EFFECT OF CHRONIC GAMMA IRRADIATION ON KENAF (*HIBISCUS CANNABINUS.* L) VARIETY V36

KESAN PENYINARAN GAMA KRONIK KE ATAS KENAF (HIBISCUS CANNABINUS. L) VARIETI V36

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Abstract

Kenaf (Hibiscus cannabinus) is originated from Africa and used in making various products such as animal food pallet, clothes, particle board, bio-plastics, paper and many other fibre related products. Due to its commercial value in various industries, research has been carried out to obtain kenaf with improved traits. Mutation breeding using ionizing radiation has been used widely and proven to be effective as an alternative method in plant improvement. In this study, chronic gamma irradiation on kenaf (Hibiscus cannabinus. L) Variety V36 was carried out at Gamma Greenhouse (GGH) facility at Malaysia Nuclear Agency. Kenaf seeds were planted in pots at the shadehouse and transferred to GGH after 7 days. These seedlings were subjected to various dose rates of 0.3 Gy/hour, 0.17 Gy/hour, 0.11 Gy/hour, 0.05 Gy/hour, 0.03 Gy/hour, 0.02 Gy/hour, and 0 Gy/hour (control). Plant survival and morphological data such as plant height and stem girth, were observed. From the result obtain, at accumulated dose of 230 Gy (Ring 4), plant showed the highest average plant height, stem girth and highest morphological changes. The finding of this study is useful in determining the most suitable dose rate for chronic gamma irradiation in the future.

Abstrak

Kenaf (Hibiscus cannabinus) berasal dari Afrika dan digunakan dalam penghasilan pelbagai produk seperti pelet makanan haiwan, pakaian, papan partikel, bio-plastik, kertas dan lain-lain produk gentisan yang berkaitan. Kerana nilai komersialnya dalam pelbagai industri, penyelidikan telah dijalankan untuk menghasilkan baka dengan ciri-ciri yang lebih baik. Pembiakan mutasi menggunakan sinaran mengion telah digunakan secara meluas dan terbukti berkesan sebagai kaedah alternatif dalam pembiakbakaan tanaman. Dalam kajian ini, sinaran gama kronik ke atas kenaf (Hibiscus cannabinus. L) varieti V36 telah dijalankan di kemudahan Rumah Hijau Gama (GGH) di Agensi Nuklear Malaysia. Biji kenaf disemai di dalam pasu di rumah teduhan dan dipindahkan ke GGH selepas 7 hari. Anak benih didedahkan pada sinaran gama dengan kadar dos berikut 0.3 Gy/jam, 0.17 Gy/jam, 0.11 Gy/jam, 0.05 Gy/jam, 0.03 Gy/jam, 0.02 Gy/jam, dan 0 Gy/jam (kawalan). Bilangan pokok hidup dan data morfologi seperti ketinggian tumbuhan, bentuk daun, tebal pokok, dan kadar kematangan telah dicerap. Dari hasil pemerhatian, pokok yang menerima dos terkumpul sebanyak 230 Gy menunjukkan ketinggian pokok yang paling tinggi, ukur lilit batang yang paling leba serta perubahan morfologi yang paling banyak. Dapatan dari kajian ini amat berguna dalam menentukan kadar dos yang paling sesuai bagi penyinaran gama kronik pada masa hadapan

Keywords: Kenaf, mutation breeding, chronic gamma irradiation, dose rate

INTRODUCTION

Kenaf (*Hibiscus cannabinus*) originated from Africa and usually planted for food and fiber (LeMahieu *et al*. 2003). Today, kenaf has been commercialized in various industries for various product and purposes. Kenaf is being

harvested for making animal food pallet, clothes, particle board, bioplastics, paper and many other fiber related products. The two fiber parts, bast fiber and core fiber which can both be utilized for different purpose, do not share the same quality as the bast fiber have better quality than the core fiber (Petrini et al., 1994). In today scenario, the shortage of tress in many areas and other environmental issues, non woody plant have become the popular choice to fill the global demand for fibrous materials (Hossain et al., 2011).

