Colchicine and the Phragmipediums

Colchicine is an organic alkaloid substance that is extracted from the seeds and corms of *Colchicum autumnale*, Meadow Saffron or Fall Crocus. Its medicinal uses are for the treatment of gout, some cancer treatments and some autoimmune disorders. It has been used since 1937 in plant breeding to produce changes in plants by doubling the number of chromosomes in cells. This is accomplished by preventing the separation of chromosomes that were doubled prior to normal cell division (mitosis). Cells normally carry 2 sets of chromosomes (diploid or 2n), one set from each parent. In order for a cell to divide into two during normal growth, the chromosomes are doubled and then the cell splits into two. If the doubling takes place but the split does not, the cell becomes polyploid, in this case, tetraploid or 4n.

The main advantage of polyploidy is the production of heterozygotes. These offspring have two different forms of a particular gene whereas a homozygote has two copies of the same allele that determines a specific trait. In a normal Mendelian diploid cross the ratio of homozygous to heterozygous offspring is 1:2:1. In a tetraploid cross, the ratio is 1:32:1. The detailed advantages of polyploidy are complex i.e. buffering effects, protection from inbreeding depression, and the unidirectional introgression phenomenon, but the bottom line is that it can produce better plants.

Colchicine treatments have had a profound effect in the breeding of Phragmipedium hybrids. Hybridization started in 1870 and by 1906, 38 crosses were registered. Then, for the next 70 years, hybridization virtually stopped. There are a couple probable reasons. With so much *Paph, schlimii* and *Paph. longifolium* in the gene pool, most of the hybrids produced started to all look the same with similar shape and pale pink coloring. And more importantly, after the first primary hybrid generation, complex Phragmipedium hybrids are nearly sterile. The discoveries of *Phragmipedium besseae* and *kovachii* produced a large spike in hybridization, but the breeders soon ran into the same problem. The complex hybrids were nearly sterile. A breakthrough happened when the Eric Young Foundation took note of the successes in Oncidinae converting plants to polyploidy resulting in more vigorous plants with larger flowers and heavier substance. The Foundation took the same concept and started to treat Phragmipediums with colchicine to produce 4n plants for breeding.

The advantage of 4N plants is that they are generally larger and more vigorous. The flowers are larger and the flower segments are wider with a better substance. Colors are enhanced and are often more saturated. An example is Phragmipedium Eric Young. The 2n form of the hybrid has down swept petals and a natural spread of about 10 cm. The 4n form has petals held much more horizontally and a natural spread of 15 cm. The most important result of polyploidy is that the plants are much more fertile and produce hybrids that are fertile. Breeding programs using complex hybrids are able to pass the old road blocks.

References

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