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Increasing the Growth of Bridal Tears Flower Stem Cuttings (*Antigonon leptopus*) by providing Plant Growth Regulators and Planting Media

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ABSTRACT

It is imperative to implement integrated control measures for Oil Palm Leaf-Eating Caterpillars (UPDKS), as continual chemical management can result in pest resistance and environmental degradation. Utilizing natural enemies for biological control involves the utilization of predators, pest-consuming animals, as well as parasites or bacteria with pathogenic properties against pests. Examples of predators, including Sycanus leucomesus and Eocanthecona furcellata, egg parasitoids, such as Trichogrammatidea thoseae, and larval parasites, such as Chaetexorista javana, are a few of the many types of organisms that can have an impact on the populations of their prey. These indigenous predators sustain themselves by feeding on host plants within their natural habitat. The bridal tears flower (*Antigonon leptopus*) is considered to be one of the host plants. Thus, it is imperative to promote the growth of *Antigonon leptopus* in order to provide a habitat for the natural predators of the UPDKS pest. The objective of this research was to identify the components of the planting medium and to establish the most effective concentration of growth regulators for propagating bridal tears stem cuttings (*Antigonon leptopus*). The research was conducted at the Indonesian Palm Oil Technology Institute (ITSI) Practice Garden in Medan, North Sumatra. The research was conducted over three months, from February to April 2024. The Factorial Randomized Block Design (RAK) method was employed, with the first factor, namely S (Planting Media), comprising three levels: Top Soil without solid, Top Soil with 20% Solid, and Top Soil with 40% Solid. The second factor, namely Plant Growth Regulators, was also treated with three levels: without plant growth regulators, concentration of 100 Mg/l, and concentration of 200 Mg/l. Thus, the study comprises nine treatment combinations, each with four replications. The analysis of variance (ANOVA) table is employed to assess the significance of the observed differences, with the Duncan multiple range test (DMRT) conducted at a 5% level of significance when warranted. The findings from the research indicated that the manipulation of the planting medium composition (S) had a notable impact on the number of leaves, number of roots, and fresh weight of the roots. Additionally, it was found to have a highly significant influence on the height of the shoots. The optimal composition of the planting medium was identified as S2. The manipulation of growth regulators (R) concentration had a notable impact on shoot height and root fresh weight, as well as a highly significant effect on the number of leaves and roots. R2 exhibited the most optimal concentration of growth regulators. The growth of *Antigonon leptopus* stem cuttings was not affected by the combination of planting medium composition (S) and growth regulator concentration (R) in a non-interacting manner.

Keywords: *Antigonon leptopus*, Growth Regulators, Planting Media, Solid, Stem Cuttings

1. INTRODUCTION

The bride's tears plant (*Antigonon leptopus*) faces numerous challenges when cultivated in oil palm plantations, mainly due to its requirement for specialized care to thrive. Propagation of *Antigonon leptopus* can be achieved through two primary methods: generative and vegetative. Generative propagation involves the sowing of seeds, which subsequently develop into new plants. In contrast, vegetative propagation is the more prevalent method, as it utilizes specific plant parts or tissues for growth and development. Naturally, propagation occurs through mechanisms such as cell division, spores, shoots, rhizomes, and tubers, while vegetative methods typically involve techniques like cuttings and grafting (Silaban et al., 2023). For grape plants, propagation is commonly performed through stem cuttings, a method favored for its practicality and cost-effectiveness, as it requires a relatively small area of land to yield a significant number of plants compared to grafting techniques (Riyanto et al., 2022)

Several factors, including endogenous, hormonal, environmental, and nutrient stock factors, influence vegetative propagation. The most significant factor at play is the influence of hormones. In general, the hormones or plant growth regulators (PGRs) can be classified into three main categories: auxin, gibberellin, and cytokinin hormones. The proposed solution for accelerating root growth involves the utilization of plant growth regulators (ZPT) containing the active ingredient Naphthaleneacetamide. This approach aims to enhance the population of predator host plants during the desired period in order to achieve optimal results. Hence, it is imperative to ascertain the appropriate concentration for the utilization of plant growth regulators in order to distinctly observe their impact on the development of both shoots and roots in *Antigonon leptopus* (Lutfiani et al., 2022).

