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POLYPLOIDY IN FLOWER CROPS

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Abstract

Polyploidy breeding is an effective method for doubling the chromosome number of a species. Genetic variations created can be further used in breeding programme.Polyploidy breeding holds immense prospects in developing desirable varieties in flower crops.With the help of polyploidy, changes in morphology and cytology of plant are observed. Tetraploids are more vigorous and larger in size. Tetraploids produce thick and dark green leaves. Mostly seen consequences of induced polyploidy are increase in size and shape of plants; leaves, branches, flower parts, fruits and seeds. Intensification of flower colour and fragrance is observed in Marigold plants following chromosome number doubling. Chemicals like colchicine, oryzalin, triXuralin and amiprophosmethyl (APM) etc. are used in induction of polyploids. Although colchicine remained the most used for induction of polyploidy. Chromosome doubling using various chemicals was observed in flower crops viz., Marigold, Aster, Orchid, Jasmine, Lillium, Chrysanthemum, Alstromeria, Anthurium, Roseand Gerbera.

Introduction:

Polyploidy breeding is an effective method for doubling the chromosome number of a species. Genetic variations created can be further used in breeding programme. Chromosome doubling has been extensively useful in several crops for breeding purpose. These new forms with improved plant architecture provide good material for breeding programme and for further development of cultivars (Mata, 2009). With the help of polyploidy, changes in morphology and cytology of plant are observed. Tetraploids are more vigorous and larger in size. Tetraploids produce thick and dark green leaves (Singh, 1996). Colchicine is extensively used for induction of polyploidy in plants. Concentration and duration of colchicine affects the success percentage in polyploidy induction. The use of colchicine as a means of chromosome doubling has opened a large reservoir of possibilities in plant breeding work.

The fact that numerical changes in chromosome number fundamentally entail a mutation which may be expressed in a number of characters of the plant indicates the significance of the above statement (Derman, 1990)

Polyploidy, being defined as chromosome doubling is best determined by chromosome counts. There are a number of characteristics that generally express polyploidy and are usually associated with it. One major characteristic involves change in size and change in shape of plant species (Chaudhari, 1980).

Mostly seen consequences of induced polyploidy are increase in size and shape of plants; leaves, branches, flower parts, fruits and seeds (Chopra, 2008). Intensification of flower colour and fragrance is observed in Marigold plants following chromosome number doubling (Morrison, 1939).

Induction of polyploidy can be a big achievement to increase the productivity in flower crops and this review can stand as valuable reference for further research work (Kazi, 2012).

Polyploidy in flower crops

3.1 Marigold

African marigold and French marigold are two major species of marigold studied under heading of polyploidy. Botanical name of African marigold is *Tagetuserecta,* its chromosome number is 2n = 24. These plants grow tall up to 90 cm in height. It is available in lemon yellow, bright yellow, golden yellow and orange colour. Botanical name of French marigold is Tagetus*patula.* These plants grow dwarf with plant height of 40 cm. Chromosome Number of this species is 2n = 48. It is available in scarlet, mahogany, orange and combination of these colours. Varieties of African marigold are Cracker jack, Climax, Golden age, Crown of gold, PusaNarangigenda, PusaBasantigenda. Varieties of French marigold are Rusty red, Butter scotch, Valencia. Nugget is triploid cultivar of marigold (Kunthe, 2005).

3.2Aster (*Callistephuschinensis*Nees.)

Colchicine at 0.1, 0.3, 0.5, 1.0 and 1.5 per cent was applied for 2, 3 and 5 days. Polyploids had thicker leaves, plant spread (31.27 cm), internodal length (3.36 cm), and number of leaves per plant (72), flower diameter (4.20 cm). Best treatment for polyploidy induction was 1-1.5% colchicine for 5 days (Hanzelka, 2001).

The other experiment to check effect of colchicine on morphology of china aster Cv. Phule Ganesh Purple was laid out in Completely Randomized Design with ten treatments *viz.,* T1 (0.1% colchicine for 6 hours), T2 (0.1% colchicine for 9 hours), T3 (0.1% colchicine for 12 hours), T4 (0.2% colchicine for 6 hours), T5 (0.2% colchicine for 9 hours), T6 (0.2%

colchicine for 12 hours), T7 (0.3% colchicine for 6 hours), T8 (0.3% colchicine for 9 hours), T9 (0.3% colchicine for 12 hours), T10 (control) replicated thrice with 5 plants per treatment. Highest duration of flowering (32.00 days) was observed in Treatment T2, T5 and T10.There was no significant difference in control and treated plants for characters like hairiness of stem, days to first flower bud initiation, days required for flowering, hairiness of flower stalk and crop duration. Gigantism was observed in this experiment with 0.2% and 0.3% colchicine for 12 hours (Kazi, 2013).

