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Introduction

In Indonesia, demand for orchid cut flower is increasing due to the growth of population and their income. According to Soeroyo (1992), the world consumption value for orchid cut flowers was US $ 1.935 billion, if Indonesia could contribute 2.5 %, it needs the availability of 129.43 million flower stalk for export quality. Whilst for those of 5 % for export quality, it needs 32,357,500 plants (supposed each plant produced 8 flower stalk). Orchid industry needs the support from science and technology based on the use of optimal natural resources. Development of technology in culturing orchids is an opportunity to create desirable characters of the flowers such as bright colour, beautiful shape and longer vase life.

Dendrobium is the most popular orchids in Indonesia (Figure 1) followed by *Catleya*, *Vanda* and *Phalaenopsis.* Recently *Dendrobium* is mostly grown in Java and Bali islands. Both sexual and asexual propagation are common for multiplication of *Dendrobium*. Orchid consumers in Indonesia tend to prefer the new type. Micropropagation in orchid is very common since the demand for potted plants and cut flowers increased.

Figure 1. *Dendrobium Jayakarta* for cut flowers is widely grown in Indonesia

Breeding of the genus *Dendrobium* has been gaining sufficient appreciation and development in Southeast Asia as the most popular source of tropical cut flowers. A large number of different cultivars of distinct colours and shapes of this species have been created and grown exclusively in farms in this area. Commercial plants produce cut flowers and cooled inflorescences are exported throughout Europe and Japan.

The fact that orchids are, in terms of their development, a very young family of plants and their genetic instability. Therefore they tend to form mutation by means deviations. Usually the frequency of mutation was very low and lack of desirable traits. In the wild, these deviations are suppressed and gradually disappear. Orchid growers are able to stabilize them by further appropriate hybridisation and maintain the desirable traits such as colour and size of the flower (Jezek, 2003).

Sutater (1997) reported that exported orchid flower from Indonesia decreased from US $ 2,1 million (1993) to US $ 1.41 million (1995), whereas imported orchid flower increased from US $ 28,831 (1994) to US $ 312,767 (1995). Based on the data mentioned above, it seems that the demand was higher than the supply. Therefore, the opportunity for growing orchid in Indonesia is very promising.

Demand of orchid especially *Dendrobium* is increasing because of its unique, beauty, frequent flowering, longevity and easier to be cultivated. These characters are leading compared with other orchids. *Dendrobium* could be used as indoor and outdoor potted plants, cut flowers or corsages. However, *Dendrobium* is very susceptible to pets and diseases. Flower damage caused by Thrips is one of the obstacles faced by orchid growers.

An effort to solve this problem had been initiated in FNCA Mutation Breeding Project Workshop held in Yogyakarta, Indonesia from 30 August – 3 September 2004 (Hutabarat et al, 2004 and Piluek, 2004). The Orchid Group agreed to use *Dendrobium* Sonia 'BOM 17 Red', a leading variety from Thailand as the main material, *Den*. Sonia 'BOM 17 Red' is a popular hybrid, fast growing, floriferous, bright colour and has long vase life.

In FNCA Mutation Breeding Project Workshop held in Bangkok from 5 - 9, September 2005, the Orchid Group decided to irradiate different growing stages of young seedlings or shoots, plantlets and PLBs of local variety from each country, such as *Dendrobium Jayakarta* from

Indonesia should be irradiated in order to obtain the optimum dose for *Dendrobium* sp. from different member countries.

The most severe damage caused by irradiation was showed by PLBs compared with plantlets and shoots. Three months after irradiation, survival rates from the dose 1,280 Gy up to the dose 40 Gy of irradiated PLBs, plantlets and shoots were 0 - 50 %, 0 - 78 % and 60 - 95 % respectively. Survival rate of untreated PLBs, plantlets and shoots remained 100 % after three months irradiation. Explants of *Den*. Sonia 'BOM 17 Red' cultured in VW enriched with BAP was not able to form roots, whilst those enriched with coconut water and active charcoal could form 2.2 - 4.7 roots (Sutarto et al 2006).

Materials and methods

Irradiated PLBs of *Den*. *Jayakarta* cultured in VW medium were regenerated to form plantlets and each plantlet was planted in a single jar. While irradiated plantlets formerly grown in community pots had been transferred to single pots. Irradiated potted plants started blooming were grown under lath house. Potted plants were grown in the lath house and fertilized every week by applying 0.2 % liquid fertilizer.

