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The Effect of Gamma Irradiation to the Phenotypic of Two Aglonema Varieties

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Abstract

Increased phenotypic diversity is needed to increase the economic value of Aglaonema. However, information on increasing phenotypic diversity of Aglaonema using gamma-ray irradiation has not been widely known. This study aimed to investigate the effect of gamma ray irradiation treatment to the performances of two varieties of Aglaonema. This research was arranged factorially using randomized group design (RKLT) of two factors consisting of 8 combinations of treatments that are 4 level of irradiation dose and 2 Aglaonema varieties. The results showed that the induction of gamma ray irradiation decreased the % viable of the plants, the number of leaves, leaf length, leaf width, and the % green color as well as increased the % blue on the leaves of *Aglaonema Butterfly* and *Aglaonema Siam Aurora*. The interaction between dose of irradiation and aglaonema varieties was obtained in the % red of leaf color. Both of Aglaonema varieties had a high radiosensitivity with LD^{50} values ranged of 16.70 - 17.14 Gy.

Keywords: Phenotypic, gamma-ray, aglaonema

A. Introduction

Aglaonema or known as *Sri Rejeki* has leaves that vary in the form of motifs, colors, shapes, and sizes. Aglaonema that adapted for growing indoors in one week without being issued is suitable to be used as indoor plants (Purwanto, 2006). In addition, the maintenance of Aglaonema is quite easy compared to the maintenance of other leaf ornamental plants. So it is not surprising if this ornamental plant to be one of the ornamental plants that are very potential to be developed and further become one of the ornamental plants sold by calculating the price per leaf (Purwanto, 2006)

Increased phenotypic diversity is needed to increase the economic value of Aglaonema. Increased phenotypic can be done by hybridization or artificial crosses and mutations. Otherways, Hybridization of Aglaonema is not easy to do as the different maturity time of male and female flowers. Therefore, one method that is considered effective for increasing diversity is a mutation, which causes changes in the color, strokes, and shape of Aglaonema leaves (Purwanto, 2006). Mutation in Aglaonema can be obtained naturally or by induction method (Wulan, 2007). However, the increase in phenotypic diversity using mutation induction is more popular in Aglaonema plants compared to natural mutations. This might be caused by the small chance of natural mutations occur in plants.

Induction of mutations in plants can be done physically and chemically. Gamma ray irradiation is one example of a physical mutation that can be done to increase the phenotypic diversity of Aglaonema. The success of increased phenotypic diversity in plants with gamma-ray irradiation is affected by several factors including appropriate dose, irradiation techniques used, plant species and plant parts used. However, Information on increased phenotypic diversity of Aglaonema with gamma-ray irradiation has not been widely known. Furthermore, Misniar (2008) stated that there is no LD^{50} at a dose of 10 - 50 Gy in Aglaonema plants. Thus, this study aimed to investigate the effect of gamma ray irradiation treatment to the performances of two varieties of Aglaonema.

B. Methodology

Gamma ray irradiation was carried out at the National Nuclear Energy Agency (BATAN), Pasar Jumat, Jakarta. The observation and maintenance of the plant were carried out at Citeureup Experimental Garden, Bogor District.

Plant materials used in this study consisted of two Aglaonema varieties that are "*Siam Aurora and Butterfly*". The irradiated material is Aglaonema seedling which has 3-4 leaves. The plant medium used in this study consisted of a mixture of cocopeat: fern: compost: husk charcoal with a ratio of 3: 3: 1: 1.

The research activity was started by preparing the root of *Aglaonema Butterfly* and *Aglaonema* Siam Aurora which has about 3-4 leaves. Before irradiation is done, the Aglaonema seedlings were cleaned first with water which was then inserted into a large brown envelope paper shaped. The Aglaonema seedlings were then irradiated with 4 doses levels of 0 Gy, 30 Gy, 60 Gy, and 90 Gy. Irradiated Aglaonema seedlings were then washed with water and then planted in pots of 15 cm in diameter media ratio of cocopeat: fern: compost: husk charcoal of 3: 3: 1: 1. Maintenance activities of the plant consisted of watering, fertilizing and controlling pests and diseases. Heavy watering was done twice a week while light watering was done once a day in the morning or afternoon by using hand sprayer. Fertilizer applied in the form of liquid and granules fertilizers. Liquid fertilizer is a leaf fertilizer with a concentration of 1-2 g l^{-1}, while the granular fertilizer is NPK Mutiara fertilizer with a concentration of 5-10 g of l^{-1} and 250 ml doses per pot. Pest control is done by sprinkling fungicides and bactericides with concentrations of 1-2 g l^{-1} and a dose of 250 ml per pot. The application of Fertilization and pesticides was done once a week. The characters observed in this study consisted of plant height (cm), stem diameter (mm), % red, green and blue (RGB) of leaf, the number of leaves, leaf length (cm), and leaf width (cm). The observation of leaf observation was performed only on leaves that grew after irradiation, while the % RGB value of leaves were obtained by using image processing software.