3.3 Polyploidy in *Phalaenopsis*orchids

Young protocorms of orchid were dipped in Colchicine (50 mg/L) for 8 hours. 50 % protocorms developed into tetraploids. Tetraploids reported increase in cell number, cell volume, flower size, leaf area; plants spread and inter nodal length (Griesbach, 1981).

3.4 Polyploidy in Jasmine

Jasminumauriculatum and J. grandiflorum seeds were treated with 0.5 % colchicine for 12 and 14 hours. One tetraploid was obtained from Parimullai seeds (0.5% colchicine for 12 hours) (Alikhan, 1969). Artificial induction of polyploids is possible in *J.auriculatum*but not in *J.grandiflorum.* Seed or seedling treatment with 1% colchicine recorded 11.4- 23.1 per cent polyploidy in *J. auriculatum*(Veluswamy, 1981).

3.**5 Polyploidy in Lillium**

Apical meristems of *Lilliumlongiflorum*were soaked in colchicine solution (0.1, 0.2, and 0.3 per cent). Seed and seedling treatments were ineffective. Most effective concentration for induction of polyploidy was 0.2% (Emsweller, 1949).

3.6 Chrysanthemum

Autotetraploids plants of *Chrysanthemum cinerariifolium*were producedby using colchicine. The chromosome number of the autotetraploid plantlet was 2n= 4x = 36. Tetraploids were reported with increased yield by 15-18 per cent.
(Liu, 2007)

Colchicine (0.0625 per cent) has been successfully used for development of flower colour mutation in Chrysanthemum Cv. SharadBahar. The original colour of SharadBahar was purple whereas mutant colour was Terracotta Red. The mutant has been released in the name of 'ColchiBahar' (Datta, 1987).

3.7 Alstromeria

In an attempt to restore the hybrid fertility in ***Alstroemeriaaurea***X ***A. caryophyllaea***, an efficient *in vitro* procedure has been developed and applied effectively in the chromosome doubling of the diploid hybrid. Forty-one percent of the treated plants were proven to be truly

tetraploid by chromosome counts and stomatal measurements after applying 0.2 % to 0.6% colchicine for 6 to 24 hours. Over 87.5% of these colchicine-induced tetraploids were stable and retained their tetraploidy after one year of growth. Cytological studies on the pollen mother cells (PMCs) of the sterile diploid hybrids revealed abnormal meiotic behaviours. In addition, aneuploid chromosome numbers, ranging from 2n = 1 to 2n = 18, were observed in over 45% of the PMCs examined (Lu, 1997).

3.8 Anthurium

Tetraploids plants of Anthuriumandraeanum‘‘Arizona’’were successfully induced after treating diploid tissue masses with colchicine. Masses originating from diploid aerial roots were treated with colchicine at three different concentrations (i.e., 0.1, 0.2, 0.3%) for about 3, 5 and 7 h, and then were transferred into Murashige and Skoog medium containing 3 mg/l BAP + 0.2 mg/l 2,4-D.After 60 days, the survival rate and numbers of regenerative shoots were scored. The high concentration and longer duration sharply reduced survival rate. In contrast, the regeneration of plantlets was not noticeably affected by colchicine. Tetraploid plants were obtained in all treatments, but the percentage of induced tetraploids ranged from0.2 to 7.6%. The best induction was obtained with a 5-h, treatment with 0.3% colchicine. The stomatal size of tetraploid plants was larger than in diploid plants; however, the stomatal density was lower than in diploid plants. Tetraploid plants possessed stronger petioles, thicker and deeper green leaves, and thicker and longer lived spathes in comparison with diploid plants. Abnormal spathes, such as double spathes or those lacking pedicels, were observed in tetraploid plants. Tetraploid plantlets could be regenerated via aerial roots; this technique could be applied to tetraploid plant propagation (Chen, 2011).

