Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 06 (NOV-DEC, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Biotechnological Interventions in Temperate Fruit Crops

(*Yukta Jaswal, Dr. Shipla Rana, Manavi, Monalisa Singh, Shivani Thakur and Richa Sharma)
Sam Higginbottam University of Agriculture Technology and Sciences, Prayagraj
*Corresponding Author's email: yuktajaswal000@gmail.com

The transformational effect of biotechnological interventions on temperate fruit crop is examined in this chapter, with a focus on innovations meant to improve resilience, yield, and quality. In the agricultural industry, biotechnology has become a potent instrument, offering innovative approaches to tackle the problems caused by pests, diseases, and climate change. The primary biotechnology technologies, including genetic modification, genome editing, and marker-assisted breeding, which have permitted the production of fruit crops with improved features like as disease resistance, increased shelf life, and higher nutritional content. It also emphasises how biotechnology may help address environmental sustainability issues by creating fruit types that can withstand stress and drought. It also covers how biotechnology methods may be used to reduce postharvest losses and raise the general effectiveness of systems used to produce fruit crops.
1. Biotechnological approaches for crop enhancement in fruit crops are included in the publication. It covers a range of traditional and biotechnological fruit crop breeding techniques, such as genetic engineering, marker-assisted selection, and molecular markers.
2. In fruit crops, molecular markers such as SSRs, SNPs, and RAPDs can be utilised for gene cloning, marker-assisted selection, and genetic mapping. The paper gives examples of how to map the genes governing strawberry and papaya fruit attributes using SSR markers.
3. By choosing genotypes with desirable features based on their marker profile, marker-assisted selection shortens the breeding cycle without requiring phenotypic assessment.

Introduction

Fruits with a temperate environment are those that typically grow beyond 23.5° from the equator. This category also contains citrus and avocado fruits, which are sometimes categorised as subtropical. Tropical latitudes may support the cultivation of several temperate fruits at higher elevations, albeit some species may have poor fruit set. "Fruits" are plant parts that carry seeds and go through a distinctive process called ripening that turns them from unpleasant to edible (vegetables don't go through this sequence). This page covers a lot of ground with information that applies to most fruits; some tropical fruits are included here for comparison. Products from the garden that may be categorised as temperate fruits include the tomato and various nuts; they are covered in different entries.

roduction of temperate fruits is a significant business. Since fresh fruit cultivation and selling need a lot more labour than broadacre crop farming, the temperate fruit business is a significant employer. Major enterprises that produce fruit on a large scale are moving their operations to more appropriate places where labour is more affordable due to the high labour component of the production. lists the principal temperate fruits and their expected global output. Large amounts of temperate fruits are processed (e.g., dried, wine, juice, glacé, canned, etc.)

A substantial industry is the production of temperate fruits. The temperate fruit industry employs a large number of people since growing and selling fresh fruit requires a lot more effort than producing broadacre crops. Because labour costs are a significant part of fruit production, big fruit production companies are shifting their operations to more suitable locations where labour is less expensive.

1. **Fast track fruit crop breeding:** Perennial trees are often used for fruit production. A new variety with the required features takes a long time to evolve because of their long reproductive cycle, protracted juvenile periods, complicated reproductive biology, and high degree of heterozygosity. The vast amount of land needed to establish fruit tree populations as seedlings and the related field operations costs are further drawbacks. To produce a new offspring that possesses the desirable agronomic and commercial qualities, introgressive backcrossing is sometimes necessary in several rounds (Petri and Scorza, 2008).
2. **Recent advances in CRISPR/Cas mediated genome editing for fruit crop improvement:** CRISPRs, or clustered regularly interspaced short palindromic repeats, are a novel technique for modifying the genome. which focus on functional characterisation of plant genes, genetic crop enhancement, and specific gene sets for expression or repression. The type II prokaryotic species' adaptive immune system serves as the foundation for the CRISPR/Cas system's theory. The biological role of the CRISPR/Cas system was just revealed in 2007 while its presence was already discovered in the Escherichia coli bacteria. CRISPR/CRISPR-associated (Cas) systems are found in around 40% of bacteria and 90% of archaea, and they provide resistance to foreign DNA elements. It is easy to develop, inexpensive, and very specialised. Three different CRISPR/Cas system types (I, II, and III) each utilise three different molecular mechanisms to identify and
3. **Speed Breeding:** Accelerated plant breeding, or speed breeding, is a novel technique employed by plant breeders to create new cultivars quickly. Speed breeding has completely changed the planet in the modern era. Scientists at the University of Queensland implemented the first-ever speed breeding technique, which was created throughNASA served as an inspiration Through the process speed breeding plant breeders can increase crop yield by modifying the temperature, length, and intensity of light to accelerate plant development. The plants in this instance are grown in carefully regulated growth chambers or greenhouses with artificial light sources (both intensity and quality), as well as particular day lengths and temperatures. This allows the plants to go through several physiological processes more quickly, most notably photosynthesis and flowering, which reduces the generation time compared to normal. In contrast to the 2-3 generations produced under typical glasshouse circumstances, speed breeding can provide up to 4-6 generations year
4. **Cisgenic and intragenic fruit plant:** A new genetic engineering technique known as "cisgenesis" or "cisgenic" has been proposed as an alternative to allay worries about conventional transgenic procedures in response to this anxiety. Genetically altered plants known as "cisgenics" are those that have had one or more genes isolated from a sexually compatible species or from the same species. By definition, cisgenic plants are considerably more similar to traditionally produced plants and do not include any alien genes, such as the selection marker gene. Unlike transgenes, which are combinations of a coding gene with a regulatory region, such as a promoter from another gene, cisgenes have their native introns and are anchored by their native promoter and terminator in sense orientation .Consumer acceptability should rise with the introduction of gene(s) from the same plant or plants that are sexually compatible with the target crop and the lack of selectable flag genes in the final product.