Typically, plant growth regulators utilized belong to the auxin group, specifically Indole Acetic Acid (IAA) and Naphthalene Acetic Acid (NAA). In addition, it is essential to note that this ZPT is artificially derived with functionality comparable to that of the natural auxin hormone. The frequently traded plant growth regulator is root Up, a blend of IBA and NAA formulations commonly used for this purpose. The increased prevalence of Root Up can be attributed to its superior efficiency, rapid growth rate, and cost-effectiveness in comparison to the less readily available Rootone F, despite the similarity in their use and functionality. (Watu et al., 2017).

The composition of the planting medium plays a crucial role in the nursery process, as it directly impacts root development, which is essential for the plant's support. To achieve optimal conditions that meet the requirements of the plants, the medium must possess a balanced nutrient profile. Organic nutrients are particularly beneficial for enhancing the growth of oil palm seedlings, contributing to both their quality and quantity while also mitigating environmental pollution and improving soil media quality (Ginting et al., 2017). Topsoil is preferred due to its loose structure, which contains pore spaces filled with water and air, thereby facilitating efficient nutrient absorption. The appropriate texture and structural conditions are vital for the success of agricultural practices, aligning with the soil structure preferred by the plants.(Fadhillah & Harahap, 2020)

The utilization of waste products generated by palm oil processing factories (PKS) can enhance the quality of oil palm seeds. These include byproducts such as empty fruit bunch ash, empty oil palm bunches (TKS), solids, and others. The solid waste in question is derived from the by-products of the processing of fresh fruit bunches (TBS) in palm oil factories, which are transformed into crude palm oil (CPO).

The application of this substance to oil palm plants has been demonstrated to enhance the physical, chemical, and biological characteristics of the plants while simultaneously reducing the reliance on inorganic fertilizers (Pahan, 2006). The nutrient composition of the decanter solid was determined through analysis of samples at the Palm Oil Research Center Laboratory in North Sumatra. The results indicated the presence of nitrogen (N) at 0.472%, phosphorus (P) at 0.046%, potassium oxide (K2O) at 0.304%, and magnesium (Mg) at 0.070% (Ginting et al., 2017).

2. MATERIAL AND METHODS

2.1 Research time and location

The research was conducted in the Greenhouse of Indonesian Palm Technology Institute (ITSI) Medan, North Sumatra (DD 3.615949, 98.711815). The research was conducted from February to April 2024.

2.2 Research Design

The research was conducted using the Factorial Randomized Group Design (RAK) method; the first factor is S (Planting Media) has 3 levels, namely Top Soil without solid, Top Soil with 20% Solid, and Top Soil with 40% Solid and the second factor is Growth Regulators has 3 levels, namely without growth regulators, a concentration of 100 Mg / l, and a concentration of 200 Mg / l. So this research has 9 treatment combinations with 4 replicates. So this study has 9 treatment combinations with 4 replicates.

2.3 Research Stages

2.3.1 Land preparation

Land preparation is done by clearing the land from weeds and ensuring that the land is flat so that the position of the polybag is not tilted.

2.3.2 Preparation of planting media

The prepared soil is mixed with solids with a predetermined composition, namely the control composition, 20%, and 40%.

2.3.3 Preparation of cuttings

The cuttings are taken from old stems. Old stems are chosen because old stems produce more roots than the middle and young stems

2.3.4 Preparation of plant growth regulators

Making a plant growth regulator solution (Root Up) by weighing 100 and 200 mg then dissolving 1 liter of water each to form a concentration of 100 Mg / l and 200 Mg / l.

2.3.5 Planting cuttings

The prepared cuttings are soaked using a ZPT solution for 1 hour by inserting the base. The prepared planting media is perforated to a depth of about 5 cm. Each polybag is labeled according to the experimental treatment, and the cuttings are made by immersing 1 bud eye.

2.3.6 Maintenance

Maintenance is done by watering the plants twice a day in the afternoon and morning, and weeding is done manually.

2.4 Research Parameter

2.4.1 Shoot height (cm)

The height of the shoots is measured from the base of the shoot to the tip of the shoot. The shoots measured are the highest. Measurements are carried out once a week at the age of 2 MST to 8 MST.

2.4.2 Number of shoots

The shoots that grow in total are counted, and the calculation is carried out once a week at the age of 2 MST to 8 MST.

2.4.3 Number of leaves

The leaves counted are perfectly open leaves. Observations are carried out once a week at the age of 2 MST to 8 MST.

2.4.4 Number of roots (cm)

The roots counted are primary roots or adventitious roots that have already developed root fibers. Measurements are carried out at the end of the study at the age of 8 MST.

