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TRANSPOSON-INDUCED COLORATION PATTERNS IN ORNAMENTALS

Document prepared by an expert from the Community Plant Variety Office (CPVO)

TRANSPOSON-INDUCED COLORATION PATTERNS IN ORNAMENTALS

1. Introductory information on transposons

2. Impact of transposons on the plant phenotype

1. INTRODUCTORY INFORMATION ON TRANSPOSONS

Transposons: nucleic acid (e.g. DNA) capable of changing its position within the genome. Other commonly used terms are ‘jumping gene’, ‘mobile DNA’, ‘transposable elements’ or ‘insertions sequence’. A transposon does not necessarily carry genetic information being translated into proteins nor does it always have the functional structure of a complete gene.

When a transponson changes its position it may integrate itself into a gene or its activity regulating area. In such an event the gene will be inactivated (switched off). If the transposon is excised from the gene then the gene may regain its normal function.

It is a main characteristic of transposons that their transpositions occur by chance. Even though transposons in all organisms tend to show some bias for particular regions targeting mechanisms for their insertion into the genome have not been identified. Recent studies revealed that stress (e.g. tissue culture) may result in increased transposition activities; however, there is no theory allowing forecasting transposition incidents.

Currently, there is no function of transposons known. They are mainly studied in genetic analysis. Even though first studies on transposons date back more than fifty years their significance was widely recognized only after Barbara Mc Clintock was awarded the Nobel Prize in 1983 for her research activities in this field.

It is not known when transposable elements arose, nor are the specific mechanisms of this origin clear. It seems likely, however, that DNA transposable elements are derivatives of independent evolutionary creations. In some species they make up over 70% of the nuclear DNA. To the vast majority, transposons are found in the non-coding areas of the genome. Also, during an individual’s life span transposons normally do not move at all. Their capability to change position in the genome rather refers to phylogenetic dimensions (several millions of years). Transposons are thought of having had a strong impact on the evolutionary expansion and diversification of genomes. Hence, transposons in general have no recognizable impact on the appearance of plants within a variety's life span. In some cases – like the examples investigated by Mc Clintock – transposons do move frequently thus giving a unique appearance to plants.

Transposons may be used in cross breeding; however, plant breeders have made only little use of them so far. One reason for that may be the rather recent general recognition. The other reason is that transposon activities cannot be controlled.

2. IMPACT OF TRANSPOSONS ON THE PLANT PHENOTYPE

Transposons may affect genes encoding macroscopically visible traits (e.g. anthocyanin pigmentation resulting in red coloration). The result is a temporary non-function of the gene (and consequently a temporary lack of e.g. red coloration of that cell). Affected plants are often featured by numerous small spots, strips or sectors of a second color spread over petals, leaves or fruits. Even in very small samples it may be difficult to determine a specific size of these spots or stripes as true to type. In larger samples, there are usually some individuals found having either no or larger sectors of the second color. In fact, since transposition events occur by chance any fixation of the number and the size of these spots is made arbitrarily. A transposon-altered phenotype differs from other bi-colored forms (like chimeras or plants with a gene-controlled coloration pattern) with regard to the coloration pattern as such and also with regard to the variability of the pattern. All individuals in a given sample (as well as all plant organs of the same kind of a given individual) show a different coloration pattern and they may give rise to individuals showing the whole range of appearance in consecutive generations. Since transposition events are neither predictable nor controllable the coloration pattern can therefore not be subject to breeding.

The pictures in the document show samples of transposon-induced coloration patterns.

Picture 1: Euphorbia pulcherrima 'Fispoin 6876' showing numerous small red spots and some big red sectors of variable size on pink petals (picture taken by the Danish testing authority)

Pictures 2-4 Petunia ‘701’: from a distance, flowers appear to be white; however, a closer look reveals that all plants (but not necessarily all flowers) show irregular pink stripes and spots on some of the white petals (pictures taken by the German testing authorities)

Pictures 5 and 6: Flowers of the Pelargonium varieties ‘pelfi Avenida MOSAIC PURPLE’ and ‘pelfi Avenida MOSAIC RED’ (pictures taken from a commercial catalogue)

It may be assumed that applications for plant breeder’s rights of varieties carrying a transposon were already filed and that they were treated in different ways:

(a) The examiner presumed that a transposon is responsible for the phenotype and did not apply uniformity requirements to the coloration pattern.

(b) The examiner did not observe any non-uniformity (or tolerated small variations).

(c) The examiner was not aware of the nature of transposons and rejected the application as non-uniform.

Since further applications for plant breeder’s rights for varieties showing the phenomenon of a transposon can be expected several questions needs to be addressed to develop a harmonized approach of their treatment.

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