 -154.

- Hegde, S. N. 2001. *Orchids: Conservation, Cultivation, Farming and Trade*. OSA, Himalayan Publishers, Itanagar, India.
- Hegde, S. N. 2006. Prospects of Orchid Trade Industry in Karnataka. *Orchid Newsletter*, **1.1**: 10-16.
- Hegde, S. N. and M. R. Hegde. 2006. Prospects of Commercial Cultivation of Tropical dendrobiums in Karnataka. *Orchid Newsletter*, **1(2)**: 29-36.
- Hegde, S. N. 2009a. Cultivation and farming of selected orchids for trade. In: *Proc. National Conference on Orchid Genetic Diversity*. pp. 52 – 61. B. N. Bandodkar College of Science, Thane, India.
- Hegde, S. N. 2012. *Ex situ* and *in situ* conservation of orchids in India. *J. Orchid Soc. India*, **26(1-2)**: 1 -4.
- Hegde, S. N. 2014. Status of exotic orchid hybrids and species in India: Its impact on Indian orchid industry. *J. Orchid Soc. India*, **28**: 23-29.
- Hooker, J. D. 1890. *Flora of British India*. Vol. V & VI. London, UK.
- Jain, S. K. and A. Mehrotra. 1984. *A Preliminary Inventory of Orchidaceae in India*. BSI, Howrah, India.
- Kaushik, P. 1983. *Anatomical and Ecological Marvels of Orchids*. Today & Tomorrow's Printer and Publishers. New Delhi, India.
- Kaushik, P. 1988. Mycorrhiza and orchid conservation. In: *Environment and Development* (eds. I. S. Grover and A. K. Thukral), Scientific Publishers, Jodhpur, India.
- Knudson, L. 1946. Solution C for orchid seedlings in culture. *Am. Orchid Soc. Bull.*, **15**: 214-17.
- Lindley, J. 1857, Contributions to the orchidology of India. *Linn. Soc. Bot. J.*, **1**:170-90.
- Misra, S. 2007. *Orchids of India – A Glimpse*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- Morel, G. M. 1960. Producing virus-free cymbidiums. *Am. Orchid. Soc. Bull.*, **33**: 473-78.
- Morel, G. M. 1964. Tissue culture- a new means of clonal propagation of orchids. *Am. Orchid Soc. Bull.*, **33**: 473-78.
- Pathak, Promila, R. N. Sehgal, N. Shekhar, M. Sharma and A. Sood. 2001. *Orchids: Science & Commerce*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.
- Paul, S. and S. N. Hegde. 2001. Some orchids of ethnobotanical importance. In: *Orchids: Conservation, Culture, Farming and Trade* (ed. S. N. Hegde) pp. 48-51. OSA, Himalayana Publishers, New Delhi/Itanagar, India.
- Rao, A. N. 2014. Orchid diversity in NorthEast India with special reference to medicinal and ornamental ones and their conservation. In: *Proc. Natl. Symposium on gene Conservation of Medicinal and Horticultural orchids of North East Region*. pp. 2-12.
- Singh, H. P. 2011. *Growing Global Orchid Industry: Opportunities in India. National Consultation for Production and Utilization of Orchids*. pp. 1- 19. NRC Orchids, Sikkim, India.
- Singh, H. P. and N. K Dadlani. 2000. Commercial Floriculture. FAO, MOA.
- Upadhyaya, R. C. and Ram Pal. 2001. NRC for orchids in the development of orchids in India. In: *Orchids: Conservation, Cultivation, Farming and Trade*. OSA, Himalayan Publishers, Itanagar, India.
- Vacin, E. and F. W. Went. 1949. Some pH changes in nutrient solutions. *Bot. Gaz.*, **110**: 605-13.
- Vij, S. P. 1986. *Biology, Conservation and Culture of Orchids*. East-West Press, New Delhi, India.
- Vij, S. P. 2001. Orchidology in India: Current status. In: *Orchids: Conservation, Culture, Farming and Trade* (ed. S. N. Hegde) pp.1-13. OSA. Himalayan Publishers, Itanagar, India.