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Molecular markers: A tool for improvement in fruit crops

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Markers can be defined as heritable entities associated with the economically important trait under the control of polygenes. Markers are any trait of an organism that can be identified with confidence and relative easy, and can be followed in a mapping population. There are two types of genetic markers *viz.*, morphological markers or naked eye polymorphism and non-morphological markers or molecular markers. Morphological markers include traits such as plant height, disease response, photoperiod, sensitivity, shape or colour of flowers, fruits or seeds etc. Molecular markers include biochemical constituents. Consequently, molecular markers could be appropriate choice to study and preserve the diversity in any germplasm. Molecular markers have diverse applications in fruit crop improvement, particularly in the areas of genetic diversity and varietal identification studies, gene tagging, disease diagnostics, pedigree analysis, hybrid detection, sex differentiation and marker assisted selection.

Types of markers :

Morphological markers :

Morphological markers are those traits that are scored visually, or morphological markers are those genetic markers whose inheritance can be followed with the naked eye. They masks the effect of linked minor gene, making it nearly impossible to identify desirable linkages for select and are limited in number, influenced by environment and also specific stage of the analysis.

Biochemical molecular markers : The first biochemical molecular markers used were the protein based markers. One of the earliest protein based markers to be used was Isozyme. These are different forms of an enzyme exhibiting the same catalytic activity but differing in charge and electrophoretic mobility. Variation in bending patterns obtained between individual samples can be used to sort out genetically the varieties tested.

DNA based markers : The sequence of nucleotides in DNA of an individual is unique and thus determines its identity. The ultimate difference between individuals lies in the nucleotide sequence of their DNA. These can be used to diagnose the presence of the gene without having to wait for gene effect to be seen.

Properties of ideal DNA markers :

– Highly polymorphic in nature.
– It has codominant expression.
– It is selectively neutral behaviour.
– It has easy access and assay.
– Easy exchange of data between laboratories.
– It follow Mendelian inheritance; genetically linked to trait in question; not affected by pleiotropism and epistatic interactions.

Applications of molecular markers :

Assessment of genetic diversity :

DNA markers to assess genetic diversity among species of several horticultural crops, as well as validation of genetic relatedness among them. Using RAPD markers the wide variability was observed in the mandarin germplasm present in N.E. Himalayas. In China using SSR markers, genetic diversity in mandarin landraces and wild races of mandarins, sweet orange, mandarins, grapefruit, lemon and citranges was resolved. DNA markers have also been utilized to find out the phylogenetic relationships in 30 accessions of citrus fruits.

Identification of QTLs :

Several characters of plant species, among which are traits of agronomic importance, are inherited quantitatively. Yield, maturity date and drought tolerance are examples of such characters. The genetic loci for such characters have been referred to as quantitative trait loci (QTLs). The essential feature which makes feasible the finding and characterization of a QTL is its linkage with a known marker locus segregating with Mendelian ratios. DNA markers provide this opportunity by making it feasible to identify, map and measure the effects of genes underlying quantitative trait. In grape QTLs were use for features such as like critical photoperiod, growth cessation, or dormancy, bud break (BB) and winter hardiness. Approximate position of 28 major genes were mapped in different populations of peach (orange background), almond (yellow background) and Myrobalan plum (green background) on the framework of the Prunus reference map. Gene abbreviations correspond to: Y, peach flesh

colour; sharka, plum pox virus resistance; Mi, nematode.

Varietal identification : Varietal identification is nothing but DNA fingerprinting. Singly or in groups, molecular markers are capable of producing patterns that are unique for each individual genotype. Their patterns, whether they are generated by PCR or by hybridization with single copy, multicopy, or repeated sequences are referred to as genetic finger printings.

Disease diagnostics : Molecular markers have made it possible to develop diagnostic techniques to identify pathogen with an unprecedented accuracy and speed and to tap genes from as diverse sources as microbes, plants and animals to enable the researchers to develop plants resistant to diseases.

Eg. Apple Fire blight resistance SCAR, SSR, Citrus leprosis virus resistance AFLP and RAPD, Pear Incompatibility AFLP and SSR.

Marker assisted selection (*MAS*) : Molecular markers can potentially increase the importance and usefulness of indirect selection in plant breeding. MAS permits the breeder to make earlier decisions about the further selections while examining fewer plants. An added advantage in breeding for disease resistance behaviour is that this could be done in the absence of pathogen once marker information is available. Earlier markers were being developed for monogenic traits but present markers are developed for traits governed by multigenes or polygenes.

Pedigree analysis and detection of hybrids : Isozyme analysis has been successfully employed to confirm parentage of plums, apple and mango cultivars and also to establish origin of several pineapple cultivars. Further isozyme been used for differentiating between progeny produced by self pollination and those produced via cross pollination and detection of hybrids. They are used to confirm the production of interspecific prunus hybrids, grape interspecific crosses and progeny screening for hybrid seedlings in citrus breeding programme, besides identification of zygotic and nucellar seedlings in citrus.

Conclusion : The old disciplines of quantitative genetics and plant taxonomy have been revived by the molecular marker approach. The markers have immediate applications in supportive research for advanced breeding programmes. The major application of markers lies in the strategic research for rapid understanding of basic genetic mechanisms and genome organization at molecular level. The success of DNA marker technology for bringing genetic improvement in fruit crops would depend on close interaction between plant breeders and biotechnologists, availability of skilled man power and substantial financial investment on research.

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