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UV-C irradiation induced alterations in shoot proliferation and in vitro flowering in plantlets developed from encapsulated and non-encapsulated microshoots of Persian violet

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ABSTRACT

Ultraviolet-C (UV-C) radiation is well-known for its germicidal effect but its mutagenic potential in aiding new plant variety development has not been explored extensively. Persian violet (*Exacum affine* Balf.f. ex Regel) is a well-known decorative plant in Thailand. In this research, the effects of 0–4 h of UV-C irradiation on shoot proliferation and in vitro flowering of Persian violet plantlets derived from non-encapsulated and encapsulated microshoots were investigated. The number of multiple shoots was found to decrease as UV-C exposure time increased. Shoot-tip decapitation increased floral number in plantlets derived from both non-capsulated and encapsulated microshoots. The plantlets developed from non-encapsulated microshoots exposed to 4 h of UV-C irradiation exhibited tiny flower buds within 3 days from shoot-tip decapitation of the plantlets. However, the time for flower initiation was 35 days in control plantlets developed from non-encapsulated microshoots without irradiation. Another interesting novel finding is that 4 h of UV-C irradiation of the non-encapsulated microshoots resulted in the highest number of flowers (6.80 flowers) in the plantlets after 10 weeks compared to all the other treatments including the control that had only 3.20 flowers. This finding of Persian violet flowers with 7 petals has never been reported before. However, this UV-C treatment of the non-encapsulated microshoots diminished viability and in vitro germinability of pollen more than those in the treatment of encapsulated microshoots. Thus, UV-C irradiation of Persian violet microshoots affected multiple shoot proliferation and in vitro flowering. Encapsulation of the microshoots could counteract many of these effects of UV-C irradiation.

1. Introduction

Persian violet (*Exacum affine* Balf.f. ex Regel) is an ornamental plant that produces very attractive violet flowers. In Thailand, the micro-propagated plantlets with in vitro flowers kept in jars have been on sale as gift items for over 7 years. The funds raised are used to support a Plant Genetic Conservation Project initiated by Her Royal Highness Princess Maha Chakri Sirindhorn.

Artificial or synthetic seed has been produced in many kinds of ornamental plants (Ozden-Tokatli et al., 2008; Maqsood et al., 2015), but there is no similar research on Persian violet. Principally, somatic embryos have been encapsulated to produce artificial seeds. However, at present, other plant propagules including axillary bud, bulblet, callus, corm, microtuber, node, protocorm-like body, rhizome and shoot tip could also be encapsulated to produce structures functionally akin to "artificial seeds" (Chandrasekhara Reddy et al., 2012; Remya et al., 2013). High-energy irradiation has been shown to be an effective mutagenic agent for mutagenesis in cells. For example, gamma ray, X-ray, ultraviolet-C (UV-C) and ion beam could cause genetic variation and could be used purposely to help in selecting some desirable traits (Magori et al., 2010; Iuliana and Cerasela, 2014). These useful traits could be achieved in a shorter time when compared to traditional breeding (Jala and Bodhipadma, 2011). For in vitro culture, UV-C had been beneficially used in many ways such as to increase drought tolerance in alfalfa callus (Ehsanpour and Razavizadeh, 2005), to initiate somaclonal variation in potato callus (Ehsanpour et al., 2007), to enhance the production of secondary metabolites in grape callus (Cetin, 2014) and to obtain the highest antioxidant activities of horseradish tree shoot culture (Petchang, 2014). In preparation for the application of this mutagenesis approach to generate new varieties of Persian

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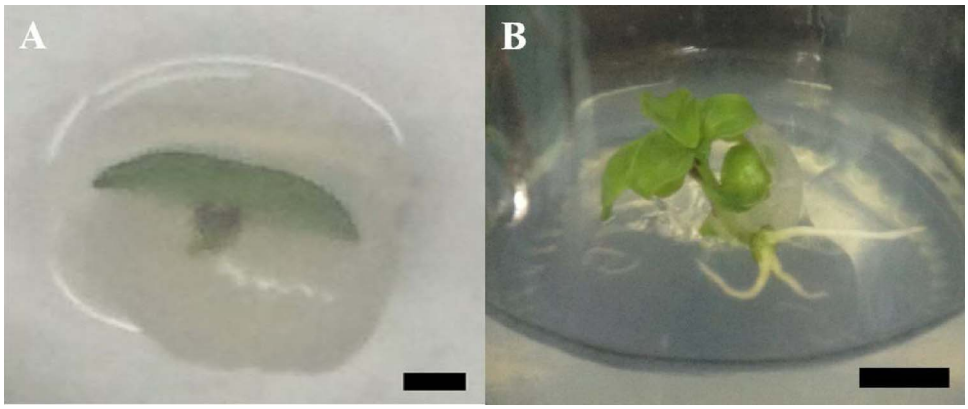

Fig. 1. A) an encapsulated Persian violet microshoot (scale bar = 1 mm); B) a plantlet derived from an encapsulated microshoot that was irradiated with UV-C for 4 h (scale bar = 3 mm).

