Chapter 1

The Relevance of Orchid Physiology to the Industry

1.1. Introduction

Layman and scientists alike have always been fascinated by the beauty and mystery of orchids. The appreciation of orchid beauty has a very long history in both the Western and Eastern cultures. Much of this is attributed to the diverse form and structure of orchids and the large number of species in the orchid family. Arditti (1992) has given an excellent historical account of orchids in Asia, Africa, Europe, New Guinea and Australia. Suffice to say, the beauty and appreciation of orchids are subjective to the beholder. Some like them small while others like them to be showy. In oriental literature, *lan* (which means orchid in Chinese), for example, is often personified as a man of virtue who strives for self-discipline, champions his principles and does not succumb to poverty and distress.

Confucius wrote:

> "*Lan* that grows in deep forests never withholds its fragrances even when no one appreciates it."

These very ethereal qualities of *lan* have been much appreciated in the Orient since some 2,500 years ago.

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1.2. Orchid Cultivation and Industry

Orchid cultivation has come a long way. Over the years, it has evolved from a hobbyists' market into a highly commercial market. Large-scale cultivation of orchid cut-flowers and potted orchids is now the trend. In the past, orchid growers and hobbyists relied solely on the collection of orchid species from the wild because the technique of breeding and selection (either by conventional or genetic manipulation) is not available. Mass cultivation becomes possible with the breakthrough in orchid seed germination. This laid the foundation for intensive breeding and selection of new orchid hybrids. The discovery and development of an asymbiotic method to germinate orchid seeds in 1921 by Lewis Knudson. This has also paved the way for the development of tissue culture technique for mass clonal propagation of orchids. The availability of asymbiotic germination and tissue culture has made large-scale orchid cultivation economically feasible. Today, orchids such as *Cymbidium*, *Dendrobium*, *Phalaenopsis* and *Oncidium* are marketed globally and the orchid industry has contributed substantially to the economy of many ASEAN (Association of the South East Asian Nations) countries (Hew, 1994; Laws, 1995).

The market potential for both orchid cut-flowers and potted orchids is very favourable (Laws, 1995). This is evident from the world market demand of planting materials for orchids grown for cut-flowers and potted plants (Table 1.1). In the year 2000, the total demand is estimated to be 1,598 million units of plant stock. Based on the Japanese flower auction sale figures for 1993, orchid cut-flowers accounted for 32% of the total market share, amounting to US$ 53.7 million, and all the orchid cut-flowers are imported from Thailand, Singapore, Malaysia and the Philippines (Fig. 1.1). Japan is now the major market for ASEAN orchid cut-flowers, replacing Germany, and the import of orchid cut-flowers into Japan has been increasing steadily from 1985 to 1995. In 1993, orchid cut-flowers formed about 7% of the US$ 3 billion cut-flower market in Japan (Fig. 1.2). The Japanese market for potted orchids was estimated to be at US$ 261 million in 1993 (Fig. 1.3). The status and future development of the orchid industry in ASEAN have been reviewed recently and the prospects for ASEAN orchid growers are indeed bright (Hew, 1994).

Table 1.1. World demand for orchid planting material.

	Plant stock turnover (million units)			Total estimated sales in 5 years (Millions of US$)
	1995	2000	Change in percentage	
Planting materials for cut-flower production	66	109	Increased by 11%	170
Planting material for potted plants	1220	1489	Increased by 4%	1891
Total	1286	1598		2061

Note: Sales values are based on blooming size plants priced at US$ 1.50 per plant.

Source: Unpublished market estimate of world orchid (tropical, sub-tropical and temperate) demand, provided by Multico Orchids Private Limited, Singapore.