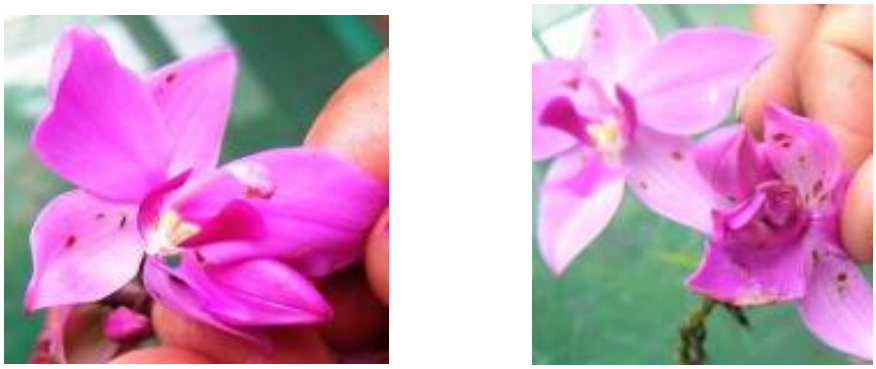
Irradiated explants of *Den.* Sonia 'BOM 17 Red' grown at CAIRT were cultured by applying modified VW medium enriched with coconut water (15 %), charcoal (0.1 %) and BAP (1 ppm). Whereas those grown at IOCRI were cultured in VW medium. The last accession of *Den.* Sonia 'BOM 17 Red' was Ac 10 + 50 +50 (Acute irradiation 10 Gy + chronic irradiation 50 + 50 Gy) and Ac 20 + 50 +50 (acute irradiation 20 Gy + chronic irradiation 50 + 50 Gy).

The use of different modified Vacin and Went (VW) media such as application of coconut water, active charcoal and Benzyl Amino Purine (BAP) was also carried out to improve the growth and propagation of irradiated plantlet of *Den.* Sonia 'BOM 17 Red' and *Den. Jayakarta*.

Application coconut water (Widyastoeti and Syafril, 1993) and active charcoal (Widyastoety and Bahar, 1995) could stimulate the growth of *Dendrobium* plantlets. Kano and Fukuoka (1996) reported that coconut water contained complex organic materials such as plant growth regulators that promoted plant growth.

Mass rearing Thrips was done at Entomology Laboratory of IOCRI by placing mature Thrips into the flask with pumpkin inside (Figure 2), and let the Thrips lay eggs and multiply its population, 25 - 30 days later mature Thrips were put on the flower of *Spathoglottis* sp (Figure 3) in order to see how the Thrips attack the flower since irradiated *Dendrobium* had not bloomed yet. When the plants started blooming, insect tolerance trial will be conducted *in vivo* in the green house.

Figure 2. Thrips were put in the flask with the pumpkin inside



(a) **(b)**

Figure 3. a. Mature Thrips were placed on the flower of Spathoglottis sp., b.Thrips attacked the flower of Spathoglottis sp.

The parameter observed were number of shoots per plant, number of leaves per shoots, plant height, number of plantlet or plant per pot and number of potted plants. The data were taken 12 months after irradiation.

Results

After 12 months irradiation, PLBs of *Dendrobium Jayakarta* grew to form plantlets. The highest number of plantlets and number of shoots per plant were found from untreated PLBs followed by irradiated PLBs at the doses of 40 and 80 Gy. In contrast the highest number of leaves per shoot was obtained from irradiated PLBs at dose 80 Gy followed by irradiated

PLBs at the dose 40 Gy and untreated PLBs, while the highest plant was showed by untreated PLBs followed by irradiated PLBs at the doses 80 and 40 Gy (Table 1 and Figure 4).

Irradiated plantlets of *Dendrobium Jayakarta* grown in the lath house showed better tolerance to gamma rays than irradiated PLBs. Plantlets were able to grow well up to the dose 160 Gy (Table 2 and Figure 5), whereas irradiated young plants could only grow at the dose 40 Gy (Table 3 and Figure 6).