2.4.5 Root Wet Weight (gr)

The roots are weighed at the end of the study at the age of 8 MST. The roots are separated from the stem of the cutting by cutting the roots from the base of the cutting. Then, weigh with an analytical scale.

2.5 Flow chart

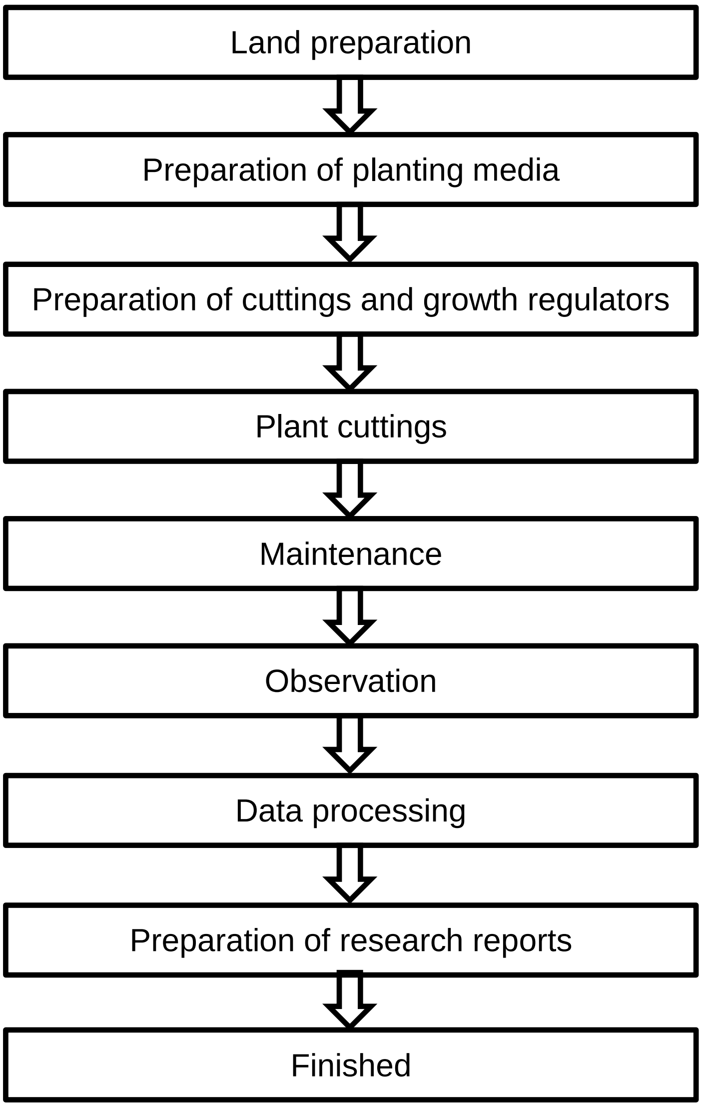

Figure 1. Research Flow Diagram

3. RESULT AND DISCUSSION

3.1 Results of Solid Nutrient Analysis

Analysis of solid nutrient levels was carried out at PT NUSA PUSAKA KENCANA ANALYTICAL & LABORATORY, which is located in the bahilang plantation of PT ASIAN AGRI, Tebing Tinggi City, North Sumatra Province. The analysis was conducted on July 24, 2024. The results of the analysis can be seen in the picture below.

Table 1. Results of Solid Nutrient Analysis

No	Parameter	Yield	Method
1	N	1.51 %	Kjeldahl
2	P	0.21%	Spectrophotometry
3	K	0.30%	Spectrophotometry
4	Mg	0.20%	AAS

The nutrients analyzed are Nitrogen (N), phosphorus (P), potassium (K), and magnesium (Mg). From the results of the analysis conducted, it was found that the levels of nitrogen nutrients analyzed by the Kjeldahl method were

1.51%, phosphorus nutrients analyzed by the Spectophotometry method were 0.21%, potassium nutrients analyzed by the Flamephotometry method were 0.30%, and magnesium nutrients analyzed by the AAS method were 0.20%.

