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SOME MORPHO-GENETICAL ASPECTS IN ORCHIDS

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ABSTRACT

Orchids are the second largest families of flowering plants and are distributed throughout the world. Globally orchids are traded as cutflowers and potted plants. Besides, orchids are used in medical, food and beverage industries. They have great economic, aesthetic and cultural significance also. Morphologically, orchids vary in shape, size, forms, colour and growth habit. Keeping in view of the development of economic globalization, scientists and breeders giving emphasis to develop new varieties with novel appearance, improved resistance and quality characteristics through various crop improvement programs

Key words: Morphological, breeding, genes, quality characteristics

INTRODUCTION

Orchids are the second largest families of flowering plants and are distributed throughout the world. The family orchidaceae is divided into five subfamilies (Apostasioideae, Cypripedioideae, Vanilloideae, Orchidoideae, Epidendroideae). Orchids account for c. 8% of angiosperm species diversity. Till date, 29,199 species have been identified and accepted, although several hundred new species are added each year. By the end of 2017, the IUCN Global Red List included assessments for 948 orchid species, of which 56.5% are reported to be threatened. Morphologically, an orchid flower is composed of three sepals, two petals, a highly specialized labellum, a basal spur or nectar or not, and a gynostemium fused by the style and atleast part of the androecium.

Globally orchids are traded as cutflowers and potted plants and market demand is increasing along with a rise in the amount of trade (Hinsley et al, 2018). They are rich in polysaccharides, alkaloids, and other chemical components. Besides, orchids are used in medical, food and beverage industries. They have great economic, aesthetic and cultural significance also. According to Chinese literatures, the orchid is known as one of the "Four Gentlemen among the Flowers" along with the Chinese Plum, Chrysanthemum and Bamboo. Keeping in view of the development of economic globalization, scientists and breeders giving emphasis to develop new varieties with novel appearance, improved resistance and quality characteristics.

STEMS

Based upon growth habit they can be classified into monopodial and sympodial

orchids. In monopodial orchids, the stem emerges from a single bud, elongates and produces leaves from the apex each year. The flower stem emerge from the base of the uppermost leaves. e.g., Phalaenopsis, Vanda and Vanilla. In sympodial orchids, the plant produces a series of adjacent shoots which grow to a certain size, bloom and then stop growing, to be then replaced. The base of the stem of sympodial epiphytes, or in some species essentially the entire stem, may be thickened to form what is called a pseudobulb that contains nutrients and water for drier periods, e.g., Cymbidium, Cattleya, Dendrobium, Oncidium.

ROOTS

Epiphytic and most lithophytic orchids have clinging roots for anchorage, absorbing roots which penetrate the humus on bark and the aerial roots hang free in the air and help to the absorption of moisture. Many a times the epiphytic roots contain chlorophylls, are capable of performing photosynthesis. The roots of genera like Phalaenopsis become flat and assist the plant to creep over the surface, while those of Aerides and Vanda help the plant to trail.

LEAVES

Like most monocots, orchids generally have simple leaves with parallel veins, although some Vanilloideae have a reticulate venation. They may be linear, oblong, ovate, lanceolate, or orbiculate and very variable in size. Lanceolate is common in Paphiopedilum, Dendrobium moschatum, Den. densiflorum, Den. aphyllum, Den. gibsonii, Den. bulboflorum, Den. thyrsiflorum, Den. farmeri; linear in Cymbidium pendulum, Coelogyne graminifolia, Eria bamboosifolia; oblong in Dendrobium nobile, Vanda tessellata, Aerides rosea, Renanthera imschootiana; Elliptic in Epidendrum spp., , Cattleya hybrids; Oblanceolate in Zygopetalum maculatum, Coelogyne nitida, Dendrobium aggregatum, Oncidium hybrids and linear-oblong in Cymbidium hybrids (De 2020).

INFLORESCENCE

Orchids are arranged with flowers on an inflorescence, which is a spike, a raceme or a panicle. Some orchids like Paphiopedilum produce single flower. The origin of the inflorescence varies depending upon genera and species. In most of the terrestrial orchids, the inflorescence is terminal but lateral in orchids like Eulophia nuda while majority of epiphytic orchids produce flowers on lateral inflorescence. However, in orchids like Porpax inflorescences are terminal. A saprophytic orchid produces only leafless flowering shoot. In orchids like Eulophia nuda inflorescence emerges before leaves while in Geoderum densiflorum leafy shoot emerges before inflorescence. Inflorescence is mostly erect in hybrids, and pendulous mostly in species.