Variation in plant's genetic can be used to improve crops. Unfortunately, in most cases, the optimal variation is not available. Mutation breeding can improve crops development by applying mutagenic agents such as ionizing radiation or specific chemicals to induce mutation in plant and cause genetic variation that allow selection for the desired genetic traits (Novak and Brunner, 1992). Mutation induction using ionizing radiation is usually done using gamma rays because its electromagnetic radiation is most energetic and when compared to other radiation, gamma rays is better at penetrating most organism (IAEA, 1977). Through mutation induction, natural and genetic resources can be improved and it is considered as an effective and economical method to develop new cultivars of many types (Azliana et al., 2015).

According to Azliana, 2015, the advantage of mutation breeding is the transformation that occurs is random but inheritable and stable. Damages that occur to plant cell are at the molecular level contributes to the stability of the mutant produced. Together with cross breeding and hybridization technique, mutation breeding using ionizing radiation can produce more variation and improve crop development. Determining the optimal dose of radiation can be useful for future studies. Thus, this study was carried out to observe the effect of chronic gamma irradiation on kenaf (*Hibiscus cannabinus* .L) variety V36.

METHODOLOGY

Kenaf variety V36 was used in this study and seeds were obtained from Lembaga Kenaf and Tembakau Negara (LKTN), Perlis. The seeds were planted in pot containing coco peat, top soil and sand at 3:2:1 ratio in the shade house. After 7 days, pots with 10 replicates each treatment were subjected to chronic gamma irradiation in Gamma Green House (GGH) facility in Malaysian Nuclear Agency at 6 different dose rate ranging from 0.3 Gy/hour, 0.17 Gy/hour, 0.11 Gy/hour, 0.05 Gy/hour, 0.03 Gy/hour, 0.02 Gy/hour, and 0 Gy/hour (control). Plant survival and morphological data such as plant height, leaf shape, stem girth, and rate of maturity were observed during the experiment. Plants were taken out from GGH at 125 days and accumulated dose of gamma irradiation for each treatment was collected at the end of the experiment. The controls were planted outside GGH facility with similar condition. Analysis of variance were performed using Statistical Analysis System (SAS) version 9.2 to measure significant differences ($p \leq 0.05$) or ($p \leq 0.01$) among characteristics data. The mean difference between doses were further tested using Turkey method at 5%.

RESULT AND DISCUSSION

Seven day old kenaf seedlings were exposed to chronic irradiation to observe plant response at continuous low dose exposure to gamma ray. Chronic irradiation is much different from acute gamma irradiation. Acute irradiation expose sample to high dose in a short amount of period once while chronic gamma irradiation continuously expose low dose of gamma irradiation in longer time period. Theoretically, the plant DNA will be continuously breakdown and repaired during the period of exposure which cause the plant to mutate in order to survive. GGH facility can be used to irradiate different type of sample such as seedlings in pots, callus, somatic embryo, and suspension of cell culture (Azhar, 2009). Other research in the past has reported that mutagenic treatment has significant effect on plant survival rate and morphological traits (Harding, 2009; Mohammad *et al*., 2002) Data on survival percentage, plant height and stem girth were obtained as shown in Table 1.

Table 1: Effect of chronic gamma irradiation on Kenaf Var. V36

Treatment	Ring	Dose Rate (Gy/hr)	Survival (%)					Plant Height (cm)		Stem Girth (cm)		
			22 days	50 days	64 days	100 days	125 days	100 days	125 days	Bottom	Middle	Top
Control	0	0	100	100	100	90	85	104.6	155.7	9.64	6.65	3.52
27	11	0.02	100	100	85	75	55	104.64	137.29	10.16	8.06	5.33
40	9	0.03	100	100	97	90	85	118.90	168.70	11.01	8.02	5.26
70	7	0.05	100	100	85	75	60	117.75	169.43	11.03	7.95	5.35
150	5	0.11	100	100	88	65	35	103.50	180.00	11.50	8.20	5.62
230	4	0.17	100	100	90	70	30	106.72	206.57	12.35	8.99	5.97
400	3	0.3	100	100	92	60	30	93.22	139.06	9.72	7.49	5.80
Mean			100	100	92	60	61	165.25	10.77	7.90	5.26	100
Standard Deviation			0	0	5.25	10.69	20.25	22.40	0.91	0.66	0.75	0

