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First African Violets (*Saintpaulia ionantha*, H. Wendl.) With a Changing Colour Pattern Induced by Mutation

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Abstract: The aim of present study was to develop stable, novel mutants of African violets induced by colchicine treatment coupled with gamma-irradiation. First, an African violets variety was applied colchicine treatment to induce mutation for developing new varieties. As the colchicine concentration was increased, inflorescence height reduced whereas flower diameter increased. At 0.06% colchicine and 22.5 h dipping time, the variety produced white flowers with purple margins (5% of 45 plants). About 7 days after flowering, the whole petals of the flowers gradually turned into purple colour. Thus, a dynamic flower colour pattern from white petals with purple margin to entire purple petals was produced. This was observed for six generations. Subsequent gamma radiation at 15 Gy improved plant architecture of the mutant.

Key words: African violets, colchicines, gamma radiation, induced mutation

INTRODUCTION

Global flower industry thrives on novelty. Traits such as flower colour, form, size and scent are primary novelty markers as they are key determinants in consumer choice of ornamental plants (Seneviratne and Wijesundara, 2004; Datta and da Silva, 2006). Flower colour is a major factor in the desirability of ornamental plants and production of new varieties with new flower colors has significant economic impact. Genetic engineering is still a relatively expensive technique, providing a valuable means of expanding the floriculture gene pool for promoting the generation of new commercial varieties. Out of cheap techniques, mutation breeding is an established method for floral improvement and has played a major role in the development of new mutants (Seneviratne and Wijesundara, 2004; Datta *et al*., 2005), in a relatively short time period. Use of colchicine, a chemical mutagen has been shown to be a simple and rapid method for mutation breeding. Irradiation techniques for breeding create variability in plant architecture and colour and shape of flowers (Datta *et al*., 2005; Jambhulkar, 2002).

African violets (Family Gesneriaceae) are rosette shaped and vegetatively propagated from whole leaf with petiole bases. It is a herbaceous plant grown as potted ornamentals (Elzer, 2000). In general, different flower colors and shapes of stable African violets come from classical breeding of the original plant. There is a great potential of developing new ornamentals by treating plant parts with physical and chemical mutagens (Datta and da Silva, 2006). Thus, the present study aimed at developing stable, novel mutants of African violets induced by colchicines treatment coupled with gamma-irradiation.

MATERIALS AND METHODS

The experiment was conducted in one of the greenhouses at the Royal Botanic Gardens, Peradeniya, Sri Lanka from January 2002 to March 2005. A variety of African violets; leaves with green upper surface, uniform purple colour flowers with frilled edges and five petals arranged in a single row was selected. Leaves were cut leaving 2.5 cm of the petiole and petiole bases were wrapped with

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cotton wool. Then they were dipped in different concentrations of colchicine solutions (0, 0.04, 0.06 and 0.09%). Treated leaves were removed at different time periods (21.5, 22.5, 23.5 and 48 h) from the solutions. Petiole bases were washed thoroughly with distilled water and placed in a mixture of river sand and leaf litter (1:1). Two months after planting, new plantlets produced from the petiole bases (number of m_1v_1 plantlets, 1289) were replanted in a 70% shaded greenhouse. Morphological characters were observed for three generations over a period of 18 months. A plant with attractive floral variations, generated from the colchicine treatment was selected for further improvements. It was tested for the Lethal Dose (LD_{50}) of gamma irradiation, which was found to be 11 Gy (original data not shown). Its leaves were then irradiated in a ^{60}Co-gamma cell at 0, 5, 10, 15 Gy. Morphological characters were recorded for three more generations over a period of 18 months. Thus, the observations were made for six generations during the entire study. The numbers of plants of m_1v_1, m_1v_2, m_1v_3 were 375, 370 and 359, respectively. The treatments were arranged in a two factor-factorial Completely Randomized Design (CRD) with 15 replicates (leaves) for the experiment with colchicine concentrations and dipping time periods. For the irradiation experiment, treatments were arranged in a CRD with 15 replicates. Number of plants produced per leaf, petiole length, leaf fresh weight and surface area, flower diameter and number per inflorescence and inflorescence height and number per plant were recorded. Data were statistically analyzed using GLM procedure and means were separated with Tukey's HSD test (SAS, 1987). Only mutants having conspicuous and significant changes are presented here.