This research was arranged factorially by using a randomized group design (RKLT) which consisted of 8 combinations of treatments, ie the radiation dose which consisting of 4 levels and two varieties. Each treatment was repeated 3 times which consisted of 5 plants. The general statistical equation for this design is:

$Yijk = \pi + \alpha i + \beta j + (\alpha\beta)ij + €ijk$
i = 0 Gy;30 Gy; 60 Gy; 90 Gy (radiation dose level)
j = Butterfly and Siam Aurora (variety level)
k = 1; 2; 3; (repetition)
π = general median
αi = Effect of dose factor on i-th radiation level
βj = Effect of variety on j-th level
(αβ)ij = Effect of the interaction of i-th dose irradiation factor and j-th variety factor
€ijk = Random error of radiation dose factor on i-th level and variety factor on j-th level

The LD^{50} analysis was done by using curvit analysis software while F test and multiple comparison tests were done by SAS software. Multiple comparison tests were performed when the F test was significantly different, by using Duncan Multiple Range test (DMRT).

C. Result and Discussion

Environmental conditions during the study were having a minimum temperature ranging 18.4° C -22.8° C, the maximum temperature of 32° C - 33.2° C, and relative humidity of 68-95%. It is less than ideal for aglaonema cultivation. Junaedhie (2006) stated that the appropriate temperature for Aglaonema was 25° C - 29° C during the day and 18° C - 21° C at night, while Djojokusumo (2006) stated that Air humidity corresponding to Aglaonema ranges Between 50 - 60%. This not ideal environmental condition caused some Aglaonema plants die due to its resistance to pests and diseases.

Recapitulation of Variance

The results of the variance analysis in Table 1 showed that the effect of gamma ray irradiation dose significantly affected the % blue color of leaf (% B) as well as significantly affected the %viable, leaf number, leaf length, leaf width, %green of leaf (% G) whereas the main effect of variety aglaonema only significantly affect on plant height character. The result of variance analysis also showed that there is an interaction effect between irradiation dose and aglaonema varieties on the character of the %red color of leaf (% R).

Table 1. Recapitulation of variance of Gamma Radiation Effect on Two Aglaonema Varieties

character	Source of variance		
	Varieties	Dose	Varieties x Dose
% viable of plant	tn	**	tn
Plant height	*	tn	tn
Stem diameter	tn	tn	tn
Number of leaves	tn	**	tn
Leaf length	tn	**	tn
Leaf width	tn	**	tn
% R	tn	tn	**
% G	tn	**	tn
% B	tn	*	tn

Note: tn = No significant effect, * = Significant effect at 5% level and ** = Significant effect at 1 % level

Main effect of the Varieties on Aglaonema

The result showed that most of the observed characters did not show significant differences between varieties of *Aglaonema Butterfly* and *Aglaonema Siam Aurora* (Table 2). It might be caused by the similarity of the elders of both varieties. Both varieties probably have genes derived from *Aglaonema rotundum* as the varieties have the red color derived from aglaonema rotundum. Purwanto (2006) stated that aglaonema rotundum species is the only species of aglaonema that has a red character.

