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**THE EFFECT OF NATURAL GROWTH REGULATORS AND SOAKING TIME  
IN INCREASING GROWTH OF RED GINGER (*ZINGIBER OFFICINALE RUBRUM R.*)  
RHIZOME SHOOTS IN PEAT SOIL**

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**ABSTRACT**

This study aims to determine the growth response of red ginger rhizome shoots to the administration of Natural Growth Regulatory Substances (ZPT) Moringa leaf extract and mung bean sprout extract combined with long soaking time on the growth of red ginger rhizome shoots. The research design used was a completely randomized design (CRD) factorial 2 factors with 5 replications. The first factor was the administration of a Natural Growth Regulatory Substance solution (moringa leaf extract and mung bean sprouts) with 4 levels namely: Z0 (0 g/L water), Z1 (Moringa leaves 300 g/L water), Z2 (mung bean sprouts 300 g/L L water), Z3 (moringa leaves 150 g/L water + mung bean sprouts 150 g/L water). The second factor is the length of immersion time with 4 levels namely: L0 (0 hours), L1 (6 hours), L2 (12 hours), L3 (18 hours). The results showed that there was an interaction between the administration of Natural Growth Regulatory Substances and the length of soaking time on shoot height (17.3 cm), shoot diameter (5.07 mm). Administration of Natural Growth Regulatory Substances Moringa leaf extract (150 g/L water) and mung bean sprout extract (150 g/L water) gave the best results for all variables of observation of sprouting time, number of shoots, shoot diameter and number of taproots. Natural ZPT of mung bean sprout extract 300 g/L water gave the best results on shoot height. While the length of soaking time (6 hours) gave the best results on the observation variables of sprouting time, shoot height and bud diameter of red ginger rhizome.

**KEY WORDS**

Soaking time, red ginger rhizome shoots, natural growth regulatory substances.

Ginger plant is a member of the Zingiberaceae family which has economic and pharmacological value. The ginger plant originates from Tropical Asia, and its distribution ranges from India to China. These plants are not only used as cooking spices, but also as raw materials for traditional medicine, phytopharmaca, health food and drink, as well as cosmetics and body care (Rostiana et al., 2009; Suliasih & Mun'im, 2022).

Ginger is one of Indonesia's exports, although ginger cultivation is not yet optimal so that the production and quality of ginger cannot be predicted. Ginger production in 2018 was 207,411,867 kilograms, production in 2019 decreased by 174,380,120 kilograms, and production in 2020 grew to 183,517,767 kilograms (BPS, 2020).

There are three main forms of ginger in Indonesia: 1) Elephant or rhinoceros ginger (white ginger), red ginger or sunti ginger, and small white ginger or emprit ginger (Rostiana et al., 2001; Anada et al., 2013). Red ginger (*Zingiber officinale rubrum R*) has the highest commercial value of all types of ginger because it contains the highest essential oil. According to Hernani and Hayani (2001), red ginger has higher levels of starch (52.9%), essential oils (3.9%), and alcohol-soluble extract (9.93%) than emprit ginger (41.3, 5%) and elephant ginger (44,2,5%).

Ginger is usually propagated vegetatively, using rhizomes or tubers. Farmers continue to make improvements, one of which is improving the quality of ginger seeds (rhizome). Seed selection is the key to success, affecting crop quality and yield. Therefore, the occasional use of ginger seeds depends only on the existing plant. When the plant has produced fruit, some of the fruit is stored to be used as seeds for the next generation, then



the seeds are replanted and will eventually produce fruit, and so on (Hieronymus, 2004).

According to Limbongan and Yonathan (2018), the long dormancy period of red ginger presents a breeding challenge. Two to four weeks after the rhizomes sprout, red ginger plants will emerge. The dormancy period of red ginger rhizomes can be shortened by intensifying cultivation or by administering growth regulators (Setyowati, 2015). One way to increase the growth of red ginger rhizome is a growth regulator or hormone (Hutubessy et al., 2008). According to Kusumo (2009), growth hormone (ZPT) is an organic molecule that is not a food and works to stimulate, inhibit, or control physiological processes in plants in very small amounts. The Auxin, Gibberellin, Cytokinin, Ethylene and Inhibitor groups consist of these hormones.

