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Effects of Gamma Radiation on Cherry Golden Tomato Variety (*Solanum lycopersicum*) Growth and Production

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ABSTRACT

The golden cherry tomato (*Solanum lycopersicum*) is a small variety with a sweet taste, crunchy texture, and high nutritional content, making it popular in salads, appetizers, and a healthy snack. Gamma radiation, a type of high ionization radiation, can cause genetic alterations and affect how plants respond to their surroundings. This study aimed to assess the impact of gamma radiation on the growth and yield of different varieties of cherry golden tomatoes. The research took place at the Irradiation and Instrumentation Laboratory on Jalan Lebak Bulus Raya in Jakarta and the Green House of Labuhanbatu University in Rantauprapat City, Labuhanbatu Regency, North Sumatra Province. The experiment took place between December 2023 and March 2024. The study utilized a non-factorial, Completely Randomized Design with 4 treatments and 5 replicates, including gamma radiation treatment at 0 Gy, 200 Gy, and 300 Gy. The findings indicated that higher doses of gamma radiation reduced germination at a dosage of 300 Gy. The parameters of plant height, number of leaves, flowering age, and fruit weight per plant were significantly affected by gamma radiation treatment, but there was no effect on plant height.

Keywords: *Gamma Ray Radiation, Genetics, Golden cherry tomatoes, Growth of Golden Cherry Tomatoes, Production of Golden Cherry Tomatoes*

1. INTRODUCTION

The Cherry Golden tomato (*Solanum lycopersicum*) is known for its small, round, attractive golden yellow fruit. This tomato is part of the cherry tomato family, known for its popularity due to its sweet flavor and small size, making it ideal for eating on its own or as a garnish in various dishes. Many tomato enthusiasts prefer Golden Cherry (*Solanum lycopersicum*) for its mild flavor and unique scent (Steven cipta putra, 2022).

Golden Cherry tomatoes (*Solanum lycopersicum*) typically produce fruits with a diameter ranging from 1 to 2 centimeters, which makes them an ideal addition to salads, appetizers, or as a nutritious snack. The vibrant golden-yellow hue serves as both an appealing visual feature and a marker of the fruit's ideal ripeness. When harvested at the appropriate stage of ripeness, these tomatoes have the potential to offer a harmonious blend of sweetness and a subtle touch of acidity, resulting in a gratifying gustatory sensation (Bafdal, 2021).

In addition to their delectable flavor, Golden Cherry tomatoes also possess beneficial nutritional qualities. They possess high levels of vitamin C, vitamin A, and antioxidants, all of which play critical roles in maintaining bodily health and bolstering the immune system. The proliferation of these tomato plants typically necessitates warm growing conditions and adequate sunlight, making them well-suited for cultivation in regions with temperate to hot climates. The variety of Cherry Golden (*Solanum lycopersicum*) is frequently favored by tomato growers due to its ability to yield a plentiful harvest, leading to its popularity among household and small-scale agricultural producers.

Tomato cultivars classified as cherry varieties are frequently characterized by a restricted genetic pool, leading to diminished resilience against various diseases, pests, and suboptimal environmental factors. In order to address this issue, the method of mutagenesis utilizing gamma ray treatment is employed. Gamma rays are capable of causing changes in the DNA of plants, resulting in the generation of novel genetic variations that were not initially present in the population. These genetic mutations can result in advantageous characteristics, such as heightened disease resistance, enhanced agricultural output, and improved ability to thrive in shifting environmental circumstances. As a result, using gamma rays presents a viable choice in cherry tomato plant breeding initiatives, fortifying the genetic foundation and enhancing the plants' overall quality (Yanti & Rasyad, 2020).