Table 2. Main effect of the varieties on aglaonema phenotypic

Varieties	Character								
	% Viable	DBAT (cm)	TT (cm)	JD	PD (cm)	LD (cm)	% R	% G	% B
Butterflay	34.58	0.74	25.71 a	0.72	3.69	1.72	0.39	0.34	0.27
Siam Aurora	29.86	0.66	23.05 b	0.63	2.56	1.26	0.39	0.35	0.25

Note: The values in the same column followed by the same letter show no significant difference based on the DMRT test at the 5% level. DBD = Stem diameter, TT = Plant height, JD = Number of leaves, PD = Leaf length, LD = Leaf width,% R =% Red color of leaves,% G =% Green color on and% B =% Blue color on leaf

However, the significant difference was found in plant height between *Aglaonema Butterfly* and *Aglaonema Siam Aurora*, of which *Aglaonema Butterfly* has higher plant height than *aglaonema Siam Aurora*. The difference plant height might be due to genetic differences between the two varieties. The phenotype of a plant is influenced by several factors such as genetic, environmental, and interaction between genetic and environmental factors. The finding research by Qodriyah and Sutisna (2007) stated that *A. pseudobracteatum* has a higher regenerative power in root formation and shoot growth than *A. commutatum*, *A. crispum*, and *A. philippinensis var. Stenophyllum f. Longifolium*. Budiarto (2007) also explained that the characteristics of faster or slower growth in plants are the original characteristic of the plant as the result of plant interaction with growing environments

Main Effect of Gamma ray Irradiation dose on Aglaonema

The results showed that the induction of gamma ray irradiation could decrease the % of viable plants, the number of leaves growing, leaf length, leaf width and% green color as well as increased the % blue on aglaonema leaf. Similarly, Misniar (2008) reported that induction of gamma ray irradiation lead to decrease the number of leaves, leaf length, and leaf width of Aglaonema. Meanwhile, Syukur (2000) reported that there was an increase in chlorophyll content in soybean plants with the treatment of a dose of 20 Krad and decreased at a dose of 35 Krad, moreover, while Fauza *et al.* (2005) also explained that the irradiation dose of 3 Krad gamma ray decreased the average number of chlorophyll of the first leaf of mangosteen plant.

Tabel 3. Main Effect of Gamma ray Irradiation dose on Aglaonema

Dose (Gy)	% viable plant	DBAT (cm)	TT (cm)	Karakter					
				JD	PD (cm)	LD (cm)	% R	% G	% B
0	100.00 a	0.67	26.40	1.53 a	10.44 a	4.09 a	0.39	0.39 a	0.23 b
20	9.72 b	0.70	23.63	0.50 b	0.61 b	0.43 b	0.39	0.34 b	0.26 a
40	11.67 b	0.73	24.31	0.33 b	0.73 b	0.53 b	0.40	0.32 b	0.28 a
60	7.50 b	0.70	23.18	0.33 b	0.73 b	0.91 b	0.40	0.34 b	0.27 a

Note: The values in the same column followed by the same letter show no significant difference based on the DMRT test at the 5% level. DBD = Stem diameter, TT = Plant height, JD = Number of leaves, PD = Leaf length, LD = Leaf width, % R =% Red color of leaves, % G = % Green color on and% B = % Blue color on leaf

The decreased % viable plants after gamma ray irradiation is due to the death of plant cells, while the decrease in the number, length, and width of the leaves is might be caused by the inhibition of aglaonema plant cell division. Broertjes and Van Harten (1988) suggested that, in general, the physiologic damage may occur in the form of inhibition of cell division, cell death, induction of mitotic activity, the effect of average growth, changes in reproductive capacity, and increased frequency of tissue formation after gamma ray irradiation. Soedjono (2003) also explained that the high-dose irradiation treatment would eliminate the mutated material or cause sterility, whereas at low irradiated dose it can generally preserve the viable plant or plant shoots.

Meanwhile, the decrease of % green and the increase of % blue color after gamma ray irradiation might be caused by the damage of cells in the chloroplast due to gamma ray irradiation. Aisyah et al (2009) stated that the occurrence of albino shoots due to gamma ray irradiation because of the disruption of chlorophyll synthesis which eventually lead to the deficiency of green leaf color.

