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The effect of colchicine application by soaking and dropping on the morphology of M1 red okra plants (*Abelmoschus esculentus* L.)

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ABSTRACT

Okra, often known as Ladies Finger, has many health benefits. Ladies fingers are widely found in tropical countries, including Asia and Africa. However, few Indonesians are familiar with okra as a health plant. This study aims to determine the effect of colchicine concentration and drops on the anthocyanin content of red okra (*Abelmoschus esculentus* L.), and to determine the interaction of colchicine concentration and drops on the anthocyanin content of red okra. This study was conducted at Gg. Susuk VIII No. 2, Padang Bulan Selayang I, Medan Selayang District, Medan City, North Sumatra. This research was conducted from October 2024 to May 2025. This research used a Randomized Block Design method with two factors, namely soaking concentrations of 0 ppm, 250 ppm, and 500 ppm and colchicine drops of 0 ppm, 3000 ppm, and 6000 ppm. The results showed that the administration of colchicine by soaking had no significant effect on plant height, stem diameter, number of leaves, and harvest age. Colchicine drops had a significant effect on stomata length, harvest age, and leaf area. And the interaction between the two treatments, namely soaking treatment and colchicine drops, had a significant effect on fruit diameter

Keyword: Colchicine, Interaction, Okra, Soaking,

ABSTRAK

Okra, yang sering dikenal sebagai Ladies Finger, memiliki banyak manfaat bagi kesehatan. Tanaman ini banyak ditemukan di negara-negara tropis, termasuk di Asia dan Afrika. Namun, tidak banyak masyarakat Indonesia yang mengenal okra sebagai tanaman berkhasiat bagi kesehatan. Penelitian ini bertujuan untuk mengetahui pengaruh konsentrasi dan pemberian tetesan kolkisin terhadap kandungan antosianin okra merah (*Abelmoschus esculentus* L.), serta untuk mengetahui interaksi antara konsentrasi dan pemberian tetesan kolkisin terhadap kandungan antosianin okra merah tersebut. Penelitian ini dilaksanakan di Gg. Susuk VIII No. 2, Padang Bulan Selayang I, Kecamatan Medan Selayang, Kota Medan, Sumatera Utara, pada periode Oktober 2024 hingga Mei 2025. Metode yang digunakan adalah Rancangan Acak Kelompok (RAK) dengan dua faktor, yaitu konsentrasi perendaman (0 ppm, 250 ppm, dan 500 ppm) dan pemberian tetesan kolkisin (0 ppm, 3000 ppm, dan 6000 ppm). Hasil penelitian menunjukkan bahwa pemberian kolkisin melalui metode perendaman tidak memberikan pengaruh nyata terhadap tinggi tanaman, diameter batang, jumlah daun, dan umur panen. Pemberian tetesan kolkisin berpengaruh nyata terhadap panjang stomata, umur panen, dan luas daun. Selain itu, interaksi antara kedua perlakuan—yaitu perendaman dan pemberian tetesan kolkisin—berpengaruh nyata terhadap diameter buah.

Keyword: Colchicine, interaksi, okra, perendaman

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1. Introduction

Vegetables are horticultural plants that contain vitamins, minerals, proteins and sources of calories and nutritious food whose needs are increasing along with the increasing awareness of nutritious food and a healthy lifestyle. One of them is okra (*Abelmoschus esculentus*) still belongs to the Malvaceae family which originates from Africa which then spread to various countries both tropical and subtropical. Okra contains a lot of fiber which is useful for aiding digestion, stabilizing blood sugar and helping control the level of sugar absorption. This vegetable contains vitamins (A, B1, B3, B6 and C), K, Mg, Mn, Fe, Betacarotene, Lutein, zeaxanthin and folate content (Akanbi et al., 2010)

Okra, often known as ladies' finger, has numerous health benefits. Ladies' finger is widely found in tropical countries, including Asia and Africa. Indonesia is still relatively unfamiliar with okra as a health plant; people typically use it as a vegetable, steamed or stir-fried (Septianingrum et all., 2018). Current okra production is still relatively low and unable to meet national demand for okra. Okra production in 2013 was 1,317 tons and in 2014 it was 1,360 tons, while demand for okra in 2015 is projected to reach 1,500 tons (Ichsan et al., 2018).