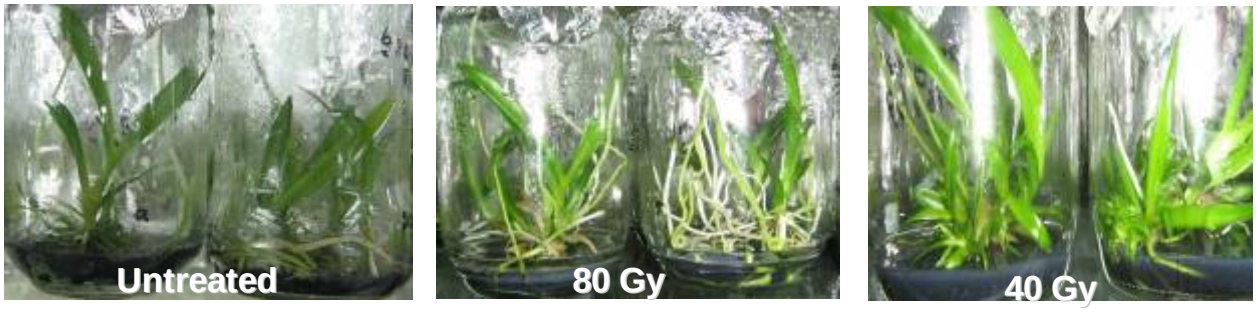


Figure 4. Untreated (0 Gy) and irradiated PLBs of *Den. Jayakarta* at the doses 40 and 80 Gy (12 months after culturing)

The most plantlets and clusters of PLBs formed were obtained from irradiated plantlets of *Den*. Sonia 'BOM 17 Red' at the dose 70 Gy. PLBs was not found from those at the dose 30 Gy and untreated plantlets (Table 4 and Figure 7). Abnormalities were found in irradiated PLBs of *Den.* Sonia 'BOM 17 Red' (Figure 8).

Acute irradiation 10 Gy followed by chronic radiation 50 + 50 Gy indicated better number of plants and leaflets, whereas acute irradiation 20 Gy followed by chronic radiation 50 + 50 Gy indicated higher number of shoots per plants and plant height (Table 5 and Figure 9).

Irradiated plantlets of *Den.* Sonia 'BOM 17 Red' at the dose of 90 Gy grown in the lath house of IOCRI for acclimatization showed better performance compared to those at the dose 80 Gy (Table 6)

Figure 5. Untreated (0 Gy) and irradiated plantlets of *Den. Jayakarta*

Compared to those after 3 and 6 months irradiation, all the parameter observed such as survival rate, number of shoots per plant, number of leaves per shoot and plant height on irradiated PLBs of *Den. Jayakarta* were gradually decreased as the doses of gamma rays increased. After 3 months irradiated plantlets were able to grow up to the dose 640 Gy although the survival rate was only 39 %. Irradiated young plants grew well until 3 and 6 months after irradiation up to the dose of 1,240 Gy (Sutarto et al, 2006).

According to Broertjes and Van Harten (1988) the optimum dose for orchids varies from approximately 10 to 40 Gy. However, in view of the great number of very different genera and species, and of the material to be irradiated, the optimum dose should be determined in every case before starting a mutation breeding program.

Figure 6. Untreated (0 Gy) and irradiated shoot of *Den. Jayakarta* (12 months after planting)

Table 1. Growth of irradiated PLBs of *Den. Jayakarta* (12 months after irradiation) cultured in jars at growth room of CAIRT

Dose of Gamma rays (Gy)	Number of plantlets	Number of shoots/plantlet	Number of leaves/shoot	Plantlet height (cm)
0	63	2.97	4.67	5.95
40	38	2.69	6.05	4.62
80	3	2.67	6.97	4.75

Table 2. Irradiated plantlets of *Den. Jayakarta* grown in the lath house of CAIRT (12 months after irradiation)

Dose of Gamma rays (Gy)	Number of plants	Number of shoots/plant	Number of leaves/shoot	Length of leaf (cm)	Width of leaf (cm)	Plant height (cm)
0	26	3.54	2.46	5.39	1.50	14.30
40	16	2.69	2.26	4.23	1.23	8.89
80	20	3.00	2.50	6.38	1.83	13.92
160	6	3.17	2.50	5.20	1.40	13.90

Table 3. Irradiated shoots (young plants) of *Den. Jayakarta* grown in the lath house of CAIRT (12 months after irradiation)