The investigation involving the same product, specifically cherry tomatoes, primarily focuses on studying the impact of different levels of gamma-ray radiation on the different stages of plant development. This study represents a fundamental shift from earlier research, which often focused on the impact of radiation on individual factors such as crop yield or disease resistance. Instead, the current study takes a more comprehensive approach, investigating a wide range of morphological, physiological, and genetic alterations resulting from exposure to different doses of radiation (0, 100, 200, and 300 Gy) at various developmental stages. Varied development. This expanded research approach seeks to determine the most effective dosage to enhance both the yield and quality of the cherry tomato harvest while bolstering the plants' overall resilience. This will ultimately contribute significantly to the ongoing efforts in cherry tomato breeding (Nur Alfiah *et al*., 2023).

Studying the impact of gamma-ray radiation on the development and crop yield of Cherry Golden tomatoes (*Solanum lycopersicum*) is a compelling area of research for enhancing agricultural productivity and quality. Since gamma-ray radiation is highly ionizing, it

has been the subject of extensive research due to its potential to cause genetic mutations and elicit physiological responses in plants to their surrounding environment. Multiple researches have demonstrated the impact of gamma irradiation on tomato plants' growth and fruit production, precisely the Cherry Golden variety (*Solanum lycopersicum*) (Asza *et al*., 2022).

Manipulating the amount of gamma-ray radiation the Golden Cherry tomato plants (*Solanum lycopersicum*) are exposed to can result in alterations in gene expression. These changes can subsequently influence the plant's growth and its fruit's characteristics. Multiple research studies have observed enhancements in growth indicators, including plant height, branch quantity, and leaf dimensions, due to exposure to this type of radiation. Moreover, a discernible positive impact has been on fruit yield and quality (Rahmawati *et al*., 2022). It is essential to consider that the impact of gamma-ray radiation on plants can fluctuate depending on the level of radiation administered and the developmental stage of the plant being subjected to it. Hence, additional investigation is required to comprehend the mechanisms underlying the reactions of plants to gamma irradiation and to enhance its effectiveness in promoting the growth and yield of Cherry Golden (*Solanum lycopersicum*) tomato plants. However, preliminary research findings indicate the favorable prospects of implementing this approach to enhance agricultural production and offer valuable insights for the advancement of sustainable agricultural methodologies (Puspitarini & Nuraeni, 2019).

This research aims to determine the effects of gamma radiation on the growth and production of Cherry Golden tomato varieties.

2. MATERIAL AND METHODS

Time And Place

The research was conducted at the Radiation and Instrumentation Laboratory on Lebak Bulus Raya Road, Jakarta, with coordinates -6.3075° N, 106.7816° E, and at the University of Labuhanbatu Greenhouse with coordinates -2.105° N, 99.8265° E. The research was conducted from December 6, 2023, to February 21, 2024.

Tools and Materials

The materials used in this research are seeds of Cherry Golden tomatoes, black soil, and compost. The tools used in this study are the gamma chamber 4000 A, polybags, digital scales, meter, writing tools, and a camera.

Figure 1. The gamma chamber device

Research Method

The completely randomized design (CRD) method is a statistical approach used in research design to reduce bias and ensure equal treatment across all treatment groups (Hasdar et al., 2021). In CRD, research units are randomly assigned to different treatment groups so that each treatment has an equal probability of being applied to each unit (Pati *et al*., 2023).

The research method used is an experimental method using a single-factor Completely Randomized Design (CRD) consisting of 4 treatments, notably 0, 100, 200 and 300 Gy, each repeated 5 times. So, 20 experimental units will be observed.

This study involved 40 tomato plants to ensure the validity of the experimental results and the accuracy of measuring the effects of gamma radiation

treatment on the growth and production of these tomato varieties.