Okra production in Indonesia needs to be increased for health and consumption purposes. Okra also has significant potential for development due to its high economic value. The average selling price of okra in traditional and modern markets in Medan City to consumers is quite high, ranging from Rp. 25,000 to Rp. 30,000 per kilogram. Okra production in Indonesia remains low due to limited seed availability and a lack of public awareness of this plant's cultivation. Okra plants in Indonesia need to be widely introduced to the public so that the public is aware of its benefits (Cahyanum, 2018).

Okra has two promising varieties for development in Indonesia: red okra and green okra. Okra is an export commodity. In 2016, 500 tons of green okra were exported to Japan. Okra development needs to emphasize high production (quantity) and quality according to market demands. Quality can be determined by appearance (size, color, shape), nutritional content, and bioactive compounds such as anthocyanins (Manik et al., 2019).

Anthocyanins are polyphenol derivatives abundant in nature, found in a wide variety of plants. They are a group of water-soluble pigments found in plants, most abundantly besides chlorophyll. These compounds are natural components that accumulate in vacuoles and are responsible for the red, blue, and purple colors of fruits, vegetables, flowers, and tubers. Anthocyanins have various health benefits, including acting as antioxidants, preventing cardiovascular disease, improving vision, acting as antidiabetics, anti-inflammatory, and anticancer agents (Ifadah et al., 2022).

Anthocyanin levels are influenced by differences in harvest age and depend on the okra variety. Increasing the harvest age by 4 days reduces the anthocyanin levels by 28.41%. Anthocyanin levels are significantly different between the two okra varieties. The highest anthocyanin levels are in red okra at 0.93 μg g-1, 43.01% higher than green okra (Aplugi et al., 2019).

Colchicine is an important mutagen that works by preventing the formation of microtubules and doubling the number of chromosomes. Colchicine is a mitosis inhibitor widely used to induce polyploidy in plants. It works by inhibiting chromosome segregation during cell division, resulting in half the gametes (sex cells) and containing twice the normal number of chromosomes. Chemical mutagens are most commonly used for seed treatment because seeds often remain dormant or can only actively grow if soaked in mutagenic fluids (Sodiq et al., 2023).

The treatment of colchicine concentration with doses of 0 ppm, 2000 ppm, 4000 ppm and 6000 ppm significantly affected the height of okra plants aged 2-13 WAP, the number of leaves at the age of 4-9 WAP, fruit length, fruit weight, number of fruits. The interaction of varieties and colchicine concentration significantly affected the height of okra plants at 11-13 WAP, and the number of leaves at the age of 8 WAP (Lubis, 2024). Therefore, the author is interested in seeing "The Effect of Colchicine Application by Soaking and Drops on the Morphology of M1 Red Okra Plants (*Abelmoschus esculentus* L.).

2. Methods

2.1 Time and place

This research was conducted at Gg. Susuk VIII No. 2, Padang Bulan Selayang I, Medan Selayang District, Medan City, North Sumatra. This location is at coordinates Lat 3.5596180 and Long 98.6488630 with a height of ±28 meters above sea level which was carried out in October 2024 until completion in May 2025.

2.2 Tools and materials

The tools used in this study were a hoe as a tool for cultivating the land, a watering can for watering plants, a rope as a tool to facilitate land preparation, a meter / ruler to measure plant height and fruit length, a hot plate and magnetic stirrer to make colchicine solution, an analytical scale to weigh the components of the colchicine solution, stationery such as pens, books, pencils, or erasers to record observation results, a cellphone to take research documentation, a caliper to measure stem diameter and also fruit diameter, labels to facilitate data collection, a spectrophotometer to measure the anthocyanin content of red okra, and also a microscope to observe the stomata of red okra. The materials used in this study were red okra seeds of the ZAHIRA IPB variety as the commodity to be observed, colchicine powder for the main ingredient of the colchicine solution, NaOH for diluting colchicine, aquabidest, water, dolomite lime for optimal soil pH, manure, compost, urea fertilizer, SP fertilizer, and KCl fertilizer.

2.3 Implementation

Land preparation was carried out by clearing the land of all kinds of weeds and trash around the research area. The planting medium was made by mixing 320 g/plot of rice husk charcoal, 320 g/plot of manure and 800 g/plot of compost on the soil on the surface of the plant plot. Colchicine solution was made. The solution was made by weighing each colchicine powder with a concentration of C1 which is 250 ppm, C2 which is 500 ppm, T1 which is 3000 ppm and T2 which is 6000 ppm.