Moringa leaf extract is a natural growth regulator. Moringa plants contain substances that can be used as medicine or to increase plant growth. Moringa leaf extract contains growth hormones, cytokinins and zeatin. Cytokinins are plant hormones that stimulate cell division and proliferation, promote new cell development, and delay cell aging. Zeatin is an effective anti-aging antioxidant (Krisnadi, 2015). According to Rahman et al (2007), treatment of sugar cane with Moringa leaf extract affected root volume, and there was an interaction between dose and variety. The height of the sugarcane plant and the number of tillers are affected by the variety. The BM 9044 variety had an effect at a dose of 10 ml/l Moringa leaf extract, while the BM 9605 and BM 9514 varieties had an effect at a dose of 20ml/l and 30ml/l, respectively.

Sprouts are a source of natural growth regulators besides Moringa leaf extract. Because mung bean extract contains auxin, which promotes cell elongation, cell division, and differentiation of xylem and phloem tissues, it can be used as a growth regulator. According to Warohmah and Karyanto's research (2018), a combination of 100 g/l sprouts extract and 100 g/l moringa leaf extract was able to increase the growth of mangosteen seedlings, as evidenced by an average increase in the number of leaves of 1.78 and the number of roots in 21 days. Moringa leaf extract and possibly bean sprout extract are believed to accelerate the growth of plant shoots in certain amounts. low concentration if it supports the given low concentration and modifies and inhibits the plant physically (Sunarlim et al., 2012).

Soaking in water removes chemicals that inhibit germination and softens the seed coat. Soaking can speed up the absorption process. Soaking is one technique for overcoming physical dormancy, but there is a risk that the seeds will die if left too long in water (Saefas et al., 2017). According to Fachri's research (2019), the height of red ginger plants is affected by the length of immersion in young coconut water. The maximum effect on plant height parameters was obtained at 18 hours of immersion, namely 11.69 cm, while the worst effect was observed at 6 hours of immersion, namely 3.59 cm. This happens because the hormone cytokinin stimulates an increase in the number of stems per bunch. This is in accordance with Ajar's statement (2015) that auxin has the ability to stretch plant cells, gibberellins can stimulate cell division and cell elongation, or both, and cytokinins encourage cell division to promote plant development.

There has been no research on the effect of natural growth regulators such as moringa leaf extract and bean sprout extract on the growth of red ginger shoots along with soaking time. Therefore, it is necessary to conduct a study to determine the growth response of red ginger rhizome to the administration of natural ZPT along with the soaking time.

## MATERIALS AND METHODS OF RESEARCH

Penelitian ini dilaksanakan di Green Experimental Garden Installation House (IKP), Department of Agricultural Cultivation, Faculty of Agriculture, University of Palangkaraya, from July to September 2022. The materials used in this study were red ginger rhizome of the Jahira II variety weighing 10 grams, having 1 bud, leaves Moringa 450 g, green beans, green bean sprouts 450 g, water, 20 x 20 cm poly bag, nordox fungicide, peat soil from Kalampangan and goat manure. The tools used are a cutter, ruler or ruler, 2000 ml plastic measuring cup, digital scale, 1500 ml blender, hoe, 5 liter bucket, cell phone camera,



container (1000 ml mica box), label paper, 15 cm diameter plastic filter, calipers. slides and writing tools that support research.

This study used a completely randomized design (CRD) arranged in a factorial manner consisting of 2 factors with 5 replications. The first factor is the natural ZPT concentration which consists of 4 levels (Z), namely: Z0 = g/liter of water (control); Z = 300 g of Moringa leaves/liter of water; Z2 = 300 g of mung bean sprouts/liter of water; Z3 = 150 g of moringa leaves/liter of water + 150 g of mung bean sprouts/liter of water. The second factor was the soaking time of the red ginger shoots which consisted of 4 levels (L), namely: L0 = No Treatment; L1 = 6 hours; L2 = 12 hours ; L3 = 18 hours.