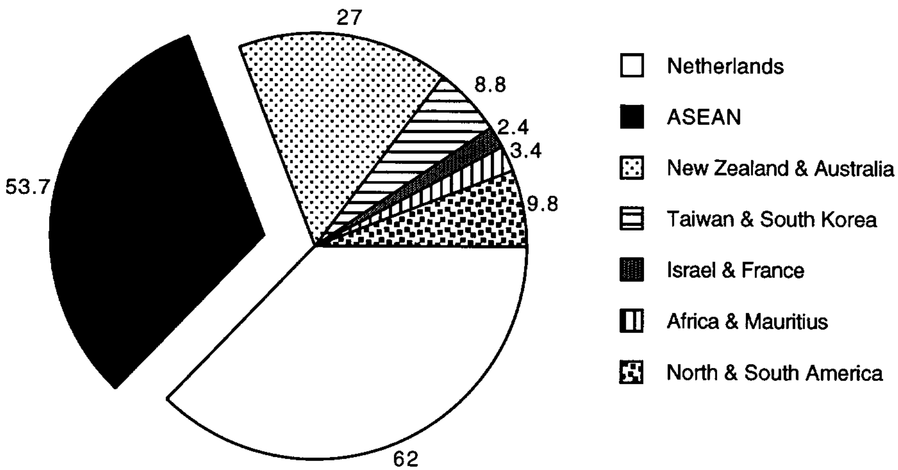

Fig. 1.1. Japanese flower imports in 1993.
Note: Figures are quoted in millions of United States dollar.

Redrawn from Suda (1995).

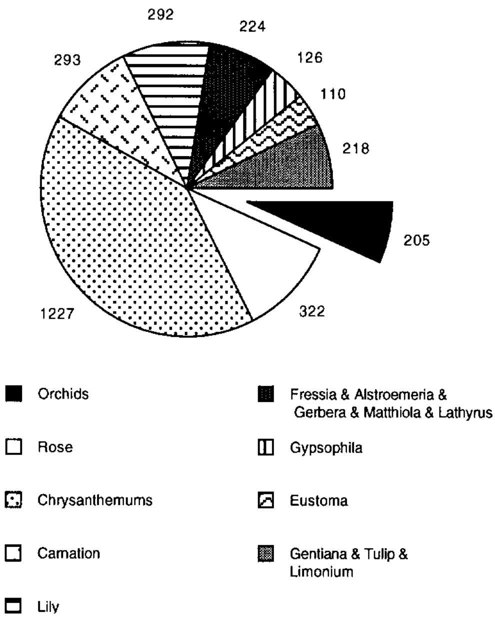

Fig. 1.2. Japanese cut-flower auction sales in 1993.
Note: Figures are quoted in millions of United States dollar.

Redrawn from Suda (1995).

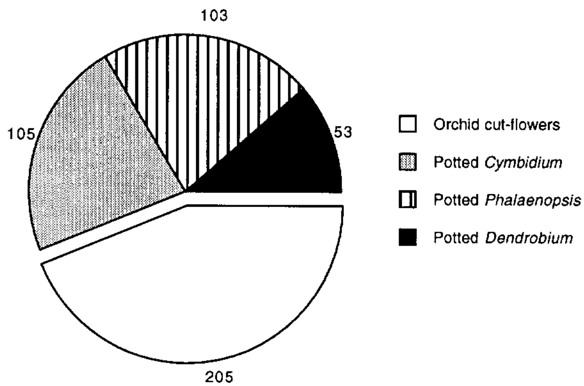

Fig. 1.3. Japanese auction sales for orchid cut-flowers and potted orchids in 1993.
Note: Figures are quoted in millions of United States dollar.

Redrawn from Suda (1995).

There are three major factors that contribute significantly to the success of the orchid industry:

1. Excellent environmental conditions that favour low production cost.
2. High production technology that results in high productivity and good product quality.
3. Good marketing and distribution leading to market advantages.

Being in the tropics, ASEAN countries are endowed with a climatic condition well-suited for large-scale orchid cultivation. Hence, it is not surprising that considerable efforts have been made to upgrade technology pertaining to commercial orchid cultivation. A good understanding of orchid physiology is the key step to improving orchid cultivation.

1.3. How Basic Orchid Physiology Can Help the Industry

The physiological basis of crop yield has been dealt with in great details for most agricultural crops (Evans, 1975). Physiological processes that determine crop yield are canopy structure, photosynthesis (pathways and rates), crop respiration, photorespiration, water relations, mineral nutrition, partitioning of assimilates and storage capacity. A thorough understanding of all these processes is essential to improve crop yield. In the following chapters, we would like to use this similar approach to improve orchid cultivation by studying the various physiological processes affecting orchid growth. We have resolved the orchid cut-flower production cycle into a series of processes and examine the relevance of orchid physiology in each process (Fig. 1.4). The resolution of the orchid cut-flower production cycle into discrete processes is a logical approach to identify any possible limiting factor. We believe that this approach is an effective way to optimise orchid cultivation for cut-flower production and to a lesser extent for potted orchids.