Dose of Gamma rays (Gy)	Number of plants	Number of shoots/plant	Number of leaves/shoot	Length of leaf (cm)	Width of leaf (cm)	Plant height (cm)
0	12	4.33	4.11	10.38	2.99	51.96
40	9	5.33	3.32	6.17	2.81	35.50

Table 4. Growth of irradiated plantlets of *Den.* Sonia 'BOM 17 Red' cultured in modified VW medium with coconut water and active charcoal (CAIRT)

Parameters	Dose of Gamma rays (Gy)			
	0	30	70	80
Number of plantlets	15	12	77	5
Number of shoots/plantlet	2.00	1.58	2.43	1.80
Plantlet height (cm)	2.05	5.00	2.64	1.96
Number of leaflets (avrg)	2.75	3.11	3.86	2.61
Number of PLBs (clusters)	0	0	13	2

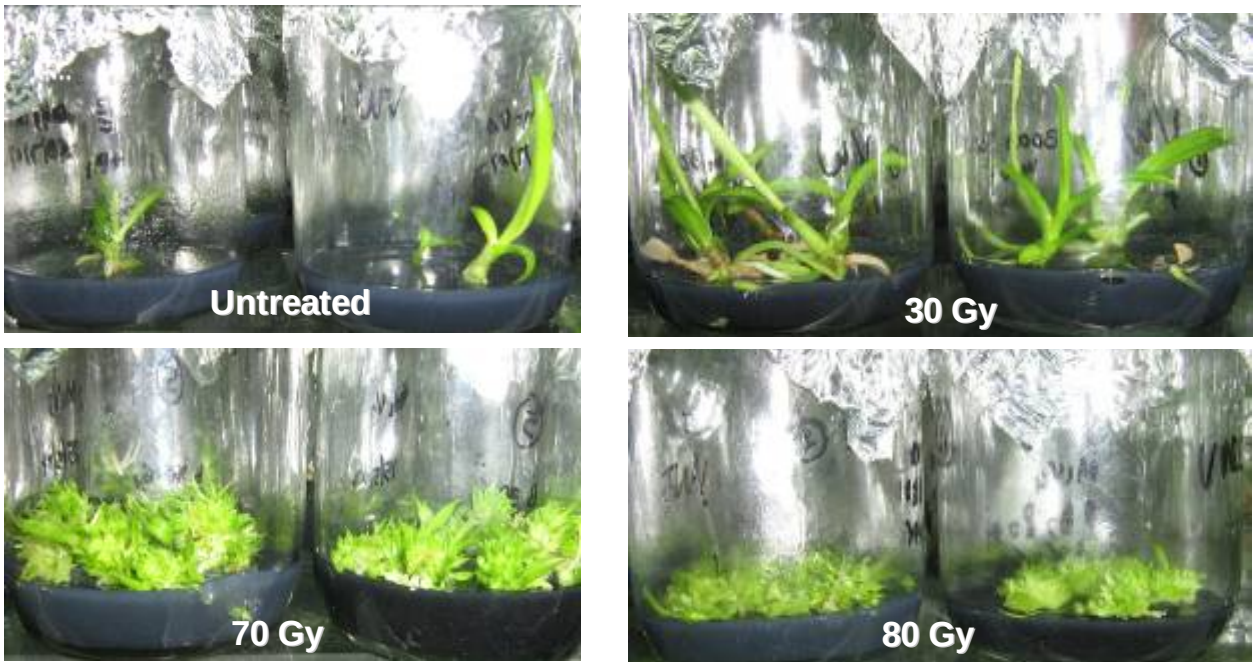


Figure 7. Untreated (0 Gy) and irradiated PLBs of *Den.* Sonia 'BOM 17 Red'

Table 5. Growth of irradiated plantlets of *Den.* Sonia 'BOM 17 Red' grown at the lath house for acclimatization (CAIRT)

Parameters	Dose of Gamma rays (Gy)	
	Ac 10 + Chr (50 + 50)	Ac 20 + Chr (50 + 50)
Number of plants	27	24
Number of shoots/plants	4.59	5.33
Plantlet height (cm) (avrg)	1.38	2.28
Number of leaflets (avrg)	2.17	1.13