After weighing, colchicine was placed in different plastic containers according to the colchicine concentration and labeled. In treatments C1 and C2, 62.5 ml of distilled water was used, and in treatments T1 and T2, 10 ml was used on a hotplate for 15 minutes, and 5-6 drops of NaOH were added to facilitate the dissolution of colchicine. The application of colchicine soaking was carried out by placing the seeds in an empty glass and then adding the colchicine solution provided, namely 250 ppm and also 500 ppm until all the seeds were submerged in the colchicine solution.

Colchicine soaking was carried out for 2 hours. Planting red okra seeds that had been given colchicine application by soaking with concentrations of 0 ppm, 250 ppm, and 500 ppm was planted individually in the prepared planting medium, planting was carried out in the morning by removing the seeds from the soaking container. Plants were sown first for 3 weeks before moving the plants to the field. Application of drip concentration in the field was carried out by dripping colchicine solution on the tips of the plants with a concentration of 0.3% (3000 ppm) in treatment C1, and 0.6% (6000 ppm) in treatment C2. Each plant was given a drop concentration of 1 drop per plant and was carried out in the afternoon, namely at 16.00 WIB.

Drip concentrate application is carried out from 1 Week After Planting (WAP), 2 WAP, and 3 WAP. Fertilization is carried out using base fertilizer with the recommended dosage in the form of 100 kg/ha, 150 kg/ha SP, and 150 kg/ha KCl using the dip method in the okra plant area. Fertilization was carried out at 21 and 42 DAP (Days After Planting). The parameters observed were; Plant Height (cm), Stem Diameter (mm), Stem Diameter (mm), Number of Leaves (Shell), Flowering Age (DAP), Harvest Age (DAP), Stomata Length (μm), Stomata Width (μm), Number of Stomata, Leaf Width (cm2), Fruit Length (cm), Fruit Diameter (mm), and Anthocyanin Content (mg/100g).

2.4 Data analysis

This study used a two-factor Randomized Block Design (RAK) with 3 replications: The first factor is Immersion with Colchicine Concentration (C) consisting of: C0: 0 ppm, C1: 250 ppm, and C2: 500 ppm. The second factor is Drop Concentration (T) consisting of: T0: 0 ppm, T1: 3000 ppm, and T2: 6000 ppm so that 9 treatment combinations were obtained. Plot size: 10.8 m x 4.2 m, planting distance: 60 x 30 cm, Number of plants: 54 plants.

The research data were analyzed using analysis of variance based on the following linear model:

$$\mathbf{Yijk = \mu + \tau i + \beta j + + \varepsilon ijk}$$

$$\mathbf{i = 3\ ;\ j = 3;\ k = 3}$$

Information :

Yijk : Observation data from the experimental unit block I with the administration of colchicine by immersion and the administration of colchicine by drops at the jth level and at the kth level repetition.

μ : General mean

τi : Effect of administering colchicine by immersion at level i

βj : The effect of administering colchicine drops at the j-th level

εijk : The effect of error from administering colchicine by immersion at the i-th level and administering colchicine by drops at the j-th level in the k-th level repetition.

The data obtained were analyzed using analysis of variance, and if the treatment had a significant effect, the Duncan's multiple range test (DMRT) was continued at a 95% confidence level. The data were analyzed using SAS software version 9.0.

3. Results and Discussion

3.1 Plant Height (cm), Stem Diameter (mm), Number of Leaves (Sheets)

The results of the analysis of variance showed that the soaking concentration treatment had a significant effect. On plant height (cm), while stem diameter (mm), number of leaves (strands) did not have a significant effect on either treatment. The concentration of soaking, drops and the interaction of the three are presented in Table 1.