FLOWERS

Orchids are monocotyledonous plants bearing flowers with seven floral parts- three sepals, three petals and the column or gynostemium. The orchid flowers show a great diversity in size, colours and form. The range of size varies from that in some species of Oberonia (0.15cm across) to Pecteilis gigantea (10 cm. across). The predominant shades are white, yellow, green and purple occurring in pure state or in every possible combination. The orchid flowers exhibit mimicry like Spiders, Dancing girls, Bees, Ladies slipper, or Insects. In few cases like Oberonia and Malaxis the flowers are in an

upside down position, having twisted through 180° on its pedicel. The inferior ovary or the pedicel usually rotates 180 degrees, so that the labellum, goes on the lower part of the flower, thus becoming suitable to form a platform for pollinators. It is called resupination. Some orchids have secondarily lost this resupination, e.g. Zygopetalum and Epidendrum secundum.

BREEDING METHODS

Till date, traditional breeding is the main approach to orchid breeding. In recent years, Transgenic molecular breeding has been extensively used employed by introducing the desired target genes into orchids using Agrobacterium mediated transformation and particle bombardment methods. The development of DNA based molecular marker technology provides plant breeders with new opportunities to employ molecular marker assisted selection in breeding. Various breeding techniques used in orchids are given below (Table 1).

Table 1. Different breeding methods used in orchids

Sl. No.	Method of breeding	Crops
1.	Cross breeding	Hybridization (Dendrobium, Phalaenopsis, Cymbidium), In-vitro propagation (Cymbidium, Phalaenopsis, Dendrobium, Oncidium, Dactylorhiza, Calanthe)
2.	Mutation breeding	Polyploidization (Cymbidium, Dendrobium, Oncidium, Phalaenopsis)
3.	Selection breeding	Phalaenopsis, Oncidium, Calanthe
4.	Molecular marker-assisted breeding	Cymbidium, Paphiopedilum, Phalaenopsis
5.	Transgenic breeding	Cymbidium, Dendrobium, Oncidium, Phalaenopsis
6.	Genome editing breeding	Phalaenopsis, Apostasia, Gastrodia, Orchis, Anoectochilus

GENETICS OF MORPHOLOGY AND PHYSIOLOGY

Flower morphology and colour are crucial for successful pollination. Fragrance is one of the key determinants of consumer preferences for orchids. Flowering time is the main factor for commercial cultivation of orchids especially early flowering varieties to meet the need of consumers. Both biotic and abiotic stresses hinder the industrialization of orchids. To improve the yield and quality attributes of orchids, breeders should consider breeding for resistance to biotic and abiotic factors. Genes responsible for morphological and physiological variations are listed in Table 2 (Chengru et al, 2021).

Table 2. Genes responsible for morphological and physiological variations in orchids

Sl. No.	Genes	Role
1.	MADS-box genes	Emergence of flower structure
2.	A-class genes	Sepals and promotion of flowering
3.	B-class genes	Development of all floral organs
4.	C/D-class genes	Development of Gynostemium
5.	E-class genes	Development of four whorls of orchid flower structure
6.	EgTCTP	Growth and development
7.	DseCHS-B, DseDFR	Flower colour in Dendrobium
8.	PSY	White colour in Oncidium
9.	CHS, DFR, bHTH, MYBx-like	Flower colour in Phalaenopsis
10.	CsFT	Early flowering in Cymbidium
11.	DOFT	Flowering in Dendrobium
12.	OMADS1	Flowering in Oncidium
13.	MSRB7	Resistance in E.pusilla
14.	OnFd OnFNR	Resistance to soft rot in Oncidium
15.	Pha21	Viral resistance to Phalaenopsis
16.	FT and AP-1 like genes	Vegetative growth to reproductive growth
17.	ODORANT1	Floral scent production
18.	PbbHLH4	Monoterpenoid production in Phalaenopsis
19.	Sael Bit MYB1	Phenylpropanoid production in Cymbidium
20.	cbf1	Higher seed setting rate in phalaenopsis

CONCLUSIONS

A good morpho-genetical study is required for conservation and utilization of endangered orchids. Native species can be effectively utilized for development of inter-generic, inter-specific or intra-specific natural hybrids of commercially orchid general like Cattleya, Cymbidium, Dendrobium, Mokara, Oncidium, Paphiopedilum, Phalaenopsis and Vanda and their compatible alliances which would be market driven having export value as well as tolerant to biotic and abiotic stresses. Investigations on morphological diversity could open up avenues for identification of new and elite germplasm for pot culture, cut flowers, dry flowers, herbal preparations and exhibits for market displays. A range of breeding methods could be integrated to facilitate the cultivation of orchids with unique flower morphologies, novel colours and rich flower scents.

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