To enhance features in crop species, speed breeding may serve as a basis for integrating gene editing, marker-assisted/genomic selection, and high-throughput phenotyping and genotyping methods. Recent developments in breeding technology have shortened the time required to create superior plant varieties when compared to traditional breeding methods. Apples and other perennial fruit crops are now being improved via the application of this technology and standardisation procedures.

5. **The role of Molecular Markers in Improvement of temperate Fruit Crop:** Any characteristic of an organism that can be reliably and comparatively easily identified, followed in a mapping population, and is a heritable item linked to the economically significant feature under the control of polygenes is referred to as a marker. Genetic markers are classified into two categories: morphological markers, which are also referred to as molecular markers, and non-morphological markers, which are also known as naked eye polymorphism. The features that may be visually assessed are known as morphological markers. Examples of these traits include plant height, sensitivity, photoperiod, disease response, and the shape or colour of flowers, fruits, or seeds. On the other hand, molecular markers consist of macromolecules like proteins and deoxyribonucleic acid as well as biochemical components like secondary metabolites in plants
6. **Genome editing for biotic strace resistance:** A promising strategy to increase temperate fruit crops' resistance to pests and diseases is genome editing for biotic stress tolerance. Here are some important factors to think about:

Species Targeted: Apples, pears, cherries, blueberries, and strawberries are common temperate fruit crops. Each has unique biotic risks, including viruses, insect pests, and fungal diseases.

Methods Employed: CRISPR/Cas9: This popular technique enables accurate genome editing to either boost or eliminate certain genes linked to disease resistance.

ZFNs and TALENs are further genome editing technologies that can be used to change genes associated with stress reactions.

Particular Goals: Finding and modifying genes that provide resistance to certain infections, such as powdery mildew in strawberries or fire blight in apples, is known as resistance gene editing.

Conclusion

To sum up, biotechnology solutions for temperate fruit crops provide a revolutionary way to deal with the problems in contemporary agriculture. Researchers and breeders may improve fruit quality, boost tolerance to environmental challenges, and improve disease resistance by utilising methods including genome editing, genetic transformation, and marker-assisted selection. These developments help sustainable farming methods and food security in addition to increasing yields and lowering dependency on chemical inputs. However, managing regulatory environments, attending to consumer concerns, and guaranteeing environmental safety are all necessary for the effective deployment of these technologies. Going forward, maximising the potential of biotechnology will need sustained research and cooperation between scientists, farmers, and legislators. ‘

References

1. Ahmed, S., Rattanpal, H. S., Kumari, P., Singh, J. (2017). Study of genetic variability in citrus fruit crop by molecular markers-a review. international Journal of Pure and Applied Bioscience, 5(1), 111–128. DOI 10.18782/2320-7051.2480.
2. Amorim, E. P., Vilarinhos, A. D., Cohen, K. O., Amorim, V. B., Santos- Serejo, J. A. D. et al. (2009). Genetic diversity of carotenoid-rich bananas evaluated by

Diversity Arrays Technology (DArT). Genetics and Molecular Biology, 32(1), 96–103. DOI 10.1590/S1415-47572009005000024.