Interaction of Gamma Rays Irradiated Dose and Aglaonema Varieties

The higher the irradiation dose in Aglaonema butterfly caused a higher % red color on leaves while the higher the dose of irradiation in the Aglaonema Siam Aurora caused the decrease of % red color on the leaves. This happens because the leaves of Aglaonema Butterfly are dominated by green color while the leaves of Aglaonema Siam Aurora are dominated by red color, so in Aglaonema, Siam Aurora damage not only to the cells of chlorophyll but also cells that contain red color in plants

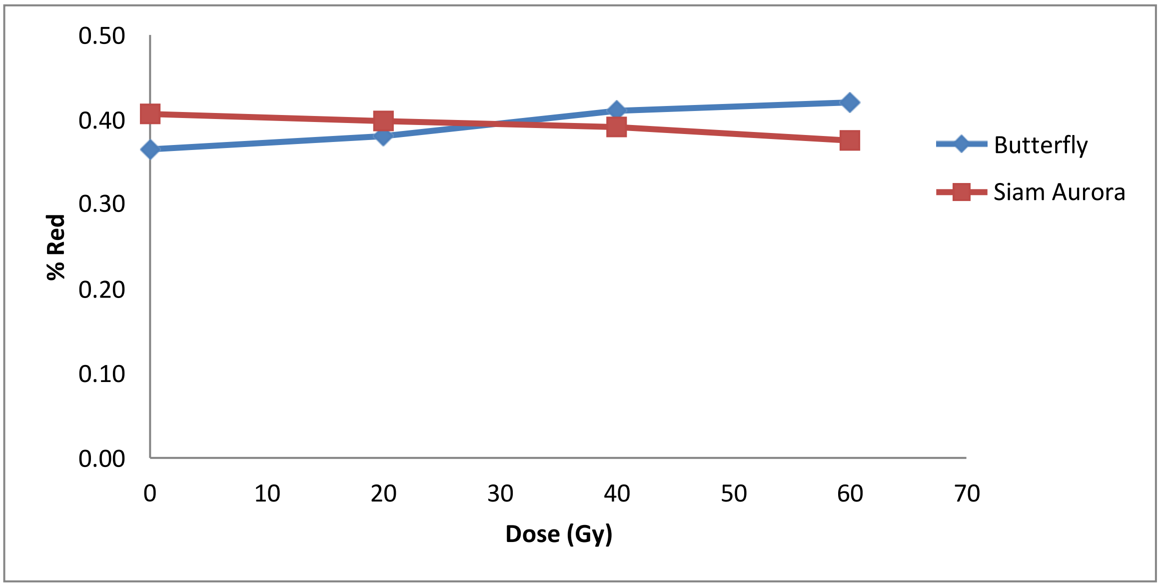

Figure 1. Graph of interaction gamma rays irradiation dose and Aglaonema varieties on the character of % Red

Based on the findings, to obtain a high red color in Aglaonema Butterfly, it should be used a high dose of gamma irradiation. Similarly, to maintain the highest red color in *Aglaonema Siam Aurora*, irradiation should be done in a low dose.

Radiosensitivy Level

Radiosensitivity Level is the ability level of plants in response to irradiation stimulation. One way that can be used to determine the level of radiosensitivity is to know the Lethal Dose (LD^{50}) of the plant (Herison, et al., 2008). The lower the LD^{50} of a plant the higher the radiosensitivity level, while the higher the LD^{50} value of a plant the lower the radiosensitivity level. Besides being used to determine radiosensitivity levels, LD^{50} is also used to increase plant diversity.

Table 4. LD^{50} value of 2 varietas of Aglaonema

Varieties	**Type of equation**	**Equation**	**Value of LD^{50}**
Butterfly	Linear fit	$y = 69.3 – 1.2x$	16.70 Gy
Siam Aurora	Linear fit	$y = 77.3 – 1.6x$	17.14 Gy

The value of LD^{50} could be obtained by correlating the irradiation dose with % viable plant. From the equation formed, then we can know the value of LD^{50} from Aglaonema. the Aglaonema variety of *Butterfly and Siam Aurora* equally produce linear equations and also have a high radiosensitivity. Both LD^{50} values of these varieties ranged from 16.70 - 17.14 Gy. A different finding reported by Misniar (2008) that there is no LD^{50} value at the irradiation dose of 0 - 50 Gy in Aglaonema. This might happen because radiosensitivity was also affected by the type of plant material used.

D. Conclusion

Induction of gamma ray irradiation can decrease % viable plants, the number of leaves, leaf length, leaf width, and % green color as well as increase % blue on aglaonema butterfly and Siam Aurora leaves. The interaction between irradiation dose and aglaonema varieties is found in % red leaf color. Both aglaonema varieties have high radiosensitivity with LD^{50} values of 16.70-17.14 Gy. Gamma-ray irradiation dose of 0-20 Gy on Aglaonema seedlings is worth to be used to increase the phenotypic diversity of Aglaonema

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