In starting an orchid farm, an important consideration is to ensure a steady supply of good quality planting materials. Obtaining planting material through conventional vegetative propagation method is a slow and costly affair. Today, the supply of uniform clonal planting material comes mainly from tissue culture. This demand for micropropagated orchids also explains the recent rapid increase in the number of commercial orchid tissue culture laboratories operating in ASEAN countries.

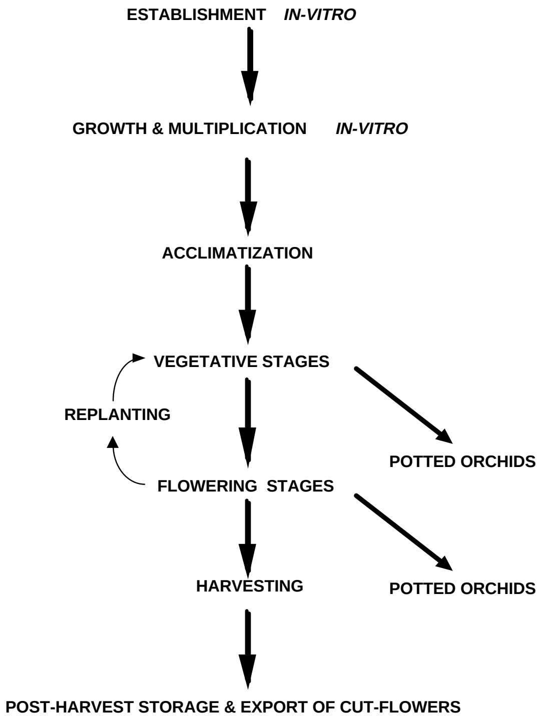

Fig. 1.4. Key production processes of the orchid industry.

Rapid and large-scale clonal propagation of orchids is made possible by using the batch tissue culture procedure. To date, more than 43 orchid genera have been mericloned successfully using different plant parts including leaves, roots, flower stalks, axillary buds and apical meristem (Arditti and Ernst, 1993). Clonal propagation of orchids using batch tissue culture has been the mainstay throughout the world since 1960. There are, however, problems associated with the batch tissue culture approach. In batch culture, the explant is cultured on a defined liquid or solid medium. Given an appropriate culture medium, the explant proliferates and then differentiates. Batch culture is essentially a closed system and the *in-vitro* conditions will change with time and may not be optimal for cell growth. Since the tissues are grown in a fixed volume of medium, there is a continual depletion of nutrients and accumulation of toxic materials. To optimise cell growth, it is important to maintain all factors at optimal conditions. In batch culture, this is only possible by very frequent subculturing. Subculturing involves considerable time and effort and will certainly cause a major increase in production cost. In recent years, there have been considerable improvements made in this area. The improved cultural methodology is essentially based on a better understanding of basic plant physiology.

Generally, orchid seedlings that are grown in flasks are first transferred to a community pot, then to thumb pots, after that to a 8 cm (in diameter) pot, and finally to a 15 cm (in diameter) pot. The duration for each transfer is about six months. It is surprising that few scientific studies have been made on the growth and survival rate of plantlets during and after the transfer from culture flask to community pots in the greenhouse. In fact, high plantlet mortality rates have often been experienced with some orchid hybrids. The hardening or acclimatisation of plantlets in flasks and community pot certainly deserves more research. The development of new approaches such as the photo-autotrophic culture system with CO_2 enrichment represents a significant contribution to improve the growth and acclimatisation of orchid plantlets under *in vitro* culture and during transplanting.