Moringa leaf extract which comes from the oldest part of the Moringa leaf is indicated by the characteristic dark green leaves. 450 grams of Moringa leaves to be used are washed thoroughly with water and then drained, after that the Moringa leaves are divided based on the treatment, namely 300 grams and 150 grams. Moringa leaves are blended for 2 minutes by adding water to the volume

500 ml then filtered. Before use, the filtered solution is added with water until the volume becomes 1000 ml. The preparation of mung bean sprout extract begins with making sprouts from mung bean seeds by soaking them in water and then soaking mung bean seeds for 24 hours. After 3 days and the hypocotyl length of the sprouts is 3 cm, the sprouts can be blended to extract the extract. The sprouts were weighed based on the weight according to the treatment, namely 300 grams and 150 grams, then blended for 2 minutes by adding 500 ml of water, then filtered. Observational variables included vigor index, sprouting time, number of shoots, shoot height, shoot diameter, number of taproots. The data obtained were analyzed by analysis of variance (Anova) using the F test at 5% and 1% level, if there is a significant difference it is continued with the Honest Significant Difference Test (HSD) at the level  $\alpha = 5\%$  to find out the difference between treatments.

## RESULTS AND DISCUSSION

The results of the analysis of variance showed that there was no interaction between the natural ZPT treatment and the long soaking time on the vigor index variable. For the single factor Natural ZPT treatment there was a significant effect on the vigor index and no significant effect on the long soaking time treatment. Vigor index (%) of red ginger rhizome shoots with natural ZPT administration and soaking time are presented in the table 1.

Table 1 – Vigor Index (%) of Red Ginger Rhizome Shoots with Natural ZPT Administration and Soaking Time

ZPT Natural (Z)	Long Soaking Time (L)				Average
	L0	L1	L2	L3	
Z0	92	90	90	88	90 a
Z1	98	100	100	100	99.5 b
Z2	98	100	100	100	99.5 b
Z3	100	100	100	98	99.5 b
Average	97	97.5	97.5	96.5	
HSD 5 % Z =	4.65				

Note: Numbers followed by the same letter in the same column are not significantly different at the significance level HSD 5%.

The results of the average vigor index showed that in the treatment of 300 g/L water (Z1) moringa leaf extract, 300 g/L water (Z2) mung bean sprout extract and 150 g/L water + green moringa leaf extract treatment. bean sprout extract 150 g/L water (Z3) was not significantly different; but significantly different when compared to the 0 g/L water treatment (Z0). During immersion, the vigor index of red ginger rhizome was greatest at 6 hours (L1) and 12 hours (L2) treatment, followed by 0 hours (L0) treatment and 18 hours treatment (L18) (Z3).

Based on Ramadhan's research, (2019) the results of this study revealed that natural ZPT could increase the vigor index of red ginger shoots. Auxin Z1 at a concentration of 150



mg/L increased the vigor index of red ginger plants by 44.44 percent compared to other concentrations. Vigor is the ability of seeds to grow normally in less than ideal environmental conditions. In general, seed vigor should be proportional to yield rate. Each plant contains hormones that stimulate germination, but their amounts are so small that they must be supplemented so that the seeds and rhizomes grow more quickly and effectively. Teffa (2015) said that low concentrations of growth regulators would inhibit plant growth, while high concentrations would kill plants. For optimal results, administration should be arranged. Kusumo (2009) further said that ZPT concentrations will change the amount and rate of absorption in seeds and rhizomes thereby affecting germination and fertility of rhizomes. The duration of soaking for the hormones auxin and cytokinins affects the response and characteristics of different plants (Hamzah et al., 2016; Junaedy, 2018; Irmayanti et al., 2021; Wafia et al., 2021; Noor & Melani, 2022). The hormones auxin and cytokinin are thought to be able to directly change the strength index of red ginger, because the number of tuna that were given long-soaking treatment tended to be more than those without treatment (control). However, soaking for too long will damage the plants. The hormone auxin contributes to apical dominance. Apical dominance will result from increased auxin activity in the shoots of the stems, causing the shoots to remain inactive and appear longer (Ferguson & Beveridge, 2009; Mason et al., 2014; Müller et al., 2015; Kebrom, 2017; Roni, 2017).

The results of the analysis of variance showed that the natural ZPT treatment and the length of soaking time did not interact with the sprouting time variable. For the single factor Natural ZPT treatment there was a significant effect on the time of sprouting and also a significant effect on the long soaking time. The germination time (days) of red ginger rhizome with natural PGR administration and soaking time are presented in the table 2.

