World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 6.129

IMPORTANCE OF PLANT TISSUE CULTURE IN PLANT BREEDING

Dhirendra Kumar Singh*

Associate Professor, Department of Agricultural Biochemistry, B.B.D. Govt. College Chimanpura, Shahpura, Jaipur, Rajasthan, India.

***Corresponding Author: Dhirendra Kumar Singh**

Associate Professor, Department of Agricultural Biochemistry, B.B.D. Govt. College Chimanpura, Shahpura, Jaipur, Rajasthan, India.

Article Received on 21/05/2017 **Article Revised on 11/06/2017** **Article Accepted on 01/07/2017**

ABSTRACT

A successful strategy depends on the physical, physiological, and genetic properties of the plant. Plant breeders use a number of techniques to increase the genetic composition of crops. Plant tissue culture is a technique used in plant breeding for post-fertilization barriers, inducing polyploidy, genetic transformation, the creation of disease-free plants, somatic embryogenesis, and embryo rescue. As it incorporates variety development, germplasm conservation, and shortens the breeding cycle by creating homozygous parents from a single generation, it plays a significant role in plant/crop improvement. The review's objective is to evaluate the use of tissue culture in field agricultural, ornamental, forest tree, or plant enhancement for the benefit of people.

KEYWORDS: Plant, Tissue Culture, Breeding.

INTRODUCTION

Growing plant cells, tissues, organs, seeds, or other plant parts in a sterile setting on a nutritional medium is known as plant tissue culture. The invention of methods now used commercially worldwide to quickly multiply a diverse variety of crops and enhance their production systems is the result of decades of research in plant tissue culture (Zulkarnain et al., 2013). After conducting an experiment on the culture of a single photosynthetic leaf cell, Gottleib Haberlandt first proposed the theoretical underpinnings of plant tissue culture in 1902. However, even though he did not fully realise the concept, it has evolved into a potent tool used in the plant sciences 105 years after his work (Touchell et al., 2008). The discovery of cytokine by Folke Skoog and colleagues in the 1950s and auxin by Frits Warmolt Went and colleagues in 1926, according to Pennazio (2001) and Kieber (2002), may have contributed to the first success of in vitro techniques in the culture of plant tissues. According to Thorpe (2006), a relatively high auxin to cytokine ratio encouraged roots, the opposite resulted in the production of shoots, and intermediate amounts resulted in the proliferation of calluses or wound parenchyma tissue. In addition to the development of unipolar shoot buds and roots, Reinert (1958, 1959) and Steward et al. (1958) independently observed the creation of bipolar somatic embryos (carrots). Additionally, numerous researchers have successfully cultivated ovary and anthers in growth media under aseptic conditions and have produced results that can be used as todays technology. Geneticists and plant breeders are showing a greater interest in the possible real-world uses of tissue and cell culture to plant breeding as seen by the growing number of pertinent articles. Natural and artificial selection are used in plant breeding to create novel gene combinations, heritable variants, and plants with unique and beneficial traits. A successful approach depends on the physical, physiological, and hereditary properties of the plant. Plant breeders use a number of techniques to increase the genetic composition of the crop. The techniques used by plant breeders have evolved along with human civilisation and have been expanded to take into account humankind's growing understanding of genetics. Plant tissue culture is a technique used in plant breeding for post-fertilization barriers and polyploidy induction, as well as for disease-free plant development, genetic transformation, somatic embryogenesis (the formation of an embryo from a somatic cell), embryo rescue, and other purposes (Touchell et al., 2008). Tissue culture has been used to enhance the amount of suitable germplasms that are available to plant breeders, improve the health of the planted material, and provide genetic variability from which agricultural plants can be improved. In addition, additional genetic variety in the breeding lines has been produced using in vitro methods for the development of protoplasts, anthers, microspores, ovules, and embryos, frequently through haploid creation (Brown and Thorpe, 1995). It can take six to seven generations of self-pollination or crosses to produce pure variants with crop development operations that emphasise conventional methods. By growing haploid plants from pollen, anther, or ovaries, followed by chromosome doubling, tissue

culture techniques can quickly produce homozygote plants. With this in mind, the review's purpose could be stated as follows.

In Vitro pollination and embryo rescue

First documented in the early 1960s for the poppy Papaver somniferum, pollen application to the ovule surface of excised placentae resulted in the development of viable seeds in vitro (Kanta et al., 1962). The method has been used to create interspecific and intergeneric hybrids by growing excised ovules and pollen grains together in the same medium. According to the researcher, direct in vitro pollination of ovules may be helpful in removing some pre-fertilization barriers caused by stigma or style incompatibility. Popielarska (2005) used modified MS culture conditions to cultivate the ovule and pollen in order to study in vitro self-pollination of isolated sunflower ovules. Then he noted that his work had been successful in obtaining significant seedlings in the culture and that it would be the foundation for future study After in vitro pollination of isolated sunflower ovules, modifications to the medium and semi-in vivo procedures may enhance pollen germination and tube growth in sunflower seedlings. When hybrid fertilisation products could ordinarily degenerate, the in vitro procedure of embryo culture, also known as embryo rescue, has been employed to preserve them. Hannig successfully cultured cruciferous embryos in 1904, and Brown successfully cultured barley embryos in 1906, marking the commencement of this practise as well (Monnier, 1995).

