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Topic- Importance of anther culture

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Let us make in-depth study of the importance, implication and applications of anther and pollen culture. They are discussed here below:

1. Utility of Anther and Pollen Culture for Basic Research
2. Use of Anther and Pollen Culture for Mutation Study
3. Use of Haploids for Cryogenic Study
4. Use of Anther and Pollen Culture for Plant Breeding and Crop Improvement
5. Application of Haploid Culture for Horticultural Plants
6. Anther Culture and Alkaloid Content
7. Haploid Culture and Molecular Biology

1. Utility of Anther and Pollen Culture for Basic Research:

1. Haploids derived from anther and pollen culture are useful in cytogenetic studies.
2. By comparing the heterozygous diploid with haploid or homozygous diploid population, recessive phenotypic characters can be identified very easily.
3. Critical genetic analysis of haploid population derived from individual microspore of pollen tetrad is very useful for the study of genetic recombination in higher plants.
4. The series of cell division and mode of differentiation (embryogenesis or organogenesis), starting from single cell (microspore) and ending in whole organism, can be studied under microscope.
5. Double haploid that are homozygous and fertile, are readily obtained, enabling the selection of desirable gene combination.
6. Culture of isolated pollen provides a novel experimental system for the study of factor controlling pollen embryogenesis of higher plants.
7. Study of meiotic behaviour of haploids provides valuable clues to measure chromosome duplication within a species and for understanding of phylogenetic relationship between species. It also provides information for the interpretation of chromosome homology.
8. Genetic analysis could be performed on haploid population to establish inheritance patterns.
9. Another application involves the use of haploids in the production of monosomies, nullisomics and other aneuploids. This approach has been used in tobacco for the isolation of nullisomics, trisomies and tetrasomics.

2. Use of Anther and Pollen Culture for Mutation Study:

One unique value of microspore culture lies in the study of somatic cell genetics. In such studies, mutant cell lines are specifically important. Several biochemical mutants have also been reported using haploid cells.

Normally, in vivo, the majority of mutation is recessive and, therefore, is not expressed in diploid cells in the presence of immutated dominant gene. Haploid callus cells

have been employed to study the effect of various mutagens, both irradiation as well as chemical.

A number of mutant cell lines have now successfully isolated and extensive work is being done to obtain cell lines that are resistant to environmental stresses, herbicides, phytopathotoxin, salts, drought, chilling, various drugs, viruses and nematodes etc. Salt resistant plants of Datura innoxia from a cell line have been selected from haploids derived from anther culture.

In Ginkgo, arginine-requiring strains from pollen culture have been obtained. With the availability of the technique, a large number of biochemical mutants have been isolated in a number of plant species using haploid cell. Cell line, tissues and complete plants resistant to streptomycin, 5-bromodeoxyuridine, methionine sulfoximine have been obtained. Nitrate reductase mutants have also been reported in Nicotiana tabacum. Recovery of auxotrops for pantothenate, adenine and nitrate reductase less variants have also been reported from Datura innoxia.

Subjecting young haploid plantlets while emerging from the anther to 1,500-3,000 Rads of gamma irradiation, a high proportion of mutants have been isolated in Nicotiana tabacum. Alternatively, flower buds of Nicotiana tabacum are irradiated to X-ray (1,000 R) and the excised anthers are subsequently cultured.

By this process, about 50% of haploid plant thus obtained are aberrant phenotypes. Differential radio sensitivity to ultraviolet and gamma-radiation and valine resistant mutants have also been regenerated from haploid cell culture using UV and gamma-irradiation.

3. Use of Haploids for Cryogenic Study:

1. Cryopreservation of haploid cell, pollen embryos, haploid meristem tips at super-low temperature (-196°C) in liquid nitrogen offers a novel approach for the long-term preservation of genetic stability and to establish a haploid germplasm bank.
2. Pollen embryos and haploid meristem are genetically stable and develop into entire plant easily. Therefore, these materials are more suitable for cryogenic studies.

4. Use of Anther and Pollen Culture for Plant Breeding and Crop Improvement:

1. The main and foremost advantage of the in vitro production of haploid over the conventional plant breeding method is the saving of time. By anther and pollen culture, homozygous diploid or isogenic diploid plant can be produced within a year as compared to the long inbreeding method which might take four to six years.
2. Isogenic lines are also beneficial where plants are self-incompatible, e.g. rye.
3. In breeding programme, isogenic line facilitates the work in inducing desirable mutation, transformation and biochemical mutation.
4. The success of any crop improvement depends on the extent of genetic variability in base population. In this regard callus cultures are a rich source of genetic variability. By anther

culture, not only haploids but plants of various ploidy level and mutants can be regenerated. The anther culture derived callus of Arachis hypogea, A. villosa, Cajanus cajan and Cicer arietinum show a wide range of genetic variability and thus can be incorporated into the breeding programmes.

5. Another advantage to plant breeders which will be within reach, when large number of microspores can be cultured, is the possibility of uncovering new and highly beneficial gene combination. If the F_1 hybrid plant possesses high-yielding qualities than either of parents, the microspore F_1 hybrid can be induced to form plantlets in culture and can be used for breeding with disease resistant variety.

6. In China, by anther culture new varieties of rice Huayu 1, Buayu 2 and Tanfong 1 have been raised. Similarly, new varieties of wheat Lunghua 1 and Huapei 1 have been released. New variety of tobacco, namely Tanyu 1, Tanyu 2 and Tanyu 3 have been obtained by anther culture.

A superior variety of tobacco named F 211, which is resistant to bacterial wilt, has been obtained by anther culture in Japan. In China, pollen plants of Zea mays, Populus nigra (Poplar), Capsicum annuum (Pepper), Beta vulgaris, Brassica pekinensis, B. chinensis have been raised for the exploitation in breeding programme.

7. Hovea brasiliensis is a rubber-yielding plant. It is perennial cross-pollinating tree and its available varieties are highly heterozygous in nature. Again, 5-7 years are required for sowing to blooming and seed set ratio of inbreeding is usually only a few of ten thousandth.

So, it is unreal to obtain pure lines by means of successive inbreeding in many generations. Pollen plants have been produced by anther culture through embryogenesis. Therefore, production of homozygous diploid pollen plants is a new way to obtain pure lines of different genotypes in a short time and can be utilized in breeding programme.

8. The haploid technique to cereal breeding is a quick route from heterozygotes to homozygotes.

9. Anther derived haploids have been extensively used in protoplast culture and somatic hybridization.

5. Application of Haploid Culture for Horticultural Plants:

In some plants of horticultural importance, haploid culture is highly significant. Freesia, a horticulturally important plant, propagates vegetatively by means of underground corms. Normally, it takes 8-10 years to produce a clone which is longer enough for commercial purpose. But in these cases, anther culture can be successfully used to obtain a clone very quickly.

6. Anther Culture and Alkaloid Content:

Amongst other uses, homozygous plants obtained through anther culture have also been employed for the selection of breeding lines of Nicotinna tabacum with high alkaloid content.

Homozygous recombinants of Hyoscyamus niger having higher alkaloid content could be obtained by anther culture.

7. Haploid Culture and Molecular Biology:

In genetic engineering, haploids can be successfully used to gene transfer. Haploid tissue of Arabidopsis and Lycopersicon have been used for the transfer and expression of three genes from Escherichia coli.