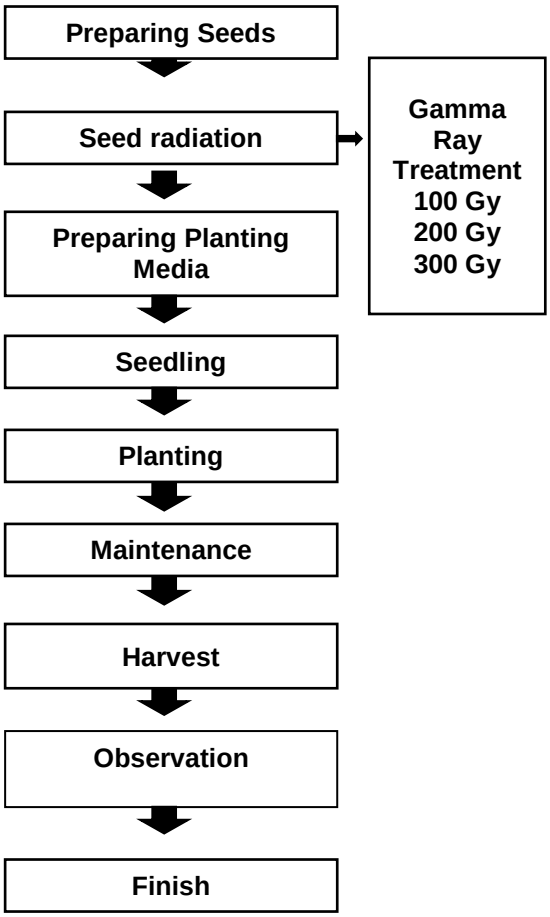

Figure 2. Research flow diagram

Observation Parameters

This study's scope extends to various critical factors in assessing the impacts of gamma-ray radiation on the development and yield of Cherry Golden tomato cultivars. Initially, the germination process serves as an early signal for comprehending the reaction of seeds to radiation exposure, thus shedding light on the possible impact of radiation on the initial stages of plant germination. Moreover, a plant's height indicates its vertical growth and reaction to radiation exposure throughout the growth phase. One of the variables used to assess the impact of environmental conditions or treatments on plant growth is the quantity of leaves. The period at which plants begin to flower and the time they are harvested indicate the duration needed to reach the peak reproductive and harvest stages post-exposure to radiation. Additionally, the quantitative measurement of fruit weight can effectively assess crop yield.

Data Analysis

Xie and Yan (2023) suggest that the impact of treatment can be assessed through analysis of variance (ANOVA). A significant difference in the F test results at the 5% level can indicate which treatment yields the most favorable outcomes. The data analysis applied the Least Significant Difference test (BNT) at a significance level of 5% (Magani *et al*., 2020).

3. RESULT AND DISCUSSION

Germination (%)

The results of the number of germinated seeds in this study can be used to calculate the percentage of

germination due to gamma-ray treatment. The test results are presented in Table 1.

Table 1. Percentage of Germination

Dosage (Gy)	Germination (%)			
	1 MSS	2 MSS	3 MSS	4 MSS
0	100	100	100	100
100	90	90	90	90
200	100	100	100	100
300	50	30	30	30

According to the findings from the germination testing of Cherry Golden tomato plants, it is evident that the treatment involving a dosage of 300 Gy results in a significantly reduced germination rate. Hence, it has been demonstrated that applying gamma ray treatment significantly impacts the quantity of sprouts produced by Cherry Golden variety tomato plants. This study aligns with Chavan et al.'s (insert year) findings as demonstrated by (insert specific examples or evidence). The research conducted in 2015 revealed that an elevation in the dosage of gamma rays caused a notable decrease in the germination rate across different plant species, such as tomatoes, due to injury to the seed tissue.

Plant Height (cm)

Based on the results of observations and analysis of data conducted on plant height parameters, the average plant height for each observation in each replication was obtained. These results are presented in Table 2.

Table 2. Average and analytical results of Cherry Golden tomato plant height

Dosage (Gy)	Plant Height (cm)						
	1 MST	2 MST	3 MST	4 MST	5 MST	6 MST	7 MST
0	15±6.7a	23,2±10.3a	37.4±16.73a	83,4±37.3a	108,8±48.6a	131,4±58.7a	154,8±69.2a
100	16,2±7,2a	25,4±11,3a	41±18,3a	87,4±39a	126±56,3a	129,4±57,8a	159,4±71,3a
200	16,2±7,2a	25,6±11,4a	42.8±19,1a	93,2±41,6a	119,8±53,5a	137,8±61,6a	148,8±66,5a
300	4,8±2,1b	8,8±3,9b	14.2±6,3b	32,6±14,5a	25,2±11,2b	28±12,5b	32±14,3b

Notes: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% BNT.