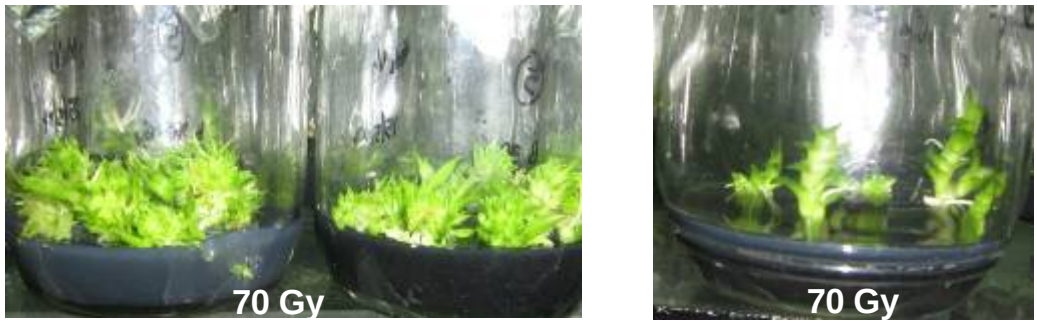


Figure 8. Abnormality found in irradiated PLBs of *Den.* Sonia 'BOM 17 Red'

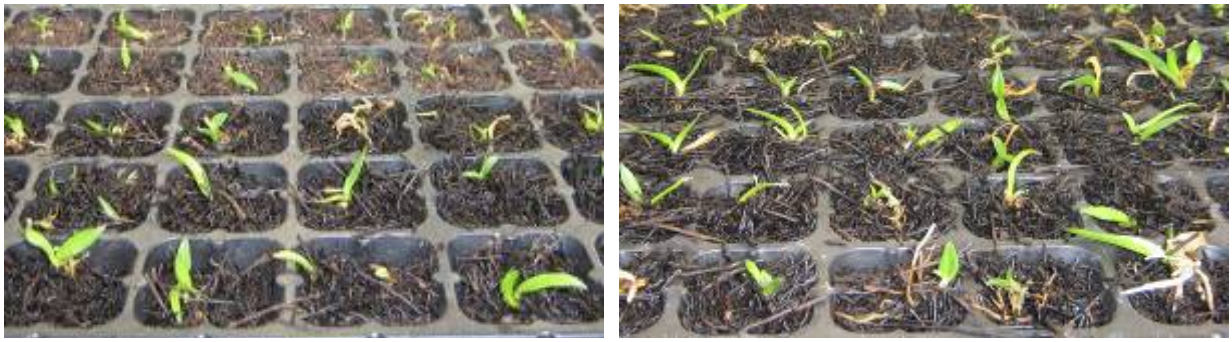


Figure 9. Acute and chronic irradiation of *Den.* Sonia 'BOM 17 Red'

Left (acute 10 Gy + chronic 50 + 50 Gy), Right (acute 20 Gy + chronic 50 + 50 Gy)

Table 6. Irradiated plantlets of *Den.* Sonia 'BOM 17 Red' grown in the lath house of IOCRI for acclimatization.

Dose of Gamma rays (Gy)	Number of plants	Number of shoots/plant	Number of leaves/shoot	Length of leaf (cm)	Width of leaf (cm)	Plant height (cm)
80	27	1.21	2.22	3.12	0.53	4.29
90	44	2.48	3.61	4.33	1.60	8.72

Figure 10. Irradiated plantlets of *Den.* Sonia 'BOM 17 Red' grown in the lath house of IOCRI (12 months after irradiation)

Conclusion

The results of this observation can be concluded that PLBs and young shoots of *Den. Jayakarta* were very sensitive to gamma rays. The optimum dose for PLBs and plantlets of *Den. Jayakarta* was 40 Gy since there was no PLBs and young shoots could grow at the doses more than 40 Gy after 12 months of irradiation. Mass rearing Thrips can be done by using pumpkin as artificial feeding. The most plantlets and clusters of PLBs formed were obtained from irradiated plantlets of *Den.* Sonia 'BOM 17 Red' at the dose 70 Gy. PLBs was not found from those at the dose 30 Gy and untreated plantlets. Irradiated plantlets of *Den.* Sonia 'BOM 17 Red' at the dose of 90 Gy grown in the lath house of IOCRI for acclimatization showed better performance compared to those at the dose 80 Gy

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