Table 1. Plant height, stem diameter, number of leaves Red okra with soaking, dropping and interaction concentration treatments

Parameters	Drop	Soak Concentration ……cm…… 0 ppm (C0)	250 ppm (C1)	500 ppm (C2)	Average
Plant Height	0 ppm (T0)	123.67	127.83	100.83	117.44
	3000 ppm (T1)	114.33	108.67	69.67	97.56
	6000 ppm (T2)	111.17	104.75	107.33	107.75
	Rataan	116.38a	113.75a	92.61b	107.58
Stem Diameter	0 ppm (T0)	29.50	27.93	24.05	27.16
	3000 ppm (T1)	23.80	23.23	22.25	23.09
	6000 ppm (T2)	25.25	23.93	39.75	29.64
	Rataan	26.18	25.03	28.68	26.63
Number of Leaves	0 ppm (T0)	40.50	52.17	31.00	41.22
	3000 ppm (T1)	36.50	38.50	34.17	36.39
	6000 ppm (T2)	47.00	43.50	35.83	42.11
	Average	41.33	44.72	33.67	39.91

Description: Numbers followed by the same letter in the same row indicate no significant difference in Duncan's test at the 5% level.

The highest average plant height was found in the control (C0), namely 116.38 cm, which was not significantly different from the soaking concentration treatment (C1), namely 113.75 cm, but was significantly different from the soaking concentration treatment of 500 ppm (C2), namely 92.61 cm. The largest average stem diameter was found in the 500 ppm soaking concentration treatment (C2), at 28.68 mm. The smallest average stem diameter was found in the 250 ppm soaking concentration treatment (C1), at 25.03 mm. The average stem diameter at 6,000 ppm drip was 29.64 mm, while the average stem diameter at 3,000 ppm drip was 23.09 mm.

The average number of leaves at the soaking concentration was 44.72 in the control (C1), which was significantly different from the other treatments. The average number of leaves at the 6000 ppm (T2) drop application was 42.11 mm. Based on the research results, administering colchicine at a soaking concentration had a significant effect on plant height The highest average plant height was found in the 0 ppm soaking concentration or control, which was 116.38 cm. Control plants had a higher average than treated plants because the colchicine mutagen can inhibit plant growth, resulting in shorter plants treated with colchicine. This occurs due to the disruption of the balance between chromosomes and nuclear components. This imbalance can cause various abnormalities during mitosis and meiosis (Comai 2005; Bharadwaj, 2015; Madlung, 2013). These changes can also give rise to new variations or can result in speciation and reproductive isolation (Vanitha et al., 2013).

Based on the research results, administering colchicine in soaking and drop concentrations did not have a significant effect on okra plant stem diameter. This may be due to each plant species having a different response to polyploidization, which depends on the genome structure, reproductive pattern, ancestral ploidy level, and the purpose for which the plant is cultivated (Sattler et al, 2016). Based on the results of the study, the administration of colchicine with soaking and drop concentrations on leaf number parameter no significant effect. Polyploid plants differ significantly, or sometimes even surpass, diploid plants in terms of their phenotypic expression, which includes morphological, physiological, biochemical, and cellular changes. These polyploid plants can also be taken as new variations or genotypes that can be used in future breeding programs for crop improvement.

3.2 Flowering age (DAS) and harvest age (DAS)

The results of the analysis of variance showed that the treatment of soaking concentration, drops and the interaction of the two did not have a significant effect on flowering age (DAS), while at harvest age (DAS). The results of the analysis of variance showed that the soaking and dripping concentration treatments had a significant effect on the harvest age of red okra.

Table 2. Flowering age and harvest age Red okra with soaking, dropping and interaction concentration treatments

Parameters	Drop	Soak Concentration			Average
		0 ppm (C0)	Day After Sowing (DAS) 250 ppm (C1)	500 ppm (C2)	
Flowering Age	0 ppm (T0)	49.83	50.83	55.00	51.89
	3000 ppm (T1)	49.50	57.00	50.33	52.28
	6000 ppm (T2)	74.00	53.50	48.83	58.78
	Average	57.78	53.78	51.39	54.31
Harvest Age	0 ppm (T0)	107.06	108.83	111.67	109.19a
	3000 ppm (T1)	105.83	114.50	112.56	110.96b
	6000 ppm (T2)	114.11	117.44	111.44	114.33c
	Average	109.00a	113.59c	111.89b	111.49

Description : Numbers followed by the same letter in the same column and row show no significant difference in the Duncan test at the 5% level.

