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Transposons in Plants

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SUMMARY

Transposable elements were first discovered in plants because they can have tremendous effects on genome structure and gene function. Although only a few or no elements may be active within a genome at any time in any individual, the genomic alterations they cause can have major outcomes for a species. All major element types appear to be present in all plant species, but their quantitative and qualitative contributions are enormously variable even between closely related lineages. In some large-genome plants, mobile DNAs make up the majority of the nuclear genome. They can rearrange genomes and alter individual gene structure and regulation through any of the activities they promote: transposition, insertion, excision, chromosome breakage, and ectopic recombination. Many genes may have been assembled or amplified through the action of transposable elements, and it is likely that most plant genes contain legacies of multiple transposable element insertions into promoters. Because chromosomal rearrangements can lead to speciating infertility in heterozygous progeny, transposable elements may be responsible for the rate at which such incompatibility is generated in separated populations. For these reasons, understanding plant gene and genome evolution is only possible if we comprehend the contributions of transposable elements.

INTRODUCTION

A transposable element is DNA sequence that can change its protein within a genome. These elements are capable to move from one location in a chromosome or into another chromosome within the same genome. In prokaryotes like bacteria, they can jump from bacterial chromosome into bacteriophages chromosome or into a plasmid and vice versa.

History:

Earlier, genes were considered to be stable bodies arranged in an orderly linear pattern on chromosomes, like beads on a string. In the late 1940s, Barbara McClintock challenged existing concepts when she found that some gene could be mobile from her studies of chromosomes breakage in corn. These genes were eventually named as transposons.

Types of Transposable Elements:

Transposable elements are of two types: (1) one group of elements propagates itself by transposition as DNA copies, e.g., insertion sequence (IS) and composition transposition and (2) another group of transposons propagates itself by making DNA copies of their RAN genomes; popularly known as retrotransposons.

Insertion Sequence (IS)

IS elements are short length DNA sequence of about 800-1400bp length and have the ability to move from one position to another position in the genome. These are the simplest form of transposable elements. IS elements have 9-24bp inverse repeats at both of the ends which are closely related rather than identical. The elements contain a single long coding region in between the two inverse repeats, which codes for the enzyme transposase, which is responsible for transposition of these elements.

Composite Transposons (Tn)

Composite transposons are generally >2000bp long have none or more genes in addition to the coding gene for transposase. The IS elements at both the ends of the end Tn elements may be either in the same or in opposite orientation. While IS elements from the two arms of a composite transposons, other genes including that for transposase are present in the central region. These elements are found in prokaryotes e.g., bacteria and in eukaryotes.

Consequences of Transposition

IS elements: Insertion of an IS element into a chromosome generates a short (usually 5to 9bp) direct repeat that flanks the IS element. When this IS element transposes, the direct repeat remains at the site of integration in the host chromosomes. Integration of the IS element within a gene prevents the function of the genes, thereby causing mutation. When two nonhomologous DNA segments contain the same IS elements, recombination can occur between there is elements known as illegitimate recombination.

Composite Transposons: The transposition of the composite transposons is promoted by one of the two IS elements located at their ends. Only the ends of transposons are required for transposition; in fact, any DNA sequence located between two IS elements can be transposed by these IS elements. The events during insertion of transposons are follows:

- Staggered breaks are produced in the target DNA,
- The transposons join to the protruding single-stranded ends, and
- The remaining gaps are then filed generating the repeats of the target DNA at the site of insertion.

Types of Transposition:

Transposition may be of three different types: (1) non replicative: transposons move out one site and becomes integrated at new site leaving a double stranded break at the old site;(2) replicative: a new copy of transposons produced which become inserted at the new site, original site remains unchanged, and (3) conservative: transposons move to a new site in such a way that a double -stranded break is not formed at the old site.

Ac-Ds system in Maize:

The first transposable element to be discovered in a eukaryote was Ac-Dc system in maize by lady Mendel, Barbara McClintock, in 1950; the elements were called controlling elements. Ac (activator) is the autonomous elements (have the ability of independent transposition), whereas Ds (dissociator) is the non-autonomous elements (can transpose only when autonomous elements of the same family is present). Ds is derived from the Ac by deletion of 194bp to 2.5kb. Ac has 11bp repeats at the ends, encodes a single protein, possibly transposase, and transposes by nonreplicated mechanism. In maize, genes C1 produces coloured kernels. If Ds elements becomes inserted within the genes C1, this gene become inactive. In case Ac is present in the same nucleus, it induces Ds to transpose out of the gene C1 to another location. This allows the gene C1 to express again in its normal way and produces coloured kernels. Transposition of the Ds elements during kernel development generates spots of colour on the colourless kernels. The earlier the occurrence of transposition: the larger the size of spot.

Retrotransposons:

Retroposons are derived from retroviruses are closely related to them, e.g., Ty element of yeast, *copia* and foldback (FB) elements of *Drosophila melanogaster* and LINES (long interspersed repeats) and SINES (short interspersed sequences) in mammals. Retroviruses are single stranded RAN viruses which replicates through a double stranded DNA intermediate. Ty elements are transcribed into mRAN. In mammals, a significant part of moderately repetitive DNA consists of retroposons. Most of these belong to the families LINES and SINES. Eukaryotic retroposons may be classified into two groups: (1) viral super family: consisting of elements resembling retroviruses, and (2) nonviral super family: having elements that are original from cellular RNA sequence.

Contribution of Transposable Elements in The Plants Genome:

A large portion of many plant genomes consists of transposable elements that create new genetic variation within plant species. TEs can generates new promoters, leading to novel expression patterns. These can also provide novel cis acting regulatory elements that act like enhance or inserts within original enhancers that are required for transcription. Thus, the regulation of plant genes expression is highly regulated by the insertion of TEs into nearby genes. Hence TE insertions can not only act as simple mutagens but can also alters the elementary functions of the plant genomes.

CONCLUSION

Transposable elements are usually in the plant kingdom and share many common features. Transposition of these elements can affect plant genes and genomes in many ways. It is also becoming clear that transposable element derived sequences can be a major component of plant genomes. These sequences are probably therefore considered significant in plant evolution.

REFERENCES

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