After analyzing the data on plant height of cherry tomato varieties, it was determined that there were noteworthy disparities between treatments comprising a 300 Gy dose and the remaining treatments. The data presented indicates that the application of 300 Gy treatment had a notable impact on suppressing the vertical growth of the Cherry Golden variety of tomato plants. When numerical data is accompanied by the same letter, there is no significant difference; however, when numerical data is not accompanied by the same letter, there is a significant difference. Furthermore, it was observed that there was a significant variance in each treatment repetition at a dose of 300 Gy gamma rays. In the study conducted by Gao and colleagues... In a study conducted in 2016, it was discovered that the use of high doses of gamma rays led to a marked suppression in the growth of plants, particularly in terms of plant height. This was attributed to the harm caused to cellular structures and the interference with physiological processes (Ni, 2020).

Number of Leaves (leaf)

The average number of leaves from each observation for each replication was obtained based on the observation and data analysis conducted on the leaf count parameter. These results are presented in Table 3.

The observations and data analysis results on the leaf count of Golden Cherry tomato plants indicate no significant difference in the number of leaves in replications 1-3. Nevertheless,

noticeable variations were observed in repetitions 4-7. Therefore, it can be inferred that administering a dosage of 0-300 Gy did not yield a notable variance in repetitions 1-3, whereas a dosage of 300 Gy in repetitions 4-7 demonstrated a significant distinction. There is no significant difference when numerical data is accompanied by the same letter. Conversely, there is a significant difference when numerical data is not accompanied by the same letter. The inhibition of leaf number in replications 4-7 was attributed to the genuine impact of gamma rays at a dosage of 300 Gy. Research that aligns with the work of Jan et al. In a study conducted in 2018, it was demonstrated that elevated levels of gamma rays can impede the growth and maturation of leaves in a variety of plant species, such as tomatoes, through the disruption of physiological functions and the infliction of damage to cellular tissue (Sofiatur Rohmah, 2019).

Table 3. Average and analysis results of the number of leaves of Golden Cherry tomatoes

Dosage (Gy)	Number of Leaves (leaf)						
	1 MST	2 MST	3 MST	4 MST	5 MST	6 MST	7 MST
0	3±1,3a	6,2±2,7±a	10,2±4,6a	14±6,2a	19,8±8,8a	26±11,6a	34,2±15,2a
100	2,8±1,2a	5,6±2,5a	8,6±3,8a	11,8±5,2a	16,2±7,2a	22±9,8a	31,8±14,2a
200	2,8±1,2a	5±2,2a	9±4a	12,6±5,6a	16±7,1a	22,4±10a	32,6±14,5a
300	1,2±0a	2,2±0a	3±1,3a	3,8±1,7b	3,2±1,4b	4,6±2b	6,8±3b

Notes: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% BNT.

Flowering Age (days)

Based on field observations, it is known that there is a variation in flowering age in cherry tomato plants. The results of this LSD test can be presented in Table 4.

According to the findings from the data analysis and the BNT test, it can be concluded that the CherryGolden variety tomato plants in the control treatment exhibited a significant disparity in the age at which they began flowering compared to the other treatments. When number data is accompanied by the same letter, there is no significant difference, whereas when number data is not accompanied by the same letter, a significant difference is observed. The inhibition of flowering time in CherryGolden variety tomato plants can be attributed to applying gamma-ray treatment. This study is consistent with the findings of Lee et al. According to a study conducted in 2017, exposure to gamma rays can lead to a decrease in flower development in plants such as tomatoes. This is due to the impact on growth hormones and the damage inflicted on cell tissue (jabal rahman ashar *et al.*, 2023).