The soaking concentration, the drops, and the interaction between the two treatments had no significant effect on the flowering time of red okra. The fastest flowering time was found in the C0T1 treatment (soaking concentration of 0 ppm and drops of 3000 ppm), at 49.50, and the longest flowering time was found in the C0T2 treatment (soaking concentration of 0 ppm and drops of 6000 ppm), at 74.00.

The fastest harvest age was found in the 0 ppm soaking concentration treatment (C0), namely 109 days after planting, which was significantly different from the 500 ppm soaking concentration treatment (C2), namely 111.89 days after planting and significantly different from the C1 250 ppm treatment, namely 113.59 days after planting. In the 0 ppm drip treatment (T0), namely 109.19 days after planting, which was significantly different from the 3000 ppm drip treatment (T1), namely 110.96 days after planting.

The longest DAS and harvest age were found in the 6000 ppm molasses treatment (T2), namely 114.33, which was significantly different from the other treatments. The results of the study showed that administering colchicine with soaking, dropping, or interaction concentrations between the two treatments had no significant effect in accelerating the growth of colchicine. Flowering age Red okra plants. Colchicine treatment does not affect all plant cells, but the colchicine mutagen affects actively dividing cells. The colchicine mutagen does not enter the plant cells simultaneously, resulting in highly variable changes in the plants due to colchicine treatment. Aili et al., Mitotic chromosome duplication through colchicine treatment produces large inflorescences with more flower parts in salvia plants (*Salvia coccinea cv. Coral Nymph*), but flowering is delayed by up to 10-30 days (Kobayashi et al., 2008).

The results of the study showed that administering colchicine drops had a real effect on harvest age of plants Red okra. The fastest harvest age was found in the control treatment (T0), at 109.19, and the slowest was found in the 6000 ppm molasses treatment (T2), at 114.33. Based on this, the administration of colchicine prolongs the harvest age of red okra plants because colchicine can inhibit plant cell development, resulting in damaged plant tissue, which affects the length of time the fruit ripens. This is in accordance with what was stated by Wiartana Colchicine causes damage to plant tissue, disrupting plant metabolism. A well-functioning plant metabolism supports the formation of plant growth regulators in the form of enzymes and hormones that stimulate cell division. So that plant growth and development can run well. However, due to colchicine treatment, metabolism in plants cannot run well so that the harvest period is longer.

3.3 Stomata Length (µm), Stomata Width (µm), Number of Stomata (Fruit)

The results of the analysis of variance showed that the drip treatment had a significant effect on the length of the stomata (µm), but the soaking concentration treatment and the interaction of the two did not have a significant effect on the length of the stomata. Meanwhile, the results of the analysis of variance for the width of the stomata (µm), the number of stomata (fruit) showed that the soaking concentration treatment, drops and the interaction of the two did not have a significant effect.

Table 3. Stomata length, stomata width, number of stomataRed okra (µm) with soaking, dropping and interaction concentration treatments

Parameters	Drop	Soak Concentration ……µm…… 0 ppm (C0)	250 ppm (C1)	500 ppm (C2)	Average
Stomata Length	0 ppm (T0)	24.61	22.29	31.06	25.98a
	3000 ppm (T1)	21.69	30.14	27.27	26.36a
	6000 ppm (T2)	18.90	22.35	22.49	21.25b
	Average	21.73	24.93	26.94	24.53
Stomata Width	0 ppm (T0)	14.97	16.13	21.90	17.67
	3000 ppm (T1)	13.62	21.36	16.07	17.02
	6000 ppm (T2)	14.90	18.22	15.71	16.28
	Average	14.50	18.57	17.89	16.99
Number of Stomata	0 ppm (T0)	31.00	18.83	22.67	24.17
	3000 ppm (T1)	23.17	13.00	21.00	19.06
	6000 ppm (T2)	20.00	22.83	15.83	19.56
	Average	24.72	18.22	19.83	20.93

Description: Numbers followed by the same letter in the same column and row show no significant difference in the Duncan test at the 5% level.

The longest stomata length of red okra was found in the 3000 ppm drip treatment (C1), namely 26.36 µm, which was not significantly different from the 0 ppm drip treatment (T1), namely 25.98 µm. The shortest average stomata length was found in the 6000 ppm drip treatment (T2), namely 21.25 µm, which was significantly different from the other treatments.