SURVIVAL RATE

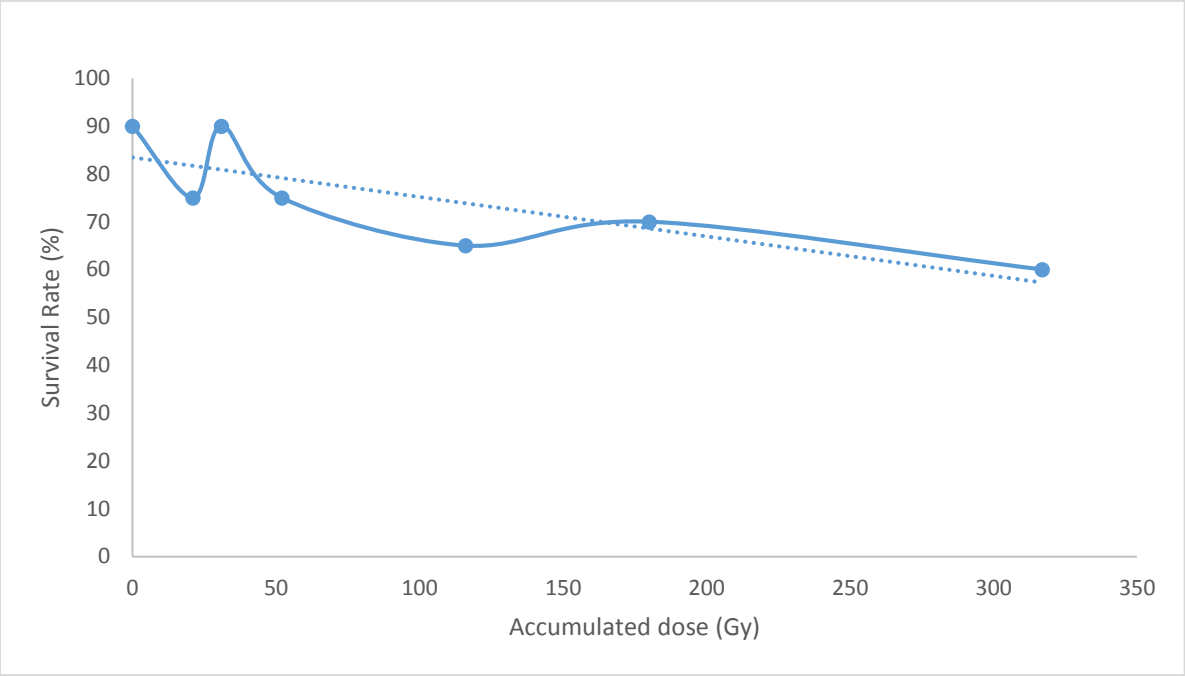

Figure 1: Survival rate of Kenaf plant at 100 days of planting. Notice the trendline show decreasing value as higher amount of accumulated dose would result in lower survival rate.

According to the data analysis, there is no significant difference in survival rates of kenaf plant during exposure to chronic gamma irradiation. After 50 days of planting, survival rates started to decrease in all groups. The highest average survival rate was observed at accumulated dose 40 Gy which shows the average of 94.72% while the lowest average survival rate was observed at accumulated dose 150 Gy which shows the average of 79.44% plant survived. At 100 days of planting, the highest percentage of plant survive was at 0 Gy and 31 Gy which shows 90% of plant survived while the lowest percentage of plant survived was at 317 Gy which shows only 60% plant survived. No lethal dose can be obtain from the experiment because no survival rate was observed under 50% during 100 days of planting. Exposure to gamma irradiation can cause blockage in the DNA which can cause plant growth to slow, stop or eventually killed the plant (Azliana et al, 2012). However, after certain amount of time, cell will eventually repair the fatal DNA damage cause by gamma irradiation (Singh et al, 2010).