Table 4. Average and analytical results of flowering age of Cherry Golden tomato plants

Dosage (Gy)	Average
0	28.4±5b
100	45.6±5,8a
200	58.4±5,8a
300	62.6±0a

Notes: Mean values in each column followed by the same letter indicate that they are not significantly different at 5% BNT.

Harvest Age (days)

Based on observations and analysis conducted in the field, the results obtained are presented in Table 5.

From the results of data analysis and testing with the BNT test at the 5% significance level, it can be concluded that the harvest age of Cherry Golden tomato plants does not show significant differences between each treatment. Data numbers followed by the same letter are not significantly different, while data

numbers are not significantly different. This is due to the effect of gamma rays that uniformly affect tomato plants in each treatment. According to research by Smith et al. (2019), treatment with gamma rays on plants can produce similar responses to plant growth and production parameters, such as harvest age, depending on the dose given (Savitri *et al*., 2015).

Table 5. Average and results of analysis of harvest age of Golden Cherry tomato plants

Dosage (Gy)	Average
0	58±4,9a
100	63±4,5a
200	68±4,6a
300	73±0a

Fruit Weight Per Plant (g)

Based on observations in the field and data analysis, the average fruit weight per crop was obtained, presented in Table 6.

According to the analysis conducted utilizing the BNT test, notable disparities were observed in the fruit weight per individual plant. The application of gamma-ray treatment at a dosage ranging from 100 to 300 Gy significantly impacted the fruit weight per plant. Number data with the same corresponding letter is not statistically significant, whereas number data without the same letter is statistically significant, as per Kumar et al. According to recent research (2020), exposure to specific levels of gamma radiation can increase or decrease fruit weight per plant in certain plant specimens. The outcome is contingent on the plant's tolerance to the radiation and the environmental factors that impact it (prof. Dr. Nurhidayati, 2023).

Table 6. Average and analysis results of fruit weight for Golden Cherry tomato plantings

Dosis (Gy)	Rata-rata
0	18±2,2b
100	70,4±4,4a
200	42,8±3,1a
300	23,5±2,6a

Notes: Mean values in each column followed by the same letter indicate not significantly different at 5% BNT.

Figure 2. Control treatment plant yield

Figure 3. Plant yield of 300 Gy gamma dinar dose treatment.

CONCLUSION

The application of gamma-ray treatment administered at a dosage ranging from 100 to 300 Gy resulted in a notable impact on both the growth and yield of the Cherry Golden tomato variety. The analysis results indicated that the specified dose of gamma rays significantly impacted the fruit weight per plant, suggesting the possibility of enhancing crop yields through the precise adjustment of radiation dosage. Nevertheless, there was variability in plant reactions to gamma rays, as evidenced by discrepancies in factors such as leaf count and age of flowering across various treatments.

REFERENCES

Asza, A. A., Moeljani, I. R., & Koentjoro, Y. (2022). Induksi Radiasi Sinar Gamma Co60 Dosis 3 Gy Terhadap Keragaman Genetik Populasi Mutan (M4) Tanaman Bawang Merah Varietas Bauji. *Agrohita*, *7*(2), 332–336.

Bafdal, N. (2021). Pengaruh Nilai Koefisien Tanaman (Kc) Pada Tanaman Tomat Cherry (*Solanum L*.Var. Cerasiforme) Dengan Sistem Fertigasi Menggunakan Autopot Pada Beberapa Tinggi Media Tanam. *Agrotekma: Jurnal Agroteknologi Dan Ilmu Pertanian*, *5*(2), 164–171. https://doi.org/10.31289/agr.v5i2.5456

Hasdar, M., Wadli, W., & Meilani, D. (2021). Rancangan Acak Lengkap Dan Rancangan Acak Kelompok Pada pH Gelatin Kulit Domba Dengan Pretreatment Larutan NaOH. *Journal of Technology and Food Processing (JTFP)*, *1*(01), 17–23. https://doi.org/10.46772/jtfp.v1i01.338

jabal rahman ashar *et al*. (2023). *pengantar kultur jaringan tanaman*. https://books.google.co.id/books?id=_zjhEAAAQBAJ&lpg=PP1&hl=id&pg=PR2#v=onepage&q&f=false