In the tropics, it may take more than two years for the orchid plantlets to reach the flowering stage. Orchids, particularly those with an epiphytic origin, are notoriously slow-growing plants. The slow growth of epiphytic orchids may be attributed to its mode of carbon acquisition. Incidentally, most economically important orchids for cut-flower production in the tropics are epiphytic in origin with Crassulacean Acid Metabolism (CAM). In their natural habitat, epiphytes usually meet with a greater degree of environmental stress (e.g., the supply of water and minerals). An understanding of how these orchids cope physiologically with the environmental stress will certainly improve the cultivation of orchids. If a commercial orchid grower wants to optimise orchid growth and flowering, he or she needs to have an understanding of the structure and physiology of orchids. Some basic physiological processes that are relevant to orchid cultivation include photosynthesis, respiration, mineral nutrition, control of flowering and partitioning of assimilates. For example, the grower may want to know the light requirement of an orchid, type of fertiliser to use, method of fertiliser application (either through leaves or roots), or the possible use of plant hormones to induce flowering. Such information can only be obtained from physiological experiments conducted on orchids.

Flower production is a major concern of an orchid farm. As in the other flower crops, the number of spray produced by an orchid varies from time to time. Flower production depends on the genetic make-up of the orchid hybrids and how well they are grown. To achieve maximum yield, proper agronomic practices must be observed. Equally important is the control of flowering to meet market demand. For example, in Japan and Taiwan, large-scale cultivation of *Phalaenopsis* and *Cymbidium* is made possible by the success in controlling flowering. Therefore, the ability to control flowering in tropical orchids using physiological tools is indeed crucial.

The importance of proper postharvest handling of cut-flowers has often been overlooked in the ASEAN orchid cut-flower industry. The management of any floricultural production requires adequate postharvest technology to ensure good marketable quality for the product. The apparent lack of proper postharvest management in many ASEAN orchid farms is attributed to the little information available for postharvest physiology of orchid flowers. This has made it difficult to formulate appropriate postharvest technology and management of orchid cut-flowers, an issue that has been repeatedly raised for discussion in the ASEAN Orchid Congresses.

1.4. Concluding Remarks

It is envisaged that growing tropical orchids for cut-flower production and potted plants will benefit from the recent advances in plant physiology and biotechnology. For the orchid industry, producing an improved hybrid, through conventional breeding or genetic engineering, is only the beginning.

Optimisation of the production processes and ensuring a quality product for the market is equally important. To achieve this goal, a good basic understanding of orchid physiology is essential to solve key physiological issues (Fig. 1.5).

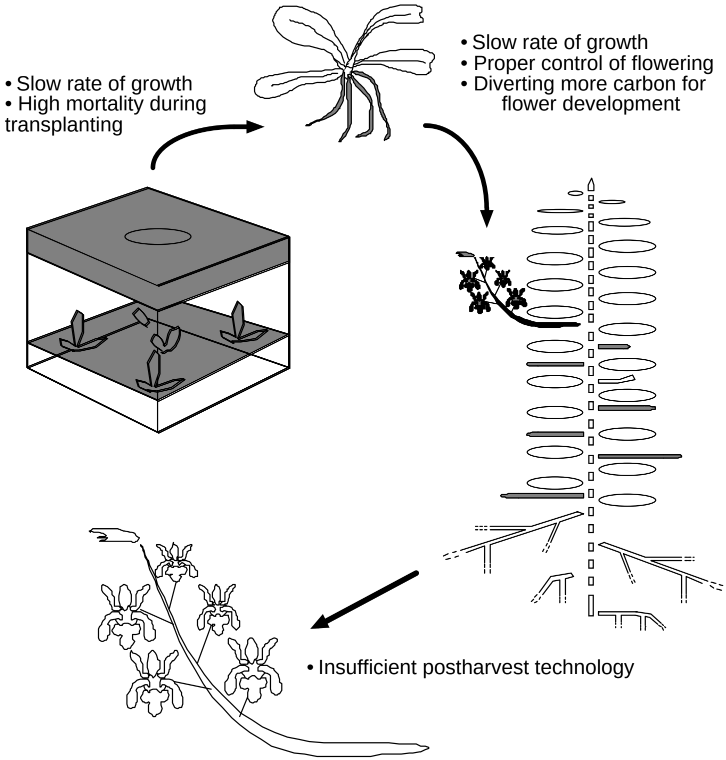

Fig. 1.5. Some key physiological issues affecting the orchid industry.

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