RESULTS AND DISCUSSION

Colchicine treated plants exhibited different responses, depending on the colchicine concentration and time of exposure (Table 1). Interaction of these two factors was not significant ($p>0.05$). The colchicines treatments over 21.5 h reduced the inflorescence height. Number of flowers increased at 0.09% colchicines and at 23.5 h dipping time. As the colchicine concentration was increased, flower diameter also increased. Number of petals was high at 0.04% colchicines and at 23.5 h dipping time. The reduced height of the inflorescence could be due to reduction of internal auxin, which leads to reduction of the length of plant parts (Aisyah and Marwoto, 2001; Al-oudat, 1990; Jambhulkar, 2002). Increased flower diameter could be attributed to polyploidization with colchicines application (Takamura and Miyajima, 1996; Walden, 2004). A polyploidy version of African violets has also been reported to have larger flowers (Gesneriads, 2003). In the first generation, at 0.06% colchicine and 22.5 h dipping time, the variety produced white flowers with purple margins (5% of 45 plants)

Table 1: Inflorescence and flower characteristics of African violets (*Saintpaulia ionantha*) when treated with different concentrations of colchicines for different time periods

Treatments	Inflorescence height (cm)	No. of flowers per inflorescence	Flower diameter (cm)	No. of petals per flower
Colchicine concentration (%)				
0	5.6a	6b	3.5c	5b
0.04	5.2b	5c	3.4c	6a
0.06	5.2b	5c	3.8b	5b
0.09	5.3b	8a	3.9a	5b
MSD (0.05)	0.3	0.5	0.1	0.3
Dipping time (h)				
21.5	5.9a	6b	3.6b	5b
22.5	4.9c	6b	3.7a	5b
23.5	5.4b	7a	3.7a	6a
48	5.0c	6b	3.6b	5b
MSD (0.05)	0.3	0.6	0.1	0.3
CV (%)	10.3	14.4	5.9	10.0

Values in the same column followed by the same letter are not significantly different at 5% probability level, according to Tukey's HSD test. MSD: Minimum Significant Difference. CV: Coefficient of Variation

Fig. 1: (a) White flowers with purple margins, produced at 0.06% colchicine and 22.5 h dipping time of African violets (*Saintpaulia ionantha*); from (a) to (c), the flowers gradually turning into purple colour

Fig. 2: The plant with improved architecture, obtained after treating with gamma irradiation at 15 Gy

(Fig. 1a). About 7 days after flowering, the whole petals of the flowers gradually turned into purple colour (Fig. 1b and c). This dynamic flower colour pattern was observed in 3 generations after the colchicines treatment. This mutant was selected for further improvements. The control plants did not show any changes. Accumulation of purple, orange and red anthocyanin pigments in the cell vacuole generates colour patterns, depending on the polyploidy level (Schepper *et al*., 2001). Floral colour change from white to purple is caused by the expression of genes along the anthocyanin biosynthetic pathway to known environmental triggers such as pollination and light during ontogeny (Farzad *et al*., 2003).

Once the selected mutant was gamma-irradiated at 0, 5, 10 and 15 Gy separately, numbers of plants produced per leaf were 9, 9, 4 and 3, respectively. At 20 Gy, all samples of the treated plant were dead. Other treatments did not show special changes in the flower colour due to gamma irradiation, except the dynamic colour pattern induced by colchicine. Thus, the dynamic floral colour pattern was observed for six generations during the study. At 15 Gy, plant architecture was improved with proportional sizes of floral and foliar characters (Fig. 2). Petiole length, leaf surface area, flower diameter and inflorescence height were reduced compared to the colchicine treated control

Table 2: Floral and foliar characteristics of newly developed African violets (*Saintpaulia ionantha*) by 0.06% colchicine treated for 22.5 h, followed by different dosages of gamma radiation

Irradiation treatment (Gy)	Petiole length (cm)	Plant fresh weight (g)	Leaf surface area (cm^2)	Flower diameter (cm)	Flower No. per inflorescence	Inflorescence height (cm)	Inflorescence No. per plant
Control	8.0b	3.25a	34.8a	3.8ab	6b	6.4b	5b
5	9.9a	2.76a	23.0b	4.4a	6b	8.1a	4b
10	9.4ab	1.33b	24.0b	3.2b	8a	6.3b	6ab
15	3.9c	1.34b	14.7c	2.1c	6b	3.7c	7a
MSD (0.05)	1.6	0.63	4.93	0.70	2	1.5	2
CV (%)	11.2	15.4	10.9	11.70	17.3	12.9	18.7

Values in the same column followed by the same letter are not significantly different at 5% probability level, according to Tukey's HSD test. MSD: Minimum Significant Difference. CV: Coefficient of Variation

(Table 2). Generally, gamma radiation produces stable mutants with improved plant architecture e.g., *Didymocarpus humboldtianus* (Seneviratne *et al*., 2002), *Chrysanthemum* (Datta *et al*., 2005).

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