3.2 Shoot Height

Table 2. Shoot Height

Treatment	Average Shoot Height (cm)						
	2 MST	**3 MST**	**4 MST**	**5 MST**	**6 MST**	**7 MST**	**8 MST**
S0R0	2.23	5.25	7.98	9.40	10.38	13.70	22.43
S0R1	2.30	5.50	8.68	10.65	12.45	18.60	24.35
S0R2	2.38	5.73	9.10	12.38	14.40	23.95	29.18
S1R0	2.33	5.03	7.95	10.53	11.65	17.65	22.40
S1R1	2.23	5.13	9.40	11.05	13.83	21.43	28.75
S1R2	2.23	5.70	8.95	12.13	17.13	24.50	34.23
S2R0	2.25	5.35	8.85	11.05	14.63	20.98	27.05
S2R1	2.30	5.73	9.53	12.53	15.70	24.60	30.93
S2R2	2.33	6.18	9.63	12.98	16.70	28.85	37.85
Planting Media							
S0	2.30	5.49	8.58 a	10.81 a	12.41 a	18.75 a	25.32 a
S1	2.26	5.28	8.76 b	11.23 a	14.20 b	21.19 ab	28.46 ab
S2	2.29	5.75	9.33 b	12.18 b	15.68 b	24.81 b	31.94 b
Analysis of variance	tn	tn	*	*	*	**	**
Plant Growth Regulators							
R0	2.72	6.25	9.91	12.39	14.66 a	20.93a	28.75 a
R1	2.73	6.54	11.04	13.69	16.79 b	25.85 b	33.61 ab
R2	2.77	7.04	11.07	14.99	19.29 b	30.92 c	40.50 b
Analysis of variance	tn	tn	tn	tn	*	*	*

Based on the table above, at the age of 8 weeks after planting, the S2R2 treatment, namely the composition of 40% solid planting media with the use of 200 Mg/l growth regulator, produced the highest average shoot height of 37.85 cm.

It can be concluded that the highest average is produced from the composition of planting media, which is 40% solid. This is thought to be because the availability of nutrients that plants can absorb is one of the essential factors affecting plant growth, which contributes to an increase in cell size, according to Fadhillah and Harahap (2020). The solid waste used has been decomposed, and the macro and micronutrients contained in solid waste are available to plants (Ginting et al., 2017). Organic matter can bind nutrients and keep these nutrients from leaching so that nutrients remain available in the soil. The availability of nutrients significantly affects the photosynthesis process; the more nutrients there are, the better the photosynthesis results are. The results of photosynthesis are more often used for vertical growth, such as the development of new shoots, rather than enlarging the stem. This happens because plants tend to have more active growth in vertical parts, such as at the ends of their shoots (Haryadi D. et al. 2015)

The concentration of plant growth regulators of 200 Mg/l produced the highest average shoot height, and this is thought to be caused by the addition of the right concentration of auxin, which can affect the balance of hormones in cuttings, which can accelerate shoot length (Silaban et al., 2023). Therefore, the dose of plant growth regulators with a concentration of 200 Mg/l produced the highest average. According to Watu et al. (2017), the administration of NAA compounds, which are synthetic ZPTs, is able to regulate various growth processes and cell elongation so that water availability increases.

3.3 Numbers of Shoot

Table 3. Numbers of Shoot

Treatment	Average Numbers of Shoot						
	2 MST	**3 MST**	**4 MST**	**5 MST**	**6 MST**	**7 MST**	**8 MST**
S0R0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S0R1	1.25	1.25	1.25	1.25	1.25	1.25	1.25
S0R2	1.00	1.00	1.00	1.00	1.00	1.25	1.25
S1R0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S1R1	1.00	1.00	1.00	1.00	1.25	1.25	1.25
S1R2	1.00	1.00	1.25	1.25	1.25	1.25	1.25
S2R0	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S2R1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
S2R2	1.25	1.25	1.25	1.50	1.50	1.50	1.50
Planting Media							
S0	1.08	1.08	1.08	1.08	1.08	1.17	1.17
S1	1.00	1.00	1.08	1.08	1.17	1.17	1.17
S2	1.08	1.08	1.08	1.17	1.17	1.17	1.17
Analysis of variance	tn	tn	tn	tn	tn	tn	tn
ZPT							
R0	1.20	1.20	1.20	1.20	1.20	1.20	1.20
R1	1.30	1.30	1.30	1.30	1.40	1.40	1.40
R2	1.30	1.30	1.40	1.50	1.50	1.60	1.60
Analysis of variance	tn	tn	tn	tn	tn	tn	tn

The observations conducted revealed that there was no significant difference in the average number of shoots between the various compositions of the planting medium and the concentrations of plant growth regulators (PGRs) at 2 to 8 weeks after planting (WAP). Notably, the S2R2 treatment yielded the highest average of 1.5 shoots, while the lowest average of 1 shoot was recorded in four treatments: S0R0. S1R0. S2R0. and S2R1. The average number of buds across the different compositions of the planting medium was consistent at 1.17 buds.