Table 2 – Germination Time (Days) of Red Ginger Rhizomes with Natural ZPT Administration and Soaking Time

ZPT Natural (Z)	Long Soaking Time (L)				Average
	L0	L1	L2	L3	
Z0	12.2	12.4	12	12.6	12.3 b
Z1	12.2	11.6	10.8	10	11.15 a
Z2	11.4	10.2	9.4	10.4	10.35 a
Z3	10.8	9.4	9.6	10.4	10.05 a
Average	11.65 b	10.9 ab	10.45 a	10.85 ab	

HSD 5% Z = 1.01  
 HSD 5% L = 1.01

The average results from table 2 show that Z3 has the shortest germination period with an average shoot of 10.05 days, while Z0 has the longest germination period of 12.3 days. The L1 treatment had the best germination time with an average of 10.9 days, while the L0 treatment had the worst germination time with an average of 11.65 days. Table 3 shows that natural ZPT treatment of Moringa leaf extract 300 g/L water (Z1), mung bean sprout extract 300 g/L water (Z2), and Moringa leaf extract 150 g/L water + mung bean sprout extract 150 g/L water (Z3) did not appear to be significantly different, but significantly different from the 0 g/L water (Z0) treatment. In the 0 hour long treatment (L0), the soaking time did not change much from the 6 hour (L1) and 18 hour (L3) treatment, but it was much different from the 8 hour treatment (L2).

On average, red ginger rhizome plants sprout 19.50 days after being given 50 percent shallot extract, according to Syahrul's research from 2022. According to Haryadi (2002), the response of each plant to the appearance of buds is different. The rate of bud emergence is influenced by several variables, including the density of the rhizome used. In addition, ZPT chemicals are not plant nutrients that can inhibit, stimulate or accelerate plant growth.

The results of the analysis of variance showed that there was no interaction between the natural ZPT treatment and the length of soaking time on the number of shoots variable. For the single factor treatment of Natural ZPT there was a significant effect on the number of shoots at the ages of 25, 35 and 45 dap. However, it had no significant effect on the long soaking time. The average number of red ginger rhizome shoots with natural ZPT administration and soaking time is presented in the table 3.



Table 3 – Average Number of Red Ginger Rhizome Shoots with Natural ZPT Administration and Soaking Time

Plant Age (DAP)	ZPT Natural (Z)	Long Soaking Time (L)				Average
		L0	L1	L2	L3	
15	Z0	1	1	1	1	1
	Z1	1	1	1	1.2	1.05
	Z2	1	1.2	1.2	1.2	1.15
	Z3	1	1.2	1.2	1	1.1
	Average	1	1.1	1.1	1.1	
25	Z0	1	1	1	1	1 a
	Z1	1	1	1	1.2	1.05 a
	Z2	1	1.2	1.4	1.2	1.2 ab
	Z3	1.2	1.6	1.2	1.4	1.35 b
	Average	1.05	1.2	1.15	1.2	
HSD 5% Z =		0.29				
35	Z0	1	1	1	1	1 a
	Z1	1.4	1.4	1.4	1.4	1.4 ab
	Z2	1.2	1.6	1.6	1.2	1.4 ab
	Z3	1.2	2	1.6	1.6	1.6 b
	Average	1.2	1.5	1.4	1.3	
HSD 5% Z =		0.40				
45	Z0	1	1	1	1	1 a
	Z1	1.4	1.4	1.4	1.4	1.4 ab
	Z2	1.2	1.6	1.6	1.2	1.4 ab
	Z3	1.2	2	1.6	1.6	1.6 b
	Average	1.2	1.5	1.4	1.3	
HSD5% Z =		0.40				

There is the influence of Natural ZPT Moringa leaf extract and mung bean sprout extract on the number of red ginger rhizome shoots at 25, 35, and 45 hst, as shown in the average data in Table 3. The highest number of rhizome shoots detected was in the treatment containing moringa leaf extract 150 g/L water + mung bean sprout extract 150 g/L water (Z3), which is as much as 1.6 tuna, while the lowest amount was found in the treatment containing 0 g/L water (Z0). At 25 hst treatment, the treatment of moringa leaf extract 150 g/L water plus mung bean sprout extract 150 g/L water (Z3) had a significant effect which was not significantly different from mung bean extract 300 g/L water (Z2), but significantly different with Moringa leaf extract 300 g/L water (Z1) and 0 g/L water (Z0). At the age of 35 and 45 hst, treatment of moringa leaf extract 150 g/L water + mung bean sprout extract 150 g/L water (Z3) had a very significant effect but was not significantly different from mung bean sprout extract 300 g/L water (Z2). and moringa leaf extract 300 g/L water (Z1), but significantly different from 0 g/L water (Z0). According to Tambunan et al (2018), auxin functions optimally at low amounts but inhibits plant development at high concentrations.