STEM GIRTH

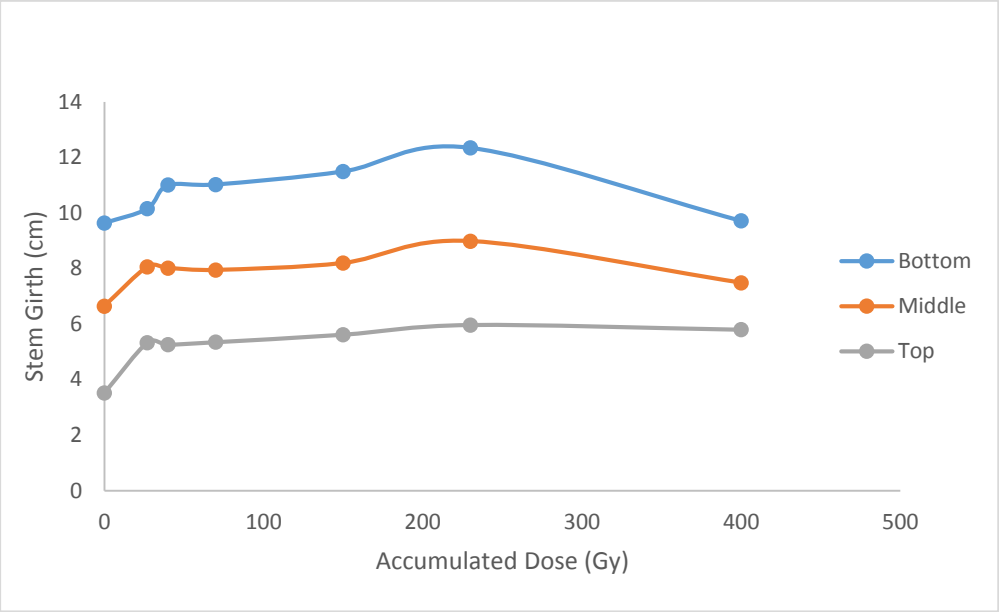

Figure 2: Stem girth observed at 125 days of planting. Each line represent different parts of the plant measured.

Stem girth was observed at 125 day on 3 different parts of the stem which is the bottom, middle, and the top. Based on the data collected, the highest average stem girth recorded for all bottom, middle, and top part of the stem is at 230 Gy which show 12.35cm, 8.99cm and 5.97cm respectively. The lowest average stem girth was recorded at control plant (0 Gy) which shows 9.64cm, 6.65cm, and 3.52cm for bottom, middle and top part of the stem respectively. Individual plant which shows the highest number for bottom and middle parts of the stem was plant in 40 Gy which shows 24.2cm and 14.6cm respectively. Highest number recorded for top part of the stem was at 230 Gy which shows 9.04cm. The lowest number recorded for each bottom middle and top part of the stem for individual plant was at 400 Gy which shows 2.8cm, 1.9cm and 1.2cm respectively.

PLANT HEIGHT

Dosage of mutagen received by plant has shown to affect the plant growth in term of size and height (Azliana et al, 2012). The higher the accumulated dosage receive by plant, the lower the plant height. In this experiment, the result agree as the highest amount of dosage received by kenaf plant shows the lowest average plant height during the whole experiment. However, when tested using ANOVA, no significant different in plant reduction size were found. Interestingly, some plants display higher plant height than control plant. This might be due to nucleic acid being synthesize due to stimulation of cell division after receiving gamma irradiation. This process would trigger plant to increase in height (Pitrimovae, 1979).