The results of the study showed that the administration of colchicine at a soaking concentration, and the interaction of the two treatments did not have a significant effect on stomata length red okra. However, the administration of colchicine via drip treatment significantly affected the length of okra stomata. The highest average stomata length was found in the 3000 ppm colchicine drip treatment (T1). Meanwhile, the smallest average was found in the treatment with a higher dose, 6000 ppm (T2). This is because higher doses of colchicine can inhibit plant cell enlargement. This is in accordance with the statement by Nahwah et al., that the administration of colchicine concentration can increase the length and width of the stomata of plant leaves so that the area of the stomata produced also increases, but if the plant is given a higher concentration of colchicine, it can cause a decrease in the area of the stomata produced.

Based on the research results, administering colchicine with soaking, dropping and interaction concentrations of the two treatments did not have a significant effect on width and number of stomata The highest average number of stomata was found in the C0T0 treatment with 31 stomata and in the C1T1 treatment with 13 stomata. Colchicine administration has a random effect and colchicine can increase the size of stomata which can reduce the number of plant stomata. According to Rohmah et al., Polyploid induction by colchicine at high concentrations causes the size of the stomata to increase and the number of stomata in one field of view at 40 x magnifications to decrease. Polyploid plants are anatomically characterized by the size of their cells becoming larger, clearly visible in the epidermal cells, cell nuclei, and stomata.

3.3 Leaf Area (cm)^2, Fruit Length (cm), Fruit Diameter (mm), Anthocyanin Content (mg/100g)

The results of the analysis of variance showed that the drip treatment had a significant effect on leaf area (cm2), red okra. While the soaking concentration treatment and the interaction of the two treatments did not significantly affect the leaf area. On the fruit diameter (mm) the results of the analysis of variance showed that the interaction of the two had a significant effect. While the results of the analysis of variance showed that the interaction of the two treatments had a significant effect on the diameter of the red okra fruit, but the soaking concentration and drops treatment had no significant effect. Parameters of fruit length (cm) and anthocyanin content (mg/100g) the results of the analysis of variance showed that the soaking concentration, drops and the interaction of the two had no significant effect.

Table 4. Leaf area, fruit length, fruit diameter, anthocyanin content Red okra with soaking, dropping and interaction concentration treatments

Parameters	Drop	Soak Concentration …..cm^2….. 0 ppm (C0)	250 ppm (C1)	500 ppm (C2)	Average
Leaf Area	0 ppm (T0)	70.92	45.745	58.535	19.47b
	3000 ppm (T1)	62.385	42.615	55.5	17.83b
	6000 ppm (T2)	76.73	104.24	58.94	26.66a
	Average	23.34	21.40	19.22	21.32
Fruit Length	0 ppm (T0)	18.01	19.15	17.89	18.35
	3000 ppm (T1)	18.18	17.93	15.77	17.29
	6000 ppm (T2)	18.30	18.35	18.05	18.23
	Average	18.16	18.48	17.24	17.96
Fruit Diameter	0 ppm (T0)	19.15bc	20.48ab	18.47cd	19.37
	3000 ppm (T1)	18.50cd	22.14a	17.59d	19.41
	6000 ppm (T2)	19.29bc	18.90bcd	20.46ab	19.55
	Average	18.98	20.51	18.84	19.44
Anthocyanin Content	0 ppm (T0)	27.60	21.41	25.39	24.80
	3000 ppm (T1)	23.58	26.68	32.90	27.72
	6000 ppm (T2)	30.54	6.11	31.19	22.61
	Average	27.24	18.07	29.83	25.04

Description: Numbers followed by the same letter in the same column and row show no significant difference in the Duncan test at the 5% level.

The highest leaf area was found in the 6000 ppm (T2) drip treatment, namely 26.66 cm2 which is significantly different from other treatments. The control plant treatment (T0) was 19.47 cm2 which is significantly different from the T2 treatment but not significantly different from the 3000 ppm (T1) drip treatment, namely 17.83 cm2. The interaction of the two treatments significantly affected the diameter of red okra fruit, but the soaking and drops concentration treatments did not significantly affect the diameter of red okra fruit. The largest fruit diameter was found in treatment C1T1 (soaking concentration 250 ppm and drops 3000 ppm) which was 22.14 mm which was significantly different from the other treatments.