Throughout the observation period, there was no increase in the number of shoots, indicating that the shot count remained stable from 2 to 8 WAP. This stagnation is likely attributed to the single application of PGRs during the soaking of the cuttings, which may not have sufficiently stimulated the physiological and metabolic processes necessary for new shoot development. Furthermore, the application of 1 ml/L of atonik ZPT appears inadequate for promoting shoot formation, as the administration was limited to a single instance during the soaking process (Riyanto et al., 2022). According to Riyanto et al. (2022), PGRs function as biocatalysts that enhance the synthesis of various compounds within plant cells and improve the plant's ability to utilize available resources for the development of new organs. The primary objective of utilizing PGRs is to expedite shoot growth.

The composition of planting media with regard to the number of buds has been found to exert no significant effect. This is presumed to be due to the fact that the solid waste utilized has undergone decomposition, thereby rendering the macro- and micronutrients present therein available to plants. The results of nutrient absorption will be processed in photosynthesis. However, the results of photosynthesis are more utilized for vertical growth, such as shoot length, than for the formation of new shoots, as the active growth of a plant is predominantly observed in vertical growth, such as in the shoots (Sarman et al., 2021).

3.4 Numbers of leaf

Table 4. Numbers of leaf

Treatment	Average Numbers of the leaf (strands)						
	2 MST	**3 MST**	**4 MST**	**5 MST**	**6 MST**	**7 MST**	**8 MST**
S0R0	1.75	3.25	4.25	4.75	6.00	8.50	11.00
S0R1	1.50	4.75	5.00	5.50	6.25	9.75	12.50
S0R2	1.25	4.25	5.25	6.00	7.75	9.75	14.25
S1R0	1.75	4.25	5.25	6.00	6.25	8.75	11.25
S1R1	1.75	3.50	4.5	5.75	6.75	8.75	12.25
S1R2	1.50	3.50	5.75	6.50	8.25	12.25	16.50
S2R0	1.75	3.25	4.75	6.00	7.00	10.00	14.25
S2R1	1.75	3.50	4.25	6.50	8.00	11.75	14.25
S2R2	2.00	4.75	6.25	7.50	9.50	13.75	20.50
Planting Media							
S0	1.50	4.08	4.83	5.42	6.67	6.67	9.33 a
S1	1.67	3.75	5.17	6.08	7.08	7.08	9.92 a
S2	1.83	3.83	5.08	6.67	8.17	8.17	11.83 b
Analysis of variance	tn	tn	tn	tn	tn	tn	*
ZPT							
R0	2.10	4.30	5.70	6.70	7.7 a	10.9 a	14.6 a
R1	2.00	4.70	5.50	7.10	8.4 ab	12.1 ab	15.6 ab
R2	1.90	5.00	6.90	8.00	10.2 b	14.3 b	20.5 b
Analysis of variance	tn	tn	tn	tn	*	*	**

The results showed that the composition of planting media at week eight had the highest average, namely, at 40%, composition had an average of 11.83 leaves; at 20%, the composition had an average of 9.92 and at the composition without solid had an average of 9.33 leaves. This shows that the 40% solid composition has the highest average number than the other two treatments. In the concentration of growth regulators in week 7, it has a significant difference and has the highest average at a concentration of 200 Mg / l with an average number of leaves of 14.3, which is greater than the other 2 treatments, namely, a concentration of 100 Mg / l has an average number of 12.1 and in the treatment without growth regulators has an average of 10.9. At week 8, the concentration treatment of growth regulators had a very significant difference with the best treatment at a concentration of 200 Mg / l with an average of 20.5 leaves, while the concentration of 100 Mg / l was 15.6 and in the treatment without growth regulators had an average of 14.6.

Based on the information presented in the table, as mentioned earlier, it can be inferred that the treatment employing a 40% solid combination exhibits the greatest mean value. It is believed that the primary factor influencing leaf growth and development is nitrogen, as it is the most influential nutrient in this process. According to Lingga and Marsono (2006), nitrogen significantly enhances overall plant growth, particularly in the development of stems and leaves. Furthermore, the presence of the P element in both decanter solids and TSP fertilizer has an impact on the growth of leaves. As per Nurjaya et al. According to a study conducted in 2009, phosphorus plays a crucial role in the growth of plants, particularly in the formation and growth of leaves.

