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Anther culture and its importance in Vegetable crops

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ARTICLE ID: 074

Abstract

The first ambitious objective, among the millennium development goals, consists in the eradication of extreme poverty and food shortage. Now-a-days, for fighting hunger and malnutrition using a sustainable and low-input farming system, plant breeding rather than agro- chemistry and mechanization seems to be able to more efficiently increase food and feed production on less land and often in a more environment-friendly way. The genetic upgradation of crops through conventional breeding approaches require longer time. So there is a need to assist these methods following certain biotechnological tools to shorten the breeding cycle. Double haploid technology is one such tool which has been widely used in breeding programme, through development of haploids by anther culture in vegetable crops.

Introduction

The first ambitious objective, among the millennium development goals, consists in the eradication of extreme poverty and food shortage. Now-a-days, for fighting hunger and malnutrition using a sustainable and low-input farming system, plant breeding rather than agro- chemistry and mechanization seems to be able to more efficiently increase food and feed production on less land and often in a more environment-friendly way. Particularly, recent advances in biotechnology represent a valuable and powerful tool to enhance the efficiency and shorten the time required to reach the fixed purposes in a breeding programme, as well as to address economic and ecological goals.

Anther culture is a means of obtaining haploids from the pollen grains. They are of special interest to geneticists and plant breeders because they contain single set of chromosomes, used for developing new crop cultivars. Haploids have been obtained from anther cultures of a number of species belonging to the families' solanaceae, poaceae and Brassicaceae.

Haploid plants may be obtained from pollen grains by placing anthers or isolated pollen grains on a suitable culture medium is called anther or pollen culture. Angiosperms are diploid and the

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only haploid stage of their life cycle is being represented by gametophytic tissue with gametic chromosome number. An individual (or) a cell that has gametic chromosome complement of the species is known as haploid. Haploid production through anther culture is known as "Androgenesis".

PRINCIPLE OF ANTHER CULTURE

- The production of haploid by plants exploiting the totipotency of microspore.
- The normal development and function of the pollen cell to become a male gamete is stopped and is diverted forcibly to a new metabolic pathway for vegetative cell division.

HAPLOID: plants that contain a single complete set of chromosomes or individuals having gametophytic chromosome number in its sporophyte.

Why there is need to develop doubled haploids?

1) For development of homozygous lines which are used in hybrid seed production.
2) For fixation of heterosis:- doubled haploids are required because are more homozygous as
3) Compared to conventional breeding methods. For mutational studies and easy to induce mutation by chromosome doubling which can be done by colchicine treatment so there is induction of mutation.
4) For production of biotic and abiotic stress resistant plants. Heterosis can be fixed. So by choosing parents of different biotic and abiotic stress resistance we can select resistant plants.
5) For cytogenetical research to study the structure and functions of chromosomes.
6) For induction of genetic variability at haploid level.
7) For evolutionary studies.
8) For genome mapping as genetic maps are very important to understand the structure and organization of genomes from which evolution patterns and syntenic relationships between species can be deduced.

Table 1: Comparison between doubled haploid breeding and conventional breeding

Particulars	Anther culture	Conventional breeding
Time required for developing pure lines	One year or one crop season	6-7 years

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Time required for developing cultivars	3-5 years	8-10 years or more
Fixation of heterosis	Possible	Not possible
Expenditure/cost involve	More	Lesser
Identification of recessive mutants	Very easy	Difficult
Mapping population	Permanent	Temporary

Androgenesis: is the process of induction and regeneration of haploids and double haploids originating from male gametic cells.

Two types of androgenesis:

- Direct androgenesis:- The microspore behaves like a zygote and undergoes chance to form embryoid which ultimately give rise to a plantlet.
- Indirect androgenesis (Organogenic pathway):- The microspores divide repeatedly to form a callus tissue which differentiates into haploid plantlets.

Limitations of Anther culture or Haploid production

- Often anthers failed, to grow in vitro (or) initial growth is followed by abortion of embryos.
- The tissue (or) callus develop from anthers generally comprises a chimera of Triploid, Tetraploid and Haploid cells.
- Selective cell division must take place in the haploid microspores conveniently restricting proliferation of unwanted diploid and polyploid tissues. This selective cell division is often impossible.
- It is difficult to isolate a haploid from a mixture of haploids and higher ploidy levels since the polyploids outgrow haploids.
- The recognition of haploids often requires cytological analysis.
- Formation albinos in anther cultures especially with cereals.
- The technique of inducing haploids in vitro is not economically viable due to low success

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rate.

- Callus derived from anther or pollen in a medium supplemented with growth regulators is usually detrimental for haploid production. Sometimes deleterious mutations may be induced during in vitro phase.
- The doubling of haploids is time consuming and may not always result in production of homozygote.
- Double haploids, sometimes exhibit segregation in their progeny.
- Occurrence of gametoclonal variation may limit the usefulness of pollen embryos for genetic transformation / gene transfer.
- Specialized skill for carrying out the various operations are required.
- A sophisticated tissue culture laboratory and a dependable greenhouse are essential for success.
- High cost of obtaining haploids and doubled haploid is still a major problem.

Advantages of anther culture

- The ability to produce homozygous lines after a single round recombination saves a lot of time for the plant breeders.
- Studies conclude that random DH's are comparable to the selected lines in pedigree inbreeding.
- The other advantages include development of large number of homozygous lines, efficient genetic analysis and development of markers for useful traits in much less time.
- More specific benefits include the possibility of seed propagation as an alternative to vegetative multiplication in ornamentals, and in species such as trees in which long life cycles and inbreeding depression preclude traditional breeding methods, doubled haploidy provides new alternatives.
- The induction of DH lines in dioecious plants, in which sex is determined by a regulating gene, has an additional advantage. Such a case is well studied in Asparagus, in which sex dimorphism is determined by a dominant gene M. Female plants are homozygous for the recessive alleles (mm), while male plants are heterozygous (Mm). Androgenically produced DH lines are therefore female (mm) or 'supermale' (MM). An advantage of supermales is that, when used as the pollinating line, all hybrid progeny are male.

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Conclusion:

Anther culture is a powerful technique that within twenty years of its discovery, it has made unprecedented impact on cultivar release. Short time required to develop completely homozygous lines is the major advantage of anther culture. In various breeding programs around the world, androgenetic doubled haploids are being used extensively for cultivar development in vegetable crops.

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