The treatment of soaking concentration, drops, and the interaction of the two did not significantly affect the length of red okra fruit. The highest anthocyanin content was found in the C2T1 treatment combination (soaking concentration of 500 ppm and drops of 3000 ppm), namely 32.90 mg/100g, and the lowest anthocyanin content was found in the C1T2 treatment (soaking concentration of 250 ppm and drops of 6000 ppm), namely 6.11 mg/100g. The results of the study showed that administering colchicine drops affected plant leaf area Okra. The largest average leaf area was found in the 6000 ppm (T2) treatment, at 26.66 cm2, and the smallest in the T1 treatment, which had no significant effect on the control plants. The larger leaf area may be due to the administration of colchicine, which inhibits plant cell division, resulting in larger leaves on red okra plants. Prakoso et al., stated that the size and number of leaves became larger after being soaked in colchicine, this is because colchicine has the property of inhibiting the process of chromosome separation, resulting in the addition of chromosomes in the cells. Induced polypoidy can also increase leaf color in balsam (Impatiens balsamina) (Du et al., 2011), self-heal (Prunella vulgaris) (Kwon et al., 2014), wishbone flower (Torenia fournieri) (Boonbongkarn et al., 2013); marigold (Erect marigold) (Shadukhan et al., 2014), chaste tree (Vitex agnus castus) (Ari et al., 2015), and chrysanthemums (Dendranthema grandiflora) (Lertsutthichawan, 2017) as well as increasing the leaf area of the plant.

Based on the research results, the administration of colchicine soaks, drops, or interactions between the two treatments did not have a significant effect on fruit length Red okra. The effects of colchicine can vary, so not all plant parts, such as fruit length, will be affected. Changes in plants resulting from colchicine administration can vary. This is in accordance with the statement by Sirojuddin Some plants experience mutations in almost all parts of the plant, from the growing point to the generative organs, while others only experience mutations in a few organs. It's possible that the colchicine administered to each individual plant doesn't affect all plant cells, but only a subset of them.

The results of the study showed that administering colchicine at soaking and drop concentrations did not have a significant effect on fruit diameter However, the interaction between the two treatments had a significant effect on stem diameter. The largest average fruit diameter was found in the C1T1 treatment, namely 22.14 mm, while the smallest average fruit diameter was found in the C2T1 treatment, namely 17.59 mm, where colchicine also increased the number of seeds, seed weight and percentage of fruit formation in balsam plants (*Impatiens balsamina*) (Dikshit et al., 2014).

Based on the research results, information was obtained that the administration of colchicine in soaking, dropping and interaction concentrations of the two treatments did not affectanthocyanin levels Red okra. Anthocyanin levels are not only influenced by substances like colchicine, but can also be influenced by environmental factors like temperature. This is in accordance with what was stated by Joseph et al. First that anthocyanin is a bioactive compound that can function as

Natural free radical scavengers, also known as natural antioxidant compounds, are known as natural antioxidants. Several factors influence anthocyanin stability, which can affect its antioxidant activity, including pH, temperature, and enzymes. Anthocyanin structure is influenced by pH, with it being more stable in acidic conditions than in alkaline conditions. There are several plants that can be used for ornamental and medicinal purposes, such as celosia flowers (Celosia argentea), which show increased biomass and pharmaceutical compounds (alkaloids, phenols, anthocyanins) in tetraploid plants (Mostafa and Alhamd, 2016). Polyploidy causes a wide variety of effects in plants, but these effects depend on the species and the range of different ploidy levels within the same species, the degree of heterozygosity and depend on various mechanisms related to gene dosage effects, gene silencing, regulation of specific traits, and gene interactions (Ranney, 2006).

4. Conclusion

The application of colchicine immersion with concentrations of 0 ppm, 250 ppm, and 500 ppm significantly affected plant height, stem diameter, number of leaves, and harvest age. In addition, the application of colchicine drops with concentrations of 0 ppm, 3000 ppm, and 6000 ppm significantly affected stomata length, harvest age, and leaf area. The interaction between the two treatments, namely the application of colchicine immersion and the application of colchicine drops, also significantly affected fruit diameter. The use of colchicine at various concentrations and durations through application methods such as whole plant immersion, application of drops to meristem tissue, or using the cotton method, aims to induce polyploidy and create genetic diversity in various types of plants.

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