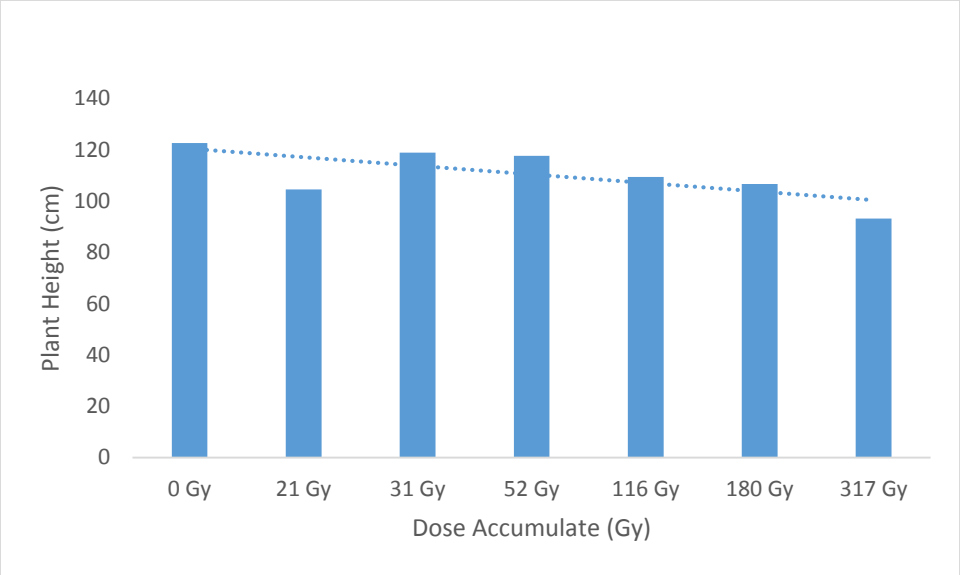

Figure 3: Graph showing plant height over dose accumulated at 100 day

At 100 days of planting, the trendline for plant height over dose accumulated shows linear decreasing from low to high dose accumulated. This happens because at 100 days of planting, most of the plant is still in vegetative state where all plant are still growing. At 100 days the highest average plant height recorded was at ring 9 which is 118.9cm while the lowest average plant height recorded was at Ring 3 which shows 93.2cm.

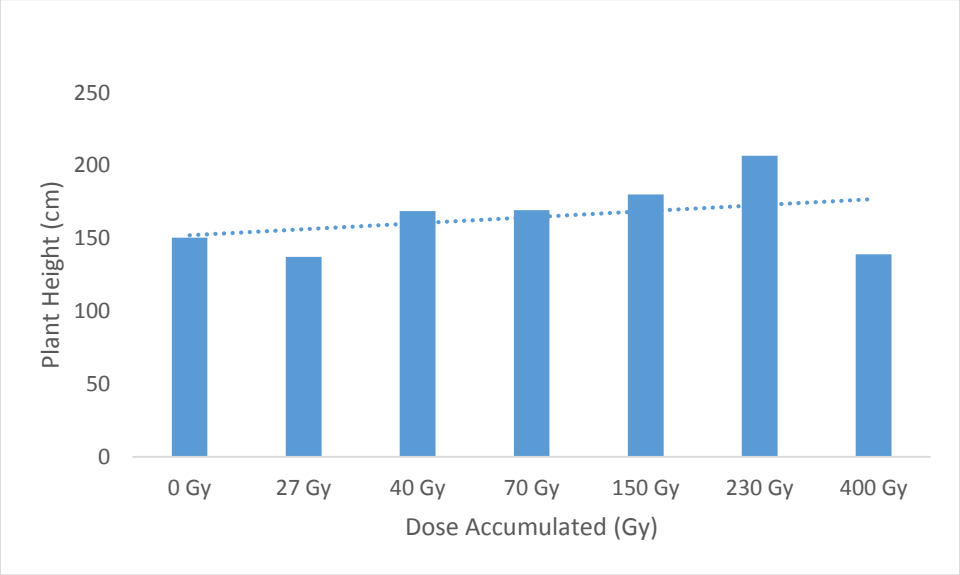

Figure 4: Graph showing plant height over dose accumulated at 125 day

At 125 days of planting, trendline for plant height over accumulated dose shows linear increasing from low dose to high dose accumulated. This is because at 125 days of planting, some plant were already entering flowering state

where vegetative growth stops. Some plant such as in Ring 4, have yet to enter their flowering state thus making them higher than other plants who have stop vegetative growth. At 125 days of experiment, the highest average plant height recorded was at Ring 4 which shows 206.57cm, while the lowest average plant height recorded was at Ring 3 whichs shows 139.06cm. The highest individual plant recorded at 125 days was at 230 Gy which was 254cm while the lowest individual plant height recorded at 125 days was at Ring 3 which show 62cm.

CONCLUSION

Based on the result we can conclude that when expose to higher dose of gamma irradiation over time can affect growth of kenaf plant. Result obtain proves that there is linear dependency between amount of gamma irradiation received and plant size. This study can later be improved by observing the growth of next mutant generation from this offspring.

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