Optimal relationship between cytokinin and auxin will promote cell division and differentiation. By increasing the rate of protein synthesis, cytokinins promote cell division. Cytokinins together with auxins play an important role in the development of stem cell division and tissue differentiation (Dwijasaputro, 2004; Su etval., 2011; Takatsuka & Umeda, 2014; Schaller et al., 2015; Singh et al., 2017; Di Mambro et al., 2017; Sharma & Zheng, 2019).

Based on the findings of this study, giving natural ZPT can increase the number of red ginger rhizome shoots. The growth of red ginger rhizome shoots was increased by administering 150 g/L moringa leaf extract and 150 g/L bean sprout extract (Z3) in water. According to research by Jufri et al (2014), administration of sprout extract in tissue culture media with a concentration of 100-200 g/L of water can give the greatest results in banana culture when compared to media without the addition of natural ZPT.

The results of the analysis of variance showed that the natural ZPT treatment and the length of immersion time had interactions with the variable number of shoots at 45 hst. The single factor of the Natural ZPT treatment and the long immersion time treatment had a significant effect on the shoot height variable. The average height of red ginger rhizome shoots with natural zpt administration and soaking time are presented in the table 4.



Table 4 – Average Height of Red Ginger Rhizome Shoots with Natural ZPT Administration and Soaking Time

Plant Age (DAP)	ZPT Natural (Z)	Long Soaking Time (L)				Average
		L0	L1	L2	L3	
15	Z0	0.44	0.4	0.74	0.7	0.57 a
	Z1	0.68	0.96	1.54	1.04	1.06 ab
	Z2	1	1.9	1.52	1.66	1.52 b
	Z3	1.18	1.62	1.84	0.82	1.37 b
	Average	0.83 a	1.22 ab	1.41 b	1.06 ab	
HSD 5% Z =		0.50				
HSD 5% L =		0.50				
25	Z0	1.78	1.5	2.12	2.26	1.92 a
	Z1	2.04	2.78	3.7	2.46	2.75 ab
	Z2	2.62	4.66	4.34	3.76	3.85 b
	Z3	2.26	3.94	3.8	1.52	2.88 ab
	Average	2.18 a	3.22 b	3.49 ab	2.50 ab	
HSD 5% Z =		1.25				
HSD 5% L =		1.25				
35	Z0	3.06	2.62	2.84	3.2	2.93 a
	Z1	4	6.06	6.68	5.58	5.58 b
	Z2	4.7	9.04	8.38	7.16	7.32 b
	Z3	5.9	10.66	7.48	3.16	6.80 b
	Average	4.42	7.10	6.36	4.78	
HSD 5% Z =		2.24				
45	Z0	5.64 a	5.36 a	5.3 a	5.26 a	5.39
	Z1	9.1 a	9 a	12.6 b	10.96 a	10.42
	Z2	8.36 a	14.24 b	15.98 b	13.92 b	13.13
	Z3	11.38 a	17.3 c	10.86 a	6.84 a	11.60
	Average	8.62	11.48	11.19	9.25	
HSD 5% ZxL =		6.65				

Natural ZPT (moringa leaf extract and mung bean sprout extract) with 45 hst soaking time resulted in the highest average height of rhizome shoots in the Z3L1 treatment, namely 17.3 cm, and the lowest average height in the Z0L3 treatment, amounting to 5.26 cm. The treatment of Z1L2, Z2L1, Z2L2, Z2L3, Z3L1 is very different from Z0L0, Z0L1, Z0L2, Z0L3, Z1L0, Z1L2, Z1L3, Z2L0, Z3L0, Z3L2 and Z3L3.