Soma clonal-Variation

Studies on it are important for its control and potential suppression with the aim of producing genetically identical plants, as well as for its use as tools to produce genetic variability, which will enable breeders to improve genetics (leva et al., 2012). The terms "soma-clone" and "somaclonal variation" were coined to refer to plants derived from any form of cell culture, respectively. According to Sato et al. (2012), "pre-existing mutations" in explants as well as "newly induced mutations" brought on by the tissue culture procedure are thought to be the sources of soma-clonal differences. According to Orbovi et al. (2008), in vitro culture conditions can be mutagenic, and regenerated plants formed from organ cultures, calli, protoplasts, and somatic embryos occasionally exhibit phenotypic and genotypic diversity. Through the selection of novel variants that may exhibit disease resistance, superior quality, or higher yield, soma-clonal variation offers a valuable source of genetic variation for the improvement of crops (Emaldi et al., 2004).

Haploid and Doubled haploids Production

Breeders have tried a variety of techniques to establish and fix homozygous genotypes, including conventional inbreeding techniques that require multiple cycles of inbreeding and selection and may not result in true homozygous lines. However, modern plant tissue culture has evolved, and anther and ovule culture have been used to produce haploid and double haploid plants (Tadesse et al., 2013). Plants having a gametophyte chromosome number are haploids, and haploids that have undergone chromosome duplication are referred to as twofold haploids. In vitro anther or isolated microspore culture are the most efficient and popular ways to obtain haploids and DHs out of the several methods that are available (Germana, 2011). Through another, haploid production has been carried out for crops like rice, tobacco, and bread wheat. As a result, antherculture takes use of the fact that some pollen grains naturally occur as embryogenic and that these pollen grains can only become embryos when they are placed on artificial media (Tadesse et al., 2013).

Somatic hybridization

An important method for creating interspecific and intergeneric hybrids is somatic hybridization (SH) via protoplast fusion, which entails fusing the protoplasts of two different genomes, choosing the desired somatic hybrid cells, and then regenerating the hybrid plant. It is an effective method of transferring genes from one species to another in order to overcome obstacles and integrate the nuclear and cytoplasmic genomes of the parental species. SH has been extensively used in a variety of horticultural crops to produce innovative hybrids with higher yields and disease tolerance. Additionally, it has been employed for improving rootstock, cytoplasmic male sterility (CMS) transfer, seedless triploids, and rootstock quality (Wang et al., 2013). Numerous issues with Citrus reproductive traits have been solved through somatic hybridization by protoplast fusion, enabling the development of novel genotypes.According to Soriano et al. (2012), SH in citrus increased rootstock resilience to a variety of biotic and abiotic stressors, increased yield, and improved fruit quality. Plants that flowered early on were produced when "Bonanza" navel orange (C. sinensis) and "Red Blush" grapefruit (C. paradisi) protoplasts were combined (Guo et al., 2000).

Genetic transformation

The most recent development in plant cell and tissue culture, genetic transformation offers a method for transferring genes with desired traits into host plants and recovering transgenic plants. By incorporating the approach into plant biotechnology and breeding programmes, it has a significant potential for genetic improvement of diverse crop plants. It has the potential to play a significant role in the introduction of crucial agronomic features like improved quality, increased yield, and increased resistance to pests and diseases (Sinclair et al., 2004). Either vector-mediated (indirect gene transfer) or vectorless (direct gene transfer) techniques can be used to modify a plant's genetic makeup. The most popular method for expressing foreign genes in plant cells that is vector dependent is Agrobacterium-mediated genetic transformation.

Genetic resource conservation

Food security and agro-biodiversity, which depend on making better use of a wider range of genetic diversity around the world, require the conservation of plant genetic resources. Through the selection and breeding of novel, more productive crops that are tolerant of biological and environmental challenges, genetic diversity offers choices for development (Rao, 2004). The development of cutting-edge technology, particularly in the fields of molecular biology and in vitro culture techniques, has given us some useful tools for better managing and conserving plant genetic resources. Where seed banking is not an option, in vitro culture provides a workable substitute for plant genetic preservation. Either cryopreservation (long-term storage in liquid nitrogen) or slow growth techniques (plantlets on media) will be used to carry it out. For gene banks, DNA banks offer fresh choices (Ganeshan, 2006).

Pathogen Eradication

Pathogens are typically present in crop plants, particularly in vegetatively propagated kinds. The most important benefits of micro propagation include the quick multiplication of organisms, the ability to produce large numbers of disease-free propagules from a single plant in a short amount of time, the ability to propagate throughout the year in a small area, the elimination of field inspections and environmental hazards, and the ease of availability of material for micro propagation (Mtui, 2011). Habtamu and Mohammed (2013) evaluated tissue culture's contribution to the development of disease-free plant material for the country's most important horticulture crops. Because of this, research centres including the Jimma, Melkasa, Holeta, and Debre Zeit agricultural research centres are concentrating on creating coffee hybrids that are high producing and resistant to the coffee berry disease, as well as related varieties of pineapple, banana, potato, and tef. To Teso pineapple cooperatives in SNNPR, Jimma Agricultural Research Centre handed the first 2000 pineapple plantlets. Another 5,500 plantlets are prepared for distribution to each Dara and Chuko Woreda farmer. Over 20,000 disease-free in vitro potato plants for the 2011–12 cropping were created at the Holeta Agricultural Research Centre thanks to Gudene, Jalene, Belete, and Awash. This technique is used to limit the spread of bacterial and viral illnesses that are frequently transmitted through propagation materials (Abraham, 2009).