3.9 Rose

Dinitroanilines represent a class of compounds that are widely used in herbicide formulations as they depolymerise plant microtubles, causing chromosome doubling. The potential of microtubule depolymerising herbicides triXuralin, oryzalin, and amiprophosmethyl (APM) for in vitro chromosome doubling of Rosa was studied. Five concentrations (0, 3, 6, 12 and 24 M) and three exposure periods (12, 24 and 48 h) for each of the compounds were compared. Oryzalin, triXuralin and APM were not significantlydivergent in their ability to induce chromosome doubling of R. hybrida Cv. Iceberg. At concentration of 6 M and exposure period of 24 h, chromosome doubling of R. hybrida Cv. Iceberg was not significantly divergent with each of the polyplodising agents. At higher concentration (24 M) and longer exposure period (48 h), 66.7% and 62.5% chromosome doubling was achieved with APM and triXuralin, respectively. However, the

application of 6 M oryzalin to R. persica (2n = 2x), R. hybrida Cv. Iceberg (2n = 3x) and R. hybrida cv Akito (2n = 4x), resulted in 60.0%, 6.3% and 0% chromosome doubling, respectively, which suggest that chromosome doubling is genotype dependent and plants with lower ploidy level have a higher propensity for chromosome doubling. Flow cytometry results at 18 and 24 weeks after herbicide treatment, indicated that the best time to test the treated plants was after 24 weeks (Khosravi, 2008).

Chromosome doubling was induced in vitro in a diploid hybrid of Rosa rugosaThunb using oryzalin as the spindle inhibitor. Nodal sections, 2 mm long, were exposed to 2.5 or 5 lMoryzalin and 10 mm nodal sections were exposed to 5 lMoryzalin for 0 (controls), 6, 12, 24 and 48 h. The ploidy of the emergent shoots was determined by flow cytometry. The frequency of tetraploid and mixoploid leaves that developed from 2 mm nodal sections exposed to 5 lMoryzalin peaked at 12 h exposure, when 35% of the leaves were tetraploid, but fell after longer exposures. Fewer tetraploid and mixoploid leaves were found when 2 mm nodes were exposed to 2.5 lMoryzalin for 6 and 12 h, indicating that it took longer for a spindle inhibiting concentration of oryzalin to build up in the meristem. However, the frequencies of tetraploid and mixoploid leaves continued to rise after 12 h and were highest at 48 h, when 44% were tetraploid. In treatments with 5 lMoryzalin, the frequencies of tetraploid and mixoploid leaves were lower, at equivalent exposure times, in 10 mm nodes than 2 mm nodes. This suggests that oryzalin diffused to the meristem mainly via the cut surfaces and that access via the epidermis and cuticle was impeded (Allum, 2007).

Gerbera

To induce variation through chromosome doubling in *Gerbera jamesonii* Bolus cv. Sciella, two-week-old in vitro grown shoots were treated with various concentrations of colchicine (0.01, 0.05, 0.10, 0.50 or 1% w/v) for 2, 4 or 8 h. Treated shoots were then cultured on Murashige and Skoog (MS) medium supplemented with 8.8 μM 6-benzyladenine (BA) and 155 μM adenine sulphate (ADS), and subsequently transferred to fresh MS medium containing 2.85 μM indole-3 acetic acid (IAA) for rooting. When shoots were treated with 0.1% colchicine for 8 h, 64% of recovered plantlets were tetraploid.Tetraploid plantlets displayed slower proliferation along with higher vigor and thickened broad leaves. Moreover, tetraploid plants developed larger flowers, longer stalks, and have improved vase-life, all contributing to higher ornamental value of gerbera(Gantait, 2011).

Conclusion:

Polyploidy breeding holds immense prospects in developing desirable varieties in flower crops. Scientist should go ahead with polyploidy breeding and mutation breeding

when a desirable trait is not available in existing genotypes. Chemicals like colchicine, oryzalin, triXuralin and amiprophosmethyl (APM) etc. are used in induction of polyploids. Colchicine was found to be used in most of the experiments. Colchicine at various concentrations and durations has induced polyploidy in various crops. Polyploidy was found to be successfully induced in in-vitro and other uncontrolled experiments. Chromosome doubling using various chemicals was observed in flower crops *viz.,* Marigold, Aster, Orchid, Jasmine, Lillium, Chrysanthemum, Alstromeria, Anthurium, Rose and Gerbera.

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