Sumarny and Padang (1983) reported that auxin and cytokinins regulate shoot height growth. Cytokinins promote cell division by increasing protein synthesis, whereas auxins stimulate cell elongation, resulting in stem elongation. According to Jeruto (2008), prolonged soaking in ZPT auxin and cytokinins results in microbial degradation, so that the longer the soaking, the lower the concentration required.

The results of the analysis of variance showed that natural ZPT administration of moringa leaf extract and mung bean sprout extract gave the best response to high growth of cob plants, especially in the treatment of bean sprout extract 300 g/L water (Z2) with an average of 1.52 cm and the lowest treatment was 0 g/L water (Z0) with an average of 0.57 cm (Z0). On the 25th day the best natural ZPT therapy was only 300 g/L water (Z2) bean sprout extract with an average height of 3.85 cm, while the worst treatment was 0 g/L water (Z0) with an average height of 1.95 cm. The Z1 treatment was not significantly different between the Z1 and Z3 treatments, but much different from the Z2 treatment. At 35 hst, the best treatment was mung bean sprout extract 300 g/L (Z2) and the worst treatment was 0 g/L water (Z0) with an average height of 2.92 cm. The Z0 treatment was distinguished from the Z1, Z2, and Z3 treatments. At 45 hst, the best treatment was 300 g/L bean sprout extract (Z2) and the worst treatment was 0 g/L water (Z0) with an average height of 5.39 cm. According to the statement, the addition of 300 g/L of mung bean sprout extract to 300 g/L of water can increase the growth of red ginger rhizomes in tuna. Chlorophyll concentration in edamame soybean plants compared to the control treatment (0%).

Based on Table 4, the 15 hst soaking time produced the best response, namely 12 hours (L2) with an average of 1.41 cm, while the treatment with the lowest response was 0 hours (L0) with an average of 0.86 cm. The 0 hour treatment (L0) was not significantly



different from the 6 hour treatment (L1), but significantly different from the 12 hour and 18 hour treatment (L2 and L3) (L3). At 25 hst, the treatment with the largest reaction was 12 hours of immersion (L2) with an average of 3.49 cm, while the treatment with the smallest response was 0 hours (L0) with an average of 2.50 cm. The 0 hour treatment (L0) was not significantly different from the 6 hour (L1) and 18 hour (L3) treatment, but significantly different from the 12 hour treatment (L2). At 35 DAP, the treatment with the longest immersion time gave the best results: 6 hours (L1) with an average of 7.10 cm while the treatment with the shortest immersion time was 0 hours (L0) with an average of 4.50 cm. At 45 HST, the treatment with the longest immersion time of 6 hours (L1) gave the highest yield with an average growth of 11.48 cm, while the treatment with the shortest immersion time of 0 hours (L0) produced an average growth of 8.52 cm. Based on this statement, soaking the rhizome of red ginger shoots for 6 to 12 hours can accelerate its growth. The duration of soaking lettuce pieces in young coconut water affects height according to Fachri's research (2019). Soaking for 12 to 18 hours had the greatest effect on plant height parameters compared to no treatment or control.

The results of this study indicate that supplementation of the rhizome of red ginger shoots with 300 g/L natural ZPT of bean sprout extract (Z2) can increase height growth. Red ginger rhizome shoots can grow taller after 6 hours of immersion (L1). According to Ramadhan's research (2019), ZPT Auxin and 300 mg/L water had the greatest effect on the average red ginger rhizome height of 21.9 centimeters compared to other treatments which produced an average of 14.2 centimeters. This is because natural ZPT concentrations and soaking time will influence each other and encourage the process of root formation followed by the process of cell division, elongation, and cell elongation at the ends, as in tuna (Ross, 2008).

The results of the analysis of variance showed that the natural ZPT treatment and the length of soaking time had interactions with the variable shoot diameter. The single factor was the Natural ZPT treatment and the long soaking time had a significant effect on the variable shoot height at the ages of 23, 35 and 45 dap. The average diameter of red ginger rhizome shoots with natural ZPT administration and soaking time is presented in the table 5.