CONCLUSION

The most promising areas of use today and in the future are those involving plant tissue culture. Plant breeding for better nutritional value of staple crop plants, conservation of plant genetic resources, and micropropagation of decorative and forest trees are only a few of the topics covered. An effective in-vitro plant regeneration system is essential for all biotechnology procedures like as genetic modification, haploid and double haploid induction, or soma-clonal variation to improve characteristics. Although soma-clonal variations during tissue culture are useful to generate new cultivar with novel qualities, it is preferable to eradicate soma-clonal variants based on our interest to ensure the quality of our crop products. In tissue cultures, a variety of beneficial compounds originating from plants can be created. Many nations that experience crop loss due to disease or climate calamity may find it quite advantageous to be able to enhance the rate of traditional multiplication. When germplasm is kept in field gene banks, the story of the loss of genetic resources is widespread. The issues with field gene banks are being addressed by slow growth in vitro storage and cryopreservation. They provide a way for future generations to have access to genetic resources for less complicated genetic transformation activities or for basic traditional breeding initiatives. Plant tissue culture, in general, plays a significant role in improving plants and crops since it involves the formation of variety, the preservation of germplasm, and the shortening of the breeding cycle through the development of homozygous parents from a single generation.

REFERENCE

1. Barkley, A., and Chumley, F.G.., 2011. A doubled haploid laboratory for Kansas wheat breeding: an economic analysis of biotechnology adoption. Int Food Agribus Manag Rev, 15: pp.99-120. Brown, D.C.W. and Thorpe, T.A., 1995. Crop improvement through tissue culture.World Journal of Microbiology and Biotechnology, 11(4): 409-415. Chandler, S.F. and Sanchez, C., 2012.
2. Genetic modification; the development of transgenic ornamental plant varieties.Plant biotechnology journal, 10(8): 891-903.
3. Eeckhaut, T., Lakshmanan, P.S., Deryckere, D., Van Bockstaele, E. and Van Huylenbroeck, J., 2013. Progress in plant protoplast research. Planta, 238(6): 991-1003. Emaldi, U., Trujillo, I. and de García, E., 2004. Comparison of characteristics of bananas (Musa sp.) from the.
4. somaclone CIEN BTA-03 and its parental clone Williams. Fruits, 59(4): 257-263. Fathi, H. and Jahani, U., 2012. Review of embryo culture in fruit trees. Ann Biol Res, 3(9): 4276-4281. Germanà, M.A., 2011.
5. Anther culture for haploid and doubled haploid production. Plant Cell, Tissue and Organ Culture (PCTOC), 104(3): 283-300. Guo, W.W., Deng, X.X. and Yi, H.L., 2000. Somatic hybrids between navel orange (Citrus sinensis) and grapefruit (C. paradisi) for seedless triploid breeding. Euphytica, 116(3): 281-285.
6. Hassawi, D.S., Qrunfleh, I. and Dradkah, N., 2005. Production of doubled haploids from some Jordanian wheat cultivars via anther culture technique. Journal of Food Agriculture and Environment, 3(1): 161-164.
7. Jiang, J.J., Zhao, X.X., Tian, W., Li, T.B. and Wang, Y.P., 2009. Intertribal somatic hybrids between Brassica napus and Camelina sativa with high

linolenic acid content. Plant Cell, Tissue and Organ Culture (PCTOC), 99(1): 91-95.

8. Kanta, K., Swamy, N.R. and Maheshwari, P., 1962. Test-tube fertilization in a flowering plant. Nature, 194(4835), 1214-1217. Kaviani, B., 2011. Conservation of plant genetic resources by cryopreservation. Aust J Crop Sci, 5(6): 778-800.
9. Kieber, J.J., 2002. Tribute to Folke Skoog: recent advances in our understanding of cytokinin biology. Journal of plant growth regulation, 21(1): 1-2.
10. Kisaka, H., Kisaka, M., Kanno, A. and Kameya, T., 1998.Intergeneric somatic hybridization of rice (Oryza sativa L.) and barley (Hordeum vulgare L.) by protoplast fusion. Plant cell reports, 17(5): 362-367.
11. Leva, A.R., Rinaldi, L.M.R. and Petruccelli, R., 2012. Somaclonal variation in tissue culture: a case study with olive. INTECH Open Access Publisher. Liu, J. and Deng, X., 1999. Production of hybrid calluses via donor-recipient fusion between Microcitrus papuana and Citrus sinensis. Plant cell, tissue and organ culture, 59(2): 81-87.