3. Balconi, C., Stevanato, P., Motto, M., & Biancardi, E. (2012). Breeding for biotic stress resistance/tolerance in plants. In Crop production for agricultural improvement (pp. 57-114). Springer, Dordrecht.
4. Baranski, R., Kaul, M. A., Nothnagel, T., Cavagnaro, P. F., Simon, P. W. et al. (2012). Genetic diversity of carrot (Daucus carota L.) cultivars revealed by analysis of SSR loci. Genetic Resources and Crop Evolution, 59(2), 163– 170. DOI 10.1007/s10722-011-9777-3.
5. Barrangou R, Fremaux C, Deveau H, Richards M, Boyaval P, Moineau S, Romero DA, Horvath P (2007) CRISPR provides acquired resistance against viruses in prokaryotes. Science 315:1709–1712.
6. A., Trujillo, I., Rosa, D. L. R., Rallo, L., Gimenez, M. J. (2001). Polymorphism and discrimination capacity of randomly ampli□ed polymorphic markers in an olive germplasm bank. Journal of the American Society for Horticultural Science, 126(1), 64–71. DOI 10.21273/JASHS.126.1.64.
7. Bergonzi S, Albani MC (2011) Reproductive competence from an annual and a perennial perspective. J Exp Bot 62:4415–4422 Blazquez MA, Soowal LN, Lee I, Weigel D (1997) LEAFY expression and fower initiation in Arabidopsis. Development 124:3835–3844
8. Blazquez MA, Weigel D (2000) Integration of □oral inductive signals in Arabidopsis. Nature 404:889–892
9. Bus, V. G. M., Chagné, D., Bassett, H. C. M., Bowatte, D., Calenge, F. et al. (2008). Genome mapping of three major resistance genes to woolly apple aphid (Eriosoma lanigerum Hausm.). Tree Genetics and Genomes, 4(2), 223–236. DOI 10.1007/s11295-007-0103-3.
10. Chagné, D., Carlisle, C. M., Blond, C., Volz, R. K., Whitworth, C. J. et al. (2007). Mapping a candidate gene (MdMYB10) for red and foliage colour in apple. BMC Genomics, 8(1), 212. DOI 10.1186/1471-2164-8-212.224
11. Chen, L.; Yang, D.; Zhang, Y. Evidence for a speci□c and critical role of mitogen-activated protein kinase 20 in uni-to-binucleate transition of microgametogenesis in tomato. Plant Biol. 2018, 219, 176
12. Cook JR (2000) Advances in plant health management in the twentieth century. Annu Rev Phytopathol 38:95–116
13. Costa, F., Stella, S., Weg, V. W. E., Guerra, W., Cecchinel, M. et al. (2005). Role of the genes Md-ACO1 and MdACS1 in ethylene production and shelf life of apple (Malus domestica Borkh). Euphytica, 141(1–2), 181–190. DOI 10.1007/s10681-005-6805-4.
14. Dhekney SA, Li ZT, Gray DJ (2011) Grapevines engineered to express cisgenic Vitis vinifera thaumatin like protein exhibit fungal disease resistance. In Vitro Cell Dev Biol Plant 47:458–466
15. Divilov, K., Barba, P., Davidson, C. L., Reisch, B. I. (2018). Single and multiple phenotype QTL analyses of downy mildew resistance in interspeci□c grapevines. Theoretical and Applied Genetics, 131(5), 1133–1143. DOI 10.1007/s00122-018-3065-y.
16. Doudna AJ, Charpentier E (2014) The new frontier of genome engineering with CRISPR-Cas9 genome editing. Sci Res 346:12580961–12580969.
17. Duan YX, Fan J, Guo WW (2010) Regeneration and characterization of transgenic kumquat plants containing the Arabidopsis APETALA1 gene. Plant Cell Tissue Organ Cult 100:273– 281
18. Fiyaz R., Ajay B.C., Ramya K.T., Aravind Kumar J., Sundaram R.M., Subba Rao L.V. (2020) Speed Breeding: Methods and Applications.

19. In: Gosal S., Wani S. (eds) Accelerated Plant Breeding, Volume 1. Springer, Cham. https://doi.org/10.1007/978-3-030-41866-3_2
20. Flachowsky H, Hattasch C, Hofer M, Peil A, Hanke M-V. 2010. Overexpression of LEAFY in apple leads to a columnar phenotype with shorter internodes. Planta 231: 251–263.
21. Flachowsky H, Le Roux P M, Peil A, Patocchi A, Richter K, Hanke M V (2011) Application of a high speed breeding technology to apple (Malus × domestica) based on transgenic early owering plants and marker assisted selection. New Phytol 192:364–377
22. Flachowsky H, Peil A, Sopanen T, Elo A, Hanke V. 2007. Overexpression of BpMADS4 from silver birch (Betula pendula Roth.) induces early fowering in apple (Malus X domestica Borkh.). Plant Breeding 126: 137–145.
23. Heszky L (2008) Challengee of plant breeding early in 21th century.
24. Hungarian Agric Res 4:4–8Imai, A., Nonaka, K., Kuniga, T., Yoshioka, T., Hayashi, T. (2018). Genome-wide association mapping of fruit quality traits using genotyping