The optimal treatment for growth regulator concentration is determined to be 200 Mg/l as it has been shown to increase auxin levels in plants, leading to the differentiation of plant cells and organs. The utilization of growth regulators on plants has also been demonstrated to enhance the quantity of foliage (Permatasari *et al.*, 2020).

3.5 Numbers of Root

Table 5. Numbers of Root

Treatment	Average Numbers of Root
S0R0	28.25
S0R1	25.00
S0R2	34.75
S1R0	28.00
S1R1	32.75
S1R2	36.50
S2R0	31.75
S2R1	37.75
S2R2	40.50
Planting Media	
S0	29.33 a
S1	32.42 a
S2	36.67 b
Analysis of variance	*
ZPT	
R0	35.20 a
R1	38.20 ab
R2	44.70 b
Analysis of variance	**

The findings from the eighth week's observations regarding the measurement of root quantity. The evidence suggests that the composition of the planting media has an impactful influence on the quantity of roots. It is believed that solid waste contains nutrients that can enhance the physical, chemical, and biological characteristics of soil, thereby promoting optimal root growth and development (Sutrisno et al., 2021). This enables an increase in the number of roots in the planting media composition by 40%. As indicated by Sutrisno and colleagues. In the year 2021. it was found that nutrients such as nitrogen, phosphorus, and potassium can promote the growth and maturation of plant roots, facilitating an expanded capacity for nutrient uptake and an increase in root volume.

Within the parameter of plant growth regulator concentration, it was observed that a concentration of 200 Mg/l resulted in the highest average and showed a statistically significant difference compared to the other two treatments. It is believed that the capacity of cuttings to develop roots is influenced by plant growth regulators, particularly auxin, and the formation of callus at the lower portion of the cuttings. During the process of root initiation, plants necessitate a supply of energy in the shape of glucose, nitrogen, and other compounds that are adequate for promoting accelerated root growth (Riyanto et al., 2022). Clipping specimens with elevated levels of carbohydrates will exhibit enhanced ease of root formation compared to those with lower carbohydrate levels. (Riyanto *et al*., 2022).

3.6 Root Wet Weight

Table 6. Root Wet Weight

Treatment	Average Root Wet Weight (g)
S0R0	0.98
S0R1	1.15
S0R2	1.35
S1R0	1.41
S1R1	1.74
S1R2	1.61
S2R0	1.08
S2R1	1.83
S2R2	1.94
Planting Media	
S0	1.16 a
S1	1.59 b
S2	1.62 b
Analysis of variance	*
Plant Growth Regulators	
R0	1.39 a
R1	1.88 b
R2	1.96 b
Analysis of variance	*

In the table above, it can be seen that there is a significant difference in the treatment of the composition of the planting media, as well as the treatment of the concentration of growth regulators that has a significant difference. It can be concluded that the composition of the planting media has a significant effect on the wet weight of the roots. This is thought to be due to the plant's ability to absorb nutrients very well. According to (Sarman et al., 2021), the root system is not only by the genetics of the seeds but also the condition of the soil or plant growing media; the wet weight of the plant is a reflection of the plant's ability to absorb the existing nutrients. If the plant's ability to absorb nutrients is higher, then the physiological processes that occur in the plant, especially the translocation of nutrients and photosynthesis results, will run well so that the plant organs can function correctly. According to the Palm Oil Research Center, Solid waste acts as organic material that provides nutrients that stimulate microorganism activity, improve soil structure, and increase aeration and soil moisture. In the treatment of ZPT, concentration significantly affects the wet root weight parameter. Pakpahan (2020) stated that the administration of ZPT gave the best results on root weight.

Figure 2. Root yield in several treatments

4. CONCLUSION

1. The treatment of growth regulator concentration (R) significantly affected the height of shoots and fresh weight of roots and was very significantly different from the parameters of the number of leaves and the number of roots. The best concentration of growth regulators was 200 Mg/l.
2. The treatment of the composition of the planting medium (S) significantly affected the number of leaves, the number of roots, and the fresh weight of roots, and it was very significantly different from the height of shoots. The best composition of the planting medium was 40% solid.
3. There was no interaction between the treatment of the composition of the planting medium (S) and the concentration of growth regulators (R) on the growth of *Antigonon leptopus* stem cuttings.

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