Magani, A. K., Tallei, T. E., & Kolondam, B. J. (2020). Uji Antibakteri Nanopartikel Kitosan terhadap Pertumbuhan Bakteri Staphylococcus aureus dan Escherichia coli. *Jurnal Bios Logos*, *10*(1), 7. https://doi.org/10.35799/jbl.10.1.2020.27978

Ni, A. (2020). *Tim Editor :Alberta Rika Pratiwi Ahmad Ni'matullah Al-Baarri Muhammad Hasdar Nurrahman Nurhidajah Rohadi Sumardi*.

Nur Alfiah, L., Abdilah Siregar, K., & Novianto, E. (2023). Increasing the growth and yield of tomato plants (Lycopersicum Esculentum Mill) by Applying Palm Oil Compost. *Jurnal Agronomi Tanaman Tropika (Juatika)*, *5*(2), 330–338. https://doi.org/10.36378/juatika.v5i2.3062

Pati, T. U., Hara, A. K., Mada, A. Lou, Radja, Y. R., Mandina, A., Namu, K., Maurice, G., & Norman, J. (2023). *HASIL TANAMAN KANGKUNG DARAT*. 286–291.

prof.Dr.Ir. Nurhidayati, M. . (2023). *Peluang dan Prospek Teknologi Nano dalam Sistem Produksi Pertanian di Indonesia* (september, p. xiv+174 hal). Unisma Press.

Puspitarini, D. S., & Nuraeni, R. (2019). Pemanfaatan Media Sosial Sebagai Media Promosi. *Jurnal Common*, *3*(1), 71–80. https://doi.org/10.34010/common.v3i1.1950

Rahmawati, D., Supriyanto, & Nugroho, A. (2022). Pengaruh Radiasi Sinar Gamma Terhadap Daya Kecambah Benih Akasia (Acacia mangium) GENERASI M2. *Jurnal Perbenihan Tanaman Hutan*, *10*(1), 23–36.

Savitri, E. S., Minarno, E. B., & Resmisari, R. S. (2015). Karaktar Molekuler Kedelai (Glycine Max) Toleran Kekeringai {Hasil Induksi

Mutasi Dengan Mutagen Ems (Ethyl Methane Salfonanate*)*.

Sofiatur Rohmah. (2019). Pengaruh Induksi Mutasi Radiasi Sinar Gamma Cobalt-60 Terhadap Keragaman Fenotip Tanaman Lidah Mertua (*Sansevieria trifasciata* Prain). In *Αγαη* (Vol. 8, Issue 5). Jurusan Biologi Fakultas Sains Dan Teknologi Universitas Islam Negeri Maulana Malik Ibrahim Malang.

Steven cipta putra. (2022). Fakultas pertanian universitas islam riau pekanbaru 2022. *Pengaruh Aplikasi Kompos Limbah Akasia Dan Pupuk NPK 16:16:16 Terhadap Pertumbuhan Serta Hasil Tanaman Tomat (Solanum Lycopersicum L.)*, *Fakultas Pertanian Universitas Riau Pekanbaru*, 14.

Xie, D., & Yan, W. (2023). A study of N = 1 SCFT derived from N = 2 SCFT: index and chiral ring. *Journal of High Energy Physics*, *2023*(3), 1–5. https://doi.org/10.1007/JHEP03(2023)201

Yanti, F., & Rasyad, A. (2020). *Analisis Keragaman Fenotipe Generasi M 2 Dan M 3 Tanaman Kacang Hijau (Vigna radiata L .) Hasil Radiasi Sinar Gamma Mahasiswa Program Pascasarjana , Fakultas Pertanian , Universitas Riau , Jurusan Agroteknologi , Fakultas Pertanian , Universitas Riau Jur*. 31–45.