Table 5 – Average Diameter of Red Ginger Rhizome Shoots with Natural ZPT Administration and Soaking Time

Age Plant (DAP)	ZPT Natural (Z)	Long Soaking Time (L)				Average
		L0	L1	L2	L3	
15	Z0	0.31	0.33	0.2	0.31	0.29 a
	Z1	0.49	0.89	0.77	0.78	0.73 b
	Z2	0.69	1.06	1.29	1.28	1.08 c
	Z3	1.27	1.42	1.58	1.30	1.39 d
	Average	0.69	0.93	0.96	0.92	
HSD 5% Z =		0.20				
25	Z0	0.84 a	0.68 a	0.84 a	1.47 b	0.96
	Z1	1.52 b	1.73 b	2.2 c	2.15 c	1.90
	Z2	2.07 b	2.49 c	2.27 c	2.12 b	2.24
	Z3	2.64 c	2.93 d	2.21 c	2.10 b	2.47
	Average	1.77	1.96	1.88	1.96	
HSD 5% ZxL =		0.66				
35	Z0	1.94 a	2.19 a	2.0 a	2.1 a	2.06
	Z1	2.61 a	3.08 b	3.01 b	2.92 b	2.91
	Z2	2.49 a	2.90 b	2.99 b	2.95 b	2.83
	Z3	2.94 b	4.35 c	2.85 b	2.74 a	3.22
	Average	2.50	3.13	2.17	2.68	
HSD 5% ZxL=		0.83				
45	Z0	3.23 a	3.28 a	3.04 a	3.02 a	3.14
	Z1	3.03 a	3.70 a	4.32 b	3.45 a	3.63
	Z2	3.14 a	4.09 b	3.85 a	3.90 a	3.75
	Z3	4.18 b	5.07 c	4.45 b	3.29 a	4.25
	Average	3.40	4.04	3.92	3.42	
HSD 5% ZxL =		0.88				



Table 5 shows the interaction between natural ZPT (moringa leaf extract and mung bean extract) and soaking time on red ginger cob rhizome diameter at 25, 35, and 45 dap. At 25 hst, treatment Z3L1 produced tuna with the largest average diameter of 2.93 mm, while treatments Z0L0 and Z0L2 produced tuna with the smallest average diameter of 0.84 mm. Z0L0, Z0L1, Z0L2 treatment significantly different from Z0L3, Z1L0, Z1L1, Z2L0, Z2L3, Z3L3 substantially different from Z1L2, Z1L3, Z2L1, Z2L2, Z3L0, Z3L2 significantly different from Z3L1 therapy. At 35 dap, the Z3L1 treatment produced tuna with an average diameter of 4.35 mm, while the Z0L0 treatment produced shoots with an average diameter of 1.90 mm. The Z0L0, Z0L1, Z0L2, Z0L3, Z1L0, Z2L0, and Z3L3 treatments can be distinguished from the Z1L1, Z1L2, Z1L3, Z2L1, Z2L2, Z2L3, Z3L0, and Z3L2 treatments, which can be distinguished from the Z3L1 treatment. The treatment with the largest average diameter of tuna at 45 dap was Z3L1, with an average of 5.07 mm, while the treatment with the smallest diameter was Z0L3, with an average of 3.0 mm. Treatment Z0L0, Z0L1, Z0L2, Z0L3, Z1L0, Z1L1, Z1L3, Z2L0, Z2L2, Z2L, Z3L3 significantly different from treatment Z1L2, Z2L1, Z3L0, Z3L2 significantly different from treatment Z3L1. This is probably the result of the interaction between the two Z3 treatments (150 g/L water of moringa leaf extract and 150 g/L water of mung bean sprouts extract) and L1 soaking time (6 hours). red. According to Hartini's research (2020), natural PGR of 20% moringa leaf extract and 5 hours of soaking time had the best effect on sugarcane seedling height, stem diameter, and number of leaves compared to no treatment/control. This is in accordance with the reserve (Mulyani, 2015) which states that soaking time and optimal solution concentration will encourage growth and produce a positive response to plant development.