Table 1
Number of multiple shoots and height of plantlets derived from encapsulated and non-encapsulated microshoots of Persian violet that were irradiated with UV-C for 0, 1, 2 and 4 h.

UV-C exposure (h)	Multiple shoot number		Plantlet height (cm)	
	Encapsulated microshoot	Non-encapsulated microshoot	Encapsulated microshoot	Non-encapsulated microshoot
0	7.18 ± 1.82a	7.15 ± 1.51a	1.78 ± 0.20abc	1.77 ± 0.17abc
1	4.83 ± 2.24b	3.03 ± 1.69c	1.71 ± 0.22a	1.80 ± 0.15abc
2	3.70 ± 2.54c	2.88 ± 2.68 cd	1.73 ± 0.19ab	1.84 ± 0.19c
4	2.05 ± 1.85de	1.25 ± 1.17e	1.81 ± 0.18bc	1.96 ± 0.14d

Values are means ± SD (n = 40). In the columns, means from each character followed by the same letters were not significant different at $p > 0.05$.

Table 2
Changes in the number of flowers formed by decapitated Persian violet plantlets derived from encapsulated and non-encapsulated microshoots that were irradiated with UV-C for 0, 1, 2 and 4 h.

Sources	UV-C exposure Time (h)	Days				
		3	7	21	35	70
Encapsulated microshoot	0	–	–	–	1.20 ± 0.76	3.20 ± 0.81a
	1	–	–	–	1.30 ± 0.79	3.27 ± 0.78a
	2	–	–	–	1.33 ± 0.92	3.47 ± 0.82a
	4	–	–	–	2.17 ± 0.75	4.33 ± 1.30b
Non-encapsulated microshoot	0	–	–	–	1.23 ± 0.94	3.17 ± 0.83a
	1	–	–	0.40 ± 0.56	2.34 ± 1.80	4.57 ± 1.19b
	2	–	0.83 ± 0.65	3.23 ± 0.86	5.77 ± 0.77	6.20 ± 0.81c
	4	0.90 ± 0.76	1.17 ± 0.75	3.43 ± 0.73	6.00 ± 1.05	6.80 ± 0.71d

Values are means ± SD (n = 30). In the final column, means followed by the same letters were not significant different at $p > 0.05$.

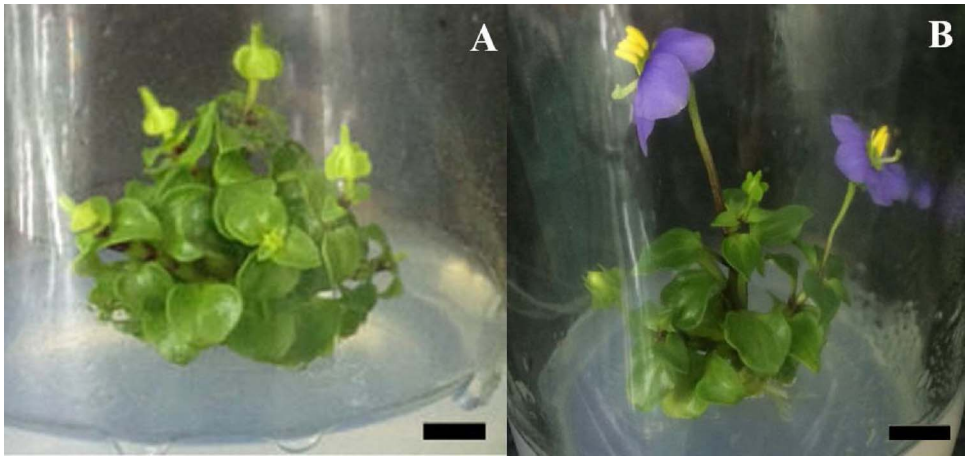

Fig. 2. In vitro flowering of Persian violet plantlets derived from a non-encapsulated microshoot irradiated with UV-C for 4 h: A) floral buds forming at 35 days after shoot-tip decapitation; B) In vitro flower blooming at 70 days after shoot-tip decapitation (scale bar = 5 mm).