Research Paper

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Colchiploidy in Fruit Breeding- A review

Horticulture

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ABSTRACT

Polyploidy is one of the crop improvement tools using in fruit crops. Colchiploidy is defined as the polyploidy induced by application of colchicne. Colchicine treatment is the most effective and the most widely used treatment for chromosome doubling. It has been used with great success in a large number of crop species belonging to both dicot and monocot groups. This method was already exploited in many fruit crops for improvement of different traits. This paper aims to give an insight on the practical application of colchiploidy in different fruit crops.

Introduction

Polyploids are organisms with multiple sets of chromosomes in surplus of the diploid number (Acquaah, 2007; Chen, 2010; Comai, 2005; Ramsey and Schemske, 1998). Polyploidy is spread throughout in plants and some estimates suggest that 30–80% of living plant species is polyploidy. Polyploid plants can arise spontaneously in nature by several mechanisms, including meiotic or mitotic failures, and fusion of unreduced (2n) gametes. The induction of polyploidy is a common technique to overcome the sterility of a hybrid species during plant breeding. After polyploidization, the hybrid becomes fertile and can thus be further propagated to become triticale.

Examples of polyploid crops includes triploid crops: apple, banana, citrus, ginger, watermelon; tetraploid crops: apple, durum or macaroni wheat, cotton, potato, cabbage, leek, tobacco, peanut, kinnow, Pelargonium; hexaploid crops: chrysanthemum, bread wheat, triticale, oat, kiwifruit; octaploid crops: strawberry, dahlia, pansies, sugar cane, oca (Oxalis tuberosa).

Colchicine

Colchicine is a poisonous chemical extracted from seeds (0.2-0.8%) and bulbs (0.1-0.5%) of autumn crocus (Colchicum autumnale). It is readily soluble in alcohol, chloroform or cold water, but is relatively less soluble in hot water. Pure colchicine is $C_{22}H_{25}O_6N$.

Botanical use

Since chromosome segregation is driven by microtubules, colchicines was used for inducing polyploidy in plant cells during cellular division by inhibiting chromosome segregation during meiosis. Half the resulting gametes therefore contain no chromosomes, while the other half contains double the usual number of chromosomes (i.e., diploid instead of haploid as gametes usually are).

Colchicine treatment

Since the colchicine affects only dividing cells, it should be applied when the tissues are actively dividing. At any given time, only a small portion of cells would be in division; therefore, repeated treatments should be given at brief intervals to double the chromosome number in a large number of cells of the shoot apex.

Method of application

The method of colchicine application varies considerably. The different methods of treatment are briefly summarized below. Colchicine is usually applied as an aqueous solution, but it is relatively unstable in aqueous solution. Therefore, it is important to use freshly prepared aqueous solutions of colchicine.

Seed treatment: - Seed treatment may be used for 1 to 10 days with concentrations from 0.001 to 1 % and 0.2% be more common. Seeds are generally soaked in shallow container to facilitate aeration.

Growing shoot apices: - Growing shoot apices are commonly treated with 0.1 to 1% colchicine, which is applied by brush or with a dropper. The treatment is repeated once or twice daily for a few days.

In woody plants: - In woody plants, 1% colchicine is generally used for application on shoot buds. A small quantity of wetting agent added in the colchicine solution for a better wetting and penetration.

Use of colchiploidy in different fruit crops

Colchiploidy was exploited in many fruit crops includes Papaya, Guava, Banana, Grape, Annona, Fig, Pine apple, Pomegranate, Passion fruit etc.

Banana

In musa colchicine-induced autotetraploids, have been proposed as a means of introducing disease resistance into banana breeding programs (Hamill et al., 1992).

Pineapple

In pineapple colchicine induces variants were found , the incidence of altered phenotype in plant culture accompanied by various genetic modifications such as resistance to diseases, herbicides, antibiotics has been reported (Brar and Jain 1998). The mechanism of altered phenotype remains unknown. In pineapple, stable variants were noticed in leaf color, wax secretion, foliage density and spines through cell culture from various sources (Wasaka 1979). The variants showed distinct altered morphology and further ex vitro studies to isolate other variants were difficult because of high mortality rate (Mujib., 2005).

Kiwifruit

Chromosome doubling has been shown to increase significantly fruit size in autotetraploid A. chinensis, spotlighting the considerable potential of this technique to produce new cultivars with fruit of adequate size. Other variants with differently shaped fruit were also produced but the genetic basis of this variation remains to be cleared. Autoploids of other Actinidia species with commercial potential may also show improved fruit characteristics, opening up many new possibilities for commercial development (Jin-Hu Wu et al., 2011).

Ber

Tetraploid plants had importantly rounder leaves and shorter and thicker shoots than diploid plants. In the field, the tetraploid plants had stout branches, rounder and succulent leaves, larger flowers with a delay in florescence time. The potential for practical usage of tetraploid winter jujube in plant breeding will depend on these fruiting characteristics and other agronomic ally important traits; although preliminary results suggest that there is good potential to enhance fruit horticultural characteristics by jujube polyploidization (Gu et al., 2005).

Conclusion

Many of our crop plants are polyploids and a number of them have and are being synthetically produced. Yet, it has been impossible to predict with certainty, which diploid genomes when merged will coexist stably. Elaborated analysis of gene expression changes in many of the newly formed polyploids could help reveal the impact of new variation on polyploid evolution.

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