Based on the follow-up test results with an honest significant difference of 5%, moringa leaf extract and possibly bean sprout extract are the most effective natural PGRs for increasing tuna diameter. Red ginger rhizome between 15 and 45 dap. At the age of 15 days the best treatment was Z3 with a diameter of 1.39 mm and the worst treatment was Z0 with a diameter of 0.29 mm. The treatment of Z0 is much different from Z1 and Z2 is significantly different from Z3. The best treatment at 25 DAP was Z3 with a diameter of 2.47 mm, while the worst treatment was Z0 with a diameter of 0.96 mm. At 35 DAP the best therapy was Z3 with a diameter of 3.22 mm, while the worst treatment was Z0 with a diameter of 2.06 mm. At 45 DAP the best treatment was Z3 with a diameter of 4.25 mm, while the worst treatment was Z0 with a diameter of 3.14 mm.

The results of this study indicate that giving ZPT natural Z3 moringa leaf extract (150 g/L water) + mung bean sprout extract (150 g/L water) produces the best response seen from a larger diameter compared to other treatments, and also that the soaking time Z1 (6 hours) increased the growth diameter of red ginger cob rhizomes with a larger diameter than the other treatments, so the Z3L1 combination gave the best response to shoot diameter. Based on the findings of Eko and Kaswan (2013), a combination of auxin and cytokinin ZPT types with 6 hours of soaking time was the most effective treatment for affecting root length, number of roots, and stem diameter of red betel cuttings.

Table 5 shows that the width of the shoot rhizome was 52% larger when exposed to natural zpt and soaking time compared to when not exposed to natural zpt and not soaked (control). This is because the administration of natural ZPT is in accordance with the recommended use of 5T (right ZPT, right plant, right time, right environment, and right concentration), giving ZPT evenly. Furthermore, it is influenced by the mechanism of action of ZPT, namely the chemical structure of the substance which includes absorption, translocation, and alliteration, as well as environmental factors such as temperature, humidity, and light intensity. And ZPT will operate most efficiently at effective concentrations.

The results of the analysis of variance in the number of taproots indicated that the natural ZPT treatment and the length of soaking time did not interact with the variable number of taproots. The single factor treatment of natural ZPT had a significant effect on the variable number of taproots but the long soaking time had no significant effect.

Natural PGR therapy has an impact on the average number of taproots of red ginger. Based on the results of follow-up tests which showed a statistically significant difference of 5%, the best natural PGR consisting of moringa leaf extract and mung bean sprout extract





gave the greatest root response to red ginger. The ZPT Natural Z3 treatment produced the highest average number of taproots with 7.25 roots, while the Z0 treatment produced the least with 4 roots. Z0 treatment was not significantly different from Z1, but significantly different from Z2 and Z3 treatment. According to (Zulfiqar et al., 2009; Krome et al., 2010; Agulló-Antón et al, 2011; Eko and Kaswan, 2013; de Vries et al., 2016; Gentile et al., 2017), the right concentration of auxin and cytokinin will encourage root elongation, the number of roots, and the diameter of plant shoots.

Table 6 – Average number of taproots with natural ZPT administration and length of soaking time at 45 dap

Plant Age (dap)	ZPT Natural (Z)	Long Soaking Time (L)				Rata- average
		L0	L1	L2	L3	
45	Z0	5	5	4.5	1.5	4 a
	Z1	5	5	6	5	5.25 ab
	Z2	5.5	7	7	6	6.38 b
	Z3	7.5	8.5	7.5	5.5	7.25 b
	average	5.75	6.38	6.25	4.5	

HSD 5% Z = 2.03

In accordance with Warohmah's research (2018), the combination of 100 g/l sprout extract and 100 g/l moringa leaf extract has the potential to increase the growth of mangosteen seedlings, as evidenced by the average increase in the number of leaves to 1.78 and the number of secondary roots to 21 strands. According to research (Adnan, 2017), treatment with auxin and cytokinin concentrations of 15-20 ml had a considerable effect on root length of watermelon seeds soaked for 6 hours compared to other treatments.

## CONCLUSION

Natural PGR application and soaking time increased stem diameter of shoots aged 25 dap (2.93 mm), 35 dap (4.35 mm), and 45 hst (17.3 cm) (5.07 mm) on peat soils. ZPT Natural Moringa leaf extract 150 g/L water with mung bean sprout extract 150 g/L water increased germination time (10.05 days), number of shoots (1.6), diameter of shoots (4.25 mm), and number of roots mount (7.25 roots). Meanwhile, soaking time of 6 hours increased germination time (10.9 days), shoot height (11.48 cm), and shoot diameter (4,04 mm).

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